Jasp-Agate

Resembles both Dendritic Agate and Moss Agate in the chalcedonic matter enveloping a pre-existent structure, which acts as a core to pseudo-stalactites. This structure in Jasp-Agate is, however, much larger in amount, and as it consists of Jasper, it has its variegated colours.

Sutherland. About one and a half miles south of Cape Wrath, near an outlier of Torridon Conglomerate, in small veins in the Hebridean Gneiss, in close association with Actinolite, Ripidolite and Potstone. The filamentous net-work is here brown.

Ayrshire. At Lagg Quarry, Fisherton, Ayr. The mossy or stalactitic structure is yellow or brown, it is surrounded by purple Chalcedony, which is zoned by layers of pale lavender (Blackwood). On both banks of Burn Anne, about one and a half mile from Galston, in veins which are segmented by Calcitic partings into brick-shaped masses. The chalcedonic matter rarely is arranged conformably to the sides of such forms, but much more generally is disposed in sheathing layers around pendulous "stalactites" of Jasper. The Chalcedony is, for the most part, of its usual blue-grey colour, but occasionally it is sprinkled with yellow or red spots, and rarely it is bright red. The included Jasper is of yellow, brown, green, red, and scarlet tints; frequently in clouded mixtures of these, and the tints are for the most part vivid. The commonest variety, which is a mottled mixture of brown, yellow, and a little red, is termed the "Partridge." The most select variety is one in which the earliest investing sheath of violet Chalcedony contains suspended spheres of red, white, or yellow colour. These spheres have a minute opaque Cacholong centre, a surrounding mass of radiating Chalcedony, and a peripheral layer of a milky tint. A still more inexplicable structure is one which resembles fragmented desmids enveloped in alternating layers of Cacholong and Chalcedony. Occasionally a true agate structure of the fortification type occupies such portions of the stone as contain less of the Jasper. The specimens are altogether unrivalled in beauty.

Haddingtonshire. At Thorntonloch, near Dunglass (Greg), probably from a breccia overlying the Silurian greywacke, and inferior to the lowest sandstone of the Old Red.

Flint.

Sutherlandshire. At Stronchrubie and elsewhere in the Cambrian dolomite [Durness Limestone] in large masses, of grey to red colour, and of a cherty appearance. Elginshire: at Duffus, with Chalcedony and Galena, in limestone. Aberdeenshire: at † Moreseat near Ellon, loose [Chalk Flint].

HORNSTONE.

Fracture subconchoidal to splintery; lustre greasy to horny.

Hebrides: Rum, at Sgurr Mor, brown, blackish-green, and lavender, banded with Prase. Eigg, in the Scuir, with Chalcedony and Heliotrope. Inverness-shire: on the summit of Braeriach, banded brown. Aberdeenshire: on the Ladder road and west side of the summit of Mount Keen, purple. Strath Dee, on the right of the road, near its turn to Glen Tilt, in beds, greenish-grey. Perthshire: south-west of Ben Vuroch, Blair Athole, earthy, banded brown and grey. Fifeshire: west side of Largo Law, banded green and wax-grey (Howie). Haddington: at Dunbar. Garleton Hills, with Chalcedony, Quartz, and Jasper. At Pencraik, near Traprain Law, in claystone, with porphyritic slate. At the summit of Lucklaw, passing into felspar. Midlothian: Blackford Hill, brown—Anal. 1. Pentland Hills, with claystone. Linlithgowshire: in an opening near the old quarry of Kirkton, in imbedded masses in limestone of Yoredale age. Lanarkshire: Tinto, in the Kirk Burn, Petrosilex, approaching to Hornstone, with imbedded crystals of Hornblende. Kirkcudbrightshire: at Barlocco Cave, brecciated (Dudgeon).

	Sp.gr.	SiO_2	Al_2O_3	FeO	Fe_2O_3	MnO	CaO	MgO	K_2O	Na_2O	H_2O	Total.
1. Chalcedonic Hornstone of Blackford Hill, .	2·598	89·692	·974	1·373	...	tr.	2·283	...	·54	2·271	2·773	99·906
2. Green Chert, Strontian,	2·632	89·692	·769	1·671	...	·076	2·843	...	·44	2·18	2·005	99·676
3. Cambrian Chert, Smoo,	2·641	97·769	...	...	1·538	·076	·301	·153	...	...	·207	100·044
4. Lydian Stone, Kinkell,	2·598	61·2	17·536	5·446	3·163	·9	3·136	2·7	...	...	5·889	99·970

CHERT.

Impalpable granular; fracture flat, angular, splintery; lustre glistening. Sutherland: Smoo, snow-white, in a thick bed in Cambrian dolomite, on the west side of the Geo—Anal. 3. Inverness-shire: top of Braeriach, banded yellow and brown. Banffshire: Cairngorm, greenish-yellow. Aberdeenshire: Hill of Fare, rarely, in veins in granite, red. Cabrach, Redford, green, pseudomorphous after Calcite. Argyllshire: Strontian, Fee Donald, grass green, with Galena—Anal. 2. Lanarkshire: Camilty Hill, near Harburn Station, blue-green. Renfrewshire: Cathkin Hills, Carmunnock quarry, in green, fragmented, layers, with Saponite, Calcite, and Zeolitic Quartz (Skipskey). Roxburghshire: near Hadden, in translucent red veins, with an agate vein in limestone. At Bedrule.

THE
MINERALOGY OF SCOTLAND

Printed by Neill and Company, Limited, Edinburgh

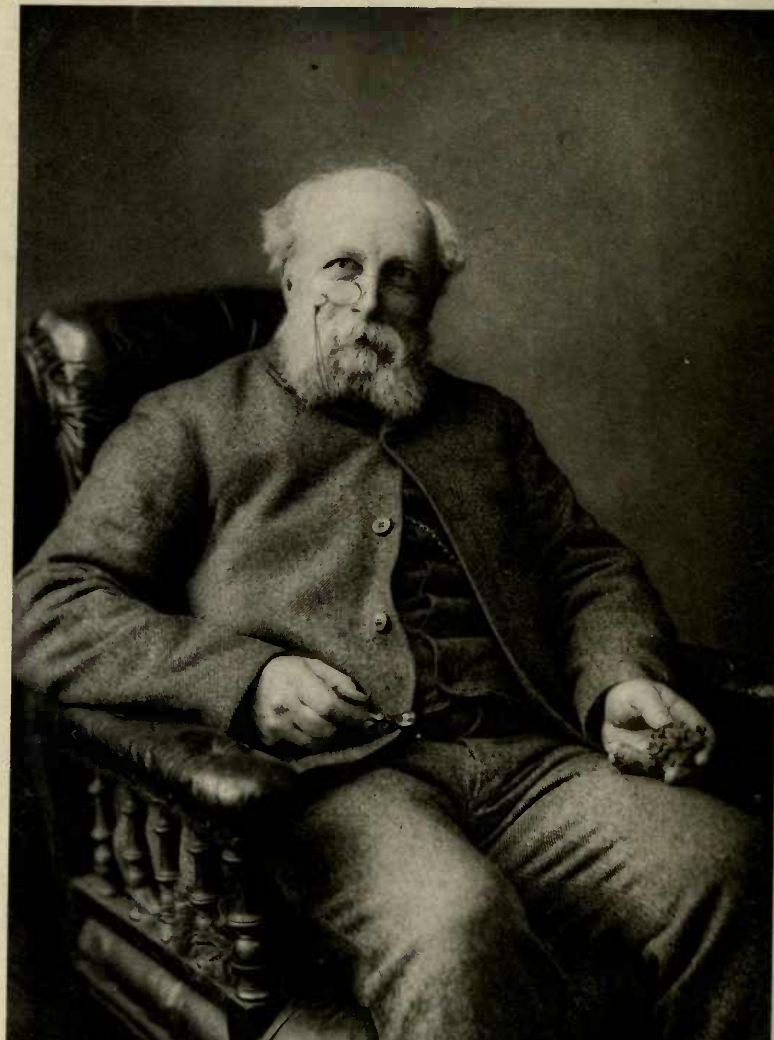
FOR

DAVID DOUGLAS

LONDON . . . SIMPKIN, MARSHALL, HAMILTON, KENT, AND CO., LIM.

CAMBRIDGE . . MACMILLAN AND BOWES.

GLASGOW . . . JAMES MACLEHOSE AND SONS.



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THE
MINERALOGY OF SCOTLAND

BY THE LATE

M. FORSTER HEDDLE, M.D., F.R.S.E.

EMERITUS PROFESSOR OF CHEMISTRY, ST ANDREWS

EDITED BY

J. G. GOODCHILD

H.M. GEOLOGICAL SURVEY, F.G.S.

VOL. I.

EDINBURGH
DAVID DOUGLAS, 10 CASTLE STREET
1901

To

CLEMENTINA C. S. THOMS (NÉE HEDDLE),

OLDEST AND LOVED DAUGHTER OF THE AUTHOR,
WHO, ON THE DEATH OF HER MOTHER, ASSUMED THE CHARGE OF HER FATHER'S HOUSE,
ACTING A MOTHER'S PART TO HER BROTHERS AND SISTERS
WITH LARGE-HEARTED GENEROSITY AND UNSELFISH LOVE, AND
DEVOTED HERSELF TO HER FATHER
UP TO AND ALL THROUGH HIS LONG AND LAST PAINFUL ILLNESS
WITH A TENDER LOVING CARE WHICH NEVER FLAGGED,

This Work of her Father's is Dedicated by

HER AFFECTIONATE HUSBAND.

PREFACE

It is now well on to fifty years since the author of the present work began to turn his attention to Mineralogy. During the time that has since elapsed he collected an exceptionally large number of specimens from almost every known mineral locality in Scotland, and made several hundred analyses. In addition, he drew a large number of figures, and published various papers containing the results of his investigations upon both the Geognosy and the Mineralogy of his native land. The present work may be regarded as the outcome of all this labour. Dr Heddle had been engaged in the preparation of *The Mineralogy of Scotland* for so many years that his friends had begun to despair of ever seeing it published, but when his health finally gave way and he foresaw that he could no longer hope to see the book completed in his own lifetime, he made over the manuscript and the figures of crystals to Mr Thoms, expressing the wish, as he did so, that he should get the book published.

In the case of a posthumous work to be completed and published under these circumstances, it was but natural that the family of the author should regard it as a point of the first importance that the book should appear as nearly as possible in the form in which it is believed the author would have completed it himself. Accordingly, as few alterations as possible have been made, and but little additional matter has been appended, except what appeared to be necessary for the full understanding of the author's meaning. The unfinished sections have been completed as much as possible from material left by the author; and in each case where any doubt arose with regard to the author's latest views, we have been guided by the information afforded by the Scottish Mineral Collection in the Edinburgh Museum of Science and Art, which was arranged under the author's own supervision, with the assistance of the Editor.

All additional matter supplied by the Editor is enclosed within square brackets.

A comparatively small number of the figures of crystals which have been engraved were left in the condition of first sketches. The majority of these have been carefully projected, in accordance with Dr Heddle's views, by Mr Wilbert Goodchild.

As Dr Heddle's labours extended over so many years, it has happened that he did not employ any particular crystallographic notation consistently throughout the work. It does not seem to have occurred to him that he might not finish the book himself, and it was, possibly, for that reason, that he left no clue to either the meaning of his symbols or the sources whence his figures of crystals were taken. As far as possible these defects have been made good; and Dr Heddle's symbols are now given with what are believed to be their indexes, which are accompanied by the symbols employed by Dana (6th Edition, *System of Mineralogy*), in each case where these differ from those employed by the author.

The author died before making the final selection of the illustrations, and it has therefore been deemed advisable to have these all engraved, just as they left his hands, even though some of them appear to have been taken from other sources.

As regards the Scottish Mineral Localities, it is important to remember that much of Dr Heddle's collecting was done before there were many railways in Scotland, and also before the Ordnance Survey maps appeared. As a consequence, there existed much diversity in the spelling of many place-names, and furthermore, many such of great importance as mineral localities never found their way on to even the best maps. Dr Heddle was, therefore, often led to adopt a phonetic spelling for the names of some of these. These, and other reasons, have made the task of identifying the exact localities whence the minerals were obtained one of considerable difficulty. A large number of correspondents in all parts of Scotland, as well as the officers of the Geological Survey, have aided in lessening this difficulty. The chief helper, however, in this as well as in other matters connected with the revision of the proof sheets, has been Mr James Currie, who has gone over much of the ground, especially on the west coast of Scotland, from which Dr Heddle collected, and whose extensive knowledge of Scottish minerals and their localities has been placed unreservedly at our disposal. Fortunately Dr Heddle traced the course of his annual wanderings upon a set of the Ordnance Survey maps of Scotland, which maps were bequeathed to the Scottish Mountaineering Club.

The Editor of the present work has also marked all the known localities of Scottish minerals upon a set of the Ordnance maps, from data got from the pages of this book, and from numerous other sources. These maps are kept for public reference at the Edinburgh Museum of Science and Art.

In an Appendix references are given to information which has been acquired since the manuscript went to the printers. The Editor has drawn some maps from data which are chiefly taken from the 6th Edition of Dana's *System.* The methods of construction of these maps is fully described by the Editor in a paper published in the *Proc. Roy. Phys. Soc. Edin.* for 1900. He has also drawn up a full Index to Localities, and has added other indexes which the reader may find useful. Mr Thoms has compiled the County List.

Messrs Macfarlane & Erskine's engravings speak for themselves, and it is certain that mineralogists will be grateful to Mr Wood for the care and skill he has bestowed upon the reproduction of Dr Heddle's delicate and artistic drawings of crystals.

EDINBURGH, 30*th January* 1901.

MEMOIR OF DR HEDDLE

By Alexander Thoms.

Matthew Forster Heddle, the second son of the late Robert Heddle, Esquire, of Melsetter, in Hoy, Orkney, was born there in the year 1828.

When the question of his education had to be considered, he was sent for that purpose to Edinburgh, the Edinburgh Academy and Merchiston both having had him as a pupil at different times. During the latter part of that period he was boarded with John Brown (Author of *Rab and his Friends*), of whom he always spoke with kindly feelings.

He afterwards attended the Edinburgh University, where in 1851 he graduated as M.D., and subsequently for a short time he practised as a Doctor in that City.

Chemistry and Botany, however, greatly interested him, and he took to these with the energy and enthusiasm that was a characteristic of the man.

Before long, however, he lent his Herbarium to a friend for a special purpose, but an accident occurred whereby this was utterly ruined. Thinking over his loss, he determined to relinquish Botany as a special study, and to devote himself to Geology and Mineralogy, which determination he never afterwards regretted.

In 1856 Professor Connel, Professor of Chemistry in the University of St Andrews, being unable from bad health to continue lecturing, Dr Heddle was appointed his Assistant, on the understanding that he was to succeed to the Chair, which he eventually did in 1862, holding the Chair until 1880, when he resigned. He was an able and interesting Lecturer and Experimenter, and is still remembered by many of his old students with respect and affection.

The summer holidays gave him the leisure, and year after year he devoted his time and talents to the study in the field of the Geognosy and especially the Mineralogy of Scotland, with occasional trips to other countries.

Dr Heddle's knowledge of Chemistry came to his aid, and enabled him to distinguish many doubtful minerals, and to add very considerably to the number known.

Of great physical strength and power of endurance, few parts of Scotland and its adjacent Islands, whether mountain-tops, valleys, railway cuttings, or mines, where there was any chance of finding rocks or minerals, were unvisited and unexplored by him. With hammers up to 28 lbs. weight, blasting powder, or dynamite, and wedges, he made the rocks give up their hidden treasures, while, on his return to St Andrews, the Chemical Laboratory, Microscope, Polariscope and Goniometer revealed many a secret.

For some years Dr Heddle's attention was more particularly directed to Sutherland and the Shetland Islands, and his published geological maps of these speak for themselves, having been adopted, with only a few changes, by the Authorities of the Geological Survey.

In 1858 he revised and practically edited Greg and Lettsom's *Mineralogy of Great Britain and Ireland*, making many original additions thereto. He also wrote the article "Mineralogy" for the last edition of the *Encyclopædia Britannica*.

Dr Heddle contributed a number of papers in connection with the rocks and minerals of Scotland, his "Chapters on the Mineralogy of Scotland," printed in the *Transactions of the Royal Society of Edinburgh*, and "Geognosy of Scotland," printed in the *Mineralogical Magazine* of the Mineralogical Society of Great Britain and Ireland, being the larger. An active member of the Scottish Mountaineering Club, few of the mountain peaks in Scotland of any pretensions but have been climbed by him at one time or other, and some weird but highly interesting stories of the Brocken, and kindred phenomena, seen by him on a few of these expeditions, when overtaken by mists and states of the atmosphere favourable to such, were related by him, either in the shape of Lectures to Societies or in private conversation. At an early period, however, he conceived the idea of bringing out a book on *The Mineralogy of Scotland*, and among all the other work he undertook, he gradually but steadily added to the material for this, in the shape of drawings of forms of crystals, analyses, localities, etc.

The slitting of Agates, Rocks and Minerals, for specimens and microscopic slides, which he did actually by thousands, amid all his other work, was little less than marvellous.

Dr Heddle gradually got together himself a collection of Scotch minerals (irrespective of a large and valuable general collection), now in the Museum of Science and Art, Edinburgh, which is generally admitted by experts to be the finest collection ever got together of any one country's minerals.

Besides the above, Dr Heddle made the subject of the formation of Agates a special study, and left a separate collection of these—quite unique—showing the various phases, peculiarities, and varieties that occur. This collection has now been placed in the Museum of Science and Art alongside of his Scotch collection.

Dr Heddle was a F.R.S.E., and in 1851 was appointed President of the Geological Society of Edinburgh, and in January 1884 this Society appointed him as their first Associate.

In February 1876 the Mineralogical Society of Great Britain and Ireland elected him as Vice-President, while in 1879 he was elected President. He was also a recipient of the Keith Gold Medal for his researches upon the Rhombohedral Carbonates and on the Feldspars, an honour he valued highly.

Although a specialist in Mineralogy, Dr Heddle's sympathies and researches were not by any means confined to this subject, and embraced not only cognate sciences, such as Chemistry and Geology, but extended to other branches of science.

Dr Heddle was a man of very high and honourable principles, to whom anything mean or dishonourable was abhorrent, and it may safely be said of him, that among all the large mass of original work he did, he never appropriated the discoveries or work of others, while he never shirked stating his convictions, however antagonistic they might be to what had previously been generally accepted.

Somewhat quick of temper, he was devoid of malice, and was of a genial, kindly and generous disposition, while those who knew him best, knew best his finer qualities and esteemed him most.

ST ANDREWS, 30*th January* 1901.

CONTENTS OF VOLUME I.

CLASS III. SULPHO-SALTS.

CLASS IV. HALOIDS.

CLASS V.—OXIDES.

CLASS VI. OXYGEN SALTS.

LIST OF ILLUSTRATIONS TO VOLUME I.

MAPS IN TEXT

PLATES AT END OF VOLUME.

SYSTEMATIC LIST OF MINERALS

(Those occurring in Scotland being marked with an asterisk)

By J. G. Goodchild.

?*1. Diamond.
*2. Graphite.
*3. Sulphur.
4. Selensulphur.
5. Selenium.
6. Selen-Tellurium.
7. Tellurium.
*8. Arsenic.
9. Allemontite.
10. Antimony.
11. Bismuth.
12. Zinc.
*13. Gold.
*14. Silver.
*15. Copper.
16. Mercury.
17. Amalgam.
?*18. Lead.
19. Tin.
20. Platinum.
21. Iridium.
22. Iridosmine.
23. Palladium.
24. Allopalladium.
*25. Iron.
26. Realgar.
27. Orpiment.
*28. Stibnite.
29. Bismuthinite.
30. Guanajuatite.
31. Tetradymite.
32. Joseëite.
33. Wehrlite.
*34. Molybdenite.
35. Dyscrasite.
36. Horsfordite.
37. Domeykite.
38. Algodonite.
39. Whitneyite.
40. Chilenite.
41. Stützite.
*42. Argentite.
43. Hessite.
44. Petzite.
*45. Galena.
46. Altaite.
47. Clausthalite.
48. Naumannite.
49. Berzelianite.
50. Lehrbachite.
51. Eucairite.
52. Zorgite.
53. Crookesite.
*54. Chalcocite.
55. Stromeyerite.
56. Sternbergite.
57. Acanthite.
*58. Sphalerite.
59. Metacinnabarite.
60. Tiemannite.
61. Onofrite.
62. Coloradoite.
63. Alabandite.
64. Oldhamite.
*65. Pentlandite.
66. Cinnabar.
67. Covellite.
*68. Greenockite.
69. Wurtzite.
*70. Millerite.
*71. Niccolite.
72. Breithauptite.
73. Troilite.
*74. Pyrrhotite.
75. Polydymite.
76. Beyrichite.
77. Melonite.
*78. Bornite.
79. Linnæite.
80. Daubreelite.
81. Cubanite.
82. Carrollite.
*83. Chalcopyrites.
84. Stannite.
*85. Pyrites.
86. Hauerite.
87. Smaltite.
88. Chloanthite.
89. Cobaltite.
*90. Gersdorffite.
91. Corynite.
92. Ullmannite.
93. Sperrylite.
94. Laurite.
95. Skutterudite.
*96. Marcasite.
97. Löllingite.
*98. Arsenopyrites.
99. Safflorite.
?*100. Rammelsbergite.
101. Glaucodot.
102. Alloclasite.
103. Wolfachite.
104. Sylvanite.
105. Krennerite.
106. Nagyagite.
*107. Kermesite.
108. Voltzite.
109. Livingstonite.
110. Guejarite.
111. Chiviatite.
112. Cuprobismutite.
113. Rezbanyite.
114. Zinkenite.
115. Sartorite.
116. Emplectite.
117. Chalcostibite.
118. Galenobismutite.
119. Berthierite.
120. Matildite.
121. Miargyrite.
122. Plagionite.
123. Binnite.
124. Klaprotholite.
125. Schirmerite.
126. Warrenite.
127. Dufrenoysite.
128. Cosalite.
129. Schapbachite.
130. Jamesonite.
131. Kobellite.
132. Brongniardite.
133. Semseyite.
134. Diaphorite.
135. Freieslebenite.

*136. Bournonite.
137. Wittichenite.
138. Aikinite.
139. Boulangerite.
140. Lillianite.
141. Stylotypite.
142. Guitermanite.
143. Tapalpite.
144. Pyrargyrite.
145. Proustite.
146. Pyrostilpnite.
147. Rittingerite.
*148. Tetrahedrite.
149. Tennantite.
150. Jordanite.
151. Meneghinite.
152. Geocronite.
153. Stephanite.
154. Kilbrickenite.
155. Beegerite.
156. Polybasite.
157. Polyargyrite.
158. Enargite.
159. Famatinite.
160. Xanthoconite.
161. Epiboulangerite.
162. Epigenite.
163. Argyrodite.
164. Calomel.
165. Nantokite.
*166. Halite.
167. Sylvite.
*168. Sal-ammoniac.
169. Cerargyrite.
170. Embolite.
171. Bromyrite.
172. Iodobromite.
173. Iodyrite.
174. Hydrophilite.
*175. Fluor.
176. Chloromagnesite.
177. Sellaite.
178. Lawrencite.
179. Scacchite.
180. Cotunnite.
181. Molysite.
182. Tysonite.
183. Cryolite.
184. Chiolite.
185. Hieratite.
186. Matlockite.
187. Mendipite.
188. Schwartzembergite.
189. Laurionite.
190. Daviesite.
191. Fiedlerite.
192. Percylite.
?*193. Atacamite.
194. Daubréeite.
195. Nocerite.
196. Fluocerite.
197. Bischofite.
198. Kremersite.
199. Erythrosiderite.
200. Douglasite.
201. Carnallite.
202. Tachhydrite.
203. Fluellite.
204. Prosopite.
205. Pachnolite.
206. Thomsenolite.
207. Gearksutite.
208. Ralstonite.
209. Yttrocerite.
*210. Quartz.
*210A. Quartzine.
*211. Tridymite.
211A. Asmanite.
*212. Opal.
213. Arsenolite.
214. Senarmontite.
215. Claudetite.
*216. Valentinite.
217. Bismite.
218. Tellurite.
?*219. Molybdite.
220. Tungstite.
*221. Cervantite.
222. Stibiconite.
*223. Water.
*224. Cuprite.
225. Periclase.
226. Manganosite.
227. Bunsenite.
228. Zincite.
229. Massicot.
*230. Tenorite.
*231. Corundum.
*232. Hæmatite.
*233. Ilmenite.
*234. Spinel.
235. Hercynite.
236. Gahnite.
*237. Magnetite.
238. Magnesioferrite.
239. Franklinite.
240. Jacobsite.
*241. Chromite.
242. Chrysoberyl.
243. Hausmannite.
?*244. Minium.
245. Crednerite.
246. Pseudobrookite.
247. Braunite.
248. Cassiterite.
249. Polianite.
*250. Rutile.
*251. Plattnerite.
252. Octahedrite.
253. Brookite.
*254. Pyrolusite.
*255. Turgite.
256. Diaspore.
*257. Göthite.
*258. Manganite.
*259. Limonite.
260. Xanthosiderite.
261. Bauxite.
*262. Brucite.
263. Pyrochroite.
264. Gibbsite.
265. Sassolite.
266. Hydrotalcite.
*267. Pyroaurite.
268. Chalcophanite.
*269. Psilomelane.
*270. Calcite.
*271. Dolomite.
*271A. Ankerite.
*272. Magnesite.
*272A. Mesitite.
*273. Siderite.
274. Rhodochrosite.
275. Smithsonite.
276. Sphærocobaltite.
*277. Aragonite.
278. Bromlite.
279. Witherite.
*280. Strontianite.
*281. Cerussite.
282. Barytocalcite.
283. Bismutosphärite.
284. Parisite.
285. Bastnäsite.
?*286. Phosgenite.
287. Teschemacherite.
*288. Malachite.
*289. Azurite.
*290. Aurichalcite.
291. Hydrozincite.
*292. Hydrocerussite.
293. Dawsonite.
294. Thermonatrite.
295. Nesquehonite.
296. Natron.
297. Gay-lussite.
298. Lanthanite.
299. Trona.
*300. Hydromagnesite.
301. Hydrogiobertite.
302. Lansfordite.
*303. Zaratite.
304. Remingtonite.
305. Tengerite.
306. Bismutite.
307. Uranothallite.
308. Liebigite.
309. Voglite.
310. Petalite.
311. Milarite.
312. Eudidymite.
*313. Orthoclase.
314. Hyalophane.
*315. Microcline.
*315A. Anorthoclase.
*316. Albite.
*317. Oligoclase.
*318. Andesine.
*319. Labradorite.
*320. Anorthite.
321. Leucite.
322. Pollucite.
*323. Enstatite.
*324. Hypersthene.
*325. Augite.
*326. Acmite (Aegirite).
*327. Spodumene.
328. Jadeite.

*329. Wollastonite.
*330. Pectolite.
331. Rosenbuschite.
332. Låvenite.
333. Wöhlerite.
334. Hiortdahlite.
?*335. Rhodonite.
*336. Babingtonite.
*337. Anthophyllite.
*338. Amphibole.
339. Glaucophane.
*340. Riebeckite.
*341. Crocidolite.
342. Arfvedsonite.
?*343. Ænigmatite.
*344. Beryl.
345. Eudialyte.
346. Catapleiite.
347. Cappelenite.
348. Melanocerite.
349. Caryocerite.
350. Tritomite.
351. Leucophanite.
352. Meliphanite.
*353. Iolite.
354. Barysilite.
355. Ganomalite.
356. Hyalotekite.
*357. Nepheline.
*358. Eucryptite.
359. Kaliophilite.
360. Cancrinite.
361. Microsommite.
*362. Sodalite.
363. Haüynite.
364. Noselite.
365. Lazurite.
366. Helvite.
367. Danalite.
368. Eulytite.
369. Zunyite.
*370. Garnet.
371. Schorlomite.
372. Partschinite.
373. Agricolite.
374. Monticellite.
*375. Forsterite.
*376. Chrysolite, Olivine.
*377. Fayalite.
378. Knebelite.
379. Tephroite.
379A. Roepperite.
380. Trimerite.
381. Willemite.
382. Phenacite.
383. Dioptase.
384. Friedelite.
385. Pyrosmalite.
386. Meionite.
*387. Wernerite.
388. Mizzonite.
389. Marialite.
390. Sarcolite.
*391. Melilite.
392. Gehlenite.
*393. Vesuvianite.
*394. Zircon.
*395. Thorite.
396. Danburite.
*397. Topaz.
*398. Andalusite.
*399. Sillimanite.
*400. Cyanite.
*401. Datolite.
402. Homilite.
403. Euclase.
?*404. Gadolinite.
405. Yttrialite.
*406. Zoisite.
*407. Epidote.
408. Piedmontite.
*409. Allanite.
?*410. Axinite.
*411. Prehnite.
412. Harstigite.
413. Cuspidine.
414. Humite.
415. Chondrodite.
416. Clinohumite.
417. Ilvaite.
418. Ardennite.
419. Långbanite.
420. Kentrolite.
421. Melanotekite.
422. Bertrandite.
*423. Calamine (Hemimorphite).
424. Carpholite.
425. Cerite.
*426. Tourmaline.
427. Dumortierite.
*428. Staurolite.
429. Kornerupine.
430. Sapphirine.
431. Inesite.
432. Ganophyllite.
*433. Okenite.
*434. Gyrolite.
*435. Apophyllite.
436. Ptilolite.
437. Mordenite.
*438. Heulandite.
*439. Brewsterite.
?*440. Epistilbite.
?*441. Phillipsite.
*442. Harmotome.
*443. Stilbite.
444. Gismondite.
*445. Laumontite.
446. Laubanite.
*447. Chabazite.
*448. Gmelinite.
*449. Levynite.
*450. Analcite.
451. Faujasite.
*452. Edingtonite.
*453. Natrolite.
*454. Scolecite.
*455. Mesolite.
*456. Thomsonite.
457. Hydronephelite.
*458. Muscovite.
459. Paragonite.
460. Lepidolite.
*461. Zinnwaldite.
*462. Biotite.
*462A. Phlogopite.
*462B. Lepidomelane.
*462C. Haughtonite.
463. Roscoelite.
464. Margarite.
465. Seybertite.
465A. Xanthophyllite.
*466. Chloritoid.
*467. Ottrelite.
*468. Clinochlore.
*468A. Penninite.
*469. Prochlorite.
470. Corundophilite.
471. Daphnite.
472. Cronstedtite.
473. Thuringite.
474. Stilpnomelane.
475. Strigovite.
476. Diabantite.
477. Aphrosiderite.
*478. Delessite.
479. Rumpfite.
480. Jefferisite.
*481. Serpentine.
482. Deweylite.
?*483. Genthite.
483A. Garnierite.
*484. Talc.
485. Sepiolite.
486. Connarite.
487. Spadaite.
*488. Saponite.
*489. Celadonite.
*490. Glauconite.
491. Pholidolite.
*492. Kaolinite.
*493. Halloysite.
494. Newtonite.
495. Cimolite.
496. Montmorillonite.
497. Pyrophyllite.
?*498. Allophane.
499. Collyrite.
500. Schrötterite.
501. Cenosite.
502. Thaumasite.
503. Uranophane.
*504. Chrysocolla.
505. Chloropal.
506. Hisingerite.
507. Bementite.
508. Caryopilite.
509. Neotocite.
*510. Titanite (Sphene).
?*511. Keilhauite.
512. Guarinite.
513. Tscheffkinite.
514. Astrophyllite.
515. Johnstrupite.
516. Mosandrite.
517. Rinkite.
518. Perovskite.

ALPHABETICAL LIST OF MINERALS

(Those occurring in Scotland being marked with an asterisk)

By J. G. Goodchild.

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*341. Abriachanite.
447. Acadialite.
57. Acanthite.
819. Achrematite.
426. Achroite.
366. Achtaragdite.
326. Acmite.
*338. Actinolite.
563. Adamite.
458. Adamsite.
N. Adelite.
524. Adelpholite.
447. Adipite.
*313. Adularia.
445. Ædelforsite.
*326. Ægirine.
?*343. Ænigmatite.
N. Aërinine.
532. Æschynite.
*458. Agalmatolite.
*210. Agate.
*210. Agate-Jasper.
306. Agnesite.
373. Agricolite.
N. Aguilarite.
138. Aikinite.
248. Ainalite.
H. Ajkite.
391. Åkermanite.
63. Alabandite.
*746. Alabaster.
325. Alalite.
118. Alaskaite.
*H. Albertite.
435. Albine.
*316. Albite.
242. Alexandrite.
38. Algodonite.
483A. Alipite.
45. Alisonite.
578. Allactite.
335. Allagite.
*409. Allanite.
9. Allemontite.
102. Alloclasite.
719. Allomorphite.
24. Allopalladium.
?*498. Allophane.
509. Allophite.
544. Alluaudite.
*370. Almandite.
510. Alshedite.
278. Alstonite.
46. Altaite.
*769. Alum, Iron.
*764. ,, Native.
736. Alumian.
791. Aluminite.
212. Alumocalcite.
800. Alumstone.
800. Alunite.
775. Alunogen.
462B. Alurgite.
394. Alvite.
17. Amalgam.
*13. ,, Gold.
17. ,, Silver.
787. Amarantite.
315. Amazonite.
*315. Amazon-stone.
*H. Amber, Succinite.
559. Amblygonite.
*324. Amblystegite.
H. Ambrite.
H. Ambrosine.
470. Amesite.
*210. Amethyst.
*338. Amianthus.
675. Ammiolite.
*338. Amphibole.
611. Amphithalite.
*450. Analcite, Analcime.
252. Anatase.
*398. Andalusite.
*318. Andesine.
*318. Andesite.
N. Andorite.
370. Andradite.
656. Andrewsite.
*721. Anglesite.
722. Anhydrite.
35. Animikite.
*271A. Ankerite.
*602. Annabergite.
530. Annerödite.
462B. Annite.
N. Anomalite.
462. Anomite.
*320. Anorthite.
*315A. Anorthoclase.
325. Anthochroite.
*337. Anthophyllite.
505. Anthosiderite.
*H. Anthracite.
H. Anthracoxenite.
H. Anthraxolite.
*481. Antigorite.
509. Antillite.
9. Antimonial Arsenic.
221. ,, Ochre.
144. ,, Red Silver.
10. Antimony.
9. ,, Arsenical.
*28. ,, Glance.
741. Antlerite.
N. Antochroite.
175. Antozonite.
455. Antrimolite.
789. Apatelite.
*549. Apatite.
270. Aphrite.
426. Aphrizite.
481. Aphrodite.
477. Aphrosiderite.
717. Aphthitalite.
770. Apjöhnite.
*370. Aplome.
*435. Apophyllite.
509. Aquacreptite.
344. Aquamarine.
*277. Aragonite.
H. Aragotite.
717. Arcanite.
509. Arctolite.
418. Ardennite.

*54. Copper Glance.
*504. ,, Pitch-blende.
*83. ,, Pyrites.
659. Copper-Uranite.
772. Coquimbite.
711. Coracite.
*353. Cordierite.
634. Cornwallite.
675. Coronguite.
470. Corundophilite.
*231. Corundum.
91. Corynite.
128. Cosalite.
459. Cossaite.
343. Cossyrite.
180. Cotunnite.
388. Couseranite.
67. Covellite.
*N. Craigtonite.
245. Crednerite.
233. Crichtonite.
211. Cristobalite.
*453. Crocalite.
*341. Crocidolite.
725. Crocoisite.
725. Crocoite.
286. Cromfordite.
472. Cronstedtite.
53. Crookesite.
N. Crossite.
98. Crucite.
183. Cryolite.
461. Cryophyllite.
553. Cryphiolite.
185. Cryptohalite.
*537. Cryptolite.
708. Cryptomorphite.
N. Cryptovalite.
81. Cubanite.
480. Culsageeite.
N. Cumengéite.
338. Cummingtonite.
*224. Cuprite.
549. Cupro-apatite.
112. Cuprobismutite.
N. Cuprocalcite.
N. Cuprocassiterite.
564. Cuprodescloizite.
N. Cuproiodargyrite.
754. Cupromagnesite.
45. Cuproplumbite.
815. Cuprotungstite.
413. Cuspidine.
*400. Cyanite.
504. Cyanochalcite.
761. Cyanochroite.
781. Cyanotrichite.
*327. Cymatolite.
*393. Cyprine.
795. Cyprusite.
394. Cyrtolite.

676. Dahllite.
57. Daleminzite.
*458. Damourite.
98. Danaite.
367. Danalite.
396. Danburite.
338. Dannemorite.
471. Daphnite.
689. Darapskite.
*401. Datolite.
194. Daubréeite.
80. Daubreelite.
*344. Davidsonite.
190. Daviesite.
509. Davreuxite.
361. Davyne.
293. Dawsonite.
? *564. Dechenite.
506. Degeröite.
269. Delafossite.
648. Delavauxite.
*478. Delessite.
370. Demantoid.
504. Demidovite.
N. Derbylite.
509. Dermatin.
483A. De Saulesite.
564. Descloizite.
*443. Desmine.
677. Destinezite.
482. Deweylite.
476. Diabantite.
*324. Diaclasite.
677. Diadochite.
*325. Diallage.
274. Diallogite.
? *1. Diamond.
134. Diaphorite.
256. Diaspore.
338. Diastatite.
588. Dickinsonite.
458. Didymite.
771. Dietrichite.
N. Dietzeite.
569. Dihydrite.
716. Dihydro-thenardite.
504. Dillenburgite.
499. Dillnite.
27. Dimorphite.
H. Dinite.
*325. Diopside.
383. Dioptase.
388. Dipyre.
*400. Disthene.
585. Dittmarite.
112. Dognacskaite.
738. Dolerophanite.
*271. Dolomite.
37. Domeykite.
H. Dopplerite.
200. Douglasite.
719. Dreelite.
83. Ducktownite.
*602. Dudgeonite.
480. Dudleyite.
573. Dufrenite.
127. Dufrenoysite.
479. Dumasite.
427. Dumortierite.
768. Dumreicherite.
509. Duporthite.
558. Durangite.
810. Durdenite.
141. Dürfeldtite.
H. Duxite.
519. Dysanalyte.
35. Dyscrasite.
236. Dysluite.
H. Dysodile.
335. Dyssnite.
458. Dysyntribite.

673. Ecdemite.
329. Edelforsite.
*338. Edenite.
*452. Edingtonite.
25. Edmonsonite.
719. Eggonite.
570. Ehlite.
500. Ehrenbergit.
262. Eisenbrucite.
479. Ekmannite.
357. Elæolite.
*H. Elastic Bitumen.
*H. Elaterite.
13. Electrum.
648. Eleonorite.
N. Elfstorpite.
453. Ellagite.
*N. Ellonite.
183. Elpasolite.
N. Elpidite.
N. Elroquite.
170. Embolite.
*344. Emerald.
*303. ,, Nickel.
231. Emery.
809. Emmonsite.
116. Emplectite.
158. Enargite.
551. Endlichite.
*323. Enstatite.
805. Enysite.
*819. Eosite.
650. Eosphorite.
509. Ephesite.
161. Epiboulangerite.
479. Epichlorite.
N. Epididymite.
*407. Epidote.
162. Epigenite.
379. ,,
585. Epigloubite.
479. Epiphanite.
549. Epiphosphorite.
457. Episphärite.
*440. Epistilbite.
*748. Epsomite.
*748. Epsom Salt.
350. Erdmannite.
402. ,,
N. Erilite.
?*568. Erinite.
386. Ersbyite.
*78. Erubescite.
795. Erusibite.

SCOTTISH PSEUDOMORPHS

By James Currie, M.A.

The subjoined list contains all the Pseudomorphs which I have been able to trace as occurring, or said to occur, in Scotland. Wherever possible, the crystal forms of the original minerals are given, with a note (fig.) if there is a figure in the work cited. Similarly, the fact that the replacing mineral has been analysed is always noted when this is the case. A few occurrences have been communicated to me by Prof. Heddle, without his having, so far as I know, published any account of them, *e.g.* Nos. 14, 15, 74, 92, 127, and 182. The original specimens of Nos. 74 and 182 are in my own collection, as are Nos. 4, 172, and 176. The authority for many of the Pseudomorphs is the tickets in the Scottish Collection of the Edinburgh Museum, and all occurrences of which an example is to be found there are marked in this list by an asterisk (*), while a note indicates those of which the British Museum possesses specimens. It will be seen that thirteen of these last (Nos. 12, 22, 36–39, 72, 85, 105, 115–117, and 125) are not represented in the Edinburgh Collection. Following this list is an Index of the original, replaced Minerals, or, as we may call them (from παλαιός, ancient, and σῶμα, body), the Palæosomes of the Scottish Pseudomorphs.

1. Agalmatolite (?) after Apatite (?): Dobston, Aberdeenshire: Heddle, *Trans. Roy. Soc. Edin.*, xxx. 440.
2. Agalmatolite after Oligoclase: Ceannabeinne, Sutherland: Heddle, *Min. Mag.*, iv. 215.
3. Agalmatolite after Oligoclase: Luib Dhaimh, Loch Eireboll, Sutherland: Heddle, *Min. Mag.*, iv. 215.
4. Agalmatolite after Oligoclase: Ceann-a-bharra, Tiree: Currie.
5. Albite after Analcime: Old Kilpatrick: Greg and Lettsom, *Min. Brit.*, 113.
6. Albite after Analcime: Lang Crag, Dumbarton: Greg and Lettsom, *Min. Brit.*, 113.

7. Albite after Analcime: Calton Hill, Edinburgh: Greg and Lettsom, *Min. Brit.*, 194.
8. Albite after Calcite: Lang Crag, Dumbarton: Greg and Lettsom, *Min. Brit.*, 113.

   This pseudomorphous substance is said by Greg and Lettsom (*loc. cit.*) to have been shown by Heddle to be Albite. Prof. Heddle, however, in his paper published the year after the appearance of the *Mineralogy of Great Britain*, gives Analcime as the replacing substance in the Calcite pseudomorph from Lang Crag (see No. 18), and Greg and Lettsom themselves refer on p. 189 to Analcime after Calcite. See, further, Note to No. 25.
9.*Albite after Heulandite: Bowling: Heddle, *Trans. Roy. Soc. Edin.*, xxvii. 510—Analysed (Museum Ticket).
10.*Albite after Laumontite: Old Kilpatrick: Greg and Lettsom, *Min. Brit.*, 113:—*m e* (fig.), *e c m b u r* (Heddle, *Phil. Mag.*, xvii. (1859) 44).
11. Albite after Laumontite: Lang Crag, Dumbarton: Greg and Lettsom, *Min. Brit.*, 113.
12. Albite after Laumontite: Calton Hill, Edinburgh: Greg and Lettsom, *Min. Brit.*, 113.

    A specimen, said to be from this locality, is in the British Museum (Miers).
13.*Albite after Prehnite (?): Bowling: Heddle, *Phil. Mag.*, xvii. 45.

    In *Phil. Mag.* the locality is given as Kilpatrick Hills.
14. Albite after Prehnite (?): Boyleston, Barrhead: Heddle.
15. Albite after Prehnite (?): Berry Glen, Ayrshire: Heddle.
16. Albite after Stilbite: Lang Crag, Dumbarton: Greg and Lettsom, *Min. Brit.*, 194:—*b c m* (fig.), *b c m f* (fig.), *b c m f r* (fig.) (Heddle, *Phil. Mag.*, xvii. 44)—Analysed.

    It is not clear from Greg and Lettsom's description of "Weissigite" (*Min. Brit.*, 194) to what pseudomorph they referred Prof. Heddle's analysis; but from the statement on p. 112 (under Albite) it is obvious that they were under the impression that it was the pseudomorphs after Laumontite (Nos. 10 and 11 *supra*) that had been investigated. Prof. Heddle's statement in the *Trans. Roy. Soc. Edin.* (xxvii. 511) proves, however, that he had analysed the Stilbite pseudomorphs, and his paper in the *Phil. Mag.* (published a year after Greg and Lettsom's volume) shows that while he was then certain as to the replacing mineral in the case of the Stilbite pseudomorphs, he was only in a position to suggest that the Laumontite pseudomorphs would prove to be the same substance. The former, therefore, must have been the specimens analysed, and Greg and Lettsom's statement, which has been copied into all the text-books, should be corrected.

17.*Albite after Stilbite: Bowling: Heddle:—*b c r*, *b c m r*.

The "Kilpatrick" specimen in the British Museum is no doubt from this or the Lang Crag locality.

18. Analcime after Calcite: Lang Crag, Dumbarton: Heddle, *Phil. Mag.*, xvii. 44:—*y* (fig.).

See No. 8. This replacement, like Nos. 27, 87, 112, 113, 118, 122, and 134, is included by Prof. Miers (*Min. Mag.*, xi. 276) in his list of pseudomorphs insufficiently vouched, apparently because the localities are not given by Greg and Lettsom. All of these, however, are referred to with descriptions and localities in Prof. Heddle's paper on "The Pseudomorphic Minerals found in Scotland," *Phil. Mag.* xvii. (1859) 42.

19.*Analcime after Calcite: Bowling: Heddle.

20.*Analcime after Laumontite: Bowling: Greg and Lettsom, *Min. Brit.*, 187.

21. Analcime after Laumontite: Kilpatrick: Greg and Lettsom, *Min. Brit.*, 189, note.

Perhaps the same locality as No. 20: see note to No. 25.

22. Analcime after Laumontite: Kilmalcolm, Renfrewshire: Miers, *Min. Mag.*, xi. 279.

A specimen from this locality is in the British Museum.

23. Analcime after Prehnite: Paisley: Hall, *Min. Dir.*, 132.

There is little doubt that this is an error for the converse substitution. See No. 105.

24. Analcime after Stilbite: Lang Crag, Dumbarton: Heddle, *Phil. Mag.*, xvii. 44:—*b c m*.

25.*Analcime after Stilbite: Bowling: Heddle.

Considerable uncertainty still exists as to these replacements by Albite and Analcime. In the first place it is only in a very few cases that the nature of the replacing substance has been determined by analysis or even approximately ascertained by the blowpipe. In the second place, the Dumbartonshire localities, both for pseudomorphs and for the unaltered minerals, are very unreliable. Kilpatrick or Old Kilpatrick, Kilpatrick Hills, Dumbarton or Dumbarton Muir, Lang Crag (or Long Craig), Frisky Hall, and Bowling are all, except perhaps the last, very vaguely used; and four times out of five in the earlier notices, whichever of these names be given, the locality intended to be indicated (or concealed) is Bowling Quarry. The only Dumbartonshire localities of any importance are Bowling, Lang Crag, Glen Arbuck, Loch Humphrey, Old Kilpatrick, and Cochno; and one of these is generally meant even when Stirlingshire localities, like Campsie, Campsie Fells, and Fintry, are

64. Hematite after Olivine: Calton Hill, Edinburgh: Tschermak, *Wien. Akad.*, xlvi. 483.

65.*Hematite after Pyrites: Bre Brough, Hoy, Orkney: Heddle, *Phil. Mag.*, xvii. 43:—*a o e* (fig.).

So also on Museum Ticket, but Limonite in *Min. Mag.*

66.*Hematite after Pyrites: Lamberton, Berwickshire: Goodchild.

Hematite after Pyrites; see also Limonite after Pyrites and No. 196.

67. Hullite after Analcime: Kinkell, Fife: Heddle, *Trans. Roy. Soc. Edin.*, xxix. 90—Analysed.

68. Kæmmererite after Talc: Hagdale, Unst: Heddle, *Phil. Mag.*, xvii. 42:—*m c* (fig.).

Apparently merely crystallised Kæmmererite.

69.*Kaolin after Pyrites: Rubislaw, Aberdeenshire: Heddle:—*a e*.

70. Kaolin after Orthoclase (?): Ledbeg, Sutherland: Heddle, *Min. Mag.*, v. 294.

71.*Kaolin after Orthoclase (Sanidine): Kinkell, Fife: Heddle.

72. Laumontite after Analcime: Kilpatrick: Miers, *Min. Mag.*, xi. 282. In the British Museum.

Limnite after Pyrites and Marcasite: see Limonite.

73.*Limonite after Calcite: Leadhills: Heddle:—*v o e*.

74. Limonite after Marcasite: Spindle Rock, Fife: Heddle.

75.*Limonite after Marcasite: Stromness, Orkney: Heddle, *Phil. Mag.*, xvii. 43. "Cockscomb."

Like Nos. 77 and 80, erroneously Limnite in *Phil. Mag.*

76. Limonite after Pyrites: Colla Firth, Shetland: Heddle, *Min. Mag.*, ii. 176.

77.*Limonite after Pyrites: Vannlip, Hillswick, Shetland: Heddle, *Min. Mag.*, iii. 30:—*a e* (fig., *Phil. Mag.*).

78.*Limonite after Pyrites: Sandlodge, Shetland: Heddle.

79.*Limonite after Pyrites: Laoch, Banffshire: Heddle.

80.*Limonite after Pyrites: East Tulloch, Perthshire: Heddle, *Phil. Mag.*, xvii. 43:—*a*, *a e* (fig.).

81.*Limonite after Pyrites: Fort William: B. N. Peach:—*a e*.

82.*Limonite after Pyrites: Kirkconnel, Kirkcudbright: Heddle.

Hematite after Pyrites, according to Goodchild.

83.*Limonite after Pyrites: Leadhills and Wanlockhead: Heddle:—*a* (Wilson), *a o*.

In some of these pseudomorphs after Pyrites the replacing mineral seems rather, as pointed out by J. G. Goodchild, to be Hematite. The change is often only superficial.

84.*Magnetite after Pyrites: Errins, near Tarbet, Kintyre: Heddle, *Phil. Mag.*, xvii. 47:—*a*, *a e*.

Miers says (*Min. Mag.*, xi. 277) that this requires confirmation. But he gives Hall as the authority, whereas the replacement was recorded by Heddle as above. Possibly only Hematite, which at least coats the altered crystals (as suggested by Goodchild).

85. Magnetite after Serpentine (Picrolite): Scalpay, Harris: Miers, *Min. Mag.*, xi. 271.

In the British Museum. This is described by Heddle as interstitial, the Magnetite occurring between the fibres of Picrolite.

86.*Malachite after Galena: Leadhills: Heddle.

87. Marcasite after Coal: Spindle Rock, Fife: Heddle, *Phil. Mag.*, xvii 43.

See note to No. 18. Pyrites in Greg and Lettsom's *Min. Brit.*

Martite after Magnetite. See No. 63.

88.*Minium (?) after Galena: Leadhills: Heddle, *Phil. Mag.*, xvii. 46 :—*a*.

The replacing substance is described as a ferruginous minium: it resembles an impure Limonite (as suggested by Goodchild).

89.*Muscovite (Damourite) after Staurolite: Boharm, Banffshire: Heddle.

90.*Muscovite (Margarodite) after Orthoclase: Cairn Durich, Braemar: Heddle.

Probably, as suggested by J. G. Goodchild, merely a fragment of schist, included in the quartz vein.

91.*Oligoclase (?) after Stilbite: Lang Crag, Dumbarton: Heddle, *Phil. Mag.*, xvi. 44 :—*b c m*, *b c m r* (fig.), *b c m r f*.

92. Oligoclase (?) after Analcime: Boyleston, Barrhead: Heddle :—*n*.

93. Olivine after Sphene: Lairg, Sutherland: Heddle, *Min. Mag.*, v. 189 :—Analysed.

94. Orthoclase after Laumontite: Kilpatrick: Haidinger: *Sitzb. Akad. Wien.*, 1849, Hft. 3 :—Analysed (Bischof).

95.*Orthoclase after Natrolite: Abergairn, Aberdeenshire: Heddle.

96. Orthoclase after Prehnite: Kilpatrick: Haidinger (Blum), *Pseud. 4te. Nachtr.* 61.

97. Orthoclase (Erythrite) after Heulandite: Bowling: Heddle, *Min. Scot.*, ii. 4.

98. Orthoclase (Erythrite) after Stilbite: Bowling: Heddle, *Min. Scot.*, ii. 4.

Similar pseudomorphs of Orthoclase (Erythrite) are said to occur at Boyleston near Barrhead, Gryfe Tunnel near Greenock, and Berry Glen in North Ayrshire (see Heddle, *Min. Scot.*, ii. 4). The replacing mineral was analysed by Thomson.

99.*Pectolite after Analcime: Ratho: Heddle, *Phil. Mag.*, xvii. 45 :—*n*, *n a*. Also in the British Museum.

100.*Pectolite after Scapolite: Lendalfoot: Heddle, *Phil. Mag.*, xvii. 45.

Prof. Heddle suggested in *Phil. Mag.* that these crystals were Scapolite in substance as well as in form and therefore not pseudomorphous at all.

Picrolite after Asbestos and Actinolite: see Serpentine, Nos. 173 and 174.

101. Pinite after Iolite: Burn of Craig: Cabrach: Heddle, *Min. Mag.*, v. 17:—Analysed.

102. Plattnerite after Calcite (Plumbocalcite): Wanlockhead: Wilson (Heddle, *Min. Scot.*, i. 103).

103. Plattnerite after Pyromorphite: Leadhills: Haidinger:—*m c.*

104.*Prehnite after Analcime: Kilpatrick: Heddle, *Phil. Mag.*, xvii. 45:—*n* (fig.); *n a* (fig.).

In the British Museum. The Edinburgh Museum Ticket has Bowling, which is probably the locality meant. The pseudomorph was formerly not uncommon at one part of Bowling Quarry.

105. Prehnite after Analcime: Hartfield, Renfrewshire: Greg and Lettsom, *Min. Brit.*, 187:—*n a* (fig.).

In the British Museum.

106.*Prehnite after Analcime: Boyleston, Barrhead: Heddle:—*n.*

107.*Prehnite after Andesine: Dalnabo, Glen Gairn: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 248—Analysed.

108.*Prehnite after Barytes: Bowling: Heddle.

109.*Prehnite after Laumontite: Kilpatrick Hills: Heddle, *Phil. Mag.*, xvii. 45:—*m e.*

See Note to No. 104, which applies also to this pseudomorph.

110. Prehnite after Natrolite: Isle of May: Heddle, *Phil. Mag.*, xvii. (1859), 44.

So in *The Shores of Fife*, p. 29: in *Phil. Mag.* the original mineral is, probably erroneously, identified as Scolecite.

111. Prehnite after Thomsonite (?): Bowling: Heddle, *Trans. Roy. Soc. Edin.*, xxvii. 511.

112.*Prochlorite after Garnet: Vannlip, Hillswick, Shetland: Heddle, *Phil. Mag.*, xvii. 42:—*d n* (fig.).

See Note to No. 18.

113. Prochlorite after Garnet: Knock. Ballintuim, Strathardle: Heddle, *Phil. Mag.*, xvii. 43:—*d* (fig.).

See Note to No. 18.

Pseudophite after Labradorite: see Serpentine, No. 179.

114. Pyrites after Aragonite: Yestenaby, Orkney: Heddle, *Min. Mag.*, iii. 222.

Pyrites after Coal: see No. 87.

115. Pyromorphite after Barytes: Leadhills: Miers, *Min. Mag.*, xi. 284.
In the British Museum.

116. Pyromorphite after Galena: Leadhills: Miers, *Min. Mag.*, xi. 284.
In the British Museum.

117. Pyromorphite after Leadhillite: Leadhills: Miers, *Min. Mag.*, xi. 284.
In the British Museum. The pseudomorph is a mixture of Pyromorphite and Cerussite (Miers).

118.*Quartz after Anglesite: Leadhills: Heddle, *Phil. Mag.*, xvii. 46.
See Note to No. 18.

119. Quartz after Barytes: Leadhills: Heddle, *Phil. Mag.*, xvii. 46.

120.*Quartz after Calcite: Leadhills: Heddle.

121.*Quartz after Chrysotile: Kilchrenan, Loch Awe: Heddle.
Quartz after Dolomite: see Chalcedony after Dolomite, No. 43.

122.*Quartz after Galena: Leadhills: Heddle, *Phil. Mag.*, xvii. 46:—*a.*
See Note to No. 18.

123.*Quartz after Garnet: Knock Hills: Banffshire: Heddle: *d.*

124.*Quartz after Psilomelane: Leadhills: Heddle, *Phil. Mag.*, xvii. 46.

125. Quartz after Stilbite: Lang Crag, Dumbarton: Heddle, *Phil. Mag.*, xvii. 44:—*b m c.*
In the British Museum.

126. Quartz after Stilbite: Kilpatrick: Greg and Lettsom, *Min. Brit.*, 95.

127. Quartz after Stilbite: Shaws, Greenock: Heddle: *b m c.*
See Chalcedony and Sandstone for other Quartz pseudomorphs.

128. Rhodonite after Sphene: Glen Gairn: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 309.
Unconfirmed, and in all probability merely Greenovite.

129.*Sahlite after Malacolite: Shiness, Sutherland: Heddle.
This seems rather to be an example of Malacolite sheathed by a later growth of a more ferriferous Pyroxene.

130. Sandstone after Salt: Currie, near Edinburgh: Goodchild (Heddle, *Min. Scot.*, i. 40):—*a.*

131. Sandstone after Salt: Kildonan, Arran: Goodchild (Heddle, *Min. Scot.*, i. 40): "hopper-shaped crystals."

132.*Saponite after Analcime: Kinkell, Fife: Heddle.

133.*Saponite after Analcime: Ratho: Heddle, *Phil. Mag.*, xvii. 45:—*n, n a.*

134.*Saponite after Barytes: Ratho: Heddle, *Phil. Mag.*, xvii. 45.
See Note to No. 18.

135.*Saponite after Natrolite: Kilpatrick Hills: Heddle, *Phil. Mag.*, xvii. 45.
The specimen in the Edinburgh Museum is from Bowling.

136.*Saponite after Pectolite: Ratho: Heddle, *Phil. Mag.*, xvii. 45 —Analysed.

Also in the British Museum.

Nos. 133 to 136 are designated Steatite in the *Philosophical Magazine*, and No. 136 is so termed by Miers; but this is erroneous. The complete analysis of the last, and the mode of occurrence of all of them, is quite conclusive.

Saussurite after Anorthite: see Zoisite after Anorthite, No. 201.

Schillerspar after Enstatite: see Serpentine, Nos. 154, 155.

SERPENTINE PSEUDOMORPHS.

(*a*) After Olivine.

137.*Serpentine after Olivine: Portsoy: Heddle.

138. Serpentine after Olivine: Hill of Dun, Dumbarton: Allport, *Q. J. G. S.*, xxx. 558.

139. Serpentine after Olivine: Lochan Strath Dubh Uisge (Loch Garabal), Inverarnan: Dakyns and Teall, *Q. J. G. S.*, xlviii. 108.

140. Serpentine after Olivine: Kirriemuir: Judd, *Q. J. G. S.*, xli. 398.

141.*Serpentine after Olivine: Belhelvie, Aberdeenshire; Judd, *Q. J. G. S.*, xli. 399.

142.*Serpentine after Olivine: Black Dog Rock, Aberdeen: Judd, *Q. J. G. S.*, xli. 399.

143. Serpentine after Olivine: Loch Scye, Caithness: Judd, *Q. J. G. S.*, xli. 405.

144. Serpentine after Olivine: Totag, Loch Duich; Heddle, *Ency. Brit.* (9th edit.), xvi. 415.

Recorded as Villarsite in the *Encyclopædia.*

(*b*) After Enstatite.

145.*Serpentine after Enstatite: Swinna Ness, Unst, Shetland: Heddle.

146.*Serpentine after Enstatite: Noss, Shetland: Heddle.

147. Serpentine after Enstatite: Loch Scye, Caithness: Judd, *Q. J. G. S.*, xli. 405.

148. Serpentine after Enstatite: Kirriemuir: Judd, *Q. J. G. S.*, xli. 299.

149.*Serpentine after Enstatite: Hill of Tombhreac, Aberdeenshire: Heddle.

150.*Serpentine after Enstatite: Green Hill of Strathdon, Aberdeenshire: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 497:—Analysed.

151.*Serpentine after Enstatite: Balhamie Hill, Ayrshire: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 494:—Analysed.

152. Serpentine after Enstatite: Knockdow, Lendalfoot: Heddle, *Trans. Roy. Soc. Edin.*, xxvii. 494.

153. Serpentine after Enstatite: Byne Hill, Girvan: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 494.

154. Serpentine after Enstatite (Schiller Spar): Black Dog Rock, Aberdeen: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 500:—Analysed.

155. Serpentine after Enstatite (Schiller Spar); Belhelvie, Aberdeenshire: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 500.

(*c*) After Pyroxene.

156.*Serpentine after Malacolite: Totag, Loch Duich: Heddle.

157.*Serpentine after Sahlite: Ballyphetrish, Tiree: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 459.

158. Serpentine after Sahlite: Glenelg: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 459.

159. Serpentine after Sahlite: Green Hill of Strathdon: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 497.

160. Serpentine after Sahlite: Totag, Loch Duich: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 497:—Analysed.

161. Serpentine after Diallage: Cross Geo, Unst: Heddle, *Min. Mag.*, ii. 22.

162. Serpentine after Diallage: Swinna Ness, Unst: Heddle, *Min. Mag.*, ii. 28.

163.*Serpentine after Diallage: Ballyphetrish, Tiree: Heddle.

164.*Serpentine after Diallage: Portsoy: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 495:—Analysed.

165. Serpentine after Augite: Totag, Loch Duich: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 455.

166.*Serpentine after Augite: Portsoy: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 493:—Analysed.

167. Serpentine after Augite: Loch Bhalumis, Lewis: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 542.

168. Serpentine after Augite: Rodil, Harris: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 542.

169. Serpentine after Augite: Dalnein, Strathdon: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 542.

170. Serpentine after Augite: Glen Tilt: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 542.

171.*Serpentine after Asbestos: Corriecharmaig, Loch Tay: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 534:—Analysed.

(*d*) After Amphibole.

172. Serpentine after Actinolite: Colla Firth, Shetland: Currie.
173. Serpentine (Picrolite) after Actinolite: Pundy Geo, Fethaland, Shetland: Heddle, *Min. Mag.*, ii. 168:—Analysed.
174.*Serpentine (Picrolite) after Asbestos: Doos' Geo, Balta, Shetland: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 530.
175.*Serpentine after Asbestos: Aith, Fetlar: Heddle.

The Museum Ticket has "Steatite after Amianthus" and "Steatite after Asbestos," for No. 174 and No. 175 respectively.

176. Serpentine after Asbestos: Leslie: Heddle, *Min. Scot.*, ii. 136.
177. Serpentine after Asbestos: Leith Hall, Kennethmont, Aberdeenshire: Heddle, *Min. Scot.*, ii. 136.

(*e*) After Feldspar.

178. Serpentine after Labradorite: Portsoy: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 496:—Analysed.
179. Serpentine after Labradorite: Beauty Hill, Aberdeenshire: Heddle, *Trans. Roy. Soc. Edin.*, xxviii. 543:—Analysed.

As pointed out by Prof. Heddle, the replacing substance in this last instance may also be regarded as *chemically* a massive Penninite (Pseudophite), which has been recorded as occurring pseudomorphous after Feldspars from other localities.

(*f*) After other Minerals.

180. Serpentine after Chromite: Balta Sound, Unst: Heddle, *Phil. Mag.*, xvii. 42:—*o* (fig.).
181. Serpentine after Pectolite (?): Aith, Fetlar: Heddle, *Min. Mag.*, ii. 129.
182. Serpentine after Wollastonite: Burn of Boyne: Heddle.
183.*Siderite after Calcite: Spindle Rock, Fife: Heddle, *Shores of Fife*, 33: *v.*

Steatite after Analcime, Barytes, Natrolite, and Pectolite: see Saponite, Nos. 133 to 136.

184.*Steatite after Andalusite: Whitehills, Banffshire: Heddle.

Steatite after Asbestos: see Serpentine, Nos. 174 and 175.

185.*Steatite after Calcite: Portsoy: Heddle.
186.*Steatite after Kyanite: Dulnanbridge, Inverness-shire: Heddle.
187.*Steatite after Wollastonite: Cowhythe, Banffshire: Heddle.

The name Steatite has been somewhat vaguely used. Sometimes the pseudomorphous substance so designated is indubitably Serpentine: in other instances it is a saponitic mineral.

188.*Talc after Anthophyllite: Hillswick, Shetland: Heddle.

189. Talc after Enstatite: Portsoy: Blum, *Pseud.* 4[te] *Nachtr.*, 61.
190. Talc after Kyanite (?): Nor Wick, Unst: Heddle, *Min. Mag.*, ii. 21.
191.*Talc after Kyanite (?): Ollaberry, Shetland: Heddle, *Min. Mag.*, ii. 184.
As suggested by Prof. Heddle, perhaps Talc after Actinolite.
192. Talc after Kyanite; Durn Hill, Banffshire: Heddle, *Min. Scot.*, ii. 138.
193. Talc after Tremolite: Cairnie, Aberdeenshire: Heddle, *Min. Scot.*, ii. 138.
194.*Tenorite after Galena: Leadhills: Heddle.
195.*Turgite after Pyrites: Kerrera: Heddle, *Min. Mag.*, v. 3: *a*, *a e*:—Analysed.
The replacing substance is erroneously called Limnite (a mistake for Limonite) in *Phil. Mag.*, where the form *a e* is given.
196. Turgite after Pyrites: Eilean Fraoch, Kerrera Sound: Heddle, *Phil. Mag.*, xvii. 47: *a*, *a e*.
Limnite in *Phil. Mag.*
197. Turgite after Pyrites: Oban (east side of Kerrera Sound): Heddle, *Phil. Mag.*, xvii. 47: *a*.
Hematite in *Phil. Mag.*
198. Vanadinite after Calamine: Wanlockhead: Greg and Lettsom, *Min. Brit.*, 450.
Given without locality by Greg and Lettsom. As, however, Wanlockhead is the only British locality given by them for Vanadinite, the pseudomorph must have occurred there, if it occurred at all, which is doubtful. Possibly it is merely an error for the converse substitution.
199. Vanadinite after Galena: Wanlockhead: Greg and Lettsom, *Min. Brit.*, 410:—*a* (Heddle, *Phil. Mag.*, xvii. 47).
Villarsite after Olivine: see Serpentine, No. 144.
200.*Wad after Calcite: Leadhills: Heddle, *Phil. Mag.*, xvii. 46: *u r* (fig.).
Weissigite after Analcime, &c.: see Albite, Nos. 5 and 6.
201.*Zoisite (Saussurite) after Anorthite: Pinbain, Lendalfoot, Ayrshire: Heddle, *Min. Mag.*, v. 6:—Analysed.

INDEX OF SCOTTISH PALÆOSOMATIC MINERALS.

SCOTTISH MINERALS ARRANGED UNDER COUNTIES.

ABERDEENSHIRE.

Graphite, Molybdenite, Galena, Blende, Pyrrhotite, Chalcopyrites, Pyrites, Marcasite, Fluor, Quartz (var. *a*, Rock Crystal, colourless, pellucid ; *b*, Massive Rock Crystal ; *c*, Crystallised White and Cairngorm, Amethyst, Pink, Scarlet, Dark Red, Salmon Coloured, Yellow, Milk-Quartz, Massive, Rose, Lamellar Quartz, Sagenitic Quartz, Iridescent Quartz, Chalcedony, Dendritic Agates, Flint, Hornstone, Chert, Dendritic), Sapphire, Hæmatite (var. Specular Iron Ore), Ilmenite, Iserine, Magnetite, Chromite, Rutile, Manganite, Psilomelane, Wad, Calcite (var. Foliated (Schiffer Spar)), Dolomite, Orthoclase, Microcline, Graphic Granite, Albite, Oligoclase, Andesine, Labradorite, Anorthite, Latrobite, Enstatite (var. Bronzite), Paulit (Hypersthene) (var. Bastite (Schiller Spar)), Augite (var. Malacolite, Sahlite, Coccolite, Funkite, Augite), Spodumene, Wollastonite, Amphibole (var. 2, Actinolite; var. 3, Amianthus (Flexible Asbestos); var. 4, Asbestos (Rigid Asbestos) ; var. 6, Nephrite ; var. 7, Actinolite and Actinolite Slate ; II., Aluminous (var. 10, Hornblende Proper), Beryl, Iolite, Garnet (var. 1, Lime-and-Alumina Garnet, Water-Garnet ; var. 2, Grossular ; var. 3, Essonite, Cinnamonstone ; var. 5, Common Garnet), Idocrase, Topaz, Andalusite, Fibrolite or Sillimanite, Kyanite or Cyanite, Epidote, Ällanite or Orthite, Axinite, Prehnite, Tourmaline, Staurolite, Analcime (Cluthalite), Muscovite (var. Margarodite), Agalmatolite, Zinnwaldite, Biotite (var. Haughtonite, Lepidomelane), Penninite ; var. Pseudophite, Chlorite, Serpentine (var. 1, Chrysotile ; var. 5, Bastite or Schiller Spar ; var. 7, Common Serpentine), Talc-Steatite (var. 1, Foliated Talc ; var. 2, Steatite), Pilolite, Rubislite, Titanite or Sphene, Apatite, Barytes.

ARGYLLSHIRE.

Graphite, Silver, Molybdenite, Galena, Blende, Pentlandite, Millerite, Pyrrhotite, Chalcopyrites, Pyrites, Gersdorffite, Marcasite, Bournonite, Fluor, Quartz (var. *a*, Rock Crystal, colourless, pellucid ; var. *c*, White Quartz and Cairngorm ; var. Amethyst ; var. Yellowish Green, Green ; var. Hacked Quartz ; var. Sagenitic Quartz ; var. Chalcedony ; var. Carnelian ; var. Heliotrope ; var. Agate ; var. Chert ; var. Basanite-Lydian Stone ; var. Ribbon Jasper), Hæmatite (var. Specular Iron Ore), Ilmenite, Iserine, Magnetite, Rutile, Turgite, Göthite (var. 2, In acicular Crystals, Needle Ironstone, Fleches d'amour, and Sammeterz), Limonite (var. 1, Compact, fibrous), Wad, Calcite (var. Coloured ; var. Foliated (Schiffer Spar) ; var. Calc Sinter), Dolomite, Siderite, Strontianite, Malachite, Orthoclase, Microcline, Paulit or Hypersthene, Augite ; (var. Hudsonite ; var. Diallage), Pectolite, Amphibole (I., containing little or no Alumina ; var. 2, Actinolite ; var. 5, Byssolite ; var. 6, Nephrite ; var. 7, Actinolite and Actinolite Slate ; II., Aluminous ; var. 9, Edenite), Garnet (var. 5, Common Garnet ; var. 7, Precious Garnet), Topaz, Andalusite, Kyanite or Cyanite, Zoizite, Epidote, Allanite or Orthite, Prehnite, Tourmaline, Okenite, Gyrolite, Apophyllite, Heulandite, Brewsterite, Harmotome, Stilbite, Laumontite, Chabazite, Analcime (Cluthalite), Natrolite (var. Crockalite), Scolecite, Mesolite, Thomsonite (var. Faroelite), Muscovite; var. Fuchite, Lepidolite, Ripidolite, Penninite, Chlorite, Delessite, Talc-Steatite (var. Potstone), Saponite, Pilolite, Titanite or Sphene, Pyromorphite, Barytes, Celestine, Gypsum, Anthracite, Lignite, Mercury doubtful.

AYRSHIRE.

Graphite, Copper, Stibnite, Galena, Chalcocite, Blende, Millerite, Chalcopyrites, Kermesite, Fluor, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. Amethyst; var. Flexible Sandstone; var. Agate; var. Fortification Agate; var. Onyx Agate; var. Faulted Agate; var. Hæmachatæ; var. Stalactitic Agate; var. Moss Agate; var. Basanite or Lydian Stone, Girasol Opal), Cervantite, Hæmatite (var. Specular Iron Ore; var. Red Hæmatite), Chromite, Limonite (var. 2, Ocherous or earthy; var. 3, Brown Clay Ironstone), Wad, Calcite (var. Foliated (Schiffer Spar)), Dolomite, Albite (var. Perthite), Labradorite, Anorthite, Enstatite (var. Bronzite, Paulit or Hypersthene (var. Bastite or Schiller Spar), Pyroxene (var. Augitic Glass; var. Diallage), Pectolite, Amphibole (var. Hydrous Anthrophyllite), Riebeckite, Prehnite, Stilbite, Chabazite, Analcime or Cluthalite, Natrolite (var. Crockalite), Biotite, Chlorite, Serpentine (var. 5, Bastite or (Schiller Spar)); var. 7, Common Serpentine, Saponite, Celadonite, Glauconite, Kaolin, Chonicrite, Vivianite, Barytes, Gypsum, Ozocerite, Anthracite.

BANFFSHIRE.

Graphite, Stibnite, Pyrrhotite, Pyrites, Fluor, Quartz (var. *c*, Crystallised White Quartz and Cairngorm; var. Milk Quartz Massive; var. Pink; var. Black; var. Leek-Green, Prase; var. Fibrous Quartz; var. Sagenitic Quartz; var. Aventurine; var. Iron Flint; var. Onyx; var. Chert; var. Jasper, Ferruginous), Ilmenite, Iserine, Magnetite, Chromite, Rutile, Pyrolusite, Limonite (var. Ocherous or earthy), Psilomelane, Calcite, Aragonite, Hydromagnesite, Orthoclase, Microcline, Graphic Granite, Andesine, Labradorite, Enstatite (var. Bronzite), Paulit or Hypersthene (var. Bastite or Schiller Spar), Pyroxene (var. Funkite; var. Augite; var. Diallage), Wollastonite, Babingtonite, Amphibole (I., containing little or no Alumina; var. 4, Rigid Asbestos; var. 6, Nephrite; var. 7, Actinolite and Actinolite Slate; II., Aluminous; var. 9, Edenite), Beryl, Garnet (var. 3, Essonite, Cinnamon Stone; var. 5, Common Garnet), Idocrase, Topaz, Andalusite, Fibrolite or Sillimanite, Kyanite or Cyanite, Epidote, Allanite or Orthite, Tourmaline, Staurolite, Muscovite (var. Margarodite), Biotite (var. Haughtonite), Chlorite, Serpentine (var. 1, Chrysotile; var. 2, Picrolite; var. 3 and 4, Precious; var. 5, Bastite or Schiller Spar; var. 7, Common; var. Serpentine Marbles), Talc-Steatite (var. 1, Foliated Talc; var. 2, Steatite), Pilolite, Titanite or Sphene, Apatite, Barytes, Celestine.

BERWICKSHIRE.

Galena, Chalcocite, Chalcopyrite, Tetrahedrite, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. Amethyst; var. Jasper, Dendritic), Hæmatite (var. Red Hæmatite), Limonite (var. 3, Brown Clay Ironstone), Dolomite, Malachite, Amphibole (I., containing little or no Alumina; var. 3, Amianthus (Flexible Asbestos)); II., Aluminous; var. 10, Hornblende Proper, Kaolin (var. Tuesite), Barytes, Gypsum, Ap. Mercury doubtful.

BUTE AND ARRAN.

Quartz (var. *c*, White Quartz and Cairngorm; var. Amethyst; var. Yellowish Green, Green), Hæmatite (var. Specular Iron Ore, Martite), Magnetite, Calcite (var. Coloured), Dolomite (var. Magnesian Marbles), Siderite, Malachite, Microcline, Albite, Labradorite, Wollastonite, Beryl, Chrysolite or Olivine, Topaz, Epidote, Prehnite, Heulandite, Stilbite, Natrolite, Muscovite, Chlorite, Barytes.

CAITHNESS-SHIRE.

Galena, Blende, Marcasite, Fluor, Psilomelane, Calcite, Pyroxene; var. Augitic Glass, Muscovite, Biotite, Titanite or Sphene, Barytes, Petroleum.

CLACKMANNANSHIRE.

Pectolite, Erythrite, Annabergite.

DUMBARTONSHIRE.

Blende, Greenockite, Fluor, Quartz (var. Zeolitic ; var. Iron Flint ; var. Agate, Dendritic), Hæmatite (var. Red Hæmatite), Göthite (var. 1, thin scale-like Crystals, tabular), Psilomelane, Calcite, Dolomite, Orthoclase (var. Erythrite), Albite (var. Perthite), Labradorite, Prehnite, Apophyllite, Heulandite, Harmotome, Stilbite, Laumontite, Chabazite, Analcime or Cluthalite, Edingtonite, Natrolite (var. Fargite), Mesolite, Thomsonite, Delessite, Saponite, Barytes, Gypsum, Asphaltum.

DUMFRIESSHIRE.

Stibnite, Galena, Blende, Nickelite, Chalcopyrites, Pyrites, Fluor, Quartz (Yellow, Hacked Quartz, Sagenitic Quartz, Chalcedony), Valentinite, Cervantite, Cuprite, Melaconite, Hæmatite (var. Red Hæmatite), Plattnerite, Pyrolusite, Limonite, Calcite, Plumbo-Calcite, Dolomite, Magnesite, Smithsonite, Cerussite, Azurite, Pyromorphite, Mimetite, Vanadinite, Dechenite, Descloizite, Barytes, Anglesite, Vauquelinite, Leadhillite, Caledonite, Linarite, Gypsum, Anthracite.

EDINBURGHSHIRE (MIDLOTHIAN).

Graphite, Copper, Galena, Blende, Chalcopyrite, Pyrites, Halite, Quartz (var. *c*, Crystallised White Quartz and Cairngorm, Amethyst, Agate, Hæmachatæ, Hornstone, Basanite or Lydian Stone, Jasper, Ferruginous, Dendritic, Ribbon), Iserine, Magnetite, Göthite (var. 3, Onegite, acicular ; var. 5, Columnar or fibrous), Calcite (var. Pulverulent or Rock Milk ; var. Stalactites), Dolomite, Aragonite (var. Satin Spar), Orthoclase (var. Sanidine), Albite, Labradorite, Pyroxene (var. Augite ; var. Hudsonite), Wollastonite, Pectolite, Chrysolite or Olivine, Datholite, Epidote, Prehnite, Apophyllite, Phillipsite, Analcime or Cluthalite, Natrolite, Saponite, Glauconite, Apatite, Vivianite, Barytes, Celestine, Gypsum, Ozocerite, Naphtha, Petroleum, Asphaltum, Elaterite, Albertite, Anthracite, Lignite, Jet.

ELGINSHIRE.

Galena, Chalcopyrite, Pyrites, Mispickel, Fluor, Quartz (var. Carnelian ; var. Flint, Hæmatite; var. Earthy), Calcite, Cerussite, Phosgenite, Microcline, Labradorite, Muscovite, Glauconite, Halloysite, Titanite or Sphene, Pyromorphite, Barytes, Celestine, Gypsum.

FIFESHIRE.

Galena, Millerite, Pyrrhotite, Chalcopyrite, Pyrites, Marcasite, Salmiac, Fluor, Quartz (var. *c*, Crystallised White and Cairngorm, Amethyst, Salmon-coloured, Brown Red, Chalcedony, Carnelian, Cachalong, Plasma, Agate, Onyx Agates, Eyed Agates, Pseudo-faulted, Hæmachatæ, Discoid Agates, Ovoidal Agates, Stalactitic Agates, Moss Agates, Dendritic Agates, Mochas, Hornstone, Chert, Basanite or Lydian Stone ; Jasper, Ferruginous, Dentritic, Porcelain), Hæmatite (var. Red Hæmatite), Iserine, Göthite (var. 1, thin scale-like Crystals, tubular ; var. 2, in acicular Crystals, Needle Ironstone, Fleches d'amour), Wad, Calcite (var. Calcite, Coloured ; var. Calcite, fibrous ; var. Calcite Stalactites ; var. Calc Sinter), Dolomite, Aragonite (var. Satin Spar), Orthoclase (var. Sanidine), Labradorite, Augite (var. Augitic Glass), Pectolite, Amphibole (II., Aluminous ; var 10, Hornblende Proper), Garnet (var. 4, Pyrope), Chrysolite or Olivine, Datholite, Prehnite, Apophyllite, Heulandite, Analcime or Cluthalite, Natrolite (var Fargite), Scolecite, Biotite, Delessite, Chlorophæite (var. Hullite). Talc-Steatite (var 2, Steatite), Saponite, Celadonite, Pilolite, Barytes, Celestine, Amber or Succinite, Guyaquillite, Petroleum, Elaterite, Anthracite.

FORFARSHIRE.

Galena, Quartz (var. *c*, Crystallised White and Cairngorm; var. Amethyst; var. Scarlet; var. Red; var. Dark Red; var. Zeolitic Quartz; var. Sard; var. Cachalong; var. Plasma; var. Agates, Fortification Agates, Onyx Agates, Eyed Agates, Faulted Agates, Brecciated Agates, Hæmachatæ, Discoid Agates, Ovoidal Agates, Potted Head Agates, Stalactitic Agates, Dendritic Agates, Mochas), Ilmenite, Magnetite, Göthite (var. 3, Onegite acicular), Calcite (var. Pellucid "Iceland Spar"), Dolomite, Aragonite (var. Satin Spar), Labradorite, Enstatite (var. Bronzite), Augite (var. Malacolite), Amphibole (var. Asbestos (Rigid Asbestos)), Tourmaline, Stilbite, Analcime or Cluthalite, Natrolite (var. Crockalite), Muscovite, Serpentine (var. 7), Common Talc-Steatite (var. 1, Foliated Talc), Saponite, Celadonite, Pilolite, Barytes, Gypsum.

HADDINGTONSHIRE.

Chalcocite, Tetrahedrite, Quartz (var. Amethyst; var. Aventurine, Chalcedony, Carnelian, Agate, Dendritic Agates, Jasp-Agates, Hornstone, Dendritic). Göthite (var. 3, Onegite, acicular; var. 5, Columnar or fibrous), Psilomelane, Calcite, Siderite, Chrysolite or Olivine, Analcime or Cluthalite, Natrolite, Muscovite, Talc-Steatite (var. 2, Steatite), Saponite, Celestine, Asphaltum.

HEBRIDES.

Graphite, Iron, Galena, Pyrrhotite, Pyrites, Quartz (*a*, Rock Crystal, colourless, pellucid, *b*, Massive Rock Crystal, *c*, Crystallised White Quartz and Cairngorm, Zeolitic Quartz, Massive Quartz, Snow-white, Milk Quartz, Massive, Blue, Pink, Rose, Yellowish Green, Green, Yellow, Chalcedony, Cachalong, Onyx, Plasma, Heliotrope, Hornstone, Basanite-Lydian Stone, Girasol Opal), Ilmenite, Iserine, Magnetite, Chromite, Pyrolusite, Limonite (var. 1, Compact fibrous; var. 2, Ocherous or earthy), Psilomelane, Calcite (var. Coloured; var. Fibrous), Dolomite, Malachite, Orthoclase (var. Sanidine), Microline, Graphic Granite, Albite, Oligoclase, Labradorite, Enstatite, Augite (var. Malacolite; var. Sahlite; var. Coccolite; var. Augite; var. Diallagic Augite; var. Hudsonite), Wollastonite, Amphibole (I., containing little or no Alumina; var. 1, Tremolite; var. 2, Actinolite; var. 4, Asbestos, Rigid Asbestos; var. 6, Nephrite; var. 7, Actinolite and Actinolite Slate, II., Aluminous; var. 11, Hornblende Slate), Riebeckite, Beryl, Nepheline, Garnet (var. 5, Common Garnet; var. 6, Almandite), Chrysolite or Olivine, Scapolite, Idocrase, Kyanite or Cyanite, Epidote, Allanite or Orthite, Tourmaline, Gyrolite, Apophyllite (var. Xonaltite; var. Tobermorite), Epistilbite, Stilbite, Gmelinite, Levyne, Analcime or Cluthalite, Muscovite, Biotite (var. Haughtonite, Lepidomelane), Penninite, Chlorite, Chlorophœite, Serpentine (var. 3, 4, Precious Serpentine; var. 7, Common; var. Serpentine Marbles), Talc-Steatite (var. 2, Steatite; var. Potstone), Saponite, Celadonite, Kaolin (var. Fuller's Earth), Pilolite, Titanite or Sphene, Apatite, Gypsum, Wolframite (Dana), Naphtha, Petrolium, Lignite.

INVERNESS-SHIRE.

Graphite, Silver, Copper, Stibnite, Molybdenite, Galena, Chalcocite, Pyrrhotite, Pyrites, Mispickel, Tetrahedrite, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. *b*, Massive Rock Crystal; var. *c*, Crystallised White Quartz and Cairngorm; var. Amethyst; var. Red; var. Snow-white; var. Milk Quartzic, Massive; var. Leek-green, Prase, Quartz; var. Sagenitic Quartz; var. Aventurine; var. Massive Grooved; var. Hornstone; var. Chert), Hæmatite (var. Specular Iron Ore), Ilmenite, Wad, Calcite (var. Stalactites), Orthoclase, Microcline, Graphic Granite, Oligoclase, Andesine, Labradorite, Augite (var. Funkite; var. Augite; var. Diallage Augite; var. Diallage), Wollastonite, Pectolite, Amphibole (I., containing little or no Alumina; var. 2, Actinolite; var. 3, Amianthus, Flexible Asbestus; var. 5, Byssolite; II., Aluminous; var. 8, Actinolitic Hornblende; var. 9, Edenite; var. 11, Hornblende Slate; var. Hydrous Anthophyllite), Abriachanite or Crocodilite, Garnet (var. Essonite (Cinnamon Stone); var. 5, Common Garnet; var. 6, Almandite), Scapolite, Kyanite or Cyanite, Zoizite, Epidote, Allanite or Orthite, Prehnite, Staurolite (var. "Xantholite,") Gyrolite, Apophyllite, Heulandite, Stilbite, Laumontite, Chabazite, Analcime or Cluthalite, Natrolite, Scolecite (Skye), Mesolite (Skye, &c.), Thomsonite (Skye); var. Faroelite (Skye, Eigg), Muscovite (var. Red Mica), Agalmatolite, Biotite (var. Haughtonite, Lepidomelane), Chlorite, Serpentine (var. 3, 4, Precious Serpentine; var. 7, Common; var. Serpentine Marbles), Balvraidite, Titanite or Sphene, Apatite, Celestine.

KINCARDINESHIRE.

Mispickel, Quartz (var. *b*, Massive Rock Crystal; var. *c*, Crystallised White Quartz and Cairngorm; var. Amethyst; var. Zeolitic Quartz; var. Heliotrope; var. Agates; var. Onyx Agates; var. Eyed Agates; var. Jasper, Ferruginous, Girasol Opal), Magnetite, Limonite (var. 2, Ocherous or earthy), Calcite, Orthoclase, Microcline, Graphic Granite, Beryl, Kyanite or Cyanite, Epidote, Prehnite, Tourmaline, Heulandite, Stilbite, Laumontite, Analcime or Cluthalite, Natrolite, Muscovite (var. Margarodite), Biotite (var. Haughtonite), Chlorite, Delessite, Saponite, Celadonite, Pilolite, Apatite.

KIRKCUDBRIGHTSHIRE.

Graphite, Arsenic, Molybdenite, Galena, Blende, Nickelite, Pyrrhotite, Chalcopyrites, Pyrites, Mispickel, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. Amethyst; var. Hornstone), Cuprite, Melaconite, Hæmatite (var. Specular Iron Ore; var. Red Hæmatite), Ilmenite, Göthite (var. 1, Thin scale-like Crystals, tabular), Manganite, Psilomelane, Calcite, Dolomite, Siderite, Aragonite, Malachite, Azurite, Microcline, Graphic Granite, Amphibole (I., containing little or no Alumina; var. 2, Actinolite; II., Aluminous; var. 10, Hornblende Proper), Garnet (var. 5, Common Garnet), Andalusite, Epidote, Allanite or Orthite, Tourmaline, Kaolin (var. Lithomarge), Titanite or Sphene, Pyromorphite, Barytes, Linarite, Wulfenite, Asphaltum, Anthracite, Platinum (?).

LANARKSHIRE.

Gold, Iron, Galena, Blende, Millerite, Nickelite, Chalcopyrites, Pyrites, Quartz (var. *c*, White Quartz and Cairngorm; var. Chalcedony; var. Hornstone; var. Chert; var. Basanite or Lydian Stone), Melaconite, Hæmatite (var. Red Hæmatite; var. Earthy), Plattnerite, Limonite (var. 1, Compact fibrous; var. 3, Brown Clay Ironstone, Limnite), Psilomelane, Wad, Calcite (var. Fibrous), Dolomite, Siderite, Aragonite, Cerussite, Malachite, Aurichalcite, Hydrocerussite, Idocrase, Stilbite, Laumontite, Analcime or Cluthalite, Mesolite, Saponite, Kaolin, Chrysocolla, Pilolite, Pyromorphite, Mimetite, Vanadinite, Barytes, Anglesite, Vanquelinite, Leadhillite (var. Susannite), Lanarkite, Caledonite, Linarite, Gypsum, Eosite (?).

LINLITHGOWSHIRE.

Arsenic, Silver, Galena, Blende, Nickelite, Chalcopyrite, Smaltine, Quartz (var. Hornstone), Hæmatite (var. Earthy), Iserine, Magnetite, Calcite, Dolomite, Orthoclase (var. Sanidine), Labradorite, Prehnite, Analcime or Cluthalite, Barytes, Ozocerite, Bathvillite, Torbanite, Middletonite, Guyaquillite, Naphtha, Elaterite, Anthracite.

NAIRNSHIRE.

Pyrites, Calcite.

ORKNEY.

Copper, Galena, Blende, Marcasite, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. Babel Quartz, or rather Babel Cairngorm; var. Aventurine; var. Iron Flint;

var. Basanite or Lydian Stone; var. Jasper Dendritic), Hæmatite (var. Red Hæmatite; var. Earthy), Iserine, Göthite (var. 2, In acicular Crystals, Needle Ironstone, Fleches d'amour, Sammet; var. 5, Columnar or fibrous), Limonite (var. 1, Compact fibrous), Psilomelane, Wad, Calcite (var. Coloured; var. Stalactites), Dolomite, Aragonite (var. Satin Spar), Malachite, Azurite, Orthoclase, Microcline, Augite, Garnet (var. 5, Common Garnet), Heulandite, Analcime or Cluthalite, Celadonite, Titanite or Sphene, in Syenite, Apatite, Barytes, Naphtha, Petroleum, Albertite, Cloustonite, Lignite, Peat Jet.

PEEBLESSHIRE.

Galena, Chalcopyrite, Quartz (var. *c*, Crystallised White Quartz and Cairngorm; var. Agate; var. Fortification Agates; var. Brecciated Agates; var. Basanite or Lydian Stone; var. Jasper, Ribbon), Wad.

PERTHSHIRE.

Graphite, Arsenic, Gold, Silver, Copper, Stibnite, Molybdenite, Galena, Chalcocite, Blende, Pyrrhotite, Bornite, Chalcopyrites, Pyrites, Mispickel, Tetrahedrite, Fluor, Quartz (var. *c*, Crystallised White Quartz and Cairngorm; var. Pink; var. Zeolitic Quartz; var. Snow-white; var. Yellowish-green, Green; var. Yellow; var. Leek-Green, Prase; var. Sagenitic Quartz; var. Aventurine; var. Heliotrope; var. Agate; var. Fortification Agates; var. Eyed Agates; var. Discoid Agates; var. Ovoidal Agates; var. Stalactitic Agates; var. Hornstone; var. Basanite or Lydian Stone Girasol Opal), Hæmatite (var. Red Hæmatite), Ilmenite, Chromite, Rutile, Göthite (var. 3, Onegite acicular; var. 5, Columnar or fibrous), Limonite (var. 3, Brown Clay Ironstone), Brucite, Calcite (var. Coloured; var. Foliated (Schiffer Spar); var. Pulverulent, Rock Milk), Dolomite, Siderite, Aragonite (Satin Spar), Cerussite, Malachite, Azurite, Microcline, Albite, Augite (var. Sahlite), Amphibole (I., containing little or no Alumina; var. 1, Tremolite; var. 2, Actinolite; var. 4, Asbestus; II., Aluminous; var. 9, Edenite; var. 10, Hornblende Proper), Beryl, Garnet (var. 5, Common Garnet), Andalusite, Kyanite or Cyanite, Datholite, Epidote, Prehnite, Tourmaline, Heulandite, Stilbite, Laumontite, Chabazite, Analcime or Cluthalite, Natrolite (var. Fargite), Muscovite (var. Margarodite), Biotite, Ripidolite, Penninite, Chlorite, Serpentine (var. 2, Picrolite; var. 7, Common; var. Serpentine Marbles), Talc-Steatite (var. 1, Foliated Talc; var. 2, Steatite; var. Potstone), Saponite, Celadonite, Titanite or Sphene, Apatite, Barytes.

RENFREWSHIRE.

Copper, Greenockite, Millerite, Bornite, Salmiac, Fluor, Quartz (var. *c*, Crystallised White Quartz and Cairngorm; var. Zeolitic Quartz; var. Chert), Hæmatite (var. Specular Iron Ore), Göthite (var. 1, thin scale-like Crystals, tabular; var. 2, In acicular crystals, Needle Ironstone, Fleches d'amour, Sammet; var. 5, Columnar or fibrous), Wad, Calcite (var. Pellucid, "Iceland Spar;" var. Coloured), Dolomite, Aragonite, Malachite, Orthoclase (var. Erythrite), Albite (var. Perthite), Pectolite, Chrysolite or Olivine, Datholite, Prehnite, Heulandite, Phillipsite, Stilbite, Laumontite, Chabazite, Analcime or Cluthalite, Natrolite, Mesolite, Thomsonite, Delessite, Saponite, Celadonite, Barytes, Gypsum, Epsomite, Melanterite, Alum, Asphaltum.

ROSS-SHIRE AND CROMARTY.

Graphite, Molybdenite, Galena, Pyrrhotite, Bornite, Pyrites, Fluor, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. *c*, Crystallised White Quartz and Cairngorm; var. Amethyst; var. Massive Quartz, Snow-white; var. Purple: var. Leek-green, Prase; var. Sagenitic Quartz; var. Fetid Quartz), Hæmatite (var. Specular Iron Ore), Magnetite, Rutile, Psilomelane, Calcite, Malachite, Orthoclase, Microcline, Albite (var. Perthite), Augite, Amianthiform (var. Malacolite; var. Sahlite; var. Coccolite; var. Funkite) Amphibole (II., Aluminous; var. 11, Hornblende Slate), Beryl, Garnet (var. Essonite or Cinnamon Stone; var. 5, Common Garnet; var. 7, Precious Garnet), Zoizite, Epidote, Allanite or Orthite, Tourmaline, Stilbite, Analcime or Cluthalite, Mesolite, Muscovite, Agalmatolite, Biotite, (var. Lepidomelane), Serpentine (var. Serpentine Marbles), Titanite or Sphene, Apatite, Fichtelite (Dana), Albertite, Anthracite.

ROXBURGHSHIRE.

Quartz (var. Leek-green, Prase; var. Carnelian; var. Agate; var. Moss Agates; var. Chert; var. Jasper-Dendritic; var. Jasper-Ribbon), Hæmatite (var. Specular Iron Ore; var. Red Hæmatite), Limonite (var. 3, Brown Clay Ironstone), Calcite, Dolomite, Orthoclase (var. Sanidine), Labradorite, Amphibole (II., Aluminous; var. 10, Hornblende Proper), Chrysolite or Olivine, Barytes, Gypsum, Anthracite.

SHETLAND.

Graphite, Copper, Iron, Chalcocite, Chalcopyrites, Pyrites, Tetrahedrite, Fluor, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. *c*, Crystallised White Quartz and Cairngorm; var. Amethyst; var. Purple; var. Purple-pink; var. Pink; var. Rose; var. Agate), Hæmatite (var. Elba Iron Ore; var. Specular Iron Ore; var. Red Hæmatite), Ilmenite, Magnetite, Chromiferous Magnetite, Chromite, Rutile, Göthite (var. 4, Feathery Columnar to scaly fibrous; var. 5, Columnar or fibrous), Limonite (var. 3, Brown Clay Ironstone), Brucite, Igelströmite, Psilomelane, Wad, Calcite, Dolomite, Ankerite, Magnesite (var. Brunnerite), Siderite (var. Sideroplesite), Aragonite, Malachite, Azurite, Hydromagnesite, Hibbertite, Zaratite, Orthoclase, Microcline, Albite, Labradorite, Anorthite, Enstatite (var. Bronzite), Augite (var. Sahlite; var. Funkite; var. Diallage), Anthophillite, Amphibole (I., containing little or no Alumina; var. 1, Tremolite; var. 2, Actinolite; var. 3, Amianthus (Flexible Asbestos); var. 4, Asbestos (Rigid Asbestos); var. 6, Nephrite; var. 7, Actinolite and Actinolite Slate, II., Aluminous; var. 10, Hornblende Proper; var. 11, Hornblende Slate), Iolite, Garnet (var. 5, Common Garnet), Kyanite or Cyanite, Epidote, Prehnite, Tourmaline, Staurolite, Henlandite, Muscovite (var. Margarodite), Biotite (var. Haughtonite, Lepidomelane), Chloritoid, Ripidolite, Penninite, Chlorite, Serpentine (var. 1, Chrysotile; var. 2, Picrolite; var. 3, 4, Precious Serpentine; var. 6, Williamsonite; var. 7, Common Serpentine), Talc-Steatite (var. 1, Foliated Talc; var. Nemalite or fibrous Talc; var. 2), Steatite (var. Potstone), Saponite, Kaolin (var. Nacrite), Pilolite, Titanite or Sphene, Apatite, Barytes, Xanthosiderite (?).

STIRLINGSHIRE.

Bismuth, Silver, Copper, Stibnite? Argentite, Galena, Chalcocite, Nickelite, Chalcopyrites, Pyrites, Smaltine, Mispickel, Tetrahedrite, Quartz (var. Amethyst; var. Zeolitic Quartz; var. Agate; var. Jasper, Dendritic), Chromite, Göthite (var. 2, in acicular Crystals, Needle Ironstone, Fleches d'amour, Sammet), Wad, Calcite, Malachite, Labradorite, Enstatite (var. Bronzite, Pectolite), Chrysolite or Olivine, Epidote, Prehnite, Apophyllite, Heulandite, Harmotome, Stilbite, Laumontite, Chabazite, Analcime or Cluthalite, Natrolite, Thomsonite, Talc-Steatite (var. 2, Steatite), Titanite or Sphene, Barytes, Gypsum, Alum, Anthracite.

SUTHERLAND.

Gold, Electrum, Iron, Molybdenite, Pyrrhotite, Chalcopyrites, Pyrites, Fluor, Quartz (var. *a*, Rock Crystal, colourless, pellucid; var. *c*, Crystallised White Quartz and Cairngorm; var. Aventurine; var. Jasp-Agates; var. Flint; var. Chert; var. Jasper Dendritic), Hæmatite (var. Specular Iron Ore; var. Earthy), Ilmenite, Iserine, Magnetite, Rutile, Pyrolusite, Göthite (var. 3, Onegite, acicular; var. 5, Columnar or fibrous), Psilomelane, Calcite, Dolomite (var. Dolomite Magnesian Marbles), Strontianite, Azurite, Orthoclase, Microcline, Graphic Granite, Albite (var. Radiated Cleavelandite), Oligoclase, Andesine, Anorthite, Augite (var. Amianthiform, Malacolite; var. Sahlite; var. Funkite), Babingtonite, Amphibole (I., containing little or no Alumina; var. 1, Tremolite; var. 2. Actinolite; var. 7, Actinolite and Actinolite Slate, II., Aluminous; var. 8, Actinolitic Hornblende; var. 11, Hornblende Slate, Hydrous Anthrophyllite), Garnet (var. 5, Common Garnet; var. 6, Almandite), Scapolite, Topaz, Andalusite, Epidote, Allanite or Orthite, Tourmaline, Muscovite (var. Margarodite; var. Sericitic Mica, Agalmatolite, Biotite (var. Haughtonite, Lepidomelane), Ripidolite, Chlorite, Serpentine (var. Serpentine Marbles), Talc-Steatite (var. 1, Foliated Talc; var. 2, Steatite), Kaolin, Bhreckite or Vreckite, Titanite or Sphene, Apatite, Barytes, Lignite.

WIGTONSHIRE.

Molybdenite, Galena, Anthracite, Lignite; var. Peat Jet.

THE MINERALOGY OF SCOTLAND.

Class I. NATIVE ELEMENTS.

Sub-Class I. NON-METALS.

[NOTE.—*The number preceding the name of the Mineral species is that of its place in the list of Scottish Minerals; the number enclosed in parentheses following the name is that adopted for the Mineral species by Dana, in the 6th Edition of his* System of Mineralogy. *Miller's symbols are taken from Phillips'* Mineralogy, *edition of* 1852; *and those of Bravais are from Goldschmidt's* Index der Crystallformen der Mineralien.]

1. **Graphite (2).** C.

Rhombohedral, with rhombohedral faces with angle 85° 29′; or, doubtfully, monoclinic. Generally in curved scaly crystals, or fine-granular to compact. Clv., basal. Lustre metallic. Colour black to dark steel-grey; streak black and shining. Very sectile. Flexible in thin laminæ. Feels greasy. Leaves a mark of its own colour on paper; conducts electricity. Powder adherent and coherent, and so may be used for burnishing. Opaque. H = 0·5 to 1; S.G. 1·8 to 2·3.

B.B. *Per se* burns with difficulty. With reagents infusible also, but deflagrates with nitre. Insoluble in acids when pure; when the sample is impure, these acids dissolve out certain of the impurities. Comp., carbon, sometimes with traces of volatile matters, and, generally, with ash—silica, alumina, and iron oxide—from 5 to 40 per cent.

Occurs in granite, gneiss, mica schist, crystalline limestone, and igneous rocks. Not yet found in Scotland in granite.

	C.	Ash.	Loss at Red Heat.	Loss at 212°.	
1. Strathfarrar, S.G. 2·416,	75·	20·93	4·07	0	100
2. Killiemore, Mull, 2·17,	83·56	14·93	·96	·55	100
3. Rothiemay,	55·88	38·12	3·80	2·20	100
4. Bodieba, Cabrach,	45·39	40·30	5·51	8·8	100
5. Craigman, Marchburn (columnar), 1·84	82·82	12·86	2·46	1·86	100

The Cabrach Graphite was more completely analysed and yielded:—

Carbon,	45·39
Silica,	15·
Alumina,	5·308
Ferric oxide,	2·529
Ferrous oxide,	3·85
Manganous oxide,	2·769
Lime,	2·461
Magnesia,	8·384
Volatile at red heat,	5·509
„ „ 212°,	8·8
	100·000

Ross-shire. In Strath Farrar, about 22 miles above Beauly, in north-east and south-west nearly vertical veins, which widen into irregular masses, in brown mica gneiss, with dip of 25°, on the north side of the River Beauly—scaly, foliated, and compact. In 1818 five tons were extracted, which sold for £93 each; the cost of raising was £13 per ton. It is associated here with felspar, quartz, mica, and garnet. The rock near the old workings now shows only scales of Graphite taking the place of mica—Anal. 1. At † Toulassie, 11 miles north of Mam Soul. One mile above Eskadale, on the south side of the River Beauly; on the south side of the river in strings and lumps. One, of a cubic foot, lay long at the hall-door of Beauly Castle. "In Strath Conan."

Inverness-shire. In a vein about 1 mile from the Caledonian Canal, near the top of a rocky ravine, about 1100 feet from the water level near the head of Loch Lochy on its south-east side. The ravine is on the west side of Leacann Doire Bannear. The vein, which is in rotting schist, was about 3 feet wide. About two tons were raised in 1825. In Glen Urquhart, in the upper quarry of crystalline limestone, in small lumps of fine quality, but rarely. "In limestone above Keppoch."

Mull. Near Pennycross (Earl Compton, 1821), in the estate of Killiemore, 2 miles from the head of Loch Scridain; found near the surface, in massive granular lumps—Anal. 2.

Aberdeenshire. Near Huntly, old mines immediately below the bridge over the Deveron, on its south bank, and at its junction with the Bogie. "In a ravine near the manse of Strath Don." Immediately north of Rothiemay Station, in small scaly lumps in a rotting trap—Anal. 3. In the Cabrach, 300 yards below the farm of Bodiebae, near the water side, in a vertical vein a few inches thick, scaly, soft, and much resembling Rubinglimmer until rubbed—Anal. 4 and 6.

Banffshire. Was mined formerly immediately to the west and south of the great Saussurite bed at Portsoy. It was here massive. It also occurs near John Legg's Well there, and at Cairney, Drumdelgie, and Broadland.

AYRSHIRE. At Stair, on the lands of Dalmore, with antimony and copper. At Marchburn, between Dalmellington and Cumnock, in the Craigman coal-mine. It is compact, scaly, and columnar (Anal. 5), 6 feet below trap, occurring along with cherry coal. In the banks of the Ayr river, of a coarse quality, about 8 miles east of Ayr, near the locality whence the Water of Ayr hones are obtained. At Taiglum, in the bed of the Ayr. At Hurlford, 2 miles from Kilmarnock.

KIRKCUDBRIGHT. At Palnure, near Cairnsmore, Newton Stewart, with Mispickel.

Scale *crystals* of Graphite imbedded in crystalline limestone, and associated with "primitive" limestone minerals, occur at Glen Elg, Inverness-shire (Jameson); in Aberdeenshire, at Muir and Midstrath, Aboyne, with Sahlite, Malacolite, and Sphene; at Eslie, 4 miles west of Laurencekirk, Kincardineshire, with Sahlite, Pyrrhotite, Apatite, Sphene, and Margarodite; at Corntulloch, near Loch Kinord, Aberdeenshire, with Pyrrhotite, Malacolite, and Wollastonite.

Replacing mica in schistose rocks, Graphite occurs in Shetland, in Fetlar, at the Black Geo, Trista Voe. The bed of the rock is vertical, and it is finely plicated. It has a highly metalline lustre. It contains also Muscovite and Pyrite. The analysis of its mass is No. 1, and of the most highly graphitic portions, No. 2, p. 4. Dr Fleming erroneously thought it alum shale. This bed can be traced, still vertical, through Uyea Island, and entering the shore of Unst, on the north side of the Uyea Sound.

ROSS-SHIRE. "In a rock at the roadside half-way up the steep road from Rosemarkie to Cromarty Road."

ARGYLLSHIRE. At Oban, in the belt of rock which lies between the town and the drained lake. The Graphite occurs at a depth of 25 feet in thin veins, which run south-west. It is very soft—Anal. 3. A brown pulverulent cake appears occasionally on the slate rocks near Oban.

PERTHSHIRE. Half a mile south of the Spital of Glen Shee, in the banks of a stream on the west side of the road, in a dull black, highly contorted schist. This occasionally carries rude but brilliant crystals of Graphite, along with Hornblende and Calcite—Anal. 4. On the south-west foot of Beinn Gulabin, near Seanna Bhaile, unconvoluted and more lustrous. At Craig Arus, the north-west end of above ridge, a large bed with felspar veins. West side of the slack of † Cairn Tau, and on the west shoulder of that hill, looking to Craggan. In the west corrie of Glen Beag, similar to the Glen Shee specimens, but less convoluted and without definite crystals —Anal. 5. The above graphitic schists for the most part soil the fingers.

At Corrycharmaig, Glen Lochay, with Picrolite and Chromite. "Near Tyndrum."

ANALYSES OF GRAPHITIC SCHISTS.

	C.	Ash.	Loss at Red Heat.	Loss at 212°.
1. Trista rock, ...	1·216	94·706	4·078	·6
2. Do., picked masses, . .	8·646	85·158	5·075	1·121
3. Oban, S.G. 1·579, . . .	1·025	92·87	5·6	·505
4. Glen Shee, 2·395, . . .	14·408	81·991	2·843	·758
5. Glen Beag, ...	15·278	81·092	3·01	·62

Graphite has been vaguely stated to occur in the Braid and Calton Hills. [The mineral observed was Anthracite.]

Sub-Class II. SEMI-METALS.

2. **Arsenic** (8). As. Native Arsenic.

Rhombohedral; *r r* 87° 35′, but very rarely crystallised. Clv., basal. Generally massive, granular, or reticulated and hackly; or in botryoidal investing layers of numberless coats which when recently separated have a splendent metallic lustre. Fracture and streak the same, but rapidly tarnishing brown-black, the colour of the ordinary surface, which is dull. Fracture hackly. H., 3·5; G., 5·7 to 5·93.

When rubbed or heated, gives out a garlic-like odour. B.B., volatilises in white fumes, and burns with a blue flame at a red heat. Comp., arsenic, generally with a little antimony.

Occurs in gneiss, the associate of nickel, cobalt, bismuth, and antimony ores.

At the † Menimure Burn, Cassencarrie, near Fleet, in Kirkcudbright, Niccolite is coated with very minute crystals presenting four faces of a dull brown-black colour, and without lustre. These crystals when heated volatilise with odour of garlic. They are lustrous when bruised.

Said to have occurred at Tyndrum in Perthshire.

At Hilderston Hills, near Bathgate, Linlithgowshire, traces upon Kupfernickel.

3. **Bismuth** (11). Bi. Native Bismuth.

Rhombohedral; *r r* 87° 40′. Generally crystalline, *r*, *c r*. Clv., *c*, perfect and very facile. Also in reticulated forms, arrow-head twins, or arborescent. Fracture easy, but falling into the cleavage faces. Sectile.

Reddish-white, but often tarnished red, blue, brown, or grey. H., 2·5; G., 9·6 to 9·8.

Fusible in candle flame. B.B., volatilises, leaving a citron-yellow crust, oxide of bismuth. Sol. in n. acid; solution is precipitated white when poured into water. Comp., bismuth, with traces of arsenic.

Occurs in veins in gneiss and clay slate, associated with cobalt, silver, lead, and tin ores.

STIRLINGSHIRE. At the old mine at Alva, reticulated, associated immediately with Erythrite and Native Silver, and near Argentite, Smaltite, and Chalcopyrite.

Sub-Class III. METALS.

4. **Gold (13).** Au. Native Gold.

Cubic. Clv., none. Fracture hackly. Crystals small, generally elongated and distorted. Capillary, arborescent, and in plates. Frequently in loose rounded masses, or in small angular grains, among gravel or clay. Lustre metallic, but frequently dull through attrition, or being encrusted by red-brown ochry matter. Colour from pale yellow to orange-red. Streak, gold yellow to pale yellow. Malleable, ductile, and sectile; the purest varieties the most so, and the softest. H., 2·5 to 3; G., 15·5 to 19·5.

B.B., easily fusible. Soluble only in mixed h. and n. acids, generally with separation of white silver chlorides, and soluble the more rapidly the less silver is present. Solution yellow, stains the skin purple-red with corrosion. Solution precipitated by solution of ferrous sulphate as a red-brown precipitate, which becomes gold yellow with metallic lustre after friction. Comp., gold, with more or less silver—from ·72 to 26 per cent.; rarely with iron or copper, under 1 per cent.

Found in beds or in veins, generally of quartz, in metamorphic rocks of a schistose nature. Rarely in diorite and porphyry, and very rarely in granite. Its usual associates are earthy Limonite (keels) from the decomposition of Pyrite, Hæmatite, and Magnetite. Occurs also in microscopic grains in vein-quartz, from which it may be extracted by crushing and amalgamation.

Localities.—These have been divided into (1) the *undoubted*; (2) those which *have been* doubted; (3) the *improbable*; and (4) such as have been proved to be *false*.

(1) SUTHERLANDSHIRE. In the north-east of the county in the Helmsdale and Brora districts, loose in grains, scales, and nuggets, in river gravel, delta detritus, and strath drift. Only in the streams which cut trenches in gneissose rocks, and so probably transported from no great

distance. The adherent associates of the nuggets being quartz and broken crystals of felspar, leads to the belief that the matrix had been exfiltration veins in the rock. Among the chief localities were—the Crask: a small quantity at the head of Clyne-Milton Burn, over flaggy gneiss. Strath Brora; the Blackwater, small scales from drift over micaceous schist with interbedded granite; also at Kilcalmkill. Strath Ullie, Helmsdale River: flaggy micaceous and gneissose beds traversed by granite, very rich washing in river side-pockets above Crask Bridge. Kildonan Burn: quartzose and gneissose, with quartz veins enclosed in chloritic clay, felspathic rock being present in small amount. The drift here is clearly of local origin. It is generally a ferruginous gravel, above which is yellow clay, overlain with coarse sand, which contains flexed dark earthy lines in section, the whole being covered with thin peat moss. (Anal. of small nuggets, 1.) Gold is here found in greatest quantity in the lowest part of the alluvium, but occasionally from the wash dirt immediately under the turf. Suisgill: flaggy gneissose rocks with much felspathic rock interbedded. The more friable felspathic varieties of the latter rock are readily disintegrated, forming sometimes a white plastic clay, sometimes a gritty sand. Towards the head of the stream this and other large-grained friable granitiform rocks become abundant, forming slopes of granular grit (Anal. 3, 4, 5; 5 was on scale the size of the little finger nail). Allt an Fhionnfhuaraidh: the same rock as Suisgill. A half-inch water-rolled pellet contained gold mixed with felspar and quartz. Allt Ceann a' Phris: red granitiform rocks with flaggy beds. A small nugget 5 dwts., and a good deal of granular gold. The associates of the gold at these localities were keels in unusually small quantity, magnetic iron sand, variety undetermined, black Rutiles, size of peas, rarely; minute garnets, and Specular Iron. The largest nuggets found in Sutherland are one found at Kildonan in 1840, which weighed nearly 1 oz., and one found in 1869 at Suisgill, which weighed 2 oz. 17 grains (Plate I. fig. 1).

	Gold.	Silver.	Iron.	Silica.		
1. Kildonan, S.G., 15·612, .	80·34	19·86	·12	tr.	100·32	...
2. Suisgill, 15·799, . .	81·11	18·45	...	·14	99·7	D. Forbes.
3. ,, ...	81·27	18·47	...	·26	100·00	,,
4. ,, 15·698, . .	81·11	18·68	...	tr.	99·79	...
5. "Sutherland," . . .	79·22	20·78	...	...	100·00	Makins.
6. Leadhills, ...	86·60	12·39	·35	·66	100·00	Church.
7. Lang Cleuch, 17·52, .	87·32	11·80	·41	·22	99·75	...

Perthshire—Loch Tay. At Corriebuie mine, $1\frac{1}{2}$ miles east of Tomnadashan; in limestone overlying mica slate, at an elevation of about 2000 feet, veins carrying quartz and argentiferous galena; "native gold twice found in breaking the ore with the hammer" (Throst). About half a mile north-east of Loch Earn Head Station, about 300 feet up the north-west shoulder of Meall nan Uamh, a small quantity, with one piece rather lighter than half a sovereign.

LANARKSHIRE. At Leadhills, and at Wanlockhead in Dumfriesshire. With brown iron ochre, in the Scar Burn, upper waters of Wanlock, 5⅜ dwt. to the ton (Wilson). Similarly in a 9-inch vein in Glen Clach Burn, nearly 5 dwt. to the ton. In drift, and impacted in crevasses of the rock bed of many of the streams of the district; as in very small pale yellow grains in the Glen Clach Burn, and shotty, of almost an orange-red, in drift at the Lang Cleuch Burn. Many others of the streams of the district yield grains, with occasional nuggets up to 100 or more grains. During the reigns of James III., IV., and V. considerable quantities of gold were collected in the district, to the value of £200,000 it is said, during the reign of the last. The largest nuggets found at or near Leadhills are, one of 280 grains from the Windgate Burn, Green Louther. The Martin Nugget, which weighs 1 oz. 6 dwt. 6 gr. (Plate I. fig. 2), was found at Straightsteps Flat; and Lord Hopetoun has one, weighing 209 grs., found eighty years ago. There has, in the drift which contains the gold in this district, been a settling of the gold to a certain bed, possibly through long-continued water soaking. The banks of drift have an average arrangement as follows:—

8 feet of stiff clay with boulders,
8 feet of sand,
16 inches of till,
8 inches of auriferous clay,

bottom sometimes rock, and sometimes a bed of till, up to 2 feet in thickness.

AYRSHIRE—AILSA. The rock of Ailsa has been found by Blackwood to contain gold in many parts, but merely in microscopic quantity; the largest particle yet seen being less than five-thousandths of an inch in length.

(2) SUTHERLAND. Kildonan Burn, in an ochry quartz vein about 1 mile from mouth. In visible specks in the granite of Suisgill.

PERTHSHIRE. Glen Quaich, at Turrich, near Amulree. A nugget with a small amount of quartz, stated by Greg, once the owner, to weigh 2 oz. 1 dwt.; 1010 grains according to Dr Porteous. The correctness of the locality at which this nugget was said to have been found, some sixty years ago, has been questioned, upon the grounds that no other gold has been found at the spot, and that nothing is known of the find in the district. As Throst, however, writes: "6 miles south of Taymouth at Glen Quaich, large quantities of hepatic pyrites are found," the locality may be correct. The correctness of the locality assigned to several large specimens of gold quartz—those, namely, said to be from Leadhills—has been questioned upon grounds which, in some cases, have some force—the largest specimen in the Edinburgh Industrial Museum, termed the "Gemmel Specimen," upon the ground that it was found loose, close by the side of a public track or road, the day after a barrow full of lumps of Australian gold-quartz had been wheeled over it; also that its gold is of Australian, and not Scotch colour. The objections to the locality assigned to the "Jameson specimen," also in the Scottish Museum, have not the same force, if any; but the authenticity of the so-called "Wright specimen" in the British Museum is exceedingly doubtful.

(3) Gold was "said to have been discovered in quantity in Durness, Sutherland, by Gilbert de Moravia in 1245." A "large mass of malleable gold said to have been got by Captain Nicol from near Tyndrum." "Observed by Mr Tennant accompanying cubic pyrites near the Marquiss of Breadalbane's shooting-box, 9 miles south of Glencoe." "Raspe got a flake of gold when analysing some ores from Islay, and also silver." At Drumgowan, 2 miles from Dunideer, and in a burn side near New Leslie, Aberdeen. At Overhill, Belhelvie.

(4) Shetland—Unst—Ura, Breiwick. With Ilmenite sand. Ollaberry, at Back, in quartz veins in epidotic syenite.

East shore of Bute.

Kincardineshire. North of Finella Hill, at the Birnie Slack. The burn sinks from sight at the spot indicated, beneath a mass of quartz fragments of great depth. Any gold present must therefore be buried beneath this mass. The quartz contains none.

Minute traces of gold may occur in quartz in many localities; a thin bed which dips towards the sea at Kinnaird Head yielded less than 12 grains to the ton (Johnson, Matthey, & Co.).

Stephen Atkinson's *Discoverie and Historie of the Gold Myncs in Scotland* (Bannatyne Club, 1825), and Cochrane-Patrick's *Early Records relating to Mining in Scotland*, give much information as to numerous other localities which can hardly be said to be authenticated. From these the following may be considered as having been at their several dates at least admitted.

Between 1538 and 1542 the Crawford Moor working, placed under the charge of John Mossman, goldsmith, afforded much gold, of which 113 ozs. was used for making crowns for James V. and his Queen, for enlarging the King's chain and for making a belt for the Queen.

In 1567 a company, of which Cornelius de Vois was the head, obtained a licence from the Regent Murray to work all Scotch mines. They employed 120 hands in the Leadhill district alone. One of the workers, by name John Gibson, was particularly fortunate in finding nuggets of large size, some as big as birds' eggs. The Dutchman, Abraham Paterson, or Greybeard, got enough to make "a faire deepe bason," of sufficient size to hold an English gallon of liquor within the brim, which was presented by the Earl of Morton, one of the company, to the King of France. On one occasion, De Vois sent eight pounds of gold to the mint at Edinburgh within thirty days.

About 1579 Sir Bewis Bulmer got a patent from the king to search for gold and silver. He was most successful upon Henderland Moor in Ettrick Forest. He presented a porringer made of native Scottish gold to Queen Elizabeth. He found two large nuggets, one weighing six ounces of pure gold, and the other more than five ounces.

In 1603 George Bowes got a similar patent, but confining him to Wanlock Water. There or at Pontshields there was got one piece of 30 oz. and some "of greatere weight," "and in sondrey other places in bygnes of cherristones and some greatere pieces."

5. **Electrum (13).** Au_2Ag.

Massive. Yellowish-white to pale yellow. G., 12·5 to 15·5. Pliny gave the name to compounds of gold with silver whenever the proportion of the latter was 20 per cent. An alloy of 2 of gold to 1 of silver contains 21 per cent. of silver, so that the Sutherland gold approaches to electrum. A much poorer electrum, however, occurs there. The crushed quartz of a vein in the Suisgill Burn yields 39·2 grains of this to the ton. It contains

Gold, 28·57. Silver, 71·43.

It was associated with Magnetite, Ilmenite, and apparently metallic iron.

6. **Silver (14).** Ag. Native Silver.

Cubic. No cleavage. Fracture hackly. Crystals generally small and arranged in a clustered manner. Also filiform, arborescent, and in plates. These several forms sometimes project into cavities, but generally ramify through the mass of the rock. Lustre metallic. Colour and streak silver white; but the surface is generally stained yellow to black. Malleable, ductile, and sectile. H., 2·5 to 3; G., 10·3 to 11·1.

B.B., easily fusible. Soluble in n. acid; on addition of h. acid there is a white precipitate, which rapidly passes through blue to black. The n. acid solution stains the skin black. Comp., silver, with varying proportions of gold, copper, mercury, or other metals.

Occurs in gneiss, clay slate, limestone, and igneous rocks.

INVERNESS-SHIRE. At Bona, near Abriachan, on Loch Ness. Filiform-arborescent, with Native Copper, in a ferruginous gangue in gneiss.

PERTHSHIRE. Glen Esk, at Craigsoales lead mine, very rarely, upon crystals of Galena, filamentous.

STIRLINGSHIRE. At Alva, near Bridge of Allan, a mine was worked between the years 1710 and 1715, which yielded nearly £50,000 worth of silver. The veinstone was in "claystone porphyry" (Andesite). The greater part of the ore was the native metal, which ramified through a decomposing matrix, largely charged with Erythrite, Malachite, Calcite, and Barytes, in skeleton crystals, which delineated the axes of an octahedron by intersecting chains of minute octahedral crystals (Plate I.).[1] These were usually very minute; but the writer saw in an old collection a specimen which showed two of these semi-axes, one of which was above 1½ inches in length. The associated minerals were Argentite, Erythrite, Chalcopyrite, and arsenical iron. A still larger sum than what was drawn from this mine was sunk in continuing the working unsuccessfully. "At Tillicoultry, with ores of lead, copper, and cobalt."

ARGYLLSHIRE. Stated to have occurred in a capillary form in veins traversing the blue limestone of Islay. Said also to have occurred in Mull.

LINLITHGOWSHIRE. Was obtained in the year 1606; it was first found imbedded in a knitted form in Niccolite at the silver-lead mine at the north-east foot of Cairn-naple Hill, the highest of the Hilderston Hills. Atkinson, in his *Gold Mynes*, p. 47, thus speaks of the discovery of this mine. "It was found by meere fortune or chance of a collier, by name Sandy Maund, a Scotsman, as he sought about the skirts of those hills neere to the bourne or water of Hilderstone. He hit upon the heavy piece of redd-mettle; no man ever saw the like. It was raced with many small strings, like unto haiers, or thredds. He sought further into the ground, and found a peece of brownish sparr stone, and it was mosaic. He broke it with is mattocke, and it was white, and glittered within like unto small white copper-keese. They said, 'Where hadst thou it?' Quoth he, 'At the Silver Bourne, under the hill called Kerne-Popple.' He tooke it unto Mr Bulmer at the Lead-hill. Mr Bulmer did not trust to the first triall, because it proved rich; but went to it againe and againe, and still it proved rich, and wondrous rich. Shortly after I was brought thither myself, the myne being sett open. I was stricken down into the shaft called God's Blessing, and I brought up with me a most admirable peece of the Cacilla stone, parte whereof I kept still, and a parte thereof I sent for a token to London. The

[1] [Dr Heddle informed the editor that the specimen from which this remarkable figure was drawn is part of the Corse-Glen Collection, which has lately been acquired by the Corporation of Glasgow.]

manner how it grew was like unto the haire of a man's head, and the grasse in the fielde. And the vaine thereof, out of which I had it, was two inches thick, by measure and rule; the mettle thereof was both malliable and thoughe. It was coarse silver, worth 4s. vj[d] the ounce weight; not fine silver as is made by the art of man. The greatest quantity of silver that ever was gotten at God's Blessing was raised and fined out of the red-mettle; and the purest sort thereof contayned in it 24 ounce of fine silver upon every hundred weight; vallewed at vj score pounds starling the ton. And much of the same redd-mettle, by the assay, held twelve score pounds starling per ton weight. When I wrought on the first sorte of redd-metal for my Lord Advocate for Scotland, sundry times I refined it, and commonly for the space of three dayes weekly I made an hundred pounds starling each day. Until the same redd-metal came unto 12 faddomes deepe it remained still good; from thence into 30 faddome deepe it proved nought."

In fact, although below the 12 fathoms the Niccolite was still got in quantity it was no longer argentiferous, though "unaltered in colour, fashion and heavyness." So long as the Niccolite carried silver the profit from the mine was £500 per month. The galena associated with the Niccolite was argentiferous to the extent of $\frac{3}{4}$ oz. to the hundredweight. The Niccolite also occasionally carried native silver in cavities, as shown by a letter from Sir William Bowyer to Lord Salisbury of 2nd August 1608. He writes: "I spent some tym below in the mynes to see whether thes peces were then broken or kept of propos for my Lord of Dunbar cominge, which I ensew your Lo. was merlye as then it fell out: I allso to satisfye my seallfe braeke a pece belowe and in a hollowe of the sam I found a clew of sillver wyer as thoughe it had bin drawne by a goldsmithe, which art beinge absolutly perffett as pollished silluer." The range is now called the Bathgate Hills.

7. **Copper (15).** Cu. Native Copper.

Cubic. Twinned on the face of the octahedron. Crystals generally much distorted. Often in leaves, arborescent or filiform. No cleavage, fracture hackly. Lustre, when freshly exposed, brilliant-metallic, and colour golden-yellow to red. Rapidly becomes dull and copper-red. Streak copper-red. Sectile. Becomes brittle after prolonged bending. H., 2·5 to 3; G., 8·5 to 8·9.

B.B., fusibility 3, colouring the outer flame green; but when moistened with h. acid, blue. Soluble in n. acid, and in ammonia with access of air, forming a deep purple-blue solution. Comp., copper, nearly pure.

Occurs in many rocks, frequently in serpentine, or in igneous rocks associated with zeolites, and especially with Prehnite.

SHETLAND. In Unst, at the south-west corner of Haroldswick, with Malachite, in serpentine. In Mainland, at Sandlodge mine rarely, with Malachite.

ORKNEYS—BURRAY ISLAND. Formerly at its west end, in leaves and sprigs, with Galena.

INVERNESS-SHIRE. On the shores of Loch Ness at Bona, near Abriachan, along with Native Silver in a ferruginous gangue.

PERTHSHIRE. In Glen Farg. In the upper railway tunnel, with earthy Malachite, in Prehnite; rarely crystallised (Plate I.).

STIRLINGSHIRE. Formerly at Blair Logie, with Chrysocolla in Barytes. At the north end of Mugdock tunnel, in thin leaves upon the surface of Prehnite.

EDINBURGH. In the Calton Hill, below the old Observatory, with Jasper and Barytes.

RENFREWSHIRE. At Boyleston Quarry, near Barrhead. It here occurs in four ways:—1. In delicate leaves and flat lumps, up to seven ounces in weight, in rents in a hard, dense band, which crosses the quarry from east to west. When the rents are opened up the copper has an orange-red to golden colour, and a very high lustre. 2. In distorted but very brilliant crystals, which are sprinkled throughout crystals of pellucid Calcite, and sometimes throughout the mass of Prehnite. 3. Very rarely in cavities in rough crystals. 4. In divergent strings with Calcite and Prehnite, which lie between the radiating crystals of the Prehnite and communicate to it a rich brown colour. When the Copper protrudes above the surface of the Prehnite it is coated with Chrysocolla, or with Malachite. It is said to occur also near Neilston.

AYRSHIRE. In thin plates between the beds of the New Red Sandstone in the railway tunnel near Mauchline. At Pinbain, north of Lendalfoot, in the beach rocks, with tufts of white Pectolite, in Anorthite.

8. **Iron (25).** Fe. Native Iron. Meteoric Iron.

Cubic. In plates or disseminated in grains. Fracture hackly. Clv., octahedral. Lustre metallic. Steel grey to iron black. Malleable and ductile. Opaque. Strongly magnetic. Streak shining. H., 4·5; G., 7 to 7·8.

B.B., infusible. Soluble in h. acid. Precipitates an acidulated solution of a copper salt.

Two kinds: (*a*) *Telluric Iron.* Comp., almost pure iron. It sometimes contains carbon, and also nickel. (*b*) *Meteoric Iron,* steel-grey to silver-white. Comp., iron, with generally nickel, cobalt, copper, and associated with imbedded minerals, which are not terrestrial. When polished and etched by a mixture of nitric and acetic acids this variety discloses a structure more complex than can be assigned to a simple cubic crystal; showing a dimmed surface, from which projects a system of unaffected and brilliant interlacing figures; along the edges of which the greater part of the nickel is segregated. Many have occluded hydrogen in their pores; this is set free when they are dissolved in acids. Most display pitted depressions upon their surface, similar to the surface of iron which has been subjected to the action of sudden detonators.

Telluric Iron.

SHETLAND—UNST. In the sands of the Dale Burn, a little above where it turns to the north. These sands contain a black chromiferous Magnetite, the native iron forming the centres of some of the grains. These dissolved in acid without residue, and precipitated an acidulated salt of copper. They were laminable and strongly magnetic.

SUTHERLANDSHIRE—TONGUE. On the west slopes of Ben Bhreac in the large boulder of Ben Loyal "syenite"; with Amazonstone, Thorite, Fluorite, and many other minerals, and forming the centres of crystals of Magnetite. Almost entirely soluble in h. acid. Suisgill Burn; in a quartz vein in the granite, along with Electrum, Ilmenite, and Magnetite, a laminable, magnetic, metallic, iron was obtained from the crushed rock, which contained ·79 per cent. of carbon with silica. Its source was, however, not obvious.

HEBRIDES. "In the igneous rocks of the Hebrides" (Buchanan).

Meteoric Iron.

LANARKSHIRE—LEADHILLS. A single small angular and somewhat rounded mass, with a closely crystalline texture. It is extremely hard, and on its polished surface shows small triangular figures, more brilliant than the rest of the surface. Found by Da Costa, and now in the British Museum.

In the *Annals of Philosophy*, vol. xiii., there is the following note upon this iron:—"Native Iron, by Mr H. M. Da Costa, M.W.S. The specimen was found associated with galena, and was discovered by the workmen from its resisting the blows of a hammer. It was found to be composed of Iron 16·5, Silica 1, loss chiefly Sulphur 0·5." Its meteoric origin is thus very problematical.

ROXBURGH—NEWSTEAD. A mass $11\frac{1}{2}$ inches in length by 7 inches broad, and weighing 32 lbs. 11 oz., was dug up in a garden, in the year 1819 or 1820. Its specific gravity was 6·517. Its analysis yielded—Iron 93·51, Nickel 4·86, Silica 0·91, Carbon 0·59—Total 99·87. The Widmanstätten figures are not well developed.

Class II. SULPHIDES, &c., OF THE SEMI-METALS.

Sub-Class I. SULPHIDES, SELENIDES, TELLURIDES OF THE SEMI-METALS.

9. **Stibnite (28).** Sb_2S_3.

[Orthorhombic; *a* 100, *b* 010, *c* 001, *p* 111, *m* 110, *u* 101, *x* 102, *s* 113, *v* 211.] *mm* 89° 6′, *pp′* 109° 26′, *pp″* 108° 21′, *p′p″* 110° 30′, *va* 144° 45′, *ps* 150° 25′, *ms* 115° 40′, *ca* 90°, *ax* 117° 4′, *au* 135° 36′.

Lateral planes deeply striated parallel to their intersections. Cleavage *a*, very perfect and brilliant; *m*, less perfect; *b* and *c*, still less so. Often coarse or fine columnar; often reticulated, also granular and rarely impalpable. Fracture conchoidal, small, and imperfect. Opaque. Lustre brilliant-metallic. Lead grey to steel grey; acquires a black to steel-blue tarnish; is often iridescent. Streak, lead-grey. Sectile. Thin laminæ slightly flexible. H., 2; G., 4·6 to 4·7.

In the open tube yields first a sublimate of antimonious acid, and then of oxide of antimony, with evolution of sulphurous fumes; the white deposit is non-volatile B.B. On charcoal, fuses easily, spreads out with evolution of sulphurous fumes, leaving a white deposit, which, when treated in the R. flame, tinges it greenish-blue. Soluble in warm h. acid, leaving occasionally a slight deposit of chloride of lead. Decomposed by n. acid, leaving oxide of antimony. Decomposed also by caustic potash. The solution yields, on the addition of h. acid, a yellowish-red flaky precipitate.

Occurs, sometimes disseminated, in beds, but usually in veins with Quartz, Blende, and Barytes.

Comp., Antimony, 71·8; Sulphur, 28·2.

Banffshire. At Maisley, near Keith, radiated and foliated, with purple Fluor, in limestone (Cunningham).

Ayrshire. At Harehill, near New Cumnock, with Cervantite and Quartz, in a vein near dolerite.

Dumfriesshire. At Glendinning, in the parish of Westerkirk, about 10 miles from Langholm. In a vein 20 inches thick, with Quartz, Calcite, and Blende. From 1793 to 1798 yielded 100 tons, which gave 50 per cent. of metal, which sold for £8400.

Doubtful localities for Stibnite are the following:—

Inverness-shire. At Abriachan, near Bona, with Galena and Vitreous Copper (Messrs Anderson).

Argyllshire. In small quantity, with Galena, or possibly an antimonial Galena, at Fee Donald ("Antimony mine"), Strontian.

Perthshire. Near Ben Lawers, on the Marquis of Breadalbane's estate (Greg).

Stirlingshire. At Ballagan Spout, Campsie, in small quantities.

Ayrshire. At Stair, on the lands of Dalmore, with Copper and Graphite.

Dumfriesshire. In the Glen Crieve vein, Wanlockhead, Antimonial Galena, or Jamesonite, is said to occur.

10. Molybdenite (34). MoS.

Rhombohedral (?).

o 111, *a* 011, *b* 211, *x* 120. The faces *o* smooth, *x a b* smooth, but striated parallel to their intersections with *o*. Seem to be twins, consisting of three crystals, sometimes indicated by striæ and by a composite structure on the basal plane. Clv., basal, perfect. Flexible. Not elastic. Sectile. H., 1 to 1·5; G., 4·6 to 4·9.

Lead grey. Streak the same on paper; on porcelain, greenish-grey. Lustre metallic. Opaque. Feels greasy.

In the open tube gives sulphurous fumes. B.B., infusible, but imparts a yellowish-green, "siskin green," colour to the flame. On charcoal the pulverised mineral gives in O. flame a strong odour of sulphur, and coats the coal with crystals of molybdic acid, which are yellow when hot, but white upon cooling; near the assay the coating is copper red, and if the white coating be touched with an intermittent R. flame, it becomes azure blue. When powdered, decomposed by n. acid, leaving a white or grey residue of molybdic acid. With hot n. and h. acid forms a greenish solution; with boiling s. acid a blue solution.

Comp., Molybdenum, 59·13; Sulphur, 40·87.

Occurs in early crystalline rocks, as gneiss, granite, syenite.

Sutherland—Shiness. In limestone contact belt, with Sahlite and Sphene (D. and H.).

Ross-shire. At Inchbae, with Allanite, in porphyritic augen-gneiss.

Inverness-shire. At Dochfour Burn, with Pyrite, in a granite vein (Aitken and H.). About a mile east of this, in "greenstone" boulders, with yellow Sphene (Aitken). Glen Elg. With Actinolite, in chlorite schist.

Argyllshire—Glen Creran. Corrie Buidhe, in quartz veins in granite, formerly; in six-sided crystals over one inch in thickness by nearly four inches in width (Plate I.). Loch Etive. At Barrs Quarry, 7 miles above Bonawe, with Sphene, in granite. BEN CRUACHAN. At the granite quarries, in quartz veins, with Epidote (Stuart Thomson and H.).

ABERDEENSHIRE. Near Inverurie, at Middleton of Balquhain, in gneiss (Nicol).

PERTHSHIRE — LOCH TAY. At Tomnadashan, in porphyry, with Quartz, hepatic Pyrites, and, rarely, with Molybdic Ochre (Thorst). Near Killin.

KIRKCUDBRIGHT. At Almorness Head, in granite (Dudgeon).

WIGTOWNSHIRE. In the Galloway, Dumfriesshire, and Wigtownshire Hills (Greg).

Sub-Class II. SULPHIDES, &c., OF THE METALS— MONOSULPHIDES.

11. **Argentite (42).** Ag_2S.

Cubic. *a*, 100; *o*, 111; *d*, 110; *n*, 211. Crystals often misshapen, with curved faces or in linear groups. Also arborescent or in crusts. Clv., indistinct. Fracture hackly. Malleable, flexible, and sectile. H., 2 to 2·5; G., 7 to 7·4. Generally dull, but also brilliant metallic; more so on streak. Blackish lead-grey, with brown, black, or sometimes iridescent, tarnish.

In open tube gives off sulphurous acid. B.B. on charcoal fuses, in O. flame intumesces, giving off sulphurous fumes, and leaves a globule of silver. Soluble in n. acid, with separation of sulphur.

Comp., Silver, 87; Sulphur, 13.

STIRLINGSHIRE. In the glen between Woodhill and Middlehill, in the Ochils. Near Alva, with Native Silver, Smaltite, Erythrite, and Chalcopyrite; in a veinstone of Barytes and Calcite in claystone porphyry [Andesite lava of Old Red Sandstone age]. The mine was worked from 1710 to 1715. Fourteen ounces of the ore yielded twelve of silver, and for a short period the proceeds of the mine were £4000 a week. In 1767 Lord Alva presented to the Church of Alva a pair of communion cups, upon which the following inscription is engraved—SACRIS IN ECCLESIA S. SERVANI APUII ALETH A.D. 1767 EX ARGENTO INDIGENA D.D.C. Q. JACOBUS ERSKINE (Plate I.).

12. **Galena (45).** PbS.

Cubic. *o*, 111; *a*, 100; *d*, 110; *p*, 221; *m*, 311; *n*, 211; *q*, 331. Crystals usually the cube, octahedron, and rhombic dodecahedron, rarely *p* and *n*, and at Leadhills many low faces, both on *a* and on *o*. Twin face, *o*. Clv., cubic highly perfect. Fracture conchoidal, but difficult to obtain on account of brittleness and perfect cleavage. Sectile. H., 2·5; G., 7·2 to 7·6. Lead-grey, with darker tarnish, which is frequently iridescent upon *o*. Streak, greyish-black. Lustre bright metallic, especially on the cleavage faces.

In open tube gives a sublimate of sulphur and of (sulphate of oxide of) lead. Decrepitates on charcoal, which it coats yellow, and after sulphur is driven off is reduced to a bead of lead, from which a globule of silver may generally be obtained by cupellation. Sol. in n. acid with evolution of nitrous acid, and separation of sulphur.

Comp., Lead, 86·7; Sulphur, 13·3, but usually contains silver from 1 to 5 parts in 10,000; rarely 1 per cent. or more. Sometimes contains copper, zinc, or antimony; rarely selenium.

Analysis by Thomson, from Durham:—

Lead, 85·13; Iron, 0·50; Sulphur, 13·02.

Occurs also massive, granular, compact, lamellar, "slickensides," and pseudomorphic. No external characters serve to distinguish the argentiferous varieties, though the granular varieties are usually considered the most highly so.

Crystallised galena occurs:—

ORKNEY—ROUSAY. One mile N.E. of Scabra Head, *a o*, in argillaceous sandstone flag (Plate I. fig. 1), with Azurite, Malachite, and Barytes. North-west slopes of the Wardhill, *a*. HOY, at Selwick, *a o*. MAINLAND, 1 mile west of the Ness, *a*. Fara, *a o* (Currie).

CAITHNESS. Gie-uisg Geo, in a calcite vein in sandstone flag, *a o* - - (Plate II. fig. 2), with Blende, Marcasite, Calcite, and Asphalt.

ROSS-SHIRE. In a burn on road between Jeantown and Loch Kishhorn, *a*, with purple Fluor (K. Murchison).

INVERNESS-SHIRE. Glen, 2 miles from Struy Bridge, *a*, in Barytes.

ARGYLLSHIRE. At Strontian, in gneiss, *a*, with Calcite; with Blende, *a o*, at Corrantee, and with Calcite, *a o*, at Bellsgrove (Currie).

ABERDEENSHIRE. At the Pass of Ballater, *a*, in granite, with Fluor.

FORFARSHIRE. On the south-west foot of Craig Soales, *a*, with Cerussite.

PERTHSHIRE. At Tyndrum and Clifton mines, *o*, *o a*, *o d* (fig. 3), with Chalcopyrite, brown Blende, Barytes, Calcite, and Quartz.

FIFE. At Inverkeithing, Castlandhill, *o*; in veins, partly in dolerite and partly in Lower Carboniferous sandstone, at the foot of a small hill, near a marsh.

BERWICKSHIRE. At the Vaults, 1½ miles east of Dunbar, *o a*, in a dolerite dyke in limestone (Adamson).

EDINBURGH. At Little Vantage, west of Balerno, *a o m q* (fig. 4); also in cubes and twins, in clay druses in sandstone (Stuart Thomson).

LINLITHGOWSHIRE. At the "silver mine," Cairn-naple, *a o*, imbedded in Barytes, with Scleretinite.

STIRLINGSHIRE. Alva; above Westerton, east of Alva, *o a* (fig. 5), also in cubes, in seams of leek-green "steatite," which lie between beds of andesitic lava (Old Red).

LANARKSHIRE. At Leadhills, *o*; *a*, *o*; *a o d* (fig. 6); *o d m* (fig. 7); *a o d m* (fig. 8); *o a r* (fig. 9); *o a m* (Plate III. fig. 10); *o a d p* (fig. 11); *o a d m* - (fig. 12); *o a d* -- (fig. 13); *o a d m n* (fig. 14); *o d a* -- (fig. 15); *o d a* -- (fig. 16); *o d a* -- (fig. 17); *o a m* - (Plate IV. fig. 18); *o a* --- (fig. 19); *o a* ---- (fig. 20); *o d a* - (fig. 21); *o a p* --- (fig. 22); *o a d m n* - (fig. 23); *a d o m n p* ----- (fig. 24); *a o m p* (fig. 25); *o a m* (Plate V. fig. 26). The numerous low faces above depicted on Leadhills specimens occur on crystals of one or more pounds in weight, and so are beyond the sustaining power of an ordinary goniometer.

AYRSHIRE. At Dalmellington, *a o*.

KIRKCUDBRIGHT. At Woodhead, near Garryhorn House, Carsphairn: *a o* with fibrous and crystallised Blende, Calcite, Barytes, and Quartz, in veins over 2 feet thick.

In the following records of old veins of Galena, the content of silver and other wonders are the statements, for the most part, of interested parties, as published at the time. They do not now yield even the lead.

ORKNEY. Hoy, at Selwick; 46 oz. of silver per ton. Also in Græmsay.

CAITHNESS. In small quantity at Skinnet and Brawl, near Halkirk. The Skinnet ore said to yield 5 per cent. of silver.

INVERNESS-SHIRE. Glen Nevis, 200 yards from the foot; two veins. In the parish of Kingussie, highly argentiferous.

HEBRIDES—COLL. North side of Crossapoll Bay. Islay, 2 miles east of Port Ascaig.

ARGYLLSHIRE—APPIN. Kilbrandon and Kilchattan, with ores of Silver, Copper, and Zinc (Raspe). Morven, Glen Sanda property. On Ben a Chaisil, with Pyrites and Blende. At Rudha a' Chamais Bhain, half a mile north-east of Glen Sanda Castle, in a vein of Mesitine spar, with Millerite and Blende. Loch Fyne, south-west of Inverneil, in quartz cutting mica schist, with Chalcopyrite and crystallised Chalybite. At a rocky point between Lochs Gilp and Fyne, near † Duncarty. Near the head of Loch Fyne. At Strontian, in veins which run in gneiss, close to its junction with granite, from Corrantee on the west to Bellsgrove on the east, associated with Calcite, Strontianite, Harmotome, Brewsterite, and Barytes. At Fassifern, Inverscadle, Ardgour.

ELGINSHIRE. At † Sherriffmile, in sandstone. At Duffus, with Chalcedony and flint, in limestone.

ABERDEENSHIRE. Glen Gairn, at Corrybeg, in two intersecting veins in gneiss, with Fluor, Schiefer Spar, and yellow Blende.

FORFAR. In the parishes of Eassie and Nevay, towards the south-east corner; argentiferous. At Loch Lee. Near the village of Glamis; wrought 1781.

PERTHSHIRE. Near Blair Athole and Struan. At † Cairn Droom; wrought many years. Ben Ledi, in a vein about a mile south of the stream on the east side, and at an elevation of 1000 feet, in clay slate. Yielded 20 oz. of silver per ton. Near the lower top of the hill, in mica slate, with Chalcopyrite and Siderite. Loch Tay, at Tomnadashan, "with Calcite in scalenohedron macles, Molybdenite, and Fahlerz" (Thorst). "At Corriebuidhe Hill, 3 miles south, in limestone overlying mica slate at an elevation of about 2000 feet, about eighteen veins from 3 to 4 feet thick, running north and south for about 200 yards. The veins carry Quartz with Galena, which yields from 85 to 600 oz. of silver per ton. The veins rapidly diminish in width downwards. The Galena is associated with Chalcopyrite and Pyrite, Blende, and Dolomite. Native gold was twice found in breaking up the ore" (Thorst). At the head of Glen Falloch, a vein striking N.N.E., 3 feet thick. In Glen Lyon. "At Tyndrum there are two veins—the first, through granular quartz; the other, close to the junction of this with mica-schist. The first follows a N.N.E., the other a north-east course. There is also a cross vein. The first vein is about 3 feet, the second from 4 to 18 feet, and the last about 2 feet thick. The first vein contains solid Galena. It also contains Blende, Chalcopyrite, rarely cobalt ore, Pyrite, and Ilmenite. The second carries Quartz, Blende, and Chalcopyrite. The first may be traced for 8 miles" (Thorst).

FIFESHIRE. Blebo, at † Myrtown, a vein north-east and south-west; wrought 1748. East Lomond, at Hanging Myre, on the south side of the hill, a vein parallel to the above.

STIRLINGSHIRE. At Dunipace, in red crystallised Barytes.

MIDLOTHIAN. Midcalder, at Skolie Burn, small crystals. † Blackbonny, at side of a fault. East Calder, where limestone abuts against a dyke (Stuart Thomson). Pentland Hills, north-east of Lynedale, in compact felspar, "argentiferous."

LINLITHGOWSHIRE. In the so-called silver mine in the north-east foot of Cairn-naple Hill. The mines were worked in 1606, and the galena was first discovered, or at least it was first declared to be argentiferous, in August 1607. There is no old record of their having been worked after 1614. Reynolds, 1608, by assay, stated the silver content at 15 oz. per ton. It has elsewhere been given at 17 oz. per ton. The mere *local* expense of working this mine for the year 1608–9 was £52,526, and for the succeeding year £11,187. A British Museum Record of the expenses of the working before it was taken up by the Lords of the King's Council, namely, for the year 1606–7, was that 30 tons had been raised at an outlay of £700, and that the profits, chiefly from native silver, were about £500 a month! The mine was reopened about the year 1878, a considerable sum was sunk in contending with water, an adjoining stream never having been properly deflected. In the old records mention is made of five shafts; three only of these can be now traced, and one only, the central, was opened during the last ill-directed trial. The vein, which has a barytic vein-stone, runs about east and west; it cuts the encrinal limestone, which here dips at an angle of about 40° to the north-west, at a depth of about 40 fathoms; the main shaft has been sunk to nearly 80 fathoms.

LANARKSHIRE. Leadhills, in many intersecting veins in graywacke; these are continuous with the veins of Wanlockhead. The Leadhills veins are associated, in the Susanna vein, with all the Leadhills minerals, except Vanadinite and Smithsonite. The other veins carry few of the rarer minerals. There were old veins at Glendorch, Gilkers Cleuch, and Glendouran, Abington. At Cumberhead.

AYRSHIRE. Banks of the Afton before it leaves the New Cumnock basin.

BERWICKSHIRE. At Abbotrule.

PEEBLES. Grieston, near Innerleithen, in a stream south of the slate quarry. In the Lyne, above West Linton.

DUMFRIESSHIRE. At Wanlockhead mines. The galena here yields from 5 to 9 oz. of silver per ton. The ore is associated with fewer minerals than at Leadhills, but Vanadinite, Smithsonite, and Blende are here more frequent; Cerussite, Anglesite, and Pyromorphite also occur frequently. Langholm Bridge and Broomholm, with Barytes, in graywacke. Falstone in limestone. Roanfell, north side of Liddesdale.

KIRKCUDBRIGHT. Minnigaff, at Black Craig mine, 3 miles to the east of Newton Stewart, with Dolomite, Pyrite, and Chalcopyrite. Woodend, 2 miles north of Carsphairn, Pibble mine.

WIGTOWN. New Luce; at Knock Bay, "very rich."

Slickensided Galena, cavernous crystals with an internal arborescent structure, and pseudomorphs of Galena after Pyromorphite, occur at Leadhills.

13. **Chalcocite (54).** Cu_2S.

[Orthorhombic; *c*, 001; *p*, 111; *b*, 010; *d*, 021; *v*, 112; *m*, 110.]

Crystals have an hexagonal aspect. Twins on *m v* and (032). Clv., *m* imperfect. Fracture conchoidal or uneven. Sectile. H., 2·5 to 3; G., 5·5 to 5·8. Lustre dull-metallic, brighter on streak. Blackish lead-grey, with a blue, lilac, green, or other tarnish.

Yields nothing volatile in the closed tube. In open tube gives off sulphurous fumes. B.B. colours the flame blue. On charcoal in the O. flame boils with spirting and fuses. In the R. flame becomes solid. With soda-salt yields a bead of copper. Decomposed by hot nitric acid, leaving a deposit of sulphur.

Comp., Copper, 79·8; Sulphur, 20·2.

Generally massive-granular; or compact-impalpable.

SHETLAND—FAIR ISLE. At North Naversgill, in a vertical vein of greenstone cutting O. R. Sandstone. At the head of Reeva Bay. Both massive.

INVERNESS-SHIRE. Near Abriachan, Bona, with Galena (Anderson).

PERTHSHIRE. Glenfarg, with Chrysocolla, Datolite, and Prehnite. *m b p c v d* (Christie).

STIRLINGSHIRE. With Barytes and Chrysocolla at Alva. One mile east of Callander in O. R. Conglomerate, with cockscomb Barytes.

HADDINGTONSHIRE. At Faseny Burn, in small veins, with Barytes in graywacke; massive, granular.

AYRSHIRE. (Greg.)

BERWICKSHIRE. Near † Keelstone Pool, with Malachite and Barytes. At † Crowheel, two veins in graywacke, running north 85° east. In the same rock at Ellemford. In the channel of Brunta Burn, below Dodds' Mill.

14. Blende (58). ZnS.

Cubic, and tetrahedral-hemihedral; [*a*, 100; *d*, 011; *o*, 111; *o*′, 111; *y* (*m*), 311; *β*, 225; *n*, 211; *κ* 311] hemihedral. Twin face *o*, occasionally many times repeated. Characteristic form, *d*, *κ* 311, *d m*; and the same twinned. The face of one of the tetrahedra is always highly polished, and of the other is drusy or rough. The faces of the cube striated. The faces of the trigonal dodecahedron, *m*, striated parallel to their intersections with *d*, and generally conically convex.

Clv., *d* very perfect and splendent. Fracture conchoidal. Very brittle. H., 3·5 to 4; G., 3·9 to 4·2. Transparent to opaque. Lustre adamantine to resinous. Colourless, white, yellow, red, brown, green, black. Streak white to reddish-brown.

Comp., Zinc, 67; Sulphur, 33. In the darker varieties from 1 to 15 of iron, or to nearly 5 of cadmium in the fibrous varieties.

In the open tube gives sulphurous fumes, and generally changes colour. B.B. *per se* decrepitates violently. On charcoal difficultly fusible on the edges. In the reducing flame, some varieties give a reddish-brown sublimate of cadmium oxide, later on a coating of oxide of zinc; this is yellow while hot, and white when cold. With cobalt solution this white coating gives a green colour in the O. flame. With soda on charcoal in the R. flame, gives the characteristic green flame, and is reduced. Most varieties, after roasting, give with borax the reaction for iron. In powder sol. in strong n. acid, with separation of sulphur. In h. acid, with evolution of sulphuretted hydrogen.

ORKNEYS—MAINLAND. In an old lead mine west of the Point of Ness, Stromness.

CAITHNESS. At Gie-uisg Geo, in a vein of Calcite, which cuts sandstone flag; *o* twins, *d m* twins (Plate V. figs. 1 and 2), with Galena, Calcite, Marcasite, and Asphalt.

ARGYLLSHIRE. Strontian, at Corrantee, with Harmotome. Morven, Glen Sanda. In a quartz vein in Gneiss on the north slope of Beinn a' Chaisil, near the summit, with Galena and Pyrites. In a trap dyke, half a mile north of Glen Sanda Castle, with Mesitine Spar, Millerite, and Barytes. Kilbrandon and Kilchattan, with ores of copper, silver, and lead (Raspe).

ABERDEENSHIRE. Glen Gairn, at Corrybeg lead mine, *o n d*, *d m* (fig. 3), bright yellow. Phosphorescent when heated. With Galena, Fluor, Schiefer Spar.

PERTHSHIRE. Tyndrum and Clifton, veins yellow and brown, with Galena, Chalcopyrite, Barytes, and Calcite, in quartz veins with felspar; phosphorescent.

MIDLOTHIAN. In Granton quarry, reddish-yellow, with Galena, in sandstone. Ratho quarry, honey-yellow, transparent, in granular quartz veins in Pectolite (Stuart Thomson).

LINLITHGOWSHIRE. Bathgate, in seams of coal, *o d*, *o o′ a* (fig. 4), with pink Dolomite, Pyrite, and Galena.

DUMBARTONSHIRE. In Bowling quarry, honey-yellow, *o o′* (fig. 5), *o o′ a*, in Prehnite, also almost colourless and transparent, with Prasilite and Natrolite.

AYRSHIRE. Beith, in Dockra quarry, *d m o* (fig. 6), with Calcite. Near Fairlie.

LANARKSHIRE. At Leadhills, but not very commonly. Sometimes of a black colour, in crystals approaching 2 inches in size, upon crystallised Calcite, and forming specimens of great magnificence, *a d m o* twins (fig. 7 and Plate VI. fig. 8); also *d m a*, with Quartz.

DUMFRIESSHIRE. At Wanlockhead, in a massive vein in the graywackes. At Glendinning, with Stibnite.

KIRKCUDBRIGHT. At Lauchentyre copper mines, with Chalcopyrite, Barytes, Pitchy Copper ore, and Malachite, *o a m* (fig. 9) (D. and H.). At Pibble mine, with Galena, Linarite, and Hemimorphite (D. and H.). Carsphairn, near Woodhead, sometimes crystallised, also fibrous, with Galena in Calcite.

15. Pentlandite (65). (FeNi) S.

Var., *Inverarite*, 5FeS + NiS.

Cubic. Clv., octahedral. Massive granular. Fracture uneven, brittle. H., 3·5 to 4; G., 4·6. Light pinchbeck-brown; streak darker. Not magnetic. Lustre metallic.

Pyrognostic and chemical characters the same as in Magnetic Pyrites, except that the borax bead becomes black and opaque in consequence of the reduction of the nickel.

Comp., Iron, 42; Nickel, 22; Sulphur, 36; but variously mixed with Pyrrhotite, Chalcopyrite, and Pyrite.

Analyses: *a.* Creag-an-Iubhair, *Forbes*; *b.* Creag-an-Iubhair, *Rivot*; *c.* Eas a' Chosain Glen, *Forbes*; *d.* Eas a' Chosain Glen, *Rivot*.

	a.	*b.*	*c.*	*d.*
Iron, ...	49·49	50·	50·87	43·76
Nickel, . . .	11·17	13·6	10·01	14·22
Sulphur, . . .	37·50	33·3	37·99	34·46
Cobalt, . . .	tr.	...	1·02	...
Arsenic, . . .	...	...	·04	...
Insoluble, . . .	1·2	3·1	·38	7·35
Total, .	99·36	100·0	100·31	99·79

ARGYLLSHIRE. At Eas a' Chosain Glen, 1 mile W.S.W. from Inveraray, with Quartz, Pyrite, and Pyrrhotite. At Creag-an-Iubhair, 10½ miles south-west from Inveraray, west of Loch Fyne, with Chlorite, Chalcopyrite, and Gersdorffite.

Crumbles very rapidly on exposure.

16. Greenockite (68). Cd S.

Rhombohedral. Hemimorphic. *a* (*m*), $01\bar{1}$, $10\bar{1}0$; *o* (*c*), 111, 0001; *x*, 120, $10\bar{1}1$; *i*, 231, $10\bar{1}2$; *z*, $13\bar{1}$, $20\bar{2}1$; *t*, 6061. Crystals *a o z* and *a z x i t* holohedral; all others hemihedral (Plate VI. figs. 1 and 2).

Clv., *a* perfect; *o* imperfect. H., 3 to 3·5; G., 4·8 to 4·9. Transparent to translucent in the lighter-coloured crystals. Opaque in the darker. Honey- to orange-yellow; rarely dark brown. Streak, yellow to reddish-yellow. Lustre, adamantine-resinous.

In the open tube yields sulphurous acid. In the closed tube assumes a carmine-red colour, which fades to the original yellow upon cooling. B.B. decrepitates, and either alone on charcoal or with soda gives in the R. flame a reddish-brown coating. Sol. in warm h. acid with evolution of sulphuretted hydrogen.

Comp., Cadmium, 77·7; Sulphur, 22·3.

Analyses—*a*, Connell; *b*, Thomson:—

		Cadmium.	Sulphur.
a,	Bishopton . .	77·30	22·56
b,	Do. . .	77·6	23·4

Dumbartonshire. Bowling quarry, with Prehnite, a crystal half an inch in diameter, found about 1800 (Brown). Cochno Burn (Thomson). Bowling, with Prehnite, 1850 (Heddle) (figs. 1 and 2).

Renfrewshire. Bishopton railway tunnel, with Prehnite, Natrolite, Thomsonite, Galena, Calcite, Harmotome, and Saponite (Lord Greenock). Barrhead, at Boyleston quarry, with Prehnite, Natrolite, and Chrysocolla.

17. **Millerite (70).** NiS.

Rhombohedral. R. 144·8′.

Clv., *r*, and parallel to a second rhombohedron of 161° 22′. Opaque. Lustre metallic. H., 3·5; G., 5·26 to 5·30. Brass-yellow to bronze yellow, but often tarnished grey or iridescent. Streak, shining. Brittle. Usually either in diverging tufts of crystals or interlacing matted. Rarely in acicular coatings.

In open tube sulphurous fumes. B.B. melts readily into a black magnetic globule which boils and sputters. Gives with borax and micro. salt a violet bead in O. flame, becoming grey from reduced metal in R. flame. Most varieties show with the fluxes also traces of copper, cobalt, and iron. Sol. in n.h. acid, giving a green solution.

Comp., 64·4 Nickel, and 35·6 Sulphur.

Argyllshire—Morven. At Rudha a' Chamais Bhain, half a mile north of Glen Sanda Castle, in a trap dyke, in tufts of crystals an inch in length, with rosettes of brilliant green Morenosite in Mesitine Spar, with Barytes, Blende, Galena, Quartz, and Calcite. Near Dunoon, in a quartz vein, with Chalybite in chlorite schist (Knapp).

Fifeshire. In a quarry 1 mile west of Chapel quarry, Kirkcaldy, with nailhead Calcite and Chalybite (Young). At Lathalmond, 4 miles north of Dunfermline, in limestone, with Calcite. At Broomhall lime quarries with Pearlspar; specimen in Raith Collection (Sowerby).

LANARKSHIRE. North-east of Glasgow, at Blochairn fireclay quarry, and in fissures of clay-ironstone balls; in divergent groups of crystals, which traverse cubic crystals of Galena, in fireclay, in Millstone Grit, on Garngad Road, leading to Provan Mill (Young).

RENFREWSHIRE. At Pollokshields, in the Giffnock limestone (J. F. Maclaren).

AYRSHIRE. At Dockra quarry, 2 miles south-east of Beith, in brilliant crystals, sometimes two inches in length, in cavities of *Productus*, and, more generally, in fissures, with finely-crystallised Calcite, Chalcopyrite, and Pearlspar (Young). In Trearne limestone quarry, with Calcite (Craig). Not infrequent in septarian cavities in clay-ironstone balls in the Ayrshire coal fields.

18. Niccolite (71). NiAs. *Copper Nickel.*

Rhombohedral. Form *o*, 111; *a*, $01\bar{1}$; *x*, 120. Crystals very rare; generally massive granular, arborescent, and reniform. No cleavage. Fracture uneven, with traces of conchoidal. Brittle. H., 5·5; G., 7·5 to 7·7. Pale copper-red, sometimes with a violet tinge. Lustre metallic. Tarnishes grey to black and assumes a green skin. Streak, pale brownish-black.

In the open tube evolves arsenious acid with some sulphurous acid, the assay becoming yellowish-green. In closed tube a faint crystalline deposit of arsenious acid. B.B. on charcoal gives arsenical fumes, and fuses to a brittle white globule, which, treated with borax glass, gives by successive oxidation reactions for iron, cobalt, and nickel. Sol. in hot n. acid with deposition of arsenious acid. More readily in n.h. acid; the solutions are green.

Comp., Nickel, 43·9; Arsenic, 56·1; generally some Cobalt.

STIRLINGSHIRE. Campsie, at Ballagan Glen, "in small quantities."

LINLITHGOWSHIRE. At the Hilderston Hills. In a vein of Barytes, cutting limestone at the east base of Cairn-naple, with Barytes in crystals, Native Silver, Annabergite, Erythrite, Blende, Galena, Pyrite, and Brown Spar. In a letter of Sir Richard Martyn to the Lords of His Majesty's Secret Council, of date Oct. 1608, he seems to refer to Niccolite, when he writes—"It is held that there is in y^e^ Scottish ure, a substance of a matter which some call a marquisit, and other some an arsenick, and others a sulphurous matter w^ch^ houldith the silver; y^t^ cannot easily be gathered out of the same togeithere, which poisoned matters if they could be distroyed, and the silver gott cleane out of y^e^ same, it were a good and profitable service." But the nature and value of the Niccolite was never recognised during the time this mine was first worked. It was all lost in extracting from it the filamentous native silver which, to a depth of 12 fathoms, it contained. Besides the large quantities thus wasted at the mines, several cargoes of this ore were shipped south.

In a curious volume, entitled *Bulmer's Skill*, professing to be a personal narrative of the good and evil fortune of the author, who had a patent from Queen Elizabeth and James VI. of Scotland to work gold and silver mines, an attractive account is given of the rich argentiferous lodes of Hilderstone in that kingdom, and how "Sandy Maund found *a heavy piece of red metal* descended from a vein where it engendered with spar called cacilla." This was taken from under "Burn at King-apple Hill," and was so rich that the purest assayed 24 oz. of fine silver to each hundredweight of rock. Down to 12 fathoms the ore was so good that the owners earned a profit of £100 a day; but it is naïvely added, "when this mine fell to the King it was not so rich." This "red metal" undoubtedly had been copper nickel.

Sir Beavys Bulmer or Bilmour was in May 1608 appointed "maister and surveyair of the earth works of the late discouerit siluer myne," discovered by Sir Thomas Hammilton of Bynnis (Binny), King's Advocate, the proprietor. Bulmer, after having been "relieved" of arrears of rents and debts for "imposts of sea coales to the extent of £2410, due to Queene Elizabeth," received as salary as "maister surveyair" £2552 for the first year, and £2160 for the second year.

During the short period when the mine was worked about 1870 a considerable quantity of Niccolite was got, having been used along with Barytes to fill up the old drifts. This was all sent to Germany, and was called platinum in the neighbourhood of the mines. Only small quantities of Annabergite are now (1893) to be found. The ore got between 1870 and 1873 was incorrectly called "an arsenious sulphuret of nickel," instead of a sulphurous arsenuret. It was said to contain "about" 30 per cent. of nickel, and 2 per cent. of cobalt.

Mr Henry Aitken, in vol. vi. of the *Transactions of Mining Engineers*, has given the following information anent the working carried on in 1870:—

"A vertical shaft was sunk to a depth of over 220 feet. This went considerably below the workings of the ancients. The vein lies on a whinstone dyke, which runs nearly east and west, with a dip to the south. This whin dyke is a branch or arm of a whin dyke to the west, running nearly north and south. A little to the east of No. 2 pit the branch whin dyke dies out entirely, and is represented in the limestone to the east by a small fault or hitch with a little spar in it but no ore.

"The strata forming the hanging wall of the vein measured vertically are :—

	Feet.
Surface clay, stones,	18
Sandstone,	11
Fakes,	37
Whinstone,	16
Blaes,	11
Limestone,	54
Marl,	42
Marl and whin,	36
	225

"Near the bottom of the pit the vein almost entirely vanished. A bore-hole was put down to a depth of 360 feet below the bottom of the pit, but proved almost nothing except marl. In none of the modern working was silver discovered; the former workers apparently exhausted the mine near the surface, and the vein proved unproductive in depth. The exploration of the old wastes proved that the former workers had worked nearly all out to a depth of about 60 feet, refilling the waste nearly entirely with baryta. In this a considerable quantity of nickel ore was found, nearly all oxidised to a powder. No silver or galena was found. The vein opposite the whinstone was 6 feet wide and consisted entirely of baryta. Opposite the blaes it carried baryta, and very little galena—non-argentiferous; opposite the limestone, baryta and a very little nickel ore and galena with a little silver were found. When the vein came to the marl it practically disappeared. The whinstone carries stringers of spar, but no ore. Various mines and ditches were driven, unproductively. A thin vein 60 yards north had a little galena, of no value. There is neither in the old or in these recent records evidence of the vein having been sufficiently traced *laterally* in either direction."

LANARKSHIRE. At Leadhills, in small quantity (Brewster's *Jour.*, vol. i.).

DUMFRIESSHIRE. Wanlockhead, at West Grove mine, with Arsenic (Wilson).

KIRKCUDBRIGHT. At Moneypool Burn, west of the Pibble mine, Creetown, with Dudgeonite and Annabergite (Dudgeon).

19. **Pyrrhotite (74).** Fe_7S_8. *Magnetic Pyrites.*

Rhombohedral. x [(s), 120, 10$\bar{1}$1], 126° 38′; o [(c), 111, 0001]; a [(m), 011, 10$\bar{1}$0]; $z\frac{1}{4}$ [?].

Crystals rare. Sometimes hemihedral. Commonly massive, with conchoidal or uneven fracture, or granular. Clv., *o* perfect, *a* less so. Brittle. H., 3·5 to 4·5; G., 4·4 to 4·7. Colour, bronze-yellow to reddish-brown, with pinchbeck-brown tarnish. Lustre metallic. Streak, dark greyish-black. Magnetic; always attracted in powder by the magnet; but not always affecting the needle.

Comp., Iron, 60·4; Sulphur, 39·6; sometimes with Nickel.

Unchanged in the closed tube. In the open tube gives sulphurous acid. B.B. infusible *per se*; but on charcoal in R.F. fuses to a black magnetic mass; in O.F. is converted into red oxide of iron, which with fluxes gives often reactions of Nickel and Cobalt. Soluble in h. acid with evolution of sulphuretted hydrogen, but leaving a residue of sulphur.

Occur generally in the older rocks. In Scotland, very common in the older limestones, and in small quantity in rocks of the diorite type. As in limestone:—

In SUTHERLAND. At Shiness, with Sahlite and Pyrites (D. and H.); and in the contact rock, with Malacolite, Sphene, Molybdenite, and Apatite (D. and H.). Arscaig, Loch Shin (Plate VI. figs. 1 and 2), *a o z* ¼, and hemihedral, with Malacolite, Sahlite, and Actinolite (D. and H.).

ROSS-SHIRE. At Totaig, Loch Duich, rarely, with Serpentine (D. and H.). In Malacolite, near Keppoch (H. and Currie).

INVERNESS-SHIRE. Glen Urquhart, in the Milltown limestone, with Edenite, Zoisite, Sphene, and Biotite. Grantown, at Achnagonalin quarry, with Zoisite, Cinnamonstone, Sahlite, and impure Saponite. Laggan, Dulnain Bridge, with Zoisite, Pyrite, Galena, Blende, and Sahlite.

HEBRIDES—HARRIS. Rodil, in limestone, with Malacolite. Tiree, rarely. At Ballyphetrish, with Sphene, Sahlite, Malacolite, and Graphite, in limestone.

BANFFSHIRE. At Redhythe, with green Talc, white Biotite, and Rutile. Limehillock, 1½ miles north-east of Grange, with Pyrite, Margarodite, and Calcite.

ABERDEENSHIRE. Between Glen Bucket and Glen Nochty, with Margarodite, Rutile, Actinolite, and Pyrite. Deskry, with Graphite and Margarodite. Forester Hill, with Sphene, Andesine, Biotite, Talc, Chlorite, Augite, Pyrite, and Actinolite; but rare. Deeside, throughout its limestones. As at Muir and at Midstrath, with Malacolite, Sphene, Graphite, and Fluor. Corntulloch, with Malacolite, Graphite, and Wollastonite. Crathie, with Idocrase, Wollastonite, Sahlite, Greenovite, Garnet, Biotite, Fluor, Actinolite, and, rarely, Pyrite. At Leac Ghorm, with Idocrase, Garnet, Malacolite, Biotite, and Andesine. Glen Gairn, at Delnabo quarry, with Idocrase, Cinnamonstone, Apatite, Prehnite, Epidote, Greenovite, Wollastonite, Coccolite, Andesine, Actinolite, Sahlite, and rarely Pyrite.

PERTHSHIRE—GLENSHEE. In the limestone of Glenbeg rarely. Blair Athole, at Edintian quarry, south of Tulach Hill, Blair Athole, with Ripidolite, Ilmenite, Sphene, and Biotite—Anal. Loch Tay, with Malacolite.

Pyrrhotite of Edintian.

Sulphur, ...	38·544
Iron, ...	60·33
Silica, ...	·153
Carbonate of Lime, . . .	1·538
	100·665

FORFARSHIRE. Tarfside, on the west shoulder of Craigsoales, with Malacolite.

FIFESHIRE. Kirkcaldy, in Chapel quarry.

In diorite it occurs in small specks occasionally, in the rock which passes up the country from Portsoy in Banffshire: as near the Old Battery, at Craigbuirach, in Glen Bucket, and on the Deskry limestone, with Graphite and Talc; at the last localities, Sphene, Ilmenite, and Allanite are rare associates.

In other rocks Pyrrhotite occurs:—

ARGYLLSHIRE. About a mile east of the mansion-house of Ballachulish, near the junction of the granite with mica slate, but in the latter with garnets. At Appin, massive (Greg).

BANFFSHIRE. At Portsoy, in clay slate, west of the serpentine, with bronzy Biotite.

PERTHSHIRE. On the Cairnwell rarely. Taymouth, in a vein in the Sawmill Burn (Allt a' Bhealaich, or Taymouth Burn), with Pyrite and Chalcopyrite.

KIRKCUDBRIGHTSHIRE. In the Galloway Hills (Greg). Palnure, Cairnsmore, Newton Stewart, with 4·36 per cent. of Nickel, associated with Mispickel.

INTERMEDIATE DIVISION.

20. **Bornite** (78). $3Cu_2S. Fe_2S_3$. *Purple Copper, Erubescite.*

Cubic. *a* 100; *o* 111; *d* 011; *n* 211. The faces *a* usually rough or curved. Twin face *o*. Cleavage *o*, traces. Generally massive. Fracture conchoidal to uneven. Streak, greyish-black. H., 3; G., 4·9 to 5·1. Colour between copper-red and pinchbeck-brown. Acquires generally an iridescent tarnish, at first red or brown, ultimately violet and blue. Lustre metallic. Structure compact, sometimes granular. Sectile. Slightly brittle.

In the open tube yields sulphurous acid, but no sublimate. In the closed tube a very small amount of sulphur. B.B. on charcoal turns black, but reddens on cooling; after long exposure to the R. flame fuses to a brittle magnetic bead, of a steel-grey colour externally, but greyish-red on the fracture. With borax and soda yields a globule of copper. Moistened with h. acid colours the flame blue. Sol. in strong h. acid, with separation of sulphur.

Comp., Copper, 55·57; Iron, 16·37; Sulphur, 28·06.

ROSS-SHIRE—LOCH CARRON. Loch Kishorn. In limestone, at the Rapal mines, with Malachite and Brochantite (Nicol).

PERTHSHIRE. Birnam Hill clay slate quarry, with Chlorite, in Quartz (Peyton).

RENFREWSHIRE. Gourock, near Drumshantie, with Malachite, in sandstone.

21. **Chalcopyrite (83).** Fe_2S_3. CuS. Copper Pyrites.

Pyramidal. Usually with tetrahedral or double tetrahedral habit. P., 109° 53 pyr., *p* on *p* tet., 71·20; A.V. 1, 0·98556.

[*c*, 001; *a*, 100; *m*, 110; *w*, 301; *r*, 332; *t*, 221; *p*, 111; *x*, 113; *g*, 203; *e*, 101; *h*, 302; *v*, 316; *k*, 511; *d*, 114; *s*, 513; *o*=*p*; *z*, 201; *n*, 112; *y* ?]. *depnvk* are usually hemihedral with inclined faces. 1. Twin-face *a*. 2. Twin-face *p*. 3. Twin-face *e*. The twins on *p* often many times repeated in parallel arrangement; those on *e* repeated parallel to the four terminal edges of the pyramid, producing with a sixth individual united by the same law a composite octahedral form.

wa	161° 34′	*rc*	115° 34′	*nn′*	132° 19′
ma	135°	*tc*	109° 44′	*ee′*	120° 30′
aa	90°	*mc*	90°	*en*	150° 15′
gc	146° 42′	*vc*	152° 33′	*pe*	144° 20′
ec	135° 25′	*ka*	164° 07′	*pp′*	109° 53′
hc	124° 05′	*pa*	125° 03′	*hh′*	108° 18′
zc	116° 54′	*e′a*	90°	*pz*	140° 54′
ac	90°	*dd′*	155° 06′	*zz′*	101° 50′
dc	160° 47′	*xx′*	145° 20′	*rr′*	100° 44′
xc	155° 05′	*vx*	168° 06′	*tt′*	96° 33′
nc	145° 08′	*gx*	157° 09′	e_1e	89° 11′
pc	125° 40′	*gg′*	134° 19′	z_1z	126° 12′

Crystals generally small and misshapen. Commonly compact and disseminated; also botryoidal and reniform. Clv., *z* perfect. Fracture conchoidal to uneven. H., 3·5 to 4; G., 4·1 to 4·3. Colour brass yellow, often with a gold yellow or iridescent tarnish (peacock copper ore). Streak, greenish-black; *p* and *m* often striated. Brittle. Lustre metallic.

In the closed tube decrepitates, and gives a sublimate of sulphur.

B.B. on charcoal becomes darker or black, and on cooling red. Melts easily and quietly into a brittle, grey, magnetic, globule. Colours glass of borax green. After long roasting in R. flame with soda or borax yields a bead of copper; moistened with h. acid colours the flame blue. Sol. in n. acid, depositing sulphur, forming a green solution which, with excess of ammonia, becomes intensely purplish-blue.

Comp., Copper, 34·5 ; Iron, 30·5 ; Sulphur, 35.

SHETLAND. Mainland at Sandlodge. In a vein of Chalybite, *c p x a z* tetrahedral (Plate VI. fig. 1), and *p z a k* triplet (fig. 2). At Cunningsburgh Cliffs (Greg). At Garthsness, Quendale Bay, massive in a vein of Pyrite traversing blue quartz (Hibbert). Fair Isle, at Dunrossness, foliated (Greg).

SUTHERLAND. Lairg, at Ord Hill, in quartz veins in red "syenite," with Rock Crystal, very rare, *p y*, twins (Plate VII. fig. 3), *p z* (fig. 4), *p m z* (fig. 5), *p m s c o* (fig. 6), and *p a*. South of Rhiconich, in a vein with Chrysocolla, in Hebridean Gneiss (D. and H.).

ELGIN. At Lossiemouth.

ARGYLLSHIRE. Loch Fyne, at St Catherines. Erins, 3½ miles N.N.W. of Tarbert, with Chalybite, Göthite, Pseudo-Magnetite, and Byssolite. South-west of Inverneil, Cantyre, with Galena and Chalybite, in quartz veins, cutting mica slate. In the Kilmartin estate, wrought for many years. In Kilbrandon and Kilchattan (Raspe).

ABERDEENSHIRE. Inverurie, in Dobston quarry, in gneiss, with Epidote and Ilmenite.

PERTHSHIRE. Glen Tilt, in the quartz veins which traverse the schist (MacCulloch). Taymouth, in the quartz veins of the hills which form Kenmore plantation, with Galena, Pyrite, and blue and green Malachite. In an old quarry in Taymouth Park; also in the Sawmill Burn, with Pyrite and Pyrrhotite. At Ardtalanaig, with Blende and Barytes. At Tomnadashan, in porphyry vein, with Galena, Fahlerz, Pyrite, and Molybdenite. In the banks of the stream above Ardeonaig, with Galena, in mica slate. In the veins at Corrie Buidhe Mine, with Galena. In Newtyle quarry, with Pyrite and Chlorite. Dunkeld, in a vein on the south side of Craigie Barns. Ben Ledi, in the channel of a burn on the east side, with Chalybite and Galena, in mica slate. Tyndrum, in Clifton mine, with Galena, Blende, Barytes, Calcite, Quartz, and Felspar, in Quartz. At Forgandenny, on the banks of the May. At Aberfoil, with crystallised Barytes, in a vein thereof on the north-west side of Arndrum Hill.

FIFESHIRE. In Magus Muir limestone quarry, with Aragonite, Quartz, and Göthite.

STIRLINGSHIRE. At Alva, with ores of silver, lead, and cobalt.

MIDLOTHIAN. Corstorphine Hill, east quarry, in Prehnite druses, *p z* (fig. 7). West Calder, at Addiewell, with Barytes and Calcspar on Pearlspar, associated with Asphalt and Salt, in a coal pit (Stuart Thomson). In Elgin Colliery.

LINLITHGOWSHIRE. In veins of Barytes, cutting limestone, on the roadside north of North Silver Mine limestone quarry. Hilderston, in the Binny estate, Bathgate.

PEEBLESSHIRE. In an old quarry at Stonypath.

LANARKSHIRE. At Leadhills, with Quartz, Galena, and Blende; *p z* (fig. 7).

AYRSHIRE. At Dockra quarry, Beith, with Calcite and Millerite (Craig). At Stair, with Stibnite, in lands of Dalmore.

BERWICKSHIRE. Top of Stainishill Hill [? Staneshiel Hill], in Quartz, with Galena.

DUMFRIESSHIRE—WANLOCKHEAD. West Grove mine, with Calcite, *p p* (fig. 8).

KIRKCUDBRIGHTSHIRE. Colvend, on the Urr. At Pibble mine, with Linarite, Galena, and Pyromorphite (D. and H.). Door of Cairnsmore. At Castle Douglas. Gatehouse, at Cally mine. Lauchentyre, with Barytes on Quartz, *pp'* (fig. 8) (D. and H.). Kings Laggan, with Pitchy Copper ore and Malachite (D. and H.). At Kells, in several places with Galena. Newton Stewart, at Black Craig mine, with pink Dolomite. Palnure, with Pyrrhotite. Balcary, *p z* (fig. 7); *p p s* (fig. 9).

DISULPHIDES, &c.

22. **Pyrite (85).** FeS_2.

Cubic. Pentagonal dodecahedron in excess, and so common as to give to this form the name *Pyritohedron*; striæ produced by oscillations of it with the cube visible. Crystals often distorted; *t* rough.

[*a*, 100; *o*, 111; *e*, 120; *f*, 310; *t*, 241; *s*, 231; *d*, 011; *n*, 211; *m*, 311; *g*, 320; *p*, 122; *v*, 531; *z*, 543; *ω*, 522; *X*, 11.5.2; *c*, 710; *L*, 10.8.7.] The forms *e*, *f*, *s*, *t*, *g*, *z*, *v* generally hemihedral, with parallel faces. Twins. 1. Twin face *o*, either single or repeated parallel to each other, producing thus forms consisting of combined pyritohedrons, or a cube which has striæ on each face parallel to its sides, and which meet at an angle along the diagonals. 2. Twin face *a*.

Also reniform, globular, or stalactitic. Sometimes internally radiated, subfibrous. Often massive, or pseudomorphous.

Clv., *a* and *o* both difficult. Brittle. Fracture conchoidal to uneven. Opaque. Lustre metallic, upon *o* splendent. Brass-yellow, rarely gold yellow, often brown from decomposition. Rarely tarnished with brilliant colours. Streak greenish-grey to brownish-black. When broken emits the smell of sulphur. Strikes fire with steel. H., 6 to 6·5; G., 4·9 to 5·2.

Heated in closed tubes sulphur sublimes. B.B. on charcoal burns with a blue flame, and odour of sulphurous acid. In inner flame fuses to a magnetic globule, which gives a bottle-green colour to borax. Sol. in n. acid with residue of sulphur. Comp., Iron, 46·7; Sulphur, 53·3. The brown or hepatic varieties sometimes show a gold colour when broken. Common in rocks of all ages.

SHETLAND—FETLAR. At Smithfield, Gruting Voe, with Chlorite, *a* (Plate VII. fig. 1), in mica schist (Dudgeon).

SUTHERLAND. At Ceannabeinne, imbedded in radiated Actinolite, *a*, *a o* (Plate VIII. fig. 2), in the Hebridean gneiss.

ROSS-SHIRE. In Strath Farrar, *a o e n s* (Plate VIII. fig. 3), in gneiss, with Graphite. Loch Maree, at Ardlair, in limestone (Plate VIII. fig. 4), *a o n*.

INVERNESS-SHIRE. On the north-east side of Alsait Hill, near Tomintoul, *e*, *a e* (Plate VIII. figs. 5 and 6), with Chlorite, in gneiss.

HEBRIDES—SHIANT ISLANDS. Eilan Mhuire. In a cave at the neck on the north-east end of the island, *a*, *a o*, in dolerite with Magnetite, Analcime, Nepheline, Labradorite, and Saponite. Skye, in Liassic shales, north-east of the Storr Rock, in aggregate crystals (Plate VIII. fig. 7 and frontispiece, vol. ii.) (Necker). JURA. In gneiss, on the shore of Small Isles harbour. Islay, at the lead mine near Port Askaig, *a o* (Currie).

ARGYLLSHIRE—MORVEN. Glen Sanda. In a vein in gneiss, on the north of Beinn a' Chaisil, *e f o* 522 (ω), 421, *t* (Plate IX. fig. 17), with Galena and Blende. Dunoon, in masses of Quartz, with Chlorite, in the banks of the Dirty Burn, *a f o e s* (Plate X. fig. 18). Strontian, with Calcite, *a e o*, at Bellsgrove, and *a o* at Corrantee (Currie).

ELGINSHIRE. Ashgrove. In limestone, with Glauconite, and Calcite, *a o e* (Plate IX. fig. 10).

NAIRNSHIRE. At Piperhill quarry, in sandstone, with Calcite on Blende. Tarnished crystals, and elongated cubes (Plate VIII. figs. 8 and 9), *o e* (Aitken).

BANFFSHIRE. At Boyndie, with Pilolite, in limestone, *a e o* (Plate IX. fig. 11). At Limehillock, near Grange, with Margarodite, Pyrrhotite, and Calcite, *a d o*.

ABERDEENSHIRE. At the balloch between Glen Bucket and Glen Nochty, with Rutile, Pyrrhotite, and Margarodite, *a s* (Plate IX. fig. 12); and *a o s* (Plate IX. fig. 13). Of a bright golden yellow, in plumose scales, on Serpentine in Bruntland Park quarry, Belhelvie Hills.

PERTHSHIRE. At Stob Coire Bhuidhe, *a*, hepatic, with Chlorite. With Garnet on Ben Vorlich, and on Stuc a' Chroin in gneiss. Dunkeld, in clay slate in the quarry on the east of the Tay, in large striated cubes (Peyton). These have apparently a cubic cleavage, along which portions are shifted. Columnar, and corded with Specular Iron, in clay slate, Birnam Hill quarries. Loch Tay, Tomnadashan mines, with Molybdenite and Fahlerz, in small, but fine, crystals, *f e o t*, *a o e n s*, *a e d o t* 11.5.2 (*X*), *a o n s e g d* (Plate IX. figs. 14, 15, 16). On Creag na Caillich, near Killin, in mica schist, *a*. One mile north of head of Loch Turret, in gneiss, *a o*, *a e o*, somewhat hepatic. In the limestone of Athole, in 1-inch cubes (Macculloch).

FIFESHIRE. At Chapel quarry, in limestone, *e o m* (Plate X. fig. 19) (Jameson Torry). At Crombie Point, in sandstone, *a*. Elie, at Kincraig, in Lower Carboniferous tufa, *a*, *a o*.

STIRLINGSHIRE. Above Westerton, Alva, in seams of leek-green "Steatite" in basaltic clinkstone [andesite], *a*.

MIDLOTHIAN. West Calder, at Skolie Burn, in fine cubes (Stuart Thomson).

LANARKSHIRE—LEADHILLS. Glen Crieve, *a o e* (Plate X. fig. 20), *a o e* 710 (*e*) *g* (Plate X. fig. 21); also stalactitic and botryoidal.

DUMFRIESSHIRE—WANLOCKHEAD. West Groove mine, with Calcite, *a o*, *a d o*, *a e o t p* 10.8.7 (*L*), (Plate X. fig. 22), *a e o* (Wilson). At Glendinning (Greg).

KIRKCUDBRIGHTSHIRE. At the Black Craig mine, Newton Stewart, with Dolomite, Chalcopyrite, Calcite, and Erythrite, in elongated cubo-octahedra (Dudgeon).

Reniform and globular Pyrite occurs at † Clashgorum, Strontian; at Glen Crieve, Leadhills (Wilson); and at Crofthead, Lanarkshire, in clay ironstone. Stalactitic at Glen Crieve (Wilson).

Massive Pyrites was wrought at Quendale, Mainland, Shetland, and at Craigthorn Hill, 1 mile east of West Quarter, Stirlingshire, in a vein 9 inches thick, in trap, near ironstone.

Hepatic Pyrites occurs in cubes, with Chlorite, in quartz, at Vanlup, Hillswick, Shetland, and at Easter Turrerich, Glen Quoich (Doran).

The Pyrites which is imbedded in Pentlandite in the wood above Inveraray Castle, Eas a' Chosain Glen, yielded Forbes:—Iron, 45·73; Nickel, 1·99; Cobalt, 1·24; Copper, 1·18; Sulphur, 49·32; insol., ·06 = 99·52. The sulphur here is insufficient for the metals, so that there may be an admixture with Pyrrhotite. Instead of the colour, however, being more bronzy, and the lustre duller, the colour approaches to that of Chalcopyrite, and the lustre is very high.

23. **Smaltite** (87). (Co, Fe, Ni.)As_2.

Cubic. Generally *a o*, but also granular, compact, and reticulated.

Clv., octahedral; also cubic. Fracture uneven. Brittle. Lustre dull metallic to shining. H., 5·5; G., 6·4 to 7·3. Colour tin white to steel grey. Streak, greyish-black. Tarnishes dull on exposure. Brittle. Evolves odour of Arsenic when heated, rubbed, or broken.

Comp., simplest: Cobalt, 28·2; Arsenic, 71·8. If cobalt, iron, and nickel are present in equal parts: Cobalt, 9·4; Nickel, 9·5; Iron, 9; Arsenic, 72·1. In closed tube gives sublimate of metallic arsenic; in the open tube a white sublimate of arsenious acid. B.B. on charcoal gives arsenical odour and fuses to a globule, which, with borax, gives, on successive additions, reactions for iron, cobalt, and nickel.

STIRLINGSHIRE. At Alva, with Native Silver, Annabergite, and Erythrite. Said formerly to have occurred at Linlithgowshire, in the Hilderston Hills:—? Craig's (old mine N.E.) in Calcite; worked by Capt. Jinks (Greg).

24. **Gersdorffite (90).** $NiS_2 . NiAs_2$.

Cubic. Crystals usually *a o e*, *a*, *o*. Clv., cubic. Generally granular, massive, or lamellar. H., 5·5; G., 6 to 6·9. Lustre metallic. Silver white to steel grey, but often tarnished grey or greyish-black. Streak, greyish-black. Fracture uneven. Brittle. In open tube yields sulphurous fumes, and white sublimate of arsenious acid. In closed tube decrepitates and gives a yellowish-brown sublimate of sulphide of arsenic. B.B. on charcoal gives garlic odour and sulphurous fumes, and fuses to a slag, which with borax gives first the reactions of iron, and, with an increase of the flux, of cobalt, and lastly of nickel. Sol. in n. acid, giving a green solution with deposition of sulphur and arsenious acid. Comp., varying—the formula gives Nickel 35·2, Arsenic 45·4, Sulphur 19·4, but generally some Iron and Cobalt.

Analysis from Creag-an-Iubhair, S.G., 5·49 to 5·65, Forbes.

As.	Ni.	Co.	Fe.	Mn.	Cu.	Mg.	S.	Insol.	Total.
34·45	21·59	6·32	13·12	·33	tr.	·66	20·01	2·71	99·19
35·84	23·16	6·64	11·02	n.d.	...	n.d.	19·75	2·60	...

ARGYLLSHIRE. Creag-an-Iubhair, Loch Fyne. Occurs in a cross course vein, 1 to 2 inches in width, intersecting the main lode of Pentlandite (Forbes and H.). [St Catherine's, and Eas a' Chosain Glen.]

25. **Marcasite (96).** FeS_2.

Orthorhombic. [M (*c*), 001; *r* (*v*), 013; *l*, 101; *g* (*e*), 011.] Twin face *M*, rarely *g*. Crystals tabular, thin-prismatic or pyramidal. Clv., *M*.

Fracture uneven. Brittle. H., 6; G., 4·65 to 4·88. Bronze yellow to greenish-grey, often with brown crust or tarnished in dull colours. Streak, greenish- or brownish-grey. B.B., etc., like pyrite. Composition the same, rarely with some arsenic. Very prone to decomposition, being changed into green vitriol, which may be detected by the tongue. When triturated, evolves the smell of sulphur. Occurs also stalactitic, botryoidal, globular, fibrous, and pseudomorphous. Generally found in the newer geological formations, and in coal, marl, and clay. Except along with coal it is very rare in Scotland.

ORKNEY—MAINLAND. In an old lead mine west of the Point of Ness, Stromness, coating sandstone, with Blende.

CAITHNESS. At Gie-uisg Geo, in cockscomb forms (Plate X. fig. 1), with Galena, Blende, Calcite, and Asphalt.

ABERDEENSHIRE. North-east of Gairn Bridge, massive, in gneiss (Nicol and H.).

ARGYLLSHIRE. Jura, shore of Small Isles Bay, with Epidote, in gneiss. Strontian, at Corrantee, in cockscomb forms (Currie).

Sphæro-crystalline in coal rifts (cleat), at Balbirnie, Fife, and elsewhere, along with coal.

26. **Mispickel (98).** FeS_2. FeAs.

Orthorhombic. [M (*m*), 110; *r* (*u*), 104; *s* (*n*), 102; *l* (*q*), 101; *g* 111.] Twins, *M* common, *g* rarer. Also massive and columnar. Clv., *M*. Fracture uneven, brittle. H., 5·5 to 6; G., 6 to 6·2. Silver white to steel grey; rarely tarnished reddish-brown. Streak, black. In closed tube yields first a red and then a brown sublimate of sulphide of arsenic; lastly, metallic arsenic. B.B. on charcoal, after the arsenic has been volatilised, fuses to a dark magnetic globule, which behaves like magnetic pyrites. Sol. in n. or n.h. acid with separation of arsenious acid and some sulphur. Comp., Iron 34·3, Arsenic 46·1, Sulphur 19·6, sometimes Silver or Gold, or 5 to 9 of Cobalt.

Generally associated with ores of cobalt, silver, or nickel. More rarely *per se* imbedded in chlorite.

INVERNESS-SHIRE. Shore of Loch Ness. In white limestone, with "Chondrodite" (Greg).

ELGINSHIRE. Stotfield, Lossiemouth, in cherty rock [Trias].

KINCARDINESHIRE. Massive in quartz, at Stonehaven (Greg).

PERTHSHIRE. At Lochearnhead, in calcareous schist, with Galena; yielding 6 oz. of gold per ton. At Ardtalanaig, argentiferous, with Pyrite, Chalcopyrite, Blende, Galena, Malachite, and Fahlerz. With Molybdenite at Tomnadashan.

STIRLINGSHIRE. Formerly at Alva, with Erythrite, Black Cobalt, Native Silver, and Argentite. At Airthrey, with Fahlerz, in Barytes and Calcite (Thomson).

Kirkcudbright. At Palnure, Cairnsmore, Newton Stewart.

OXYSULPHIDES.

27. **Kermesite (107).** Sb_2O_3. $2Sb_2S_3$.

Monoclinic. Crystals usually acicular and diverging. Clv., basal. H., 1·15; G., 4·5 to 4·6. Semitransparent; adamantine. Cherry red. Streak, brownish-red. Sol. in h. acid. Comp., Antimony 75·3, Sulphur 19·8, and Oxygen 4·9.

Ayrshire. Occurs as a pulverulent coating, investing Antimonite, and associated with Cervantite, in a quartz vein traversing an eruptive rock, at Hare Hill, New Cumnock.

Class III. SULPHO-SALTS.

ORTHO-DIVISION.

28. **Bournonite (136).** $(Pb_1Cu_2)_3Sb_2S_6$. [$3(Pb,Cu_2)S.Sb_2S_3$.]

Orthorhombic. [*a*, 100; *b*, 010; *c*, 001; *m*, 110; *n* (*o*), 011; *o* (*n*), 101; *z*, 021; *x*, 102.] Twins. Twin face *m*. Cleavage *a* indistinct; *b* and *c* less distinct. Fracture conchoidal, uneven. Opaque. Lustre metallic. Steel grey, inclining to lead grey or iron black. Streak, similar. Brittle. H., 2·5 to 3; G., 5·7 to 5·87. Often massive or granular.

In open tube disengages sulphurous acid, and gives off white fumes, which deposit as a sublimate of antimony oxide at the upper part of the tube, and of antimonite of lead at the lower part.

B.B. on charcoal decrepitates, fuses for a time, giving off white fumes, and then sets to a black globule, which, on the heat being further urged, yields a sublimate of oxide of lead; and then on the removal of the lead, produces a globule of copper.

Partially soluble in n. acid, forming a blue solution, and leaving a residue of sulphur and of oxide of antimony. Partially decomposed by n.h. acid, leaving a residue of sulphur, of lead chloride, and of antimonite of lead.

Comp., Lead, 42·4; Copper, 13; Antimony, 25; and Sulphur, 19·6.

Argyllshire — Morven. Glen Sanda, at Allt na Meinne, with Galena.

BASIC DIVISION.

29. **Tetrahedrite (148).** $4Cu_2S. Sb_2S_3$.

Cubic and tetrahedral. [*a*, 100; *o*, 111; *d*, 011; *f*, 310; *n*, 211; *m*, 311; *y* [*r*], 233; *s*, 321]; *o*, *m*, *n*, *y* are hemihedral, with inclined faces.

aa, 90°; *oa*, 125° 16′; *dd′*, 120°; oo_1, 70° 32′; *od*, 144° 44′; *on*, 160° 32′; *ad*, 135°; *nd′*, 150°; *om*, 150° 30′; *os*, 157° 47′; *oy*, 169° 49′; *yd*, 135° 27′; *an*, 144° 41′; *af*, 161° 34′; *df*, 153° 26′; *as*, 143° 18′; *am*, 154° 36′.

o and *n* striated parallel with their intersections with each other; *d* sometimes rough; the smaller of the faces o_1 o' very rough.

Twins. Twin face *o*, tetrahedron in a reversed position, and also interpenetrating. Cleavage *o* imperfect; sometimes traces parallel to *a* and *d*. Fracture conchoidal, uneven. Opaque, in thin splinters cherry-red. Lustre metallic. Steel-grey and flint-grey to iron-black. Streak, black, sometimes brown or cherry-red, if much zinc is present. Brittle. Sometimes massive, granular, or compact. H., 3 to 4; G., 4·5 to 5·2.

In closed tube all varieties fuse and give a dark red sublimate of sulphide of antimony. If mercury is present, a faint dark-grey sublimate appears at a low red heat; and if there is much arsenic a sublimate of sulphide of arsenic first appears.

In the open tube fuses, evolves sulphurous fumes, and deposits a white sublimate of antimony. If arsenic is present, a crystalline volatile sublimate condenses with the antimony. If mercury is present, it condenses in the cold portion of the tube in minute shining globules.

B.B. on charcoal decrepitates, emits sulphurous acid, and deposits a sublimate, which consists of antimonious acid, and sometimes arsenious acid, oxide of zinc, or oxide of lead. The arsenic may be detected by the odour in the R. flame; the oxide of zinc becomes green when heated with cobalt solution. The roasted residue melts easily with slight ebullition into a steel-grey slag, which is usually magnetic, and with borax fuses into a grey metallic bead, which with soda yields a globule of copper.

Directly to determine the presence of small traces of arsenic by the odour it is best to fuse the mineral on charcoal with soda. Mercury is best directly ascertained by fusing the powdered ore in a close tube with three times its weight of dry soda,—the volatilised metal condenses in minute globules. Silver may be determined by cupellation.

The powdered mineral is decomposed by n. acid, with disengagement of nitrous fumes, and separation of antimony oxide, arsenious acid, and sulphur. The solution has a brownish-green colour. In powder it is also partially decomposed by caustic potash, which dissolves out the sulphides of antimony and arsenic, which are precipitated of an orange-red or lemon-yellow colour on the addition of an acid.

Composition very various, from replacement of the copper by iron, zinc, silver, or mercury; and of the antimony by arsenic or bismuth.

SHETLAND. Mainland, at Sandlodge mine, with Chalcopyrite and Malachite, in veins in Old Red Sandstone.

INVERNESS-SHIRE—SKYE. At the Echoing Cliff, north of Quiraing, in zeolitic cavities, with Chabazite, Gyrolite, and Plynthite.

PERTHSHIRE. At Tomnadashan on Loch Tay, argentiferous, with Chalcopyrite, Pyrite, Molybdenite, and Galena, in a vein in porphyry, *o n* (Plate X. fig. 1).

STIRLINGSHIRE. At Airthrey in the Ochil Hills, with Mispickel, in veins in dark brown trap tuff. The veinstone being Barytes and Calcite. At Blairlogie, with Chrysocolla, in Barytes.

HADDINGTONSHIRE. At Faseny Burn.

BERWICKSHIRE. On the Whiteadder above Hoardweel, north-east of Cockburn Law, with Malachite, in schists [argillites] which alternate with graywacke.

Old reports on the Airthrey ore describe it as light steel-grey, tarnishing dull lead-grey. Sometimes tarnished like tempered steel. Hardness that of Calcite. Fracture, small grained. Massive. Brittle. Lustre shining and metallic, but speedily tarnishing. S.G., 4·878.

The rough ore yielded—

Iron,	51
Copper,	19·2
Arsenic,	15·7
Sulphur,	14·4
	100·3 (Thomson),

but was largely contaminated with Pyrite and Mispickel.

This indicates rather a Tennantite, than a Tetrahedrite (Currie).

Class IV. HALOIDS.

ANHYDROUS CHLORIDES AND FLUORIDES.

30. **Halite (166).** NaCl. *Common Salt.*

Cubic. [*a*, 100; *o*, 111; *d*, 110; *e*, 210; *s*, 321.] Clv., cubic. Granular and stalactitic. Transparent or translucent. Colourless, or white, blue, grey, brown, and yellow. Brittle. Fracture conchoidal. Lustre vitreous. Soluble in three parts of water. Taste saline. Slightly deliquescent. Thin polished plates transmit heat rays. H., 2; G., 2·2.

B.B. fuses and slowly sublimes. Colours the flame yellow. Precipitates soluble silver salts white. Comp., Sodium, 39·3; Chlorine, 60·7.

Occurs in beds, or as an efflorescence, as a sublimation from volcanoes, in solution in spring waters, and in the ocean.

EDINBURGHSHIRE. Midcalder, at Pumpherston, in cavities in the oil shales, with saline water, associated with fine crystals of Barytes, and with Calcite, Pearlspar, and Bitumen (Stuart Thomson).

[Pseudomorphs of Rock-Salt, sometimes represented by cubic vacuities, and sometimes by casts, occur in various formations and localities in Scotland. In the first form they are found in the sediments of the Earn about one mile above the Bridge of Earn, in the second they occur near the Poet's Glen near Currie, the casts being in sandstone, and as much as an inch across. They also occur as hopper-shaped pseudomorphs on the surface of some of the New Red Marls, near Kildonan, in the south-east of Arran (Goodchild).]

31. **Salmiac (168).** NH_4Cl. *Salammoniac.*

Cubic. Octahedral, also stalactitic and as an efflorescence. Colour white, yellow, and grey. Fracture and lustre vitreous. Translucent. Taste pungent. H., 1·5 to 2; G., 1·5 to 1·6.

B.B. completely volatile in white fumes. When triturated with lime evolves a pungent odour. Soluble in less than three times its weight of water. Comp., Ammonium, 33·6; Chlorine, 66·4.

Usually occurs in the neighbourhood of volcanoes; in this country in the vicinity of ignited coal seams, as at West Wemyss in Fife, and at Hurlet near Paisley in Renfrewshire.

32. **Fluor (175).** CaF. *Bruiachite.*

Cubic. [*a*, 100; *o*, 111; *d*, 011; *m*, 311; *n*, 211; *t*, 421; *p*, 122; *f*, 130; *k*, 250; *w*, (*v*) 731; *x*, 11.5.3.] Clv., octahedral, perfect; *d* and *a* traces. Fracture conchoidal, difficult. Usually crystalline, also divergent-crystalline, granular, and compact. Brittle. Hemitropes on *o*. Twins parallel to each face of *o*. Faces *a* smooth, or striated parallel to *t* or *f*; *o* and *f* rough, the former sometimes made up of small cubes. *o* and *a* sometimes with rectangular cavities. When pure, transparent. Of many colours; in Scotland, colourless, white, honey-yellow, blue, purple, violet, emerald-green, sap-green. Colours sometimes disposed two or more in layers parallel to faces of *a* and *o*, or the solid angles of a cube of one colour are made up by another. The colours differ as they are seen by reflected or by transmitted light. Lustre vitreous. H., 4; G., 3·02 to 3·25.

B.B. decrepitates and fuses to an opaque bead, colouring the flame red. Gently heated sometimes phosphoresces with different tints of light. Sol. in s. acid, with evolution of fumes of hydrofluoric acid, which corrode glass. Not readily decomposed by h. or n. acids.

Occurs in beds, but generally in veins; in granite, gneiss, clay slate, mica slate; also in sandstones, in limestones, both crystalline and uncrystalline, in porphyry, and in amygdaloid. Frequently the gangue of metallic ores.

SHETLAND. Mainland, west shore of Sandwick Bay, Hillswick, pale pea-green (Copland). Hillswick promontory at North Quin Geo, *o* (Pl. X. fig. 1) violet, in Calcite, with Epidote, in veins in diorite. Papa Stour, at the Kirksands, south end, in an amygdaloidal claystone in druses lined with Chalcedony, Quartz, Calcite, and Barytes, the Fluor being uppermost. It is in pale violet and dark blue cubes (Jameson). Saponite also is associated with it. On the north-east shore of Kirkavoe, crystallised in druses in the same rock with amethystine Quartz, in cubes, built up of alternating layers of colourless and deep purple tints.

CAITHNESS. At the Ord. At the Burn of Ousdale near a rocky gorge over which the stream falls, at a short distance from its mouth; in imbedded concretions in granite; also in small cubic crystals, and in veins of a deep purple (Cunningham). Imbedded in a reticulated manner in the granite of the ridge from Culgower to Loth, of a blue colour (Joass).

SUTHERLAND. In "syenite" at Lairg (Cunningham). In the "syenite" boulder on the west side of Ben Bhreac, Tongue; with Amazonstone, Babingtonite, Orangite, Magnetite, etc.; of a pale purple.

ROSS-SHIRE. Abriachan granite quarry, in blue cubic crystals, with Epidote (Aitken and H.). In large purple cubes, with Galena, in a burn on the north side of the road between Jeantown and Kishorn (Kenneth Murchison). Glen Logan, blue veins in rifts of faulted Hebridian Gneiss, with Epidosite, rare.

INVERNESS-SHIRE. Near the south-east shore of Loch a Bhruthaich, in crystalline greyish-yellow crystals, *a o*, imbedded in crystalline layers in Barytes (Bruiachite) (Aitken).

ELGIN. In New Red Sandstone, in Findrassie quarry, in yellow and red cubes, *a*, *a e k* (Nicol and H.). At Inverugie, in blue and green crystals (Gordon).

BANFFSHIRE. In the Burn of Boharm, in purple cubes (Cunningham). Quarry of † Ardonato, in purple cubes (Cunningham). Near the Avon, 2 miles above Gaulrig between Tomintoul and Inchrory, in three burns [Allt tri Caochan] which flow into it from the west, about 400 yards from their mouths, in a band of yellow limestone or calcite which cuts all three. The Fluor occurs in rude cubic crystals about 10 inches in the side, imbedded in the calcite. These are of a pale green. Also in crystals an inch in size, *d o* (Plate X. fig. 1), *a o*; the two last being formed of alternate layers of about an eighth of an inch in thickness, of emerald-green and deep purple. This Fluor is highly phosphorescent. It is associated with Steatite, Ripidolite, and yellow Sphene. At Maisley quarry near Keith, *o a n* (Plate XI. fig. 2), with Stilbite (Cunningham).

ARGYLLSHIRE. At Strontian, in granite and the metalliferous veins (MacCulloch and Connell).

ABERDEENSHIRE. At Murdoch's Cairn granite quarry in fine blue crystals, *o a t* (Plate XI. fig. 3), *w o*, with Albite, Haughtonite, Orthoclase, and Quartz. Near Monaltrie House and the Pass of Ballater, in purple cubes and green and purple veins, sometimes with galena (Jameson). Also in purple and amber-coloured crystals *a*, *a o*, *a o d*, with unusually well-crystallised Orthoclase, and Zinnwaldite, in rents in the granite (Thoms). In the limestone quarry of Muir, Deeside, in deep purple octahedra, in a quartzose belt, associated with Malacolite, Graphite, Sphene, and Pyrrhotite. Similarly in the quarry at Midstrath. Above Kylacreich in violet crystals in yellow limestone. At Crathie limestone quarry, with Garnet, Sahlite, Sphene, Pyrrhotite, and Wollastonite. At the Corrybeg mines, Abergairn, with Galena, Blende, Schiefer Spar, Psilomelane, Manganite, and Steatite. In the Galena vein, red, honey-yellow, green, and purple—*a*, *a f* (Plate XI. fig. 4), *a f o* (Plate XI. fig. 5), *a d o* (Plate XI. fig. 6), *a m*, *a d m* (Plate XI. fig. 7), *a d m o* (Plate XI. fig. 8), *a n* (Plate XI. fig. 9), *a d o n* (Plate XII. fig. 10), *a p* (Plate XII. fig. 11). Pale yellow cubic crystals of an inch in size have a ridge of circumvallation on their *d* edges. In the intersecting vein, green, yellow, violet, and blue-grey—*a*, *o*, *a o*. All the colours are strongly phosphorescent except the yellow. The matrix is a decomposing and highly ferruginous gneiss. On the north bank of the Dee, about two miles above the last locality (Michie). To the west of Middleton of Balquhain, imbedded in loose blocks of radiating Rock-Crystal, in purple and pale green isolated octahedra. These blocks were probably transported from Brindy Hill.

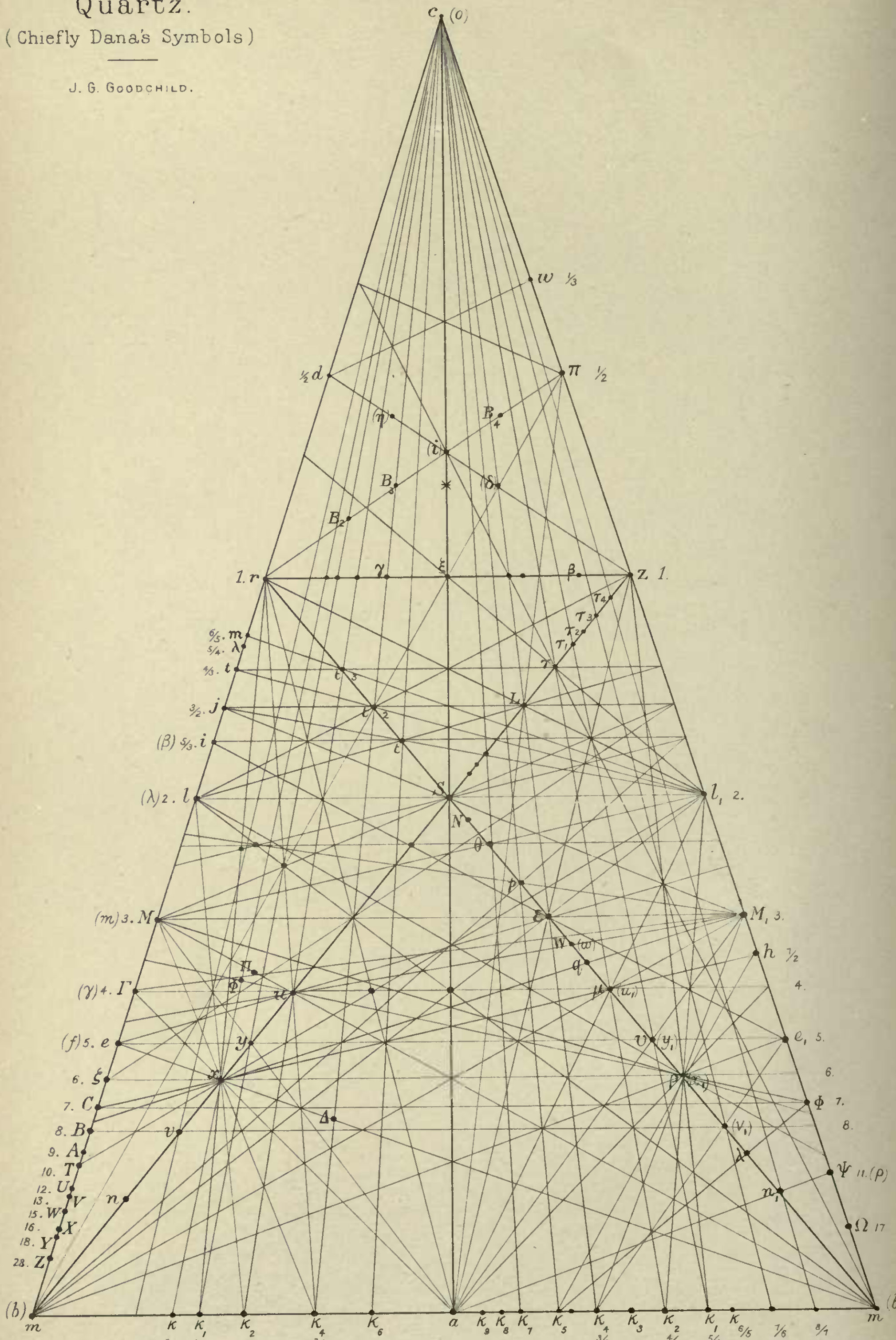
PERTHSHIRE. At the foot of Beinn a' Ghlo, on the east side of Glen Tilt, in pale red cubes (Knox).

FIFESHIRE. At Glenfarg, in the railway cutting, of a blue-grey colour (Adamson).

RENFREWSHIRE. Gourock quarry, in porphyry (Jameson). Colourless, honey-yellow, pink, emerald-green, and purple. The first three colours are rare. The associated minerals are brown Quartz, Calcite,

Gnomonogram
of
Quartz.
(Chiefly Dana's Symbols)

J. G. Goodchild.



Pearlspar, and Selenite rarely. The forms are *a* twinned (Plate XII. fig. 12), *f* (Plate XII. fig. 13), *a o* (Plate XII. fig. 14), *a o*, circumvallated and tesselated (Plate XII. fig. 15), *a f* (Plate XII. fig. 16), *a f d* (Plate XII. fig. 17), *a f o*. The cubic crystals are also sometimes circumvallated. The usual colour is purple, the rarer colours occur only in such cavities as contain Calcite. Some of the green crystals are built up with a series of minute cubes, the solid angles of which are deficient by a regular decrement. Other calcitic druses contain colourless cubic crystals with layers of green. The purple crystals are usually *a f*. Some octahedral crystals are built up of a series of minute cubes. A dark brown mineral in radiating groups of minute crystals which resembles Göthite, but which is magnetic, is also sometimes associated with the Fluor here.

Dumbartonshire. At Dumbarton, in perfect cubes, both purple and deep green, with Calcite, in cavities of "greenstone" (Greg).

Ayrshire. In Hillhead limestone quarry (Lower Carboniferous), 2 miles south-west of Beith, with dog-tooth Calcite, in pale-yellow cubes (Young). At Lugton, Dunlop, in Waterland limestone-quarry, in very fine yellow cubes, *a m x* (Plate XII. fig. 18) (Young).

Dumfriesshire. At Wanlockhead. In the High Pirn mine, in large muddy white cubes, with unplanted Vanadinite (Wilson).

The specimens which were called "Bruiachite" from Inverness-shire, yielded

Calcium, . .	51·12	51·09
Fluorine, . .	48·56	48·75
Barium Sulphide,	·23	...
	99·91 (Heddle).	99·84 (Stuart Thomson),

and are thus simply Fluorite.

Class V. OXIDES.

Sub-Class I. OXIDES OF SILICON.

33. **Quartz (210).** SiO_2. Rock crystal.

Rhombohedral. *O* (*c*), 111, 0001; *a*, $01\bar{1}$, $11\bar{2}0$; *k*, $11\,\bar{4}\,\bar{7}$, $51\bar{6}0$; *r*, 100, $10\bar{1}0$; *z*, $\bar{1}22$, $\bar{1}011$; *s*, $14\bar{2}$, $11\bar{2}1$; *i* (π), 011, $\bar{1}012$; *d*, 411, $10\bar{1}2$; β (*i*), $13\,\bar{2}\,\bar{2}$, $50\bar{5}3$; *l*, 111, $\bar{2}021$; λ (*l*), $5\,\bar{1}\,\bar{1}$, $20\bar{2}1$; *m* (M), $7\bar{2}\bar{2}$, $30\bar{3}1$; γ (Γ), $3\bar{1}\bar{1}$, $40\bar{4}1$; *f*, $8\bar{3}\bar{3}$, $11.0.\overline{11}.2$; ζ, $13.\bar{5}.\bar{5}$, $60\bar{6}1$; *h*, $\bar{4}33$, $\bar{7}072$; ϕ

(Φ), $\overline{13}.8.8$, $\bar{7}071$; ρ (Ψ), $\bar{7}\ 4\ 4$, $\overline{11}.0.11.1$; v, $16.\bar{5}.\bar{8}$, $71\bar{8}1$; x, $4\bar{1}\bar{2}$, $51\bar{6}1$; y, $10.\bar{2}.\bar{5}$, $41\bar{5}1$; u, $8\bar{1}\bar{4}$, $31\bar{4}1$; t, $\bar{4}.11.2$, $32\bar{5}3$; θ, $\overline{14}.22.7$, $\bar{7}.\bar{5}.12.5$; p, $\overline{10}.14.5$, $\bar{5}383$; e (ϵ), $\bar{4}\ 5\ 2$, $2\bar{1}31$; w (W), $\overline{14}.16.7$, $\bar{7}.\bar{3}.10.3$; q, $\overline{16}.17.8$, $\bar{8}.\bar{3}.11.3$; μ, $\bar{2}21$, $\bar{3}\bar{1}41$; n, $\bar{8}54$, $12.\bar{1}.13.1$; ξ, $25\bar{1}$, $11\bar{2}2$; δ (?), $22.19.\bar{2}$; η (?), 11.14.2.

The forms $v, x, y, u, s, t, p, \theta, w, q, \mu, n$, are hemihedral with asymmetric faces, occurring in one only of the two zones $r'\,z''\,b$, $r''\,z'\,b$, and in the same alternate lunes between b, b'', b'. The forms η, s are also hemihedral with asymmetric faces. The faces a, k appear upon the edges of the six-sided prism bb'', on which v, x, y do not occur.

$b\,o$	90° 0′	$h\,b$	167° 19′	$q\,b$	159° 43′
$a\,o$	90° 0′	$\phi\,b$	173° 35′	$\mu\,b$	161° 31′
$k\,b$	8° 27′	$\rho\,b$	175° 54′	$n\,b$	174° 39′
$b\,a'$	30° 0′	$v\,b$	8° 52′	$s\,a$	24° 27′
$b\,b''$	60° 0′	$x\,b$	12° 1′	$\xi\,a$	42° 17′
$\zeta\,b$	7° 29′	$y\,b$	14° 35′	$r\,r'$	85° 45′
$f\,b$	8° 9′	$u\,b$	18° 29′	$r\,z'$	46° 16′
$\gamma\,b$	11° 8′	$b\,s'$	37° 58′	$\eta\,z$	63° 5′
$m\,b$	14° 42′	$b\,z''$	66° 52′	$\delta\,z$	77° 20′
$l\,b$	21° 29′	$b\,r'$	113° 8′	$\delta\,z''$	16° 1′
$\beta\,b$	25° 17′	$t\,b$	135° 5′	$\delta\,r$	39° 6′
$r\,b$	38° 13′	$b\,s''$	142° 2′	$\delta\,r'$	46° 55′
$d\,b$	57° 35′	$\theta\,b$	148° 22′	$\eta\,r$	49° 29′
$i\,b$	122° 25′	$p\,b$	151° 37′	$\eta\,r'$	36° 58′
$z\,b$	141° 47′	$e\,b$	154° 55′	$\eta\,r''$	25° 37′
$l\,b$	158° 31′	$w\,b$	157° 34′		

Rarely the rhombohedron (r) alone, with polar edges 94° 15′. More frequently in combination with the − rhombohedron (z), forming the hexagonal pyramid, with polar edges 133° 44′, and with the middle edge (or Pm − P) 103° 44′. When this edge is truncated and largely developed, the hexagonal prism with hexagonal pyramids, a very common form, is produced. The combination of the faces of the pyramids with those of the prism often takes place in an oscillatory manner, which produces transverse striæ on the faces of the prism. In their commoner forms the faces of the $-r$ are often distinguishable from the primary r by being smaller, and sometimes in having a feebler lustre or less smoothness. Many, if not most, of the modifications of these simpler forms are hemihedral to the rhombohedron (or tetartohedral to the hexagonal prism). Planes x, s are very common, but only hemihedrally; they thus correspond to the faces of a double three-sided pyramid. Various rhombohedrons replacing the basal edges of the hexagonal pyramid occur. Various trapezohedral forms situated obliquely about the angles of the pyramids, the planes *gyroidal* or *plagihedral* in position, and inclining upward, sometimes to the right, sometimes to the left, and being thus *right-handed* or *left-handed*; or occurring on each solid angle, in which case they are *hemihedral*; or generally only on the alternate solid angles, when they are *tetartohedral.* More rarely, again, they occur *right-handed* on one solid angle, and *left-handed* on the next.

Twins, rarely with the axes at an angle of 84° 33′; but frequently with the axes parallel, or in juxtaposition in that direction. Frequently in individuals interpenetrating each other in the same position.

Clv., *r* difficult; *b* indistinct. Fracture, perfect conchoidal to splintery. Tough, brittle, friable. Transparent to opaque. Lustre vitreous, sometimes resinous. Colourless when pure; but even in crystals often various shades of yellow, brown, red, green, blue, or black. Streak, white; when impure, slightly coloured. Gives sparks with steel. H., 7; G., 2·5 to 2·8; 2·65 when pure. When rubbed in the dark phosphoresces, with ozonic odour. Phosphorescence seen under water. Exhibits double refraction. Polarisation circular, there being a plain coloured central space, with therein no cross. The rings of colour encircling this space enlarging as the analyser is turned to the right in right-handed quartz, or to the left in left-handed. Coloured spirals are seen, which rotate to right or left, when the incident light and emergent light are polarised, the one circularly, the other plain.

In the coloured variety called Amethyst, the fracture often presents numerous delicate, rippled lines, somewhat resembling those seen on the palm of the hand, and sometimes intersecting one another as in "engine turning." This is due to the crystal being composed of layers which have opposite optical properties. When a slice of Amethyst, if of an interpenetrating twin cut at right angles to the vertical axis, is examined in the polarising apparatus, the different component portions become visible by difference of colours. Moreover, in Amethyst, the section is seen to be built up in a tesselated manner by sectors of 60° parallel to the plane P, and these sectors are alternately lineated by rippled markings which lie parallel to the sides of the adjacent sectors, the alternate light and dark bands being due to alternate right- and left-handed layers of the mineral. In incorporation twins, again, successive layers of deposition are sometimes alternately right- and left-handed, showing a constant oscillation of polarity in the course of their formation; while the twin formation is developed by one part being right-handed and the other left.

The Amethysts obtained in Glen Oban, Loch Morar, and crystals of Cairngorm, both display the above structures in perfection.

Occurs also massive, coarse, or fine granular to flint-like. Sometimes fibrous, laminar, mammillary, stalactitic, or in concretionary forms.

B.B. infusible. With sodium carbonate dissolves with effervescence, forming a clear glass. Unacted on with micro. salt. Insol. in all acids except hydrofluoric, heated with which it volatilises. When pulverised slightly sol. in solution of potash. Comp., pure silica. Massive varieties often contain a little opal.

a. Rock Crystal. Colourless, pellucid.

SHETLAND—FETLAR. At Hestaness, on the east side of Gruting Bay, in mica slate, *b*(*m*)*rz*, the terminal planes circumvallated (Dudgeon). On the south shore of Fetlar (Jameson).

ORKNEY—HOY. At the Burn of the Sale, the Bring. In brilliant, isolated, doubly-terminated crystals, disposed on the surface of Göthite, *b*(*m*)*r z* (Plate XIII. fig. 1).

SUTHERLAND. At the Ord Hill, Lairg, in veins of gneiss. With Chalcopyrite and Barytes, *r z b*(*m*)*v s* (Plate XIII. fig. 2).

ROSS-SHIRE—TORRIDON. In veins of the Bad Step, west side of Sgorr a' Chadail. In veins in Torridon Sandstone, west side of Liathach; and also at the east end of Loch Torridon, in a cutting, with Prase.

INVERNESS-SHIRE. On Creag a' Mhaim, near Clunie, with Chlorite and Lepidomelane.

HEBRIDES. Eigg, on east side opposite Eilean Chasgaidh Island, in druses in basalt over Calcite. Mull, with Epidote, on the south-west spur of Ben More, in claystone, *r z b*(*m*)*x l φ* (Pl. XIII. fig. 3), *r z b*(*m*)*x l s*, and *p f r* (Currie and H.). South Uist, Loch Bee, in Hebridian Gneiss, *s r*.

ABERDEENSHIRE. East of Kinnaird Lighthouse, in veins in gneiss, doubly-terminated, *p b*(*m*)*z* (Grant Wilson and H.), usually opaque or yellow.

ARGYLLSHIRE. Near Ballachulish, in clay slate. Mull of Kintyre, at summit of Killellan Hill, and at Wigle, south of Campbeltown; internally capped with Göthite (M'Sporran). At Galdrings, south shore of Machrihanish Bay, in druses in basalt, in doubly-terminated crystals, *r z b*(*m*) (Plate XIII. fig. 6). On the north shore of Holy Loch, in chloritic gneiss, *r*, *r z b*(*m*) (Plate XIII. figs. 4 and 5). East slope of Bishops Seat, Dunoon, 900 feet from the sea, *r*, in chlorite schist.

AYRSHIRE. At Kaim Hill, 1 mile east of Fairlie, in "greenstone," overlying a quarry of Old Red Conglomerate. Parish of Dunlop, in the farms of †Fallhead and Lochridge Hill, on the sides of a dyke of columnar basalt. Dockra quarry, near Beith, in limestone, *φ h* (Plate XIII. fig. 7) (Craig).

BERWICKSHIRE. At Hadden, below Sprouston, on the Tweed, with jasper, in limestone of Lower Carboniferous age. On the Leithen, below Williamslee, in a quartz vein; similarly in the hill above Priestshope.

KIRKCUDBRIGHT. In the channel of the stream at Orchardton.

b. Massive Rock Crystal has been found, in Inverness-shire, in veins in gneiss in the south face of the Feodain of Sgor na Ciche, at the height of 2500 feet. In Aberdeenshire, in the fields of Kilmundy; near Mintlaw, Old Deer; and at † Knockhill, near Peterhead. Kincardineshire, at Birnie Slack, near Fettercairn. In veins in chlorite schist at the south-east corner of Jura, and at the north-east corner of Islay (MacCulloch).

c. Crystallised White Quartz.

SHETLAND. Mainland, Sandlodge mine, milk-white, with Limonite (D. and H.).

HEBRIDES—MULL. Carsaig Arches, in druses in the wakenitic lava of Tertiary age, close to other beds carrying zeolites.

KINCARDINESHIRE. At † Thornyhythe in druses in eruptive rocks. Sometimes transparent. At the Pass of The Ladder. Also in specimens in which the angles of the pyramid are opaque white quartz, but their general substance is clear rock crystal.

MIDLOTHIAN. At Craiglockhart, near Edinburgh, *r z*. In the north Ratho quarry, disposed upon Pectolite, in druses in dolerite (Stuart Thomson and H.).

LANARKSHIRE. Leadhills mines, with Calcite, Barytes, and Blende. At † Kiffockside, with Barytes.

FIFESHIRE. At Chapel quarry, near Raith, often colourless and transparent, with Calcite and Pyrite in dolomitised limestone of Lower Carboniferous [Yoredale] age.

PEEBLESSHIRE. In a quartz vein which crosses the Leithen below Williamslee; also in a vein in a hill above Priesthope.

CAIRNGORM, OR SMOKY QUARTZ.

SUTHERLANDSHIRE. On the north cliff of Ben Loyal, and in a boulder of pegmatite on Ben Bhreac, associated with Amazonstone, Strontianite, Specular Iron, Thorite, etc. Near the summit of Quinag, on its east side, in augen-gneiss, *b m* (*M*) *r z e x* (Plate XIII. fig. 8) (Morrison).

HEBRIDES—NORTH RONA. In granitic veins, usually graphic. (MacCulloch and H.)

BANFFSHIRE. On Cairngorm and some of the adjoining hills. In decomposed granitic veins, generally in loose crystals impacted in Kaolin; sometimes with adherent crystals of Orthoclase; rare associates are Beryl and blue Topaz. Occasionally found loose on the surface;

also in the bed of the Avon. The crystals sometimes attain to a weight of 40 lbs. or more.

The following forms have been observed: — Cairngorm—*f m r z*, (**M r z*); *b v m ζ r z*, (*m v M ζ r z*); *b x φ r z*, (*m x Φ r z*), Pl. XIV. fig. 9; *b r z x m f*, (*m r z x M**); *b r x z β f φ e*, (*m r x z i* * *Φ ε*), *b r x ξ z φ f*, (*m r x ξ z Φ M**), Pl. XIV. fig. 10. At the foot of Ben a Mhain [Beinn a Mheadoin], *r z b s*, (*r z m s*), Pl. XIV. fig. 12; *r z b x*, (*r z m x*), Pl. XIV. fig. 11; *r z b ζ x*, (*r z M ζ x*), Pl. XIV. fig. 13; *b r z s e x*, (*m r z s ε x*); *b r z x m d*, (*m r z x M d*), *b r z m θ t*, (*m r z x* * *t*). Ben Avon, *r z b s t*, (*r z m s t*); *r z b m x*, (*r z m M x*); *r z b x m e*, (*r z m x M ε*); *r z b x β v*, (*r z m x i v*); *m*; *r z b f m x*, (*r z m* * *M x*); *r z b f*, (*r z m* *); *r z b*, (*r z m*); *r z b β x*, (*r z m i x*); *r z b f x u*, (*r z m* * *x u*); and incorporation-twins of *r b x*, (*r m x*). The crystals found on the south side of Loch Avon are light in colour and very pellucid; those on the north side are dark brown to jet-black [Edin. Museum, *r z m Φ x*, *m M r x*]. Ben a Mhain, *b z r x m φ*, (*m z r x M Φ*), Pl. XIV. fig. 14; *b r z v s x*, (*m r z v s x*), Pl. XIV. fig. 15; *b r z φ λ l q m x*, (*m r z Φ l ? W M x*), Pl. XIV. fig. 16; *b x r v m ζ*, (*m x r v M ζ*), Pl. XV. fig. 17; *r z m f l φ*, (*r z M* * *l Φ*), Pl. XV. fig. 18; [Edin. Museum, *r z b x m λ*], (*r z m x M l*); *r z b ζ v*, (*r z m ζ v*); *r z m f*, (*r z M f*); *m b r z θ t*, (*M m r z* * *t*); and Loch Avon, (*m M Γ r z i*).

Aberdeenshire. At Sterling Hill quarry, 3 miles south of Peterhead, in magnificent doubly-terminated crystals, *b r z*, (*m r z*), 6 by 3 inches, of a rich brown colour, with Orthoclase, Albite, and, rarely, Muscovite. At Murdoch's Cairn, and other quarries in the red granite south of the Bullers of Buchan, occasionally in still-larger crystals, associated, in the first-named of these quarries, with Albite, Fluor, Talc, Epidote, and Lepidomelane. Also at Black hill, and more southerly quarries. In the Cabrach, rarely, at the Black Hill, of fine colour. Culblean, Deeside, capped by milk-white quartz; in granite-veins at the head of Queel Burn; and on the foot of the hill between Blairglass Burn and Red Burn (Michie). Near the summit of Bennachie, by incorporation-twins, like Pl. XV. fig. 19, with one-half dissolved and roughened, positive to the other. Jet-black, on the slopes and corries of Ben a Mhain, and in the east cliffs of Beinn a Bhuird, with blue and colourless Topaz, and, rarely, with Amethyst. Tillyfourie, *r z γ*, *r z h γ*, Pl. XV. fig. 20, with Chlorite. At Craigton quarry, Hill of Fare (Currie).

Forfarshire. Montrose; at the Blue Hole, Usan, lining the centres of agate druses, in andesitic lavas of the Old Red Sandstone.

Argyllshire. Kintyre, at Ballivouline Hill, 1½ miles north of Campbeltown, with Calcite, in limestone (Macdonald); also at Balligroggan, Kintyre, in Lower Carboniferous trap.

Fifeshire. At Heather Hill, Luthrie, lining blue agates.

Renfrewshire. At Gourock, in druses in porphyry [Lower Carboniferous lava], rarely colourless, with Fluor, Gypsum, Barytes, Göthite, and Calcite.

Buteshire. Arran, in the granite on the east side of Goatfell, with Murchisonite and, rarely, Muscovite. Forms: *r z b ζ x*, (*r z m ζ x*), *r z b s*, (*r z m s*), *r z b x*, (*r z m x*), *r z b m x e*, (*r z m M x ϵ*), Plate XV. fig. 24; *r z b m x s* (*r z m M x s*), Plate XV. fig. 22; *r z b v x m*, (*r z m v x M*), Plate XV. fig. 23; *r z b v*, (*r z m v*), *r z b f x u*, (*r z m * x u*), Plate XV. fig. 21; *r z b x β m*, (*r z m x i M*), Plate XVI. fig. 25. Ben Nuis, *r z b*, (*r z m*), *r z b m*, (*r z m M*). Cir Mhor, *r z b f*, (*r z m **), Plate XVI. fig. 27. Am Binnein, *r z b f x*, (*r z m * x*), *r z b f m λ β*, (*r z m * M l i*), Plate XVI. fig. 26. On Caisteal Abhail, and on the hills near Loch Ranza, *r z b m β x*, (*r z m M i x*), Plate XVI. fig. 28; *r z b m x e*, (*r z m M x ϵ*), and interpenetration-twins of *r z b m s*, (*r z m M s*), and (*r z x v*). [Figs. 30, 31, and 32 of Pl. XVI. also represent Scottish crystals of Quartz drawn by Dr Heddle.]

Many years ago Greg remarked upon the great want of variety exhibited in the crystalline forms of Quartz in Britain; forty years of exploitation have not added much to his record; still, the forms at Loch Bee, at Tillyfourie, and at Dockra, are very different from any figured by him. Nor can it be said that the forms are intricate or fine, Plate XVI. fig. 29 (21 of Des Cloizeaux), drawn from a twin cairngorm of the author's, being the most intricate.

HYALINE QUARTZ.

A variety of Cairngorm, having much of a claret colour, occurs somewhat abundantly in the belt of chloritic quartz rock which stretches from Fortingal through Ben Lawers and the central Perthshire hills to Loch Eck in Argyllshire. This variety, which *is never crystallised*, and has something of colloidal appearance, is frequently pervaded by Chlorite, and is the ordinary matrix of Ilmenite and Rutile. It specially occurs in the precipices round Lochan a' Chait, Ben Lawers, Creag na Caillich, Creag Mhor, specially the Mid Hill of Glen Lochay, and Beinn Bheula of Loch Goil. When cut as an ornamental stone this variety surpasses ordinary Cairngorm, not only in colour but in brilliancy and pellucidity. It occurs also at Quinag, Sutherland (Morrison). In Inverness-shire, at Stob a' Choire Mheadhonaiche, near Loch Treig, with Chlorite and Ilmenite; and in Stob Coire Gaibhre, north of Stob Choire Claurigh, with Chlorite and Ilmenite.

AMETHYST.

Shetland. Mainland, Northmaven, at The Cannon, Esha Ness, in cavities in amygdaloid, with Saponite and Göthite (Dudgeon and H.).

Ross-shire. Fannich, 1000 feet up the south slope of Meallan Rairigidh, brilliant in colour.

Inverness-shire. Loch Morar. In the Corrie Carr of Lurg Mhor, with Garnet in crystals the size of an egg. "Loch Mòrair, in Glen Oban, the eastermost of two streams which descend from Ben Streipe, in crystals an inch in thickness" (Joass). The crystals here are usually capped; being alternately purple and colourless; but their brilliancy is great, and the purple has a delicate pink tinge, which is surpassingly beautiful.

Aberdeenshire. At the south side of Brindy Hill, south of Premnay, Amethystine Quartz. In the cliffs of Beinn a Bhuird.

Kincardineshire. At the Long Gallery, in cavities in trap, coating Crocalite.

Forfarshire. Montrose, in large druses, with red Quartz, at Scurdy Ness. Forming the centres of agates at Usan. At Lunan Bay railway cutting, and at Craig cutting, in agate druses, with Onyx (Mitchell).

Fifeshire. Near Newburgh, with Chalcedony. In agates, rarely, at the Heather Hills, Luthrie. Amethystine Quartz, with Calcite, in amygdaloid, near Pettycur. Near Burntisland, in veins and druses in greenstone, with small Rock Crystal and Saponite. Kincraig, Elie, rarely.

Argyllshire. South of Campbeltown, near the summit of Killellan Hill, and at Wigle, in large and fine specimens (M'Sporran).

Stirlingshire. Near the road from Campsie Hill to Fintry, and at Cathcart Castle.

Haddingtonshire. North Berwick, opposite the † Sheep Crag, with Natrolite and Analcime; also nearly opposite the Bass Rock.

Midlothian. At Corstorphine Hill, with Prehnite. At Craiglockhart. Formerly on the Calton Hill, at the back of the High School, in trap; and in dolerite in Broughton Street quarry. [In Blackford Hill quarry, and at South Queensferry.]

Renfrewshire. Near Lochwinnoch, at Linthills and Lairdside, with Rock Crystal, Carnelian, and Agates.

Ayrshire. At Catburn, in the parish of Largs. On blue Chalcedony, 400 feet up the west side of Kaim Hill.

Bute. Arran, on the west side of Goatfell. In Glencloy, on its south-west side. Near Ascog, in Bute (Glen).

Berwickshire. At Wilkiehaugh, with Quartz, Barytes, and Calcite, in dolerite and amygdaloid.

Kirkcudbrightshire. Near the rock Lot's Wife, and not far from the cliff Needle's Eye, veins of fibrous Amethyst, with cavities containing crystals of the same, and Quartz coated with iron froth (Dudgeon).

Other Forms of Crystalline Quartz.

Pink.—At the Brindy Hill, 2½ miles south of Premnay. On the Ladder Road, near Mount Keen, ABERDEENSHIRE. ARGYLLSHIRE, on Beinn Doireann, in a vein 250 feet below the summit on its north-west shoulder, and also in veins on its west slope.

Scarlet.—On the west shoulder of Mount Keen, ABERDEENSHIRE. In druses near Ferry Den, Montrose, with Amethyst.

Red.—On the south slope of Ciste Dhubh, Clunie, INVERNESS-SHIRE. On the slopes at head of Glen Mark, FORFARSHIRE.

Dark Red.—Near the summit of Craigendarroch, Ballater; and, sprinkled with red, near Kylacreich Inn, Deeside, ABERDEENSHIRE. Coated with a transparent colourless layer, on the Tarf, 2 miles above Tarfside.

Salmon-coloured.—In doubly-terminated crystals, with blue Barytes, on Dolomite, in druses in tufa at Kinkell, FIFESHIRE. On Mount Keen, ABERDEENSHIRE.

Yellow.—Near the Ladder, Mount Keen. Wanlockhead, DUMFRIESSHIRE. Very rarely on south side of Loch Avon (False Topaz).

Brown-Red.—Kincraig, near Elie, FIFESHIRE, in tufa, with Barytes (Dudgeon and H.).

Purple.—In a vein at junction at the north-east extremity of Foula, SHETLAND.

Babel Quartz, or rather Babel Cairngorm, occurs rarely at Sands Geo, Walls, Orkney.

Zeolitic Quartz. Sphæro-radiant structure. More or less stalactitic; often to be traced to fibres of a radiating zeolite (Natrolite).

HEBRIDES. Skye, in an old quarry near Stein, Loch Bay, Dunvegan. Mull, at the Carsaig Arches, with zeolites, and also in stalactitic groups sheathing acute crystals of Calcite, and over a cave of Saponite. KINCARDINESHIRE, near the church of Kinneff, in tufts, with zeolites and crystallised Saponite. FORFARSHIRE, in the Craig cutting, with Saponite and zeolites (Mitchell). PERTHSHIRE, with Göthite, at Corsiehill quarry (Lauder Lindsay). STIRLINGSHIRE, at the Boquhan Hills, of a blue colour, with red Stilbite (Kidston). DUMBARTONSHIRE, at Bowling quarry, with pink Natrolite (Rose). At Lang Crag, with red Stilbite and red Heulandite (Thomson). On the east shore of Loch Humphrey, Kilpatrick Hills. RENFREWSHIRE, at Hartfield Moss, with Prehnite.

MASSIVE QUARTZ.

Snow-white.—Massive, granular:—

Ross-shire. Ben Lair, in a vein, where it passes to hyaline, massive Rock Crystal (MacCulloch).

Inverness-shire—Kintail. In veins in gneiss, on the west summit of Sgurr nan Ceathreamhnan. Perthshire: in a vein between Ben Iutharn Mhor and the hill to the south-east. In a vein a foot wide on the lower eastern peak of Meall Ghaordie. Argyllshire: Beinn Doireann, in veins 50 feet below the summit on the south-west side. Harris: Roneval, in a vein on the south-east side.

Milk quartz.—Massive, fracture conchoidal, translucent, somewhat opaline; lustre somewhat greasy.

Hebrides—North Uist. In a vein below high water on the north-east shore of Port nan Long, with blue Quartz. Tiree: Crossapoll, in granitic veins, in patches, with Sonnenstein, Agalmatolite, and Haughtonite. In Creachasdal, east of Tiree, in lumps 2 feet thick, imbedded in dark mica gneiss. Inverness-shire, on the top of Braeriach, crystallised, with banded Chalcedony. Banffshire, in loose lumps, rarely, on the west side of Craigbuirach. Aberdeenshire, rarely in granite veins in gneiss, at Girdleness lighthouse, opaline.

Blue.—Hebrides. In Taransay, at the south end in the granite veins which strike N.N.W. Harris: in the great vein of Chaipaval, with Rose Quartz, Graphic Granite, and green Muscovite (D. and H.). North Uist: at Port nan Long, indigo-blue, with milk quartz; both with rhombic cleavage. *Greyish-blue,* in granitic veins, half a mile north-west of the pier at Loch Maddy, somewhat opalescent, with Orthoclase. *Purplish-blue,* at Miabhag, West Loch Roag, Lewis (Currie).

Purple.—Shetland. Hillswick: at Carneba, with Schorl, red Felspar, and Epidote. Ross-shire, west of Garve, in veins in gneiss in the railway cutting. At Eaglesham, in a whinstone quarry, with Labradorite. *Red-purple.*—Shetland, Mainland, on the south-east shore of Kirka Ness (Hibbert).

Purple-pink.—Shetland. Hillswick, at North- and South-Quin Geo (D. and H.), in gneiss.

Pink.—Shetland. Mainland, Seelie Voe, east shore, with Chlorite, pellucid (D. and H.). Banffshire, on the south-east branch of the Burn of Boharm. *Opaque pink,* in gneiss in Lewis (MacCulloch).

Brown-red.—In veins in gneiss, at Gairloch, Ross-shire, sometimes milky (MacCulloch). Similarly, but transparent, in veins traversing granite, on the coast between Loch Inver and Rudha Storr (MacCulloch).

Grey or *French Grey.*—Opaque, in Glen Tilt, and in North Rona, in veins in granite (MacCulloch).

Grey-blackish.—At Gairloch and in Beinn Airidh a' Char, in gneiss; varying from very pale grey to very dark blackish-grey (MacCulloch).

Rose.—SHETLAND. Mainland, Hillswick, at North and South Quin Geo, in a vein with Epidote, somewhat chalcedonic (D. and H.). HEBRIDES, HARRIS: in the great dyke of Chaipaval, with Graphic Granite, and green Muscovite (D. and H.). In a vein west of Hushinish House, south-east of the bifurcation of the road. Hyaline granular in a granite vein south-east of Sgurr Ruadh. North Uist, on the north-west side at Hornish Point, with Oligoclase. Coll, in loose pieces on the beach near Breachacha Castle (MacCulloch); on the north shore of Loch Eatharna, near Arivirig, in granitic belts in gneiss; also loose. Tiree, with Milk Quartz in veins in gneiss in Creachasdal Mòr. ABERDEENSHIRE—Clova: in three nearly parallel veins. The most westerly is near Badenshore moss of Glenlaff Hill. This vein, which is of great width, is at the surface bleached nearly white. The second is on the south side of the rise between Earlseat Hill and Peat Hill. The third is on the north-east slope of Earlseat, Mount Keen and Earlseat being in line. On the Craigengell Hill of Cushnie a vein runs nearly true north and south between Sockaugh and Tap o' North. Found also loose at Black Middens, Glencuie, and banded with white on the north side of Glen Kindie, either in the line of these veins or east of them. In the Slacks of Glen Carvie, half-way up. Rarely, near the limestone of Tillquhilly. In gneiss, as at Poolewe, Glen Logan, and Rona.

Yellowish-green. — Coloured by filamentous and granular Epidote (Epidosite). Usually in districts where the rocks have been much crushed, or in veins in the Archæan Rocks.

Green.—HEBRIDES. Tiree: near Crossapoll, in a granite vein, in small patches, with Haughtonite, Agalmatolite, and Sonnenstein. ARGYLLSHIRE: Beinn Doireann, 50 feet below the summit, on the south-east side, in thin veins, along with massive snow-white quartz. Coloured by Chlorite, east side of Bishop's Seat, Dunoon. Also in Bute, and on the shore of Cowal, sometimes nearly black. On the south-east shore of Jura, and north-east of Islay, in veins in Chlorite schist, with crystallised Chlorite (Jameson).

Leek-green—Quartz Prase.—ROSS-SHIRE. Torridon, on the south-east shore at head of the loch, in anastomosing and branching veins, $\frac{1}{4}$ of an inch wide, which cut Torridon Sandstone, with Rock Crystal. INVERNESS-SHIRE, on † Bulgay Island, within the entrance of Loch Hourn, in veins in actinolite schist, light to dark green, with Chalcopyrite (MacCulloch). BANFFSHIRE: west of the exposure of Serpentine at Portsoy, in nodular veins traversing Chiastolite Slate, with green Kyanite, and Pyrite. PERTHSHIRE: in Corsiehill quarry, Kinnoull Hill, along with Saponite (Lauder Lindsay). ROXBURGHSHIRE: at its south-east corner, with Rose Quartz, in the andesitic lavas of Old Red Sandstone age in the Cheviots (Nicol).

Yellow.—PERTHSHIRE, at many spots in the quartzite belt which traverses the centre of the country, as in Lude limestone quarry, south-east of Carn Tullich, Blair Athole, and westward to Ben Lui.

Emerald-Green.—Coloured by the Celedonite or Saponite of igneous rocks, as at Sgurr Mòr, RUM, with Heliotrope. PERTH: Kinnoull Hill; Corsiehill; Ben Lui, east ridge.

Black—"Morion."—BANFFSHIRE. Portsoy, in veins in Chiastolite Schist, west of the serpentine bed. ROSS-SHIRE: in veins in Beinn Airidh a' Char, apparently coloured by Actinolite (MacCulloch).

FIBROUS QUARTZ.

BANFFSHIRE. In a bed to the east of the greater mass of Serpentine at Portsoy, with crumpled mica.

LAMELLAR QUARTZ.

ABERDEENSHIRE. In the limestone quarry of Delnabo, Glen Gairn.

HACKED QUARTZ.

ARGYLLSHIRE: Oban, in veins of phyllite and of graphitic schist. Wanlockhead, DUMFRIESSHIRE, the cellular structure being filled up with Pyrite (Wilson).

SAGENITIC QUARTZ (*σαγηνη, a net*),

Containing acicular crystals of other minerals. *Rutile,* at Creag na Caillich, Craig More, Glen Lochy, The Cobbler, and Beinn Bheula. *Göthite,* see under. *Tourmaline,* Cairngorm. *Chlorite,* Bishop's Seat, Dunoon.

Penetrated by *Tourmaline,* in granitic veins east of Portsoy; Black Hill, Cabrach; Thief's Hollow, Glen Kindy. By *Apatite,* railway cutting, Glen Skioch, ROSS-SHIRE. By *Staurolite,* Burn of Aldernie, BANFFSHIRE. By *Kyanite,* Finlarig Castle, BANFFSHIRE. By *Zoisite,* Dulnein, INVERNESS-SHIRE (Geikie); Milltown, Urquhart. By *Beryl,* Cairngorm. By *Stibnite,* Glendinning, DUMFRIESSHIRE (Dudgeon). By *Garnet,* summit of Ben Resipol, ARGYLLSHIRE (Rose). Hollow casts of *Rutile,* in quartz, summit of Beinn a' Ghlo, PERTHSHIRE.

AVANTURINE.

Spangling from imbedded scales, or reflection from fissures. ORKNEY: Mainland, at Birstane Bay, in deep-red sandstone, reddish-brown to yellow (Traill). SUTHERLAND: Ben Hope, at the east shore of Am Gorm Loch; bright-red, from a rose-mica and red Zircons. INVERNESS-SHIRE: near the summit of Ben Eibhinn, south of Moy, on its eastern side, containing a bright-red mica. Near the summits of Ben a' Chaisteil and Stob Coire an Laoigh, on their west sides, and on the connecting ridge, of a yellow colour. BANFFSHIRE: on the west side of the Ailnack River, about 3 miles above its junction with the Avon. PERTHSHIRE: in Glen Fernate, about 2½ miles above its opening, on its west side, greyish-blue (MacCulloch). Granular quartz, near Dunbar, approaches avanturine.

IRIDESCENT QUARTZ.

From surface-tarnish. ABERDEENSHIRE: Pitfechie Hill, near Monymusk, from Specular Iron. KIRKCUDBRIGHT: Door of Cairnsmore.

FLEXIBLE SANDSTONE.

AYRSHIRE: at Barskimming.

IRON FLINT, OR FERRUGINOUS QUARTZ,

Is a structureless admixture of Quartz with red or yellow ochre. ORKNEY: Hoy, rarely, on the hill tops. BANFFSHIRE: Letterfourie, in quartz-rock. DUMBARTONSHIRE; Stockymoor, Carbeth (Greg).

FETID QUARTZ.

ROSS-SHIRE: at Poolewe and Loch Greinord, in veins in gneiss. The smell, which resembles that of putrid seaweed, is evolved on friction, and diminishes "when the specimen has been so long kept as to lose its water" (MacCulloch).

OTHER FORMS OF QUARTZ.

Massive quartz having surfaces grooved and highly polished occurs in loose blocks of the Torridon Conglomerate, lying east of Inchnadamph; and *in situ* at Dulnan, INVERNESS-SHIRE. At the first of these localities this seems the result of air-dust friction [Eolian erosion].

CRYPTO-CRYSTALLINE QUARTZ.

Containing generally some Opaline Silica, and, in some varieties, probably also Tridymite.

CHALCEDONY.

HEBRIDES: Skye, Dunvegan Head (Greg). Loch Bracadale, at Orbost Bay. Rum: in druses near Heliotrope, Sgurr Mòr. Eigg: in the "Pitchstone Porphyry" of the Scuir, that in the south side being quite opalescent. On the shore west of Uamh Fhraing, in basalt, in cavities apart from others with zeolites. Oighsgeir, south-west of Canna, in the South Skerry in large druses in the "pitchstone porphyry," with Olivine. Mull: at the Carsaig Arches. ARGYLLSHIRE: Ardnamurchan, in druses on the shore at Maclean's Nose. ABERDEENSHIRE: Cabrach, in the banks of the stream, at the farm of the Buck, with Jasper. FIFESHIRE: at the summit of the Binn of Glen Farg, with Moss Agate and red-and-white Carnelian. HADDINGTON: at the Leethies, North Berwick, opalescent, apparently from decomposition. LANARKSHIRE: Leadhills, loose on Hawkwood. DUMFRIESSHIRE: on the Annan, at St Mungo, near Dalton, in "greenstone," with Saponite.

CARNELIAN.

Flesh-red, translucent Chalcedony. ELGINSHIRE: at Duffus, in limestone, with flint, and Galena. ARGYLLSHIRE: Kintyre, at the Kildalloig shore, with Eyed Cachalong. FIFESHIRE: at the Tay Bridge. In a quarry on the ridge east of Gallow Hill. On Scurr Hill rarely. At the summit of the Binn of Glen Farg, with Moss Agate. At the Patent Slip cutting, "Ferry-Port-on-Craig" (Partan Craig), with milky Calcite. On Foodie Hill, muddy. At Wormit Bay. Near Kinghorn, on the coast, in trap, bright-red (Greg). HADDINGTONSHIRE: North Berwick, shore opposite Craigleith, in Lower Carboniferous lavas. ROXBURGHSHIRE: on a hill near † Old Saughton, with compact milky Chalcedony (Nicol).

SARD.

Orange-brown Chalcedony. FORFARSHIRE: on the shore near Usan (Keith).

CACHOLONG

Is chalcedony rendered opaque or milk white, rarely by minute fibres of a zeolite (Okenite, Pectolite, or Mesolite), more commonly from an admixture with Milk Opal. It seldom occurs alone, but is generally found in parallel bands, with translucent, grey Chalcedony, forming Onyx; less frequently, it is similarly interbanded with Carnelian, forming the lower layers of Onyx Agates or Sardonyx, and, still more rarely, as concentric bands of agates. Forming Onyx, it rarely occurs at the base of zeolitic druses at Quirang, Skye: forming Onyx Agates, and agates at the "Blue Hole" (Usan), FORFAR, and Balmeadowside, FIFE. Rarely, at the Blue Hole it fills the whole agate.

ONYX.

HEBRIDES: Skye, at Storr, and Quirang, forming the bottom of druses containing zeolites. Rum: at Sgurr Mòr, south of the Heliotrope vein. At Bàgh an Ruadh Mhoil, on the north shore, loose. BANFFSHIRE, on the south-west slopes of the summit of Cairngorm, brown-red and white. INVERNESS-SHIRE: summit of Braeriach, muddy-yellow and white, with Milk Quartz.

PLASMA.

Chalcedony stained bright green by uniform admixture with Delessite or Celedonite. Lustre, greasy to horny. HEBRIDES: Rum, at Sgurr Mòr, very rare, passing into Prase. FIFESHIRE: Scurr Hill, near Balmerino, very rarely, in thin veins, and forming the outer portions of some agates. PERTHSHIRE: Ballindean, rarely, as the first layers of deposit, in brecciated agates.

HELIOTROPE.

Chalcedony stained various shades of green, dark to leek-green, by intermixture with Celedonite, and, when sprinkled with red spots, becomes Bloodstone; when these, from confluence, become blotches, it is Heliotrope.

HEBRIDES: Rum, in the amygdaloidal basalt lava of Creag nan Stardean, Sgurr Mor, in amygdules of every size, and also in a vein. Every stage of the passage of Chalcedony into Heliotrope is here seen; and sometimes loose pulverulent Celedonite lies in cavities of the stone. Rarely it is translucent in thin slices, of a splendid emerald colour and a mossy structure. Concentric and undulating bands of white and green also show that the mode of formation is similar to that of Agates. In many cases the Chalcedony passes through liver-brown and lavender bands into Hornstone. In all the Rum specimens small concentrically-zoned spheres of Chalybite, decomposed largely into a brown ochre, stud the stone. PERTHSHIRE: in Kinnoull Hill, with a minute closely-adherent sphæro-radiant structure, which polarises throughout with a black cross (MacCulloch). Also loose on the shores of the Tay. Occasionally this passes into a rich brown tint. EIGG: "The pitchstone porphyry" of the Scuir, upon its south side, contains nodules of Chalcedony which occasionally passes into Heliotrope and conchoidal Hornstone. MULL: at the south end, in trap, and below Gribun (MacCulloch). At the Carsaig Arches, on the shore, coarser than that of Rum. ARGYLLSHIRE: Kintyre, near Machrihanish Bay, in a vein 2 inches wide, at Galdrings, with much blood-red, very fine.

Nodules [pebbles] of coarse Heliotrope occur in the [Old Red] Conglomerate of Kerrera (MacCulloch). Also in the Old Red Conglomerate of Tod Head, KINCARDINESHIRE. AYRSHIRE: In loose nodules [pebbles] on the shore near Lendalfoot, a brecciated variety with red and green subangular fragments.

AGATE. VARIEGATED CHALCEDONY. "SCOTCH PEBBLES."

Agates represent various modifications of silica—hydrous or anhydrous—together with zeolitic materials, which occupy the former vapour-vesicles of [sub-basic, and sometimes of basic] eruptive rocks. These materials represent the decomposition-products of the eruptive rocks, which have been carried by means of water into these closed cavities, from the surrounding rock, by endosmose. Within the vesicles they have been deposited in successive layers, through which layers osmotic pressure continued to act. After the deposition or the coagulation of the material forming the layers was completed, the solvent liquid was forced out of the cavity through one, or through many, openings, by the entrance of an additional quantity of strong solution, according to the ordinary law of endosmose. These openings may be called *tubes of escape* (see figs. 12–15).

No absolute line can be drawn to separate a druse more or less completely filled by silica from a *zeolitic* cavity, as the same vesicle may contain both siliceous layers and zeolites, and that in varying order of superposition. Neither can it be definitely stated which ingredients of the rock, by its decomposition, determines the formation of either; but this distinction has to be pointed out in the formation or filling-up of such druses, namely, that there is *a perfectly definite order* in the successive deposition of the various zeolitic minerals which fill drusy cavities, while there is no definite order whatsoever in the deposition of the various forms of silica whose layers form an agate.

[A splendid series of Scottish agates, illustrating the structural characters described in this and the following sections, which were collected and arranged by the Author, has lately (May 1898) been presented by Mr Alex. Thoms to the Edinburgh Museum of Science and Art, and is placed in the Collection of Scottish Minerals.]

AGATES; NORMAL STRUCTURE.

FORM.

The form of the vapour-vesicle is determined by the amount of fluidity or of viscosity of the fluid rock through which it is ascending; and also by the state of the flow—whether of motion or of rest. If it had little or no motion and great fluidity, the vesicle, especially if it be small, is *round*. When the viscosity of the lava was so great that the vesicles rose with difficulty, while the flow still continued, the vesicles have been drawn out into more or less of a *rod-shaped* form, and often lie horizontally—the more-rounded extremity pointing in the direction of the flow. If there has been little motion and considerable fluidity the vesicle is *pear-* or *balloon-shaped*. If some motion and considerable fluidity, it is *axe-shaped* (fig. 1). If rapid motion and considerable fluidity, it is *lanceolate*. When very large there is frequently an elevation in the centre of the floor, as in a *wine bottle*. Agates with a flat underside are almost invariably *Onyx-agates* (fig. 2). The flattening may have resulted from the matrix concreting and solidifying at a uniform distance from the underlying cooling surface: (as this surface has been probably somewhat sloping, the onyx banding, which is invariably

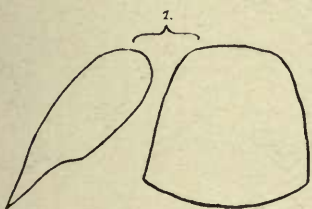


FIG. 1.—Axe-shaped Agate—in two positions.

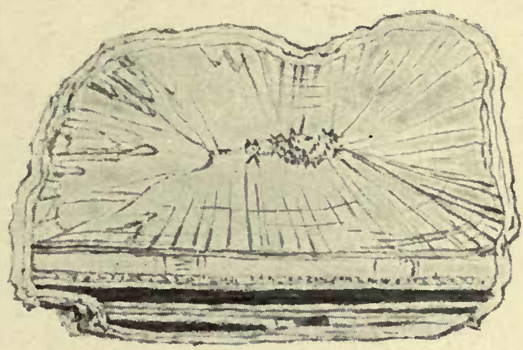


FIG. 2.—Onyx-Agate. Onyx parallel to flat side, druse filled with Quartz.

horizontal, does not always absolutely accord with the flat surface). When, subsequent to solidification, a rent has been formed in the rock, the rent may, when not opening to the surface, become coated on both sides with Chalcedony, and so form a *Vein-agate*.

THE LAYERS.

The substances which form the layers or bands of agate are:—the skin, Chalcedony, Carnelian, Cacholong, Girasol-Opal, Wax-Opal—all of which are colloids—and hydrated silica; and Quartz, Amethyst, Cairngorm—all of which are crystalline,—and anhydrous silica. Jasper rarely occurs.

These several substances may be deposited in any order from without inwards (figs. 3 and 4)—the hydrated varieties being usually the earlier deposited. Clear Chalcedony usually forms the outer layer—after the skin; this is succeeded by milky Chalcedony, or by Cacholong. Amethyst, Quartz, or Carnelian, usually form the centre. When Quartz or Amethyst is in quantity, and is the last-deposited layer, an unfilled central cavity often remains. When Carnelian fills the centre it is frequently rent. At some localities Girasol or Milk-Opal forms the outer zone.

The regular concentric deposition of the layers of an agate is due to a considerable and uniform amount of adhesion between the surface of each layer and that of the layer previously deposited. When that

Fig. 3.—Varying order of deposition.

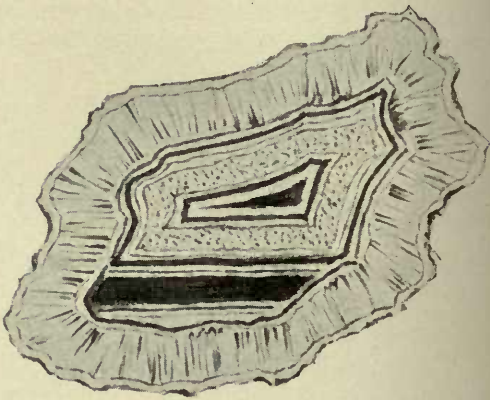


Fig. 4.—Varying order of deposition.

adhesion is weak, the layer may be somewhat thickened towards the lower part of the cavity,—gravitation in this case operating upon the only partially-solidified Chalcedony.

The Skin.

The first or outer-deposited layer in the vesicle results from the decomposition of the Augite of the rock-matrix. This layer may consist of

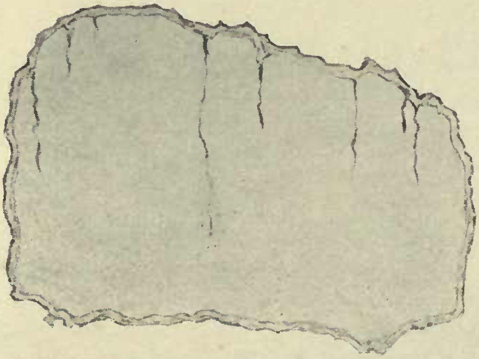


Fig. 5.—Celedonite Stalactites.

Celedonite, Chlorophæite, or Delessite. If the Labradorite (or the Nepheline) in the rock be also altered, the outer layer of the agate may consist of either Natrolite or Heulandite.

The first three of these materials which form the "skin" invariably coat every portion of the inner surface of the cavity.

If the skin be present in *unusual* amount it appears in threads, which are pendulous from the upper part towards the lower part of the cavity (fig. 5). Such threads, upon the after-injection of siliceous solutions,

Fig. 6.—Interlacing Celedonite, the framework.

Fig. 7.—First coating of Chalcedony on Celedonite filaments.

determine the formation, and form the centre of, the so-called *stalactites*. When it is in *large* amount it is deposited as an interlacing net-work of fibres. These, upon being sheathed by the ingress of siliceous solutions, determine the formation of *Moss-Agates* (fig. 6).

Stalactitic-Agates.

The first layer, or layers, of Chalcedony, invariably coat every part of the surface of the Celedonite or skin. In an ordinarily-formed agate the surface of these layers is smooth; but, where the Celedonite invested a rough cavity, the Chalcedony subsequently deposited upon it conforms to the shape of the surface, and, consequently, is slightly mammillated.

In such agates as contain pendulous threads of Celedonite, these are coated by the Chalcedony to a thickness equal to that on the sides of the cavity; so that pendulous processes of Chalcedony, simulating stalactites in appearance, result.

Should the process of filling of the cavity be completed by any new arrangement of parts, the stalactites come to be imbedded in the substance of these new arrangements. Any difference in the manner in which they are so imbedded alters much the appearance of the agate (figs. 7, 8, and 9).

Moss-Agates.

In manner identical with that which obtains in the formation of stalactitic agates, are *moss-agates* formed. These may exist as an open network of mutually-interlacing tortuous strings of Celedonite or of

Oxide of Iron (those of Mochas are Oxides of Manganese), or the continued filling-up of the cavity may unite all into a solid mass. In some localities the reticulated filaments of moss-agates have assumed a dendritic or tufted arrangement; they are then generally brown or yellow in colour.

STRUCTURE.

Like Malachite, Göthite, Hæmatite, and many substances deposited from solution upon uneven surfaces, the chalcedonic matter of agates has

FIG. 8.—Varieties of Agate building.

a double structure, the second of which lies more or less at right angles to the bounding surfaces of the first. There is a surface-enfolding deposi-

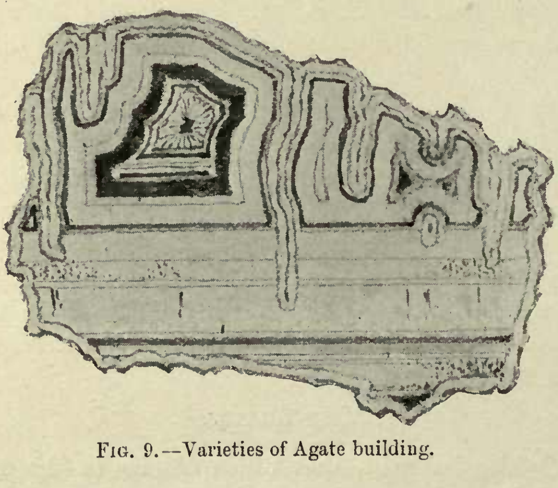


FIG. 9.—Varieties of Agate building.

tion in layers, which successively assumes more and more of a *mammillated* appearance; and a divergent or *radiating-acicular* structure, which lies more or less at right angles to the first. This incorporated dual structure is nearly equally manifest when the agate is cut in a direction which cross-sections the layers.

As the material which forms the acicular structure is much less soluble in alkalies than is the general substance of the Chalcedony, and as it is anisotropic, it is probably of the nature of *Tridymite*—the general mass of the Agate being colloidal, and true *Chalcedony*. The thickness of the layers of this latter increases with the amount of impurity in each layer.

So long as the material deposited is of the same nature, the adhesion of the several layers is perfect, and the most facile fracture is along the fibres of the divergent spiculæ of the (supposed) Tridymite.

At the margin of any alteration of material there is much less, sometimes little or no, adhesion, and but a slight shock is sufficient to detach the layers from each other.

Cacholong-Agate.

The substance Cacholong (Mongolian, kaschtschilon—*beautiful stone*) is usually classed with the Opals, and is of a somewhat-mixed composition —one which indicates a small admixture of a zeolite with Opal.

The Cacholong which forms the white band of Scottish agates consists, however, in far the greater number of cases, of a substance which, under the microscope, displays a strongly-marked radiating structure (*Tridymite?*) disposed transversely to the bands, and penetrating a magma of highly-chromatic Opal. This variety is semi-transparent.

An opaque milk-white variety seems composed of Chalcedony charged with " quartz nectique." This sometimes adheres to the tongue.

A third very rare variety with a tufted structure may contain a fibrous zeolite.

The Cacholong of white Onyx is *Milk-Opal*; the loss of its small content of water makes it more or less opaque.

Carnelian.

True Carnelian, or red-tinted chalcedony, is exceedingly rare in Scotland, the colour of the red-tinted bands of Scottish agates being due to a multitude of spots of a ferruginous silicate, which have segregated out of a stained chalcedony. These red spots are frequently replaced, with amazing suddenness, by others of an equally brilliant yellow, or both will equally suddenly disappear—the band which carried them appearing as if bleached.

Fortification-Agates.

The mammillated structure which the layers of an agate assume when they line rugose surfaces or cavities of very-irregular form increases in

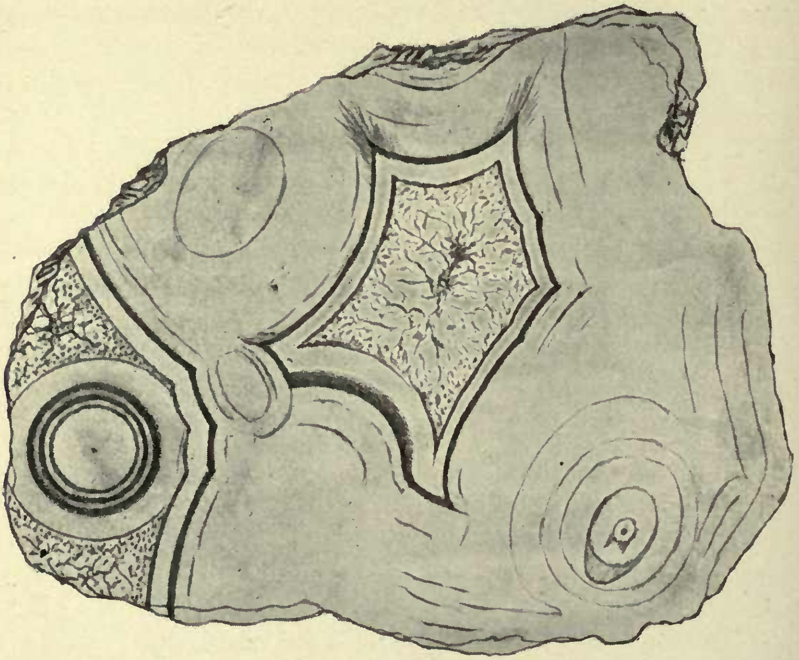


Fig. 10.—Fortification-Agate, with sectioned stalactites.

size with every successive layer, so that towards the central parts of an agate, sharp, re-entering, but curvilinear, angular folds lie between these mammillations. These are due to deposition upon irregularities of the cavity, whereby the layers are eventually caused to impinge on each other. Should one or more of the succeeding layers be Cacholong or Sard, these, taking, as it were, a cast of such re-entering angles, exhibit, when cross-sectioned, salient and retiring angles, and resemble the rectilinear parapets of a fortification (figs. 10 and 11).

Fig. 11.—Fortification-Agate.

Entrance of Solution.

That the siliceous solution entered uniformly round the whole surface of the druse would seem evident from portions of the skin having been frequently forced into the cavity throughout its whole periphery, and from these having been sheathed in clear Chalcedony upon *both sides* of such portions, forming a False Moss-Agate. This envelopment of the intruded skin is either immediate, or the clear Chalcedony is seen to invest both the skin and a previously-deposited layer of Chalcedony which had, previous to their intrusion, lined the *inner* surface of the disrupted fragments.

The Tube of Escape.

The liquid which holds the chalcedonic material in solution is forced, by endosmose, through the several layers of Chalcedony, along the divergent fibres of Tridymite. After the deposition of its content of silica, the liquid is forced out of the cavity by the accession of a new supply of chalcedonic solution passing inwards from all sides of the agate. The

Fig. 12.—Cacholong and Chalcedony Agate, with one tube for all the Cacholong layers.

now de-silicified medium escapes through one or many tubular openings, which may be disposed at any part of the surface-cavity, but very rarely near its base. Frequently this opening is linear, with a false appearance of being a rent; and not infrequently a linear projection on the surface of the agate follows the course of the opening. This opening forms the "tube of escape."

The thickness of each layer of deposited material invariably diminishes as it approaches the "tube of escape." This tube, with the dilatation which frequently occurs thereon, is the last portion of the cavity to be filled; and in that portion which passes through the outer, clear, chalcedonic layer, the tube is of microscopic dimensions—almost invisible to the eye—and it most frequently remains open (figs. 12 and 13), and may become a rent.

Dilatation on the Tube of Escape.

In almost all cases there occurs on the tube of escape a dilatation of considerable size. This is situated near the point where the tube reaches the earliest-deposited layer of Chalcedony. It is filled somewhat pos-

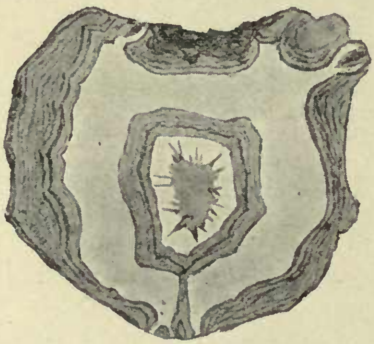


Fig. 13.—Cacholong-and-Carnelian Agate, with two tubes for the Cacholong and one for the Carnelian layers.

teriorly to the centre of the agate, but generally with the same material—Quartz. Occasionally it alone contains Cacholong, and very rarely it alone contains Onyx.

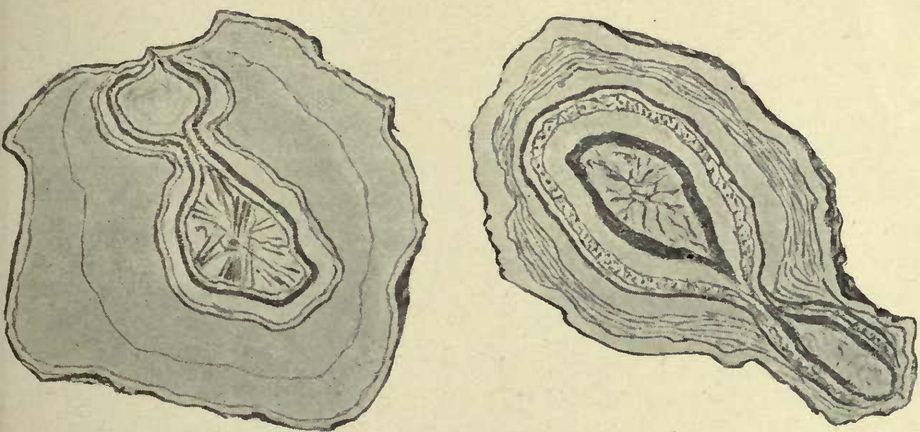
No attempt has been made to explain this dilatation, although probably the whole secret of agate-formation is connected with its presence. It resembles the congestion which takes place when a moving stream of persons is arrested at a narrow exit (figs. 13, 14, and 15).

ABNORMAL STRUCTURES.

Onyx.

The adhesion of the layers of deposit of pure Chalcedony to one another is so great that gravitation does not interfere appreciably or determine any undue thickness of these layers at the lower part of the cavity. The thickness of the layers which form the so-called "stalactites" is no greater at their pendulous extremities than elsewhere (figs. 8 and 9). In the case of other of the materials which go to the formation of Agates, however, there is so much feebler an adhesion both to Chalcedony and to each other, that gravitation interferes to a marked extent, so that most of the coagulating material is found at the lower part of the cavity, and a zonation or parallel banding of Cacholong, Sard, Opal, Quartz, and Chalcedony appears—forming horizontal layers or bands in the lower part, or less frequently so in the greater part of the remaining cavity. This banded structure, from a resemblance to the human nail, is termed *Onyx* (figs. 2, 4, 8, 9, 11, 16, 17, and 18).

The layers of an Onyx, especially those consisting of Cacholong and Opal, are occasionally nearly an inch in thickness; but, however wide,



FIGS. 14 and 15.—Dilatation on the tube—the first (fig. 14) filled with same material as the centre, Quartz; the second (fig. 15) with Cacholong.

each separate band is continuous round the whole upper part or "dome" of a cavity, though the bands are there of *extreme tenuity* (figs. 4 and 16). Opal in this acts exceptionally, remaining apparently absolutely as a band at the floor of the cavity (fig. 17). In many chalcedonic druses the dome remains unfilled.

Should purer chalcedonic substance succeed the cessation of onyx-formation, the upper part of the cavity is again lined with layers of uniform width, or a second onyx-structure may appear at the actual centre (figs. 3 and 16).

Onyx-structure is invariably horizontal, and so it *discloses the position which the agate occupied in a rock.* Should an inner, and therefore secondary, deposition of Onyx appear, in which the bands lie in a position different from the first, it shows that the rock had been tilted before the filling of the druse had been completed. No Scottish instance of this kind has yet been discovered.

PLYNTHOID ONYX.

During the shrinkage which may be supposed to be associated with, or to accompany, the solidification of the chalcedonic matter (and which shrinkage in certain cases may account for the easy separability of the layers from one another), it may be seen that, as a general rule, the parallel layers which go to form Onyx do not obey the usual law. These layers rend *vertically*, and the material which forms them concretes

FIG. 16.—Oynx Agate.

laterally into, as it were, a series of brick-shaped bodies. The spaces intervening between these, if they are mere rents, are subsequently filled with Chalcedony; if they are wide, they are either, at the time of the concreting, filled up with Rock Crystal, which has separated from the Chalcedony or Cacholong,—or else they are thereafter plugged with independently-formed agates of more or less rectangular shape (fig. 17, [lower part]).

WAVE ONYX.

In these the various layers have not, in solidifying, been rent asunder by transverse planes of division, but have assumed curvilinear outlines at their fringes. Overlying layers have been deposited successively in the

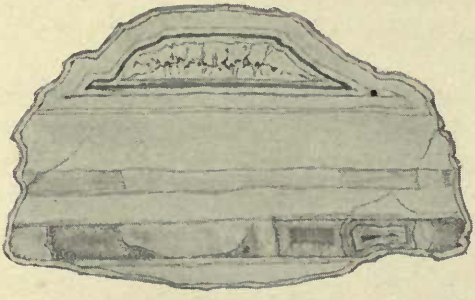


FIG. 17.—Plynthoid Agate.

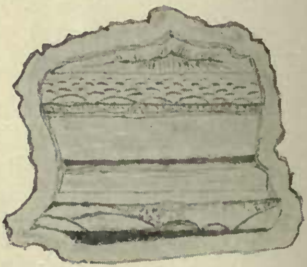
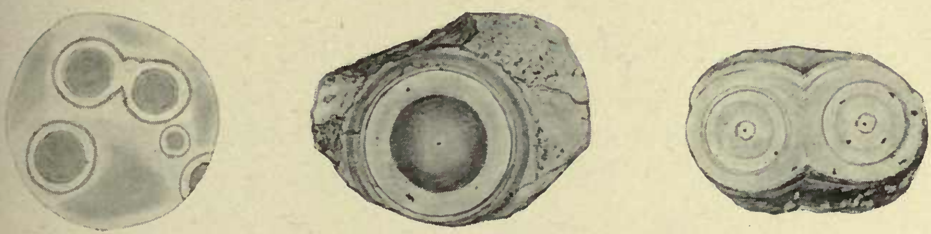


FIG. 18.—Wave Oynx.

hollows between such fringes, so that this structure, when seen in section, presents an appearance similar to that of tumbling waves or of hummocky ice (fig. 18).

EYED AGATES.

Occasionally—but in a very marked manner at certain localities—after the deposition of the first thin layers of Chalcedony, some of the succeeding layers are not disposed uniformly over the inner surface, but are confined



FIGS. 19, 20, and 21.—Cross-section of Eyed Agate.

to one or more spots, where a slight roughness, or a thickening of the skin, seems to exercise an undue amount of adhesion, or even of attraction, upon the material which is being deposited. Around this the succeeding layers are, during a brief succession, exclusively deposited—hence assuming a hemispherical form. Cacholong, or Carnelian, when present, is generally seen in these hemispherical layers, alternating with

FIG. 22.—Section of Cacholong Eyes.

FIG. 23.—Cacholong Eyes. Inside Skin of an Inky Onyx.

layers of Chalcedony; so that, upon sectioning, an appearance like that of an eye is disclosed. Such "eyes" occasionally, but rarely, occur on more central layers. Not unfrequently they are, to a considerable extent, formed of an impure, fibrous Calcite (figs. 10, 19, 20, 21, 22, and 23).

ABNORMAL STRUCTURES IN THE LAYERS.

That the gelatinous Chalcedony of the layers is not rigidly solidified immediately upon its separation from the solvent is shown by the concreting at certain spots of substances which may be regarded as having been dissolved in or held in suspension in the Chalcedony solution. Through the segregation of these certain isolated—and apparently suspended—structures appear in the layers of deposit. Agates exhibiting these various structures are termed Discachatæ, Oonachatæ, and Hæmachatæ.

Discachatæ, or Disc-bearing Agates.

The layers of agates very infrequently consist of the *pure* material of the several varieties of silica of which an agate is built up. Very generally there is some admixture—as of Chalcedony with Opal (or *vice versâ*)—of Chalcedony with Cacholong, or of Chalcedony with a ferruginous silicate.

Fig. 24.—Disc-bearing Agate.

When the amount of such admixture exceeds a certain limit there is a concretionary separation of that substance which occurs in *smaller* amount,—and the concretionary forms are characteristic. The clouded milky appearance of some chalcedonic layers, due to uniform diffusion of Cacholong, is cleared up as it were, in some parts of the layer, by that substance having been concreted laterally around a spot of roughness, or of difference of substance. When this concreting is confined to one layer, one or more opaque milk-white discs result (figs. 24 and 25).

Oonachatæ, or Ovoid-bearing Agates.

There are two varieties of these—chalcedonic, and Cacholong. Both result from the concreting of a small portion of one substance which has been suspended in, or mixed with, an excess of another. In both there is the assumption of an egg-like form, but the structure of these is very different.

Such shapes, when formed of Chalcedony, occur in Milk-Opal, and have a fibrous structure, which radiates from the centre uniformly in every direction.

When formed of Cacholong these ovoidal bodies occur in Chalcedony, and then the form results from the superposition of a system of discs (*see*

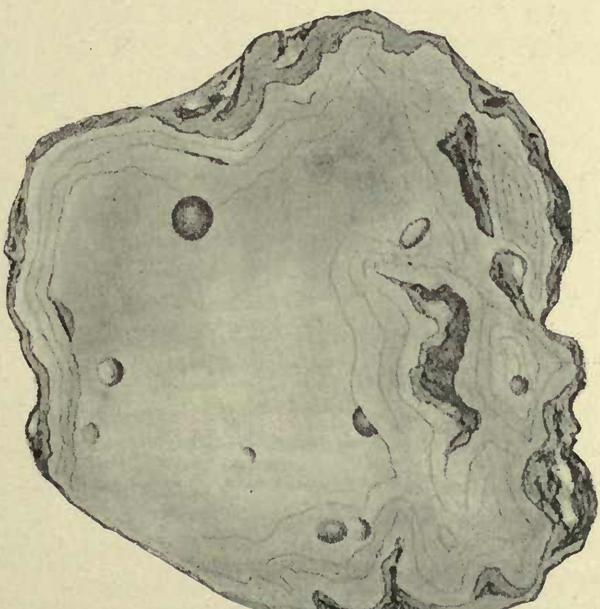


Fig. 25.—Disc-bearing Agate.

Discachatæ), one over the other, in successive layers. The pre-existence of a disc in a layer of earlier deposition seems to determine the formation of others in superposition. The relative size of these discs increases with successive layers, and, thereafter, again diminishes, so that a solid opaque ovoid suspended in clear Chalcedony results. Occasionally each alternately-succeeding layer is uniformly clear, so that a series of opaque white discs, successively enlarging and then successively diminishing in size, is here presented (fig. 26).

Hæmachatæ.

These are Agates, with blood-red discs, or with spots, approaching in form more or less to perfect spheres. Such are formed in red-tinted Chalcedony in the manner already described in connection with disc-bearing and ovoid-bearing agates. Frequently the ferruginous silicate assumes an annular form, which is merely the periphery of a colourless disc (figs. 26, 27, and 28).

Hæma-Ovoid-Agates.

These result from one abnormal structure being present within another. The milky material, segregated apart to form the discs (whose superposition in varying size results in an ovoidal structure of Cacholong), contains within itself red colouring-matter, which has separated in each disc into a series of rings made up of red discoidal spots. As these rings of dots are at the same distance from the circumference of the discs, it

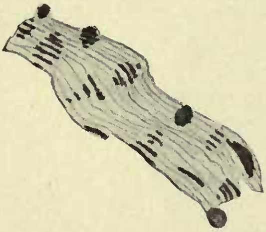


Fig. 26.—Discachatæ and Oonachatæ.

Fig. 27.—Hæmachatæ Ovoids.

Fig. 28.—Hæma-Ovoid Rings.

results that each ovule displays upon *longitudinal* section either a single dot-ring, or a system of red, oval dot-rings,—as well as upon *cross* section, either a single dot-ring, or a system of circular dot-rings (fig. 28).

Red- or Carnelian Agates are frequently sprinkled throughout with lustrous spheres, which resemble drops of yellow oil. As these show no varying colours in the polariscope they cannot be Opal.

In certain agates the colours and the structure are both due to visible impurities. Not infrequently portions of the original lining of the druse or cavity, Celedonite, Delessite, or Jasper, have been forced into the cavity, so that the layers of chalcedonic substance enfold and envelop them. Where brown Jasper has been the intruded substance they have been named "Potted Head Agates."

CRACKS IN AGATES.

First.—The rock may have been rent—dislocated by a lateral shift—and re-cemented, so as again to be impervious, before the endosmotic filling of the cavity. In such cases the layers of deposit in the agate follow the cracks of the rock, [and are not themselves fractured].

Second.—The rock, with included agate, may have been rent with dislodgment of parts, and these may have been thereafter re-cemented by a new access either of Chalcedony, or of Calcite.

Again, the rock and its enclosed agate may have been shattered, with dislocation and almost inversion of fragments—with extrusion of some—or intrusion of the matrix or of Jasper, followed by re-cementation by means of clear, vein-like Chalcedony. Very rarely, when the fracture occurred before the cavity of the agate was entirely filled, the subsequent layers were folded into the rent and thus effected a re-union.

At certain localities the agates are frequently divided by a straight rent, and one portion entirely removed.

Recent open cracks are probably due to frost.

MOCHA-AGATES.

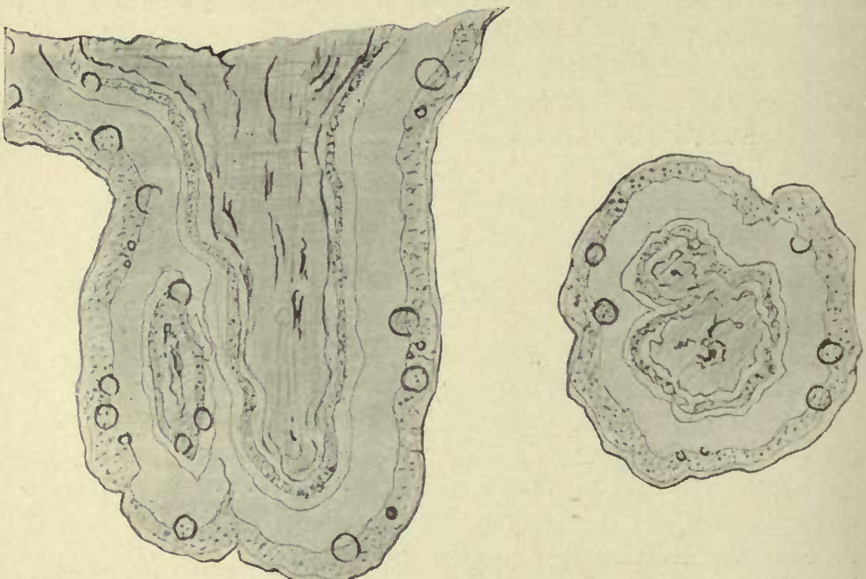
Mochas are agates into which, after a certain stage of consolidation of the constituents has been reached, water containing manganesian or ferruginous matters in solution has infiltrated between the layers of deposit, or, more rarely, into cracks. Upon the evaporation of the water these substances have been left behind in an arborescent form. Usually they are brown, but they may be red or yellow. The ramifications of the moss-like structures may generally be seen to start from actual rents in the stone.

JASP-AGATES.

Stalactites of Celedonite, or other "skin material," are invested by a thick layer of colourless, or by jasperous, Chalcedony. This Chalcedony holds, as it were in suspension, multitudes of spheres of Carnelian. This structure-within-structure shows that the deposited layers of Chalcedony do not, immediately after their deposition, concrete into a solid, but, on the contrary, allow of motion sufficient for the formation of an independent structure within their substance. Anomalous as such an arrangement may appear, the structure of these spheres is still more so, as many of them show that their colouring matter is disposed so as to simulate the whorls of a volute. They thus occasionally present a certain resemblance to minute ammonites. Jasp-Agates are usually vein-agates, that is to say, they are not formed in vapour cavities, but are deposited in fissures of later date than the eruptive rock to whose decomposition their materials are due (figs. 29, 30).

Stalactitic Jasp-Agate.

In this, the more-common variety of Jasp-Agate, the stalactites which impart the prevailing characteristic are disposed in the same nearly-parallel arrangement which is seen in ordinary stalactitic agates —being pendulous from the upper part of the vein. In many cases where there has been an excess of Celedonite, or of other basement



Figs. 29 and 30.—Longitudinal- and transverse-sections of Stalactite structure in Jasp-Agate—Ayrshire.

material of these stalactites, there is a greater or less approach to the structure of Moss-Agate. When the fibrillæ which determine this structure are separated to any great extent, the ordinary agate arrangement of successive layers occurs; even a central mass of Quartz occasionally presenting itself.

When, again, the moss-agate-structure is unusually close, there is an approach to ordinary Jasper. When central vacuities occur in this, the parts margining these vacuities are sheathed by a layer of Carnelian—the centre being here filled with a manganesian Calcite.

Brick-shaped Jasp-Agate.

At the Ayrshire locality which yields Jasp-agate, a prevailing structure is that of a Vein-agate which has been cross-rent into brick-shaped segments. The rents which intersect these veins are filled with impure manganesian Dolomite, which is the lining material of the veins themselves. The coagulating silica which fills these rectangular spaces has thereafter concreted so as to line the sides with layers of brilliant red, yellow, pink, and white colours—these colours being usually deposited in a system of minute spots. Thereafter these *brick-shaped* structures have themselves frequently been rent—these secondary rents being also filled by a dolomitic paste.

True jasper very rarely forms layers in an agate: when it occurs it invariably is confined to a small portion of the periphery, being deposited somewhat after the manner of an "eye."

ALTERATIONS OF COLOUR.

Agates may be naturally or artifically stained. They may also be bleached.

Open cracks frequently form channels for the passage of ferruginous waters, which stain agates elsewhere colourless, or for waters charged with humus acids, which bleach red-tinted stones.

The loss of the small amount of water present in Chalcedony transforms its translucent structure into one which is white and opaque. The loss of the large amount present in Opal renders it also white, opaque, and granular (*quartz nectique*); and the subsequent removal of this loose powder by water splits up an Onyx into plates of chalcedony, which exhibit an ovoidal or micro-mammillated surface.

The appearance of the commoner varieties of agates may be improved by artificial staining. Chalcedony absorbs staining liquids. Cacholong, Opal, and Quartz do not. Colourless Chalcedony may be stained dark brown by being heated in strong solutions of honey, sugar, treacle, or oil, which are afterwards carbonised and rendered black in its pores by the action of sulphuric acid. The stain so produced penetrates to about the fortieth of an inch.

AGATE LOCALITIES.

SHETLAND — MAINLAND. Northmaven, opposite Dore Holm, in porphyry.

KINCARDINESHIRE. Dull brown (D. and H.). Near Allardice, Arbuthnott. At the Pulpit Rock, near Grange Burn, Kinneff. St Cyrus, in interbedded trap [andesite] of Old Red, fine colours, in elongated forms. Fenella Den.

FORFARSHIRE — MONTROSE. At Ferry Den, thickly studding the stones of which the houses are built. Scurdy Ness [The Ness, Montrose]. Rich brown, with colourless bands, very irregularly deposited. The brown contains much opal. Usan, at the Blue Hole, brilliant inky-blue and white colours; also wax-yellow — *Cerachates.* Centres often hollow and lined with Quartz or with Amethyst. Rock of St Skae. Near Ethie House. Lunan Bay railway-cutting. At Blackness Hill and East Balgay. Panmure Den.

PERTHSHIRE. Gourdie, near Cluny, with the exterior layers enveloping red Natrolite. Pitroddie Den. Formerly at Kinnoull Hill. At the Agate Knowe, Tinkletop, Ballindean, Inchture, of the most delicate tints of lilac, flesh-red, and rose, in grey-blue Chalcedony, often with an outer layer of milk-white Girasol Opal: the most exquisite and delicately-tinted agates known. In the Ochils, of red tints. South of Pitkeathly. At the Path of Condie, in many fine colours, often red. Rossie Ochil, carnelian-red, with grey.

FIFESHIRE. Luthrie, at the Heather Hill, Carphin, dark-blue to almost brown-black, with milk-white bands. Balmeadowside, brown, and also a rose blush in a centre of translucent grey; others with banded Cacholong in colourless Chalcedony. Near Balmerino, grey, often with brushes of Natrolite in the outer layers. Shore of the Tay. At the farm of Middlefield, Cupar, of brilliant yellow and red colours; sometimes enclosing radiating Natrolite. Railway cutting east of Cupar. At + Shepherd's Knowe, and at East Lalathan, 3 miles north-west of Leven.

STIRLINGSHIRE. Occasionally in the Campsie Hills, and in rifts in the hills near Corrie, Kilsyth.

INVERNESS-SHIRE—ARISAIG. At Luinga Bheag Island, violet-coloured agate, in a N.N.W. dyke.

ARGYLLSHIRE—KINTYRE. At top of Killellan Hill, 5 miles south of Campbeltown, pink. Loose on the shores of Machrihanish Bay and Iona.

MIDLOTHIAN. † Lennis Quarry. † Morton's Smiddy, Midcalder. Pentland Hills, at Hillend, grey. [Blackford Hill, in veins, in andesite of Devonian age, with lavender and violet Chalcedony, Carnelian, and vermilion Jasper.]

PEEBLESSHIRE. At Carlops, brown, and, rarely, in large specimens, of fine red and white. Linhouse, in bed of gravel, banks of Linhouse Water, 1 mile from Harburn Station.

AYRSHIRE. Along the coast at Dunure, and south of the Heads of Ayr. Rarely at Burn Anne, Galston, in magnificent brilliant red-and-yellow colours, with milk-white bands; the same layers of deposit changing with extreme abruptness from red to yellow, or losing all colour. Also in lavender and purple colours, spotted yellow or red.

HADDINGTON. At Dunbar (Greg). In the shingle on the beach near Dunglass, red and mottled (Greg), and violet (Turton).

ROXBURGHSHIRE. At Robert's Linn, in Hobkirk Parish, in whin (Nicol). At Thirlestane Hill (Nicol).

Fortification Agate

Occurs in Forfarshire, in the Blue Hole, near Usan. In Perthshire, at the Path of Condie. In Ayrshire, at Burn Anne, near Galston. Peeblesshire, at Carlops; in veins, white and grey, with centre of Lydian Stone, and transverse threads of red Chalcedony, which cements the rents.

Onyx Agate

Occurs in Kincardineshire, at St Cyrus (Rose), grey and white. At Kinnaber Water Works, Watermouth, North Esk, blue, white, and red. Forfarshire, at Scurdy Ness, rarely, brown and white. At the Blue Hole, Usan, blue, grey, and white, blue, red, and colourless, white, wax-yellow, and grey. At Lunan Bay railway-cutting, red, blue, and white. At Fullerton Den and Fotheringham. At Panmure Den, blood-red and white. Ayrshire, at Burn Anne, rarely, yellow, grey, and white. Fifeshire, at Middlefield, near Cupar, red, white, and quartzose. Onyx agates have never been found at Norman's Law, Carphin, and Balmeadowside, in Fife.

Eyed Agates.

Kincardineshire, at St Cyrus, with Onyx, white and grey colours (Rose). Forfarshire, at Scurdy Ness, the eyes being uniformly cream-coloured Cacholong, and frequently coalescing to form a mammillated layer of the stone. At the Blue Hole, Usan, and near Ethie House, of grey and white, and red, blue, and white colours. Perthshire, at Ballindean, the eyes white, with a central red spot. Path of Condie, rare. Fifeshire, in the cutting above "Ferry Port-on-Craig" (Partan Craig), some of the layers being formed of divergent fibrous Calcite of a red colour, and others of Celedonite of different tints.

Faulted Agates.

Forfarshire, at the Blue Hole, Usan, Faulted Onyx; fractured and recemented agates, the parts often not displaced. Ayrshire, at Burn Anne, Galston.

Pseudo-Faulted.

The rock having been faulted with dislocation of portions of the cavity before the infiltration of chalcedonic matter. Fifeshire, Balmeadowside, Luthrie.

Brecciated Agates.

Forfarshire, at Scurdy Ness. Peeblesshire, Carlops. The Fortification Vein Agate, in parts, much brecciated, the fragments being impacted in a matrix of Lydian Stone.

Hæmachatæ.

Blood-red, globular sprinkled;—discoid,—and in bands. The last being formed of layers of confluent discs. The first occurs in Forfarshire, at the Blue Hole, Usan; at Roy Quarry, Broughty Ferry, with an outer zone of flêches d'amour; Blackford Hill, Edinburgh; and Burn Anne, Ayrshire. The second, Ballindean, Perthshire; rarely at Balmerino, Fife.

Many Scotch agates, especially those from Usan, and from Burn Anne, have layers of Cacholong sprinkled with minute red globules; these alternate with pale violet bands, with small red discs, imparting to such portions a flesh-red to roseate hue.

Discoid Agates.

Forfarshire, at Blue Hole, Usan, white, rarely. Perthshire, at the Path of Condie, both red and white. Fifeshire, loose at Morton, Tents Muir, white, [bleached by exposure on the sea beach (R. Miln)].

Ovoidal Agates.

Forfarshire, at the Blue Hole, white. Perthshire, at Path of Condie, white, spotted with red. Fifeshire, loose at Morton, Tents Muir, white, [from exposure on the sea beach (R. M.)].

Potted Head Agates.

With intruded Celedonite skin, at the Blue Hole, at the Path of Condie, at Scurr Hill, Balmerino, and elsewhere. With intruded fragments of a jasperine or hornstone layer, at the Blue Hole, Usan; at Ballindean, Forfarshire. Path of Condie, Perthshire.

Stalactitic Agates

Occur at the Blue Hole, of two varieties. The first with grey stalactites, having a central core of Celedonite; the second in magnificent specimens, which have a central core of scarlet Jasper, with a sheath of milky Cacholong, sprinkled with red spots; these stalactites pass through a base of Onyx composed of alternate layers of transparent Chalcedony and opaque Cacholong. At Balshando, Sidlaws, rarely. Perthshire, at Ballindean, in magnificent specimens of variegated and unusual colours, sometimes ochre-yellow, diversified with pink, the stalactites exhibiting a beautiful structure. Fifeshire, one mile north-east of Norman's Law, in very translucent-grey specimens. Middlefield, near Cupar, fiery-red and orange-yellow, the core of the stalactites being crystals of Natrolite. Jock's Hole, north of Scurr Hill, rarely; magnificent specimens of red Carnelian stalactites passing through milky Chalcedony. Ayrshire, at Burn Anne, stalactites bright-red, sheathed in alternate bands of milk-white and colourless Chalcedony.

Stalactitic Agates, when cut transversely, are called "piped agates."

Moss Agates.

Fifeshire, on the west slope of Scurr Hill, Balmerino, in two veins. In the lower an open reticulation of dark-green Celedonite crosses throughout a red-and-grey Chalcedony. In the upper an exceedingly-close and minutely-anastomosing reticulation of vivid light green pervades a Chalcedony of a lively blue. The outer crust contains imbedded crystals of red Heulandite, with brushes of yellow Natrolite. At the summit of the Binn of Glen Farg, rarely. At Morton, Tents Muir, loose. At Middlefield, near Cupar, rarely, green traversing red Chalcedony. Ayrshire, at Burn Anne, close in structure, the "moss" green and red, in blue Chalcedony, rarely. Roxburghshire, near Stewartfield, with a brown moss. Moss Agate, so close in structure as to simulate Plasma, occurs near Parbroath, Luthrie, Fifeshire. Sphæroradiate Moss Agate of a green colour, near Scurr Hill and at Kinnoull Hill.

Dendritic Agates.

Aberdeenshire. Cabrach, at Redford and the farm of the Buck, brown in blue Chalcedony. Forfarshire: in Roy Quarry, Broughty Ferry, Reres Hill, and elsewhere in the district, in beautiful specimens, which carry yellow and red jasperine tufts. Fifeshire: in the cutting west of Partan Craig. St Monans. St Andrews, East Sands, occasionally, loose, fine. Haddingtonshire: Whittinghame, between Haddington and Dunbar (Bairnsfather).

Mochas.

Forfarshire. At the Blue Hole, rich brown, very rarely.

Fifeshire. Heather Hill, Luthrie. Middlefield, bright yellow, fine.

The *habit* of Agates, both as regards their form and the successive arrangement of the layers of Chalcedonic deposition within them, varies in a remarkable manner at different localities, and even in the different eruptive rocks at these localities. There may be an occasional well-marked variety, but, as a rule, a prevailing habit is conspicuous, at least at all the localities which yield Agates in abundance.

Agates have been, as "pebbles," without sufficient specification as to their matrices or character, stated to occur "near the village of † Sartle, in Skye, and also near Loch Follart, in the bed of a rivulet." "On the side of a hill near the church of Rothes, white and red." "Below the Red Head, Forfarshire." "Along the shore of Peterhead, pebbles of the Onyx class."

Most of the above are probably worn fragments of brilliantly-coloured rocks.

Jasp-Agate

Resembles both Dendritic Agate and Moss Agate in the chalcedonic matter enveloping a pre-existent structure, which acts as a core to pseudo-stalactites. This structure in Jasp-Agate is, however, much larger in amount, and as it consists of Jasper, it has its variegated colours.

Sutherland. About one and a half miles south of Cape Wrath, near an outlier of Torridon Conglomerate, in small veins in the Hebridean Gneiss, in close association with Actinolite, Ripidolite and Potstone. The filamentous net-work is here brown.

Ayrshire. At Lagg Quarry, Fisherton, Ayr. The mossy or stalactitic structure is yellow or brown, it is surrounded by purple Chalcedony, which is zoned by layers of pale lavender (Blackwood). On both banks of Burn Anne, about one and a half mile from Galston, in veins which are segmented by Calcitic partings into brick-shaped masses. The chalcedonic matter rarely is arranged conformably to the sides of such forms, but much more generally is disposed in sheathing layers around pendulous "stalactites" of Jasper. The Chalcedony is, for the most part, of its usual blue-grey colour, but occasionally it is sprinkled with yellow or red spots, and rarely it is bright red. The included Jasper is of yellow, brown, green, red, and scarlet tints; frequently in clouded mixtures of these, and the tints are for the most part vivid. The commonest variety, which is a mottled mixture of brown, yellow, and a little red, is termed the "Partridge." The most select variety is one in which the earliest investing sheath of violet Chalcedony contains suspended spheres of red, white, or yellow colour. These spheres have a minute opaque Cacholong centre, a surrounding mass of radiating Chalcedony, and a peripheral layer of a milky tint. A still more inexplicable structure is one which resembles fragmented desmids enveloped in alternating layers of Cacholong and Chalcedony. Occasionally a true agate structure of the fortification type occupies such portions of the stone as contain less of the Jasper. The specimens are altogether unrivalled in beauty.

Haddingtonshire. At Thorntonloch, near Dunglass (Greg), probably from a breccia overlying the Silurian greywacke, and inferior to the lowest sandstone of the Old Red.

Flint.

Sutherlandshire. At Stronchrubie and elsewhere in the Cambrian dolomite [Durness Limestone] in large masses, of grey to red colour, and of a cherty appearance. Elginshire: at Duffus, with Chalcedony and Galena, in limestone. Aberdeenshire: at † Morescat near Ellon, loose [Chalk Flint].

Hornstone.

Fracture subconchoidal to splintery; lustre greasy to horny.

Hebrides: Rum, at Sgurr Mor, brown, blackish-green, and lavender, banded with Prase. Eigg, in the Scuir, with Chalcedony and Heliotrope. Inverness-shire: on the summit of Braeriach, banded brown. Aberdeenshire: on the Ladder road and west side of the summit of Mount Keen, purple. Strath Dee, on the right of the road, near its turn to Glen Tilt, in beds, greenish-grey. Perthshire: south-west of Ben Vuroch, Blair Athole, earthy, banded brown and grey. Fifeshire: west side of Largo Law, banded green and wax-grey (Howie). Haddington: at Dunbar. Garleton Hills, with Chalcedony, Quartz, and Jasper. At Pencraik, near Traprain Law, in claystone, with porphyritic slate. At the summit of Lucklaw, passing into felspar. Midlothian: Blackford Hill, brown—Anal. 1. Pentland Hills, with claystone. Linlithgowshire: in an opening near the old quarry of Kirkton, in imbedded masses in limestone of Yoredale age. Lanarkshire: Tinto, in the Kirk Burn, Petrosilex, approaching to Hornstone, with imbedded crystals of Hornblende. Kirkcudbrightshire: at Barlocco Cave, brecciated (Dudgeon).

	Sp.gr.	SiO_2	Al_2O_3	FeO	Fe_2O_3	MnO	CaO	MgO	K_2O	Na_2O	H_2O	Total.
1. Chalcedonic Hornstone of Blackford Hill, .	2·598	89·692	·974	1·373	...	tr.	2·283	...	·54	2·271	2·773	99·906
2. Green Chert, Strontian,	2·632	89·692	·769	1·671	...	·076	2·843	...	·44	2·18	2·005	99·676
3. Cambrian Chert, Smoo,	2·641	97·769	...	...	1·538	·076	·301	·153	...	...	·207	100·044
4. Lydian Stone, Kinkell,	2·598	61·2	17·536	5·446	3·163	·9	3·136	2·7	...	...	5·889	99·970

Chert.

Impalpable granular; fracture flat, angular, splintery; lustre glistening. Sutherland: Smoo, snow-white, in a thick bed in Cambrian dolomite, on the west side of the Geo—Anal. 3. Inverness-shire: top of Braeriach, banded yellow and brown. Banffshire: Cairngorm, greenish-yellow. Aberdeenshire: Hill of Fare, rarely, in veins in granite, red. Cabrach, Redford, green, pseudomorphous after Calcite. Argyllshire: Strontian, Fee Donald, grass green, with Galena—Anal. 2. Lanarkshire: Camilty Hill, near Harburn Station, blue-green. Renfrewshire: Cathkin Hills, Carmunnock quarry, in green, fragmented, layers, with Saponite, Calcite, and Zeolitic Quartz (Skipskey). Roxburghshire: near Hadden, in translucent red veins, with an agate vein in limestone. At Bedrule.

Fifeshire. In Lower Carboniferous limestone [Yoredale], wax-brown, mottled with yellow, at Kingsbarns, brecciated.

Basanite.

Lydian Stone. Touchstone. A velvet-black, flinty stone, with fine granular structure, which appears to be either flinty slate, or bituminous and carbonaceous shales which have been altered by contact with eruptive rocks; occasionally derived from these. From flinty slate. Orkney: Mainland, Stromness, at Point of Ness, in sandstone flag. Hebrides: Skye, at Duntulm Castle, with flinty slate in trap (MacCulloch). Perthshire: at Hallshole, on the Tay, above Stanley, with Hornstone and Jasper. Argyllshire: on the south side of Ben Cruachan.

From Shales. Hebrides: Skye, in Stenscholl Burn, Staffin Bay, from the alteration of Liassic shales. Fifeshire: near Aberdour, banded at contact of dolerite with Lower Carboniferous shales. At Kinkell, in masses imbedded in agglomerate—Anal. 4. East of Burntisland, in Whinny Hall quarry and in Whinny Hill, from indurated shale. Inchkeith, in tufa, interstratified with limestone. Midlothian: near Midcalder Station, at Lyden quarry, Belstane, banded brown. Lanarkshire: at Earnock Moor quarry, from the alteration of Carboniferous shale, of igneous origin. Skye: in Dolerite on the north side of Talisker Bay (Peyton). Midlothian: at the Braid and Moorfoot Hills (Greg). Peeblesshire: near Carlops, forming the centre of veins of Fortification Cacholong Agate. Ayrshire: at Lendalfoot, in interrupted bands, sometimes passing into brown, green, and yellow, where the diorite passes into Serpentine.

JASPER.

This is compact quartz, rendered opaque and coloured red by silicious combinations with Hæmatite, or yellow and brown by Göthite; such combinations being intermixed in more or less of an arborescent arrangement with ordinary white Quartz and Chalcedony. Varieties are:—Common Jasper, or Ferruginous Jasper, Dendritic Jasper, Ribbon Jasper. The colours range from bright yellow, bright red, dull red, brown, to lavender, and, rarely, green; all of these being occasionally intermingled.

Ferruginous Jasper.

Dull, massive, uniform in structure. Ayrshire: at Cuff Hill, near Beith. Kincardineshire: Kinneff, north of the Burn of Grange, on the shore, with hollow pseudomorphs after Barytes. Fifeshire: in a large vein midway between Burntisland and Pettycur. Midlothian: Pentland Hills, in claystone. Blackford Hill, bright red, in veins.

DENDRITIC JASPER.

ORKNEY. North Ronaldshay, in veins in Old Red Sandstone, bright yellow, with light-green patches.

SUTHERLAND. $1\frac{1}{2}$ miles south of Cape Wrath, in veins cutting Hornblendic Gneiss, which here underlies Torridon Sandstone. Brown dendrites in a purple matrix, and approaching to Moss Agate; associated with Hydrous Anthophyllite, Ripidolite, and Steatite.

ABERDEENSHIRE. Leslie, with Amianthus. Kincardineshire: in veins in the south bank of the North Esk at The Burn. Bright red, veined with white Quartz (Imrie).

FORFARSHIRE. Hedderwick, near Montrose. Perthshire: † Kelry, near Blairgowrie, mottled yellow; mossy, near Alyth.

FIFESHIRE, near Balvaird. Inchkeith, formerly, green with a dusky white line.

STIRLINGSHIRE. Campsie Hills. Chiefly in a rock face in the hill above Strathblane; red and yellow. Kilsyth, in a rift of the hills near Corrie; red and yellow, sometimes penetrated by diverging sheaves of zeolite; associated with Agates, and traces of copper ore, in Barytes. Among fragments of basaltic pillars at Killearn.

MIDLOTHIAN. Formerly below St Anthony's Chapel. The basis usually of a uniform colour, either lavender or dull red, but sometimes in bands of these colours; mottled throughout by minute spheres of an iron-ochre with white spots. The usual colours are :—Brown, with white spots; lavender-blue, with white spots; and red, with white and black spots. Sometimes all are blended together.

HADDINGTON. At Garleton Hills, near East Linton, and at Bangly quarry, $1\frac{1}{2}$ miles west of the Hopetoun Monument; of a dusky to an ochre-yellow, with brownish-red mottlings in clusters, in claystone and porphyritic slate. The veins are generally vertical, diminishing much in width as they descend, and ramifying minutely. Frequently also passing into Quartz, Chalcedony, and Hornstone on the one hand, and into a dull earthy claystone on the other. Less fine at Balgone, 3 miles south of North Berwick. At Dunglass, loose, near Thorntonloch, in yellow brushes imbedded in dull red earthy Jasper.

BERWICKSHIRE. Near the basaltic ridge of † Grindean.

Dumbartonshire : at Dunglass, mossy and dendritic.

Roxburghshire: in a rivulet east of Stobs quarry, one of the sources of the Slitrig, below Robert's Linn. In a bed, with veins of red Chalcedony (Nicol). At Stewartfield, near Jedburgh, on the Jed. In large masses, brown, with brilliant red, spotted with white.

RIBBON JASPER.

Midlothian: Craiglockhart Hill, in veins; the stripes being brilliant red, yellow, and white. Argyllshire: at Galdrings, the south corner of Machrihanish Bay; veins in basalt; stripes brown-red and buff. Roxburghshire: at Robert's Linn. Windburgh, head of the Slitrig (Nicol). Peeblesshire: at Carlops, south side of the Pentland Hills, in veins of a lavender colour, with streaks of red and white crossing one another.

PORCELAIN JASPER

Is baked clay. Fifeshire: Dysart, lavender coloured; from heat of burning coal seam, on coal (Rose).

[34. **Tridymite (211).** SiO_2.

May occur in some rocks of eruptive origin; and is supposed to be the mineral which forms the acicular crystals occurring in agates (see above).]

35. **Opal (212).** SiO_2,nH_2O.

GIRASOL OPAL.

KINCARDINESHIRE. At the Blue Hole, Usan, very rarely, of an amber colour, in bands of Onyx, occasionally barred with Milk Opal. These opal bands are occasionally of such width that stones of very considerable size might be cut from them were they not usually much cracked.

ARGYLLSHIRE. Campbeltown, at Kilkerran Point, filling small druses, of pure milk colour, and perfect fire red by transmitted light.

MILK OPAL.

KINCARDINESHIRE. At the Blue Hole, Usan; rarely, in bands of Onyx, sometimes passing into Wax Opal, deep-red in colour. The bands of Onyx, which contain, or consist chiefly of, Cacholong or Opal, are often transversely barred with angular blocks of Amethyst, Quartz, or sharp-margined cavities filled with Chalcedony in layers of regular agatic structure.

PERTHSHIRE. † Peeble Knowe, Ballindean. The outer layer, nearly a quarter of an inch thick, of the better class Agates, here consists of Milk Opal, with Fire- or Girasol-flash by transmitted light. The same layer of Agates and Chalcedonic druses from other localities appears to contain some Milk Opal.

Some of the Ballindean Agates, and also some from Galston, in Ayrshire, exhibit a beautiful opaline play of colour when cut into thin slices.

Jasp Opal.

Skye. In a vein in wackenitic trap, on the coast at the cliff foot south of the Stack, at Talisker.

OXIDES OF THE SEMI-METALS.

Teroxides.

36. **Valentinite (216).** Sb_2O_3.

Orthorhomb. Clv., *b* perfect. Transparent. Adamantine to pearly on brachydiagonal. Snow-white; sometimes tinged peach blossom to grey or brown. Streak, white. H., 2·5 to 3; G., 5·6.

B.B. on charcoal fuses easily and gives a white coating. This in R. flame colours the outer flame greenish-blue. In closed tube fuses and partially sublimes. Sol. in h. acid. Comp., Antimony, 83·56; Oxygen, 16·44.

Dumfriesshire. At Glendinning mines, in a group of minute acicular crystals in a cavity of Stibnite, with Cervantite (Dudgeon).

37. **Cervantite (221).** $Sb_2O_3 . Sb_2O_5$.

Orthorhomb. Acicular, generally earthy as a coating. Isabella-yellow. Lustre, greasy to dull. Streak, yellowish-white to white. H., 4 to 5; G., 4·1.

B.B., infusible and unaltered. On charcoal easily reduced. Sol. in h. acid. Comp., Antimony, 79·2; Oxygen, 20·8.

Dumfriesshire. At Glendinning, in Stibnite, and sometimes pseudomorphous after the latter (Dudgeon).

Ayrshire. At Hare Hill near New Cumnock, in fine specimens, upon Stibnite (Rose).

OXIDES OF METALS.

Anhydrous Oxides.

SUBOXIDES AND PROTOXIDES.

Water (223). H_2O. **Ice, fluid above 32°.**

Hexagonal when solid. In many complex twins in snow crystals. Rhombohedric by cleavage in ice. R., 117° 23′. Ice colourless, but in bulk pale emerald green. H., 1·5; G., ·918. Hence 1000 of water = 1089·5 of ice; or water expands $\frac{1}{11}$th in freezing. Greatest density of water at about 39°·2′ F. It expands as it approaches 32°, owing probably to incipient crystallisation. Colourless when pure, but in bulk bluish-green. Standard for specific gravities of solids and liquids: 1 cubic inch of water at 60° F. and 30 inches of the barometer weighs 252·458 grains; 1 litre weighs 1000 grammes. Natural waters never pure, from holding gases and soluble solids in solution. Water of the ocean, from saline matters, has G. = 1·027 to 1·0285. Waters of saline lakes contain sometimes 26 per cent. of salts and have G., 1·212.

Besides its vast bulk in the ocean, water occurs in enormous amount in the solid form in the earth's crust (as in hydrated salts partly in the form of ice). The greater portion of this may be as a base in combination; that portion which can be driven off by heat may be simply in the form of ice. In some cases its presence may determine the assumption of crystalline, that is, regular geometric, form, as in the zeolites. The mode or quality of its combination in non-crystallisable minerals is little understood. Igneous rocks, in some districts, are largely converted into Saponite. This contains 25 per cent. of water, the greater portion of which is driven off below a temperature of 100°, but this is reabsorbed, and only to the normal quantity, very speedily upon cooling.

Water filtering through rocks, sometimes holding oxygen and sometimes carbonic acid in solution, or at other times soluble salts, is the chief agent in the transmutation of rock-masses near the surface, and of the transference of certain of their components—as in the cases of lime carbonate into caves, chalcedonic compounds into agates, and zeolites into amygdaloidal druses. In such situations the operative water frequently remains lodged in the cavities. Where such cavities lie near to the rock-surface the expansion of the water in becoming ice rends the inclosing rock, so that, upon remelting, the water escapes through the rents, and air enters to peroxidise the remaining contents. Uncombined imprisoned water has been found in Orkney, in stalactite-sheathed washed-out trap dykes, north of the Berry Head in Hoy. The water is inclosed in deep pools sealed from the air by an upper floor of Stalagmite. In the amygdaloidal traps of the Storr, in Skye, and elsewhere in the Hebrides, all zeolitic druses, which have not been rent either by freezing of the inclosed water or by the shock of falls from a cliff, contain either mobile water or are moist from its being held as in a sponge by the downy Mesolite which such cavities usually contain.

38. **Cuprite (224).** Cu_2O.

Cubic. Clv., octahedral. Fracture conchoidal to uneven. Brittle.

Streak, brownish-red, transparent to opaque; when transparent, crimson. Lustre, adamantine to metallic; in impure massive or granular varieties, dull earthy; and colour brick-red or cochineal, often tarnished grey. H., 3·5 to 4; G., 5·7 to 6.

B.B. on charcoal becomes black, then fuses, and finally gives a globule of copper. In the forceps alone colours the flame green; if moistened with h. acid, deep blue. Soluble in acids and in ammonia. The concentrated h. solution, when diluted with water, gives at first a white precipitate. Comp., 88·9 Copper, 11·1 Oxygen.

Chalcotrichite consists of cubes so elongated along one axis as to become fibrous. *Tile ore* is a granular, earthy, ferruginous variety.

CHALCOTRICHITE.

KIRKCUDBRIGHT. At Balcary mines, with Pitchy Copper and Malachite, very rarely (D. and H.).

TILE ORE.

LANARKSHIRE. Rarely at Leadhills, with Chrysocolla and Malachite.

DUMFRIESSHIRE. Wanlockhead, in the Bay mine, in minute octahedra, with Chalcopyrite (Wilson). Kirkcudbright, at Balcary and at Kingslaggan mines, with Pitchy Copper and Malachite (D. and H.). [Associated with Native Copper and Zeolites in the Old Red Andesitic lava of Glen Farg (Craig Christie).]

39. **Melaconite (230).** CuO.

Massive; pulverulent and earthy. Sometimes in pseudomorphous cubic forms. Lustre, of the massive, sub-metallic; of the earthy, dull. Streak shining. Opaque. Colour of massive, iron-grey, of earthy, black. Soils the fingers. H., 3; G., 6 to 6·3.

B.B. infusible. Soluble in acids.

LEADHILLS (Greg). Loose powder, with intermixed shapeless fragments of Chalcopyrite, from the decomposition of which it seems to have arisen.

DUMFRIES—WANLOCKHEAD. Bay vein, with Chrysocolla (Wilson). Massive, and apparently in cubic forms.

KIRKCUDBRIGHT. At Balcary, with Malachite (D. and H.).

SESQUIOXIDES.

40. **Sapphire (231).** Al_2O_3.

Hexagonal; R. 86° 4′. Twins common. Clv., rhombohedral, and basal. Excessively tough, and difficultly frangible. H., 9; G., 3·9 to 4·2. Transparent to translucent; lustre, vitreous, but pearly to metallic on basal face. B.B., unchanged. Comp., Alumina, with a little oxide of iron.

ABERDEENSHIRE—CLOVA, CLASHNARAE HILL. Occurs imbedded in red Andalusite. Crystal $\frac{1}{30}$th of an inch diameter. Hexagonal; pale blue, with dark blue centre and asteriated structure. [*Min. Mag.*, vol. ix. p. 389.]

41. **Hæmatite (232).** Fe_2O_3.

Rhombohedral [*o*, (*c*), 111; *u*, 211; *c*, (*o*), 255; *r*, 100]; R. 86° 10′. Crystals rhombohedric, prismatic, and tabular. Twins on R also on *o*. Clv., rhombohedral, and also parallel to the base. Fracture conchoidal. Brittle. Iron black to steel grey; often iridescent. Streak cherry-red, brownish-red to reddish-brown. In thin laminæ transparent and blood-red. Metallic lustre, brilliant. H., 5·5 to 6·5; G., 4·3 to 6·3. Rarely feebly magnetic.

B.B. in inner flame becomes black and magnetic. Very slowly soluble in acids. Comp., Iron, 70; Oxygen, 30.

Is subdivided into the following:—

1. ELBA IRON ORE.

Crystals of rhombohedral type, thick and modified.

SHETLAND—MAINLAND, HILLSWICK. At Vanlup, *o u c r* (Pl. XVII.), with Specular Iron, Margarodite, Chlorite, and near Kyanite; in quartz veins in mica-schist. The faces *u* are striated by an oscillation with *r*, or an intermediate face.

EDINBURGH. Salisbury Crags, north quarry. "Flat nail-headed crystals," with Quartz, in cavities of Göthite.

2. SPECULAR OR MICACEOUS-IRON ORE.

In thin flat crystals.

SHETLAND—MAINLAND. In a vein which has its north outgoing at the junction of the clay slate with the Old Red Sandstone on the west shore of Levenwick, and which courses along the east side of the Scousburgh Hill. It enters the clay slate and reappears of very considerable thickness at the south-east end of Scousburgh Hill near the Brough. At Hoswick, north side of Levenwick (Hay). At the Girths of Quendale north of Fitful Head, in a vein in clay slate (Hibbert). At Kleber Geo Fethaland, in thin crystalline scales, imbedded in potstone.

Sutherland. On the west slope of Foinne Bheinn, 700 feet up, with Orthoclase and Haughtonite, in Hebridean Gneiss.

Ross and Cromarty. In the burn of Edderton, on the surface of botryoidal Hæmatite. On the north slopes of the Cromalt Hills, about 2 miles east of Knockan, upon quartzite. At Ullapool, near the top of the south-east of the Bay, in limestone (Nicol).

Inverness-shire. At Allt Cuaig Burn, near Dochfour, in granite (Aitken Dott).

Aberdeenshire. At Pitfichie Hill, near Monymusk, in the felspar quarry, in twisted brown-black plates, tarnished and tarnishing quartz—Anal. 1. S.G., 4·58.

	Fe_2O_3.	FeO.	Al_2O_3.	MnO.	CaO.	H_2O.	SiO_2.	Total.	
Anal. 1,	81·70	7·74	4·86	·08	·60	1·18	3·84	100 .	Heddle.

Argyllshire. On the south slopes of Am Bodach, Glencoe; with Hornblende, in porphyry. Loch Eck, on the west shore, 1 mile north of Ballymore, in gneiss. In Islay, at the Mull of Oa.

Perthshire. Birnam, Dunkeld, in Highland Schists.

Bute. Micaceous, in clay slate (Greg).

Renfrewshire. Gourock, at the porphyry quarry, in thin crystals, with Calcite, Fluor, and Quartz.

Roxburghshire. "At Carolside, in Earlston, a dyke in the Leader Water contains minute red crystals of Fe_2O_3."

Kirkcudbright. At Auchencairn, upon mammillated Hæmatite; and at † Auchinleck.

Ayrshire. [? Auchenlongford] near Muirkirk, at the Pennel Burn, Garpel River, upon fine mammillated Hæmatite, with Calcite (Wilson). Burn Anne, Galston, in red jasper (Brown).

3. Red Hæmatite.

In mammillated and reniform forms, which are internally composed of radiating fibres, and which often have a concentric structure from intermittent growth of these. The external surface has generally a smooth polish and a brownish-red hue.

Shetland—Papa Stour. At Kirksands, in veins in amygdaloid (Fleming).

Orkney. In Walls, on the east shore of Aith Hope, in hollow stalactites, and at Lead Geo in bands with yellow ochre.

Perthshire—The Ochils. At Ben Cleuch, in narrow veins in trap.

Fifeshire—Kirkcaldy. Near Seafield Tower, with yellow Göthite, in a vein traversing rocks of Lower Carboniferous age.

DUMBARTON. In Bowling quarry, with Analcime, rarely.

LANARKSHIRE. At the Moor of Rawhead. In Jerviswood grounds in a quartz vein. Cumberhead at Glenbuck. Leadhills.

AYRSHIRE. At the Black Craig, near the summit overlooking the castle of Loch Doon, in veins. Muirkirk, at Auchenlongford.

ROXBURGHSHIRE. On the Eildon Hills, on the south-west side, near Bowden. At Classleypeel, on the Jed, in graywacke.

BERWICKSHIRE. Below Cowdenknowes, in the channel of the Leader River, in veins in graywacke.

KIRKCUDBRIGHT. Near Burnfoot, almost opposite to that part of the peninsula upon which the house of St Mary's Isle is built, in fine specimens. Also upon the west side of Kirkcudbright Bay, in veins, with Calcite, in brown-red graywacke. At Auchencairn.

DUMFRIESSHIRE. On Stake Moss, Wanlockhead, in graywacke. At Rerrick (abandoned).

4. EARTHY.

Compact and ochry "*Keels*"; earthy and foliated *Reddle.*

ORKNEY. In Old Red Sandstone, Walls, near Tor Ness (reddle or red chalk), in imbedded scale-like patches—Anal. 2. At the Meadow of the Kaim, Hoy. With Limonite, in a granular form, in formerly-worked veins near the Manse.

SUTHERLANDSHIRE. In the stream gravel, with gold (Keels).

ELGINSHIRE. At Newtown quarry, in imbedded patches, in sandstone (reddle), both yellow (Anal. 3) and bright red (Anal. 4).

LINLITHGOWSHIRE. At Uphall.

LANARKSHIRE. At Leadhills, in stream gravel, with gold (Keels). At Stonelaw, blood-red.

[EDINBURGH. Coating the fragments in the agglomerates of Arthur's Seat.]

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	CaO	MgO	K_2O	Na_2O	H_2O	Totals	
Anal. 2, .	62·56	17·25	3·46	2·21	tr.	·48	1·62	4·68	·6	6·72	99·58	Heddle.
,, 3, .	59·21	16·09	3·30	...	·38	·52	2·1	5·64	1·25	9·88	98·37	Heddle.
,, 4, .	55·75	17·25	8·26	1·66	·28	·57	2·48	5·59	1·4	6·55	99·79	Heddle.

These analyses show *reddle* to be of the nature of a decomposed micaceous gneiss.

Dendritic markings of Hæmatite, simulating plants, occur at a quarry at Garths Ness, near Lerwick, Shetland; and in blanched sandstone, in the quarry of Black Hill, above the farmhouse of Cowdenknowes, near Dryburgh.

41a. **Martite (232a).** Fe_2O_3.

This is sesquioxide of Iron, apparently pseudomorphous after Magnetite. It is in octahedrons. Clv., none, or traces of conchoidal fracture. Lustre submetallic. Iron black, blue-black, to brownish. Streak reddish-brown or purplish. Not Magnetic. H., 6 to 7; G., 4·8 to 4·83.

	Fe_2O_3	FeO	MnO	CaO	SiO_2	Total.	
Bute,	97·05	1·1	·2	·95	·77	100·07 .	Heddle.

Occurs on the shore of Bute, near Rothesay Bay (Archer).

42. **Ilmenite (233).** $(FeTi)_2O_3$.

Rhombohedral; R. 86°. Crystals tabular, and rhombohedral rarely in twins. Clv., basal. Fracture conchoidal. Brittle. Powder black to brownish-red. Semi-metallic lustre. Iron black to reddish-brown. Rarely feebly magnetic. H., 5 to 6; G., 4·5 to 5·3.

B.B. infusible. With microcosmic salt forms, in the inner flame, a dull red glass; this, treated with tin on charcoal, becomes violet-red, unless there are only traces of titanium. In fine powder slowly soluble in h. acid to a yellow solution, which, after dilution with much water, and after long boiling, deposits titanic acid somewhat coloured with iron. Finely-powdered it imparts first a blue colour to s. acid, and is very slowly soluble. Decomposed by fusion with bisulphates. Comp., Peroxide of Iron, with replacement of the iron by Titanium, in proportions varying from $\frac{1}{9}$: 1 to 5 : 1.

Occurs in granite, limestones, and, rarely, in diorite, but specially in metamorphic rocks, with Chlorite and Kyanite as associates; has not been found in Scotland in igneous rocks proper, *i.e.*, volcanic or trappean rocks.

In Scotland it has been found (1) in exfiltration veins, called "crocus" by the quarrymen, in granite; (2) in similar veins, sometimes of a pegmatitic nature, which cut the beds of gneiss and of schists; (3) in quartzose bands, in similar rocks, which bands follow the flexures into which the rock has been thrown; (4) in metamorphic limestones in these rocks; (5) in Chloritic or serpentinous bands in the same; (6) apparently as simply an accessory mineral of the rock mass.

	TiO_2	Fe_2O_3	Al_2O_3	FeO	MnO	CaO	MgO	SiO_2	Total.	
1. Ben Bhreac: "syenite,"	50·65	9·87	...	17·78	5·17	3·14	11·63	1·12	99·36	Heddle.
2. Anguston: granite, S.G., 4·908, . . .	23.67	43·06	...	29·01	2·34	1·01	...	2·07	101·16	Heddle.
3. Hillswick, S.G., 4·916,	20·60	63·55	1·44	11·26	·02	1·79	...	1·4	100·06	Heddle.
4. Ben More, ...	18·4	55·31	...	23·86	...	1·34	...	1·2	100·81	Heddle.
5. Crois, S.G., 4·86, . .	40·4	41·87	...	15·40	·2	1·46	...	·7	100·03	Heddle.

(1) Sutherland. Tongue, in the vein in the syenitic boulder on Ben Bhreac, with Microcline, Magnetite, Sphene, Thorite, Lepidomelane, Babingtonite, etc., in small quantity—Anal. 1. Ben Hiel, south-west foot, with Chlorite in white Orthoclase. Loose lumps.

Aberdeen. Anguston quarry, in veins in the granite, with Quartz, Microcline, Sphene, Allanite, and Haughtonite. Plates 1 inch in size—Anal. 2.

Kirkcudbright. At Cassencarrie, in quartz veins in red granite, with Chlorite and Epidote (D. and H.).

(2) Shetland — Mainland. At Hillswickness, at Vanlup, with Chlorite and Margarodite, near Kyanite, in large foliated crystals, which are acutely folded upon themselves, following the contortions of the rock—Anal. 3. In thick crystals in quartz, with Kyanite, at the south-east end of the Ward of Scousburgh. In the Vee Skerries, with Quartz, Chlorite, and Margarodite.

Sutherlandshire. At Clach an Eoin, near the Betty Hill of Farr, in quartz veins, with Chlorite, Rutile, Haughtonite, and Garnet. Blue-black in colour (D. and H.). Loch Shin, near Achadh a' Phris, with Lepidomelane, in quartz veins (D. and H.). Ben Loyal, at the foot of Sgor a Chonais-aite, in quartz veins, which cut the schists underlying the "syenite" of the hill; with Chlorite.

Hebrides. In West Monach Island, in lumps of a brownish colour, in veins of Oligoclase, which cut the Hebridean Gneiss. With Epidote, Sphene, and Apatite. Similarly on Eternal Island.

Banffshire. West of Findlater Castle, Cullen, in quartz veins, in Chloritic and Margarodite schists. On the north slopes of Alsat Hill, near the road to Tomintoul, with granular Chlorite, and with Pyrite.

Aberdeenshire. At Dobston quarry, Blackhall, 2 miles west of Inverurie, with Apatite, Chlorite, and Biotite.

Forfarshire. Tarfside, on the north-west side of Cowie Hill, in graphic-granite veins in gneiss, with Kyanite and Margarodite. On the south-west side of Cowie Hill, with Kyanite. Three miles above the foot of Glen Effock, in quartzose veins, with crystallised Chlorite.

Perthshire. Two miles above the Bridge of Cally, Glen Shee, in quartz veins, with crystallised Epidote and Chlorite. South side of the Moor of Rannoch, on the slopes on the east side of Loch Tulla in the corry of Meall Buidhe, with Kyanite and Chlorite. In the corry [? Coire Achallater] north of Meall Buidhe, with Kyanite and Chlorite.

Inverness-shire. In Lochaber. On the north-west slopes of Meall Garbh, Loch Treig, with Tourmaline (Cunningham). On the north slopes of Meall Cian Dearg of Stob a' Coire Mheadhonaiche, with Chlorite and Hyaline Quartz. On the south slopes of the cone of Stob à Coire Mheadhonaiche, a crystal (Pl. XVII. fig. 1), imbedded in stubby gneiss. Stob Coire a Gaibhre, below Claurigh, with Chlorite. Glen Nevis, on the north-west slopes of Mullach nan Coirean, with Chlorite in quartz (loose).

Argyllshire. At Glen Creran, on the south slopes of Fraochaidh, with Chlorite, near the top of Beinn Doireann.

(3) Three great belts of quartz cross central Scotland from north-east to south-west. The most southerly of these appears more as a system of dense bands or layers which thin off and anastomose with one another throughout the gneiss, and are subject to all its flexures. It is best developed from Fortingal, stretching W.S.W. to Loch Killisport in Argyll. Towards the east it is much stained yellow by decomposing pyrite; passing westward, it is much like loaf-sugar, but here its grains coalesce, so that in the smaller rifts it becomes hyaline, and of a purplish-brown hue. It then also assumes Chlorite, and, towards the western side of the country, has all the characters of a chloritic schist. Its quartzose bands are markedly chloritic from Creag an Lochain of Meall Tarmachan, Loch Tay, to Ben More of Loch Eck; and wherever it is so, Ilmenite, often associated with Rutile, is to be expected. It is specially found at the following points along this line:—Meall Buidhe, north side of Glen Lyon, east of the summit. Creag an Lochain of Meall nan Tarmachan, with scaly and foliated Chlorite. Top of Creag na Caillich, with Rutile. East foot of Meall Garbh of Ben Lawers. North side of Mid Hill, Killin. North slopes of Craig Mhòr, Glen Lochay, with hyaline Quartz and Chlorite. North-east side of Stob Luib, 650 feet up, with Chlorite. North-east shoulder of Ben More, 300 feet below the summit at the foot of a small east and west cliff in fine specimens of a blue-black colour, with Chlorite (Macknight)—Anal. 4. Am Binnein, with hyaline Quartz, in the small cliffs at the summit where they face the south. Stob Garbh, in the south-west corries at the summit. Cruach Ardran, at the summit. Meall Dhamh, south-west slopes. Beinn Chabhair, south side, with Chlorite and Quartz. Beinn a' Chroin, north-east crags. Beinn a' Chaisteal, Glen Falloch, in the corry to the south-east side, with Tourmaline, under the summit. In a quarry on the road, one mile east from Arrochar, in quartz veins, with Chlorite. North-west slopes of Ben Ime, in crystals 3

inches in width, with Chlorite (Glass). Ben Crois, 700 feet up the east slope, in white Quartz veins—Anal. 5 (Plate XVII. fig. 2). Ben Arthur, at the east side of the foot of the great square pillar, with Rutile and Chlorite, very fine. Beinn an Lochain, east slopes, with Rutile. Beinn Bheula, in the great rents at the summit, with crystallised Rutile, Quartz, and Schorl. Glen Finnart, on a spur on the north of the glen, with fibrous Tourmaline. Clach Beinn, Loch Eck, on its east slopes, in Quartz. Towards the upper parts of Glen Massan (Young). In loose blocks on the south side of east Loch Tarbert (Hamilton).

(4) Aberdeenshire. At Foresterhill, Old Meldrum, with Hornblende, Sphene, Orthoclase, Pyrrhotite, and Biotite.

Perthshire. Near Blair Athole, in the quarry immediately south of the village, on the south side of the Garry, with Sphene and crystallised Ripidolite. At Edintian, with Ripidolite, Sphene, Biotite, and Pyrrhotite.

(5) Shetland—Mainland. At Kleber Geo, Point of Fethaland, in flat blue-black crystals, in a vein of potstone, traversing gneiss (D. and H.).

Banffshire. In a roadside quarry about 2 miles west of Rothiemay, north of the Bin of Huntly, in foliated Talc, with Chrysotile.

(6) Shetland—Unst. At Urie, minute flakes seem to be incorporated in the general mass of the mica schist (D. and H.).

Argyllshire—Glencoe. A little north of the summit of the Devil's Staircase, twisted flakes occur in the brown mica (? Lepidomelane) gneiss.

43. **Iserine (233a).** $(FeTi)_2O_3 . Fe_2O_3$. Trappeisen Erz. Magnetic Iron Sand.

Cubic. Possibly pseudomorphous. Generally with rounded edges, or in rough grains. Fracture uneven and conchoidal. Lustre metallic to dull. Iron black. Brittle. Streak black. Strongly magnetic. H., 6 to 6·5; G., 4·7 to 5·1.

Chemical characters the same as those of Ilmenite, only reacts for more iron, and more easily attacked by acids.

Often mixed with Magnetite; hardly to be separated or known when occurring as "black sand," except that magnetite is more brittle from cleavage.

Occurs in diorite, basalt, dolerite, gabbro, and many basic volcanic rocks; or in sands formed from their decomposition, when it is generally mixed with Magnetite. At some of localities mentioned for sands, may be thus mixed. Analysis only can determine.

	TiO_2	Fe_2O_3	Al_2O_3	FeO	MnO	CaO	MgO	SiO_2	Total	
1. Hoy, Orkney,	18·4	54·98	·6	14·42	...	5·6	·2	6·1	100·30	Heddle.
2. Kildonan, G., 5·08, . .	8·03	91·26	...	...	...	...	...	·71	100	Forbes.
3. Sandwood, .	10·60	80·88	·07	5·96	·4	·95	...	1·5	100·36	Heddle.
4. St Andrews, .	22·9	22·87	...	30·98	1	5·94	1·6	15·1	100·39	Heddle.
5. Ardross Castle, Fife, . .	16	43·74	...	28·01	·1	4·4	...	7	99·25	Heddle.
6. Elie Ness, .	21·3	42·67	...	21·89	·7	4·48	1·6	7·5	100·14	Heddle.
7. Granton, .	16·1	39·29	11·47	...	·6	7·9	1·4	24	100·76	Heddle.
8. Caroline Park, magnetic, .	19·4	37·97	...	24·33	·8	6·5	...	10·8	99·8	Heddle.
9. Caroline Park, non-magnetic,	15	40·73	..	18·24	1	7	...	18·1	100·07	Heddle.
10. Almond, . .	18	39·61	...	26·74	·6	6·7	...	8·4	100·05	Heddle.

Orkney—Hoy. Occurs as a minutely-divided deep black sand, with Martite, below the cliff bank north-east of the manse—Anal. 1.

Sutherland. Kildonan, in the gravels, with Gold and Rutiles (Joass)—Anal. 2. On the west shore of the Lake of Sandwood, and in dykes in the Hebridean gneiss, on the north shore of the lake—Anal. 3.

Hebrides. On the shore of Canna (Clark). Skye, among the sands of Talisker Bay (Davison). Mull, Beinn a' Ghraig, Loch Ba: in small lumps imbedded in a pale-coloured acidic trap (" Syenite").

Banffshire. Below the bridge over the Deveron, at Macduff, on the banks. In the eruptive rock which, from the shore at Portsoy (Gabbro), passes up the centre of the county to Morven, everywhere having the form of its associated minerals impressed upon it, and nowhere showing any trace of crystalline form. As at Craigbuirach and Retanach, with Paulite, Enstatite, Labradorite, and Pyrrhotite. In the rock beneath the old battery at Portsoy, rarely with Hornblende, Augite, Biotite, and Labradorite.

Aberdeenshire. As a black sand on the road to New Merdrum, near Rhynie (?). In a vein near the roadside near Pooldhulie Bridge. Forbestown, on the Don, with Hornblende, Biotite, and Labradorite. Glenbucket, in the low flanks of Creag an Innean, near Craig Wood, with gigantic crystals of Actinolitic Hornblende, Sphene, Labradorite, and Biotite. South-east of Tillyduke, and near Badnagoach, on the Deskry, with dark Hornblende, Allanite, Sphene, Labradorite, and Biotite. In a small cliff near the road side on the west, at the summit level passing south to Tillykirie and Coldstone, with Hornblende, Labradorite, Allanite, and Sphene.

In passing from north to south this rock assumes more and more the aspect of a " Syenite," as seen on the north spur of Morven, where but little of the Iserine is seen. Sphene and Magnetite gradually take its place, and the former almost disappears where the rock passes over into the granite of Culblean.

ABERDEENSHIRE. In several places among the sands of the Don, G., 4·49 (Thomson), and at its former mouth, G., 4·77. At the sands of Forvie, near the mouth of the Ythan, and in the parishes of Deer (?) and Rathen. At the mouth of the stream of the Black Dog (? magnetite). In quantities on the road west of Middleton of Balquhain.

ARGYLLSHIRE. At Galdrings, Balligroggan, Machrihanish Bay, on the shore below igneous rock; in regular octahedra. May be partly magnetite.

FIFESHIRE. At the south end of the east sands of St Andrews, at the mouth of a small stream coursing from vesicular trap—Anal. 4. In small brilliant jet-black lumps in basalt in tufa at the Rock and Spindle Kinkell with Hullite. In basalt, similarly, a little to the north of the East Neuk of Fife. In the sands beneath Ardross Castle (Geikie and H.)—Anal. 5. In brilliant black, apparently fragmentary chips, in two dykes 1 mile east of Elie, with Pyrope, Saponite, Sanidine, and Olivine—Anal. 6. At Ruddon Point, west of Elie, with Olivine and Pyrope.

EDINBURGHSHIRE. Imbedded in the trap rocks of Arthur's Seat, rarely (Greg). Near the west breakwater of Granton harbour—Anal. 7. On the sea shore below Caroline Park, in large quantity; highly magnetic, and showing both regular octahedra and elongated cubes, also cubo-octahedral crystals—Anal. 8. The less-magnetic portion is hackly—Anal. 9.

LINLITHGOWSHIRE. On the sands, a little to both sides of the mouth of the Almond. One crystal combination of dodecahedron with octahedron was seen—Anal. 10.

COMPOUNDS OF SESQUIOXIDES WITH PROTOXIDES: RO R_2O_3 (SPINEL GROUP).

44. **Picotite (234).** $(Mg,Fe)O.(Al,Cr)_2O_3$.

Occurs at a rock-constituent in rocks of ultrabasic composition.

45. **Magnetite (237).** FeO,Fe_2O_3.

Cubic. Clv., octahedral; also sometimes cubic. Faces *d* usually striated, parallel to *a*. Often compact, and also granular. Fracture conchoidal to uneven. Brittle. Lustre metallic, when changing imperfect. Opaque. Iron black to brown. Streak, black. Highly magnetic; often polar, especially the massive varieties. H., 5·5 to 6·5; G., 4·9 to 5·2.

B.B. fuses with great difficulty. In the oxidising flame, loses its magnetism. With salts gives reactions of iron. In powder completely soluble in h. acid. Comp., Protoxide of iron, 31; Peroxide, 69; or 72·4 of Iron and 27·6 of Oxygen. Sometimes with some Titanic Acid.

Mostly confined to crystalline rocks, and most abundantly in metamorphic rocks. Also found in grains, and in both distorted and skeleton crystals in eruptive rocks. Sometimes forms beds and large irregular masses. In imbedded crystals, and also disseminated in chlorite slate, serpentine, limestone, basalt, syenite, and granite.

	Fe_2O_3.	FeO.	MnO.	Al_2O_3.	CaO.	MgO.	SiO_2.	TiO_2.	Total.	
1. Pundy Geo, . .	65·62	32·17	·5	·39	·22	·68	·7	...	100·28	Heddle.
2. Tongue boulder, .	83·48	12·63	1·2	·23	·9	·5	1·2	...	100·14	Heddle.
3. Rispond, G., 5·15,	63·19	29·59	·4	...	1·62	1·1	3·9	...	99·8	Heddle.
4. Sangobeag, . . .	89·63	4·24	·3	...	2·69	·9	1·9	·5	100·16	Heddle.
5. Roneval, G., 5·154,	68·1	29·1	·5	·62	·17	·6	1	...	99·19	Heddle.

Shetland—Unst. At North Quin Geo, in brilliant blue-black crystals, *o d* (Plate XVII. fig. 1), with green Talc, fibrous Nemalite, Brucite, Magnesite, and Dolomite, in a vein of Serpentine (D. and H.). Swinna Ness, *d*, in a vein of pale green serpentine, striated crystal. At Wood Wick, massive with Kyanite and Staurolite. Haaf Gruney, granular, massive, in veins of yellow Serpentine, on the south-east shore. Fetlar, at Oddsta, the north-west point, *o*, in massive Chlorite (Hibbert). At Aith, Fetlar, on the south shore, in minute *a* crystals in yellow Precious Serpentine. Mainland. At Pundy Geo, on the south shore of Fethaland, in large fine crystals, *o*, and hemitropes (Plate XVII. fig. 2), in granular massive Chlorite (D. and H.)—Anal 1. Hillswick, at Carnebe, *o*, (Hibbert). At Vanlup, opposite the Drongs, *d o* (Plate XVII. fig. 3), *d* striated. At Sandy Geo (the Carnebie of Hibbert), near Gordi Stack, *o*, each crystal being the central radiant point for fine groups of Ripidolite crystals (D. and H.).

Sutherland. At Cnoc na Stroine, Loch Borrolan, *d*, "disseminated through felspathic granitoid" (Cunningham). In the granite vein in the boulder on Ben Bhreac, Tongue, in twins, *o t* (Plate XVII. fig. 4), and simple, *o*, sometimes sheathing Native Iron; with Microcline, Cleavelandite, Ilmenite, Orangite, etc.—Anal. 2. In granitic veins in "syenite," on the face of Sgor a Chonais-aite, Ben Loyal, *o* and *d*, with Amazonstone, Thorite, and Topaz. The octahedral crystals show the irregularities of surface delineated in Pl. XVII. figs. 5 and 6. At Rispond, Loch Eireboll. In red graphic-granite, in tetrahedral crystals (Pl. XVIII. fig. 7), and in lumps the size of the fist, G., 5·15, along with Oligoclase and Haughtonite

—Anal. 3. In a coarse Oligoclase-granite, in the cliffs east of Sangobeag, *do*; along, occasionally, with Agalmatolite—Anal. 4. There is here a manifest passage into *Martite.* In the dolomitic marble, north-west of Ledbeg, with Malacolite and white Biotite. East side of Eilean Bulgach, in pegmatite veins (Horne).

ROSS-SHIRE. In thin flakes, occasionally, in the mica of the pegmatite of Raven's Rock, Strathpeffer; and, similarly, at Struy Bridge quarry.

HEBRIDES—NORTH RONA. At the north side of the hill ridge, with Garnet and Actinolite. (Can this be MacCulloch's "Wolfram"?) Harris, in the great granite vein on the east of Roneval, in flattened *o* crystals (Pl. XVIII. fig. 8), with Haughtonite and Oligoclase (D. and H.)—Anal. 5. At Miabhag, West Loch Roag, Lewis, in graphic granite (Currie). Scalpay Island, at Klibberness, beneath the lighthouse, in small crystals with Actinolite in the Potstone vein in Serpentine (D. and H.). Also near the dolomite vein, so much mixed with Asbestus as to be fibrous in structure (Neill). Stromay Island, Sound of Harris, in a coarse brown Orthoclase and Microcline vein immediately to the east of the great vein of graphic-granite, in coarse crystals and lumps the size of goose eggs, with Haughtonite. North Uist, at Suenish Point, in the north-west, in minute tarnished cubes, in a hornblendic belt of the Hebridean Gneiss. Tiree, in a granitic vein near Crossapoll, with Sonnenstein, Oligoclase, Agalmatolite, and Haughtonite. Skye, in the Coolin Hills, in segregated octahedral crystals, and in masses up to 40 lbs. weight in veins in Hyperite. Mingulay, Macphee's Hill, on the south side near the summit, in flattened octahedra, in veins of white Quartz in red orthoclase-granite. On Berneray, Barra Head, at Mullach a' Lusgan, with Apatite, in Hebridean gneiss. In East Rona, in hemitropes *o* in granite (Greg). In Islay, in white limestone, with Hæmatite, at Lossit Hill, in small crystals (Greg). Monach Islands, massive, with Oligoclase, Sphene, and Epidote. Shiant Islands, Eilan Mhuire, in a small cave at the neck at the east end. In a very coarse dolerite, *o*, with Pyrite, Analcime, Nepheline, and Saponite. Eigg, "in grains in a greenstone formed of glassy felspar and Hornblende" (? both Iserine).

BANFFSHIRE. "In Serpentine, Portsoy" (*Chromite*, Wollaston).

ABERDEENSHIRE. Cabrach, 300 yards from Threeburnshead, in Serpentine. Middle Coyle Hill, in Serpentine. Alford, at Sylavethy quarry, twins, *o t*, with Dolomite and Uralite.

KINCARDINESHIRE. At Garron Point, formerly (Nicol).

FORFARSHIRE. †"Little Kilrannoch, Clova, in Serpentine" (MacCulloch). At Balloch Carity, with Asbestus.

ARGYLLSHIRE. Loch Fyne, *o*, in chlorite schist. "Near Loch Long"

(Greg). One mile south of Meall Mor, west of Erins, Knapdale, in a copper mine, in minute octahedra, and in large cubes, apparently pseudomorphous after Pyrite; with Chalcopyrite, Byssolite, Dolomite, and Göthite.

DUMBARTONSHIRE. On Ben Vorlich of Loch Lomond, on the south-east slopes of † Cnoc an Each, about a mile from Upper Inveruglas, octahedra in rippled mica gneiss (Cadell).

EDINBURGHSHIRE. Salisbury Crags, near the south end, minute *o* and *a o* crystals with Apatite in dolerite.

LINLITHGOWSHIRE. Bathgate, at Kirkton quarry, in crystals with Quartz and Calcite, in cavities of limestone of Lower Carboniferous (Yoredale) age.

BUTE. Along the shore, on both sides of Rothesay, in loose octahedra, with Martite.

45a. Chromiferous Magnetite (237a).

Traces of Chromium are found in magnetic sands. In the substances noted below, its amount is such that they might be used as ores of Chromium; both, however, were commingled with sand grains, from which the magnet failed to separate them.

	Fe_2O_3	Cr_2O_3	FeO	MnO	Al_2O_3	CaO	MgO	SiO_2	Total.	
1. Dale, Unst, . .	57·29	9·4	24·94	·4	...	1·12	...	7·2	100·35	Heddle.
2. Tresta, Fetlar, .	56·69	17·53	15·55	·6	...	1·29	3·9	5·1	100·66	Heddle.

SHETLAND. Unst, at the bend to the north of the Dale Burn. Among ordinary sands. Blue-black. Not strongly magnetic. Much cleaved and hackly. No crystal forms. Sometimes sheathes Native Iron (D. and H.). Fetlar, on the shores of the Loch of Tresta, but, according to Fleming, it occurs imbedded in small grains in the "primative" limestone along with Sphene. From the Dullans, according to Webster. It is either in octahedral crystals, or in much rounded grains, with conchoidal fracture, jet black colour, and highly lustrous.

46. Chromite (241). FeO,Cr_2O_3.

Cubic. Clv., octahedral, imperfect; generally granular, massive, fine, or coarse in grain. Opaque. Semimetallic to resinous. Iron black to dull brown. Streak, brown. Brittle. Sometimes feebly magnetic. Fracture conchoidal to uneven. H., 5·5 to 6·5; G., 4·32 to 4·57.

B.B. in O. flame infusible and unchanged; in R. flame becomes magnetic. With borax and micro. salt gives beads red when hot, but on cooling chrome green. The latter colour is heightened on charcoal with tin. Fused with nitre, gives yellow solution in water, in which Chromium may be detected. Insoluble in acid, but decomposed with difficulty by fusion with bisulphates. Comp. varying much: 19 to 37 $\dot{\text{F}}\text{e}$, 36 to 64 $\ddot{\text{C}}\text{r}$, 0 to 15 Magnesia, 9 to 23 Alumina.

Seems to be confined to Serpentinous rocks or their allies.

	FeO.	MnO.	Cr_2O_3.	Al_2O_3.	CaO.	MgO.	SiO_2.	Total.	
1. Unst, Hagdale,	17·52	·5	44·56	23·74	1·29	...	11·09	98·70	Heddle.
2. Unst, Buness,	18·08	tr.	48·03	16·55	·88	16·61	·83	100·98	Heddle.
3. Askival, Rum,	34·11	·75	26·34	18·28	6·38	14·09	6·24	106·19	Heddle.

Shetland—Unst. On the north side of Balta Sound, in a series of large nodular masses, which seem to be connected as a vein, though a tortuous one, in serpentine (Hibbert). In the large old quarry called Hagdale, but situated between Heog and Keen Hills. Here it is an enormous mass, 86 feet deep and about 60 feet wide. The ore is for the most part black (Anal. 1), and it is associated with Kämmererite rarely, Aragonite, Emerald Nickel, Pentlandite in specks, and crystallised Penninite. Small black octahedra rarely occur here imbedded in a foliated green unctuous mineral, perhaps Pennite. In a quarry near to the house of Buness, the Chromite is dull brown in colour, rarely in imbedded crystals the size of peas. This variety contains Magnesia, and is the richest—Anal. 2. It is here associated with crystallised Kämmererite, Aragonite, and Precious Serpentine. Haaf Gruney, at the north-east and south-west ends, massive, granular, of poor quality, imbedded in yellow Serpentine. In Fetlar, in the hill of the Vord, in grains like gunpowder, throughout the Serpentine, and at Hestaness, with Chrysotile (Dudgeon). Mainland. At Quey Firth, about half a mile from the south shore, granular (D. and H.). To the north side of the entrance of Bixter Voe. East of Kirka Ness.

Hebrides. Rum, Askival, near the summit, on the north-west front a thin vein occurred in a belt of altered Olivine, in augitic rock. It had G., 4·163, was jet black, non-magnetic, very lustrous, and very hard. It was decomposed with extreme difficulty, both by Fresenius' flux and bisulphate of potash, and yielded the unsatisfactory result given in Anal. 3.

Banffshire. In serpentine, Portsoy (Wollaston). In limestone, Portsoy (Greg).

Aberdeenshire. In the parishes of Kildrummy and Towie (Greg). In the parish of Auchindoir, at the Red Craig, north of the Burn of Craig and opposite Tombhreac, in rude octahedra, imbedded in rotting Serpentine, with Pseudo-Enstatite.

PERTHSHIRE. In Glen Lochay, at Corrycharmaig, in granular veins in Picrolite, with Ripidolite (Greg). On the east side of Ben Lui, in talc schist.

STIRLINGSHIRE. At Buchanan, in small granular masses disseminated in a greenish-white marble (Sir H. Davy). The specimen was in the Allan-Greg Collection.

AYRSHIRE. With Serpentine, between Craighill and Knockdaw Hill, north-west of Colmonell (Macconochie).

The immense amount of working which has lately been carried out on Sobul Hill, Unst—the size of the water-filled quarries, and the quantity of the stacked and unsalable ore prove that if Chromite does not pass by insensible gradation into *Picotite*, the average exploiter is at least quite unable to discriminate between the two minerals.

47. **Minium (244).** $2PbO, PbO_2$.

Pulverulent. Dull. Colour bright red, streak orange-yellow. Opaque. Fracture earthy to conchoidal. H., 2 to 3; G., 4·6.

B.B. darkens when slightly heated, on cooling resumes its colour. At a red heat becomes yellow; melts easily, and is reduced on charcoal. Sol. in h. acid, with evolution of chlorine. Partially sol. in n. acid. Comp., Lead, 90·66; Oxygen, 9·34.

Leadhills, exceedingly rarely.

DEUTOXIDES, RO_2.

48. **Rutile (250).** TiO_2.

Tetragonal; *c*, 001; *a*, 100; *m*, 110; *l*, 310; *h*, 210; *s*, 111; *t*, 313; *g*, 212; *z*, 321. *c*, 84° 10; pyr., 123° 8′. Combinations of prisms, octahedrons, and zirconoids; the first dominant. Hemitropes common; with axes of the halves, 114° 26′. Clv., *m* and *a* perfect; *s*, traces. Fracture subconchoidal, uneven. Brittle. Streak, brown. Transparent to opaque. Brown-red, hair-brown, red, honey yellow, and black. Lustre, adamantine on cleavage faces, dull on others frequently. H., 6 to 6·5; G., 4·18 to 4·3.

B.B. infusible. With micro. salt a colourless bead, in R. flame, violet when cold. With borax a greenish glass in O. flame, dirty violet in R. flame. The varieties containing iron with micro. salt, brown-yellow or red in R. flame; but this bead, when treated with tin on charcoal, becomes violet. Insoluble in acids until after fusion with an alkali or alkalinic carbonate; solution after addition of tinfoil becomes violet upon concentration. Comp., Titanium, 61; Oxygen, 39, generally with some ferric oxide.

Occurs in granite, syenite, gneiss, chiefly in pegmatite bands, also in mica schist and in metamorphic lime stones.

In *granite.*—BANFFSHIRE, imbedded, very rarely, in brown Rock Crystal, at Cairngorm. ABERDEENSHIRE, at Torry, in granitoid veins, cutting gneiss, along with Orthoclase, Microcline, Pinite, Muscovite, Davidsonite (Beryl), Epidote, Specular Iron, and Albite.

In *gneiss.*—SHETLAND, at Burra (Fleming). At Vanlup, Hillswick, with faces *m h l* in margarodite schist, with Kyanite.

SUTHERLAND. At Achadh a' Phris, Loch Shin, fibrous, with Apatite and Sphene. At Achnapearain, in white Quartz, in fine crystals, *m h a e s t* (Plate XVIII. fig. 1) (D. and H.). At Clach an Eoin, near Betty Hill, in crystals, *m h s* (Plate XVIII. fig. 2), in veins with Ilmenite, Haughtonite, and Garnet (D. and H.). To the south of Naver Broch, in white Quartz, in long dislocated crystals. At Kildonan, in gravel, in rolled black crystals, twins (Plate XVIII. fig. 3), *m z e*, at Suisgill, *m h r* (Heathfield).

ROSS-SHIRE. Fannich, in the bed rock of the stream in Allt a Choire Mhoir, in thick dark brown crystals.

BANFFSHIRE. Strath Ailnack, 2 miles from its mouth, on the west side of the stream, with Chlorite and crystallised Orthoclase. At Preshome, on the Engie (Wallace).

PERTHSHIRE. On Beinn a Ghlo; pulverulent, scaly, and investing, in the rifts of the quartz rock (MacCulloch). In massive Quartz, along with hollow pseudo-casts of Kyanite, along the summit ridge of Carn nan Gabhar. Hills bounding the south-east side of Glen Tilt, crystallised in prismatic forms, imbedded in massive Chlorite, associated with Quartz veins traversing mica schist (MacCulloch). On An Sgarsoch, in Quartz (MacCulloch).

Associated with Ilmenite, Chlorite, and purple colloidal Quartz, it occurs in central Perth and Argyllshires at the Mid Hill, west from Killin, with Quartz and Chlorite, *m a e s* (Pl. XVIII. fig. 4). Creag Mhòr, its north side, similarly. At Corrycharmaig, Glen Lochay, along with Graphite and Chromite, in hyaline Quartz (Thorst). At Creag na Caillich, both at the summit and at the foot of the cliffs, with white Quartz, Sphene, and Chlorite. Also in foliated massive Chlorite. "The crystals appear to grow out of this, penetrating the Quartz; but sometimes accommodating themselves to its irregularities" (MacCulloch), *m g r* (Pl. XVIII. fig. 5). Near Crianlarich, formerly, in massive, white, horny-looking Quartz, in striated crystals, 3 inches to 4 by $\frac{3}{4}$ thick (Jameson). Similarly with Chlorite, south of Loch Tummel (Currie). On the south-east slopes of

Beinn Heasgarnich, near the summit, with Actinolite, Margarodite, Chlorite, and Ripidolite. On the Cobbler, at the south-east foot of the great square tower, crystallised, with Ilmenite and Chlorite. On the north-west slopes of Ben Ime, with Ilmenite, very rarely. Ben an Lochain, on its east slopes. Beinn Bheula, in twins, with Ilmenite and Chlorite, in the rock-rents at the summit. In Glen Finart, in Quartz veins on the north side, with fibrous Tourmaline.

In *limestone*.—In both the "syenite" and the limestone of Reay. "In Rannoch" (MacCulloch). BANFFSHIRE, in the white crystalline limestone inland from Redhythe, in bright red crystals, *h m s* (fig. 4), with white and brown Biotite, and pale-green Talc. In the limestone quarries at the balloch between Glen Bucket and Glen Nochty, with Pyrrhotite, Pyrite, Margarodite, Biotite, and Actinolite.

49. **Plattnerite (251).** PbO_2.

Rhombohedral. Probably pseudomorphous after Pyromorphite, and after Plumbo-Calcite. Clv., none. Fracture uneven to conchoidal. Brittle. Opaque. Iron black, velvet black to brown. Streak, rich brown, lustrous. Lustre, splendent to submetallic on fracture. In mammillated concretions. H., 4·5 to 5; G., 9·4, Plattner; 8·54, Kinch; 8·8 to 9·27, Heddle. Comp., Lead, 86·2; Oxygen, 13·8.

B.B. reduced on charcoal. Heated *per se* gives off oxygen, leaving litharge. With h. acid gives off chlorine in the cold; entirely soluble when heated with it.

	Pb.	O.	CO_2 and H_2O.	Total.	
1. Leadhills, .	86·62	13·38	...	100·	Plattner.
2. ,, .	86·01	12·85	·90	99·76	Kinch.

LANARKSHIRE. Leadhills (?).

DUMFRIESSHIRE—WANLOCKHEAD. Belton Grain vein, with Plumbo-Calcite (Wilson). Bay vein, with Smithsonite (Millar, a miner).

50. **Pyrolusite (254).** MnO_2.

? Orthorhombic. ∞ P., 93° 40′; generally radiating fibrous or earthy. Clv., P. Fracture uneven; friable. Opaque. Colour, steel-grey to brown-black. Lustre, bright metallic to silky. Soils. Streak, black shining. Brittle, and sectile. H., 2 to 2·5; G., 4·7 to 5 .

B.B. infusible, but loses oxygen, and grey varieties become brown. In O. flame imparts a violet colour to borax, and a blue-green to soda carbonate. Sol. in h. acid, with evolution of chlorine. Comp., Manganese, 63·3; Oxygen, 37·7.

SUTHERLAND. At the Allt Mor of Invernauld, Rosehall.

BANFFSHIRE. Half a mile north of Arndilly, near Rothes, with Limonite. At the † Laoch mines [or Ironstone mines], near Tomintoul, with Psilomelane and Limonite.

HEBRIDES. Islay, at the Mull of Oa, in ochreous sandstone, with Limonite; fine.

DUMFRIES. Closeburn. "Cavities in the upper limestone (Lower Carboniferous), often lined with Black Oxide of Manganese" (? Göthite).

HYDROUS OXIDES.

51. Turgite (255). $2Fe_2O_3.H_2O$.

Massive, fibrous, earthy. Botryoidal and stalactitic, also as a red ochre. Lustre, submetallic to satin-like or to dull. Colour, reddish-black, brown, dark or light red. When botryoidal, lustrous. Opaque. H., 5 to 6; G., 5·5.

B.B., heated in closed tube, flies violently to pieces, and so distinct from hæmatite and limonite. Gives out water; otherwise like hæmatite. Comp., Ferric oxide, 94·7; Water, 5·3.

Fe_2O_3.	CaO.	SiO_2.	H_2O.	Total.	
86·59	·82	7·69	5·56	100·66	Heddle.

ARGYLLSHIRE. Island of Kerrera, in red-brown striated cubic crystals in clay slate (phyllite). The crystals are invariably hollow, and as unaltered Pyrite occurs in the near neighbourhood they must be regarded as pseudomorphous after that mineral. Also in the neighbourhood of Oban.

52. Göthite (257). Fe_2O_3,H_2O.

Orthorhombic. ∞ P., 94° 53′. Crystals striated; also scaly, acicular, feathery fibrous, columnar radiate, and so reniform and stalactitic, and rarely massive granular. Clv., brachydiagonal perfect. Fracture hackly, rather tough. Lustre of crystals, adamantine; of reniform masses, sometimes shining, sometimes dull; of fracture, dull or silky to glimmering. Colour, light yellow, reddish, reddish-brown, and blackish-brown. By transmitted light, blood red. Streak, brownish-yellow to ochre-yellow. H., 5 to 5·5; G., 3·8 to 4·4.

B.B. in closed tube loses water and becomes red. Without tube, red-brown in O. flame, but in R. flame black and magnetic. Difficultly fusible; with reagents the reactions for iron. In h. acid easily and perfectly soluble; residue of silica. Comp., Ferric oxide, 89·9; Water, 10·1.

	Fe_2O_3	Al_2O_3	FeO	MnO	CuO	CaO	MgO	SiO_2	H_2O	Total.	
1. Sandlodge (Göthite),	78·03	...	...	3·2	·6	·24	·74	5·9	10·8	99·51	M'Attey.
2. ,, (Lepidocrocite), . .	83·20	...	22	2·43	...	·28	·87	1·92	11·44	100·36	Heddle.
3. Hoy, Sale Burn, G., 4·13, . .	84·39	1·29	·05	·1	...	1·32	...	2	10·86	100·01	Heddle.
4. Achvarasdal, .	88·69	...	...	...	...	...	·30	2·76	8·25	100·00	Anderson
5. ,, .	88·66	·34	·66	...	...	...	...	1·78	8·8	100·24	Heddle.
6. Garleton Hills, .	...	...	...	...	...	...	...	...	...	...	Heddle.
7. ,, G., 3·77	89·72	...	...	...	...	...	...	·22	9·98	99·92	Heddle.
8. Salisbury Crags, G., 4·146, .	79·02	...	7·19	...	...	·28	...	2·67	10·05	99·21	Heddle.

Varieties—1. In thin scale-like crystals, tabular through dominance of the brachypinacoid; generally attached by one edge; transparent and blood-red. The original Göthite—*Rubinglimmer* or Pyrrhosiderite.

2. In acicular crystals, the main axis dominant, generally capillary, and often radiately grouped. *Needle Ironstone*, *Flèches d'amour.* Frequently by the older mineralogists called "Spiculæ of Titanium," "Rutilites," or even "Rutile." This passes into a variety with a velvety surface—*Sammeterz.*

3. *Onegite.* This is the last variety, in its acicular form penetrating Quartz, and often used as an ornamental stone.

4. Feathery columnar to scaly fibrous, somewhat in structure like plumose mica. Lustre, waxy and tremulous. Lepidocrocite (λεπὶς, scale, and κροκὶς, fibre).

5. Columnar or fibrous. The fibres grouped radially so as to produce the usual reniform, botryoidal, or stalactitic forms. Very similar in appearance to Limonite.

6. Compact, massive or granular.

Var. 1. Rubinglimmer is usually confined to cavities in eruptive rocks, and to association with zeolites; but it is markedly selective in regard to the zeolites whose association it affects.

Perthshire. In a quarry 1 mile south-west (? N.W.) of Abernethy; disposed on the surface of rhombs of Calcite and Pearlspar, with Saponite, in pale-red scales.

Dumbartonshire. In Bowling quarry, in the veins which carry

Analcime and Thomsonite alone, and also in those which carried Harmotome and Edingtonite alone. Deep-red scales.

Renfrewshire. At Kilmalcolm, with Chabazite, Calcite, and Stilbite. At Boyleston quarry, near Barrhead, in beautiful dark-red rosettes of crystals, adherent in isolated groups to the surfaces of Analcime crystals, and lodged throughout the crystals of the scaly Thomsonite there found, but avoiding the other zeolites even in the same cavity. Bishopton tunnel, rarely, associated with Harmotome. Gourock quarry, with Fluor and Quartz.

Kirkcudbright. At Mabie, in cavities of Hæmatite, blood-red. (? Hæmatite) (Dudgeon).

In a granitic vein in a "syenite" boulder on Ben Bhreac, Tongue, Sutherland, coating Magnetite.

Var. 2. 2 and 3 are often associated. That is, acicular crystals imbedded in, and shooting through, crystals of Quartz, frequently protrude from the surfaces of these crystals. The first of these occurs in Orkney, Hoy, at the Bring, mouth of Burn of the Sale, in acicular crystals, in massive granular Hæmatite.

Clackmannanshire. At Balquharn Hill, Ochils, "fine crystals of Rutilite in syenitic greenstone" (Macknight).

Stirlingshire. At Fintry, in rosette groups, with Calcite and Amethyst (Kidston and Archibald).

Argyllshire. At Meall Mor, near Erins, 4 miles north of Tarbert, Knapdale, in the copper mine, in the forms *d k u*, *d k u e*, in cavities of a manganesian Chalybite (Plate XVIII.).

Renfrewshire. In Gourock quarry, with Fluor, Quartz, Rubinglimmer, etc.

Var. 3. Shetland — Mainland. Northmaven, at The Cannon, near the village of Stenness, in amygdaloidal cavities, imbedded in Rock Crystal and Amethystine Quartz, in delicate yellow tufts (D. and H.).

Caithness. At Isauld Burn, Reay, Achvarasdal, clear Rock-Crystal, overlying mammillated Göthite, is penetrated by golden-yellow tufts, termed "needles of Titanium."

Forfarshire. At Lunan Bay railway cutting, Quartz druses, with the Quartz pervaded by delicate hairs of lustrous golden-yellow colour. Roy quarry, piercing Calcite. Frequent in the Cairngorm of hollow agates, as at the Blue Hole, Usan.

Fifeshire. In Magus Muir limestone quarry, druses lined with Rock Crystal, pervaded with brushes of acicular, deep brown-coloured, crystals, rising in tufts from their surface. At †Rabbit Hill, Luthrie, and several other spots, hollow agates, lined with either brown or amethystine Quartz, with protruding tufts.

PERTHSHIRE—KINNOULL HILL. Veins of white Quartz, with brown, acicular crystals.

HADDINGTONSHIRE. North Berwick, opposite to †Sheep Crag, in both ordinary and amethystine Quartz, in trap druses.

ARGYLLSHIRE. In amethystine Quartz, at Auchaleck, 1 mile north-west of Campbelton; golden-yellow, passing to red-brown, in specimens fit for jewellery (M'Sporran). At Galdrings, near Ballygroggan, Machrihanish Bay.

EDINBURGHSHIRE — DUNSAPIE HILL. "Amethystine Quartz, with spiculæ of titanium." Penetrating Amethystine Quartz at Arthur's Seat.

Var. 4. SHETLAND—MAINLAND. At Sandlodge mine, rarely, associated with Psilomelane, with true Lepidocrocite colour, lustre, and structure—Anal. 1. Such specimens as show no Psilomelane are like Var. 5.

Var. 5. At the same mine, with Malachite, Chalcopyrite, Siderite, etc.—Anal. 2.

ORKNEY—HOY. At the Bring. In the chasm of the Burn of the Sale, in large mammillated specimens, with Rock Crystal. Precisely like Limonite—Anal. 3. G., 4·13.

CAITHNESS. At Achvarasdal, in fine mammillated veins, with crystallised Barytes, and Rock Crystal—Anals. 4 and 5.

FIFESHIRE. [In three fault-veins traversing the Yoredale Rocks, on the shore a few hundred yards south of] Seafield Tower, Kirkcaldy, forming ochre-yellow layers of a fibrous structure, in the centre of veins of Hæmatite.

PERTHSHIRE. In feathery tufts, coating gneiss at "the Queen's View," east of Loch Tummel.

HADDINGTONSHIRE. In the Garleton Hills, ¼ mile south-east of the Hopetoun Monument, in veins of a mammillated structure, associated with red Quartz in grey and red clay slate; G., 3·768—Anals. 6 and 7. Rarely crystallised: often zoned yellow and brown.

EDINBURGHSHIRE. In the quarry at the north end of the Salisbury Crags [on the upper surface of the dolerite, near Cat Nick], in fine radiating stellar specimens, of a purplish-brown colour and steely lustre —Anal. 8. G., 4·146.

RENFREWSHIRE. At Gourock quarry. Rarely, with Fluor, Quartz, etc.

53. **Manganite (258).** Mn_2O_3, H_2O.

Orthorhombic. *a*, 100; *b*, 010; *c*, 001; *k*, 320; *m*, 110; *e*, 101. Crystals columnar, consisting of combination of prisms, which are striated parallel to their intersections with one another. Often in grouped bundles, due to partially-interpenetrating twinning upon both the macro- and brachy-diagonals. Hemitropes upon the brachydome *e*. Radiating fibrous and crystalline granular. Cleavage *a*, brachydiagonal very perfect; *m* perfect. Base and macrodiagonal traces. Opaque. Lustre, imperfect metallic. Steel grey to iron black. Streak, brown. Brittle. H., 3·5 to 4; G., 4·3 to 4·4.

B.B. in closed tube yields water. Infusible. In O. flame imparts an amethystine colour to borax and micro. salt, which disappears in the R. flame. Sol. in h. acid, with evolution of chlorine. Sparingly in s. acid, with pink colour. Comp., Manganese peroxide, 89·9; Water, 10·1.

m m', 99° 40′ | *m c*, 90° 00′ | *k k*, 103° 24′ | *e c*, 122° 50′

Scottish forms, *m c*, *m c k*, *k c*, *k c*.

Occurs in veins traversing porphyry or gneiss, associated with Calcite and Barytes.

Aberdeenshire. Formerly at Laverock Braes, near "Grandholm" (Granam), north of Persley; *m c*, *m c k*, *k e*, with Baryte, well-crystallised. At the Corry Beg lead mine, Glen Gairn, very rarely, with Fluor, in extremely minute crystals, *k c*.

Kirkcudbright. At Kinharvie, south-west of New Abbey, crystallised in Psilomelane (Dudgeon).

Haddingtonshire. Fenton Tower quarry, near North Berwick; associated with Psilomelane, Varvicite, and pink Saponite, in felsite; in elongated brilliant crystals.

54. Limonite (259). $2Fe_2O_3, 3H_2O$.

In reniform, mammillated, and stalactitic forms, having a fibrous structure; also concretionary, massive, or earthy. Frequently with a black varnish-like exterior, and high lustre on surface. Lustre of interior and of surface of reniform masses silky to submetallic, sometimes dull. Colour brown, of shades from pale to dark, but none bright. When earthy, brownish-yellow and ochre-yellow. Streak, yellowish-brown. H., 5 to 5·5; G., 3·6 to 4.

B.B. like Göthite, but some varieties leave a skeleton of silica to both fluxes and acids. Comp., Ferric oxide, 85·6; Water, 14·4.

	Fe_2O_3.	FeO.	MnO.	Al_2O_3.	CaO.	MgO.	SiO_2.	H_2O.	Total.	
1. Lead Geo, Hoy, brown,	78·79	3·24	·15	·56	·47	...	3·07	14·31	100·59	Heddle.
2. Lead Geo, Hoy, black,	82·14	...	·34	...	·57	·21	3·32	13·87	100·45	Heddle.
3. Laoch, . .	74·80	...	...	2·47	...	·67	8·97	12·66	99·57	Heddle.
4. Laoch, S.G., 3·65, . .	52·09	22·22	·8	8·22	·67	·5	·7	14·57	99·77	Heddle.
5. Garron Point,	36·83	4·34	·15	4·89	5·64	1·92	36·62	7·94	98·33	Heddle.

The following varieties have to be noted:—

1. Compact fibrous. 2. Ochreous or earthy; often impure from presence of clay or sand. 3. Brown clay-ironstone. In concretionary nodules or compact masses; having a brownish-yellow streak, and so distinguishable from the clay-ironstone of the species Hæmatite and Siderite. Limonite is sometimes oolitic and sometimes pisolitic. 4. Bog Iron Ore; from marshy places, concreted from Chalybeate waters or by the action of decomposing organic matters, and often enclosing leaves or twigs.

1. Orkney. Hoy Head, at Lead Geo, of two varieties. The first forms a coating upon Psilomelane, and has a reticulated and stalactitic surface, of a greenish or ochry tint. Its fibrous surface is purplish-brown; it has a tremulous lustre, and its powder is ochry brown —Anal. 1. The second variety has a brilliant glossy black surface ("Black Hæmatite"); it is often stalactitic, and occasionally coats sandstone directly. Powder, ochre yellow—Anal. 2. In veins cutting flags of the Old Red Sandstone, near the manse of Hoy, in mammillated coatings over reddle.

Hebrides—Islay. Lossit Hill (Greg).

Argyllshire—Kintyre. At the Largybaan Caves, with Siderite, in very fine specimens.

Lanarkshire. At Leadhills, and Cumberhead (Greg).

The second variety may be noticed as occurring at the east side of Alsat Hill, in Banffshire, on the west side of the road which passes from the Laoch mines to Cock Bridge. The structure here is from massive, foliated, to pitch-like, in the richer varieties. It varies much in composition at the different pits—Anals. 3 and 4. In Kincardine, at Garron Point, the only ore at present seen is a laminated clay-iron ore of an ochre-brown colour—Anal. 5. Yellow ochre is found at the north Hill of Scullion Gour, at Campsie, and at † Glencart, Dalry, Ayrshire. Columnar clay-ironstone occurs in Arran.

The third variety may be noted—Pea Iron Ore. Shetland, at Papa Stour, and near Galston, in Ayrshire. Button Iron Ore, in Perthshire, at Glen Quaich, and nodular in Chloritic Quartz, Stob a' Choin, Loch Katrine. Button Ore, in the bed of the Esk, near † Picket Craig, in nodules from the size of a bean to that of a golf ball. Lanark, near † Edward's Hall, Rawhead Moor. Roxburghshire, in a limestone quarry in the hill above Bedrule, west of Jedburgh, with crystallised Calcite and Jasper (Nicol). Berwick, at † Atherston Ford. Silicious and massive at Macringan's Point, Campbelton Loch, with earthy Malachite (?).

Bog Iron Ore is so universally distributed throughout peat bogs, and the iron once extracted therefrom was so inferior, that it does not call for notice.

Pseudomorphs of Limonite after Pyrite, *a d o*, occur at Bre Brough Hoy, and also after Pyrite in the Bay Vein, Wanlockhead (Wilson). After Marcasite, near an old lead mine at Stromness, Orkney.

55. Limnite (260a). $Fe_2O_3, 3H_2O$.

Massive in veins, or stalactitic; also as a yellow ochre. Physical and chemical characters the same as those of Limonite, but with a pitchy lustre and a brown-black colour. Brittle.

Comp., Ferric oxide, 74·8; Water, 25·2; but sometimes a bog ore, and then with phosphoric and organic acids.

Occurs in narrow veins absolutely *per se* at the Leadhills.

56. Brucite (262). MgO, H_2O.

Rhombohedral. R., 82° 22′. Crystals broad tabular. Also foliated and botryoidal columnar. Clv., basal, eminent; folia flexible. Rarely fibrous; fibres flexible and elastic. *Nemalite*. Lustre, pearly on cleavage face; waxy on others. Translucent. The fibres silky. Colour, white, inclining to grey, blue, and green. Streak, white. Sectile. H., 2·5; G., 2·3 to 2·4.

B.B. infusible; emits a brilliant light, and reacts alkaline. With cobalt solution gives the violet-red of magnesia. In closed tube gives off water, becoming white and friable, sometimes grey. Sol. in acids without effervescence. After exposure becomes more or less carbonated and dull.

	MgO.	FeO.	MnO.	CuO.	H_2O.	Total.	
1. Swinna Ness, . .	66·67	1·18	1·57	·19	30·39	100	Stromeyer.
2. ,, . .	69·75	...	...	...	30·25	100	Fyfe.
3. ,, . .	67·98	1·	57	...	30·96	100·51	Thomson.
4. ,, . .	67·99	·41	·31	tr.	30·99	99·70	Heddle.

SHETLAND—UNST. At North Cross Geo, Haroldswick, with green Talc, Magnesite, Magnetite, and Nemalite (D. and H.), at junction of serpentine with gneiss. At Swinna Ness, in veins, chiefly in plates some inches each way, rarely in traces of crystals, with Hydromagnesite, in serpentine. Also rarely in botryoidal masses, with a columnar structure. This latter structure is disposed parallel to the length of the vein. Calcite is associated with these specimens. Haaf Gruney, at the north-east extremity, with Chromite and Pyroaurite.

Nemalite occurs at North Cross Geo, in a vein in which the fibres, 1½ inches in length, lie transversely. It has a pale green colour (D. and H.). A specimen, apparently of Nemalite, from Corrycharmaig, Loch Tay, is in the Edinburgh Museum.

The specimens of "Brucite" from † Argully farm, and from the serpentine west vein at Portsoy, appear to be white Biotite.

57. **Pyroaurite (267).** Fe_2O_3, $3H_2O.6MgO$, H_2O+6H_2O.

Hexagonal. In tables and scaly plates. Lustre pearly. Translucent. Flexible somewhat. White and gold yellow. H., 2.

B.B. infusible. Does not agglutinate; yields water; becomes chocolate-brown and strongly magnetic. Soluble in s. and h. acid. Solution in last rich yellow. Comp., Ferric oxide, 23·9; Magnesia, 35·8; Water, 40·3.

	Fe_2O_3.	MgO.	H_2O.	CO_2.	Total.	
1. Haaf Gruney, . .	23·63	36·85	40·02	...	100·50	Heddle.
2. ,, ,, . .	22·45	37·57	39·51	1·03	100·56	Heddle.

SHETLAND. At the north-east extremity of Haaf Gruney, with Chromite and Brucite in yellow Serpentine, in scaly, tortuous, plates of a subfibrous or slickenside appearance, silvery white (Igelströmite). In an earthy, or, rather, saponitic, form in rents in the Chromite of Hagdale, in Unst. In golden-yellow small crystals in veins in Chromite and Serpentine in the quarries south of Nikka Vord, Unst (Currie). [See "Geognosy of Scotland," *Min. Mag.*, vol. ii. pp. 32, 33.]

58. **Psilomelane (269).** $(BaO,MnO)MnO_2+3H_2O,MnO_2+3H_2O$.

Massive and reniform. Botryoidal, stalactitic, and in drops. Structure generally subfibrous. Fracture conchoidal. Lustre submetallic. Iron black to steel grey. H., 5·5 to 6; G., 4 to 4·3.

B.B. infusible, but loses oxygen and yields water. With fluxes reacts for manganese. Soluble in h. acid with evolution of chlorine. Comp., somewhat varying, potash taking the place of baryta. Generally about 80 per cent. of Manganese oxides.

	MnO	CoO	Al_2O_3	MgO	BaO	K_2O	Na_2O	SiO_2	O	H_2O	Total.	
1. Hoy Head, fibrous, .	71·87	1·48	...	·1	14·88	·5	...	...	6·66	6·05	101·48	Heddle.
2. Hoy Head, massive vein, .	69·58	1·99	1·1	·2	14·97	·25	·26	·9	5·52	5·69	100·46	Heddle.
3. High Pirn,	76·31	·37	Cu ·54	·01	3·66	4·09	·26	2·11	9·09	4·02	100·46	Heddle.

SHETLAND. Mainland, Sandlodge mine, in stalactites, underlying Limonite. Papa Stour, at the Kirksands, at the furthest east end of the west cliff, with Wad, red Heulandite, and Stilbite (D. and H.).

ORKNEY. At Hoy Head, in Upper Old Red Sandstone; at Bre Brough, in coralloidal and minutely-columnar masses. At the Lead Geo, 200 feet over the cliff verge, in magnificent specimens. Stalactitic, botryoidal, and flat, with a subfibrous structure and G. 4·607—Anal. 1. Also in loose hemispherical drops, in cavities, with a highly-polished surface and blue-black colour. These occasionally show upon their surface apparently pseudo-forms after Quartz. When broken, the cavities are seen to be lined with Mangan-Sammat-Erz. Near this place there is a massive granular vein of a blue-black colour, and conchoidal fracture. G., 4·4—Anal. 2. In the corries of the Meadow of the Kame, in sandstone. Walls; in botryoidal specimens in sandstone, at the Echoing Rock, near Tor Ness (Plates XVIIIA. and XVIIIB.).

CAITHNESS. In Gleann Thorcaill, the head of Sandside Burn, coating fine-grained granite.

SUTHERLAND. Ben Loyal, loose lumps on the ridge between the Castle and the top of Sgor a Chonais-aite (Cunningham). Forming the cement of a breccia of quartzite near the side of the lake between the tops of Ben Fhurain and Meall na Iarloch.

ROSS-SHIRE—BEN ALLIGIN. 200 feet below the peak of Spidean Coir' an Laoigh, on its south-west side, just at the top of the corry. Massive and cementing fragmented Torridon Sandstone.

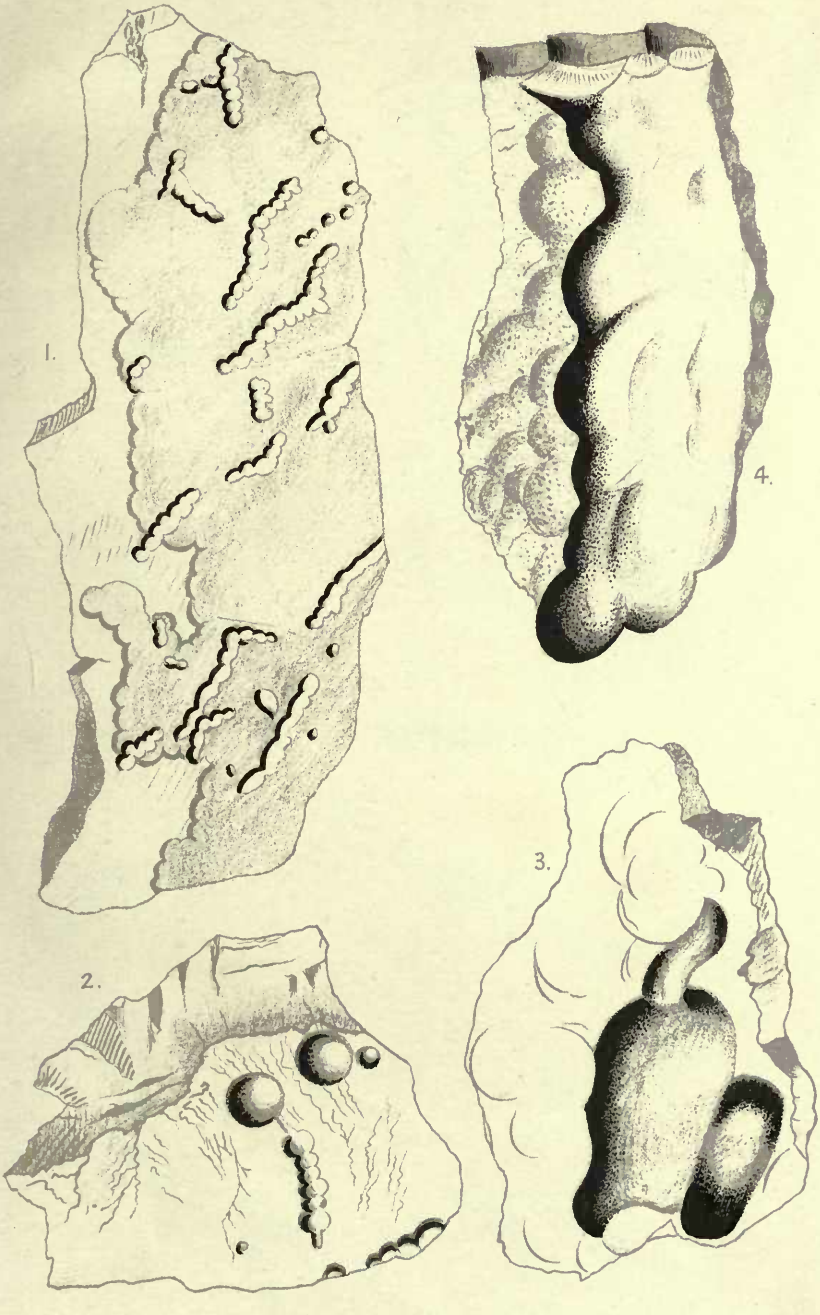
HEBRIDES. In basalt of Tertiary age in Rum (Greg).

ABERDEENSHIRE. With Manganite at Laverock Braes, Grandholm, rarely. Abergairn mines, very rarely, with Fluor, Galena, and Blende, in Quartz.

BANFFSHIRE. At the Laoch mines near Tomintoul; with Limonite, in considerable quantity.

HADDINGTON. At Fenton Tower quarry, near North Berwick, with Manganite in "felsite."

DUMBARTONSHIRE. At Old Kilpatrick, found in laying the foundations of the Established Church (Clacher), botryoidal, and glossy black.



HOY PSILOMELANES.

M. F. H. Del.

LAKE & LAKE, LITH. TRURO.

LANARKSHIRE. Leadhills, at Belton Grain vein (Wilson), and at Wanlockhead, DUMFRIESSHIRE, at the High Pirn mine (Anal. 3), with Plumbocalcite, Vanadinite, and Chrysocolla.

KIRKCUDBRIGHT. In a vein at Maxwellbank farm (Dudgeon); with crystallised Manganite, at Kinharvie, south-west of New Abbey (Dudgeon).

59. Wad (269a).

Amorphous. Occurs botryoidal, reniform, massive, impalpable granular, and investing as a froth-like coating. Lustre imperfect, sometimes metallic to dull. Colour, bluish, dull black to brown. Loosely aggregated, feels very light, and soils. Very sectile. Streak, brown, shining. Unctuous to the touch. H., 0·5 to 1; G., 2·17 to 4·26.

B.B. in closed tube yields water. Sol. in h. acid, with evolution of chlorine. Reacts like Psilomelane. Comp.: the richer varieties approach Psilomelane, but the mineral is generally a mixture, sometimes largely with Cobalt or with Copper. Is a product of decomposition, often largely impure with rock admixture. Dendritic markings on the surface of rock rents, or sometimes ramifying throughout their mass, generally consist of some such manganesian compound, carried into the rent probably by carbonated waters. The brown mochas in agates are of this nature.

SHETLAND. Sandlodge, on Siderite and Pyrite.

ORKNEY. At Lead Geo, Hoy Head, rarely, coating Psilomelane, and passing into it. Analysis:—

MnO.	CoO.	MgO.	BaO.	K_2O.	Na_2O.	Al_2O_3.	SiO_2.	O.	H_2O.	Total.
64·87 to 69·58	1·995	·199	14·97	·247	·259	1·097	·898	5·521	5·688	100·454

INVERNESS-SHIRE. At Clunie, in granitic veins, which cut gneiss 1750 feet up in the cliffs of a stream which descends from the spur on the east side of Carn Fuaralach.

ABERDEENSHIRE. In fine botryoidal masses, light brown and lustrous, half a mile west of Sylavethy quarry, Alford.

RENFREWSHIRE. In Gourock quarry, solidly plugging druses up to 6 inches wide, rarely, with acicular Göthite.

ARGYLLSHIRE. Dunoon, very impure in cavities of Quartz blocks in the Dirty [or Balgie] Burn, with Pyrite. The Quartz seemed to have come from the Bishop's Seat. This yielded—

MnO.	Fe_2O_3.	Al_2O_3.	CaO.	MgO.	K_2O.	Na_2O.	H_2O.	Insol.	Total.	
38·58	11·83	6·32	2·78	1·01	1·5	1·42	13·18	23·21	99·83	Heddle.

FIFESHIRE. At Heather Hill, Luthrie, filling centres of hollow agates, of a brown colour. Is an almost pure hydrated oxide of manganese.

Also "widely diffused, Duns" (Stevenson), and "near Lamancha Peebles."

LANARKSHIRE. At Leadhills, in fine specimens, the surfaces of which have a structure resembling the convolutions of the brain.

Blue-black and brown manganesian dendrites occur at an Old Red Sandstone quarry west of Melsetter, in South Walls. On the surface of granite rents, in Craigton quarry, Hill of Fare, Aberdeenshire. These dendrites consisted of—

Al_2O_3.	Fe_2O_3.	MnO.	MgO.	K_2O.	Na_2O.		
32·20	38·31	7·46	16·61	4·75	·68	100·01	Heddle.

STIRLINGSHIRE. At Garrel Glen, in white sandstone.

Also in a quarry to the south of Beith, Ayrshire, and in porphyry on Tinto, Lanarkshire.

Class VI. OXYGEN SALTS.

I. CARBONATES.

A. ANHYDROUS CARBONATES.

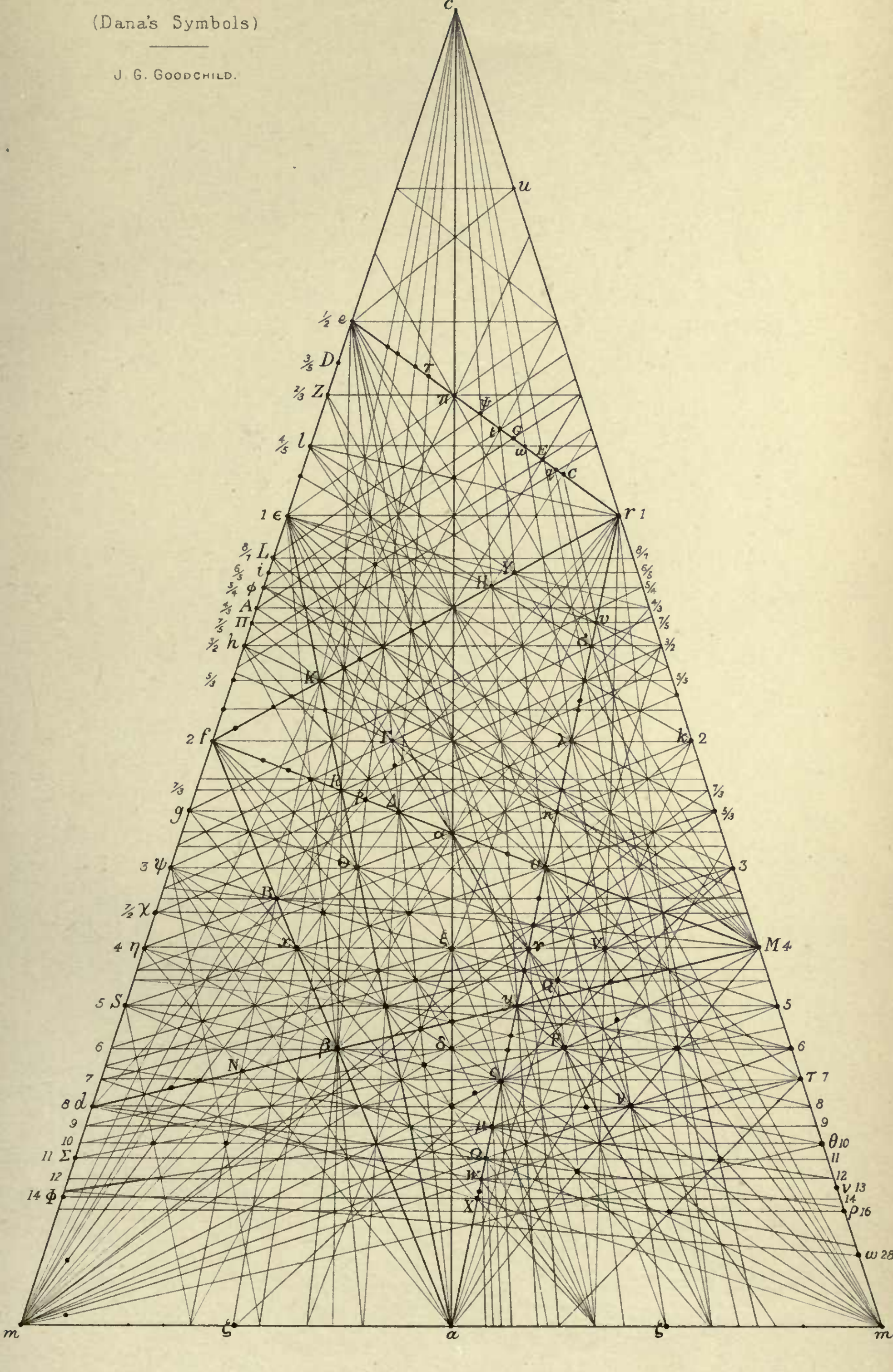
60. **Calcite (270).** $CaCO_3$.

[*o* (c), 111, 0001; *a*, $01\bar{1}$, $11\bar{2}0$; *b* (*m*), $2\bar{1}\bar{1}$, $10\bar{1}0$; ζ, $7\bar{2}\bar{5}$, $31\bar{4}0$; *m* (M), $3\bar{1}\bar{1}$, $40\bar{4}1$; *r*, 100, $10\bar{1}1$; Π, 711, $20\bar{2}3$; *u*, 211, $10\bar{1}4$; κ, 255; *e*, 001, $\bar{1}012$; *l*, $\bar{1}33$, $\bar{4}045$; ε, $\bar{1}22$, $\bar{1}011$; *i*, $\bar{7}.11.11$, $\bar{6}065$; φ, $\bar{2}33$, $\bar{5}054$; *h*, $\bar{4}55$, $\bar{3}032$; *f*, $\bar{1}11$, $\bar{2}021$; *g*, $\bar{8}77$, $\bar{5}052$; ψ, $\bar{5}44$, $\bar{3}031$; χ, $\bar{4}33$, $\bar{7}072$; η, $\bar{7}55$, $\bar{4}041$; *s*, $\bar{3}22$, $\bar{5}051$; *d*, $\bar{5}33$, $\bar{8}081$; π, 210, $\bar{2}113$; α, $51\bar{3}$, $\bar{8}443$; ξ, $71\bar{5}$, $\bar{4}221$; τ, 320, $\bar{2}.\bar{1}.3.5$; ♀, 730, $4.3.\bar{7}.10$; *t*, 810, $21\bar{3}4$; *w*, 410, $31\bar{4}5$; *q*, 610, $51\bar{6}7$; *c* (C), 710, $61\bar{7}8$; ν (υ), $60\bar{1}$, $61\bar{7}5$; σ, $50\bar{1}$, $51\bar{6}4$; *n* (*K*), $40\bar{1}$, $41\bar{5}3$; ☽, $11.0.\bar{3}$, $11.3.\bar{1}4.8$; λ, $30\bar{1}$, $31\bar{4}2$; ♃, $50\bar{2}$, $52\bar{7}3$; *v*, $20\bar{1}$, $21\bar{3}1$; δ, $70\bar{4}$, $7.4.\overline{11}.3$; ♈ (Y), $50\bar{3}$, $53\bar{8}2$; *y*, $30\bar{2}$, $32\bar{5}1$; ς, $40\bar{3}$, $43\bar{7}1$; μ ( ), $50\bar{4}$, $54\bar{9}1$; ♄ ( ), $60\bar{5}$, $6.5.\overline{11}.1$; ♎ ( ), 13.0.11, $13.11.\bar{2}4.2$; ☿

Gnomonogram of Calcite.

(Dana's Symbols)

J. G. Goodchild.



( ), $55\bar{2}$, $\bar{4}.\bar{3}.7.5$; ♁ ( ), $73\bar{3}$, $\bar{6}.\bar{4}.10.7$; ↨ ( ), $21\bar{1}$, $2.\bar{1}.3.1$; ♌ ( ), $95\bar{5}$, $\overline{10}.\bar{4}.14.9$; ♂ (*B*), $53\bar{5}$, $\bar{8}.\bar{2}.10.3$; *x*, $21\bar{2}$, $\bar{3}\bar{1}41$; β (*F*), $31\bar{3}$, $\bar{4}\bar{2}61$; ⊙ ( ), $53\bar{4}$, $\bar{7}\bar{2}94$; ρ (*R*), $42\bar{3}$, $\bar{5}\bar{2}73$; *p* ( ), $73\bar{5}$, $\bar{8}.\bar{4}.12.5$; ♉ ( ), $31\bar{2}$, $\bar{3}\bar{2}51$; γ ( ), $52\bar{3}$, $\bar{5}\bar{3}84$; θ (Θ), $52\bar{4}$, $\bar{2}\bar{1}31$; *z* (Q), $15\,\bar{1}\,\bar{9}$, $16.8.\overline{24}.5$; (Σ), $44\bar{7}$, $0.11.\overline{11}.1$; (Φ), 559, $0.14.\overline{14}.1$.

In addition to the foregoing symbols, the following are occasionally employed in Dr Heddle's description of Calcite:—

(Ω) [the scalenohedral face in the zone *a v r e*, denoted by this letter in figure 26 of Calcite in the Sixth Ed. of Dana]; G (of Des Cloizeaux), $13.1.\overline{11}$, $44\bar{8}1$, 8P2; L, $91\bar{7}$, $8.8.\overline{16}.3$; $e^{\frac{6}{7}}$, $77\bar{6}$, $\overline{13}.0.13.8$; e^4, (*k*), $11\bar{4}$, $50\bar{5}\bar{2}$; e^6, $11\bar{6}$, $70\bar{7}4$; $e^{\frac{3}{4}}$, $44\bar{3}$, $\bar{7}075$; $e^{\frac{9}{5}}$, or *s*, *k*, (Φ), $55\bar{9}$, $\overline{14}.0.14.1-14$ R; $e^{\frac{6}{5}}$, $55\bar{6}$, $\overline{11}.0.11.4$; $e^{\frac{5}{3}}=d$ of Miller; $e^{\frac{3}{2}}=s$ of Miller; $e_{\frac{1}{4}}$, $41\bar{4}$, $\bar{5}\bar{3}81$; $e^{\frac{11}{4}}$, $4.4.\overline{11}$, $50\bar{5}1$, $+5$ R; $e^{\frac{9}{4}}$, $9\bar{4}\bar{4}$, $13.0.\overline{13}.1+13$ R; $e^{\frac{4}{3}}$, χ of Miller; $e^{\frac{1}{3}}$, *l* of Miller; $e^{\frac{5}{6}}$, $66\bar{5}$, $\overline{11}.0.11.7$; $e^{\frac{8}{7}}$, *g* of Miller; $e^{\frac{5}{2}}$, $52\bar{2}$, $70\bar{7}1$; $b^{\frac{5}{3}}$, 530, $\bar{3}\bar{1}48$; $d^{\frac{7}{6}}$, $70\bar{6}$, $7.6.\overline{13}.1$; $e_{\frac{4}{3}}$, $\bar{6}\bar{1}74$; $e^{\frac{2}{3}}=\phi$ of Miller; $e^{\frac{11}{5}}$, $11.\bar{5}.\bar{5}$, $16.0.\overline{16}.1$, (ρ)+ 16 R; $e^{\frac{19}{9}}$ (ω), + 28 R, $28.0.\overline{28}.1$; $d^{\frac{7}{16}}$, (ν)+R 13, $7.6.\overline{13}.1$; $d^{\frac{6}{5}}$, = ♄ of Miller, +11 R, $6.5.\overline{11}.1$; ψ, θ, Q, ϵ, of Des Cloizeaux are, respectively, $\bar{7}\bar{1}81$, $\bar{2}\bar{1}31$, $\bar{3}\bar{1}42$, and $\bar{8}.\bar{5}.13.3$; i, of Haüy, $11\bar{6}$, $70\bar{7}4$, $=e^6$ of Des Cl.]

Rhombohedral, $r \wedge r$ over terminal edge, 105° 5′; over lateral edge, 180°; $o \wedge r$, 135° 23′.

The forms group into five types:—

1. Rhombohedra.
2. Scalenohedra.
3. Regular six-sided pyramids.
4. Prisms.
5. Basal plane.

1. Rhombohedra (two sets).

First.—Forms whose planes are in the same vertical zone with *r-o r m b*. Of these nineteen are known, and they range from one so obtuse that its vertical axis is one-fourth that of *r*, relatively to the lateral axes (*u*), to one so acute that it is twenty-eight times the length of that of *r* (ω). This is termed the *Plus* series.

Second—the *Minus* series.—This is in an inverse position—that is, its planes lie in the same zone with ϵ (the inverse rhombohedron to *r*)—zone *o e ε f b*. Of these thirty-four are known, and they range from a vertical axis one-tenth that of *r* ( ) to one seventeen times its length ( ).

The fundamental rhombohedron is uncommon, except in combination; the only common simple forms in the *plus* series being *m* and *u*.

In the *minus* series the inverse form to r is still more uncommon than is the primary, but e, which truncates the terminal edges of the primary, and which is termed "nail head," is exceedingly common, both simple and in combination, as are also the forms f and d.

Of common *plus* rhombohedra we have u, r, m, and of negative, e, f, d.

Now u	truncates	the terminal	edges of	e,
e	"	"	"	r,
r	"	"	"	f,
f	"	"	"	m,
m	"	"	"	a,
d	"	"	"	$e^{\frac{11}{5}}$ an acute *plus* form.

The relationship of these forms is further evidenced by the "Structure Planes" being situated parallel to three of these:—

1. The Gleit face, or direction of *molecular* instability (along which direct pressure, by the polar revolution of one or more layers of molecules, produces twin laminæ of excessive tenuity). This plane is parallel to the faces of the form e.

2. The Cleavage face, or direction of *cohesive* weakness (along which a crystal rends when a disruptive force is applied to it at certain sides). This plane is parallel to the faces of the form r.

3. The Solution plane, or direction of *chemical* weakness (along which water or other solvents act in preference to, and with greater rapidity than, along other planes). This plane is parallel to the faces of the form f.

Rhombohedra may be considered as derivable from hexagonal pyramids by a suppression of the alternate planes, and the extension of those remaining. The suppression of one set of such planes would produce the *plus* set of such rhombohedra; the suppression of the other would produce the *minus* set. The fact that these sets alternate, rather than coexist, is a strong argument against the crystalline form of calcite being referred to the Hexagonal System.

The two series of rhombohedra, so far as at present known, together with the symbols employed to denote them, are as follows:—

[In the following tables Des Cloizeaux's symbols of the zone faces were compiled from the stereographic projection of Calcite in that author's *Manuel de Mineralogie*, Paris, 1874; the angles given are from the same work. The Bravais symbols, and also Goldschmidt's letters, are from Goldschmidt's *Index der Krystallformen der Mineralien*, Berlin, 1886. Miller's symbols and letters are from Phillips' edition of Brooke and Miller's *Mineralogy*, London, 1852; and Dana's letters, and his symbols (given in the descriptive part in parentheses), are from the 6th edition of the *System of Mineralogy*, 1892.]

Plus Series.						Minus Series.					
Zone *b m r o.*						Zone *b d f ϵ e o.*					
M.	G.	Da.	Br.	Des.	Angle over *o.*	Angle over *o.*	Des.	Br.	Da.	G.	M.
						174°·22		1.0.1.10	$-\frac{1}{10}$	8	
						168°·50	$a^{\frac{1}{2}}$	$\bar{1}015$	$-\frac{1}{5}$	α	
u, 211	d.	$u\frac{1}{4}$	$10\bar{1}4$	a^2	166°·09	166°·09	$a^{\frac{2}{5}}$	$\bar{1}014$	$-\frac{1}{4}$	9	
						160°·57		$\bar{7}.0.7.20$	$-\frac{7}{20}$	β	
	e	$\frac{2}{5}$	$20\bar{2}5$	a^3	158°·28	158°·28	$a^{\frac{1}{7}}$	$\bar{2}025$	$-\frac{2}{5}$	γ	
	f	$\frac{1}{2}$	$10\bar{1}2$	a^4	153°·45	153°·45	b^1	$\bar{1}012$	e, $-\frac{1}{2}$	δ	*e*, 011
	g.	$\frac{4}{7}$	$40\bar{4}7$	a^5	150°·35						
Π, 711	h.	$\pi\frac{2}{3}$	$20\bar{2}3$	a^7	146°·40	146°·40	$e^{\frac{1}{5}}$	$\bar{2}023$	Z, $-\frac{2}{3}$	ζ	
						141°·43	$e^{\frac{1}{3}}$	$\bar{4}045$	*l*, $-\frac{4}{5}$	η	*l*, $\bar{1}33$
						139°·12	$e^{\frac{2}{5}}$	$\bar{7}078$	$-\frac{7}{8}$	ϑ	
r, 100		1 R	$10\bar{1}1$	p	135°·23	135°·23	$e^{\frac{1}{2}}$	$\bar{1}011$	ϵ, -1	χ	ϵ, $\bar{1}22$
						131°·35	$e^{\frac{3}{5}}$	$\bar{8}087$	L, $-\frac{8}{7}$	λ	
						130°·11	$e^{\frac{7}{11}}$	$\bar{6}065$	i, $-\frac{6}{5}$	μ	*i*, $\bar{7}.11.11$
						129°·02	$e^{\frac{2}{3}}$	$\bar{5}054$	ϕ, $-\frac{5}{4}$	ν	ϕ, $\bar{2}33$
						127°·15	$e^{\frac{5}{7}}$	$\bar{4}043$	A, $-\frac{4}{3}$	ξ	
						125°·58	$e^{\frac{3}{4}}$	$\bar{7}075$	Π, $-\frac{7}{5}$	π	
						124°·03	$e^{\frac{4}{5}}$	$\bar{3}032$	h $-\frac{3}{2}$	ρ	*h*, $\bar{4}55$
						122°·49	$e^{\frac{5}{6}}$	$\bar{11}.0.11.7$	$-\frac{11}{7}$	*s*	
						121°·58	$e^{\frac{6}{7}}$	$\bar{13}.0.13.8$	$-\frac{13}{8}$	τ	
						120°·05		[?]	$-\frac{9}{5}$ [*s*]	A	[?]
						116°·52	e^1	$\bar{2}021$	f -2	ϕ	*f*, $\bar{1}11$
						114°·15	$e^{\frac{14}{13}}$	$\bar{9}094$	$-\frac{9}{4}$	X	
						? 112°·56	$e^{\frac{19}{17}}$	?	$-\frac{12}{5}$		
	k	$\frac{5}{2}$	$50\bar{5}2$	e^4	112°·4	112°·04	$e^{\frac{8}{7}}$	$\bar{5}052$	g $-\frac{5}{2}$	ψ	*g*, $\bar{8}77$
						110°·14	$e^{\frac{6}{5}}$	$\bar{11}.0.11.4$	$-\frac{11}{4}$	ω	
	l	3	$30\bar{3}1$	$e^{\frac{7}{2}}$	108°·40	108°·40	$e^{\frac{5}{4}}$	$\bar{3}031$	ψ $-$ 3R	Γ	ψ, $\bar{5}44$
		$\frac{13}{4}$	$14.0.\bar{14}.3$	$e^{\frac{10}{3}}$	107°·20 ?						
						106°·09	$e^{\frac{4}{3}}$	$\bar{7}072$	χ $-\frac{7}{2}$	Δ	χ, $\bar{4}33$
m, $3\bar{1}\bar{1}$	m	*M*, 4	$40\bar{4}1$	e^3	104°·13	104°·13	$e^{\frac{7}{5}}$	$\bar{4}041$	η -4	Θ	η, $\bar{7}55$
						102°·42	$e^{\frac{16}{11}}$	$\bar{9}092$	$-\frac{9}{2}$	Λ	
	n.	5	$50\bar{5}1$	$e^{\frac{11}{4}}$	101°·28	101°·28	$e^{\frac{3}{2}}$	$\bar{5}051$	*S* -5	Ξ	*s*, $\bar{3}22$
	o.	$\frac{11}{2}$	$11.0.\bar{11}.3$	$e^{\frac{8}{3}}$	100°·27						
	p.	6	$60\bar{6}1$	$e^{\frac{13}{5}}$	99°·35	99°·35			-6		
	q.	τ, 7	$70\bar{7}1$	$e^{\frac{5}{2}}$	98°·14						
						97°·13	$e^{\frac{5}{3}}$	$\bar{8}081$	d -8	Π	*d*, $\bar{5}33$
						96°·25		$\bar{9}091$	-9	B.	

Plus Series.						Minus Series.					
Zone $b\ m\ r\ o$.						Zone $b\ d\ f\ \epsilon\ e\ o$.					
M.	G.	Da.	Br.	Des.	Angle over o.	Angle over o.	Des.	Br.	Da.	G.	M.
	r	ϑ, 10	$10.0.\overline{10}.1$	$e^{\frac{7}{3}}$	95°·47						
						95°·16	$e^{\frac{7}{4}}$	$\overline{11}.0.11.1$	$\Sigma - 11$	Σ	
	s	ν, 13	$13.0.\overline{13}.1$	$e^{\frac{9}{4}}$	94°·28						
						K, Haüy 94°·8	$e^{\frac{9}{5}}$	$\overline{14}.0.14.1$	$\Phi - 14$	Φ	
	t	ρ, 16	$16.0.\overline{16}.1$	$e^{\frac{11}{5}}$	93°·38						
						93°·25	$e^{\frac{11}{6}}$	$\overline{17}.0.17.1$	-17	Ψ	
		w	$18.0.\overline{18}.1$		93°·13						
	u		$19.0.\overline{19}.1$								
	z	ω, 28	$28.0.\overline{28}.1$	$e^{\frac{19}{9}}$	92°·4						

It will be seen that about one-fourth of the minus forms are inverse.

Forms which *bevel* the lateral and the terminal edges of the more commonly-occurring rhombohedra constitute (since they fall into the same zone) a series of *scalenohedra*. By far the greater number of these fall into—

a. The edge-zone of the Primitive;
b. The horizontal diagonal zone of the faces of that form.

In like manner as rhombohedra may be considered as hemihedral developments of hexagonal pyramids, may scalenohedra be regarded as hemihedral developments of di-hexagonal pyramids; but in scalenohedra the occurrence of inverse forms is even rarer than in the case of rhombohedra.

a. Scalenohedra of the first zone: *i.e.*, with planes bevelling the lateral edges of r, and so lying in the zone $a\ r\ e$. These, when extended to e, form a complete *plus* series. In Dana's symbols, 1 signifies that they are related to the rhombohedron 1 R,—the annexed number signifies or indicates the length of the vertical axis as compared with that of 1 R.

There is also a *minus* series, whose planes bevel the lateral edges of ϵ the inverse rhombohedron to r, and which thus lie in the zone $a\ \theta\ \epsilon\ a^4$, -1 having the same relation to rhombohedron -1 R.

z. SCALENOHEDRA (Zone *a r e*).

Zone *e a* over *r*.						Inverse a^4 over ϵ to *a*.					
M.	G.	Da.	Br.	Des.	Angle over *a*.	Angle over *a*.	Des.	Br.	Da.	G.	M.
	zz :			$b^{\frac{5}{4}}$	50°·13						
τ, 320	z :		$\bar{2}\bar{1}35$	$b^{\frac{3}{2}}$	54°·3						
	y :		$\bar{3}\bar{1}48$	$b^{\frac{5}{3}}$	56°·6						
π, 210				b^2	59°·18						
♀, 730	x :		$4.3.\bar{7}.10$	$b^{\frac{7}{3}}$	61°·42						
	v :		$7.4.\bar{11}.15$	$b^{\frac{11}{4}}$	63°·53						
t, 310	t :		2134	b^3	64°·54						
	g :		$52\bar{7}9$	$b^{\frac{7}{2}}$	66°·30						
w, 410	w :		$31\bar{4}5$	b^4	67°·41						
	f :		$7.2.\bar{9}.11$	$b^{\frac{9}{2}}$	86°·35						
	e :		$41\bar{5}6$	b^5	69°·18						
q, 610	q :		$51\bar{6}7$	b^6	70°·21						
	α :		$13.2.\bar{13}.15$	[?]$b^{\frac{13}{2}}$							
c, 710	c :		$61\bar{7}8$	b^7	71°·5						
	b :		$71\bar{8}9$	b^8	71°·37						
	a :		$8.1.\bar{9}.10$	b^9	72°·27						
	β :		$9.1.\bar{10}.11$	[?] b^{10}							
	d :		$13.1.\bar{14}.15$	[?] b^{14}	73°·9						
r, 100	p	1	$10\bar{1}1$	p	74°·55	74°·55	$e^{\frac{1}{2}}$	$\bar{1}011$	ϵ, − 1	χ	ϵ, $\bar{1}22$
	A :		$11.1.\bar{12}.10$								
	B :	$1^{\frac{19}{16}}$	$17.2.\bar{19}.15$	$d^{\frac{17}{2}}$	88°·17						
	C :	$1^{\frac{4}{3}}$	$71\bar{8}6$	d^7	91°·13						
	γ :		$19.3.\bar{22}.16$								
ν, $60\bar{1}$	D :	υ, $1^{\frac{7}{5}}$	$61\bar{7}5$	d^6	94°·1						
σ, $50\bar{1}$	E :	σ, $1^{\frac{3}{2}}$	$51\bar{6}4$	d^5	97°·57						
n, $40\bar{1}$	F :	n, $1^{\frac{5}{3}}$	$41\bar{5}3$	d^4	103°·52	103°·52	$e^{\frac{3}{2}}$	$\bar{4}153$	*K*-$1^{\frac{5}{3}}$	𝔤 :	
	δ :	$1^{\frac{12}{7}}$	$19.5.\bar{24}.14$								
☽, $11.0.\bar{3}$		$1^{\frac{7}{4}}$	$11.3.\bar{14}.8$	$d^{\frac{11}{3}}$	106°·34						
	G :	$1^{\frac{9}{5}}$	$72\bar{9}5$	$d^{\frac{7}{2}}$	108°·6	108°·6	Λ	$\bar{7}295$		Λ	
λ, $30\bar{1}$	H :	λ, 1^2	$31\bar{4}2$	d^3	113°·45	113°·45	Q	$\bar{3}142$		Q	
♃, $50\bar{2}$	J :	$1^{\frac{7}{3}}$	$52\bar{7}3$	$d^{\frac{5}{2}}$	121°·33	121°·33	ρ	$5\bar{2}73$	R − $1^{\frac{7}{3}}$	𝔊	ρ, $42\bar{3}$
v, $20\bar{1}$	K :	υ, 1^3	$21\bar{3}1$	d^2	132°·59	132°·59	Θ	$\bar{7}294$		𝔗	⊙, $53\bar{4}$
	L :	$1^{\frac{13}{4}}$	$17.9.\bar{26}.8$	$d^{\frac{17}{9}}$	136°·14						
	ϵ :		$9.5.\bar{14}.4$								
δ, $70\bar{4}$	M :	$1^{\frac{11}{3}}$	$7.4.\bar{11}.3$	$d^{\frac{7}{4}}$	140°·49						
♈, $50\bar{3}$	N :	ϒ, 1^4	$53\bar{8}2$	$d^{\frac{5}{3}}$	143°·51						
	O :	$1^{\frac{13}{3}}$	$8.5.\bar{13}.3$	$d^{\frac{8}{5}}$	146°·29	146°·29	ϵ	$\bar{8}.\bar{5}.13.3$		43	

Zone $e\ a$ over r.						Inverse a^4 over ϵ to a.					
M.	G.	Da.	Br.	Des.	Angle over a.	Angle over a.	Des.	Br.	Da.	G.	M.
y, $30\bar{2}$	P :	y, 1^5	$32\bar{5}1$	$d^{\frac{3}{2}}$	150°·44	150°·44	ψ	$\bar{7}181$			
	Q :	$1^{\frac{16}{3}}$	$19.13.\bar{32}.6$	$d^{\frac{19}{13}}$	153°·30						
	R :	$1^{\frac{17}{3}}$	$10.7.\bar{17}.3$	$d^{\frac{10}{7}}$	154°·03						
	ζ :	1^6	$7.5.\bar{12}.2$	[?] $d^{\frac{7}{5}}$							
	S :	$1^{\frac{19}{3}}$	$11.8.\bar{19}.3$	$d^{\frac{11}{8}}$	156°·43						
	η :	$1^{\frac{20}{3}}$	$23.17.\bar{40}.6$								
s, $40\bar{3}$	T :	s, 1^7	$43\bar{7}1$	$d^{\frac{4}{3}}$	158°·53						
	ϑ :		$9.7.\bar{16}.2$	[?] $d^{\frac{9}{7}}$							
μ, $50\bar{4}$	U :	μ, 1^9	$54\bar{9}1$	$d^{\frac{5}{4}}$	163°·30						
♄, $60\bar{5}$	V :	Ω, 1^{11}	$6.5.\bar{11}.1$	$d^{\frac{6}{5}}$	166°·28						
♎, $13.0.\bar{11}$	W :	W, 1^{12}	$13.11.\bar{24}.2$	$d^{\frac{13}{11}}$	167°·35						
	X :	X, 1^{13}	$7.6.\bar{13}.1$	$d^{\frac{7}{6}}$	163°·32						
	τ :	1^{16}	$17.15.\bar{32}.2$								
	Y :	1^{17}	$9.8.\bar{17}.1$		171°·13						
a, $01\bar{1}$	2	$a\ i^2$	$1.1.\bar{2}0$	d^1		Here all the forms of the *minus* series are inverse to the positive.					

The relations of the previously-mentioned forms to these scalenohedra are:—

a truncates the lateral edges of all;
rhombohedron m truncates the obtuse angle of y;
rhombohedron $e^{\frac{5}{3}}$ [d] truncates the acute angle of y;
" e^4 " " obtuse " λ;
" $e^{\frac{4}{3}}$ [χ] " " acute " λ;
a^3 and a^4 truncate the terminal edges of τ and π respectively.
The acute lateral angle of ϵ [of Des Cloizeaux] is truncated by e_4,($\bar{6}174$).
" " " θ is truncated by $e^{\frac{19}{17}}$ [? by $e^{\frac{8}{7}}$, g, $\bar{8}77$].
The acute edge of v is bevelled by a numerous series of faces.
" " of y " " by four faces, and its obtuse by two.
The most commonly-occurring scalenohedra, y, v, and λ, are represented in the inverse series by the ψ, θ, and Q [of Des Cloizeaux] respectively.

b. SCALENOHEDRA of the second zone, that is to say, with planes bevelling both the lateral and the terminal edges of f (e^1 Descl.),—or in the horizontal diagonal line of r:—zone $a\,x\,f\,r$. In the inverse position, the zone to ϵ ($e^{\frac{1}{2}}$ Descl.) (the inverse of r). As there is no inverse to rhombohedron *f* there cannot be said to be any inverse scalenohedral series.

M.	G.	Da.	Br.	Des.	Angle over *a*.	Angle over *a*.	Des.	Br.	Da.	G.	M.
	$\mathfrak{r}$		$\bar{5}\bar{3}81$	$e_{\frac{1}{4}}$	156°·46						
β, $31\dot{3}$	$\mathfrak{q}$:	$\beta - \frac{2}{3}$	$\bar{4}\bar{2}61$	$e_{\frac{1}{3}}$	149°·21	149°·21D.					
			$\bar{7}.\bar{3}.10.2$	$e_{\frac{2}{5}}$	143°·36						
x, $21\bar{2}$	$\mathfrak{p}$:	$x - 2^2$	$\bar{3}\bar{1}41$	$e_{\frac{1}{2}}$	135°·18						
δ, $53\bar{5}$	$\mathfrak{o}$:		$\bar{8}.\bar{2}.10.3$	$e_{\frac{3}{5}}$	127°·39						
	$\mathfrak{n}$:		$\bar{5}0\bar{6}2$	$e_{\frac{2}{3}}$	122°·23						
f, $\bar{1}11$	ϕ	$f - 2$	$\bar{2}021$	e_1	107°·45		d^4				
	$\mathfrak{m}$:		$\bar{16}.\bar{1}.17.9$	$e_{\frac{9}{8}}$	102°·32						
	$\mathfrak{l}$:		$\bar{8}\bar{1}95$	$e_{\frac{5}{4}}$	103°·22						
	$\mathfrak{i}$:		$\bar{6}\bar{1}74$	$e_{\frac{4}{3}}$	103°·41						
	$\mathfrak{g}$:	K − $1\frac{5}{3}$	$\bar{5}\bar{1}62$	$e_{\frac{3}{2}}$	103°·52						
☊ $95\bar{5}$	$\mathfrak{k}$:		$\bar{10}.\bar{4}.14.9$	$e_{\frac{9}{5}}$	103°·14						
⸸ $21\bar{1}$	$\mathfrak{e}$:		$\bar{2}\bar{1}31$	e_2	102°·25						
♁ $73\bar{3}$	$\mathfrak{d}$:		$\bar{6}.\bar{4}.10.7$	$e_{\frac{7}{3}}$	100°·47						
☿ $52\bar{2}$	$\mathfrak{c}$:		$\bar{4}.\bar{3}.7.5$	$e_{\frac{5}{2}}$	99°·56						
				e_3	97°·26		e^3				
				e_4	93°·20						
				e_5	90°·20						
r 100	p.	*m* I	$10\bar{1}1$	*p*							

With planes having the same relation to $m(e^3)$; *i.e.*, bevelling the lateral and terminal edges; or, if referred to the fundamental rhombohedron, replacing its lateral angles.

Zone *a m v f*. This replaces the lateral angles of *f*; and bevels the acute angle of rhombohedron *r* and the transverse diagonal of *f*.

M.	G.	Da.	Br.	Des.	Angle over *a*.
			$\bar{23}.\bar{2}.25.12$	X	106°·50
	$\mathfrak{B}$:		$\bar{9}.\bar{2}.11.5$	T	114°·14
⊙, $53\bar{4}$	$\mathfrak{C}$:		$\bar{7}\bar{2}94$	Θ	117°·8
	$\mathfrak{D}$:		$\bar{12}.\bar{4}.16.7$	ω	119°·6
ρ, $42\bar{3}$	$\mathfrak{E}$:		$\bar{5}\bar{2}73$	ρ	121°·33
p, $73\bar{5}$	$\mathfrak{F}$:		$\bar{8}.\bar{4}.12.5$	π	124°·40
♉, $31\bar{2}$	$\mathfrak{G}$:		$\bar{3}\bar{2}51$	♉	128°·30
				χ	131°·19
a, $51\bar{3}$	a	a, $\frac{8}{2} - 2$	$44\bar{8}3$	a	132°·36
	$\mathfrak{H}$:		$12.8.\bar{20}.7$	□	133°·53
v, $20\bar{1}$	K:	v, 1^3	$2.1\bar{3}.1$	d^2	132° 59
m, $3\bar{1}\bar{1}$	m	*M*, 4	$40\bar{4}1$	e^3	1
	$\mathfrak{P}$:		$51\bar{6}1$	x	133°·19
	$\mathfrak{S}$:	$V\ 4^2$	$628\bar{1}$	v	144°·8
	$\mathfrak{K}$:		$8.4.\bar{12}.1$	y	155°·39
a, $10\bar{1}$	q	a, $i - 2$	$11\bar{2}0$	d^1	

With planes having the same relations to *d* ($e^{\frac{5}{3}}$):—

Zone *a d β y m*.

M.	G.	Da.	Br.	Des.	Angle over *a*.
a, $01\bar{1}$		*a*	$11\bar{2}0$	d^1	
	ʒ:		$\bar{9}.\bar{1}.10.1$	n	129°·3
d, $\bar{5}33$	п	*d*,	$\bar{8}081$	$e^{\frac{5}{3}}$	
	34		$\bar{44}.\bar{6}.50.7$	μ	129°·48
	𝔏:		$\bar{6}171$	λ	132°·1
	𝔛:		$\bar{16}.\bar{4}.20.3$	N	137°·33
β, $31\bar{3}$	q:		$\bar{4}261$	$e_{\frac{1}{3}}$	149°·21
	33		$\bar{6}.\bar{5}.11.2$	φ	155°·16
	γ		$8.8.\bar{16}.3$	L	155°·14
y, $30\bar{2}$	P:	*y*	$32\bar{5}1$	$d^{\frac{3}{2}}$	150°·44
z, $15.\bar{1}.\bar{9}$	𝔅:		$16.8.\bar{24}.5$	z	145°·29
	𝔘:		$24.8.\bar{32}.7$	Ω	137°·48
m, $3\bar{1}\bar{1}$	m	M	$40\bar{4}1$	e^3	

With planes having the same relation to *e* (b′):—

Zone *a* ↥ *e u*.

M.	G.	Da.	Br.	Des.	Angle over *a*.
a, $01\bar{1}$	q	*a*	$11\bar{2}0$	d^1	
	g:		$\bar{7}.\bar{6}.13.2$	Δ	158°·59
	33		$\bar{6}.\bar{5}.11.2$	φ	155°·16
	ꝺ:		$\bar{5}492$	β	150°
	69		$\bar{13}.\bar{5}.18.5$	q	141°·59
ȣ, $31\bar{2}$	𝔔:		$\bar{3}251$	ȣ	129°·30
				τ	121°·49
γ, $52\bar{3}$	ƀ:		$\bar{5}384$	γ	117°·50
↥, $21\bar{1}$	𝔠:		$\bar{2}131$	e_2	102°·25
	32		$\bar{18}.\bar{5}.23.15$	σ	88°·07
e, 011	δ.	*e*	$\bar{1}012$	b^1	
u, 211	d.	*u*	$10\bar{1}4$	a^2	

With planes which truncate the edges of *f* in the zone *b y ξ θ f* λ.

M.	G.	Da.	Br.	Des.	Angle over *a*.
b, $2\bar{1}\bar{1}$	b	*m*	$10\bar{1}0$	e^2	
	𝔍:		$62\bar{8}1$	v	144°·08
	T		$42\bar{6}1$	D	149°·21
y, $30\bar{2}$	P:	*y*	$32\bar{5}1$	$d^{\frac{3}{2}}$	150°·44
ξ, $71\bar{5}$	ξ	ξ	$22\bar{4}1$	ξ	147°·23
	69		$1\bar{3}.\bar{5}.18.5$	q	141°·59
θ, $52\bar{4}$	Θ	Θ	$\bar{2}131$	θ	132°·59
f, $\bar{1}11$	φ	f−	$\bar{2}021$	e^1	
	Q		$\bar{3}142$	Q	113°·45
	W		$\bar{7}3.10.5$	χ	115°·39
γ, $52\bar{3}$	b:	Γ	$\bar{5}384$	γ	
[?] ♈, $50\bar{3}$	N:	ϒ, 1⁴	$53\bar{8}2$	[?] $d^{\frac{5}{3}}$	117°·50
λ, $30\bar{1}$	H:	λ	$31\bar{4}2$	d^3	113°·45

With planes in the zone *b x θ* ♉ *r*.

M.	G.	Da.	Br.	Des.	Angle over *a*.
b, $2\bar{1}\bar{1}$	q	*m*	$10\bar{1}0$	e^2	
	39		$\bar{30}.\bar{1}.31.1$	B	123°·8
	𝔍:		$\bar{9}.\bar{1}.10.1$	n	129°·3
	𝔏:		$\bar{6}.\bar{1}.7.1$	λ	132°·1
x, $21\bar{2}$	𝔓:	*x*	$\bar{3}141$	$e_{\frac{1}{2}}$	135°·18
	69		$\bar{13}.\bar{5}.18.5$	q	135°
	𝔇:		$\bar{12}.\bar{4}.16.7$	ω	134°·49
θ, $52\bar{4}$	Θ	Θ	$\bar{2}131$	θ	132°·59
♉, $31\bar{2}$	𝔊:	--	$\bar{3}251$	♉	128°·30
r, 100	p.	*R*	$10\bar{1}1$	p	

With planes in the zone $b\,\beta\,\xi\,v$.

M.	G.	Da.	Br.	Des.	Angle over *a*.
b, $2\bar{1}\bar{1}$	b	*m*	$10\bar{1}0$	e^2	
	46		$\bar{8}.\bar{2}.10.1$	η	139°·50
β, $31\bar{3}$	𝔮:	β	$\bar{4}\bar{2}61$	$e_{\frac{1}{3}}$	149°·21
	W		$\bar{7}\bar{3}.10.5$	χ	150°·44
	d:		$\bar{5}\bar{4}92$	β	150
ξ, $71\bar{5}$	ξ	ξ	$22\bar{4}1$	ξ	147°·23
v, $20\bar{1}$	K:	*v*	$21\bar{3}1$	d^2	

With planes bevelling the lateral and the terminal edges of χ ($e^{\frac{4}{3}}$); and bevelling the acute edge of scalenohedron *y* ($d^{\frac{3}{2}}$) in the zone *a y x*.

M.	G.	Da.	Br.	Des.	Angle over *a*.
χ, $\bar{4}33$	Δ.	X	$\bar{7}072$	$e^{\frac{4}{3}}$	
x, $21\bar{2}$	𝔭:		$\bar{3}\bar{1}41$	$e_{\frac{1}{2}}$	135°·18
	43		$\bar{8}.\bar{5}.13.3$	ϵ	146°·29
	d:		$\bar{5}\bar{4}92$	β	150°
	β		$7.7.\bar{14}.3$	Γ	151°·50
y, $30\bar{2}$	P:	*y*	$32\bar{5}1$	$d^{\frac{3}{2}}$	150°·44
	53		$12.4.\bar{16}.3$	[?] Σ	140°·8
	𝔓:		$51\bar{6}1$	x	133°·19
	q.		$70\bar{7}1$	$e^{\frac{5}{2}}$	
a, $01\bar{1}$	q	*a*	$11\bar{2}0$	d^1	

With planes bevelling the lateral and the terminal edges of rhombohedron *s* ($e^{\frac{3}{2}}$); and bevelling the acute edge of scalenohedron ς ($d^{\frac{4}{3}}$). In the zone $a\,\beta\,s$:—

M.	G.	Da.	Br.	Des.	Angle over *a*.
s, $\bar{3}22$	Ξ	*s*	$\bar{5}051$	$e^{\frac{3}{2}}$	
β, $31\bar{3}$	𝔮:	β	$\bar{4}\bar{2}61$	$e_{\frac{1}{3}}$	149°·21
	𝔤:		$\bar{7}.\bar{6}.13.2$	Δ	158°·59
ς, 403	T:	ς	$43\bar{7}1$	$d^{\frac{4}{3}}$	158°·53
	𝔗:	*V*	$62\bar{8}1$	v	144°·8
	r.	θ	$10.0.\bar{10}.1$	$e^{\frac{7}{3}}$	
	28		$32.2.\bar{34}.3$	Ξ	125°·6
	29		$14.4.\bar{18}.1$	Π	143°·45
a, $01\bar{1}$	q	*a*	$11\bar{2}0$	d^1	

3. Regular Six-Sided Pyramids.

Of such are known the ten following crystallographic forms; the angles given are those over the base:—

M.	G.	Da.	Br.	Des.	
	ϵ		$44\bar{8}1$	G	163°·21
	δ	δ	$33\bar{6}1$	δ	157°·55
	γ		$8.8.\overline{16}.3$	L	155°·15
	β		$7.7.\overline{14}.3$	Γ	151°·50
ξ, $7.1.\bar{5}$	ξ	ξ	$22\bar{4}1$	ξ	147°·23
α, $51\bar{3}$	α	α	$44\bar{8}3$	α	132°·36
					119°·20
	λ		$22\bar{4}3$	e_3	97°·26
	x		$7.7.\overline{14}.12$	s	89°·43
π, 210	π	π	$11\bar{2}3$	b^2	59°·18

4. Prisms.

Of such, four are known—the regular six-sided, *b*, the inverse of this, *a*, and two intermediate prisms, ζ and *k*.

5. The Basal Plane, *o* (*c*), 111, 0001.

266 distinct crystalline faces have been measured and described; and as these may be combined in every way with one another, it follows that the possible number of combinations is almost innumerable. Moreover, as certain of the faces may be dominant in some cases, and certain other faces in others, and as the habit and appearance of the crystals is entirely altered thereby (as from flat tables to acute pyramids), the number of *apparently* diverse forms becomes infinite. Insurmountable intricacy would thus seem to prevail. The difficulty of the reading of any form is, however, very materially diminished by the assistance furnished in the three following respects:—*Firstly*, from the frequency of the occurrence of certain faces which are recognisable by their physical peculiarities. *Secondly*, from the dominance of certain of the simpler forms. *Thirdly*, from some part of the crystals showing the position of the cleavage faces.

Thus, the basal plane is often opaque, rough, or milky. The face *b* is frequently dull. That of τ is curved. The faces *t* and *w* are striated parallel to their intersections with e, and a, e, π, and λ are striated parallel to their intersections with r.

The more frequently occurring (and often dominant) faces which serve as guides are:—the basal plane; one or other of the prism faces; the rhombohedra e, r, f, m; and the scalenohedra v, t, y.

Though varying in proportions from flat-tabular to slender-acicular, the extreme varieties pass into one another through every variety of intermediate form, so that no satisfactory classification based upon form alone is possible. Many are of somewhat regular proportions because normally so; but others, which would be either long acicular, or would occur in thin sheets, in their full development, occur as forms which are short and stout, because abbreviated by an abrupt termination, or by some rhombohedral lateral truncation. The following groups may, however, be useful for purposes of classification:—

1. The flat tabular.
2. The long prismatic.
3. The rhombohedral.
4. The scalenohedral.

Not only from the vast number of faces in Calcite, but also from the frequency of its occurrence, the number of geological formations in which it is found, and the great variety of its mineral associates, does it stand in advance of all other minerals as that to which we are to look for information on many points. Among these are—(1.) The relation of the faces of crystals to one another. (2.) Their functioning in the development of complex crystals. (3.) The influence which the concomitant presence, or the concomitant crystallisation in the mother liquid, of other substances may exert in the production of such modifications.

Sufficiently ample records do not at present exist for the tabulation of definite results on any one of these points. As a guide, however, in such inquiry, we have the information afforded by the artificial formation of Calcite crystals. In such as are formed when no substance but lime carbonate itself is present, the primary rhomb dominates in frequency, and the modifications which first appear are the faces o and b, which truncate the solid angles of that form,—that is, the protruding parts least buttressed by surrounding support; the lateral angles, those furthest removed from the centre of the crystallising force, being most frequently removed.

The proportional number of such modified crystals, however, largely increases with the introduction of other substances in solution, even when these are not markedly alien to carbonate of lime: while replacements of the lateral edges by one or other of the scalenohedra *v* or *y* are now occasionally present; and lastly, similar bevelling replacements of the terminal edges.

With the simultaneous existence in solution of larger amounts or of more alien substances, a larger number of modified crystals and more complex modifications make their appearance; but so dominant is the number of primative rhombohedra, even when formed in a variety of ways, that *it* is clearly indicated as the *beginning of the crystallisation* and the other forms as derived from it.

So far as observations regarding the natural occurrences of crystals of Calcite go, the same laws dominate. The primary rhomb occurs alone in rents of limestone; the simpler modifications appear when bituminous matter has been present in the rents. Simple unmodified forms occur in such zeolitic cavities as contain only a single species of zeolite; and certain zeolites seem to induce certain special forms. As the number of species of zeolites in the cavity increases, the crystals of calcite become progressively more and more highly modified.

That this occurs by *progressive* change is in some cases chronicled by the occurrence of certain forms of calcite within others. Usually the imbedded form is crystallographically nearer to the primative; when the central form happens to be the more complex, it would seem to indicate that the modifying associates had, during the last stage of crystal growth, become smaller in amount or simpler in character.

Certain crystallographic forms appear to have certain functions in reference to the primary form,—functions of truncation or of bevelment. As the architect, if the estimates of a structure prove too high, removes a turret from his design, so nature's forces bevel an edge or truncate an angle, if some other mineral, by simultaneously crystallising in the same solution, abstracts some of the lime and leaves a supply insufficient for the completion of the form which was primarily projected.

Bevelments and truncations appear to be limitless, but they are, through all their perplexing intricacies, nevertheless subject to law.

The paragenesis of other material causes the primary to be a rare form, and one which is almost confined to limestone rocks. The throwing off of the molecules most distant from the centre—the lateral angles (the "turrets" of the building)—results in the formation of the face *b*, the resultant being the hexagonal prism, the most common of all forms of calcite. The truncating, again, of the terminal edges of the primary, yields the face *e*, the familiar "nail-head." The bevelling of the lateral edges of the primary results in the common "dog-tooth" scalenohedron *v*. The production of a face which is truncated by the primary gives us the lozenge rhombohedron *f*. The shearing-off of the summit angle affords the flat termination *o*. These forms occur in the foregoing order of frequency, and the succeeding frequency of occurrence of faces takes place by a similarly progressive departure from simplicity.

TWINS.

(1.) Face of union basal. Hemitrope revolution of one-half of a single individual being recognised by the terminal faces being in the inverse position.

(2.) Face of union *e*. The vertical axes of the two halves form an angle of 127° 30′ with one another. The composition generally so frequently repeated as to produce lamellæ of extreme tenuity (which intersect different forms) and appear on the faces of the primary rhombohedron as striæ. As separation occasionally takes place along these directions of molecular inversion, a false cleavage is produced. The colour changes effected by these attenuated twin plates in the grains of primary limestones is their prominent characteristic.

(3.) Face of union *r*. The vertical axes of the two halves or forms are inclined at an angle 90° 46′ to each other.

(4.) Face of union *f*. The vertical axes of the two individuals form an angle of 53° 46′.

There are also polar-parallel arrangements of the plus- and minus-primary rhombohedra parallel to the face *b*. From the centre of blocks of Iceland Spar interpenetrating crystals of these forms occur, simulating twins of the primary, with a revolution of 120°.

Cleavage, *r* perfect. Fracture conchoidal, obtained with great difficulty, but occasionally found in large masses. Lustre vitreous, on curved planes resinous; *o* sometimes pearly. Faces brightly polished. *o*, and *l*, *e*, and *h* of the minus rhombohedra often dull. Streak, white, dull. Colourless to white. Also, when not absolutely pure, of all tints to brown and black; the tints are frequently brilliant. Transparent to opaque when white or coloured.

Double refraction strong. Brittle. H., 2·5 to 3·5. The hardness of the lateral planes, and also of some of the others, is markedly higher than that of the cleavage plane. Becomes vitreously electric by pressure. Sp. Gr., 2·72 when pure.

B.B., infusible; becomes caustic, and shines with great brightness.

If powdered and exposed to a high temperature under pressure, or surrounded with an atmosphere of carbonic acid, it fuses without decomposition, and is converted upon the removal of the heat into a crystalline mass.

Soluble in borax and micro. salt, forming an opaque bead.

Effervesces freely with h. acid. Readily and totally soluble in that or in n. acid, without being reduced to powder, and without the aid of heat.

Comp., Lime, 56; carbonic Acid, 44; but usually with small admixtures of the carbonates of magnesia, iron, manganese, and, rarely, zinc.

Occurs in rocks of every age, but in most of these in cavities or veins as a secondary product.

Analyses:—Heddle, *Trans. Roy. Soc. Edin.*, vol. xxvii. p. 499.

	$CaCO_3$.	$MgCO_3$.	$FeCO_3$.	$MnCO_3$.
1. Gourock, ...	93·16	·472	1·984	4·276
2. Tomnadashan, . .	97·763	·076	·765	1·119
3. Rock and Spindle, .	88·08	4·996	2·028	·48
4. Ruddon Point, . .	94·20	1·276	1·628	1·868
5. Lochearnhead, . .	86·741	...	·598	...
6. Kintyre, ...	89·39	6·396	2·182	2·032
7. Kinghorn, Fife, . .	94·20	1·276	1·628	1·868
8. Abergairn, . . .	94·23	1·363	·556	2·893
9. Ashgrove, Elgin, . .	95·776	tr.	·982	3·241

(*The symbols - - denote unknown faces.*)

SHETLAND. Unst, at Swinna Ness, *e o b* (Plate XIX. fig. 1), with Brucite, in serpentine. In the Chromite quarries of Sobul Hill, $e^{\frac{9}{5}}$ *e o* (Plate XIX. fig. 2), with Aragonite, in serpentine. In the Hagdale quarry, *f r*; Sandlodge, *f* (Currie).

ORKNEY. Hoy, at Selwick, twins, *e b* (Plate XIX. fig. 3), $e^{\frac{9}{5}}$ *e f* (Plate XIX. fig. 5), in rents in sandstone flag. At Rackwick, *e b* (Plate XIX. fig. 4), *b m n* (Plate XIX. fig. 6), in veins in blue flag. Walls, at Brims Ness, in sandstone flag, *m v* (Plate XIX. fig. 7), and *m* (Plate XIX. fig. 8); Burn of Summery, *y o* (Plate XX. fig. 9). In the shore cliffs at Orphir, in calcite veins in flag, *v y*, twins (Plate XX. fig. 10) (Hamilton).

CAITHNESS. At Gie-uisg Geo, *r v a o* ϵ *y w* (Plate XX. fig. 11), with Blende, Pyrite, Galena, and Bitumen. At Dirlot, in limestone, *b e* (Plate XX. fig. 12).

SUTHERLAND. At Heilem, Loch Eireboll, *b r e v p* - (Plate XX. fig. 13), in Dolomite. Near Culgower, *v* (Plate XX. fig. 15); *e* (Plate XX. fig. 14); *v*, in septarian veins in the Upper Oolite, with Asphalt (Joass and Gunn) (Plate XX. fig. 15). In the limestone of Loch Assynt, *e* (Plate XX. fig. 14) (Joass).

ROSS-SHIRE. At the Burn of Edderton, *f* (Plate XX. fig. 16), with Hæmatite.

Hebrides. Skye, at Talisker, f, m (Plate XXI. fig. 17), colourless and honey-yellow, with zeolites (MacCulloch); also, r (? ϕ) (MacCulloch). Loch Bracadale, at Rudha nan Clach, ϕ and f, honey-yellow and pale brown, associated with rock containing large crystals of Olivine, and also with Saponite. Sgurr nam Fiadh, ϕ, invested with Laumontite, and honey-yellow *per se.* Orbost, at the head of the Loch, ϕ and ϵ (Plate XXI. fig. 18). Allt Leith Uillt, Loch Brittle, with Heulandite, $e^{\frac{6}{7}} m$ (Plate XXI. fig. 19). At Geodha Tuill, Loch Eynort, $e^{\frac{3}{2}} a$ (Plate XXI. fig. 20), in veins. Near Quiraing, at the "Echoing Rock," $d^{\frac{7}{6}}$ (Plate XXI. fig. 21), coated with Thomsonite; and ϕ with Chabazite and Thomsonite. South-east of Quiraing, with Stilbite, $d^{\frac{7}{6}} e^{\frac{9}{5}} e^{\frac{6}{5}}$ (Currie); with Analcime and Chabazite, $d^{\frac{7}{6}} r t$ (Plate XXI. fig. 22) (Currie). Mull, Loch Scridain, near Kilfinichen, $f \Sigma \varsigma e^{\frac{3}{4}}$ (Plate XXI. fig. 23); $f e^{\frac{3}{4}} e^{6} \varsigma \Sigma$- (Plate XXI. fig. 24); h (Plate XXII. fig. 25); in quartz druses in "wackenitic dolerite" (Rose). Treshnish Islands, Bac Mòr, with Quartz, $v t$ (Plate XXII. fig. 26) (Currie). Islay, at the lead mine, south of Port Askaig, $e \lambda$ (Plate XXII. fig. 27) (Currie).

Argyllshire. At Strontian, near the junction of the granite with the gneiss. With Schieferspar, Blende, and Brewsterite, $o a$ (Plate XXII. fig. 28) (Levy). With Schieferspar and Harmotome, in striated yellow crystals, $b^{\frac{5}{3}}$ (Plate XXII. fig. 29) (Levy); ϵ; f; $o a v n$ (Plate XXII. fig. 30); $a b \Omega t$ (Plate XXII. fig. 31); $b e q v a i$ (Greg); $v a b e$-- (Plate XXII. fig. 32). Bellsgrove Mine, $a o$, with Barytes; $e e^{\frac{9}{5}}$, with globular Pyrites (Currie). Fee Donald Mine, *tabular*, $o a \nu e f$, $o a b G \pi$ (Plate XXIII. fig. 33); $o a b \eta G \pi$ (Plate XXIII. fig. 34); $o b$ (Plate XXIII. fig. 35); *rhombohedral*, $e b$ (Plate XXIII. fig. 36); $a^{4} a \lambda v b^{\frac{9}{4}} e^{6}$ (Plate XXIII. fig. 37); $e f b v y n x$ (Plate XXIII. fig. 38); $f a b d^{\frac{9}{7}} y \mu$ (Plate XXIII. fig. 39); $f o e a a$-$v e^{\frac{1}{4}} \Xi e^{\frac{5}{2}} \mathfrak{U} r t$ (Plate XXIII. fig. 40); $o a v e^{\frac{1}{2}}$ (Plate XXIV. fig. 41); $y o$ inclosing v (Plate XXIV. fig. 42); *pyramidal*, $a \xi v y f \chi e^{\frac{6}{7}}$ (Plate XXIV. fig. 43); and many other forms coronetted around the periphery of simple crystals, and forming vacuous arrangements. Campbelton Loch, in a limestone quarry on the north shore, --- (Plate XXIV. fig. 44); $e b \lambda r$ (Plate XXIV. fig. 45); $b m v$-- (Plate XXIV. fig. 46); $r \Pi$ (Plate XXIV. fig. 47). Machrihanish Bay, at Galdrings, Balligroggan, in druses of Quartz in dense basalt, v twins (Plate XXIV. fig. 48); $f v o b \xi \mathfrak{J} \psi$ (Plate XXV. fig. 49). At Meall Mor, west of Erins, in the copper mines, with Siderite, $e b d r$ (Plate XXV. fig. 50). South of the Kerrera Ferry, near Oban, in "wackenitic trap," e (Plate XXV. fig. 51).

Nairnshire. At Piperhill quarry, with Pyrite, on Blende, $v\,t\,b$ (Plate XXV. fig. 52) (Aitken).

Elginshire. At Ashgrove limestone quarry, near Elgin, with Pyrite and "Glauconite," $v\,t$ (Plate XXV. fig. 53); $x\,\chi\,v\,f$ (Plate XXV. fig. 54).

Banffshire. At Limehillock, near Grange, with Pyrrhotite, Margarodite, and Pyrites, $v, r\,v$. At Boyne limestone quarry, with Mountain Paper, $b\,e\,r$. At Sandend, in veins in gneiss, $k\,b\,v\,\theta\,r$ (Plate XXV. fig. 55). At Portsoy, at John Legg's Well, in "clay slate," $e\,s$ (Plate XXV. fig. 56).

Aberdeenshire. At the Abergairn or Corrybeg mines, with Fluor, Blende, and Schieferspar.

Kincardineshire. At the Long Gallery, near Stonehaven, with Heulandite and Analcime.

Forfarshire. Usan, near Montrose, at "The Blue Hole," in the central quartz-lined druses of agates. At the Craig railway cutting, rarely, associated with Natrolite, Analcime, Saponite, and Pilolite; in small but brilliant pale wine-yellow crystals. The crystals are of the ordinary scalenohedron type, but with the v faces highly modified by a number of low but well-defined faces (none of which have been determined), and with the edges between the scalene faces and the truncating face h emarginated by three forms, which are here somewhat conjecturally lettered. $v\text{-}\text{-}e\,\phi\,h\,p\,Q\,\chi\,\psi$ (Plate XXVI. fig. 57); $v\text{-}\text{-}\phi\,h\,t\,r\,p\,Q\,\chi\,\psi$ (Plate XXVI. fig. 58); $v\text{-}\text{-}e\,\phi\,h\,t\,r\,p\,Q\,\chi\,\psi$ (Plate XXVI. fig. 59); $v\text{-}\text{-}\text{-}r\,\sigma\,\phi\,h\text{-}p\,\alpha\,Q\,\chi\,\gamma\,\psi$ (Plate XXVI. fig. 60); $v\text{-}\text{-}\text{-}\text{-}\text{-}\text{-}\text{-}t\,p\text{-}e\,\phi\,h\,p\,Q\,\chi\,\gamma\,\psi\,\rho$ (Plate XXVI. fig. 61). Broughty Ferry, in Roy quarry, with Amethystine Quartz.

Perthshire. Dogtooth, primary, and nail-head forms, in Athole (MacCulloch). Dogtooth, in limestone at Cluny (MacCulloch). At Tomnadashan on Loch Tay, in "porphyry," with Pyrites, $v\,r$ twins (Plate XXVI. fig. 62), r. At Callander, in Old Red Sandstone conglomerate, in veins, with Chalcocite; $v\,n\,\beta\,\updownarrow\,e\,\epsilon\,\phi\,\gamma\text{-}$ (Plate XXVII. fig. 63); the same with r. In Glen Farg, in andesites of the Old Red Sandstone, with Analcime, $v\,a\,b\,e^4\,[=s]\,\zeta\,y\,r$ (Plate XXVII. fig. 64) $v\,a\,b\,\zeta\,y\,r\,\chi$, both twins, in decomposed amygdaloid, with Barytes. Forgandenny, $v\,[a\,♃]\,e\,t\,\pi\,f\text{-}r\tfrac{9}{4}\,\zeta$ (Plate XXVII. fig. 65).

Fifeshire. In the central druses of agates, in andesitic lavas of the Old Red Sandstone, at Heather Hill, Luthrie. At Kinkell, near St Andrews, in Lower Carboniferous agglomerate, with Dolomite, Barytes, and pink Quartz, $v\,y\,a\,b\,\odot\,f\,e$ (Plate XXVII. fig. 66); $b\,e$, with pink Barytes (Plate XXVII. fig. 67). v inclosed in f (Plate XXVII. fig. 68). At Kincraig, near Elie, with Barytes and Amethystine Quartz, in Lower Carboniferous agglomerate, $v\,a\,\chi\,x\,\theta\,e^3$ (Plate XXVII. figs. 69, 70); $v\,a\,b\,\chi\,x\,\theta\,\gamma\,\phi\,\updownarrow\,e^6\,e^{\frac{11}{4}}$

(Plate XXVIII. fig. 71); $v\,a\,r\,\lambda\,w\,e^4 f\,\theta\,e^{\frac{6}{7}}\,\phi$ (Plate XXVIII. fig. 72). At Bogie quarry, near Kirkcaldy (Greg). At Chapel quarry, Raith, with Bitumen and Apophyllite, *s r o* (Plate XXVIII. fig. 73); $f\,y\,o,\ e^{\frac{9}{5}}$ [s] *e o* (Plate XXVIII. fig. 74) (Greg); *k f r o* (Plate XXVIII. fig. 75); *s* (Φ) *r o* (Plate XXVIII. fig. 76); $e^{\frac{9}{5}}$ [s or Φ] *r o y* (Plate XXIX. figs. 77, 78). *Rhombohedral* type, long to short. Accuminated, $s\,e^{\frac{9}{5}} f\,o$ (Plate XXIX. fig. 79); *d o y f* (Plate XXIX. fig. 80); $e^{\frac{9}{5}}$ [s or Φ] $y\,r\,e\,\tau$ (Plate XXIX. fig. 81); short, with low and oscillating faces, $f\,e^{\frac{3}{4}}$ - - (Plate XXIX. fig. 82); $f\,e^{\frac{3}{4}}\,e^{\frac{4}{3}}$ - - - (Plate XXIX. fig. 83); $f\,h\,e^{\frac{3}{4}}\,r\,e^{\frac{4}{3}}$ - - (Plate XXIX. fig. 84). *Scalenohedral* type, $\lambda\,a\,r \odot y\,h$. *Pyramidal scalenohedral*, $L\,v\,e\,\epsilon\,f\,\lambda$ (Pl. XXX. fig. 85); also many other complex forms which are in the Raith Collection. Magus Muir limestone quarry, $e^{\frac{9}{5}}$ [*s* or Φ] *o y* (Pl. XXX. fig. 86). At Broomhall, with Millerite, in limestone (Sowerby).

STIRLINGSHIRE. At Alva (Greg). At Mugdock Tunnel, with zeolites, $f\,o\,r\,m\,e^6$ (Plate XXX. fig. 87).

DUMBARTONSHIRE. Kilpatrick, near Cochno House, with red Stilbite, *y f* (Plate XXX. fig. 88). In Bowling quarry *per se*, $v\,\phi$ (Plate XXX. fig. 89); *v m t* (Plate XXX. fig. 90); *e b* - (Plate XXX. fig. 91); with Prehnite, $e^{\frac{4}{3}}$ (Plate XXX. fig. 92); $e^{\frac{4}{3}}\,e^{\frac{6}{7}}$ (Plate XXXI. fig. 93); $e^{\frac{4}{3}}\,e^{\frac{6}{7}}\,e^{\frac{5}{6}}\,e^{\frac{3}{4}}\,e$ (Plate XXXI. fig. 94); $e^{\frac{4}{3}}$ - $e^{\frac{6}{7}}\,e^{\frac{5}{6}}\,e\,o$ - (Plate XXXI. fig. 100); $e^{\frac{4}{3}}\,e^{\frac{6}{7}}\,e^{\frac{5}{6}}\,e^{\frac{3}{4}}\,r\,t\,\pi$ - (Plate XXXII. fig. 101); $e^{\frac{4}{3}}\,e^{\frac{6}{7}}\,e^{\frac{5}{6}}\,e\,o\,b\,r$ - $t\,\tau$ (Plate XXXI. fig. 95); *f m* (Plate XXXI. fig. 96); $f\,o\,b\,e^{\frac{9}{4}}\,m\,v\,\lambda\,\pi\,[\chi]$ (Plate XXXI. fig. 97); with Prehnite and Thomsonite, *h a b o f* - (Plate XXXI. fig. 98); $h\,o\,b\,\zeta\,f$ (Plate XXXI. fig. 99); with Analcime and Prehnite, *s e g* (Plate XXXII. fig. 102); a triplet crystal, $v\,m\,f\,r\,t\,n\,e \odot p$ (Plate XXXII. figs. 103, 104); with twin Chabasite, *v f r m* (Plate XXXII. fig. 105). Glen Arbuck, with Saponite, Phacolite, Analcime, Stilbite, Heulandite, *m a y* (Plate XXXII. fig. 106) ($y = 715$) (Currie). With Saponite and Phacolite (fig. 33*a*, Dana, 6th ed., p. 265), *v* twin; with the same, fig. 35, Dana (*loc. cit.*), $v\,f\,\psi$.

HADDINGTONSHIRE. "Between Weaklaw and North Berwick, crystallised, with Quartz, in greenstone."

EDINBURGHSHIRE. In amygdaloidal cavities in the Old Red lavas of the Pentland Hills, $r\,e^{\frac{2}{5}}\,g\,e^{\frac{5}{2}}$ (?) (Plate XXXII. fig. 107) (Sowerby). In the veins traversing the Lower Carboniferous tuffs of the Calton Hill, with Bitumen; twins, *v* (Plate XXXIII. fig. 108). In veins in the Dolerite of Salisbury Crags, with Prehnite, $v\,x$ (v e$\frac{1}{7} = 41\bar{3} = \frac{1}{2}R^7$) (Plate XXXIII. fig. 109); with Analcime and Prehnite, $f\,v\,\pi$ (Plate XXXIII. fig. 110). Corstorphine Hill, in veins in Dolerite, with Prehnite, *m r* (Plate XXXIII. fig. 111); *f. f r o*, near Datolite. Ratho, in the great quarry, with

Prasilite, *g l f* (Plate XXXIII. fig. 112); in the Station quarry, *f*, brown; also *e v m y a ζ* (Plate XXXIII. fig. 113); coating rents in dolerite, *c v e*, twins (Plate XXXIII. fig. 114). Addiewell, near West Calder, with Barytes, Salt, and Petroleum, in Lower Carboniferous sandstone; in twins, *v e i* (Plate XXXIII. fig. 115). At New Park Station, Braids limestone pit, *r*, *r e* (Stuart Thomson). At Harburn Head quarry (Forrester), in fissures in limestone. At † West quarry, Camps, East Calder.

Linlithgowshire. At an old working at the Craigs, 1 mile north-east of Bathgate, in veins with Galena, Niccolite, and Barytes (Stuart Thomson). Bathgate Hills, at South Mine and North Mine limeworks, *r* (Stuart Thomson); *e b* - - (Plate XXXIV. fig. 116); *e b* - - - (Plate XXXIV. fig. 117); *a e y ξ* ♉ - (Plate XXXIV. fig. 118). Uphall, in marl pits, *r*, *r e* (Plate XXXIV. fig. 119); *r e f b v* (Plate XXXIV. fig. 120), near Forkneuk (Stuart Thomson). Binny Craig, in fissures in dolerite, in a south-west spur of the hill, *f r o* (Plate XXXIV. fig. 122); $f\,r\,o\,e^{\frac{9}{5}}$ (Plate XXXIV. fig. 123); $f\,r\,o\,e^{\frac{9}{5}}\,a$ (Plate XXXV. fig. 124). Ecclesmachen, at † Canty quarry, in basalt, *c b* and *r* (Plate XXXV. fig. 125). † Newbigging Craig, near Uphall, coated with Quartz and Göthite, in dolerite, *f*. Hilderston Hills, at Cairn-naple, with Copper Nickel, *e a v* - (Plate XXXV. fig. 126). Bed of the River Almond, near Blackburn, with asbestiform Hornblende and Saponite (Forrester).

Lanarkshire. North of Glasgow, at the Cadder pits, *e a* (Plate XXXV. fig. 127). At Craigpark quarry, Dennistoun, in veins in dolerite, $e\,b\,r\,y\,\theta\,[\Omega]$ (Plate XXXV. fig. 128); $e\,e_{\frac{9}{4}}\,a\,y\,n\,[d^4]$ (Plate XXXV. fig. 129). At Jackton, "hexahedral and truncated," *b e* (Plate XXXV. fig. 130). Leadhills, generally from the Susanna mine, *r o f e* (Plate XXXV. fig. 131); $v\,\epsilon$ - (Plate XXXVI. fig. 132); $v\,\phi\,\odot$ - (Plate XXXVI. fig. 133); *v f e h* (Plate XXXVI. fig. 134); $d^{\frac{7}{6}}\,e^{\frac{6}{5}}$ (Plate XXXVI. fig. 135); *v x e h t* (Plate XXXVI. fig. 136); *v x h e m* - - - (Plate XXXVI. fig. 137); *a e* (Plate XXXVI. fig. 138); *a e l d* (Plate XXXVI. fig. 139); *a e* - (Plate XXXVII. fig. 140); *b e o* (Plate XXXVII. fig. 141); $e^{\frac{9}{5}}\,a\,e\,r$ (Plate XXXVII. fig. 142); $e^{\frac{9}{5}}\,a\,e\,f$ (Plate XXXVII. fig. 143); *k* (?) *e* (Plate XXXVII. fig. 144); $e^{\frac{9}{5}}\,a\,e$ (Plate XXXVII. fig. 145).

Renfrewshire. At Rashielee quarry, near Erskine, in dolerite, $v\,r\,e\,a\,x\,\gamma$ ♀, twins (Pl. XXXVII. fig. 146) (Greg). At Boyleston quarry, near Barrhead, with Analcime, Prehnite, Thomsonite, and Natrolite. In exquisitely-pellucid crystals; type form, *a y* ♈ $v\,r\,m\,e\,f\,\chi$ (Pl. XXXVII. fig. 147); $a\,\delta\,v\,r\,m\,f\,\gamma$ (Pl. XXXVIII. figs. 148, 149); $a\,\delta\,v\,r\,e^4\,f\,e^{\frac{1}{2}}\,Q\,s$; $a\,\delta\,v\,m\,e^4\,f\,\sigma\,\gamma\,\tau\,b\,\Upsilon\,w\,e^{\frac{6}{7}}$ (Pl. XXXVIII. fig. 150); *a* ♈ $v\,m\,e^4\,r\,f\,\gamma$ - τ (Pl. XXXVIII. fig. 151); *a ς* ♈ $v\,r\,m\,e^4\,f\,\gamma\,e^{\frac{6}{5}}\,e^{\frac{2}{3}}\,b\,e_{\frac{1}{4}}$ (Pl.

XXXVIII. fig. 152); $a \, ♈ \, r f \gamma \varsigma \text{-} e^{\frac{2}{3}}$ (Pl. XXXVIII. fig. 153); $a \gamma r f e$ $b v e^{4}$ (Pl. XXXVIII. fig. 154); $a v r \text{-} f e^{4} e_{\frac{1}{4}} Q \gamma \delta$ (Pl. XXXVIII. fig. 155); $b \omega t e r \eta$ (Pl. XXXIX. fig. 156); with Prehnite and Copper, $b e^{\frac{9}{4}}$ $r w t e$. Bishopton, at the railway tunnel, with Prehnite, Harmotome, and Greenockite, $y \zeta e f s z \theta$ (Pl. XXXIX. fig. 157); $\zeta e s y \theta$; with Greenockite, Galena, and Thomsonite, $v r d \mathfrak{J}$ (Pl. XXXIX. fig. 158); with Prehnite, $y s$ (Currie); with Greenockite, $v \odot s$; $v \odot h$; $y v$ (Currie); with Prehnite and Greenockite, $v f$; $v r$; h (Currie). Kilmalcolm, with Stilbite, Chabasite, and "Cottonstone," Natrolite: *Type e.*—$e r b v m$ (Greg); $e r b v e^{5}$ (Pl. XXXIX. fig. 159); τ to $\pi \, r b s y \, \Omega$ (Pl. XXXIX. fig. 160); $e \pi b f \psi \chi e_{\frac{1}{4}} y \, \Omega$ (Pl. XXXIX. fig. 161); $e r m f x$ (Pl. XXXIX. fig. 162); $e v$ (Pl. XXXIX. fig. 163). *Type g.*—$e \text{-} g m r b y \varsigma$ (Pl. XXXIX. fig. 164); $f a b r y v m$ (Pl. XXXIX. fig. 165); $g a m y$ (Pl. XL. fig. 166); $g m a y$ (Pl. XL. fig. 167); $e^{\frac{6}{5}} a r \psi$ (Pl. XL. fig. 168); $e^{\frac{6}{5}} a b m \, ♈ \text{-}$ (Pl. XL. fig. 169). *Type m.*—$m \, \Omega \, \Pi \, b e^{\frac{5}{2}} e^{\frac{11}{4}} \zeta t$ (Pl. XL. fig. 170). *Type v.*—$v o e h r n$; $v y o \text{-} f \, ♉ \, \theta \pi$ (Pl. XL. fig. 171); $v y$. Gryffe waterworks tunnel, with Analcime; with Thomsonite and Natrolite, $y v m r$ (Pl. XLI. fig. 172). At Gourock, in Lower Carboniferous lavas, with Quartz, Fluor, Dolomite, and Selenite. *Type v.*—$v e_{7}$ (Pl. XLI. fig. 173); $v e^{4} r \lambda \chi$ (Pl. XLI. fig. 174). *Type r.*—$r \omega \lambda v \psi \xi \text{-}^{2}$ (Pl. XLI. fig. 175); $r m \xi \Psi \text{--}$ (Pl. XLI. fig. 176); $\epsilon v y \psi$ (Pl. XLI. fig. 177); $r w \lambda v f \, \Omega \, \xi \text{-----}$ (Pl. XLI. fig. 178); $r w \lambda v i \text{-----}$ (Pl. XLI. fig. 179).

AYRSHIRE. Near Beith, at Dockra limestone quarry, with Chalcopyrite, Pyrite, and Millerite, $e^{\frac{9}{4}} n e$ (Pl. XLII. fig. 180); $m \, \Omega \, w b e$ (Pl. XLII. fig 181); $m \, \Omega \, w \tau \mathfrak{z} b \text{-}$ (Pl. XLII. fig. 182); $b m r \lambda n e w e$ (Pl. XLII. fig. 183); $v r z n w h$ (Pl. XLII. fig. 184). At Lugton quarry, in limestone, $m v b t e$, inclosing v crystals of a dark tint (Pl. XLII. fig. 185); $m b v \lambda n r t$ (Pl. XLII. fig. 186); $m b e^{\frac{19}{9}} v g t e$ (Pl. XLII. fig. 187). At Waterland quarry, Dunlop, in calcareous clay, $e r$ (Pl. XLIII. figs. 188, 191). Near Muirkirk, at Pennel Burn, Garpel, on Hæmatite, $e^{\frac{9}{4}} e$ (Pl. XLIII. figs. 189, 192). At Beith, $m b v r \lambda$ (Pl. XLIII. figs. 190, 193); $m v y$ (Pl. XLIII. fig. 194); $m b y v r \varsigma$ (Pl. XLIII. fig. 195); $y m v r b$ (Pl. XLIV. fig. 196).

DUMFRIESSHIRE. At Wanlockhead mines, in the following veins:— West Grove. *Type, rhombohedral,* $r e \tau w e \nu k$ (Pl. XLIV. fig. 197); $r z \nu$ (Pl. XLIV. fig. 198); $r w \lambda v z \pi$ (Pl. XLIV. fig. 199); $r w \nu v h$ (Pl. XLIV. fig. 200); $r v \omega f$ (Pl. XLIV. fig. 201); a passage suite. *Type, prismatic and rhombohedral,* $e b e^{\frac{9}{5}}$ (Pl. XLIV. fig. 202); $e b e^{\frac{9}{5}} v$ (Pl. XLIV. fig. 203); $e e^{\frac{9}{5}} a y$ (Pl. XLV. fig. 204); $e e^{\frac{9}{5}} e x \varsigma \chi$ (Pl. XLV. fig. 205); $e^{\frac{9}{5}} e r t b \varsigma y \eta N$

(Pl. XLV. fig. 206). *Type, scalenohedral*, $v\,e\,m$ (Pl. XLV. fig. 207); $v\,e\,\varsigma$ (Pl. XLV. fig. 208); $x\,e\,e^{\frac{5}{2}}$ (Pl. XLV. fig. 209).

Glen Crieve. *Type, prismatic and rhomboidal*, $e^{\frac{9}{5}}\,a\,l\,\varsigma\,b$ (Pl. XLV. fig. 210). *Type, scalenohedral*, $v\,e\,t\,\odot$ (Pl. XLV. fig. 211); $v\,e\,i\,f$ (Pl. XLVI. fig. 212); v - $\epsilon\,a^4\,h$ (Pl. XLVI. fig. 213); $v\,h\,\sigma\,x$ (Pl. XLVI. fig. 214); $v\,\phi\,e\,i\,a_{\frac{7}{2}}$ (Pl. XLVI. fig. 215); $b\,y\,e$ (Pl. XLVI. fig. 216); $b\,x\,r\,[\phi]\,e\,w$ (Pl. XLVI. fig. 217); $y\,x\,\nu\,[\gamma]\,\tau$, with Pyrites (Pl. XLVI. fig. 218).

Bay Vein. *Type, scalenohedral*, $d^{\frac{7}{6}}$ (Pl. XLVI. fig. 219); $d^{\frac{7}{6}}\ e^{\frac{6}{5}}$; $d_{\frac{7}{6}}\,n$ [of Descloizeaux]; $d^{\frac{7}{6}}\,e^{\frac{6}{5}}\,e^{\frac{9}{4}}$; $d^{\frac{6}{5}}\,d$; $v\,h\,f\,\theta$: [of Goldschmidt, $=41\bar{3}$, $\bar{4}\bar{3}72$] (Pl. XLVII. fig. 220). *Plumbo-calcite.*—r; [Plumbo-calcite] $r\,a\,b$ (Pl. XLVII. fig. 221); $r\,e\,f$.

BUTE. Arran, $f\,o\,r$ (Pl. XLVII. fig. 224).

KIRKCUDBRIGHT. At Mabie, on Hæmatite, $b\,x\,r$ (Pl. XLVII. fig. 222) (Dudgeon). Newton Stewart, at Blackcraig mine, with Dolomite, Pyrite, and Chalcopyrite (Pl. XLVII. fig. 223).

ROXBURGHSHIRE. At Larriston, "crystallised in acute pyramids with pyrite." At Stobs quarry, "red crystallised." Hill of Bedrule, west of Jedburgh, in a limestone quarry, "crystallised," with Jasper and Limonite.

PELLUCID CALCITE,—"Iceland Spar" occurs.

FORFARSHIRE. At Todhead, in a vein which cuts Old Red Conglomerate. It contains imbedded Laumontite, and is immediately associated with Barytes and Pilolite.

RENFREWSHIRE. Bishopton, with Prehnite, Natrolite, and Greenockite.

COLOURED CALCITES.

Pink.—RENFREWSHIRE. At Gourock quarry, with Fluor, Selenite, and Barytes, in quartzose druses, in "porphyry" [andesite]—Anal. 1.

Red.—PERTHSHIRE. At Tomnadashan, Loch Tay, with Fahlerz, Chalcopyrite, Pyrites, in porphyry—Anal. 2.

Green.—ISLAND OF RUM. At Sgùrr Mòr, in amygdaloid. Coloured by Celedonite (Hislopite) (MacCulloch).

FIFESHIRE. At the Rock and Spindle, Kinkell, in a vein in tufa—Anal. 3. Coloured by Delessite.

BUTE. Dark green from Chlorite.

Brown.—FIFESHIRE. At Ruddon Point, with Analcime; west of Kinghorn, in sheafs, in amygdaloid (Grieve)—Anal. 4.

Black.—PERTHSHIRE. Lochearnhead quarry, on the north shore, one mile east of (Macdonald)—Anal. 5.

ARGYLLSHIRE. Campbelton, from the † Largy shore, and two miles north of the town (Macdonald) (Anal. 6); also on both shores of Campbelton Loch, with feeble iridescent colours from fossils (Lucullite).

ORKNEY, HOY. At Rackwick. Lustrous, blue, inclining to satin-spar in Fara.

FIBROUS CALCITE.

FIFESHIRE. In veins in King Alexander's Cliff, Burntisland.

LANARK. At Kiffockside.

EIGG. Among the loose rocks at the northern extremity of Blar Mor (Currie).

FOLIATED CALCITE—SCHIEFERSPAR.

ABERDEENSHIRE. At the Abergairn lead mines, with Fluor and Blende—Anal. 7.

ARGYLLSHIRE. Strontian, at Fee Donald and Bellsgrove lead mines, rarely, with Harmotome and Galena (Bournon).

PERTHSHIRE. At Glen Tilt marble quarries (MacCulloch).

AYRSHIRE. At Ballantrae (Greg).

PULVERULENT CALCITE—AGARIC MINERAL, ROCK MILK.

PERTHSHIRE. In the tunnel at Glen Farg.

EDINBURGHSHIRE. Coating Lower Carboniferous sandstone at Salisbury Crags.

STALACTITES.

ORKNEY. Hoy, in a cave north of the Berry Head, snow-white.

INVERNESS-SHIRE. Skye, at Macallister's Cave [the Spar-cave of Strathaird].

FIFESHIRE. At Magus Muir limestone quarry.

EDINBURGHSHIRE. At Burdiehouse, in limestone, honey-yellow, and arborescent.

STALAGMITES.

ARGYLLSHIRE. Mull, in [Nuns Cave, near Carsaig].

CALC SINTER.

ARGYLLSHIRE. Oban, in basalt.

FIFESHIRE. At Starleyburn, coralloidal.

PLUMBO-CALCITE.

The crystallised rhombohedral variety is found with Plattnerite, Vanadinite, and Calamine [=Hemimorphite] at the High Pirn vein, Wanlockhead. A milky coralloidal variety, and a brown acicular variety occur at several of the Wanlockhead veins—Anals. 1, 2, 3.

	$CaCO_3$.	$PbCO_3$.	$MgCO_3$.
Wanlockhead (1), . . .	97·182	2·709	tr.
„ (2), . . .	90·44	9·425	...
„ (3), . . .	90·406	9·468	...

61. **Dolomite (271).** $CaCO_3.MgCO_3$.

Rhombohedral; most frequent form *r*, in curved and saddle-shaped aggregations. Also granular or compact; often cellular and porous. Clv., rhombohedral. H., 3·5 to 4·5; G., 2·85 to 2·95. Translucent; vitreous, but often pearly. Colourless or white, but frequently pale red, yellow, or even green. B.B. infusible; but becomes caustic, and often shows traces of iron and manganese. Fragments effervesce very slightly or not at all in cold hydrochloric acid; the powder is partially soluble in cold, wholly in hot, acid. Comp., 54·3 Carbonate of Lime, and 45·7 Carbonate of Magnesia; but it generally consists of Carbonate of Lime with more than twenty per cent. of Carbonate of Magnesia, and less than twenty per cent. of Carbonate of Iron.

Analyses—Heddle, *Trans. Roy. Soc. Edin.*, xxvii. p. 495 *et seq.*:—

	$CaCO_3$.	$MgCO_3$.	$FeCO_3$.	$MnCO_3$.
Dolomite—				
North Cross Geo, . . (1)	52·548	43·772	1·972	1·368
,, ,, . . (2)	55·344	41·911	2·193	·6
Ting of Norwick ("Ankerite"), (3)	51·804	37·998	7·82	2·314
Haaf Grunay, . . . (4)	53·803	44·852	·768	·083
Walls, ... (5)	62·4	32·056	1·74	4·276
Scalpay, ... (6)	50·244	43·028	2·504	2·896
Loch Fyne (Young), . . (7)	...	...	...	...
Largybaan, . . . (8)	55·80	36·296	6·612	1·264
Kinkell, ... (9)	51·48	37·42	7·016	1·928
,, ... (10)	50·026	39·108	6·7	3·736
Peanes Quarry, Largo Law, (11)	49·076	39·461	9·48	1·153
Pumpherston (Stuart Thomson), ... (12)	52·00	40·91	6·61	...
Black Craig Mine, . . (13)	55·08	37·092	5·716	1·368
Dolomitic and other Limestones—				
Ledbeg (H.), ...	46·307	37·632	1·022	·368
,, (Dr Anderson), . .	91·32	4·74	...	...
Garbh Eilean (H.), . . .	92·000	5·856	...	...
Largo (H.), ...	49·076	39·461	9·48	1·153
Tiree (H.), ...	95·94	1·78	·576	1·028
Eireboll (A.), ...	51·04	41·36	...	...
Achmore (A.), ...	53·51	43·20	...	...
Stronchrubie (A.), . . .	45·79	48·72	...	...
Knockdhu (A.), ...	41·58	33·47	...	...
,, (A.), ...	53·77	41·01	...	...
Kirkton (A.), ...	50·21	41·22	...	...
,, (A.), ...	51·33	41·08	...	...
Durness (A.), ...	90·01	6·50	...	...

SHETLAND. Unst, at North Cross Geo, colourless and transparent, with green Talc and Magnetite (D. and H.)—Anals. 1 and 2. Haaf Grunay, on the east shore in a vein of saccharoid structure—Anal. 4. Mainland, Fethaland promontory, at Kleber Geo, in cleavable, solid, nodules in actynolite slate, pure white and pale green. In the Brethren Rocks, crystalline, in limestone (D. and H.). In Greenholm, crystallised, with Calcite, in cavities in limestone, *r* (Plate XLVII. fig. 1) (D. and H.).

ORKNEY. In Walls, at Sands Geo, in amygdaloid, with Analcime, Barytes, and Calcite, of a pink colour—Anal. 5.

SUTHERLAND. Near the Cave of Smoo, in cavities in white chert; *r*, curved.

HEBRIDES. Harris, Scalpay Island, near the lighthouse, in a vein in Serpentine. This vein consists of curved interlacing crystals, snow-white, with Penninite upon one side and Steatite upon the other (D. and H.)—Anal. 6. Islay, near Peel, in indurated rock.

ARGYLLSHIRE. Loch Fyne, at St Catherines, *r* (Young)—Anal. 7. Erins, three miles west of, in the copper mine, with Chalcopyrite, Göthite, and Byssolite. Mull of Kintyre, at the Largybaan caves, with Limonite—Anal. 8.

ABERDEENSHIRE. At the Abergairn lead mines, with Fluor, Galena, Blende, etc. Alford, at Sylavethy quarry, snow-white, crystallised in druses, in [vein in] granite, with fibrous Hornblende. At Tyrebagger, Dyce, with Tremolite (Greg).

FORFARSHIRE. At Balloch Carity, brown, and flesh-coloured, in altered sandstone (Lyell). At Prosenhaugh, with Serpentine and Diallage (Lyell). At Burnside, in a red indurated rock.

PERTHSHIRE. East of † Boothe, on the Tay, a vein of Calcite in porphyry contains Brown Spar and Siderite (Fleming).

FIFESHIRE. At Kinkell, pink, in a vein with Barytes, Calcite, and Rock Crystal—Anal. 9. Also pseudomorphous after Calcite, *d o*—Anal. 10. Kirkcaldy, in Chapel quarry. Charlestown, in the limestone quarries. To the south-east of Abernethy. Peanes quarry, Largo—Anal. 11.

DUMBARTONSHIRE. On the banks of Loch Lomond, in chlorite schist (Greg).

MIDLOTHIAN. West Calder, at Addiewell, with Chalcopyrite and Barytes (Stuart Thomson). Pumpherston, fibrous, in a vein (Stuart Thomson)—Anal. 12. Whitburn, pink (Stuart Thomson).

LINLITHGOWSHIRE. At Broxburn.

LANARKSHIRE. At Leadhills, Wilson's shaft, colourless and pink (Wilson and H.)

RENFREWSHIRE. At Gourock quarry, with Quartz, Fluor, Göthite, Wad, Selenite, and Calcite. At Bishopton (Thomson).

BUTE. In fine iridescent curved rhombohedrons (Greg). Near

Ascog, in Millhole quarry; brown with Pyrite in chlorite slate (Glen).

AYRSHIRE. At Waterland quarry, east of Beith, brown, with a pavonine lustre, with Calcite (Young).

BERWICKSHIRE. One mile north of Tweedmouth, *r*, in coal over limestone.

ROXBURGHSHIRE. At Muirhouse Law, south of Maxton, rose-red, in veins with Steatite and crystallised Quartz.

DUMFRIESSHIRE. At Wanlockhead.

KIRKCUDBRIGHTSHIRE. Newton Stewart, at Blackcraig mine, in very fine lilac crystals (Rose); also in brown twins, *r* (Plate XLVII. fig. 1) (Anal. 13); and in elongated colourless crystals, with Chalcopyrite, Pyrites, and Erythrite.

Magnesian marbles and limestones occur at Eireboll, Assynt, Iona, Tiree; Dumfries, at Closeburn and Barjarg; Arran, in a bed at Corrie, four feet thick. [See analyses above.]

62. Ankerite (271a). $CaCO_3.(MgFeMn)CO_3$.

Rhombohedral; *r*. 106° 12′. Usually massive and granular. G., 2·9 to 3·1. Normal Ankerite is $2CaCO_3$, $MgCO_3$, $FeCO_3$ = Calcium Carbonate, 50·0; Magnesium Carbonate, 21·0; Iron Carbonate, 29·0.

SHETLAND—UNST. Ting of Norwick, west side, associated with yellowish Talc, in a vein at the junction of serpentine with mica slate. In bluish-grey rhombohedra. S.G., 2·91; cleavage angle, 106° 6′ (D. and H.). [The "Ankerite" from Walls (G. and L.) is merely Dolomite.] Analysis:—

	$CaCO_3$.	$MgCO_3$.	$FeCO_3$.	$MnCO_3$.
Ting of Norwick, .	51·804	37·998	7·82	2·314

63. Magnesite (272). $MgCO_3$.

Rhombohedral; 107° 10′–30′. Reniform or massive. H. = 3·5; G. = 2·85 to 2·95. Subtranslucent or opaque; streak shining. Snow-white, greyish- or yellowish-white, and pale yellow. [*o*, 111, 0001; *b*, $2\bar{1}\bar{1}$, $10\bar{1}0$; *a*, $10\bar{1}$, $11\bar{2}0$; *i* ? *r*, 100, $10\bar{1}0$.]

Occurs, very rarely, in the Bay vein in the form *i b o a* (Plate XLVII. fig. 1).

64. Breunnerite (272a). $MgCO_3$.

Rhombohedral; R. 107° 10′–30′. Granular or columnar. Clv., *r* very perfect. H. = 4 to 4·5; G. = 2·9 to 3·1. Transparent or translucent on the edges; highly vitreous. Colourless, but often yellowish-brown or blackish-grey. Comp., essentially carbonate of magnesia, with 51·7 carbonic acid and 48·3 magnesia, but often mixed with 8 to 17 carbonate of iron or manganese.

SHETLAND—UNST. North Cross Geo, in a vein with green Talc, Nemalite, Magnetite, and Dolomite. In pale brown rhombohedra. S.G., 3·095; cleavage angle, 106° 50′ (D. and H.). Analysis:—

	$MgCO_3$.	$FeCO_3$.	$MnCO_3$.
North Cross Geo, Unst, .	91·395	6·784	·780

65. **Siderite (273).** $FeCO_3$.

Rhombohedral; R. 107°. Chiefly *r*, often curved, saddle-shaped (Pl. XLVIII. fig. 1), or lenticular. Clv., rhombohedral along R. perfect; brittle. H. = 3·5 to 4·5; G. = 3·7 to 3·9. Translucent in various degrees, becoming opaque when weathered; vitreous or pearly. Rarely white, generally yellowish-grey or yellowish-brown, changing to red or blackish-brown on exposure. B.B. infusible, but becomes black and magnetic; with borax and salt of phosphorus shows reaction for iron; with soda often for manganese. In acids soluble with effervescence. Comp., carbonate of iron, with 62·1 protoxide of iron and 37·9 carbonic acid, but usually 0·5 to 10, or even 25, protoxide of manganese, 0·2 to 15 magnesia, and 0·1 to 2 lime.

SHETLAND—MAINLAND. Aithness Hill, in veins in the banks (Hibbert). Sandlodge (Fleming).

PERTHSHIRE. Ben Ledi, at the lower top and in the channel of the stream on the east side, with Chalcopyrites and Galena. Transparent and brown (Macknight). East of †Boothe, on the Tay, with Brown Spar in a Calcite vein in porphyry (Fleming).

ARGYLLSHIRE. Glencoe, crystallised, in Quartz. Near the head of Loch Long, in clear rhombs, in a Quartz vein, with Chlorite in chlorite schist (Dalziel). Kintyre, at Inverneil, crystallised with Chalcopyrite and Galena, in a Quartz vein. Morven, Glen Sanda property, at Rudha a Chamais Bhain, half a mile north of the castle, in two trap dykes, with crystallised Quartz, Calcite, Barytes, Millerite, Blende, and Galena. At Erins, north of Loch Tarbert, manganesian, in simple rhombs, with Chalcopyrite and Göthite. Mull of Kintyre, at the Largybaan caves, in large rhombs, with Limonite.

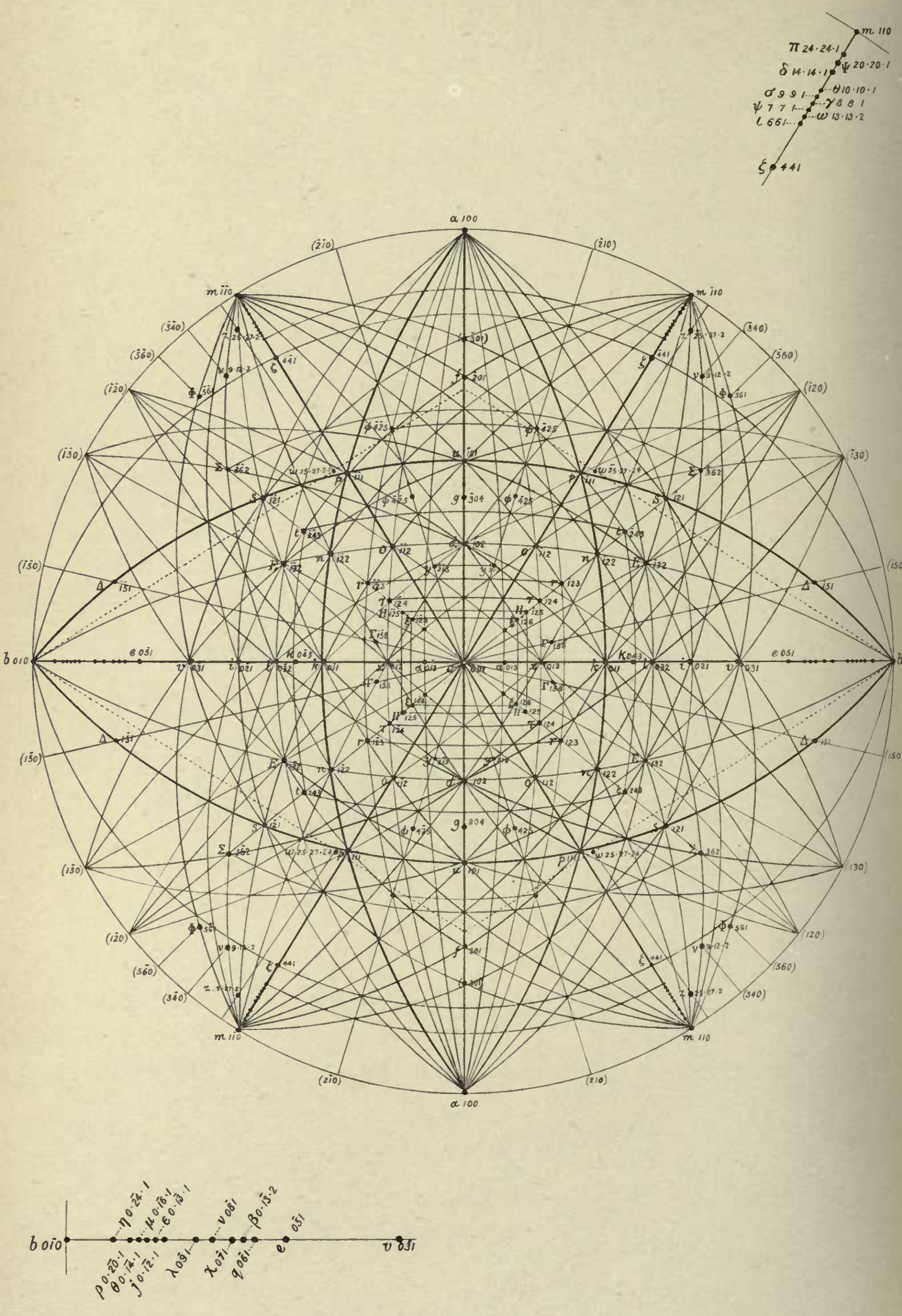
HADDINGTON. At the Garleton Hills, in small rhombs, with Göthite.

LANARKSHIRE. Rarely in the Glengonnar shaft, Leadhills, in twisted rhombs (Plate XLVII. fig. 1).

KIRKCUDBRIGHT. At the Pibble mine, with ores of lead and copper (D. and H.).

ARRAN. Said to occur in a columnar form (Greg).

J. G. Goodchild.



A variety which is possibly Mesetite (272a), a subspecies intermediate between Magnesite, Breunnerite, and Siderite) occurs [in a vein] in sandstone, at Strathwhellan, near Brodick (Currie).

Sideroplesite (273) [a calciferous variety of, or a calciferous Pistomesitite].

SHETLAND—MAINLAND. Sandlodge mines. In crystals imbedded in Quartz, and specially associated with Chalcopyrite, in the deeper parts of the mine (Fleming). Analysis:—

Carbonate of Iron,	. . .	62·4
,, of Manganese,	. . .	2
,, of Magnesia,	. . .	24·9
,, of Lime,	. . .	9·9
Silica,	. . . . .	·8
		100·0

[**Smithsonite (275)**, $ZnCO_3$, Zinc Carbonate, has not yet been detected in Scotland.]

66. **Aragonite (277).** $CaCO_3$.

Orthorhombic; [*a*, 100; *m*, 110; *b*, 010; *p*, 111; *k*, 011; *x* and *r*, 012; *u*, 101; $g\frac{1}{12}$ [$=e\frac{1}{12}$, Descl.] 091 (λ); $m\frac{1}{12}$ [$=b\frac{1}{12}$, Descl.] 991· (σ); ν, 081; ζ, 441; ξ, 126]. The most common crystals are long-prismatic, short-prismatic, or acute-pyramidal. But simple crystals are rare, from the great tendency which the mineral exhibits to form twins and compound aggregations. Also occurs as columnar, fibrous, and in crusts, stalactites, and other forms. Clv., brachydiagonal distinct; fracture conchoidal or uneven. H.$=$3·5 to 4; G.$=$2·9 to 3 (massive 2·7). Transparent or translucent; vitreous. Colourless, but yellowish-white to brick-red; also light green, violet-blue, or grey. In the closed tube, before reaching a red heat, it swells, and falls down into a white coarse powder, evolving a little water.

SHETLAND—UNST. Hagdale quarry. In stellar and diverging groups of crystals on Chromite, *m u b*; also $m\frac{1}{12}$ $g\frac{1}{12}$ *p k x* (Plate XLVIII. fig. 1). Nikka Vord Hill similarly, with Kämmererite and Hydromagnesite (D. and H.). On a hill north of Uya Sound, in large crystals, in veins in Serpentine, with Picotite, also in lustrous fibrous brushes—Anal. . Mainland, Colla Firth, on the south shore, in rosette crystals, on pale green serpentine (D. and H.).

[? INVERNESS-SHIRE.] †The Leys, associated with Barytes, Calcite, and Pyrites.

BANFFSHIRE. Portsoy, in rosette crystals, upon pale-green serpentine, very lustrous.

FIFESHIRE. In Magus Muir limestone quarry, rarely, in fine groups of divergent crystals, and in the forms $\nu \xi u$; $\nu \zeta x$.

LANARKSHIRE. On the upper waters of the Daer, Clyde, at Potrail, crystallised in veins in Silurian rocks. At Leadhills, in long radiating transparent crystals, $m k r$ (Plate XLVIII. fig. 2), and $\nu \zeta x$; $\nu \zeta k$. Also in snow-white stalactitic and coralloidal masses, and in sea-green divergent groups resembling Strontianite—Anal. 1 (H., *Min. Mag.*, v. 22).

RENFREWSHIRE. Occasionally terminates as in Plate XLVIII. figs. 3, 4, and 5. Near Pollock Castle, in trap.

KIRKCUDBRIGHTSHIRE. In Dirk Hatterick's Cave, in radiated and stalactitic shapes, and also in silky fibrous masses (Greg).

The fibrous variety, which rarely assumes a silky lustre, and is termed *satin spar*, occurs in :—

ORKNEY. Island of Fara, in a vein two inches thick (Fleming). Hoy, at Rackwick, on the north shore of the bay, in narrow veins.

FIFESHIRE. To the east side of the old tower of Seafield. East of Elie, of a pink colour, in veins some inches wide, with Barytes (Greg). Kincraig, at its western extremity, in similar veins, and of a still-finer pink, about high-water mark, in horizontal tufa, near the sand of the bay—Anal. 2. Near Crail. Near Lochgelly. On Inchkeith (Currie).

FORFARSHIRE. In the Craig railway cutting. In veins with Barytes and Zeolitic Quartz (Mitchell and H.).

PERTHSHIRE. Along the banks of the Earn, in small veins, with rock marl. Glen Tilt, at Gows Bridge, in marble (MacCulloch).

MIDLOTHIAN Midcalder, at Pumpherston, in a vein an inch in thickness.

	$CaCO_3$.	$SrCO_3$.	$FeCO_3$.	$MgCO_3$.	$MnCO_3$.
Leadhills, . .	96·43	1·73	...	...	...
Kincraig, . .	99·365	...	·412	·093	·028

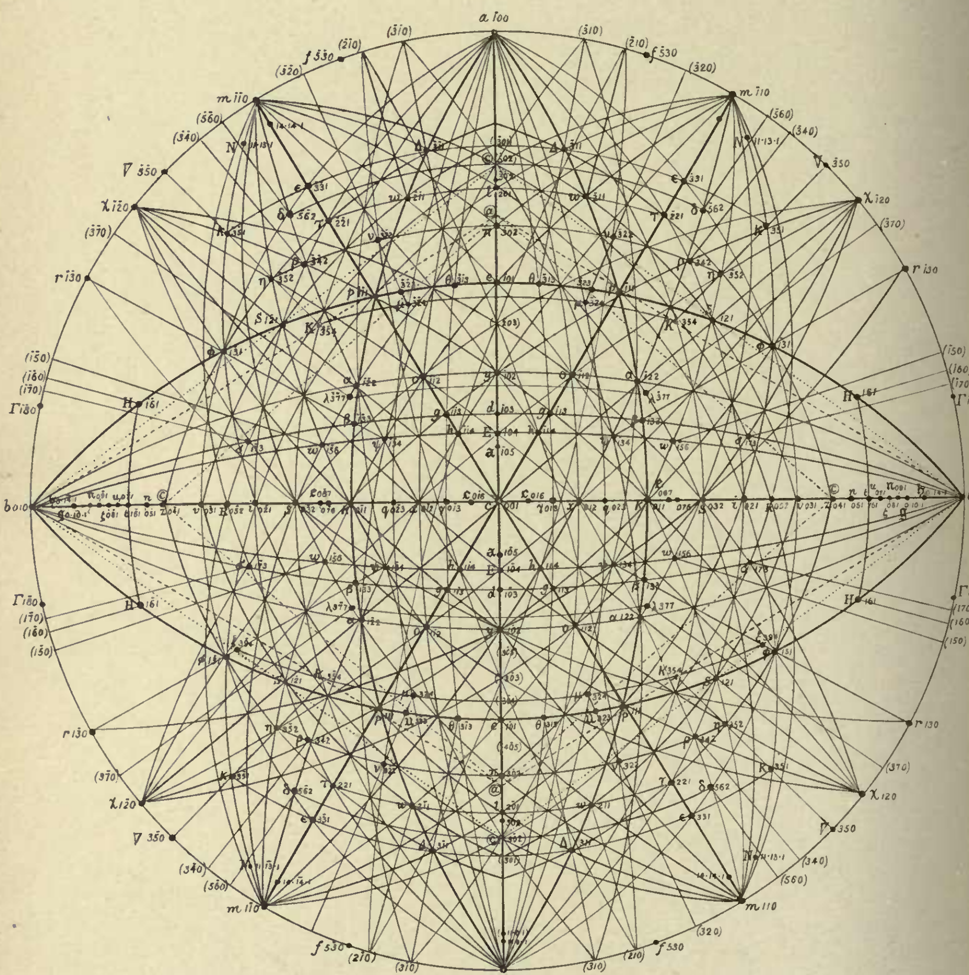
[**Witherite (279)**, $BaCO_3$, has not yet been detected in Scotland.]

67. **Strontianite (280).** $SrCO_3$.

Orthorhombic. Crystals and twins like Aragonite; also broad columnar and fibrous. Clv., prismatic, along *m*. H. = 3·5; G. = 3·6 to 3·8. Translucent or transparent; vitreous, or resinous on fracture. Colourless, but often light asparagus- or apple-green, more rarely greyish, yellowish, or brownish. B.B. fuses in a strong heat only on

Cerussite.

J. G. Goodchild.



very thin edges, intumesces in cauliflower-like forms, shines brightly, and colours the flame red; easily soluble with effervescence in acids. Comp., 30 Carbonic Acid and 70 Strontia, but often contains carbonate of lime (6 to 8). [*a*, 100; *c*, 001; *m*, 110; *i*, 021; *p*, 111; *o*, 112; χ, 012·1; ζ, 081.]

SUTHERLAND. Tongue, Ben Bhreac, in the great "syenite" boulder, in diverging crystals, which form spherical masses in a cavity in the granitic vein, disposed upon Rock Crystal and Amazonstone. Colour nearly white. S.G., 3·447 (D. and H.). Also in the mass of the syenite near the granitic vein, in small cavities, which were lined with crystals of hornblende and felspar. It occurs in the form of a white powder—Anal. 1.

ARGYLLSHIRE. At Strontian. At Whitesmith, Bellsgrove, and Fee Donald mines, with Harmotome, Calcite, and Galena, rarely with Brewsterite. At Whitesmith mine, at Strontian, its associate is Calcite and calcareous Barytes. Here it is generally green or white. Rarely in crystals [specimens in the Edinburgh Museum from this mine are of the forms $c\,a\,\chi\,\zeta\,m\,p\,o$; $a\,\chi\,i\,m\,o$]—Anal. 2. At Bellsgrove its associates are Calcite and Harmotome, and here it frequently is brown in colour. At Fee Donald mine, Strontian, it is rare, and is associated with Barytes. [Fig. 2, Plate XLVIII., represents also Strontianite.]

Strontianite was discovered by Walker in 1764; but he had, in 1761, noticed it at Leadhills, on specimens unquestionably brought by miners from Strontian. In 1791, Dr Hope discovered the earth Strontia in some of the specimens noticed by Walker.

Stromnite, a variety of Strontianite, occurs in veins in the Caithness Flags (Middle Old Red Sandstone) at the Point of Ness, Stromness, Orkney (Traill). It is a mixture of Strontianite and Barytes.

	SrO.	CaO.	CO_2.
The great Boulder at Tongue, Sutherland, ... (1)	58·846	8·529	32·305
Whitesmith Mine, Strontian, . (2)	...	...	...

68. **Cerussite (281).** $PbCO_3$.

Orthorhombic. [*N.B.*—The symbols and letters employed in the following description of Cerussite are those used by Schrauf in his *Atlas der Crystall-Formen des Mineralreichs.* $a:b:c=1:0·9988:0·8127$. *a* (*b*), 100; *b* (*a*), 010; *c*, 001; *y*, 011; *e*, 021; γ, 203; *x*, 101; *k*, 201; *i*, 401; *v*, 601;

BUTE. Port Bannatyne, on a hill near the church on the road to Etterick Bay, 250 feet up the hill.

BERWICKSHIRE. At Keelstone Pool, with Chalcocite and Barytes.

KIRKCUDBRIGHT. Near Castle Douglas, at the Balcary mine, Lauchentyre, in pale green fibrous brushes (D. and H.). At Kings Laggan mine (D. and H.). At the Pibble mine, south of Cairnsmore of Fleet, with Linarite, Chalcopyrite, etc. (D. and H.). At Barlocco, near Orroland, with Azurite, in a vein of Baryte.

71. **Azurite (289).** $Cu_3(OH)_2(CO_3)_2$.

Monoclinic. Rarely found well-crystallised in Scotland. Clv., clinodomatic, rather perfect; fracture conchoidal or splintery. H., 3·5 to 4·2; G., 3·7 to 3·8. Translucent or opaque; lustre vitreous. Colour azure blue to smalt blue. B.B., etc., the same as Malachite. Comp., 69·1 Protoxide of Copper, 25·7 Carbonic Acid, 5·2 Water.

SHETLAND—MAINLAND. Hillswick, Grariesum, investing Cyanite, pale blue (D. and H.).

ORKNEY. Viera, Rousay, in a Barytes vein in Caithness Flagstone, in small crystals, with Galena, Malachite, Calamine [=Hemimorphite], etc.

SUTHERLAND. In Torridon Sandstone, in the south cliff of Quinag (Nicol).

ROSS. North-west of Loch Garbhaig.

PERTHSHIRE. Taymouth Park, in the old quarry, with Malachite and Chalcopyrite. Near Grandtully, with Chalcocite and Malachite.

LOTHIANS. Coating joints and fissures in Lower Carboniferous Sandstone, on the Pentland Hills, above Torduff (Goodchild).

KIRKCUDBRIGHTSHIRE. At Barlocco, near the house of Orroland, with Malachite, in a vein of Barytes.

At Leadhills and Wanlockhead (Greg); probably a mistake for Linarite.

72. **Aurichalcite (290).** $(Zn,Cu)_5(OH)_6(CO_3)_2$.

? Monoclinic. In groups of acicular crystals, forming incrustations. Transparent, pearly, and in colour verdigris-green. Comp., 29·2 Copper Protoxide, 44·7 Zinc Oxide, 16·2 Carbonic Acid, 9·9 Water.

Occurs chiefly in metalliferous veins traversing Silurian and Ordovician graywackes in the south-west of Scotland. At Wanlockhead, it occurs as small incrusting masses associated with Susannite, Malachite, Leadhillite, and Hydrocerussite, chiefly at the Susanna mine. Its analysis gave:—CuO, 28·402; ZnO, 45·67; CaO, ·22; CO_2, 16·064; H_2O, 9·981 (H.). It is also found at Balcary, in Kirkcudbright, associated with Quartz, Dolomite, and Pitchy Copper ore. A globular mineral, referred with some doubt to the same species, is associated with Calcite in a mineral vein at Lauchentyre, in the same county.

73. Hydrocerussite (292). $Pb_3(OH)_2(CO_3)_2$?.

Rhombohedral. Occurs in thin scaly coatings, of a white colour and with a pearly lustre, in cavities in galena, associated with Cerussite and globular Plumbo-calcite, at Belton Grain mine, Wanlockhead.

Analysis:—

PbO.	H_2O.	CO_2.
92·848	2·008	4·764

$= PbO,CO_2.3PbO,H_2O$. Heddle.

74. Hydromagnesite (300). $Mg_4(OH)_2(CO_3)_3+3H_2O$.

Monoclinic. Crystals small, rare; also massive. H., 1·5 to 3; G., 2·14 to 2·18. Vitreous or silky; colour white. Comp., 36·2 Carbonic Acid, 44 Magnesia, 19·8 Water.

SHETLAND. Unst, at Swinna Ness, in the veins in Serpentine which carry Brucite. It occurs in cavities in the Brucite, in minute shining crystals which line their sides, the centres of these cavities being filled with a brown powder. The largest crystals were not one-eighth of an inch in length. The forms appear to be identical with those given in Dana's *Mineralogy*, 6th edition, page 304, and the faces *a* (100) and *y* (121) are distinctly measurable. It also occasionally here coats Brucite in an earthy form. Rarely in small rosettes of crystals, one face of which has a pearly lustre, upon pale green serpentine, in the quarries south of Nikka Vord Hill. Mainland, Colla Firth, on the south shore, similarly to the above, also upon pale-green serpentine, rarely (D. and H.).

BANFFSHIRE. At Portsoy, on the verdigris-green serpentine, in similar rosettes of crystals with one lustrous face, near veins of Precious Serpentine, very rarely.

75. Pennite (302). $(CaMg_2)CO_3+H_2O$.

Surrounds Chromite and coats with a greenish incrustation shrinkage cracks of that mineral, at the Hagdale Quarry, Unst, SHETLAND (Currie).

76. Hibbertite (302). (Heddle, *Min. Mag.*, ii. p. 24.)

A pulverulent lemon-yellow substance, occurring as an incrustation; and associated with Kämmererite and Chromite, in the Serpentine of Nikka Vord and Hagdale, Unst.

Analysis :—

$CaCO_3$.	Fe_2O_3.	MnO.	MgO.	CO_2.	H_2O.
28·459	3·229	·583	26·554	25·442	15·733

$= 3CaO,CO_2.3(MgO,H_2O)$. (Heddle, as above.)

77. **Zaratite** (303). $Ni_3(OH)_4CO_3+4H_2O$.

Amorphous, reniform, and incrusting. H., 3; G., 2·6 to 2·7. Translucent; vitreous. Colour emerald-green.

Occurs as an incrustation, chiefly on, or in association with, Chromite, in the Serpentine of Hagdale quarry, Unst, Shetland. A mineral doubtfully referred to the same species occurs on Amphibolite schist at Erins, Argyllshire, in association with Chalcopyrites.

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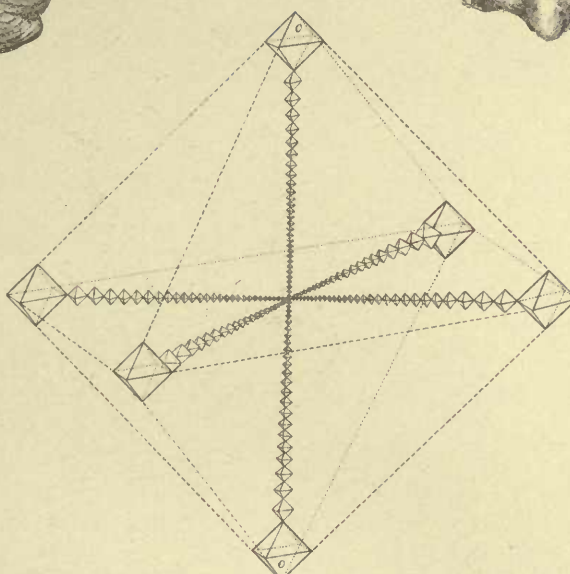
Plate I.

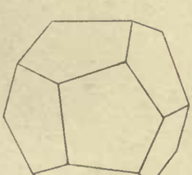
Gold-(**13**) Fig. 1.

(**13**) Fig. 2.

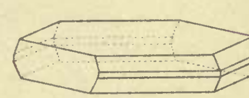
Silver-(**14**)



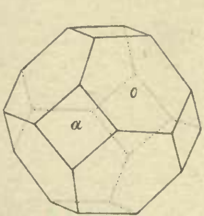
Copper-(**15**)



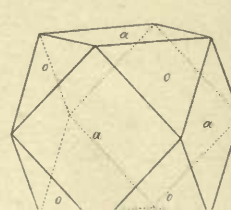
Molybdenite-(**34**)



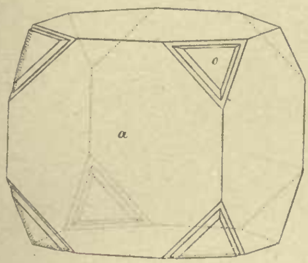
Argentite-(**42**)



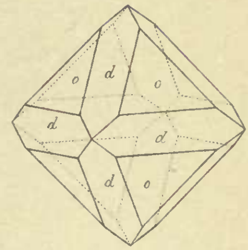
Galena-(**45**) Fig. 1.



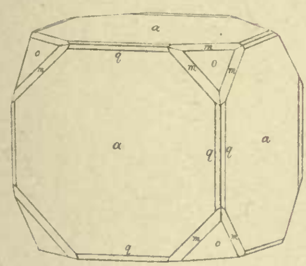
Galena (**45**) Fig. 2.



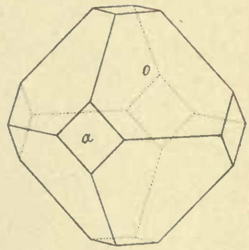
(**45**) Fig. 3.



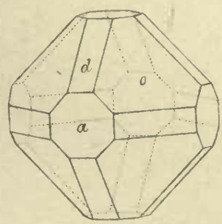
(**45**) Fig. 4.



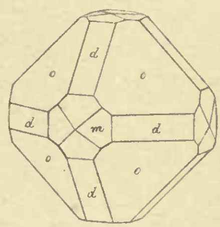
(**45**) Fig. 5.



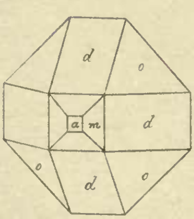
(**45**) Fig. 6.



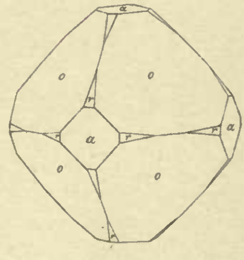
(**45**) Fig. 7.



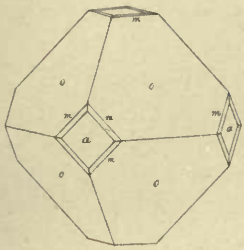
(**45**) Fig. 8.



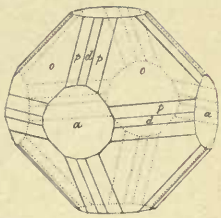
(**45**) Fig. 9.



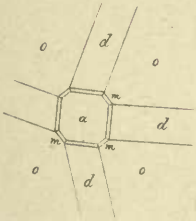
Galena (45) Fig. 10.



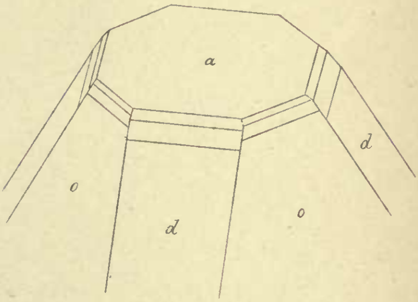
(45) Fig. 11.



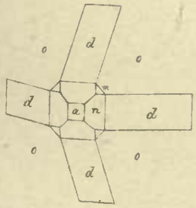
(45) Fig. 12.



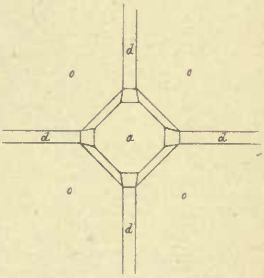
(45) Fig. 13.



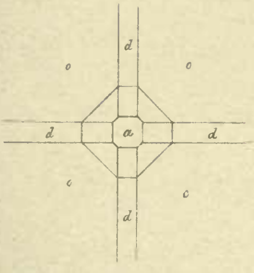
(45) Fig. 14



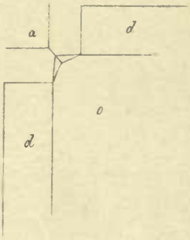
(45) Fig. 15.



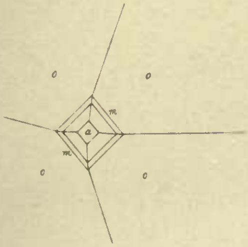
(45) Fig. 16.



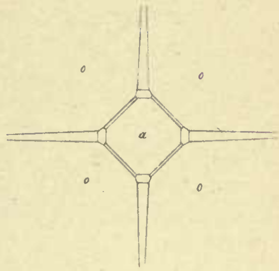
(45) Fig. 17.



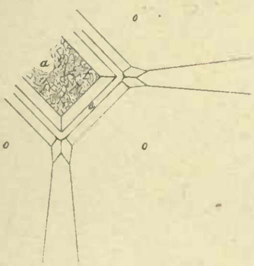
Galena (45) Fig. 18.



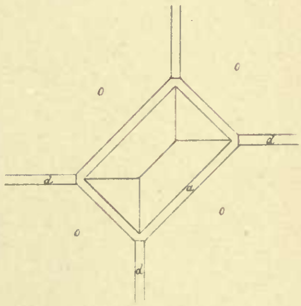
(45) Fig. 19.



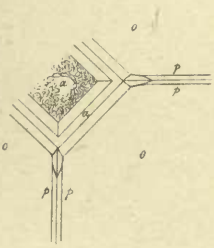
(45) Fig. 20.



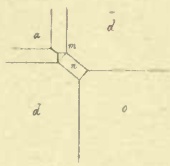
(45) Fig. 21.



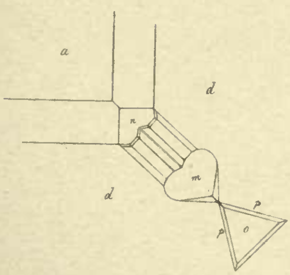
(45) Fig. 22.



(45) Fig. 23.



(45) Fig. 24.



(45) Fig. 25.

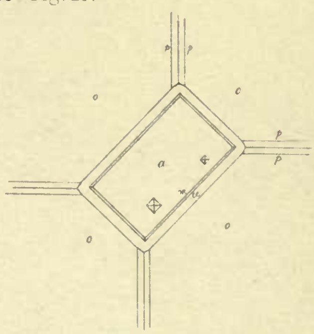
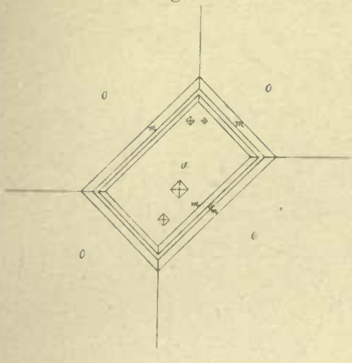
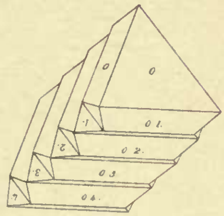


Plate V.

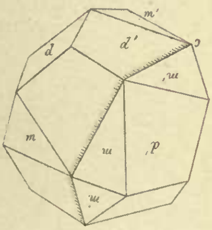
Galena (45) Fig. 26.



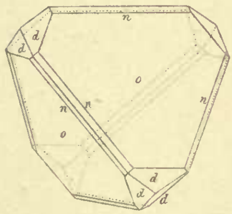
Blende (58) Fig. 1.



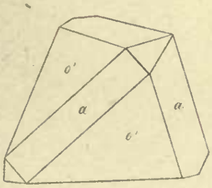
(58) Fig. 2.



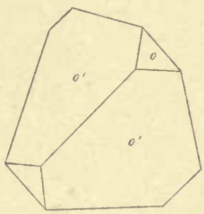
(58) Fig. 3.



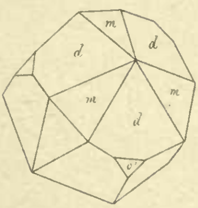
(58) Fig. 4.



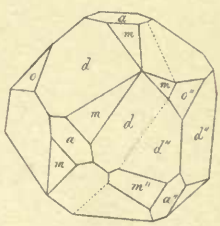
(58) Fig. 5.

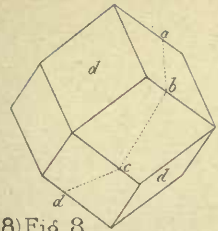


(58) Fig. 6.

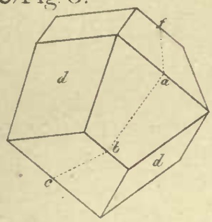


(58) Fig. 7.

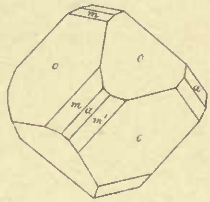




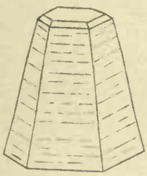
Blende (58) Fig. 8.



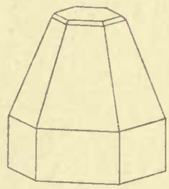
(58) Fig. 9.



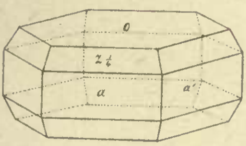
Greenockite (68) Fig. 1.



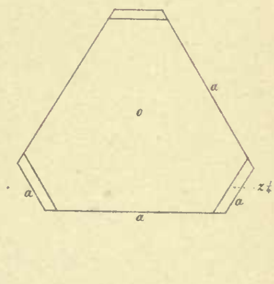
(68) Fig. 2.



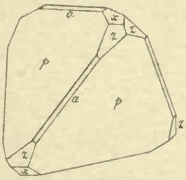
Pyrrhotite (74) Fig. 1.



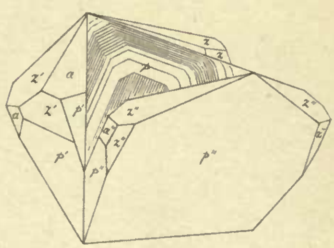
(74) Fig. 2.



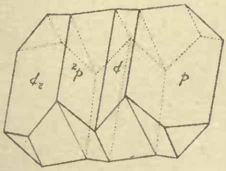
Chalcopyrite (83) Fig. 1.



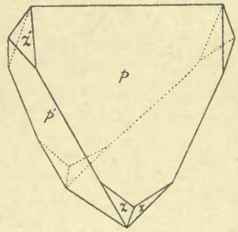
(83) Fig. 2.



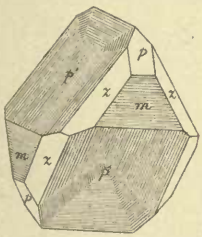
Chalcopyrite (**83**) Fig. 3.



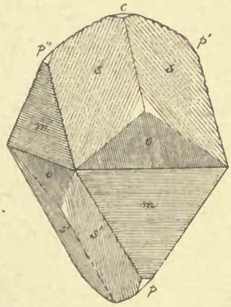
(**83**) Fig. 4.



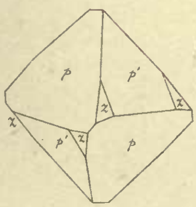
(**83**) Fig. 5.



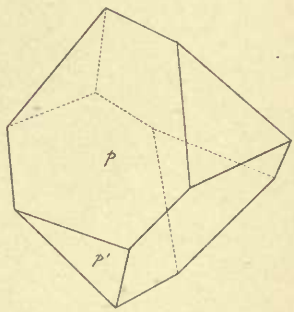
(**83**) Fig. 6.



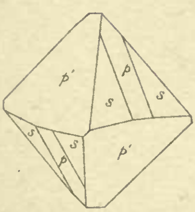
(**83**) Fig. 7.



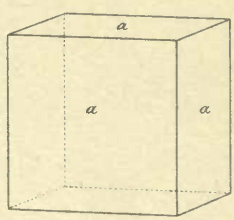
(**83**) Fig. 8.



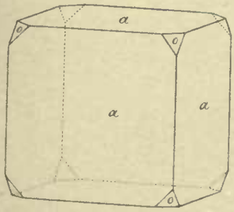
(**83**) Fig. 9.



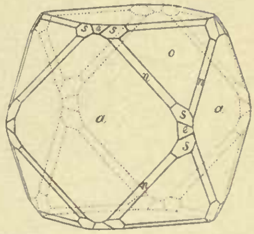
Pyrites (**85**) Fig. 1.



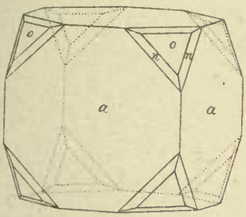
Pyrites (85) Fig. 2.



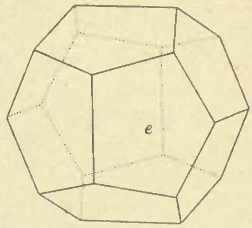
(85) Fig. 3.



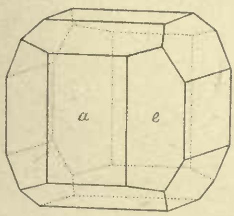
(85) Fig. 4.



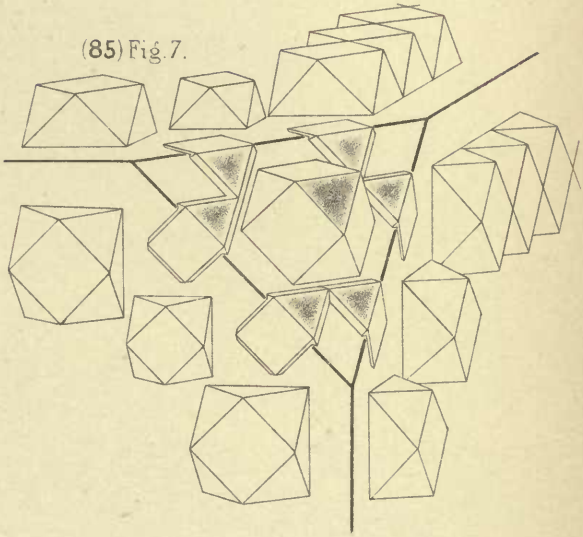
(85) Fig. 5.



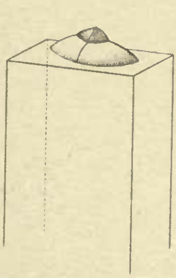
(85) Fig. 6.



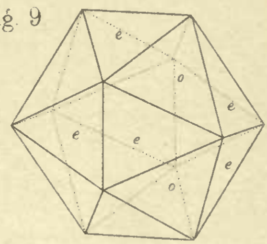
(85) Fig. 7.



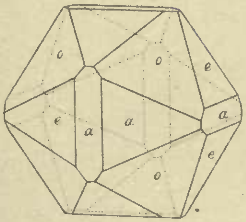
(85) Fig. 8.



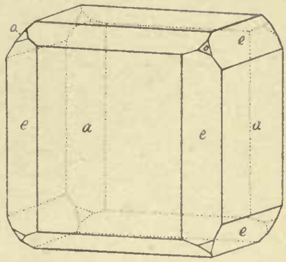
(85) Fig. 9



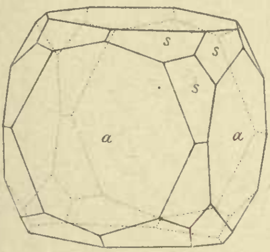
Pyrite (85) Fig. 10.



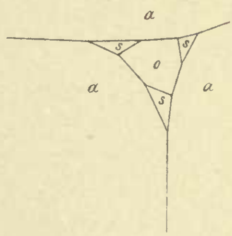
(85) Fig. 11.



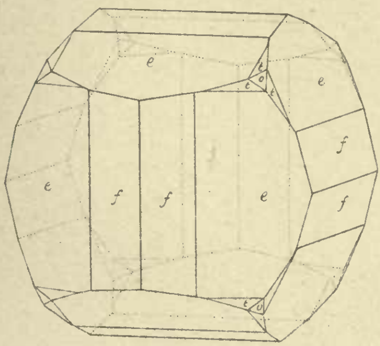
(85) Fig. 12.



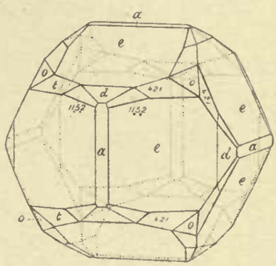
(85) Fig. 13.



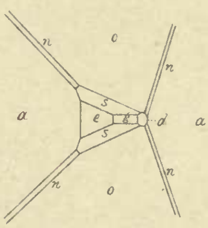
(85) Fig. 14.



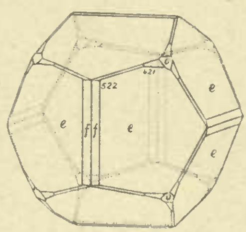
(85) Fig. 15.



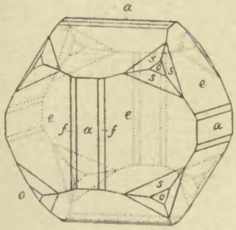
(85) Fig. 16.



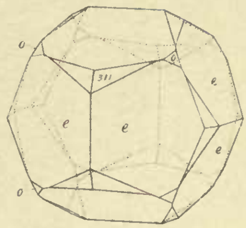
(85) Fig. 17.



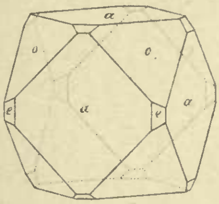
Pyrite (85) Fig. 18.



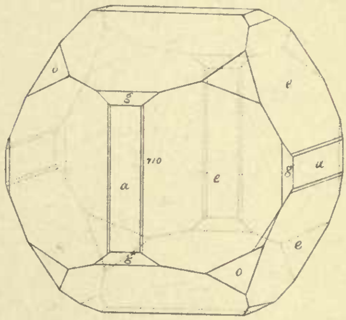
(85) Fig. 19.



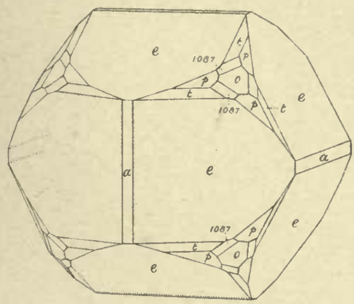
(85) Fig. 20.



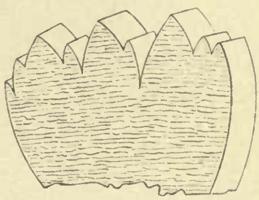
(85) Fig. 21.



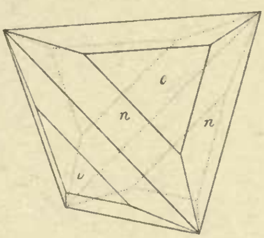
(85) Fig. 22.



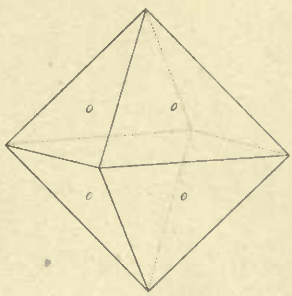
Marcasite (96)



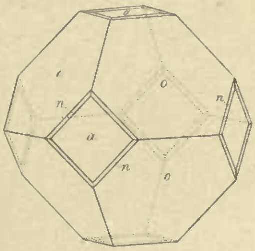
Tetrahedrite (148)



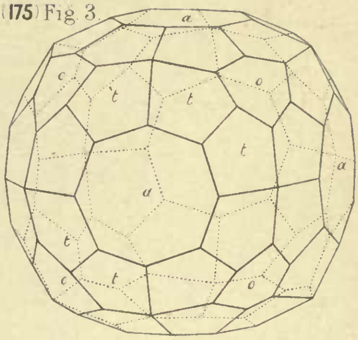
Fluorite (175) Fig. 1.



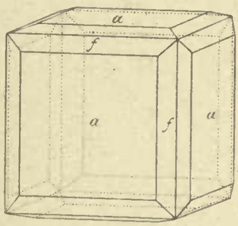
Fluorite (175) Fig. 2.



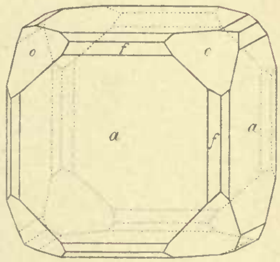
(175) Fig. 3.



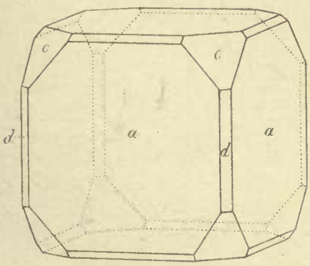
(175) Fig. 4.



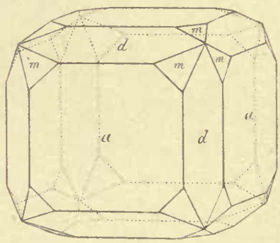
(175) Fig. 5.



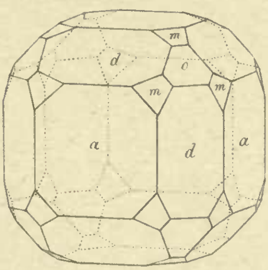
(175) Fig. 6.



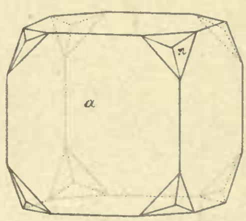
(175) Fig. 7.



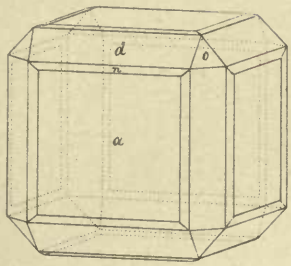
(175) Fig. 8.



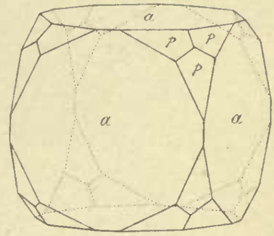
(175) Fig. 9.



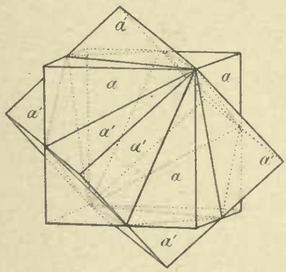
Fluorite (175) Fig. 10.



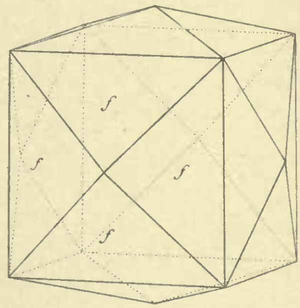
(175) Fig. 11.



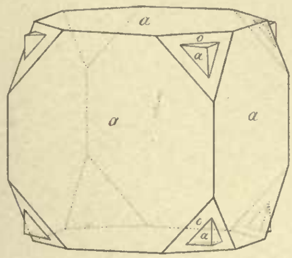
(175) Fig. 12.



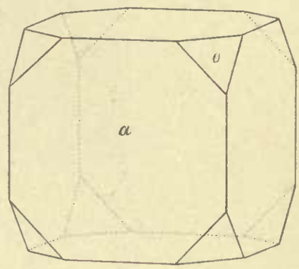
(175) Fig. 13.



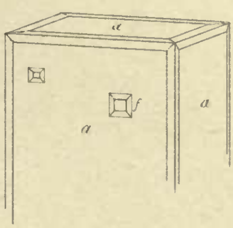
(175) Fig. 14.



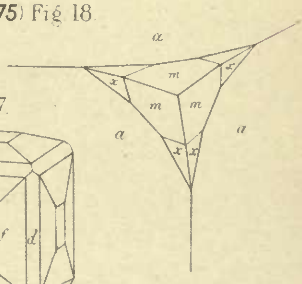
(175) Fig. 15.



(175) Fig. 16.



(175) Fig. 18.



(175) Fig. 17.

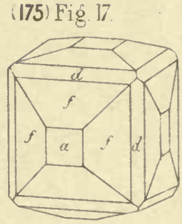
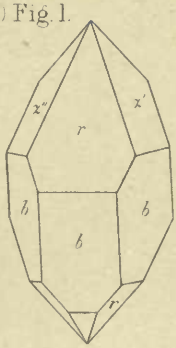
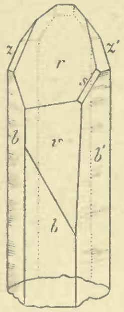


Plate XIII.

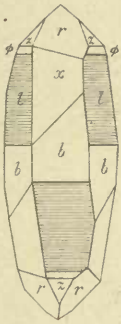
Quartz (210) Fig. 1.



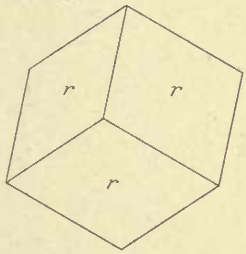
(210) Fig. 2.



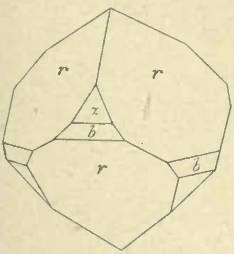
(210) Fig. 3.



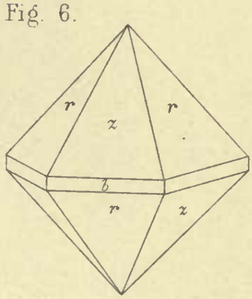
(210) Fig. 4.



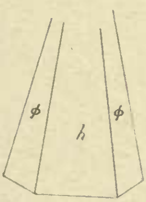
(210) Fig. 5.



(210) Fig. 6.

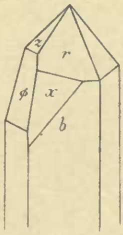


(210) Fig. 7.

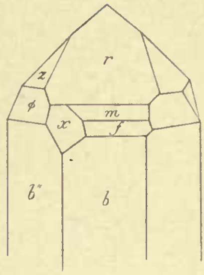


(210) Fig. 8.

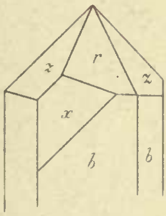
Quartz (210) Fig. 9.



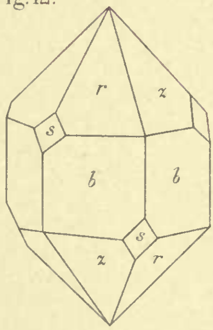
(210) Fig. 10.



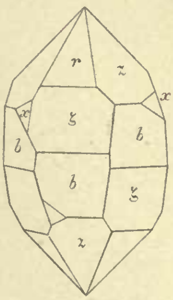
(210) Fig. 11.



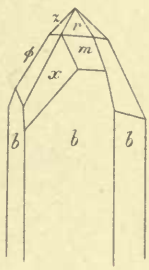
(210) Fig. 12.



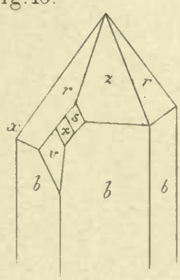
(210) Fig. 13.



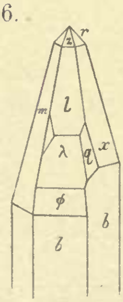
(210) Fig. 14.



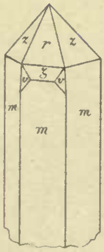
(210) Fig. 15.



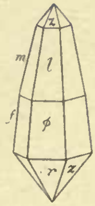
(210) Fig. 16.



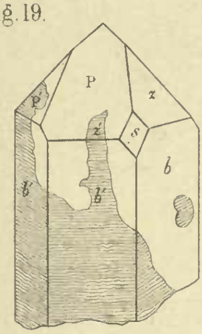
Quartz (210) Fig. 17.



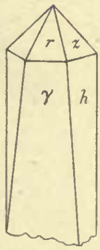
(210) Fig. 18.



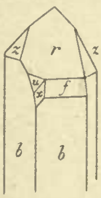
(210) Fig. 19.



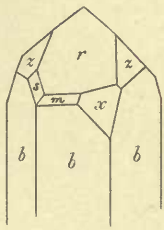
(210) Fig. 20.



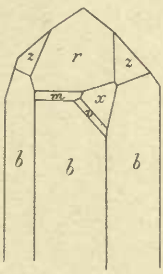
(210) Fig. 21.



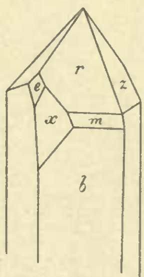
(210) Fig. 22.



(210) Fig. 23.

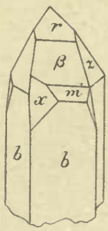


(210) Fig. 24.

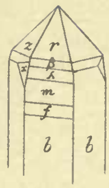


McFarlane & Erskine, Edinr

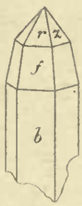
Quartz (210) Fig. 25.



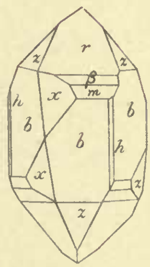
(210) Fig. 26.



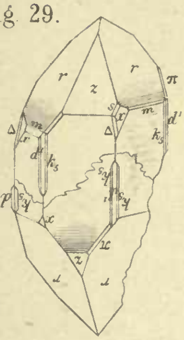
(210) Fig. 27.



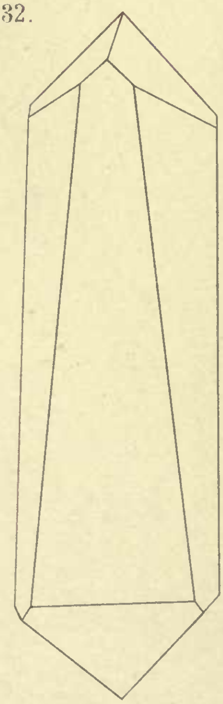
(210) Fig. 28.



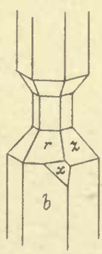
(210) Fig. 29.



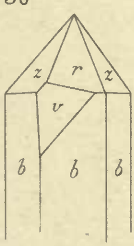
(210) Fig. 32.



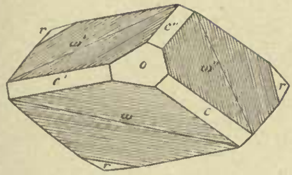
(210) Fig. 31.



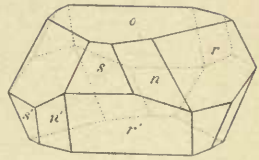
(210) Fig. 30



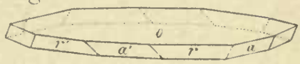
Hæmatite (232).



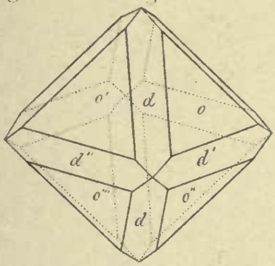
Ilmenite (233) Fig. 1.



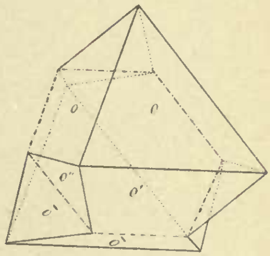
(233) Fig. 2.



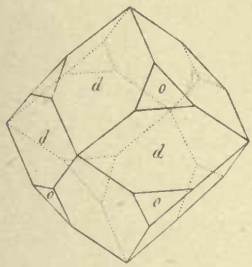
Magnetite (237) Fig. 1.



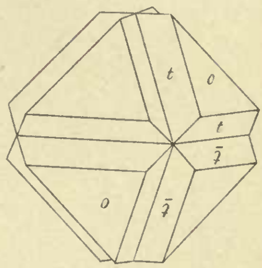
(237) Fig. 2.



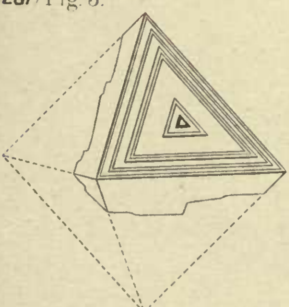
(237) Fig. 3.



(237) Fig. 4.



(237) Fig. 5.



(237) Fig. 6.

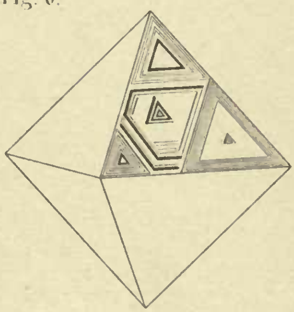
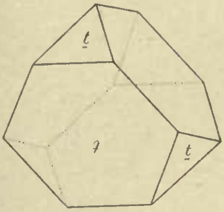
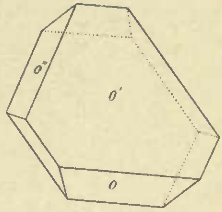


Plate XVIII.

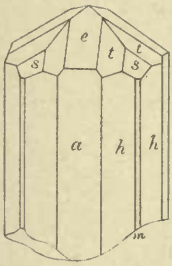
Magnetite (**237**) Fig. 7.



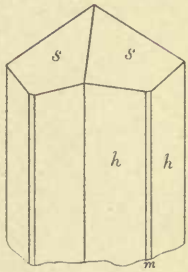
(**237**) Fig. 8.



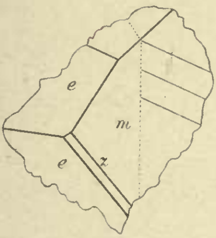
Rutile (**250**) Fig. 1.



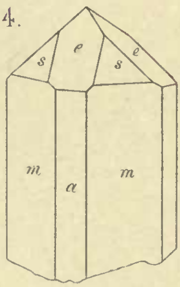
(**250**) Fig. 2.



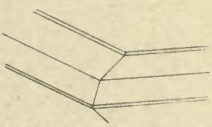
(**250**) Fig. 3.



(**250**) Fig. 4.



(**250**) Fig. 5.



Göthite (**257**).

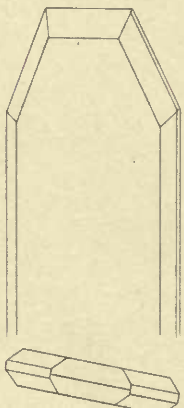
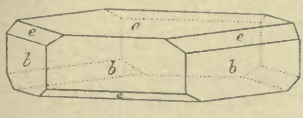
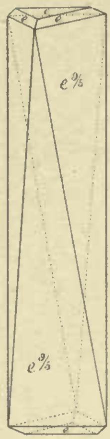


Plate XIX.

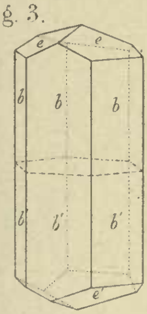
Calcite (270) Fig. 1.



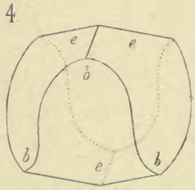
(270) Fig. 2.



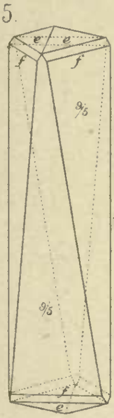
(270) Fig. 3.



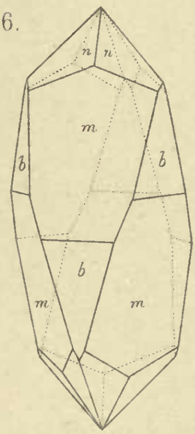
(270) Fig. 4.



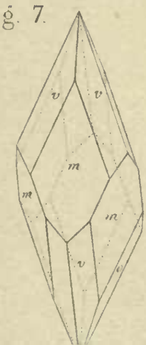
(270) Fig. 5.



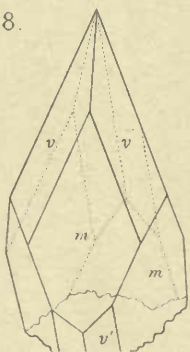
(270) Fig. 6.



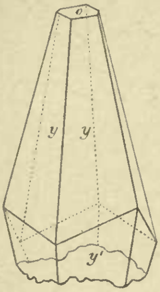
(270) Fig. 7.



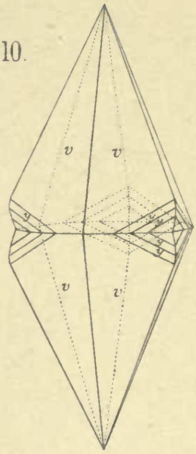
(270) Fig. 8.



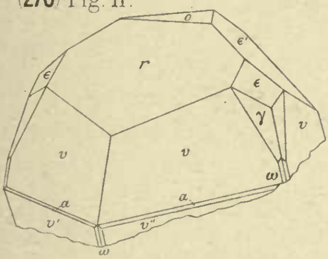
Calcite (270) Fig. 9.



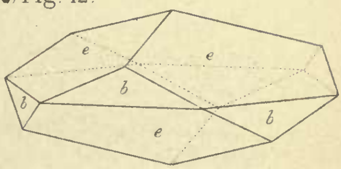
(270) Fig. 10.



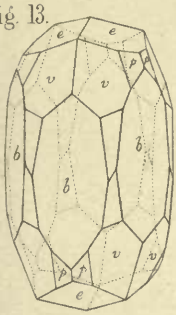
(270) Fig. 11.



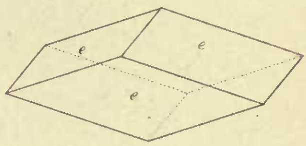
(270) Fig. 12.



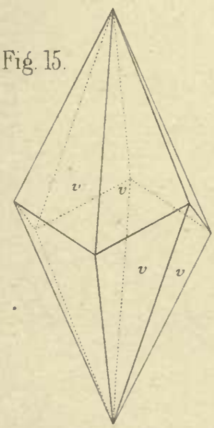
(270) Fig. 13.



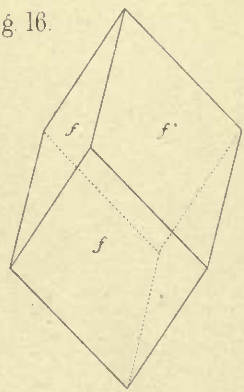
(270) Fig. 14.



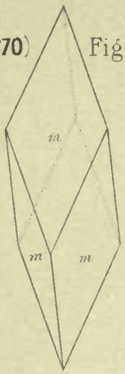
(270) Fig. 15.



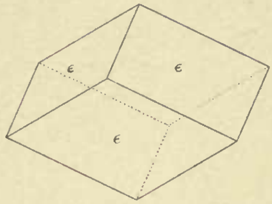
(270) Fig. 16.



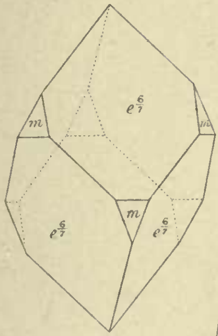
Calcite (**270**) Fig. 17.



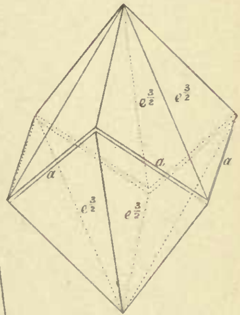
(**270**) Fig. 18.



(**270**) Fig. 19.

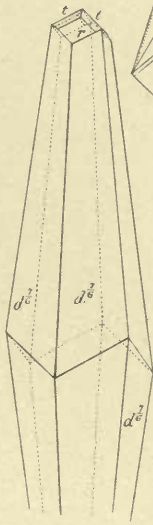


(**270**) Fig. 20.

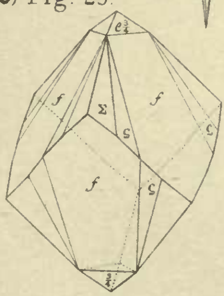


(**270**) Fig. 21.

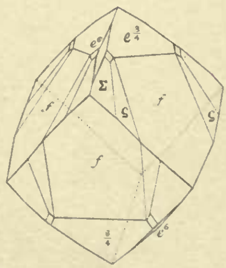
(**270**) Fig. 22.



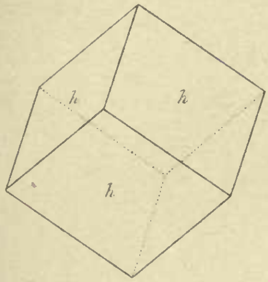
(**270**) Fig. 23.



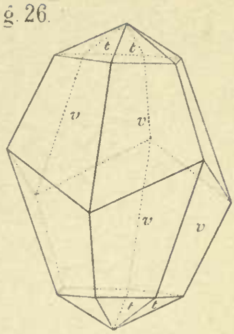
(**270**) Fig. 24.



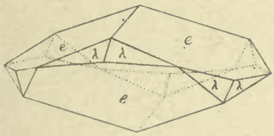
Calcite (270) Fig. 25.



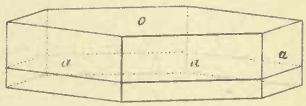
(270) Fig. 26.



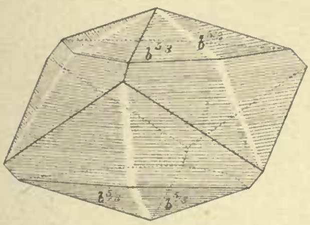
(270) Fig. 27.



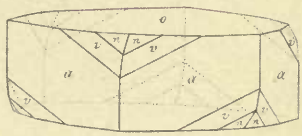
(270) Fig. 28.



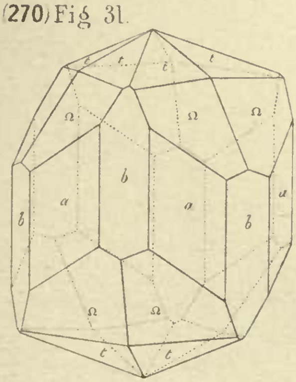
(270) Fig. 29.



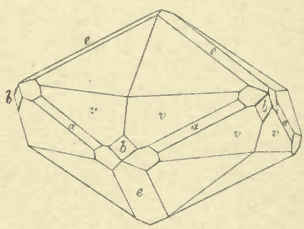
(270) Fig. 30.



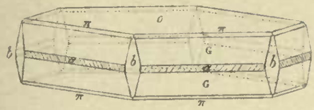
(270) Fig. 31.



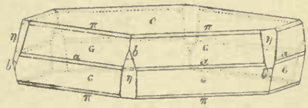
(270) Fig. 32.



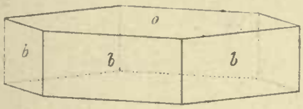
Calcite (270) Fig. 33.



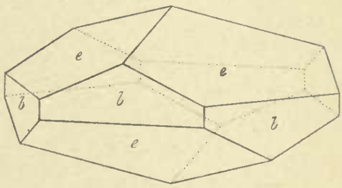
(270) Fig. 34.



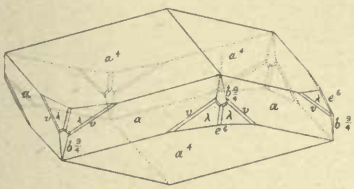
(270) Fig. 35.



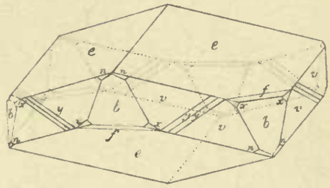
(270) Fig. 36.



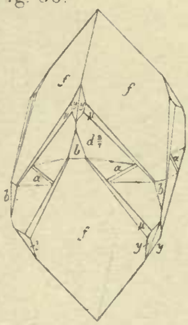
(270) Fig. 37.



(270) Fig. 38.



(270) Fig. 39.



(270) Fig. 40.

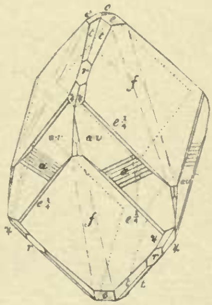
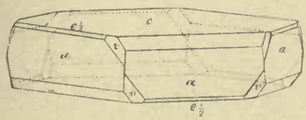
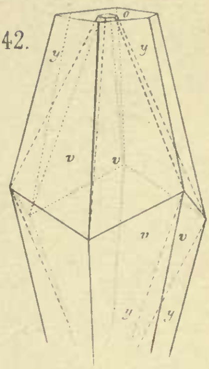


Plate XXIV.

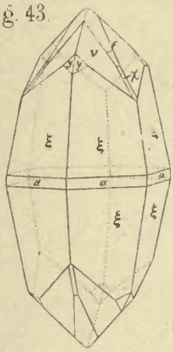
Calcite (270) Fig. 41.



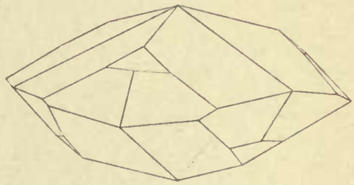
(270) Fig. 42.



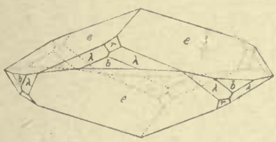
(270) Fig. 43.



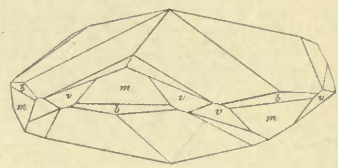
(270) Fig. 44.



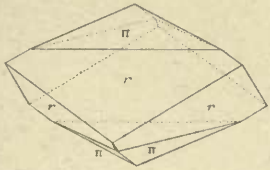
(270) Fig. 45.



(270) Fig. 46.



(270) Fig. 47.



(270) Fig. 48.

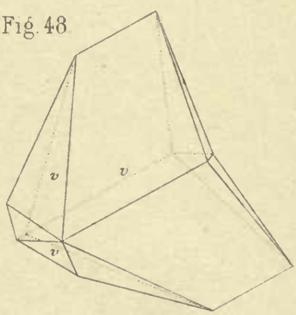
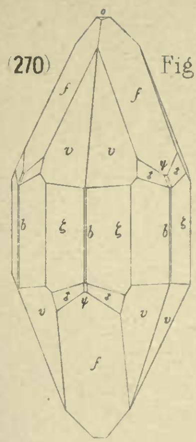
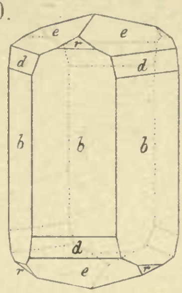


Plate XXV.

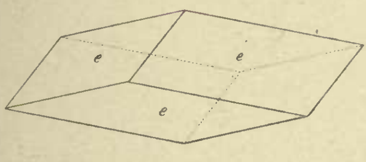
Calcite (270) Fig. 49.



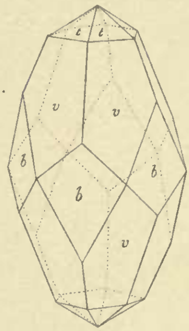
(270) Fig. 50.



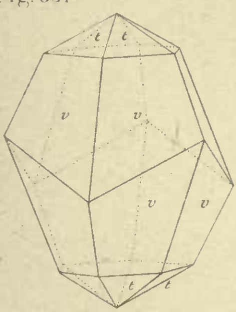
(270) Fig. 51.



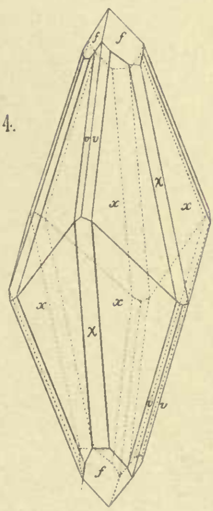
(270) Fig. 52.



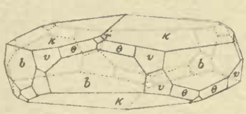
(270) Fig. 53.



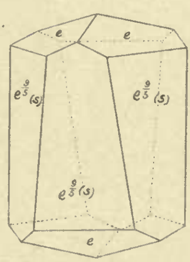
(270) Fig. 54.



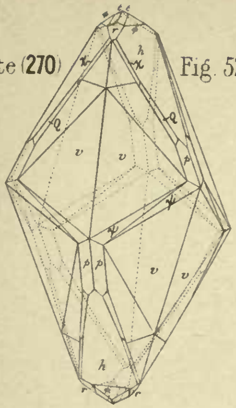
(270) Fig. 55.



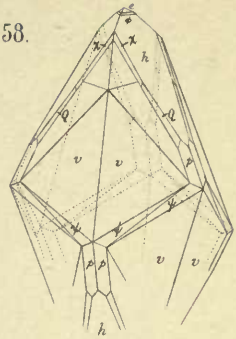
(270) Fig. 56.



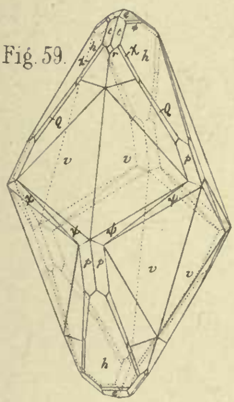
Calcite (270) Fig. 57.



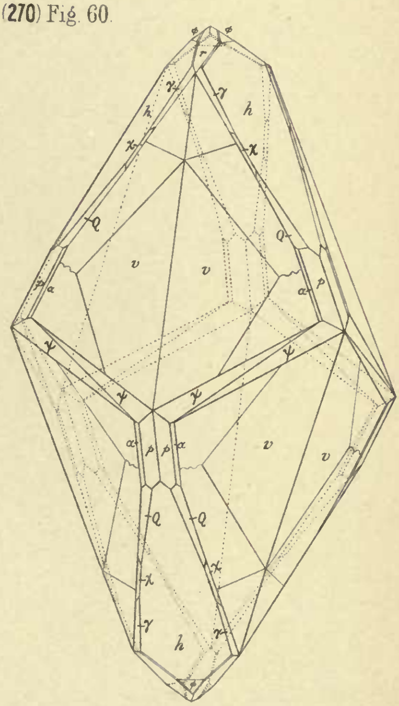
(270) Fig. 58.



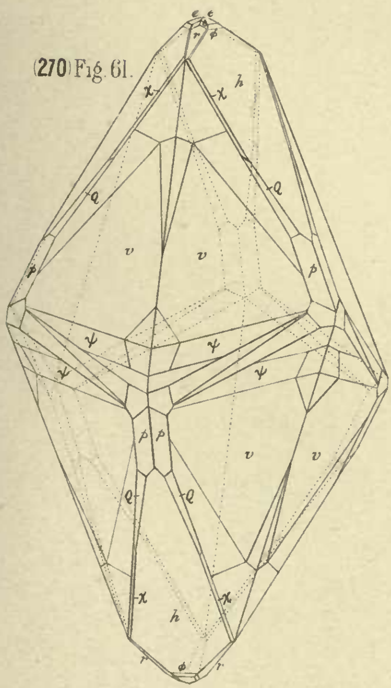
(270) Fig. 59.



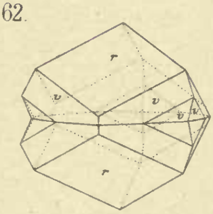
(270) Fig. 60.



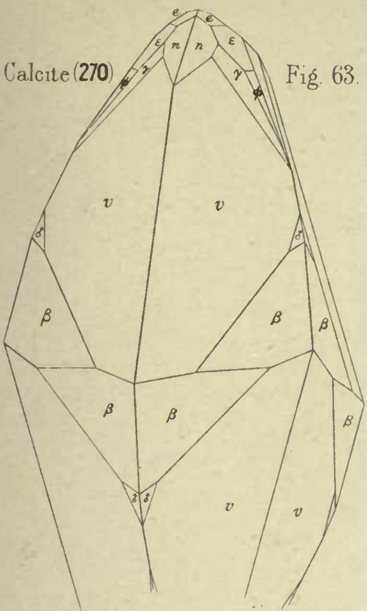
(270) Fig. 61.



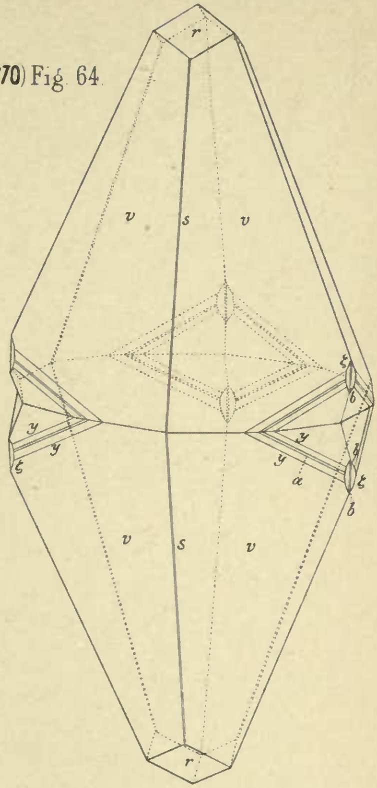
(270) Fig. 62.



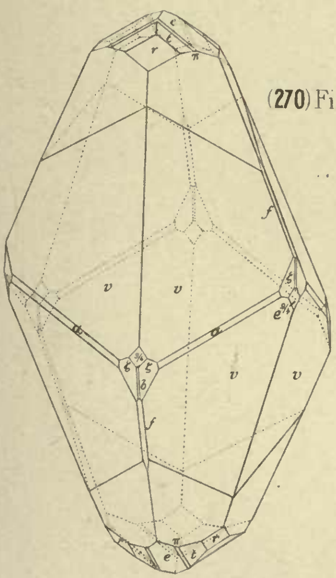
Calcite (270) Fig. 63.



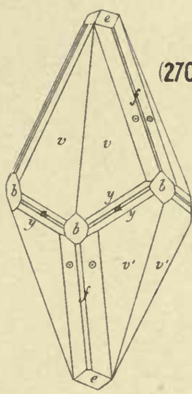
(270) Fig. 64.



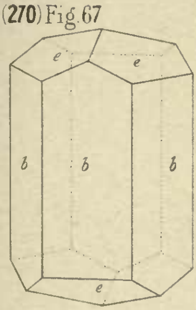
(270) Fig. 65.



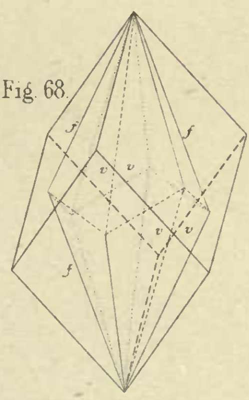
(270) Fig. 66.



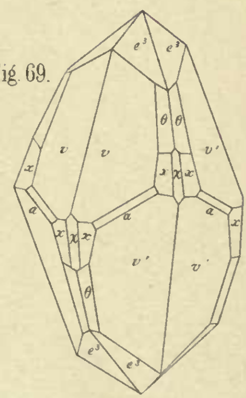
(270) Fig. 67



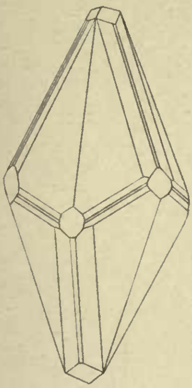
(270) Fig. 68.



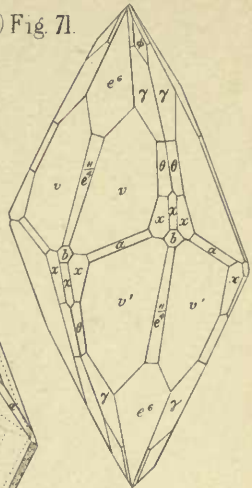
(270) Fig. 69.



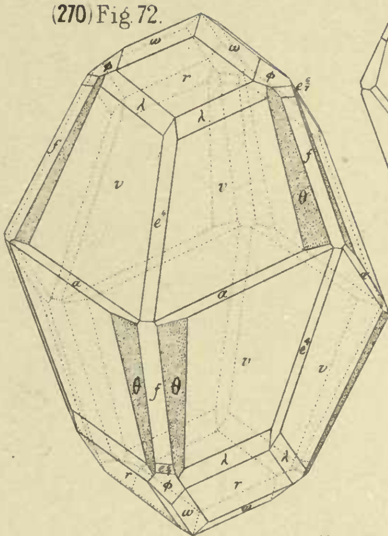
Calcite (270) Fig. 70.



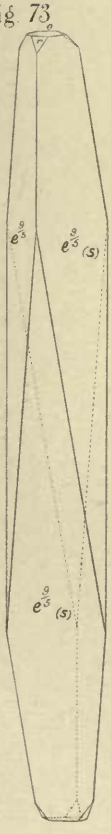
(270) Fig. 71.



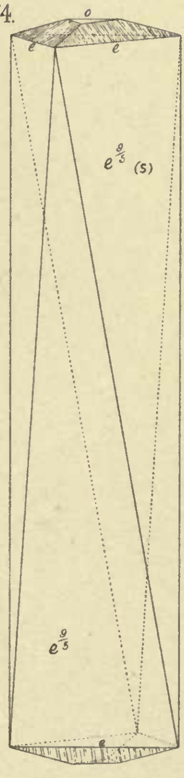
(270) Fig. 72.



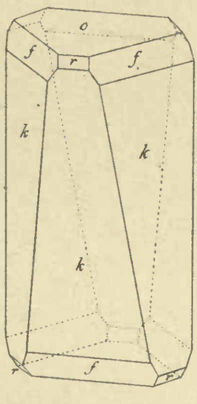
(270) Fig. 73.



(270) Fig. 74.



(270) Fig. 75.



(270) Fig. 76.

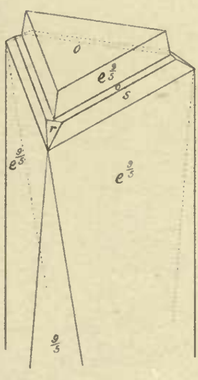
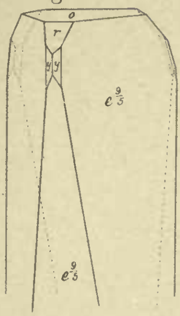
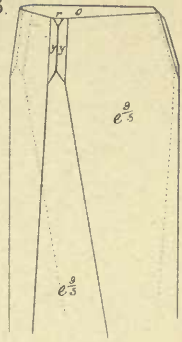


Plate XXIX.

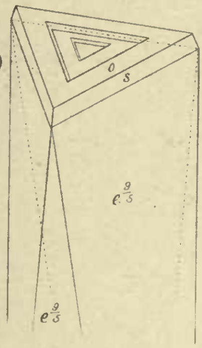
Calcite (270) Fig. 77.



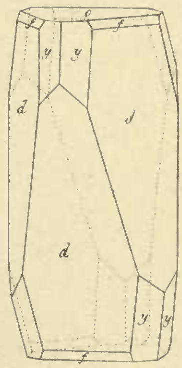
(270) Fig. 78.



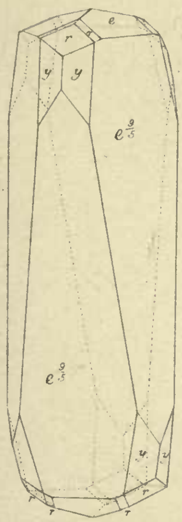
(270) Fig. 79.



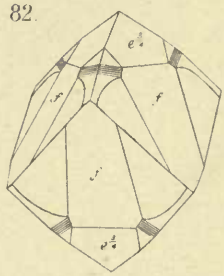
(270) Fig. 80.



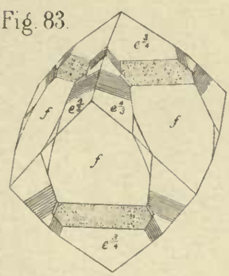
(270) Fig. 81.



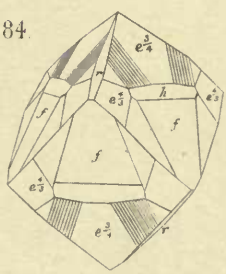
(270) Fig. 82.



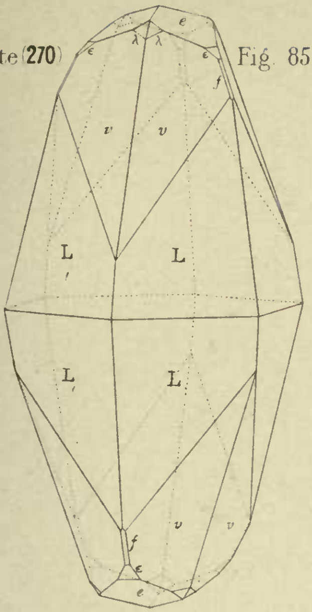
(270) Fig. 83.



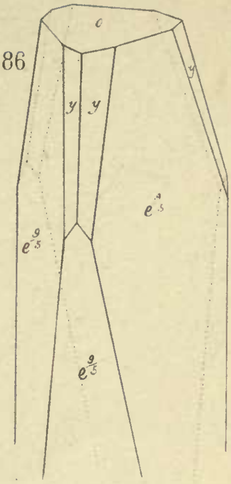
(270) Fig. 84.



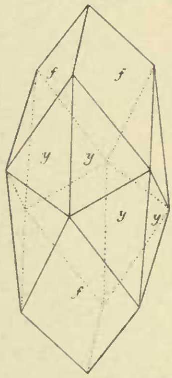
Calcite (270) Fig. 85.



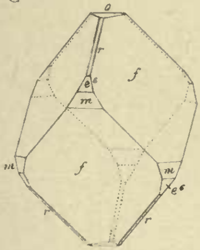
(270) Fig. 86



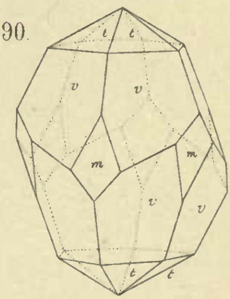
(270) Fig. 88.



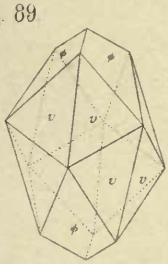
(270) Fig. 87



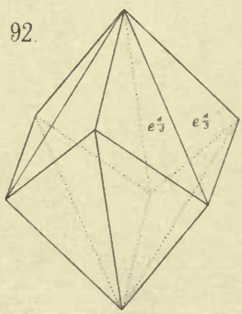
(270) Fig. 90.



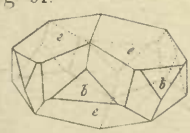
(270) Fig. 89



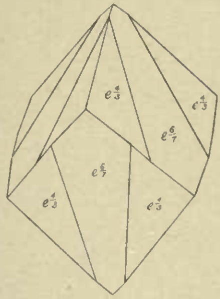
(270) Fig. 92.



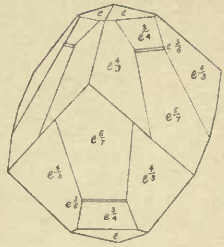
(270) Fig. 91.



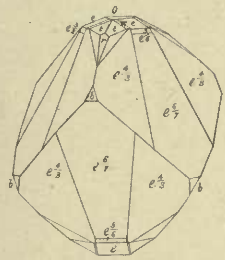
Calcite (270) Fig. 93.



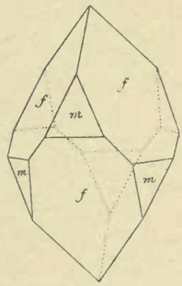
(270) Fig. 94.



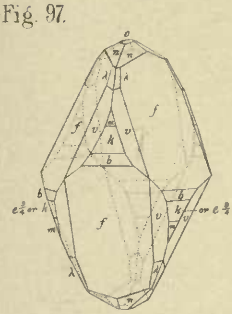
(270) Fig. 95.



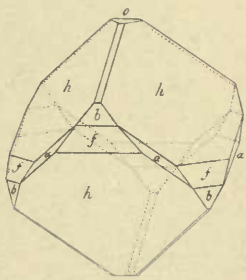
(270) Fig. 96.



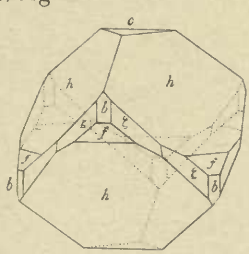
(270) Fig. 97.



(270) Fig. 98.



(270) Fig. 99.



(270) Fig. 100.

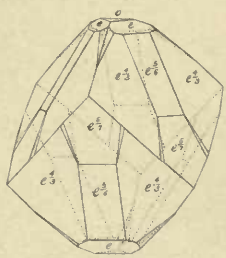
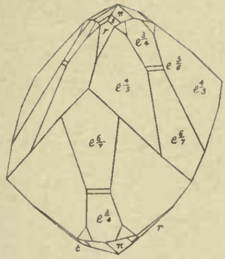
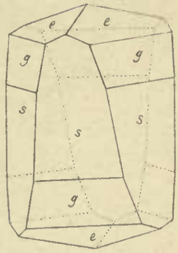


Plate XXXII.

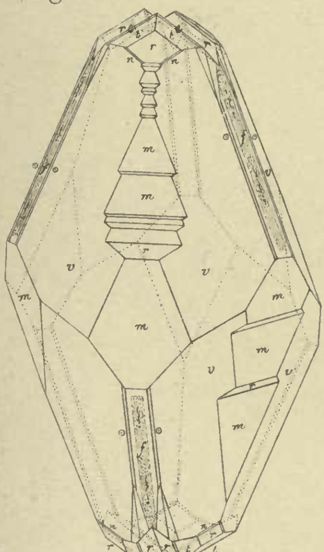
Calcite (270) Fig. 101.



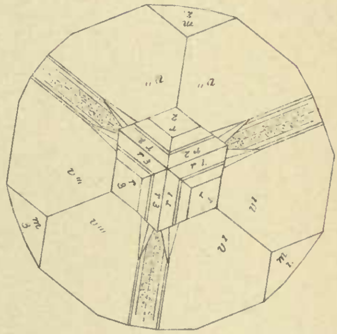
(270) Fig. 102.



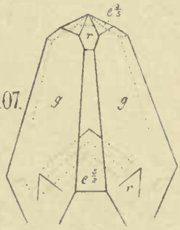
(270) Fig. 103.



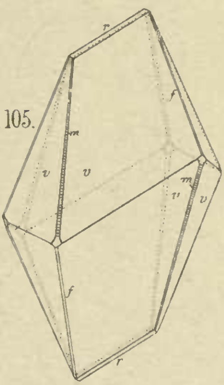
(270) Fig. 104.



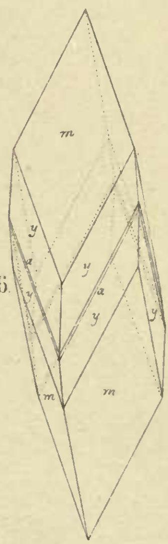
(270) Fig. 107.



(270) Fig. 105.

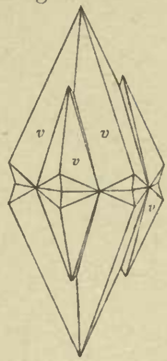


(270) Fig. 106.

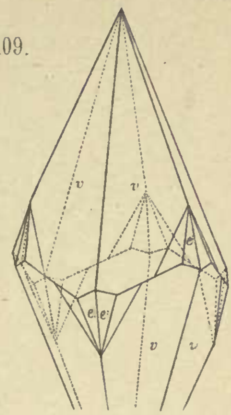


McFarlane & Erskine, Edinr

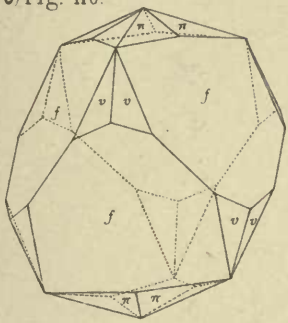
Calcite (270) Fig. 108.



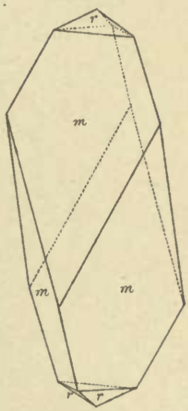
(270) Fig. 109.



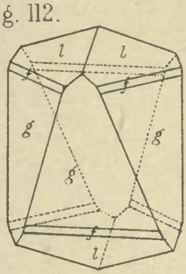
(270) Fig. 110.



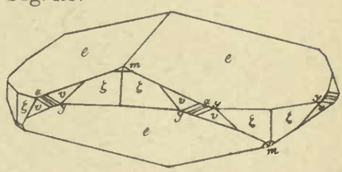
(270) Fig. 111.



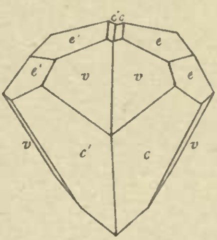
(270) Fig. 112.



(270) Fig. 113.



(270) Fig. 114.



(270) Fig. 115.

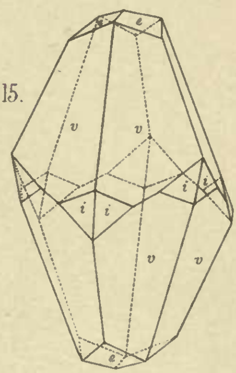
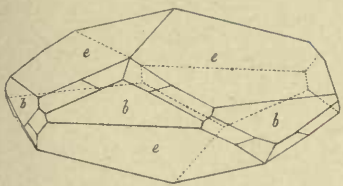
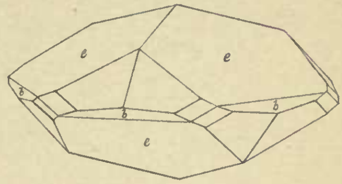


Plate XXXIV.

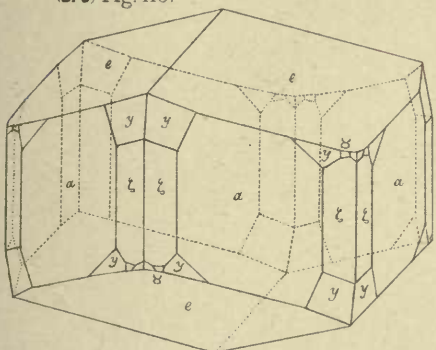
Calcite (270) Fig. 116.



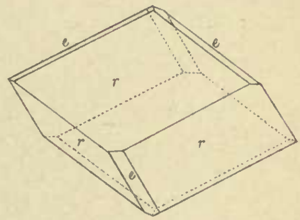
(270) Fig. 117.



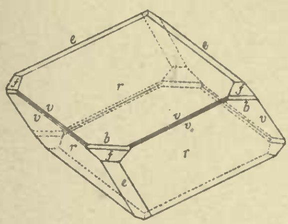
(270) Fig. 118.



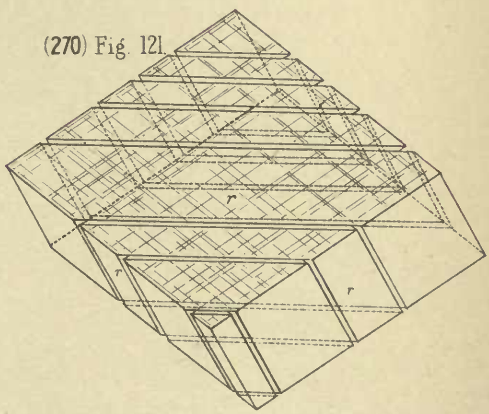
(270) Fig. 119.



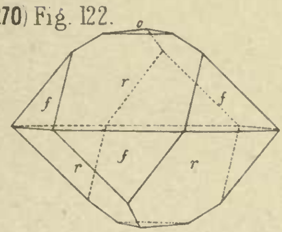
(270) Fig. 120.



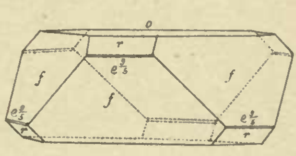
(270) Fig. 121.



(270) Fig. 122.

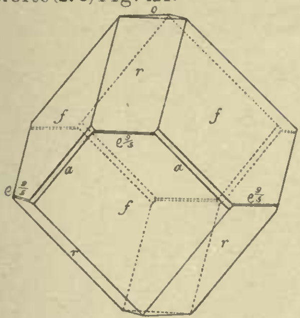


(270) Fig. 123.

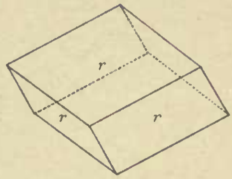


McFarlane & Erskine, Edin^r

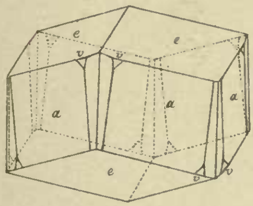
Calcite (270) Fig. 124.



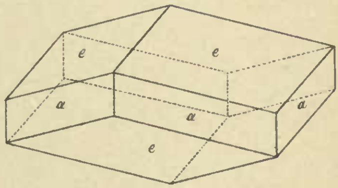
(270) Fig. 125.



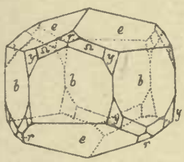
(270) Fig. 126.



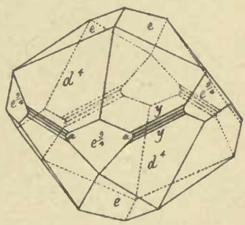
(270) Fig. 127.



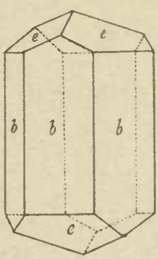
(270) Fig. 128.



(270) Fig. 129.



(270) Fig. 130.



(270) Fig. 131.

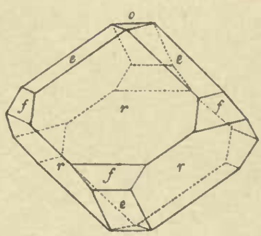
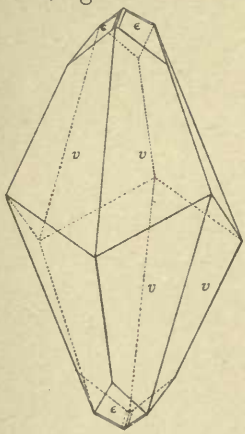
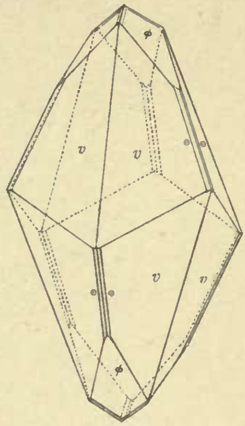


Plate XXXVI.

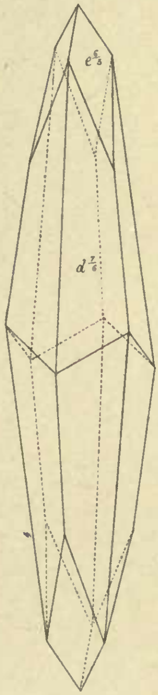
Calcite (270) Fig. 132.



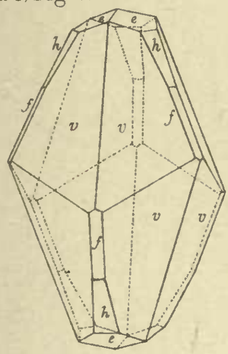
(270) Fig. 133.



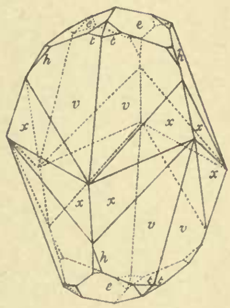
(270) Fig. 135.



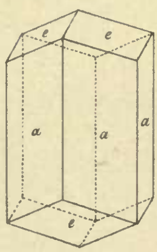
(270) Fig. 134.



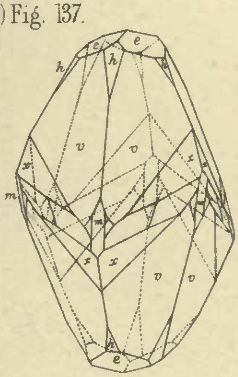
(270) Fig. 136.



(270) Fig. 138.



(270) Fig. 137.



(270) Fig. 139.

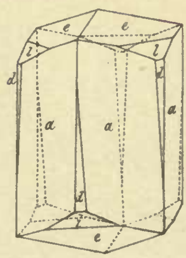
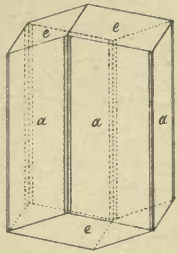
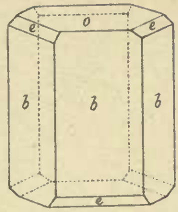


Plate XXXVII.

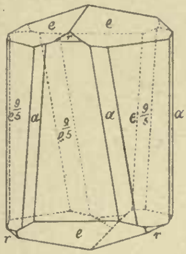
Calcite (270) Fig. 140.



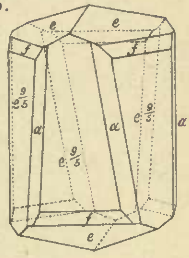
(270) Fig. 141.



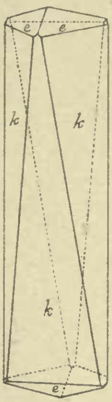
(270) Fig. 142.



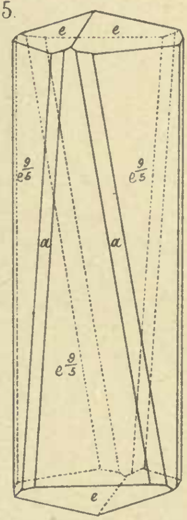
(270) Fig. 143.



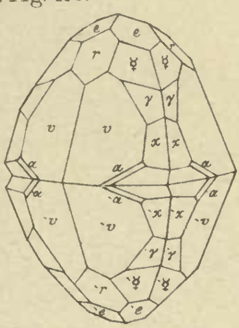
(270) Fig. 144.



(270) Fig. 145.



(270) Fig. 146.



(270) Fig. 147.

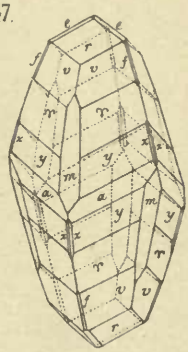
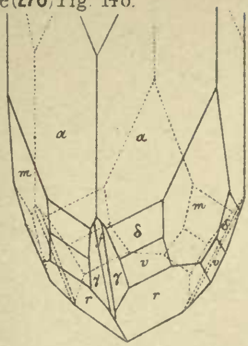
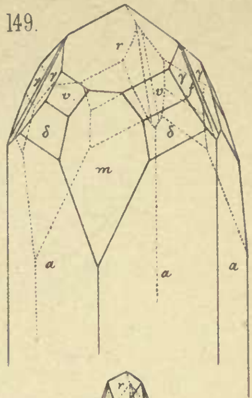


Plate XXXVIII.

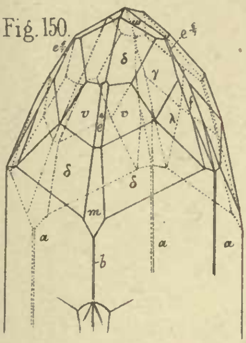
Calcite (270) Fig. 148.



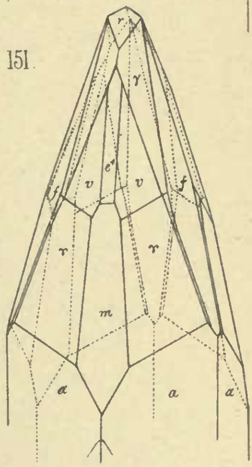
(270) Fig. 149.



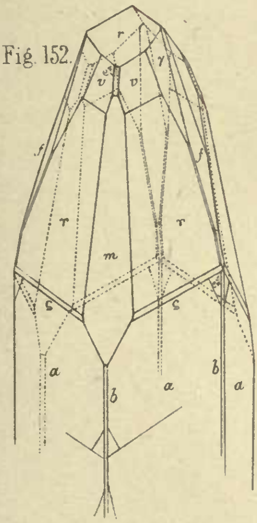
(270) Fig. 150.



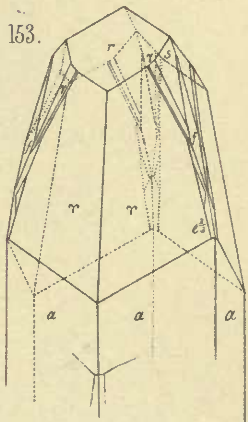
(270) Fig. 151.



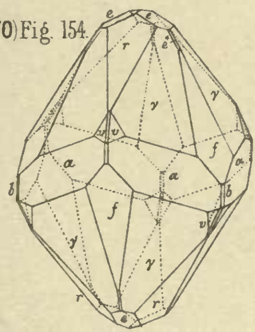
(270) Fig. 152.



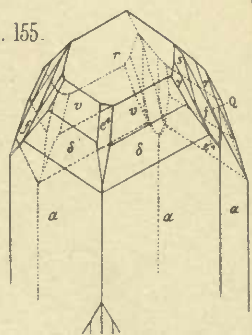
(270) Fig. 153.



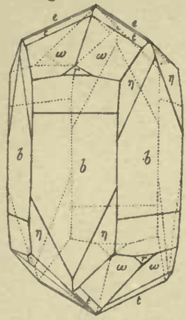
(270) Fig. 154.



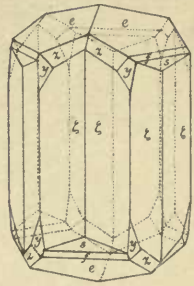
(270) Fig. 155.



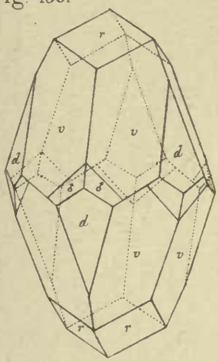
Calcite (270) Fig. 156.



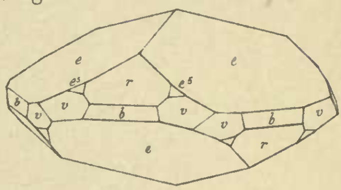
(270) Fig. 157.



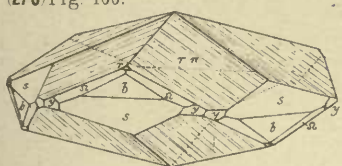
(270) Fig. 158.



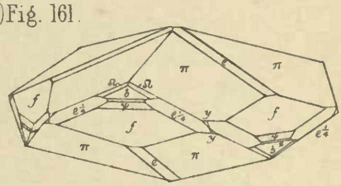
(270) Fig. 159.



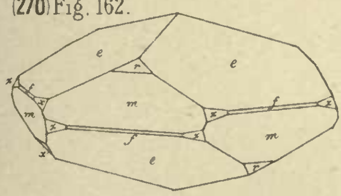
(270) Fig. 160.



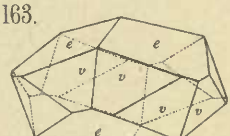
(270) Fig. 161.



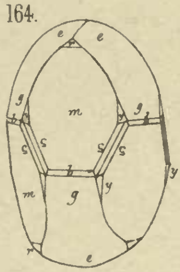
(270) Fig. 162.



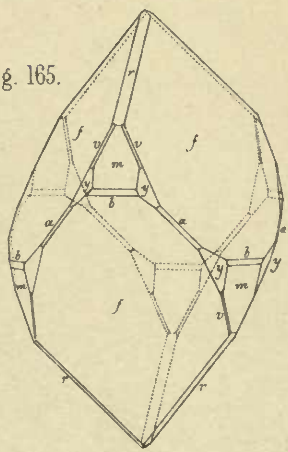
(270) Fig. 163.



(270) Fig. 164.

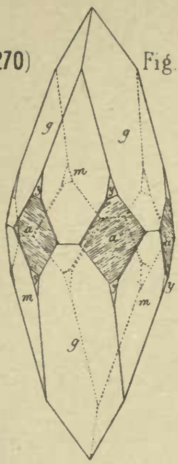


(270) Fig. 165.

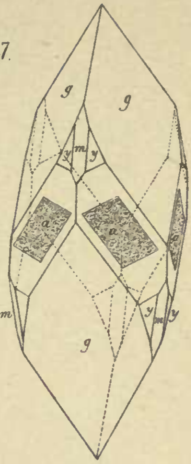


M'Farlane & Erskine, Edinr

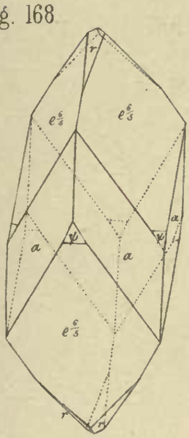
Calcite (**270**) Fig. 166.



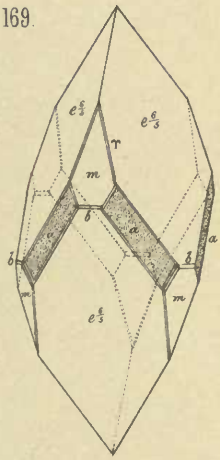
(**270**) Fig. 167.



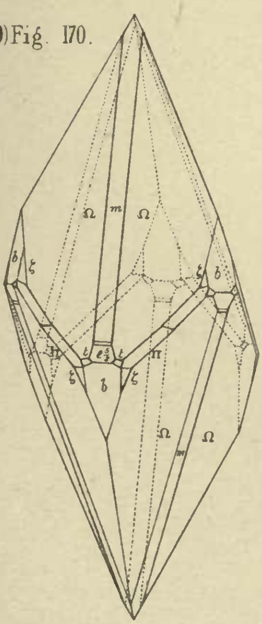
(**270**) Fig. 168



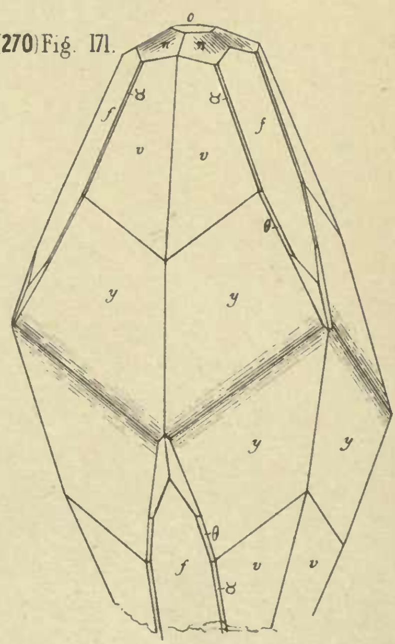
(**270**) Fig. 169.



(**270**) Fig. 170.

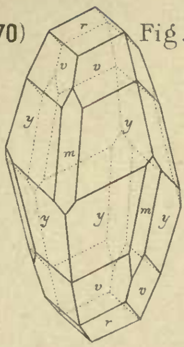


(**270**) Fig. 171.

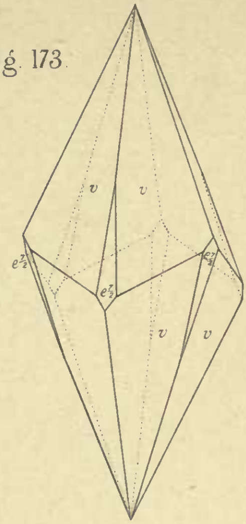


McFarlane & Erskine, Edinr

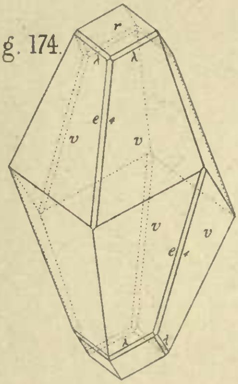
Calcite (270) Fig. 172



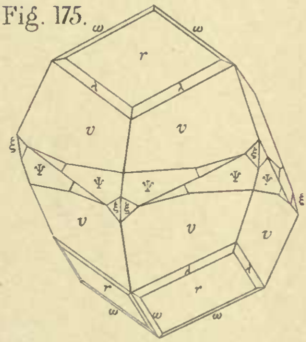
(270) Fig. 173.



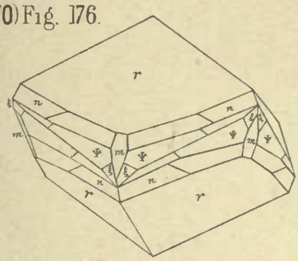
(270) Fig. 174.



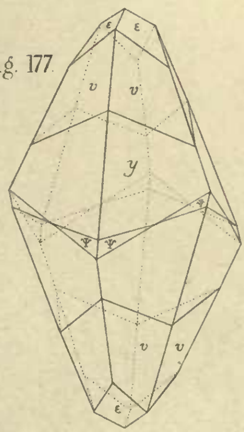
(270) Fig. 175.



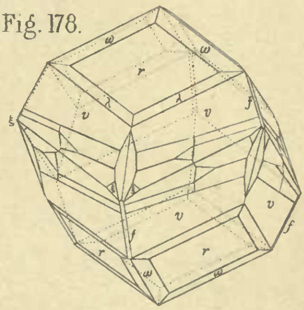
(270) Fig. 176.



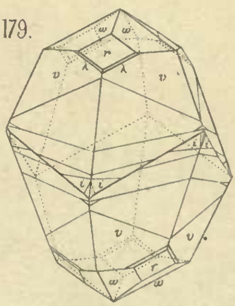
(270) Fig. 177.



(270) Fig. 178.

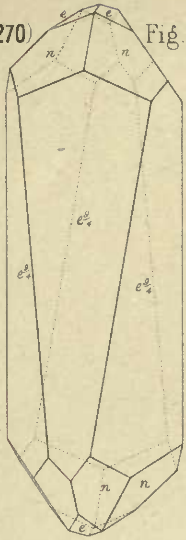


(270) Fig. 179.

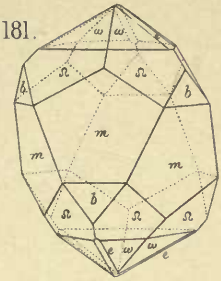


M^cFarlane & Erskine Edin^r

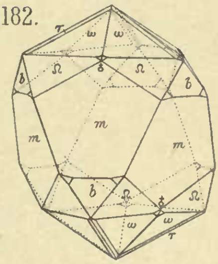
Calcite (270) Fig. 180.



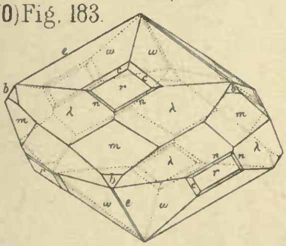
(270) Fig. 181.



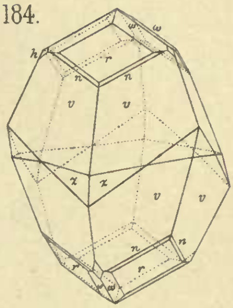
(270) Fig. 182.



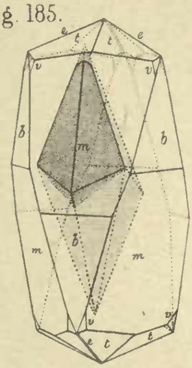
(270) Fig. 183.



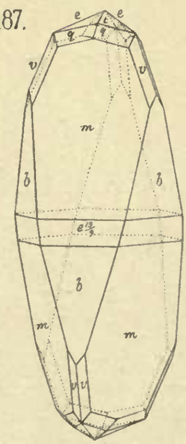
(270) Fig. 184.



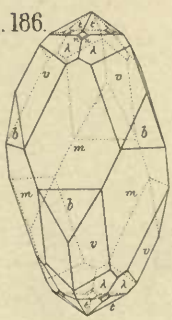
(270) Fig. 185.



(270) Fig. 187.



(270) Fig. 186.

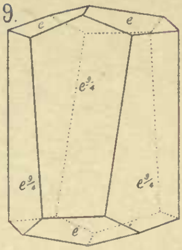


McFarlane & Erskine, Edinr.

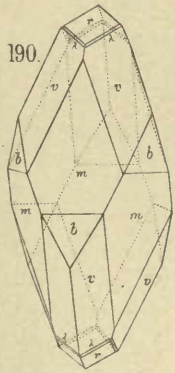
Plate XLIII.

Calcite (270) Fig. 188

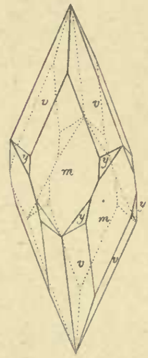
(270) Fig. 189.



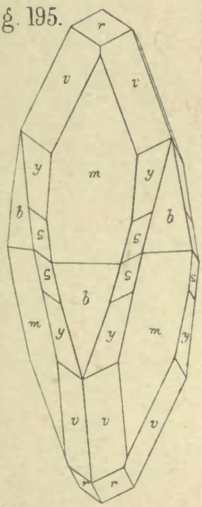
(270) Fig. 190.



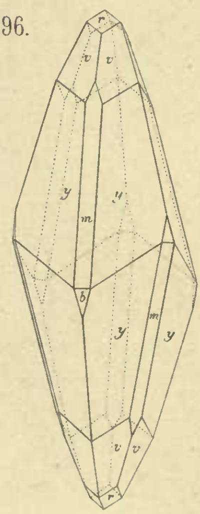
(270) Fig. 194.



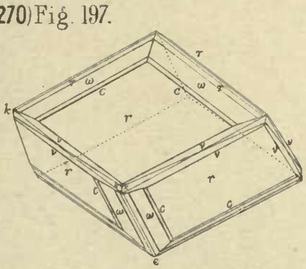
(270) Fig. 195.



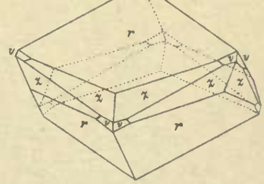
(270) Fig. 196.



(270) Fig. 197.

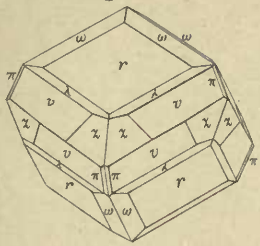


(270) Fig. 198.

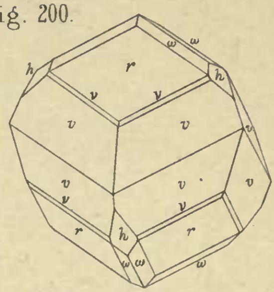


M'Farlane & Erskine, Edin^r

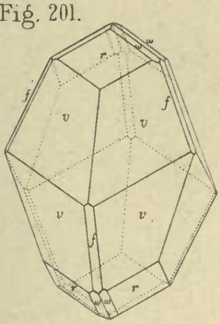
Calcite (**270**) Fig. 199.



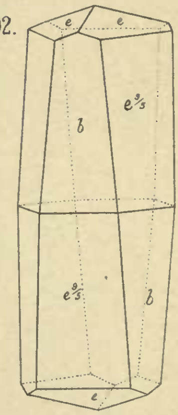
(**270**) Fig. 200.



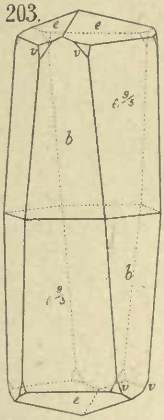
(**270**) Fig. 201.



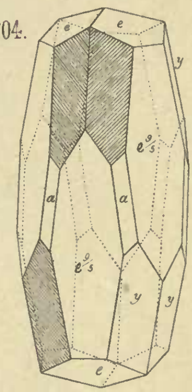
(**270**) Fig. 202.



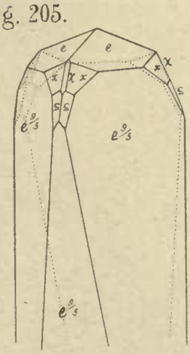
(**270**) Fig. 203.



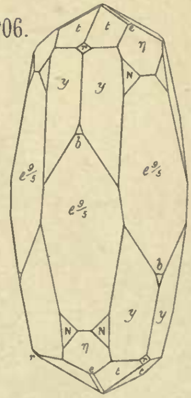
(**270**) Fig. 204.



(**270**) Fig. 205.

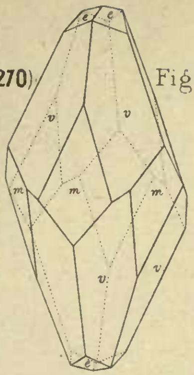


(**270**) Fig. 206.

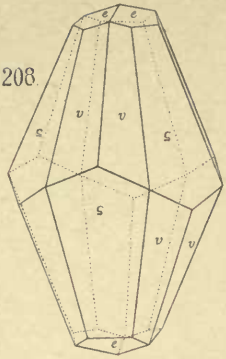


M'Farlane & Erskine, Edin.r

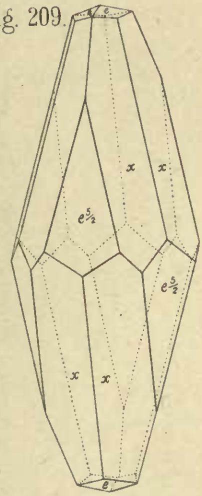
Calcite (**270**) Fig. 207.



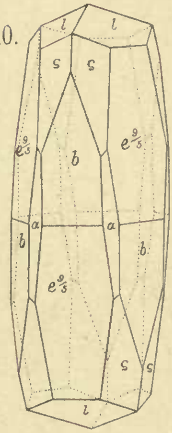
(**270**) Fig. 208.



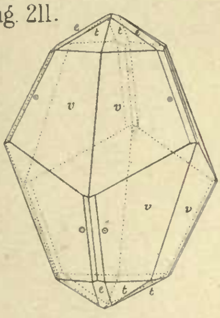
(**270**) Fig. 209.



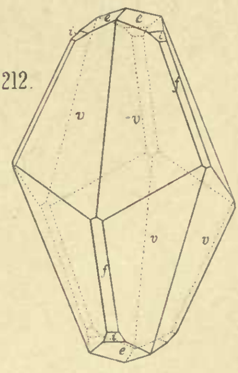
(**270**) Fig. 210.



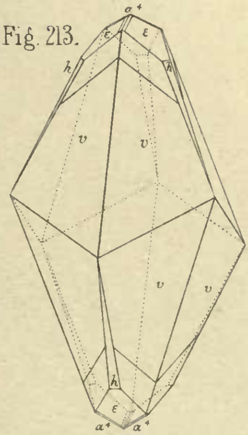
(**270**) Fig. 211.



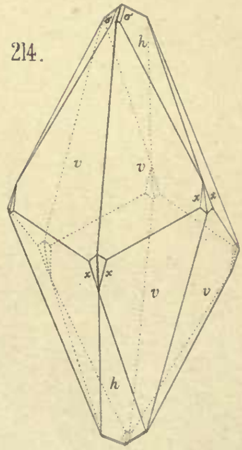
(**270**) Fig. 212.



(**270**) Fig. 213.



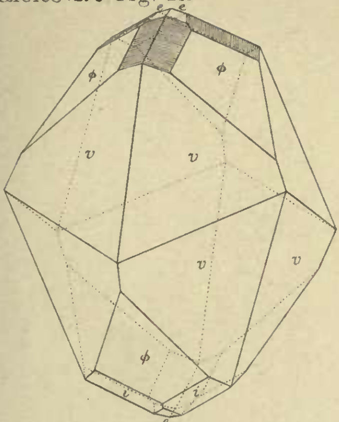
(**270**) Fig. 214.



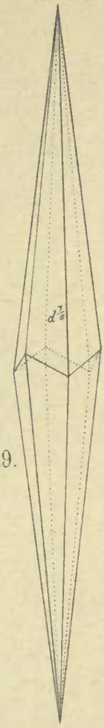
McFarlane & Erskine Edin.r

Plate XLVI.

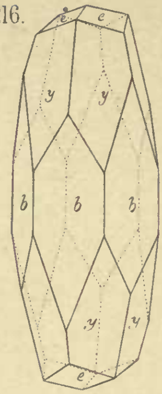
Calcite (270) Fig. 215.



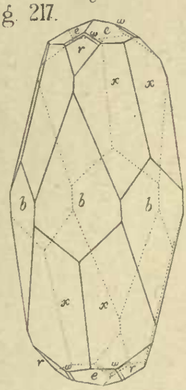
(270) Fig. 219.



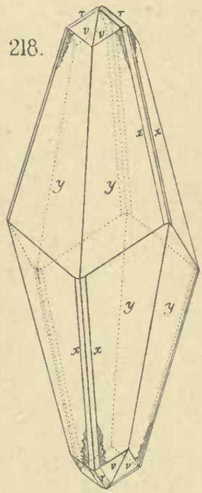
(270) Fig. 216.



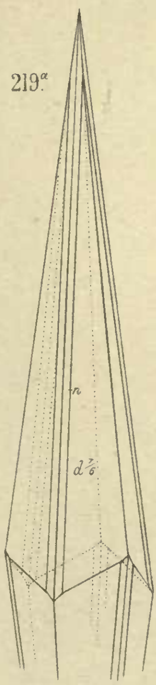
(270) Fig. 217.



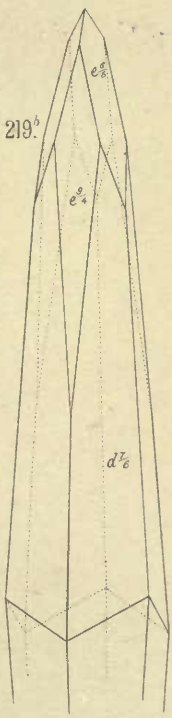
(270) Fig. 218.



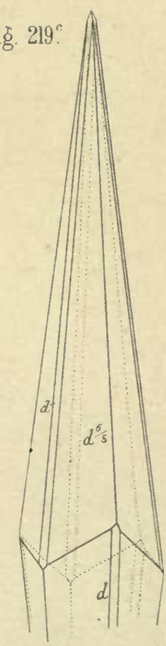
(270) Fig. 219.ª



(270) Fig. 219.ᵇ

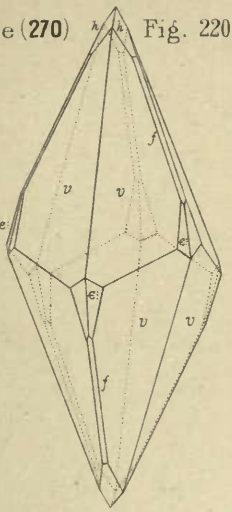


(270) Fig. 219.ᶜ

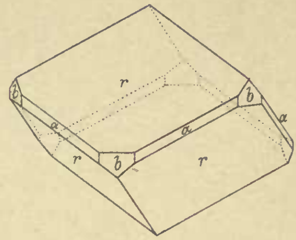


McFarlane & Erskine, Edinʳ

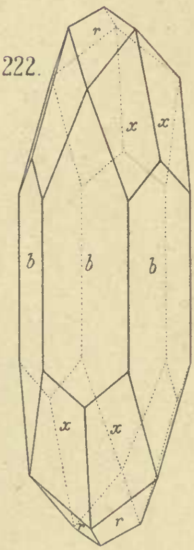
Calcite (270) Fig. 220.



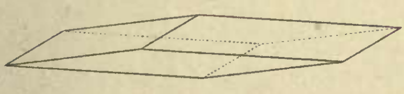
(270) Fig. 221.



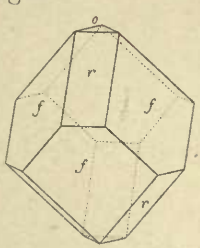
(270) Fig. 222.



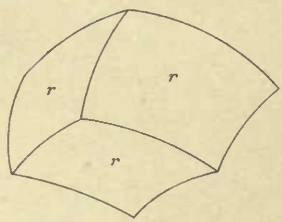
(270) Fig. 223.



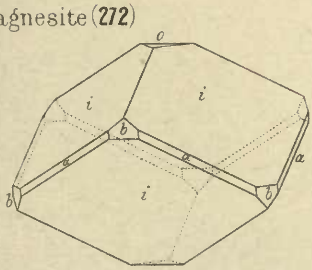
(270) Fig. 224.



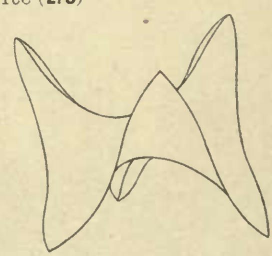
Dolomite (271)



Magnesite (272)

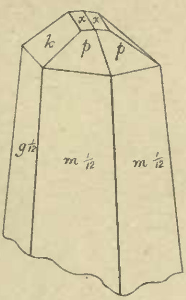


Siderite (273)

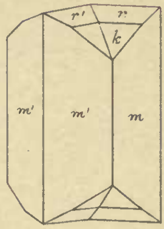


McFarlane & Erskine, Edinr

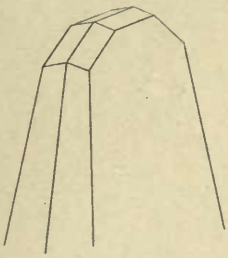
Aragonite (277) Fig. 1.



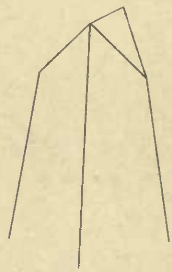
(277) Fig. 2.



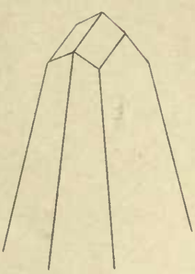
(277) Fig. 3.



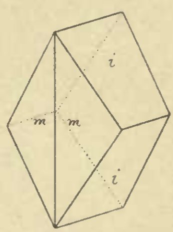
(277) Fig. 4.



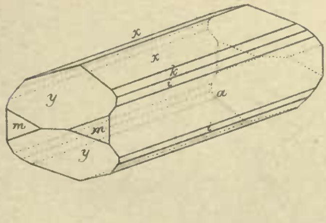
(277) Fig. 5.



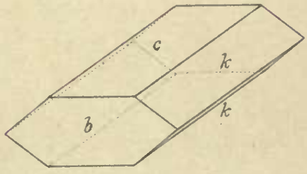
Cerussite (281) Fig. 1.



(281) Fig. 2.

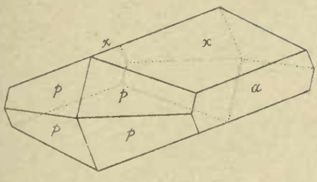


(281) Fig. 3.

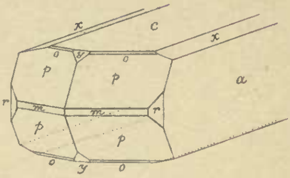


M'Farlane & Erskine Edin^r

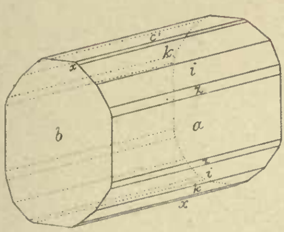
Cerussite (281) Fig. 4.



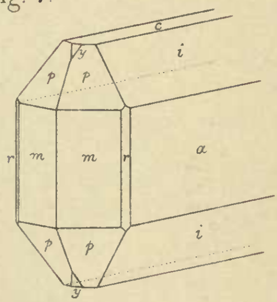
(281) Fig. 5.



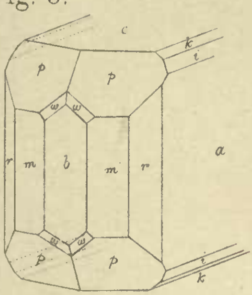
(281) Fig. 6.



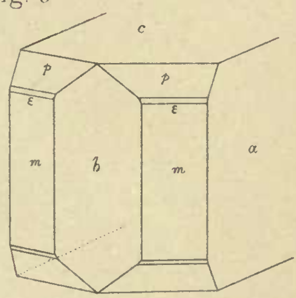
(281) Fig. 7.



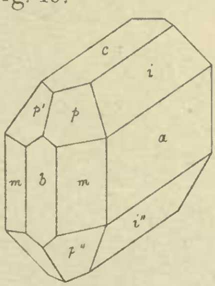
(281) Fig. 8.



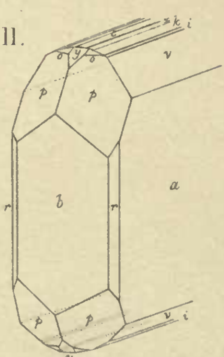
(281) Fig. 9



(281) Fig. 10.

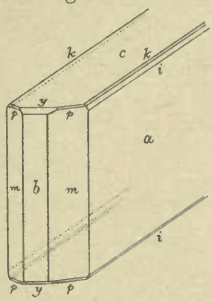


(281) Fig. 11.

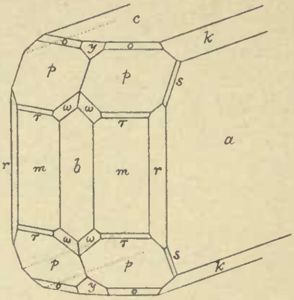


McFarlane & Erskine, Edin^r

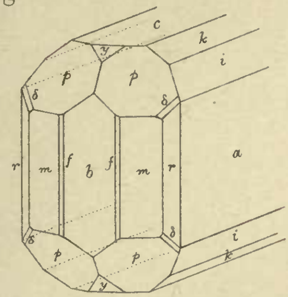
Cerussite (281) Fig. 12.



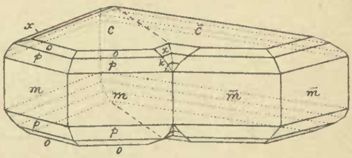
(281) Fig. 13.



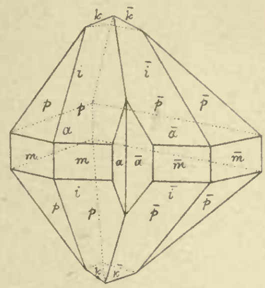
(281) Fig. 14.



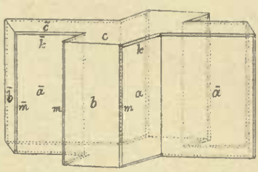
(281) Fig. 15.



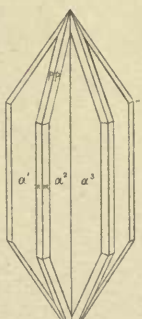
(281) Fig. 16.



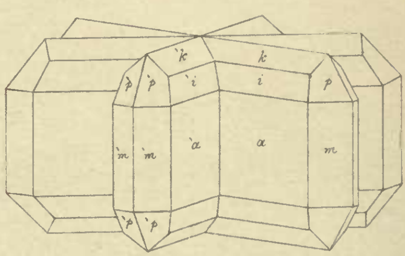
(281) Fig. 17.



(281) Fig. 18.

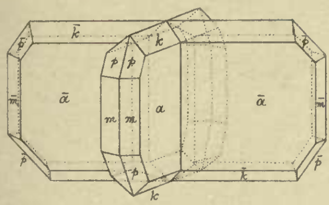


(281) Fig. 19.

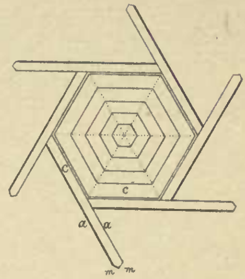


M'Farlane & Erskine, Edin[r]

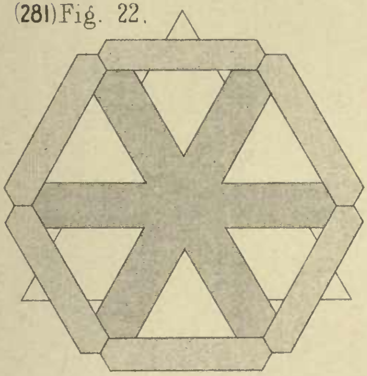
Cerussite (281) Fig. 20.



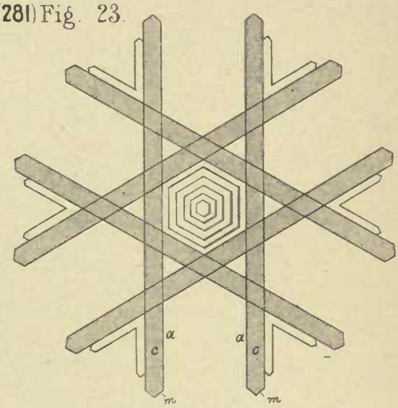
(281) Fig. 21.



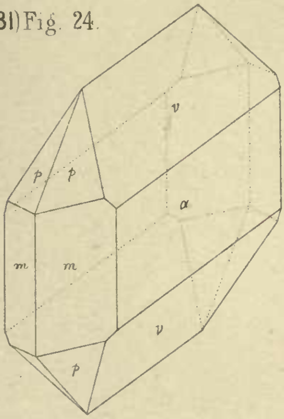
(281) Fig. 22.



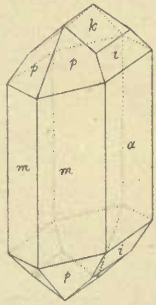
(281) Fig. 23.



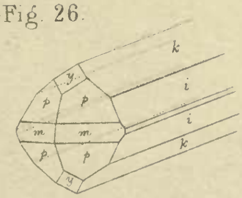
(281) Fig. 24.



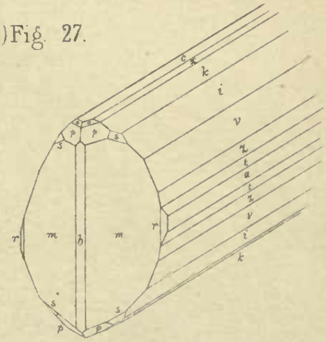
(281) Fig. 25.



(281) Fig. 26.



(281) Fig. 27.



M'Farlane & Erskine, Edin^r