

GEOLOGICAL SURVEY
OF



MICHIGAN
1873.

GEOLOGICAL SURVEY OF MICHIGAN.

UPPER PENINSULA

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VOL. II.

APPENDICES TO PART I., VOL. I.—IRON-BEARING ROCKS
(ECONOMIC)

BY

T. B. BROOKS

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APPENDIX A.

L I T H O L O G Y .

BY

ALEXIS A. JULIEN.

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T. B. BROOKS,

*State Geologist in Charge of Survey of Lake Superior Iron
Region:*

SIR—I hereby submit my preliminary report on the five hundred specimens from the Iron Region, selected by you from your large collection to represent the lithological character of the rocks and ores of the Huronian formation in that district.

The subject of their lithology has already been briefly and popularly treated, for the benefit of the explorer and miner, in Chapter III. of your own report.*

However, you have desired me to make—*first*, a detailed description of the same specimens; *secondly*, a series of provisional names; and *finally*, such a lithological examination and classification as time should permit.

The great number of the specimens—the variety and frequently novel character of the rocks they represent—their commonly fine-grained texture—and the short time at my disposal for this investigation, have effectually precluded my report from any claim to being exhaustive. So that although over fifty microscopic sections have been made and hastily examined of all the principal fine-grained varieties, and this essential branch of the work has not been neglected, nor such chemical examinations as seemed absolutely necessary to confirm the most doubtful results; all these have been only begun, and no mention will be made of them in this report. I make this omission the more readily, on account of the careful microscopic investigation, on another collection, reported in Appendix C, by Mr. Charles E. Wright, in association with Profs. Kreischer and Von Cotta, of Freiburg; all interested in this subject may refer to that report, in which are given, I believe, the

* Vol. I., page 82.

first published results on microscopic sections of Lake Superior rocks. With most of the compact rocks I have been compelled to rely mostly on their coarser transition varieties, observed in the field during a visit to that region in the summer of 1866. Consequently the careful examination of the microscopic texture of the finer-grained crystalline varieties: the identification of the minerals, which I will provisionally class under the names Amphibole, Chlorite, Mica, and Feldspar: the determination of the exact nature and relations of the remarkable processes of alteration to which these minerals have been subjected, and of the interesting series of transition-rocks, which have been the result: and the whole subject of the origin both of the rocks and ores, must be deferred to some other time and channel.

My present aim, therefore, in accordance with your expressed desire, is but a provisional one, viz., to give a somewhat popular description of such characteristics of the common varieties as may be easily discerned (with a very few exceptions) in the field, with the use of such simple means as a pocket lens (loupe), a knife, and a magnet: and also to propose a temporary nomenclature and classification for the present use of your Report.

The descriptions begin with that characteristic of the fresh fracture—color—which is usually most quickly apparent: and then proceed with the general hardness, texture, and structure of the rock: its constituent minerals, their physical characteristics, and their proportion (approximately estimated by the eye in *tenths*): the fracture, streak (in a fine-grained rock), and magnetic character: the joints, seams, and veins: and the nature of the weathered surface. Where the depth of weathering is not stated, a merely superficial stain is meant. I have made no determinations of specific gravity, on account of the full series given in your Report. In regard to nomenclature, although anxious to avoid novelty in the present inchoate state of my work and of American Lithology, I venture to adopt entirely and throughout the changes in mineralogical nomenclature proposed by Prof. J. D. Dana (*e.g.* Amphibole in place of Hornblende, Sphalerite in place of Blende, etc.); and also his suggestion*—the necessity of which, and of its immediate

* System of Mineralogy, page xxxiv.

adoption, I believe every lithologist will approve,—that the termination *yte* should be substituted for *ite*, to distinguish rocks from minerals, with the exception of granite and syenite (and, I also understand, dolomite). The result of this last change is the introduction into my report of the unfamiliar terminations of Quartzyte, Novaculyte, Argillyte, Dioryte, Amphibolyte, and Aphanyte. But, as generally happens in working up a new region, I have also been reluctantly compelled, even for my temporary object, to propose some slight modifications of names long accepted (*e.g.* Anthophyllite-Schist, Feldspathic Argillyte, Micaceous Greenstone-Schist, etc.), for the reasons stated in the Introduction. The choice and use of my compound names, chiefly schists, have been founded on the following principles, which I believe to be generally admitted, though not always consistently adhered to. *First*—The generic name of the schistose form of a rock possessing a distinctive name, or of a rock chiefly composed (more than half) of any one mineral, is formed by simply prefixing the name of the rock or of the mineral to the word "schist" (*e.g.* Dioryte-Schist, not Diorytic Schist, and Chlorite-Schist, not Chloritic Schist). *Secondly*—The name of a variety, produced by a large proportion (less than half) of another mineral, is distinguished by an adjective termination (*e.g.* Chloritic Dioryte-Schist); but when the chief constituents of the rock have not been certainly made out, but one mineral imparts a distinctive character, then the name of the latter is prefixed, with an adjective termination (*e.g.* Chloritic Schist, Talcose Schist, etc., where the chief constituent may be Feldspar, Quartz, or an Argillyte).

In regard to classification, I have adopted in the main, as at least best adapted to my present purpose, that system employed in the works on Petrography, etc., by Zirkel and Credner, rather than those of other authors.*

* The following are works on Lithology, etc., to which references are made in this report merely by the author's name:

Bischof, G. Chemical and Physical Geology. 3 vols. London, 1858.

Blum, J. R. Handbuch der Lithologie oder Gesteinlehre. Erlangen, 1860.

Cotta, B. Von. Rocks classified and described. Lawrence's edition. London, 1866.

My chief departures from that system have been in grouping Amphibolyte and Serpentine under Dioryte, Hornblende-Schist under Hornblende-Gneiss, the Greenstone-Ashes together with Argillyte, and a series of peculiar rocks (made up of Feldspar and Chlorite) under Dioryte, because, in each of these cases, the first-mentioned is certainly a transition form of the second.

The object of the examination has been purely the lithological character of the Huronian rocks; but about fifty specimens are also included from a few classes of the Laurentian rocks, especially the Gneisses and Mica-Slates, which happen to be closely allied in composition to the Huronian rocks, and intimately associated with them on the borders of the Marquette region. Specimens are also described which represent a few boulders from unknown beds which may yet be discovered in the course of exploration.

The numbers, from 1 to 100, refer to the series of which many duplicates, almost complete, have been widely distributed, of the specimens of which only brief descriptions were therefore considered necessary, and of which a table is given in Appendix B.

The numbers, 101 to 360, refer to the descriptions given in this report, and are adopted throughout the chapter above mentioned. The specimens were furnished me from your private collection of over 2,000 specimens, which have an independent numbering; but when any of these, not included in the above 360, shall be referred to, they are distinguished by numbers which commence above 600. About thirty additional full descriptions have been omitted, and a large number of others greatly condensed, in order to abbreviate this Report. To prevent confusion, and also to facilitate reference

Credner, H. *Elemente der Geologie*. Leipzig, 1872.

“ “ Article.—“Die Vorsilurischen Gebilde der ‘Oberen Halbinsel von Michigan’ in Nord-Amerika.” *Zeits. der D. geol. Gesell.*, XXI. Band, 1869.

Dana, J. D. *System of Mineralogy*. New York, 1869.

Foster and Whitney. *Report on the Geology of the L. S. Land District*. Part II. Washington, 1851.

Jukes, J. B. *Student's Manual of Geology*. Edinburgh, 1862.

Kenngott, A. *Elemente der Petrographie*. Leipzig, 1868.

Naumann. *Lehrbuch der Geognosie*. Vol. II. Leipzig, 1862.

Senft, F. *Lehrbuch der Mineralien und Felsartenkunde*. Jena, 1869.

Zirkel, F. *Lehrbuch der Petrographie*. 2 vols. Bonn, 1866.

to any desirous to consult your collection, comparative tables of both series of numbers are also appended.

Finally, I would call your attention to the first organic remains yet discovered in the formation—the imperfect fucoidal impressions which I have observed, in the course of this examination, in the Carbonaceous Shale (No. 251) and in Hematite-Ochre (No. 67). They will be hereafter submitted to some competent authority for examination. My acknowledgments are due, for the loan of specimens, to Prof. J. S. Newberry, of the School of Mines, Columbia College, and Prof. M. W. Harrington, of the University of Michigan.

I remain, very respectfully,

Your obedient servant,

ALEXIS A. JULIEN.

SCHOOL OF MINES, COLUMBIA COLLEGE,
NEW YORK, July, 1873.

COMPARATIVE TABLES OF NUMBERS.

I.*

Number.	Specimen.	Name.
101	984	Ferruginous Crystalline Limestone.
102	1231	White Saccharoidal Dolomite-Marble.
103	1233	Grayish Saccharoidal Dolomite-Marble.
104	877	Fine-grained Greenish-white Dolomite.
105	1242	Fine-grained Gray Dolomite-Marble.
106	795	Coarse Red Dolomite.
107	796	Banded Dolomite-Marble.
108	797	Rosy Siliceous Dolomite.
109	798	Mottled Dolomite-Marble.
110	799	Talco-Siliceous Dolomite.
111	800 } 808 }	Rosy Talcose Dolomite.
112	809	Mottled Dolomite.
113	811	Rosy Talcose Dolomite.
114	688	Black Quartz-Conglomerate.
115	715	Gray Quartz-Conglomerate.
116	716	Mottled Quartz-Conglomerate.
117	717	Chloritic Quartz-Conglomerate.
	718) 719)	
118	720 } 721 } 727 }	Greenish Quartz-Conglomerate.

* The numbers in the first column are those attached to the descriptions, merely for their arrangement in this report; those from 1 to 100 are given in Appendix B. The numbers in the second column are those attached to the specimens from the collection of T. B. Brooks; a few loaned from the collection of the School of Mines, Columbia College, by the kindness of Prof. J. S. Newberry, have been designated by the letter "S", and a few, from my own collection, by the letter "J".

Number.	Specimen.	Name.
119	J.	Kaolinic Hematite-Breccia.
120	875	Red Jasper-Conglomerate.
121	878	Brown Jasper-Conglomerate.
122	1085	Micaceous Conglomerate-Schist.
123	693	Quartzose Feldspar-Breccia.
124	1487	Schistose Jasper-Breccia.
125	1490	Drusy Jasper-Breccia.
126	990	Grayish-white Quartzite.
127	991	Conglomeritic Feldspathic Quartzite.
128	803	Reddish-brown Quartzite.
129	1251	Light-brown Quartzite.
130	1471	Flesh-colored Quartzite.
	1472	
131	907	Smoky-gray Quartzite.
	909	
	1243	
132	1459	Greenish-gray Quartzite.
133	812	Rosy-gray Quartzite.
134	816	Slaty-gray Quartzite.
135	1473	Brownish-gray Quartzite.
136	1476	Bluish-gray Quartzite.
137	901	Manganiferous Smoky Quartzite.
138	939	Feldspathic Quartzite.
	977	
139	1478	Jaspery Quartzite.
140	1479	Magnetic Jaspery Quartzite.
141	1477	Chalcedonic Quartzite.
142	1225	Reddish Hematitic Quartzite.
143	993	Ochrey Cellular Quartzite.
144	902	Banded Quartz-Schist.
145	903	Banded Quartz-Schist.
146	1232	Greenish Quartz-Schist.
147	1092	Chloritic Quartz-Schist.
148	801	Calcareous Quartz-Schist.
	802	
149	891	Opaline Quartz-Schist.
150	J.	Talcosc Quartz-Schist.
151	734	Magnetic Quartz-Schist.

Number.	Specimen.	Name.
152	740	Magnetic Quartz-Schist.
153	999	Magnetic Quartz-Schist.
154	1227	Hematitic Quartz-Schist.
155	1236	Hematitic Quartz-Schist.
156	994	Ferruginous Quartz-Schist.
157	883	Limonitic Quartz-Schist.
158	1484	Green Banded Siliceous Schist.
	1493	
	1499	
	1500	
159	1508	Argillaceous Siliceous Slate.
160	806	Greenish Siliceous Schist (Novaculite).
161	804	Greenish-drab Siliceous Slate (Novaculite).
	805	
	807	
162	1509	Banded Talco-Siliceous Slate.
163	1458	Ferruginous Siliceous Slate.
164	1503	Ferruginous Siliceous Slate.
165	747	Hematitic Siliceous Schist.
166	1485	Banded Jasper-Schist.
167	1486	Banded Jasper-Schist.
168	1491	Banded Jasper-Slate.
	1492	
169	1510	Banded Jasper-Slate.
170	1506	Green Jasper-Slate.
171	690	Magnetic Jasper-Slate.
172	1480	Hematitic Jasper-Schist.
173	1488	Hematitic Jasper-Schist.
174	1088	Brown Anthophyllitic Quartz-Schist.
175	1090	Brown Anthophyllite-Schist.
	1091	
176	1093	Brown Anthophyllite-Schist.
	1094	
	1095	
177	1098	Brown Anthophyllite-Schist (passing into Magnetite-Schist).
178	1116	Magnetic Anthophyllite-Slate.
	1155	

Number.	Specimen.	Name.
179	729	Pseudomorphous Chlorite-Schist.
180	730	Pseudomorphous Chlorite-Schist.
181	731	Pseudomorphous Chlorite-Schist.
182	820	Dark-green Chlorite-Schist.
183	828 } 829 }	Green Calcareous Chloritic Schist.
184	1097	Garnetiferous Chlorite-Schist.
185	1130	Green Chlorite-Schist.
186	1148	Porphyritic Chlorite-Schist.
187	1543 } 1544 }	Chloritic Feldspathic Schist.
188	1545	Green Calcareous Chloritic Schist.
189	692	Micaceous Feldspathic Argillyte.
190	794	Brown Chloritic Argillyte.
191	810	Brown Feldspathic Argillyte.
192	814	Banded Chloritic Argillyte.
193	815	Banded Chloritic Argillyte.
194	881	Micaceous Feldspathic Argillyte.
195	882	Greenish-gray Shale.
196	906	Siliceous Feldspathic Argillyte.
197	908	Greenish-gray Feldspathic Argillyte.
198	917 } 918 } 919 }	Banded Feldspathic Argillyte.
199	920 } 921 } 922 }	Greenish Feldspathic Argillyte.
200	982	Gray Feldspathic Argillyte.
201	992	Green Speckled Argillyte.
202	998	Brownish-gray Feldspathic Argillyte.
203	1101	Magnetic Feldspathic Slate.
204	1102	Micaceous Feldspathic Slate.
205	1109	Amygdaloidal Amphibole-Schist.
206	1138	Greenish Feldspathic Argillyte.
207	1238	Micaceous Feldspathic Argillyte.
208	1240	Chloritic Argillyte.
209	1249	Chloritic Feldspathic Argillyte.
210	1250	Micaceous Siliceous Slate.

Number.	Specimen.	Name.
211	1368	Iron-gray Argillaceous Mica-Slate.
212	1369	Gray Feldspathic Schist (Siliceous).
213	1379	Banded Magnetic Mica-Slate.
214	1380	Banded Magnetic Siliceous Schist.
215	1390	Greenish Feldspathic Schist (Siliceous).
216	1466	Feldspathic Siliceous Schist (Micaceous).
217	1467	Feldspathic Siliceous Schist (Micaceous).
218	1474 } 1475 }	Green Feldspathic Schist (Siliceous).
219	1523	Decomposed Chloritic Schist.
220	1540 } 1541 }	Green Feldspathic Schist (Siliceous).
221	968 } 969 } 970 } 971 } 983 }	Bluish-gray Argillyte-Slate.
222	974 } 975 }	Bluish-gray Argillyte-Slate.
223	976 } 979 }	Pyritiferous Argillyte-Slate.
224	1104	Talcosc Feldspathic Argillyte.
225	1241	Talcosc Feldspathic Argillyte.
226	1081	Magnetic Talc-Schist.
227	S.	Porphyritic Talc-Schist.
228	738	Tabular Magnetite-Schist.
229	728	Fine-grained Magnetite-Schist.
230	1502	Black Magnetite-Slate.
231	737	Chloritic Magnetite-Schist.
232	733	Chloritic Magnetite-Schist.
233	1512	Green Magnetite-Schist.
234	736	Quartzose Magnetite-Schist.
235	1230	Quartzose Magnetite-Schist.
236	735	Ochrey Magnetite-Schist.
237	689	Specular Iron-Schist.
238	1234	Quartzose Hematite-Schist.
239	1235	Quartzose Hematite-Schist.
240	1237	Quartzose Hematite-Schist.

Number.	Specimen.	Name.
241	1429	Ochrey Quartzose Hematite-Schist.
242	872	Calcareous Ochrey Siliceous Schist.
243	995	Ochrey Calcareous Hematite.
244	896	Kaolinic Ochre-Schist.
245	890	Brown Limonite-Schist.
246	879	Carbonaceous Slate.
247	904	Carbonaceous Shale.
248	880	Quartzose Carbonaceous Shale.
249	898	Quartzose Carbonaceous Slate.
250	899	Graphitic Shale.
251	900	Graphitic Shale.
252	S.	Coarse Red Granite.
253	1228	Ferruginous Granite.
254	741	Fine-grained White Granite.
255	746	Fine-grained Black Gneiss.
256	1248, B.	Fine-grained Black Gneiss.
257	1252	} Fine-grained Grayish-Black Gneiss.
	1253	
258	935	} Coarse Reddish Gneiss.
	936	
	937	
259	947	Grayish-white Gneiss.
260	1548	Mottled Gneiss.
261	1224	} Black Hornblende-Gneiss.
	1226	
	1229	
262	949	Black Hornblende-Gneiss.
263	742	Coarse Altered Hornblende-Gneiss.
264	744	Altered Hornblende-Gneiss.
265	954	Altered Hornblende-Gneiss.
266	1086	Chloritic Hornblende-Gneiss.
267	1087	Hornblende-Gneiss.
268	1361	Banded Hornblende-Gneiss (Epidotic).
269	1362	} Chloritic Hornblende-Gneiss.
	1363	
270	1370	Altered Hornblende-Gneiss.
271	1089	Black Hornblende-Schist.
272	946	Chloritic Hornblende-Schist.

Number.	Specimen.	Name.
273	948	Chloritic Hornblende-Schist.
274	950	Chloritic Hornblende-Schist.
275	1393	Greenish Chloritic Gneiss.
276	867	Chloritic Gneiss.
277	870	} Epidotic Chloritic Gneiss.
	874	
278	938	Chloritic Gneiss.
279	941	Red Chloritic Gneiss.
280	942	Red Chloritic Gneiss.
281	951	} Porphyritic Chloritic Gneiss.
	953	
282	952	Greenish Chloritic Gneiss.
283	955	Coarse Chloritic Gneiss.
284	956	Fine-grained Chloritic Gneiss.
285	1128	White Chloritic Gneiss.
286	1367	Fine-grained Chloritic Gneiss.
287	1375	Banded Chloritic Gneiss.
288	1377	Chloritic Gneiss.
289	1378	White Chloritic Gneiss.
290	1381	} Banded Chloritic Gneiss.
	1383	
291	1391	Decomposed Chloritic Gneiss.
292	1392	Decomposed Chloritic Gneiss.
293	1398	} Banded Chloritic Gneiss.
	1399	
294	1400	Red Chloritic Gneiss.
295	1402	Chloritic Gneiss.
296	1546	} White Chloritic Gneiss.
	1547	
297	940	Talcy Chloritic Gneiss.
298	944	Talcy Chloritic Gneiss.
299	945	Talcy Chloritic Gneiss.
300	1389	Brownish-gray Mica-Slate.
301	No. 61.	Stauroliferous Mica-Schist.
302	743	Altered Porphyritic Dioryte.
303	1103	Black Dioryte.
304	1244	Green Dioryte.
305	1246	Green Altered Dioryte.

Number.	Specimen.	Name.
306	1409	Black Porphyritic Dioryte (Micaceous).
307	1427	Black Dioryte.
308	1432	Altered Porphyritic Dioryte (Magnetic).
309	1454	Fine-grained Gray Dioryte.
310	1498	Fine-grained Blackish-green Dioryte.
311	1501	Fine-grained Black Dioryte.
312	1504	} Greenish Altered Dioryte.
	1505	
	1549	
313	1550	} Fine-grained Black Dioryte.
	1551	
	1720	
314	1721	} Quartzose Porphyritic Dioryte.
	1723	
315	1723	Quartzose Porphyritic Dioryte.
316	1724	} Epidotic Porphyritic Dioryte.
	1725	
317	1733	Porphyritic Dioryte.
318	1734	Quartzose Porphyritic Dioryte.
319	J.	Coarse Green Amphibolyte.
320	745	Coarse Green Amphibolyte.
321	876	Black Serpentine.
322	1245	Green Magnesian Dioryte (Serpentine).
323	1247	Black Magnesian Dioryte (Serpentine).
324	1530	} Chloritic Dioryte.
	to	
	1539	
325	1428	Chloritic Dioryte-Wacké.
326	818	} Chloritic Dioryte-Schist.
	823	
327	1099	Blackish-green Dioryte-Schist.
328	1384	Greenish Dioryte-Schist.
329	1385	Greenish Dioryte-Schist.
330	1401	Greenish Dioryte-Schist.
331	821	Calcareous Dioryte-Greenstone.
332	1527	} Fine-grained Dioryte-Greenstone.
	1528	
	1529	
333	819	Epidotic Dioryte-Greenstone.

Number.	Specimen.	Name.
334	S.	Dioryte-Greenstone.
335	826	Micaceous Greenstone-Schist.
336	827	Micaceous Greenstone-Schist.
337	1096	Micaceous Greenstone-Schist.
338	1100	Schalstone.
339	824	} Green Aphanyte-Schist.
	825	
340	817	Greenish-gray Chlorite-Potstone.
341	1494	} Green Chlorite-Potstone.
	to	
	1497	
342	884	} Black Trappean Dioryte.
	885	
343	886	Black Trappean Dioryte.
344	888	Trappean Dioryte.
345	889	Altered Trappean Dioryte.
346	905	Speckled Trappean Dioryte.
347	912	Black Trappean Dioryte.
348	913	Brown Trappean Dioryte.
349	915	Brown Trappean Dioryte.
350	996	} Compact Green Trappean Dioryte.
	997	
351	911	Green Porphyry.
352	887	Brown Wacké.
353	914	Speckled Wacké.
354	1110	Black Dioryte-Aphanyte.
355	1382	Black Dioryte-Aphanyte.
356	S.	Black Dioryte-Aphanyte.
357	S.	Green Dioryte-Aphanyte.
358	732	Arenaceous Sandstone-Schist.
359	739	Magnetic Arenaceous Sandstone-Schist.
360	923	Chloritic Sandstone-Schist.

II.

This Table is inserted to facilitate reference to the numbers of my descriptions, given on the right hand of each pair of parallel columns, from the numbers of the specimens in Brooks's Collection, given consecutively in the left-hand column.

Specimen.	Number.	Specimen.	Number.	Specimen.	Number.	Specimen.	Number.
688	114	799	110	880	248	936	258
689	237	800	111	881	194	937	258
690	171	801	148	882	195	938	278
692	189	802	148	883	157	939	138
693	123	803	128	884	342	940	297
715	115	804	161	885	342	941	279
716	116	805	161	886	343	942	280
717	117	806	160	887	352	944	298
718	118	807	161	888	344	945	299
719	118	808	111	889	345	946	272
720	118	809	112	890	245	947	259
721	118	810	191	891	149	948	273
727	118	811	113	896	244	949	262
728	229	812	133	898	249	950	274
729	179	814	192	899	250	951	281
730	180	815	193	900	251	952	282
731	181	816	134	901	137	953	281
732	358	817	340	902	144	954	265
733	232	818	326	903	145	955	283
734	151	819	333	904	247	956	284
735	236	820	182	905	346	968	221
736	234	821	331	906	196	969	221
737	231	823	326	907	131	970	221
738	228	824	339	908	197	971	221
739	359	825	339	909	131	974	222
740	152	826	335	911	351	975	222
741	254	827	336	912	347	976	223
742	263	828	183	913	348	977	138
743	302	829	183	914	353	979	223
744	264	867	276	915	349	982	200
745	320	870	277	917	198	983	221
746	255	872	242	918	198	984	101
747	165	874	277	919	198	990	126
794	190	875	120	920	199	991	127
795	106	876	321	921	199	992	201
796	107	877	104	922	199	993	143
797	108	878	121	923	360	994	156
798	109	879	246	935	258	995	243

APPENDIX A.

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Specimen.	Number.	Specimen.	Number.	Specimen.	Number.	Specimen.	Number.
996	350	1233	103	1398	293	1502	230
997	350	1234	238	1399	293	1503	164
998	202	1235	239	1400	294	1504	312
999	153	1236	155	1401	330	1505	312
1081	226	1237	240	1402	295	1506	170
1085	122	1238	207	1409	306	1508	159
1086	266	1240	208	1427	307	1509	162
1087	267	1241	225	1428	325	1510	169
1088	174	1242	105	1429	241	1512	233
1089	271	1243	131	1432	308	1523	219
1090	175	1244	304	1454	309	1527	332
1091	175	1245	322	1458	163	1528	332
1092	147	1246	305	1459	132	1529	332
1093	176	1247	323	1466	216	1530	324
1094	176	1248(B)	256	1467	217	1531	324
1095	176	1249	209	1471	130	1532	324
1096	337	1250	210	1472	130	1533	324
1097	184	1251	129	1473	135	1534	324
1098	177	1252	257	1474	218	1535	324
1099	327	1253	257	1475	218	1536	324
1100	338	1361	268	1476	136	1537	324
1101	203	1362	269	1477	141	1538	324
1102	204	1363	269	1478	139	1539	324
1103	303	1367	286	1479	140	1540	220
1104	224	1368	211	1480	172	1541	220
1109	205	1369	212	1484	158	1543	187
1110	354	1370	270	1485	166	1544	187
1116	178	1375	287	1486	167	1545	188
1128	285	1377	288	1487	124	1546	296
1130	185	1378	289	1488	173	1547	296
1138	206	1379	213	1490	125	1548	260
1148	186	1380	214	1491	168	1549	313
1155	178	1381	290	1492	168	1550	313
1224	261	1382	355	1493	158	1551	313
1225	142	1383	290	1494	341	1720	314
1226	261	1384	328	1495	341	1721	314
1227	154	1385	329	1496	341	1723	315
1228	253	1389	300	1497	341	1724	316
1229	261	1390	215	1498	310	1725	316
1230	235	1391	291	1499	158	1733	317
1231	102	1392	292	1500	158	1734	318
1232	146	1393	275	1501	311		

INTRODUCTION.

(NOTE.—The numbers from 1 to 100 are found in Appendix B.)

A. SIMPLE ROCKS.

I. Calcareous Rocks.

(See Vol. I., page 109.)

Granular Limestone.—Only one specimen occurs (No. 101), which is a grayish-white, coarsely-granular limestone, containing very little magnesia, but intermingled with much Siderite. The concretionary arrangement of the latter within the grains of Calcite will be further studied. Weathers with a brownish-red, roughly-pitted surface.

Granular Dolomite.—The specimens from one locality represent a fine-grained white saccharoidal Marble (No. 102), sometimes abounding in crystals of Tremolite (No. 103). Weathers rather evenly to a yellowish-brown. A Silurian variety, from Presqu'isle, is of a grayish-white color, and is rich in particles of Serpentine (No. 104).

Talco-Siliceous Dolomite.—The purest form is a rare variety, made up of coarse, cleavable, red masses of the pure mineral (No. 111). After solution in heated hydrochloric acid, the coloring matter of the rock remains as an insoluble red powder of very small amount, whose composition has not yet been determined. More common varieties consist of alternations of reddish-white and brownish-red Dolomite (No. 107), generally rich either in films and bunches of Quartz (Nos. 9, 66, and 105), or in flakes of Talc (No. 106), or in both (Nos. 111 and 113), and pass into a still commoner form, in which the two minerals are disseminated in thicker films and layers (Nos. 110 and 112), finally predominating so as to

pass into a fine-grained schistose Quartzyte, with peculiar cleavage, of feldspathic appearance (No. 148). The association in the same rock of two minerals of such different hardness as Dolomite and Quartz of course produces a remarkably-ribbed, weathered surface, the siliceous layers sometimes projecting an inch or more, and which is very beautiful where the Quartz laminations are very thin, parallel, closely aggregated, and bent into zigzag forms (No. 108). The color of the weathered surface is usually mottled with brown and cream color. A rare variety occurs, mottled with hard brownish-red rhombs of Dolomite, $\frac{1}{4}$ to $\frac{1}{2}$ inch across, and resembling a Feldspar in appearance, abundantly disseminated throughout both the Dolomitic and Quartzose layers, making a fine contrast when the general color is light, and often projecting above the weathered surface (No. 109). All the limestones were examined before the spectroscope for Barium, Strontium, Lithium, etc., without finding any trace.

II. Quartzose Rocks.

Quartz-Conglomerate.—The ordinary varieties of this rock, which is a coarse conglomeritic form of Quartzyte, often of a schistose structure, consist chiefly of pebbles of all sizes, up to several inches in diameter (1 to 2 feet at the Keystone Company's mine), chiefly of smoky and milky Quartz, and more rarely of Chalcedony and Jasper (Nos. 114 and 119). The pebbles often consist mostly (No. 116) of soft white arenaceous Quartz, exactly like that of No. 7, sometimes intermingled with fragments of Chlorite-Schist (No. 115), or embedded in a fine-grained aggregate of Quartz and Chlorite (Nos. 117 and 118). A little Pyrite is almost always disseminated. In some cases the matrix abounds in Mica (No. 51) or in Mica and Micaceous-Iron (No. 122). The weathered surface is unchanged in color, but always greatly roughened, where a softer constituent, like Chlorite, has been worn away. In a Silurian variety from Presqu'isle, the pebbles consist chiefly of brownish-Jasper (Nos. 120 and 121); weathered surface uneven.

Quartz-Breccia.—This is a common rock, which in general consists chiefly of angular flat fragments of brownish-red or of greenish Jasper (No. 125), often having a schistose structure (No.

124), more or less intermingled with similar fragments of smoky Quartz and Hematite and passing into a Hematite-Breccia sufficiently rich for an ore (No. 119). An interesting variety, from a boulder, is a Quartzose Feldspar-Breccia (No. 123). Most of these Conglomerates and Breccias pass through their finer-grained varieties directly into the ordinary Quartzytes.

*Quartzyte.**—This rock occurs in great variety, both as to color, texture, and composition. The color is generally light shades of white, ranging through greenish (Nos. 21 and 132), brownish (Nos. 8, 129, and 135), slaty (No. 134), grayish (No. 126), reddish (Nos. 128 and 130), bluish (No. 136), rosy (No. 133), smoky (Nos. 131 and 137), and purplish (No. 128); but sometimes still darker, even black (No. 127). The texture is rarely so compact as to disguise its granules (No. 136), but the latter are generally plainly revealed on a fresh fracture (Nos. 130 and 134), and especially on the weathered surface (Nos. 126 and 128). Though nearly always composed of grayish-white and glassy Quartz, often milky and smoky (No. 135), some varieties consist chiefly of Jasper and Chalcedony, with enough Magnetite to render them magnetic (Nos. 139, 140, and 141). It is sometimes mixed with a few fragments of Feldspar (Nos. 127, 131, and 138), Argillyte (Nos. 133 and 138), Pyrolusite (No. 137), Calcite (Nos. 131 and 136), Talc (No. 133), Magnetite and Micaceous-Iron (Nos. 50 and 142), Ochre (Nos. 8, 128, 135, and 143), and rarely Hornblende (No. 127), Garnet, Actinolite, and Mica (Nos. 129 and 142), and perhaps Kaolin (No. 126). A little Pyrite is also commonly disseminated. A sub-schistose structure is often more or less apparent (Nos. 130, 132, and 133), passing into that of the next rock.

When Talc is present in some quantity, the rock sometimes graduates into Talcose Schists—as on the Lake shore east of the Chocolate River. Weathers usually with only a superficial loss of lustre and a little lighter color, the constituent grains being sometimes brought out prettily by the glacial polish. See also Nos. 1027, 1029, 1041, 1042, and 1056 of Appendix C.

Quartz-Schist.†—A very common rock, of finer grain than most

* See Vol. I., page 106.

† See Vol. I., page 97.

of the Quartzites, and with less variations in color. Some varieties are banded and contain a little Ochre and Pyrolusite (Nos. 144 and 145), while others contain a green mineral, as yet undetermined (No. 146), Semi-Opal and Pyrolusite (No. 149), Dolomite, as stated in connection with the calcareous rocks (No. 148), Talc (Nos. 74 and 150), and Garnets (No. 23). A peculiar variety (No. 147) seems to be a pseudomorphous aggregate of arenaceous Quartz, Chlorite, and Mica, with a brown mineral. Most commonly, however, the schistose structure is produced by a greater or less intermixture of Magnetite (Nos. 15, 19, 23, and 52), or of Micaceous-Iron, often in triangular scales (Nos. 32, 33, 36, and 37), or of Magnetite and Micaceous-Iron, in which either the former predominates (Nos. 151, 152, and 153), or the latter (Nos. 16, 154, and 155), associated with a little Mica or Chlorite: and in other cases of Limonite (No. 26), of Limonite-Ochre (No. 157), or of Calcite, Hematite, and Limonite-Ochre (Nos. 57 and 156), or Talc (No. 74). By the predominance of such minerals, all these varieties pass into the Iron ores. Compare Nos. 1040 and 1069, and Nos. 1045, 1064, 1066, 1075, and 1076, of Appendix C. No. 16 is a Micaceous-Iron Quartz-Schist, which passes into a Mica-Schist containing Feldspar, and is therefore allied to Itabirite; but it differs from that rock in the concentration of the Micaceous-Iron in somewhat parallel films or seams, in the predominance of the Quartz, and in the absence of the various minerals which are necessary (Specular-Iron and Magnetite) or accessory (Talc, Chlorite, Actinolite, etc.) constituents of Itabirite. An Ochrey Quartz-Schist, of very cellular structure, also occurs at the Foster mine, in which the chief constituent—Quartz—is almost entirely stalactitic, and the cavities are lined or filled with more or less Ochre of coppery color and lustre. When chiefly Quartzose, weathers like Quartzite, the laminæ being rendered more distinct by the glacial polish; when partially made up of laminæ of other minerals, weathers unevenly and often to darker or ochrey shades of color. See also Nos. 1035 and 1078 of Appendix C.

Siliceous Schist.—Many varieties of this rock occur, whose colors vary from white, drab (No. 164), green (Nos. 158, 160, 161), brown (No. 159), and iron-gray (No. 165), to black (No. 163). The structure is sometimes slaty (Nos. 163 and 164), often banded (Nos. 158, 159, 161, 162, and 165), and sometimes characterized by a

peculiarly sharp rhombohedral cleavage (No. 163). Its composition and physical properties are varied by the presence of Limonite (No. 163), Mica and Chlorite (Nos. 158 and 164), or Talc, and in the last case becomes a Novaculyte (Nos. 13, 160, and 161), or passes, by alternating layers, through No. 162 into Talcose Schist, through No. 139 into Argillyte, and through No. 165 into Hematite-Schist. Weathers smoothly (except when a softer mineral is present) to a rather darker brownish shade; the chloritic variety (e.g. that which occurs near Lake Fairbanks) weathers, to the depth of several inches from the surface, and along the fissures, to a deep reddish-brown. A peculiar variety occurs at Presqu'isle (No. 242), which is intermingled and colored with Ochre, and traversed by an abundance of thin reticulating seams of Calcite.

Jasper-Schist.—This, the finest-grained form of the Quartzose rocks, is a common and abundant accompaniment of the ores, and varies in texture from the coarse Conglomerates (Nos. 120 and 121) and Breccias (No. 125) already mentioned, to the crypto-crystalline schists described below. A rare form is a thinly laminated green slate (No. 170); but the structure is generally banded, and the colors consist of alternating stripes of brownish-red, gray, green, brown, yellow, and black (Nos. 166, 167, 168, 169, 171, 172, and 173). It sometimes contains a little Mica (Nos. 170 and 172), Gëthite (No. 168), Chlorite (No. 169), and Magnetite (No. 171); but the most common form consists of alternations of bluish-black crystalline Hematite (Martite) and brownish-red Jasper, associated sometimes with a little Ochre and Kaolin (Nos. 172 and 173). Weathers smoothly and unchanged in color, but layers containing a ferruginous mineral become darkened in color and sometimes more deeply worn.

III. Silicate Rocks.

Amphibolyte.—(See under Dioryte.)

Amphibole-Schist.—(See under Dioryte.)

Hornblende-Schist.—(See after Hornblende-Gneiss.)

Anthophyllite-Schist.*—This is a form of Quartz-Schist, through which is disseminated an abundance of a brownish-gray hydrous mineral, in tiny silvery scales or fibrous blades, first identified by Prof. G. J. Brush as Anthophyllite, and of which I have made no examination. The Quartz sometimes predominates (No. 174), but usually the Anthophyllite (Nos. 175 and 176). Magnetite is almost always present, either generally dispersed in minute granules (No. 174), or especially gathered into certain laminæ (Nos. 27, 175, and 176), or into thicker alternating layers (No. 177), so that the rock becomes strongly magnetic (Nos. 177 and 178), and passes into an ore of Magnetite, associated with much Pyrolusite, which imparts to the rock a metallic streak (No. 59). A little Hematite-Ochre is also disseminated through these latter varieties (No. 58). Weathers unevenly to a reddish-brown, or, when rich in Pyrolusite, to a blackish-brown, slightly shining. See also Nos. 1027, 1032, 1033, and 1037, of Appendix C.

Chloritic Schist.†—This rock is developed in great abundance and with several interesting varieties. Its color is usually olive-to blackish-green; its texture is very fine-grained; and its schistose structure sometimes approaches that of a slate, and is sometimes distinct only on a large scale. Five marked varieties occur, which may be distinguished by their apparent origin.

First.—Chlorite-Schist, derived from Hornblende- or Actinolite-Schist by alteration (Nos. 179, 180, 181, and perhaps 184 and 185). Streak light-green to greenish-gray. Consists chiefly of minute scales of Chlorite; is sometimes filled with Garnets (Nos. 179 and 184), has generally much Magnetite disseminated in octahedra, which are often altered into Chlorite (No. 179. See Bischof's *Chem. and Phys. Geology*, London, 1855, Vol. II., p. 409) or Martite (No. 185)§, and sometimes still retains the blades of Amphibole, more or less altered (No. 180). A highly quartzose variety (No. 76) may fall within this division. Its deep green color, feeble lamination, and granular structure (produced by the tiny scales of Chlorite, inclined in all directions, of which it chiefly consists) sufficiently distinguish this from the succeeding varieties.

* See Vol. I., page 114.

† See Vol. I., page 104.

§ See also Credner, Article, page 545.

Secondly.—Chloritic Schist, derived from Chloritic Dioryte-Schist, through Aphanyte-Schist, by the increased proportion of Chlorite (Nos. 182 and 183). Streak greenish-white. Consists chiefly of Feldspar, with rather less Chlorite, and is always traversed by Calcite in more or less abundant films and seams. It may generally be distinguished by its geological association, by its light color and streak (due to the predominance of Feldspar), and by its aphanitic texture and somewhat irregular scaly cleavage. See also Nos. 1015 and 1026 of Appendix C.

Thirdly.—Chloritic Schist, produced in Greenstone-Ash or Argillite, by the increased proportion of Chlorite (No. 188). Streak generally greenish-white. Consists chiefly of Feldspar, and generally contains Calcite. It can generally be distinguished from the other kinds by the transition varieties (Nos. 28, 208, and 219), which pass into the Greenstone-Ashes, by its parallel lamination, dark color, and the frequent isolation but parallel arrangement of its scales of Chlorite.

Fourthly.—Chloritic Schist, produced in Chloritic Gneiss by the increased proportion of Chlorite (Nos. 186 and 187). Streak greenish-gray. Consists of about equal quantities of Feldspar, Chlorite, and Quartz. The Quartz may generally be distinguished by the lens, but the chief difference between this kind and the three foregoing consists in the isolation and greater size of the individuals of Feldspar, so as to frequently produce a porphyritic structure (No. 186).

Fifthly.—Chloritic Schist, produced in Argillite by the presence of a small quantity of Chlorite (see Nos. 10, 190, 191, 192, 193, etc., under Feldspathic Argillite, with which they are most nearly connected). This class may very possibly consist only of aphanitic varieties of the First and Third. One form, which occurs in great abundance North of Teal Lake and elsewhere, seems to be an indurated rock derived from Chloritic Schist by alteration, exhibiting a coarsely schistose structure on a large scale, containing a little Talc (in tiny shining scales) and filled with the irregular cracks due to contraction (largely occupied by Calcite).

By the decomposition of all these varieties of the Fifth class, and the further oxidation of the Ferrous Oxide, the color partially or entirely passes into reddish-brown, and the rock graduates into a mottled Chloritic Argillite, an Ochrey Argillite, and ochrey

schists, in which the more compact and softer portions sometimes consist of Red Chalk. All these varieties may be best studied at Kimball's Cut, on the Peninsular Railroad.

Weathers unevenly to shades of reddish-brown, often mottled with greenish. See also Nos. 1028, 1030, 1038, and 1052, of Appendix C.

Argillyte * (Greenstone-Ash, etc.).—The fine-grained schistose rocks or slates, evidently metamorphic forms of mechanical deposits (Argillaceous, Chloritic, Talcose, Feldspathic, and Siliceous schists), are very largely developed and with many varieties. They are naturally divided into two great groups, Huronian and Laurentian, including many similar varieties. The latter are evidently deposits derived from the erosion of the Laurentian Gneisses, etc., and their discussion will be taken up further on under the heading of Mica-Slates, although their descriptions (Nos. 187, 188, and 211 to 220) are mostly arranged in association with the others.

The former group, or Huronian, will be alone discussed here. They are evidently derived from the erosion of dioritic rocks, and are apparently identical with the fine-grained forms of Greenstone-Ash (Jukes, pages 68, 81, and 323), or Greenstone-Tuff (Cotta, page 310, and Zirkel, II., page 535, the latter including only the European form, derived from Diabase-Greenstone).

The less alterable constituent of the Diorytes, Feldspar, of course predominates in most of the rocks, revealing itself in chemical analysis by the presence of a notable quantity of the alkalis, and on microscopic examination of a section, in exceedingly abundant, irregular, and somewhat angular particles; but it has often subsequently been decomposed in a greater or less degree into Kaolin. The other constituent, Amphibole, seems to be of such a character as very rarely to resist decomposition, and its fragments have almost always passed into Chlorite or Mica, or have been resolved into its elements, Silica, Ferric Oxide, etc. The accessory minerals of the Diorytes, Quartz, Mica, Chlorite, and Talc, seem to have generally passed unchanged into these deposits; the Magnetite has been gathered, through its greater Specific Gravity, into an iron-sand, and has thus been concentrated into certain beds,

* See Vol. I., page 111.

layers, or laminæ; while the Pyrite has probably been generally decomposed and diffused in the form of ochre.

The result has been a series of rocks, whose exact constitution can of course be only determined by a thorough microscopic and chemical investigation, which I have as yet only begun. These I will now divide into three classes, in which the material is made up respectively of Feldspar, of Amphibole or Chlorite, or of amorphous substances derived from the decomposition of these minerals.

First, a schistose rock, mainly composed of particles of Feldspar, but little altered, with varying quantities of Mica, Chlorite, Talc, Quartz, etc. This is very abundant, and has generally been called Clay-Slate or Argillyte; but as its chief component seems to have been a feldspathic rather than ordinary clay, I have called it *Feldspathic Argillyte*. Its chief characteristics are its peculiar fusibility, light color, and, I presume, its content of the alkalis. (Nos. 197, 198, 199, etc.)

The following varieties are produced by the decomposition of the Feldspar, and by the presence of one of the accessory minerals in such proportion or method of concentration or arrangement as to render it conspicuous.

Argillyte, or *Shale*, a slaty or shaly form of the preceding, in which the Feldspar seems to have been mostly converted into Kaolin; so that the fresh fracture yields an argillaceous odor, when moistened, and clings to the tongue. It is distinguished by these clayey characteristics, and, I presume, by containing but little of the alkalis, and therefore seems to be a normal Clay-Slate or Argillyte.

Siliceous Feldspathic Argillyte, a schist to which the particles of Quartz impart a peculiar hardness and the streak partly consists of a metallic abrasion from the knife; it sometimes passes into a kind of *Siliceous Slate*, in which the Quartz seems to predominate above the Feldspar, while the slaty structure is produced by the Mica. The presence of the latter mineral, and a slight fusibility, distinguish this Siliceous Schist from that associated with the Quartzites.

Micaceous Feldspathic Argillyte (or, as above, *Micaceous Siliceous Slate*), passing into *Feldspathic* or *Argillaceous Mica-Slate*, with

the increased proportion of Mica. It is distinguished from the Laurentian Mica-Slates, described further on, by the much smaller content of Mica, in this rock, and its distribution in minute isolated scales, and by the siliceous character of the Laurentian variety.

Chloritic Feldspathic Argillyte, or *Chloritic Argillyte* (see Zirkel, II., p. 599; Blum, pp. 77 and 227; Kenngott, p. 205; and Naumann, p. 544). This includes the fifth variety of *Chloritic Schist*, already described under that heading, and passes into the *Chlorite-Schist* of the Second Class. It differs from the other varieties in its greenish color, and sometimes the scales of Chlorite are distinct. Its color is of a darker green than that of the similar Laurentian rock.

Talcose Feldspathic Argillyte (see Zirkel, I., p. 318; Kenngott, p. 205; and Naumann, p. 544), a rare variety, distinguished by its soapy feel, but in which the Talc never predominates.

Magnetic Feldspathic Slate, sufficiently distinguished by its magnetic character, and which closely approaches a Laurentian variety.

Secondly, a schistose, often slaty rock, derived from the erosion of Diorytes rich in Amphibole—but which rarely retains any large quantity of particles preserving the form of that mineral—which may be called an *Amphibole-Schist* (No. 205).

Generally the Amphibole survives only in the form of Chlorite, associated with an abundance of particles of Quartz, and so this class includes the first and third varieties of *Chlorite-Schist*, already described under that heading (Nos. 179, 180, 208, 219, etc.).

Thirdly, *Argillyte-Slate* (Nos. 221, 222, and 223), the typical "roofing-slate," whose constitution appears to be generally amorphous, even under the microscope, and which in most cases is probably made up of the ruins of the minerals of the preceding two classes. However, it often retains a sufficient quantity of these minerals unaltered as to be divided into Actinolitic, Feldspathic (light-colored), or Chloritic (greenish) varieties. The name "Argillyte" is ordinarily taken to imply a schistose structure, but for its slate lithologists employ either an additional name, "Clay

Slate" (Thonschiefer), which however seems to be used in English very loosely, or the popular term "roofing-slate," whose objectionable character is apparent. In the hope to simplify the matter, I propose, with the approval of Prof. Dana, the latinized translation of Thonschiefer—*Argillyte-Slate*—as a slight but sufficient distinction, for the purposes of this Report.

Feldspathic Argillyte and *Chlorite-Schist*.—On account of the greenish color of the Feldspar, as well as of the Chlorite, of which the schists of the first two classes are composed, their color is in most cases a shade of greenish-gray; but in others, the color is grayish-white, grayish-green (Nos. 201, 206, and 209), brown and yellow (Nos. 190, 191, 192, and 193), cast-iron gray (No. 200), blackish-gray (Nos. 203 and 204), and grayish-black (No. 205). The texture is almost always crypto-crystalline, but the materials can often be distinguished by means of a lens, and are occasionally so coarse as to reveal the striated facets of Feldspar (No. 196), or the scales of Mica (No. 207, etc.) distinctly to the eye. The structure is in almost all cases imperfectly schistose. It is also often minutely streaked or banded (No. 189, etc.), in consequence of a fibrous cleavage (Cotta, page 255). Occasionally an amygdaloidal structure occurs (No. 205). The composition seems generally to consist chiefly of Feldspar (No. 206, etc.), which sometimes may be partly decomposed into Kaolin (No. 195). With the Feldspar a brownish-gray Mica is generally associated, sometimes white, silvery-gray, and black, usually in minute disseminated scales (No. 210), which sometimes are very abundant (No. 207). Granules of Quartz are sometimes associated with the Feldspar (Nos. 204, 208, 209, and 210), or are gathered into separate layers alternating with Argillyte, and making a transition form (No. 159). Chlorite often replaces the Mica, either partially (No. 208) or entirely (Nos. 28, 190, 192, 193, and 199), being sometimes present in such quantity as to produce a Chloritic Schist. (Compare Nos. 1039, 1068, and 1072 of Appendix C.) When the Chlorite is decomposed, another brown variety results, which strongly resembles a coarse Clay-Slate in odor when moistened, etc., but which contains in place of Alumina a considerable proportion of Hematite-Ochre (Nos. 190, 191, 192, 193, and 199). A very little Talc also occurs in a few rare varieties (No. 201)—one of which contains a sufficient quantity

to be called a Talcose Schist (No. 225)—and also in association with Chlorite (Nos. 190 and 192). A common transition variety, near the mouth of the Chocolate River, is a Talco-Argillaceous Slate, with siliceous bunches, which passes by the predominance of any one of its constituents into a Talcose, an Argillaceous, or a Siliceous Schist. Magnetite is disseminated through a few varieties (Nos. 55, 203, and 204). Micaceous-Iron sometimes replaces the scales of Mica, either partially or wholly (No. 206). Pyrite and Calcite (No. 194) are also very generally disseminated, in minute particles and films, and one variety (from a boulder) contains many small bunches of Siderite (No. 189). Weathers evenly and without change of color, but, in the common chloritic varieties, more or less unevenly to brownish shades.

Argillyte-Slate.—Its color is the usual blackish-gray, inclining to bluish and to greenish (Nos. 221 and 222); seems to be chiefly composed of Quartz, Feldspar, and Mica; and is sometimes filled with particles and films of Pyrite (No. 223). It is connected through the imperfectly schistose varieties (Nos. 221 and 222) with the Feldspathic Argillytes. Weathers rather evenly to a lighter color.

Talcose Schist.—The scarcity of Talc in the rocks of this region, and especially of its concentration in beds, makes this rock of rare occurrence. Two kinds occur, the Feldspathic (already described) and Quartzose. In addition to the usual greenish-gray variety of the first (No. 225), mentioned under Feldspathic Argillyte, the color is sometimes grayish-green (No. 53), or brownish-gray (No. 54). Other varieties occur, which differ chiefly in the dissemination of Magnetite (Nos. 54 and 226), or Hematite-Ochre (No. 227): in the last case porphyritic with Feldspar crystals. All these consist chiefly of triclinic Feldspar* and Talc, in various proportions, the Talc rarely amounting to half. The most common form of the Quartzose variety is a Siliceous Schist permeated with Talc in minute scales—Novaculyte (Nos. 13, 160, and 161). A transition form is made up of alternating talcose and siliceous layers (No. 162). A rarer and

* Credner (Article, pages 529 and 553) considers it Orthoclase, in a Menominee variety, and indeed finds that feldspar also in a Huronian Chlorite-Schist (page 539)—both which cases seem to me doubtful.

coarser variety is a thinly laminated white Quartzose Slate, made up of laminae and scales of Quartz and white Talc (No. 74), or of Jasper and Talc (near E. Section line in S. E. $\frac{1}{4}$ of N. E. $\frac{1}{4}$ of Section 23, T. 47, R. 26): sometimes passing into a talcy Quartzite (N. W. $\frac{1}{4}$ of N. W. $\frac{1}{4}$ of S. 24, T. 47, R. 26, and near mouth of Chocolate River, etc.), or into a Talcy Quartz-Schist (No. 150); and sometimes, by an intermixture of Quartz pebbles, into a Conglomeritic Talc-Schist or a Talcose Conglomerate (N. side of Lake Palmer); or, by an intermixture of pebbles of Dioryte-Greenstone, into a Talcose (perhaps Chloritic?) Greenstone-Conglomerate (S. W. $\frac{1}{4}$ of S. W. $\frac{1}{4}$ of S. 1, T. 47, R. 27).—See Vol. I., page 99: also Cotta, page 310.

By an intermixture of Feldspar with the Talcose Quartz-Conglomerate above mentioned (N. side of Lake Palmer), a Talcy Conglomeritic Gneiss is produced, or, with the Talcy Quartz-Schist, a Talcose-Gneiss ("Protogine Gneiss"), or Talcy Chloritic Gneiss, in considerable beds; but this is merely a local development, and the rounded grains or pebbles generally distinguish these Huronian varieties from the allied Laurentian gneisses described further on.

Steatite is said to occur at a locality north of Teal Lake, but there is no specimen in this collection.

The Talc-Schists weather rather unevenly to darker shades of brown.

IV. Iron-Ore Rocks.

(See also Vol. I., page 85.)

The collection does not include any great variety of these rocks, most of which are lithologically identical with the similar ores from other regions; but the specimens have apparently been selected rather from those which represent the local characteristics, and to these only the following remarks will be specially devoted.

Magnetite-Schist.—The color of these rocks is usually bluish-black (No. 738), sometimes grayish-black (No. 39), or brownish-black (Nos. 40, 41, and 42), often having a greenish shade by the presence of Chlorite (No. 233), or mottled by grayish-white Quartz (No. 234). The lustre is generally much less, and the texture of a

much finer grain, than in the ores from the Adirondack region of New York, Northern New Jersey, etc., but the granules are more perfectly octahedral, even in the ores of steely compactness.

A crypto-crystalline, dull variety also occurs (No. 230). A schistose structure is in consequence strongly defined in most cases, and sometimes becomes tabular or slaty (No. 228). Films of Chlorite are often disseminated (Nos. 42, 43, 231, and 232): a Mica, allied to Chlorite, more rarely (Nos. 15, 233, and 235): in one case, Garnet (No. 23): and very commonly, Quartz, in bunches or alternating laminæ, and thus passing into Quartzite (Nos. 234 and 235), or Quartz-Schist (Nos. 19, 23, and 52). But the greatest peculiarity depends upon the extensive process of alteration to which most of the original magnetic ores have been subjected, and the result is shown in a series of transition varieties between Magnetite and Hematite. The present beds of compact Magnetite have been thus affected only in a small degree, though many varieties of Hematite show evidences of this method of origin (Nos. 2, 5, 43, 46, and 49)—as in the “red ore” of the Washington mine (a mixture of the two ores), and in the iridescent seams and in the chloritic films which traverse the Magnetite beds at the same mine. The chief alteration has taken place in the more common schists, made up of thin alternations of fine-grained Magnetite with Quartz (Nos. 151, 152, and 153), or Jasper (No. 171): the ferruginous layers being chiefly (Nos. 238, 239, and 240), or wholly (Nos. 172 and 173) composed of Martite (Dana's System of Mineralogy, No. 180, *A*) when associated with Jasper, and of Micaceous-Iron (Nos. 16, 33, 38, 50, and 142), when associated with Quartz (see also under Quartz-Schist). Hematite-Ochre is sometimes dispersed in small quantity (No. 236); and a rare variety is made up of thin alternating laminæ of Actinolite and Magnetite (No. 17. See also Nos. 1032, 1033, 1034, 1037, 1057, 1058, and 1061, of Appendix C). The association with Anthophyllite has already been referred to, under the Anthophyllite-Schists (Nos. 174, 175, 177, and 59); and also the association with Feldspathic Argillite, under that head; in both cases only lean, worthless ores being produced. Weathers rather evenly to lighter, usually brownish shades. (See also Nos. 1044, 1054, and 1059 of Appendix C.)

Hematite-Schist.—This ore presents the characteristics and varie-

ties usual in other regions of America. They may be arranged as follows, in reference to crystalline condition.

First. An Ochrey Hematite-Schist (Nos. 35 and 67), sometimes containing much Pyrolusite, Quartz, and Kaolin (Nos. 24 and 25), and often disintegrated into gravel (No. 34). Peculiar varieties occur (Nos. 25 and 34), sometimes rich in Quartz and Calcite (Nos. 242 and 243), or in Kaolin (No. 244). Compare No. 1074 of Appendix C.

Secondly. A Compact Hematite-Schist, having a feeble lustre (Nos. 5 and 68), and sometimes containing Kaolin (No. 44). In other cases it contains many octahedra of Martite (No. 5), or Magnetite, being a transition variety (No. 43) from a Magnetite-Schist.

Thirdly. A Specular-Iron Schist, with decided lustre (Nos. 6, 38, 45, 47, and 237), made up of thin scales and laminæ of shining Specular-Iron and of minute granules of Quartz. Dispersed crystals of Martite (No. 48), or decomposed Garnets (No. 6), sometimes produce the so-called “Birdseye ore.”

Fourthly. A Micaceous-Iron Schist, with high lustre (No. 46). This also sometimes contains octahedra of Martite or Magnetite (No. 49).

Fifthly. A fine-grained Martite-Schist, made up almost entirely of that mineral with a little Quartz and Kaolin (No. 2). See also No. 1060 of Appendix C.

With these are associated two common transition varieties of Quartz and Jasper-Schist, called “lean ores.” The one is produced by the alternation of layers of Micaceous-Iron and Quartz, the latter usually predominating largely, so as to produce a Quartz-Schist (Nos. 16, 32, 33, 36, and 37). Magnetite is generally associated with the Micaceous-Iron, and sometimes the former predominates (Nos. 151, 152, and 153), and sometimes the latter (Nos. 16, 154, and 155), together with a little Mica. The other transition variety is made up of layers of crystalline bluish-black Martite, alternating with others of brownish-red Jasper (Nos. 172 and 173), or of grayish-white Quartz (Nos. 238, 239, and 240), which passes through a transition variety (No. 241) into the ochrey schists. A rather infrequent variety, by which this rock is connected with the Quartz-Breccias, is a Hematite-Breccia, sometimes abounding in Kaolin (No. 119) and generally schistose, as at the Jackson mine and on the north side of Moss Mountain. Weathers unevenly to reddish-

yellowish-, and blackish-brown. See also Nos. 1046, 1050, 1067, 1070, 1071, and 1073, of Appendix C.

Limonite-Schist.—This ore (No. 245) is not usually developed to any great extent, and its varieties and mammillary concretions resemble those from the other Iron regions. A little Göthite and Turgite are associated with it in a few localities. It is connected with Quartzite and the Quartz-Schists through the banded transition varieties (Nos. 26, 57, and 157), made up of alternations of Limonite and Quartz. Weathers smoothly, with a surface covered with Ochre.

V. Carbonaceous Rocks.

(See Vol. I., page 115.)

These slates and shales (Nos. 246 and 247), which are of rare occurrence and little variety, have usually a grayish or brownish-black color, dull lustre, and fine-grained texture; are usually so soft as to soil paper; receive a high polish by friction; and sometimes contain much Quartz and Ochre, and a little Mica, in veins and seams (Nos. 248 and 249). The Carbon seems to constitute only a small part of the rock, and more rarely some of it occurs in bright films of Graphite, so as to produce a Graphitic Shale (Nos. 250 and 251). Weathers smoothly and without change of color, graphitic laminæ assuming a polish. See also No. 1036 of Appendix C.

B. MIXED CRYSTALLINE ROCKS.

OLDER FELDSPATHIC ROCKS.

ORTHOCLASE ROCKS.

VI. Granite.

This abundant rock in the Laurentian region is barely represented in the collection, and the only typical variety (No. 252) is a very coarse aggregate of Orthoclase and Quartz, with a very little Mica; by the disappearance of the latter, varieties of Pegmatite and Graphic Granite are produced, in considerable abundance. Two

Huronian specimens are included in this group, merely for temporary convenience. The one (No. 253) is from a dyke through a bed of Iron-ore, and consists of Feldspar (perhaps Orthoclase), Quartz, and Micaceous-Iron in place of Mica; thus corresponding to the "Eisen Granit" of German Lithology. The other (No. 254) is a fine-grained rock, which is chiefly made up of a triclinic Feldspar, and may very probably turn out to be a variety of the Gneiss of similar composition described below.

PLAGIOCLASE ROCKS.

Under this name, adopted by Breithaupt for the group of triclinic Feldspars, it seems best at present to follow Credner in classifying the Gneisses and Greenstones of this region.

VII. Gneiss.

Common Gneiss.—This is a very abundant Laurentian rock, and is here represented by a very few varieties. Its color generally inclines to black, when its Mica is prominent (Nos. 255, 256, and 257); and sometimes to reddish (No. 258) or grayish-white (No. 259), by the predominance of its Feldspar. Its texture is rather fine-grained, the grains rarely exceeding $\frac{1}{8}$ inch in diameter, and its structure sometimes approaches a slate (No. 257). The Feldspar has almost always a good cleavage and lustre; many of its facets are minutely striated; its general color is grayish-white, becoming reddish-brown by incipient decomposition (No. 258); occurs sometimes in small crystals (Nos. 258 and 259); and it amounts to from 4 to 7 parts (tenths) of the rock. The Quartz is generally grayish-white and smoky, in still smaller grains, and amounts to from 2 to 5 parts. The Mica is generally black or blackish-brown, but is rendered soft and yields a greenish-gray streak by incipient decomposition (No. 258), and amounts to from 1 to 4 parts. Pyrite is universally disseminated in small quantity (No. 256). Epidote occurs in one specimen (No. 259), and Chlorite (No. 257). A peculiar and very coarse variety (No. 7) seems to be rich in Orthoclase. Weathers evenly to a lighter color, usually reddish-gray.

Hornblende-Gneiss.—This abundant Laurentian rock is represented by only 2 specimens from a Huronian locality (Nos. 266 and 267). It is composed of the same minerals as the Gneiss just described, with the substitution, in the unaltered specimens, of greenish-black Amphibole in place of Mica. Its general color is blackish-green,—dull, in the Huronian variety, or sparkling, in the Laurentian,—more or less speckled (especially in the Laurentian) with grayish-white, according to the amount of Feldspar. Its texture is usually rather fine-grained—few of the granules, scales, etc., exceeding $\frac{1}{16}$ inch; but coarser layers are common, in which the diameter of the grains reaches $\frac{1}{8}$ to $\frac{1}{4}$ inch. The structure is always decidedly schistose, often banded by the lighter-colored coarser layers (Nos. 263, 264, and 270), and becomes fissile by the presence and increase of scales of Mica and Chlorite. The Feldspar is exactly like that of the common Gneiss just described, very rarely greenish-white in color, does not often assume the reddish tinge by incipient decomposition (Nos. 264 and 270), and makes up from 1 (No. 266) to 6 parts of the rock (No. 265); it especially predominates in the Laurentian variety, and is at once distinguishable on a fresh fracture, while, in the Huronian, it is obscured by the Amphibole. The Quartz makes up from 2 to 6 parts of the rock, and is often arranged in parallel flakes (No. 266). The Amphibole makes up from 2 to 5 parts, and has been subjected to a process of alteration, whose several stages are well illustrated in this Collection (see especially Nos. 261 and 269), and show that the micaceous gneisses have been, at least sometimes, and the chloritic gneisses perhaps always, derived from this rock. It very rarely, especially in the Huronian variety, retains its normal hardness, structure, color, and streak (Nos. 261, 262, and 267); but the blades become soft to the knife, with a greenish-gray streak (Nos. 265 and 268), assume a blackish-green color, yellowish-green translucency, and scaly structure (No. 269), pass into blackish-green scales of Chlorite, which often still retain the fibrous structure (No. 266), and finally into scales of a harder Mica, which sometimes are greenish-black (No. 265), brownish-black (No. 263), black (No. 264), and grayish-white (Nos. 264 and 266): a Mica of two of these colors being often intermingled in the same specimen (No. 264). A little Pyrite is disseminated throughout this rock in minute particles (Nos. 262, 267, etc.). Epidote abounds in the more altered varieties (Nos. 263, 264, and 268),

often in grains $\frac{1}{8}$ inch across; and sometimes the presence of Calcite is shown by the effervescence of the rock when immersed in acid (No. 268). The weathered surface is generally even though rough, and, in the Laurentian variety, of a lighter color, reddish or brownish (Feldspar), while in the Huronian it is often mottled with blackish-green (Amphibole). This rock may possibly be related to some of the Specimens, Nos. 1019, 1020, 1021, 1022, 1023, and 1029, of Appendix C.

Hornblende-Schist.—A less common variety of the preceding rock, represented by specimens from both a Huronian and a Laurentian locality. It is generally fine-grained (Nos. 271, 272, and 273), sometimes coarse (No. 274), is chiefly composed of Hornblende, almost always effervesces slightly in acid, and contains a little Chlorite, especially in the Laurentian variety. Only one variety occurs in this collection which has been derived from or is related to any other rock—a Greenstone-Ash (No. 205)—but I shall refer, under Dioryte, to a variety I have frequently observed in the field, derived from that rock. Weathers unevenly, with a surface mottled with brown and green.

Chloritic Gneiss.—This exclusively Laurentian rock has evidently resulted by the complete disappearance of the Hornblende from the preceding. Its color is generally greenish-gray (Nos. 276, 278, 282, etc.), or grayish-white (Nos. 285, 288, 289, etc.), often brownish-red, by the decomposition of its Feldspar (Nos. 279, 280, 294, etc.), and sometimes reddish-white (Nos. 80 and 291), olive-green (No. 269, Sp. 1362), or greenish-black (No. 287). Its texture varies from very fine-grained (Nos. 284, 287, 290, etc.), to coarse (Nos. 280, 283, etc.). Its structure is decidedly schistose when the Micas are abundant (Nos. 278, 295, etc.), and also when, in other varieties, the Quartz occurs in parallel flakes, but quite massive in their absence (Nos. 280, 285, and 289), and is sometimes banded (Nos. 290 and 293) or porphyritic (No. 281).

The Feldspar is the chief constituent, being generally greenish-white (Nos. 279 and 280), reddish (Nos. 8 and 282), or grayish-white (No. 281), sometimes light-brown (No. 3); has almost always good cleavage, lustre, and distinct striation, but is sometimes milky-white and amorphous (No. 288); and occurs generally in minute

granules, often $\frac{1}{16}$ to $\frac{1}{8}$ inch in diameter, but sometimes $\frac{1}{4}$ to $\frac{1}{2}$ inch or even 1 inch (Nos. 280, 281, 283, and 288). The Quartz varies in amount from 1 part, when it can be distinguished with difficulty (No. 279), to 2 or 3 parts, sometimes occurring in bunches $\frac{1}{2}$ inch across (No. 280), but more commonly in thin parallel equidistant flakes, which appear on the section as abundant lines, about $\frac{1}{4}$ to $\frac{1}{2}$ inch long, $\frac{1}{32}$ inch thick, and about $\frac{1}{8}$ to $\frac{1}{4}$ inch apart. The micaceous constituent is either a greenish-black or brown (No. 284), or grayish-white Mica (Nos. 276 and 279), generally softened, so as to cut with nearly the softness of Chlorite, or it consists of the latter mineral in scales, sometimes fibrous (No. 279), or in films (Nos. 276 and 282), amounting to nearly 3 parts (No. 281), or almost disappearing from the rock. Epidote generally replaces the Chlorite in the last case, sometimes being present to the extent of 2 or 3 parts (Nos. 277 and 290, Specimen 1383), and very commonly disseminated in small quantity (Nos. 281, 288, etc.), sometimes in transparent crystals (No. 296). A peculiar fine-grained Greenstone occurs as a broad vein in this rock, which consists of Feldspar, Chlorite, and about 3 parts of Epidote (No. 277, note). The Chlorite is sometimes partly decomposed into a brownish-yellow Ochre (No. 291), or is entirely replaced by it (No. 292). Seams of Calcite often traverse the rock (Nos. 278, 279, and 284); and a little Pyrite is commonly disseminated (No. 287, etc.). Weathers to the depth of $\frac{1}{8}$ to $\frac{1}{2}$ inch, with an even surface, generally roughened by the greater erosion of the Chlorite, with a lighter and duller shade of the same color as the fresh fracture, or inclining to brownish.

Talcose Gneiss.—In a rare variety of the preceding Laurentian rock, a greenish form of Talc seems to replace a part (Nos. 297, 298, and 299), or all (No. 65), of the Chlorite in the green films, being distinguished by its lighter-colored silvery scales, greenish-white streak, and more greasy feel. It is possible that future exploration may show that this variety is far more abundant than would appear from its representation in this collection and from my own limited examinations of the borders of the Huronian region, where the Chloritic Gneiss abounds.

The greasy feel of many varieties, classed under Chloritic Gneiss, also suggests a magnesian constituent—perhaps Talc, in many or possibly in all cases. But at present it seems an accidental and

rare form, and for that reason alone it seems unwise to adopt the name "Protogine-Gneiss," which has sometimes been applied to this rock as well as to the preceding. It is further to be considered that the name Protogine is etymologically objectionable, especially if used beyond the region in which it originated; and that although its micaceous constituent, like that of the rock under discussion, is either a decomposed Mica, Talc, Chlorite, or related mineral, the Talc seems to be its most characteristic feature. I have therefore adopted for the preceding rock the name Chloritic Gneiss—used by Zirkel, Blum, Credner, and Roth,—and for this variety the names of Talcose Gneiss and Talcy Chloritic Gneiss.*

By the disappearance of the Chlorite and Talc in the preceding two rocks, a variety of Pegmatite is sometimes produced (*e.g.* near Collinsville), but which is generally easily distinguished from the Granitic Pegmatite, already referred to, by its gneissoid structure, and often by the presence of the parallel lenticular flakes of Quartz.

In the vicinity of Lake Palmer there occur several forms of a Huronian Talcose Schist, which graduate into a Talcose and Talcy Chloritic Gneiss, entirely distinct from the above Laurentian rocks.

VIII. Mica Schist.

(See Vol. I., page 113.)

This abundant Huronian rock, of which Formation XIX. chiefly consists (No. 301), is entirely made up of small scales of brownish or brownish-black Mica, and tiny granules of grayish-white Quartz; the former inclining to bend round the tiny bunches of Quartz and crystals of Staurolite, etc., and so producing a decidedly bunched structure; the Quartz generally predominating, sometimes to such a degree as to produce almost a micaceous Quartzite. The Quartz is also often isolated in seams and bunches; sometimes an abundance of small Garnets, of scales of Chlorite, or blades of black Hornblende, occurs in seams or distributed through certain layers; and elsewhere the rock is remarkable for the small crystals of blackish-brown Staurolite, the larger but imperfect crystals or crystalline

* Credner in his Article (*loc. cit.*, pages 520-524) mentions similar varieties as occurring on the Menominee.

masses of fibrous, pink Andalusite, or both, disseminated in considerable abundance throughout. See also Nos. 1030 and 1031 of Appendix C. Weathered surface lighter in color, by the bleaching of the Mica. Again, one variety of the micaceous Greenstone-Schist, derived from the alteration of a Huronian Dioryte, seems to be so rich in black and brown Mica as to have been sometimes styled a Mica-Schist (at Republic Mountain).

Mica-Slate.—A large and important group of Laurentian Schists, temporarily styled "Gogebic Schists" by Messrs. Brooks and Pumpelly in the course of their survey (on account of their abundance in the vicinity of the lake of that name), are intimately allied to the Huronian Argillytes, Chloritic Schists, etc., but have apparently been derived from the mechanical erosion of the Laurentian Gneisses. Feldspar is never so prominent a constituent as in their Huronian allies, and often disappears; but, on the other hand, Mica and Quartz generally predominate, frequently attended with a slaty structure. The texture of the rocks is generally rather coarser than in the Huronian, so that even the lustre and cleavage of the Feldspar may be generally distinguished by means of a loupe. The ordinary varieties are as follows:

Feldspathic Argillyte; coarser than the Huronian; sometimes Chloritic (No. 187) and always Siliceous (Nos. 187 and 218), and so passing into

Siliceous Schist; generally Feldspathic (Nos. 212, 215, and 220), and also decidedly Micaceous (Nos. 216 and 217), and rarely Magnetic (No. 214).

Mica-Slate; a micaceous variety of the Feldspathic Argillyte (No. 300). In regard to this as well as its Huronian ally, as the scales of Mica are small, and as it is "a shining slaty rock, smooth in surface, intermediate between Mica-Schist and Clay-Slate," I prefer this name, "Mica-Slate," recently proposed for a similar rock by Prof. J. D. Dana (*Am. Jour. Sci.*, 2, iv., Nov., 1872). An argillaceous form of the same rock occurs (No. 211), and also a siliceous form, rich in Magnetite (No. 213).

Chloritic Schist (No. 219); sometimes rich in Calcite (No. 188).

Finally, although the Hornblende-Schists already described (after the Hornblende-Gneisses), are probably in most cases produced only by a predominance of Hornblende in the latter rock, others may hereafter be found which are fragmentary deposits, and belong to the present group (No. 215).

The rocks of this Laurentian group of Schists can be generally distinguished from the Huronian by the following characteristics: A slightly coarser texture, with distinguishable particles of Feldspar: the abundance of Mica, and its concentration in continuous films, with the consequent inclination to a slaty structure (although the Huronian varieties, Nos. 204 and 210, are similar): the almost universal presence of particles of Quartz, making the fresh surface slightly harder to the knife, with a partially metallic streak by abrasion (although the Huronian varieties, Nos. 196 and 210, are similar): and the method of weathering, which in the Huronian Argillytes generally produces a surface which is smooth, darker than the fresh fracture, and colored by brownish Ochre, from the decomposition of Chlorite, while in the Laurentian the surface is generally lighter colored (except in the rare chloritic varieties), and slightly roughened, by the weathering out of the Mica and projection of minute particles of Feldspar or of flakes of Quartz.

IX. Greenstones.

(See also Vol. I., page 99, and Appendix E in this Volume.)

This is one of the largest and most varied classes of rocks in the Huronian region; but the commonly fine-grained and often cryptocrystalline texture demands a careful microscopic investigation, which I have had as yet only enough time to begin. For the same reason no analyses have yet been made of the constituent minerals—the Feldspar and Amphibole—although a few varieties are sufficiently coarse for their mechanical separation and determination in this way. Their descriptions, therefore, and the following classification, are offered only as a provisional attempt.

Certain Greenstones occur throughout this region, interstratified with the ore-beds in great abundance (as in the vicinity of Negau-nee)—whose texture is fine-grained, often nearly compact—which

are of indistinct constitution, but contain a notable quantity of Magnetite and Chlorite, and are thereby colored a dark greenish-gray, and which effervesce slightly in acids. For these reasons, and perhaps also because the dichromatic power of their Amphibole crystals is often very feeble, in a microscopic section they greatly resemble the Diabase of Europe, and have been called by that name. From my observations in the field and the extensive collection I have had the opportunity to examine, I can hardly believe that any other rock but this can occur in the Iron region to which Credner has applied the name (*Elemente der Geologie*, pages 276 and 282-285). This would be applicable if used, as by Dana, for "a fine-grained, compact hornblende-rock, tough and heavy," but most authors (Credner, Zirkel, etc.) define it to consist of Labradorite and Augite as the chief constituents. As will be explained below, I consider all these Greenstones to have been derived from the alteration of Diorytes, and, although compelled at present to rely more on ordinary observations in the field than on microscopic investigation, I am decidedly of opinion that no Augite occurs in these rocks (not even perhaps as an accessory mineral), and that there is no Diabase whatever in this region. See also, in this connection, Nos. 1012 and 1025 of Appendix C.

The massive varieties of Dioryte will first be given, and then the schistose—which are usually the more altered. In regard to the Huronian Diorytes, even when massive, there is as yet no method of determining (though the study of microscopic sections may possibly reveal it) whether any given Dioryte belongs to the original source of the *present* Greenstone-Ashes (*i.e.* the present Argillytes, Chloritic Schists, etc.) or is an indurated form of these more recent fragmentary rocks. There is reason to suspect that No. 210 may belong to the latter class, from its characteristics and from its association with certain Huronian Chloritic Schists; but, on the other hand, all the schistose forms of the Huronian Diorytes, which are of course more open to this suspicion (see Jukes, pages 82 and 323), seem to have derived their schistose structure from the scales of Mica and films of Chlorite produced by the process of alteration. Furthermore, there are Laurentian varieties, sometimes massive (No. 324) and sometimes schistose (No. 329), which *may* owe their origin to the induration of the Ashes of the Laurentian Gneisses, etc.

Dioryte.—This occurs both as a Laurentian and as a Huronian rock, but in the latter case in great abundance and in several varieties. The most typical and beautiful is that represented by Nos. 314 to 318, while several are of doubtful character and may *possibly* contain Pyroxene in place of Amphibole (Nos. 306, 308, and 313). The color varies from black (Nos. 306, 307, etc.), to greenish-black (Nos. 302, 303, etc.), blackish-green (Nos. 308, 314, etc.), to greenish-gray (Nos. 304 and 308). Its texture varies from a coarse aggregate of grains, $\frac{1}{4}$ inch or more across (Nos. 30, 303, 306, 314, etc.), to a fine-grained rock, with granules less than $\frac{1}{32}$ inch across (Nos. 307, 310, 311, etc. See also Nos. 1011, 1024, and 1017, of Appendix C), and more rarely to a Jasper-like mass, which occurs in seams of small quantity (Nos. 315 and 318); the rock is characterized by a remarkable toughness under the hammer, often powdering before fracture. Its structure is generally compact, often traversed by joints and fissures, and frequently rendered minutely porphyritic by tiny Amphibole crystals (Nos. 69, 302, 305, 307, etc.). On a hill near Negaunee, west of the Pioneer Furnace, the weathered surface of the Dioryte abounds in large crystals of Feldspar, implying an unusual porphyritic structure. Among the Diorytes, porphyritic with Amphibole, observed on a section from Teal Lake northward to the Holyoke mine, a rock resembling a Dioryte-Porphry was observed, consisting of tiny black crystals of Amphibole through a hard gray aphanitic paste.

The Amphibole generally predominates, amounting to 5 or 6 parts (Nos. 302, 304, 310, etc.), or sometimes to only 3 parts (No. 315). Its fibrous blades average $\frac{1}{16}$ to $\frac{1}{8}$ inch in length, but sometimes amount to $\frac{1}{4}$ and even to $\frac{5}{8}$ inch (Nos. 302 and 315). Its color when unaltered is black or greenish-black, sometimes brownish-green (No. 69), and gives a grayish or greenish-white streak (Nos. 305, 311, and 314); but when altered, it is blackish-green (Nos. 310, 318, etc.), cuts soft like Chlorite, and gives a greenish-gray streak (Nos. 303, 306, 312, etc.). In the latter cases it sometimes loses its lustre and fibrous structure, and becomes smooth (No. 302), or assumes a micaceous structure (No. 303), or passes into a Chlorite whose scales still retain the fibrous markings (No. 313). The Feldspar* resembles that of the

* Probably Oligoclase.

Gneisses, and generally amounts to about 4 parts of the rock, but sometimes increases up to 6 or 7 (Nos. 308, 313, and 315). Its granules range in size from $\frac{1}{32}$ to $\frac{1}{4}$ inch (No. 315), averaging $\frac{1}{16}$ to $\frac{1}{8}$ inch across, and are less commonly striated than in the Gneisses (No. 313). Its color is generally greenish-gray (No. 312), grayish-white (Nos. 306, 307, and 310), or yellowish-white (No. 309), sometimes white (No. 69), and, when partially decomposed, brownish-red (No. 314), or brown (No. 305); two of these colors being often intermingled in the same specimen (Nos. 302, 308, etc.). It has generally good cleavage and lustre (Nos. 308 and 309), but loses both in altered specimens (Nos. 302 and 304). Seams or bunches of Feldspar and Quartz sometimes occur (No. 315), or of pure brownish-red Feldspar, containing small drusy geodes (No. 316). Chlorite seems to be almost always disseminated, generally in quantity sufficient to brighten the greenish color of the rock (No. 303, etc. See also Nos. 1001 and 1023 of Appendix C), sometimes retaining somewhat of the fibrous bladed form of the crystals of Amphibole, from which it has been derived (No. 313), and sometimes occurring as a crypto-crystalline green paste (No. 305). A brown magnesian Mica often occurs in small scales: see Nos. 18 and 22 of Appendix B, and Nos. 1018, 1019, 1020, 1021, 1022, and 1023, of Appendix C: also the variety from a boulder (No. 306), which may be a quartz-less form of a Laurentian Hornblende-Gneiss. Quartz occurs in small quantity in several varieties (Nos. 308, 309, etc.), sometimes in large bunches easily observed (Nos. 314 to 318), so as to resemble a Conglomerate (No. 71) or even in a hand specimen, amounting to nearly one part (No. 303). Magnetite is universally distributed in minute crystalline granules, especially remarkable on a weathered surface, and in one case seems to amount to nearly 3 parts (No. 308). On finely pulverizing the rock, the magnet separates* from 2.8 (No. 309) to 8.5 (No. 308) per cent. by weight, of a powder whose color generally shows it to consist chiefly of Magnetite, with more or less of the rock-powder adhering. The rock usually affects the magnetic needle, and decidedly so when over 5 per cent. can be thus separated from its powder by a magnet.

* See Appendix H.

Pyrite is also distributed in small quantity, associated with the blades of Amphibole, sometimes in abundant granules $\frac{1}{16}$ inch in diameter (Nos. 305, 306, 308, and 318), or even amounting to nearly one part (No. 304).

Epidote is also sometimes attached to the blades of Amphibole (No. 318) in masses $\frac{1}{8}$ to $\frac{1}{4}$ inch across (No. 316), or occurs in thin seams (No. 75); but the Diorytes differ from the Gneisses in the comparatively rare occurrence of this mineral. Calcite can sometimes be distinguished in films (No. 305), but its presence is very commonly shown only by the effervescence of the rock when immersed in acid.

The weathered surface is generally even or rounded, but, especially in the coarser varieties, roughened by the projection of the harder crystals of Amphibole, sometimes larger crystals of the Feldspar, little bunches of Quartz, Magnetite, etc.; its color is usually some shade of brown, mottled by blackish-green if the Amphibole projects; an exceptional and beautiful weathering is described under No. 317; the weathering is generally deep, sometimes an inch or more, and the Dioryte-Wacké probably represents its last stage. See also Nos. 1002, 1003, 1004, 1007, 1008, 1009, 1010, 1012, 1013, 1014, 1016, 1024, 1025, 1043, 1047, and 1049, of Appendix C.

Amphibolyte.—By the predominance of the Amphibole in Dioryte to about 7 parts, a common Amphibolyte is produced, very tough under the hammer, which appears to the eye to be made up entirely of coarse facets, $\frac{1}{8}$ to $\frac{3}{4}$ inch in diameter, of blackish-green and almost unaltered Amphibole, inclined irregularly in all directions; but on closer examination of a fresh fracture, a greenish-gray paste is revealed, amounting to about 3 parts, which is made up of minute granules of greenish-gray, grayish-white, and yellowish-green Feldspar (No. 319). In a similar rock from a boulder (No. 320), the paste amounts to about 5 parts, and is made up of Feldspar, tiny needles of Amphibole, scales of white Mica, and granules of Quartz. It is peculiar to the weathering of this rock and of many Diorytes, that the Feldspar resists decomposition better than the Amphibole, and becomes whiter and more prominent; so that the conclusion might be obtained—exactly contrary to that derived from the fresh fracture—that the Feldspar

was the predominant constituent. A transition form is a Chloritic Amphibolyte, in which a softened Amphibole occurs, in broad curving films or flakes inclined in all directions, and passing into Chlorite. Chlorite, green Quartz, and a purplish Feldspar were found in a vein through the Amphibolyte first mentioned above. See also Nos. 1003, 1004, 1018, and 1020, of Appendix C. The schistose form of Amphibolyte, Amphibole-Schist, is considered further on.

Magnesian Dioryte (Serpentine).—No true Serpentine * occurs in this collection or was observed by me in the field; but a few rare varieties of Dioryte occur (Nos. 321, 322, and 323), first noticed by Foster and Whitney in their Report (Part II., pages 17 and 25), which have been altered apparently by the introduction of Magnesia, and approach impure Serpentine (especially No. 322) in physical character, though imperfectly in chemical composition (Foster and Whitney's Report, Part II., page 92). They are rather hard, compact, with a dull iron-black color, mottled by greenish-gray, and a texture which is fine-grained and almost cryptocrystalline, but in one case coarse (No. 323). They are made up of about 7 parts of dull, black, angular masses, with a slightly columnar structure, apparently altered Amphibole (No. 78), in a greenish-gray, or yellowish-green Feldspathic or Magnesian paste. A brown Mica, brownish-white Calcite, Pyrite, and Ochre also occur in small quantity. Weathers unevenly to mottled shades of reddish- and blackish-brown.

Chloritic Dioryte.—A rather common form of Dioryte (No. 324), which contains sufficient Chlorite not only to cause the color to incline to green, but to be distinguishable in minute scales and films, and to render the other constituents rather indistinct; more or less of a brown Mica is also associated with it, together with Calcite, Quartz (No. 71), and sometimes reddish Ochre derived from its decomposition. By the gradual alteration and disappearance of the crystals of Amphibole, transition varieties are produced, which finally pass into Dioryte-Greenstone. Weathers evenly to brown-

* Credner (Article, pages 534, 535, 544, 545, 553) identifies a rock as Serpentine at the Michigamme Iron Mt., and at the Jackson Mine, but I have never seen it.

ish and greenish shades. See also Nos. 1001, 1005, 1006, and 1023, of Appendix C.

Dioryte-Wacké.—A rather rare form (No. 325) of a Chloritic Dioryte, decomposed by weathering or other agency; the Feldspar becoming reddish-brown; the Amphibole, soft, blackish-green, and indistinct; and the Chlorite almost entirely decomposed into a brick-red or reddish-brown Ochre, which imparts its color to the rock. The weathered surface is uneven and mottled with reddish- and yellowish-brown.

Dioryte-Schist.—A greenish-black and rather fine-grained form of Dioryte (represented by both Huronian and Laurentian varieties), having a more or less schistose, sometimes flaky, structure, so as to break up into layers which are often less than an inch thick. There are two varieties.

First. A Dioryte-Schist produced by the parallel arrangement of the blades of Amphibole (No. 29). Sometimes the Feldspar occurs as a granular paste through which the Amphibole crystals are uniformly disseminated. Again, the Feldspar may occur gathered and intercalated in thin parallel white lenses, 1 to 5 inches long, which assist in producing the schistose structure ($3\frac{2}{3}$ miles from Holyoke mine, on road to Marquette). In still another case (Forestville) the Amphibole occurs in dull, dark-green, flaky lenses, distributed with a parallel arrangement through a paste of finely-granular white Feldspar.

I believe the Laurentian Dioryte-Schists to belong chiefly, perhaps entirely, to this class, but are easily distinguished from the Huronian by the bright crystalline character and black color of their Hornblende.

Secondly. A Dioryte-Schist (Huronian) produced in general by the alteration of the tiny blades of Amphibole, which first become iridescent and soft and assume a micaceous structure, and then pass into scales of blackish-green Chlorite, which retains more or less of the form of the blades (Nos. 327, 328, 329, and 330), and has somewhat of a parallel arrangement.

Other forms occur, which display the changes mentioned under Chloritic Dioryte and Dioryte-Wacké (No. 326), and the same accessory minerals occur. Weathers generally to a lighter color, often in-

clined to brownish, with an even surface slightly roughened and pitted by the unequal erosion of its constituents. See also Nos. 1005, 1006, 1016, and 1055, of Appendix C.

Amphibole-Schist (probably entirely Huronian).—I am convinced, by frequent references in my field note-books, that a schistose variety of Amphibolyte, or a form of Dioryte-Schist in which the Amphibole predominates, occurs in great abundance and in many localities; the facets of Amphibole, or its altered flakes with associated Chlorite, having such a parallel arrangement that a rock is produced which would be called an Amphibole—rather than a Dioryte-Schist. Calcite is sometimes disseminated in tiny amygdules, crystals, or lenses, so as to produce an amygdaloidal or porphyritic structure or a Schalstone. I have now no specimens of this rock, and will not venture to make any further description; but it may be easily studied in the vicinity of Negaunee, especially on its west and south sides, where it passes into Amphibolyte and Dioryte.

It is easily distinguished from the Laurentian rock, derived from Gneiss, by the dull lustre, dark green color, and softened condition peculiar to the Huronian Amphibole; and until the exact nature of the latter has been determined by analysis, the name “Amphibole-Schist” seems preferable to “Hornblende-Schist” for this variety.

Dioryte-Greenstone.—This is a grayish-green rock (belonging both to the Huronian and Laurentian), of rather uncommon occurrence, and seems to be a variety of altered or Chloritic Dioryte. From that rock it differs in its fine-grained—almost aphanitic—texture, in the consequent indistinctness of its constituents, in the predominance of the green color, and in the universal presence of Calcite. In one locality (Ely's point, Marquette), it possesses a remarkable concretionary structure, the concretions varying from an inch to several feet in diameter. It is made up of about 4 to 6 parts of Feldspar, often more or less altered, and of about 6 to 4 parts either of scales of Chlorite (No. 332), or of altered blades of Amphibole (No. 333), or of both these minerals, together with a little Mica (Nos. 331 and 334).

This rock is remarkable, especially when it approaches an aphanitic texture, for an extremely fissured structure, by which a fresh

fracture is hard to be obtained. These fissures are generally lined with films of Chlorite and grayish-white or brownish Calcite (No. 331); the latter often occurs in seams (No. 333), or geodes (No. 332), sometimes associated with Epidote in considerable quantity (No. 333). A characteristic Amygdaloid occurs in a small ridge in the swamp north-west of the Foster mine, the somewhat flattened amygdules reaching from $\frac{1}{2}$ to $2\frac{3}{4}$ inches in length and being occupied by Calcite, Quartz, Magnetic Iron (?), Epidote, and Feldspar (?); this rock is free from amygdules in some parts, and passes into a coarse Dioryte and apparently an Amphibole-Schist. Weathers unevenly, usually to a darker green, mottled with brownish spots or stripes. See also No. 1025 of Appendix C.

Micaceous Greenstone-Schist.—This is a Huronian rock of infrequent occurrence, which resembles the preceding in texture, color, and general composition, but differs in a more or less decided schistose structure. This is produced by the Chlorite and altered Amphibole being partially (Nos. 331 and 335), or entirely replaced (Nos. 336 and 337), by a reddish-brown (Nos. 335 and 336), or a black (No. 337) Mica, in parallel scales, rarely $\frac{1}{32}$ inch in diameter, which sometimes retain the form of the original fibrous blades of Amphibole (No. 337). The Feldspar also seems to occur, in thin parallel flakes, between the scales of Mica and Chlorite, and this structure is sometimes revealed on the weathered surface (No. 336). The Magnetite, which is a universal, but generally invisible, accessory constituent of all these rocks derived from the decomposition of Dioryte, is sometimes sufficient in quantity to make some specimens affect the magnetic needle.

This rock is evidently closely allied to Kersanton and Kersantite, grouped by Cotta under his class of Mica-Trap rocks (Glimmer-trapp). However, the determination of the Feldspar in this rock has not yet been made, and the rock seems to differ from Kersanton, etc., in its schistose structure, homogeneous texture, etc. I have therefore preferred to propose the provisional name—“Micaceous Greenstone-Schist”—rather than employ either the name “Mica-Trap,” which would suggest a false idea in regard to its origin, or the local names, Kersanton, etc., which would also require a careful comparison of actual specimens for identification. Weathers

unevenly, by the removal of the Mica, to a minutely flaky surface of a reddish- or blackish-brown color.

It is possible that the Mica in some cases becomes so prominent as to entitle the rock to the name "Mica-Schist" (*e.g.* Formation XI., at Republic Mountain). See also Nos. 1018, 1019, 1020, 1021, 1022, and 1023, and also Nos. 1005, 1006, 1016, and 1055, of Appendix C, and Vol. I., page 100.

Schalstone.—This Huronian rock has been found in four or five localities, but only one specimen occurs in the collection (No. 338), probably corresponding to No. 1025 of Appendix C. It is a variety produced in the preceding rock by an increased proportion of Calcite, up to 2 or 3 parts. This mineral is distributed, either in thin lenticular flakes or in amygdules, both probably originating in an amygdaloidal structure. To this rock probably belongs a part of the Amygdaloid described under Dioryte-Greenstone. One variety, by no means uncommon, is rich in Chlorite, the grains of Calcite being quite small. There is also a variety of Greenstone-Ash (Nos. 194 and 205), which contains much Calcite in small grains and might be called a Schalstone. Weathers unevenly to a greenish-gray surface, sometimes covered with tiny pits of a reddish-brown color. See also Nos. 1012 and 1025 of Appendix C.

Aphanite-Schist.—This is a grayish-green aphanitic Huronian rock, of rather rare occurrence (Nos. 70 and 339), whose nature can be determined only by a microscopic examination, or by its association with the preceding rocks. It is evidently a transition variety of Greenstone-Schist, differing in its aphanitic texture and its universal content of Chlorite. By the predominance of this mineral, and the consequent production of a thinly laminated structure, the rock passes into the second variety of Chloritic Schists, described under that class (Nos. 182 and 183). Weathers evenly to a lighter green.

Chlorite-Potstone.—This is a soft, greenish, and mostly aphanitic Huronian rock, also of rather rare occurrence, which resembles the preceding, but is chiefly composed of Chlorite, and is traversed by this mineral in an irregular network (No. 341).

Transition varieties occur, in which the Chlorite is disseminated as usual in scales and irregularly, or by its parallel arrangement produces a schist (No. 73), or decreases in quantity to 2 parts (No. 340); but even these are characterized by their softness and the large quantity of water they lose by ignition. Calcite is also present, sometimes in considerable quantity (No. 73). Weathers unevenly to a darker green.

X. Trappean Dioryte.

This name is proposed provisionally for a peculiar and interesting rock which seems to be identical in composition with the Diorytes, but rather resembles a Doleryte in general appearance and mode of weathering. There is reason to believe (see Vol. I., pages 155 and 156) that it is an intrusive rock, and, as I have not yet been able to identify it with any certainty, the above name will suffice for our present purpose.

The color of this rock is, when unaltered, black (Nos. 342, 343, and 347), but in other cases, greenish-gray (Nos. 344 and 346), grayish-green (No. 350), and blackish-brown (Nos. 345, 348, and 349). Its structure is always massive like that of the unaltered Diorytes, but more crystalline, being porphyritic in regard to both its constituent minerals. Its texture varies from a coarse rock, in which the crystals are usually $\frac{1}{16}$ inch, sometimes $\frac{1}{8}$ inch across (Nos. 342 and 347), to a fine-grained rock in which they appear as glittering points to the naked eye (Nos. 343, 345, and 350).

The Amphibole resembles Augite in appearance, and amounts to 5, sometimes 6, parts of the rock (No. 347); is of a black (Nos. 342 and 347), brownish-black (Nos. 344 and 348), or grayish-green color (No. 350), brownish when altered (No. 345); and weathers out unchanged in color and projecting above the Feldspar. The Feldspar amounts to nearly 5 parts, and its color is grayish-white (Nos. 342, 344, 346, and 347), sometimes inclining to greenish or yellowish, and sometimes greenish-gray (No. 345).

Magnetite is universally present and may be generally distinguished easily upon the weathered surface; so that the magnet separates from 3 to 5 per cent. of the powder, and the rock is feebly magnetic (Nos. 342, 343, and 346).

Chlorite was distinguished in only one specimen (No. 349), in thin films; also Epidote (No. 348), and two minerals resembling Serpentine and Micaceous-Iron, in small quantity (No. 345). In one specimen (No. 342) the rock gives a feeble effervescence in acid.

In weathering, the fine-grained varieties assume a light color (yellowish- or reddish-brown), are traversed by Chlorite, etc., and pass into a soft Wacké (No. 352 and 353); the coarser varieties assume a much lighter color (usually brownish-gray), mottled with the blackish-green and roughened by the projection of the less altered crystals of Amphibole, and the rock is traversed by minute fissures (No. 342), more abundantly than in the Diorytes, becomes very friable (No. 344), and finally disintegrates into a coarse, angular, dark-greenish sand largely made up of weather-worn, separated crystals of the two minerals.

Porphyry.—Only one specimen has been observed (No. 351), consisting of about 3 parts of tiny crystals of brown Feldspar, in about 7 parts of a bluish-green pyritiferous paste. In the latter, crystals of altered blackish-green Amphibole can be distinguished on a polished section.

Wacké.—In the decomposition, by weathering, of the two preceding rocks, the Feldspar becomes softened and resembles Kaolin, assuming a grayish-green (No. 345) or yellowish color (Nos. 352 and 353). The Amphibole is softened, becomes a reddish-brown, and is sometimes associated with Ochre or Micaceous-Iron. The result is a soft earthy Wacké, in which the reddish-brown color predominates (Nos. 352 and 353).

YOUNGER FELDSPATHIC ROCKS.

XI. Dioryte-Aphanyte.

Certain dykes, of a distinctly intrusive character, occur in this region in four inconspicuous localities, represented by Nos. 354 to 357—No. 355 being Laurentian. Their material is always very

hard, compact, heavy, and, unless fissured by weathering, tough, but its texture is too nearly crypto-crystalline to allow its exact identification without a more thorough microscopic investigation than I have yet made.

In structure it is either compact (Nos. 355 and 357), or coarsely laminated (No. 354), or possesses the coarse cross-cleavage characteristic of a trap-dyke (No. 356, and also in other varieties of No. 357 not in this collection). In texture the coarsest variety (No. 354) is finer than almost any Dioryte, while others resemble jasper (Nos. 355 and 356) or the finest porcelain (No. 357), with a few coarse specks—but never vitreous. The color varies from grayish-black to grayish-green, with a gray streak, with sometimes a little shining lustre, and almost always minute glittering facets. The fracture varies from conchoidal to even, but, by weathering, usually becomes very irregular and uneven through the formation of innumerable minute fissures. The weathered surface assumes a brownish color, lighter than the fresh fracture, and is generally smooth, giving no clue to the constituent minerals.

The constitution of this rock is, in the main, evidently feldspathic, as revealed by its fusion before the blowpipe, general physical properties, and the determination of the glittering facets under the loupe as tiny crystals of greenish or blackish feldspar.

A hard black mineral also can sometimes be distinguished in facets, feldspathic in appearance, some of which are even $\frac{1}{16}$ inch in length (Nos. 354 and 356, and No. 79 of Appendix B). Much Pyrite is also disseminated, in particles and seams associated with films of grayish-white Calcite (No. 354).

In a very thin microscopic section, tiny crystals of a triclinic feldspar (the facets already referred to) are readily distinguished, and, smaller and more rarely, hexagonal sections of a greenish hornblendic mineral, whose dichroism identifies it as Amphibole—dispersed through a cloudy ground-mass which I have not yet seen satisfactorily resolved.

The most interesting locality to examine this dyke-material is at the extremity of Light-House Point, near Marquette, where a highly metamorphosed rock occurs, in beds dipping about 80° to the north, which in different parts would be called a Chloritic Schist, Talcose Schist, and Amphibole-Schist. This passes in some places into indurated varieties of these rocks, a massive coarse Dioryte,

Dioryte-Schist, Greenstone-Schist, and a dark Dioryte-Greenstone, sometimes concretionary in structure. Towards the east end of the Point, and mostly along with the strike, these schists are traversed, with rare and slight evidences of flexure or any movement by disruption, by numerous small and branching dykes, from less than an inch to 3 or 4 feet across, broken into angular elbows and occasionally enclosing small dislodged fragments of the schist. Their ordinary arrangement may be understood from the description and figures of Credner, in his Article (loc. cit., pages 548 and 549, with Table XII., figs. 3 and 4), but it is also interesting that in the narrower dykes, three or four successive intersections of each other can be made out, as if belonging to successive periods. The wider and coarser dykes consist of the coarse Dioryte, and can mostly be seen to branch out from the larger masses of that rock, which appear to me in general not to be intrusive but merely due to the metamorphism of the original schist. In some of the dykes, as they thin out towards their terminations, the material becomes finer-grained, shows a tendency to cross-cleavage, and passes into the crypto-crystalline texture represented by No. 357. This locality I think well deserves a more thorough study, both for its geological and lithological phenomena.

At another locality, on the Mineral-Branch Railroad, at the west end of the first bridge east of Iron Cliffs (on the line between Sections 18 and 19—T. 47—R. 27), occurs a fine section of a large outcrop of Dioryte-Greenstone overlaid by Chloritic Schist. At the junction of these two rocks a black, heavy, aphanitic rock, with sub-conchoidal fracture, may be observed, which, though not intrusive, appears to be identical in constitution with this class.

C. FRAGMENTAL ROCKS.

Two varieties of rock of, I believe, rare occurrence, have been included in this division. The first mentioned occurs also in pebbles in the Quartz-Conglomerates, and it is probably a variety which has escaped the induration by which the Quartzites and Quartz-Schists have been produced.

XII. Sandstone-Schist.

The more common variety of this rock (Nos. 358 and 359) is a loosely-aggregated, arenaceous, grayish-white Sandstone, inclining to a banded structure, chiefly composed of minute granules of grayish-white Quartz, with a little Magnetite arranged in the black layers, and small particles of Ochre, Mica, and Chlorite, irregularly dispersed.

The other variety (No. 360) is one of the Kaolinic Sandstone-Schists of the Silurian beds, and is peculiar for a predominance of flakes of Chloritic Schist.

DESCRIPTIVE LITHOLOGY.

The numbers, from 101 to 360 inclusive, are attached to the descriptions, and are those referred to in Vol. I., Part I. The numbers from 688 upward are those attached to the specimens in the collection of T. B. Brooks. The numbers from 1 to 100 are contained in Appendix B.

No. 101 (Specimen 984).—*Ferruginous Crystalline Limestone.*

Huronian.—Section 28—Township 51—Range 31.

Grayish-white, speckled with blackish-gray and brownish-red spots.

A tough, coarsely granular Limestone, sparkling with facets of Calcite, about $\frac{1}{8}$ inch across, about one-half of which are blackish-gray and brownish-red in color, and the remainder grayish-white. It is also evident, on the somewhat weathered surface of a fissure, that the facets of Calcite are enclosed and separated by thin films of Siderite, of a yellowish-brown color, and this mineral probably amounts to about $\frac{1}{4}$ of the bulk of the rock.

Fracture uneven. Streak reddish-white. Effervesces strongly in hydrochloric acid, dissolving readily with very little residue, and the solution contains only a very small quantity of Magnesia.

The weathered surface is of a brownish-red color, deeply and roughly pitted by the erosion of the calcareous grains. The con-

cretionary character of most of the latter is beautifully shown by the projection, around and within the little pit formerly occupied by each grain, of minute laminæ of Siderite, of a yellowish-brown color; six or seven of such concentric circles may be sometimes counted within each cavity, surrounding a tiny solid nucleus of the same material.

No. 102 (Sp. 1231).—*White Saccharoidal Dolomite-Marble.*

Huronian.—S. E. $\frac{1}{4}$ Sect. 35—T. 42—R. 30.

White, with a slight yellowish tinge, and yellowish streak; sparkling.

A rather fine grained, saccharoidal, compact Dolomite, with a few short parallel but not continuous streaks of a light yellowish-brown color, which suggest its plane of stratification.

Fracture even and smooth. Streak white. Effervesces very slowly in cold hydrochloric acid, like a pure Dolomite, and dissolves with a small, white, siliceous residue.

Weathering even, but a little roughened by the projection of the crystalline grains, about $\frac{1}{16}$ inch in depth, and of a dirty yellowish-brown color. The edges of the laminæ of the rock are rendered apparent as minute crevices on a weathered transverse section.

No. 103 (Sp. 1233).—*Grayish Saccharoidal Dolomite-Marble.*

Huronian.—North $\frac{1}{2}$ Sect. 35—T. 42—R. 30.

Grayish-white, with light-green spots.

A marble similar to No. 102, but grayish-white in color, and without the streaks or any other indication of lamination in the hand specimen.

Broad, irregular-bladed crystals, $\frac{1}{8}$ – $\frac{1}{2}$ inch long, of a very light-green mineral (apparently Tremolite) are dispersed through the specimen.

Fracture uneven. Streak white. Effervesces like No. 102 in acid, and leaves a larger residue.

Weathering similar to that of No. 102, the tabular crystals projecting considerably above the surface.

No. 104 (Sp. 877).—*Fine-grained Greenish-white Dolomite.*

Silurian.—Presqu'isle, near S. end of Island.

Grayish-white, with tinge of green, mottled with light reddish-brown and olive-green specks.

A hard, tough, compact, fine-grained saccharoidal Dolomite, through which many tiny particles and bunches of soft olive-green Serpentine are irregularly dispersed. A few minute fissures occur, sometimes expanding into geodes lined with rhombs of Dolomite.

Fracture rather uneven. Streak greenish-white.

Weathers roughly to a grayish-black color.

No. 105 (Sp. 1242).—*Fine-grained Gray Dolomite-Marble.*

Huronian.—Fence and Deer River.

A light grayish-drab, with a decided rosy tinge, and a few small rose-brown spots.

A very hard and tough, fine-grained, crystalline, compact, siliceous Dolomite, with a little brown Dolomite interspersed in irregular minute seams and tiny bunches.

Fracture even and smooth. Streak grayish-white. Effervesces very feebly, but dissolves almost entirely in hydrochloric acid.

Weathering very thin, of a dirty cream color, streaked irregularly by the blackish-brown parallel edges of minute cherty seams and bunches, which slightly project over all the surface and betoken the lamination of the material.

No. 106 (Sp. 795).—*Coarse Red Dolomite.*

Huronian.—V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

Light flesh-red, with brown and blackish-brown streaks and spots; glistening.

A tough, coarsely crystalline, compact Dolomite, made up of Dolomite in facets $\frac{1}{16}$ to $\frac{1}{8}$ inch across. Many minute seams and small irregular spots or stains of a brownish or blackish-brown color, and others, not quite so numerous, of green Talc.

Fracture uneven. Effervesces very feebly in cold, strongly in hot acid.

Weathering about $\frac{1}{4}$ inch in depth, of a brownish-red color (darker than fresh surface), with a surface roughened by the deeper erosion of the talcose layers and bunches.

No. 107 (Sp. 796).—*Banded Dolomite-Marble*.

Huronian.—V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

Brownish-red, with many grayish-white, reddish-gray, and light flesh-red bands; glittering.

A tough, finely granular compact Marble, generally much harder than No. 106, made up of alternating layers, usually $\frac{1}{8}$ to $\frac{1}{2}$ inch in thickness, of two materials; the one of a grayish-white or reddish-white color, and the other darker and harder, of a brownish-red color, inclining to rose. The lighter colored layers are made up of coarsely crystallized Dolomite, with facets rarely as large as $\frac{1}{16}$ of an inch. The darker layers consist of a fine-grained, compact mixture of Quartz and Dolomite, and are harder than the others. Many seams cross the lamination irregularly, sometimes with tiny faults filled with brown Dolomite and milky or glassy Quartz, and in the latter small cherty bunches occur.

Fracture rather even, especially on the siliceous layers. Effervesces in acid like No. 106.

Weathered surface smooth and of a dirty light-brown color.

No. 108 (Sp. 797).—*Rosy Siliceous Dolomite*.

Huronian.—Bed V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

A reddish-brown, inclining to rose, with a very few dirty gray streaks (similar in color to the darker bands in No. 107); glittering.

A very tough, hard, fine-grained, compact Dolomite, with a lamination faintly indicated by parallel bands of a darker shade, inclining to gray. It consists of layers, usually from $\frac{1}{2}$ to 1 inch in thickness, of two materials: the one consists of Dolomite of a reddish-brown color inclining to rose, and so fine-grained as to be almost crypto-crystalline, and the other of aggregations of thin wavy laminæ, about $\frac{1}{16}$ inch in thickness, of Quartz or Horn-

stone of a very light reddish-brown or a smoky-gray color. The whole rock is also traversed (and so receives a peculiar cleavage) by innumerable minute seams, at an angle of about 60° with the lamination, filled with minute films of silver-gray and light-green scales of Talc. Other more irregular seams sometimes occur, up to $\frac{1}{8}$ inch in thickness, and filled with brown coarsely crystalline Dolomite.

Fracture uneven. Effervesces like No. 107, leaving much residue after solution, consisting of white and reddish-white particles.

Weathers very decidedly, the calcareous layers assuming a cream color, with a light reddish-brown shade; while the siliceous layers project uniformly above the surface, sometimes as much as $\frac{1}{4}$ inch, unchanged in color, and presenting a beautifully distinct section of the wavy laminæ of which they are composed.

No. 109 (Sp. 798).—*Mottled Dolomite-Marble*.

Huronian.—Bed V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

Light reddish-brown, inclining to rose, mottled with gray; minutely glittering.

A very tough, hard, fine-grained, and compact siliceous Dolomite, made up of little angular masses, $\frac{1}{8}$ to $\frac{1}{4}$ inch across, of a reddish-white and of a reddish-brown color, and with minute seams of silvery-gray and light green scales of Talc disseminated throughout.

Fracture uneven. Streak reddish-white. Effervesces more briskly in cold acid than No. 106, and leaves much white residue after solution.

Weathered surface of a dirty cream color, and rendered uneven by the projection of certain harder laminæ (revealing the schistose structure of the rock), and of roughly rhombohedral crystals of Dolomite of a reddish-brown color, inclining to rose, and about $\frac{1}{4}$ inch across.

No. 110 (Sp. 799).—*Talco-Siliceous Dolomite*.

Huronian.—Bed V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

Resembles No. 108 in color, structure, and weathering; but the

siliceous layers are not over $\frac{1}{8}$ inch in thickness, and without the wavy lamination. The Talc is also more irregularly disposed and in thicker seams.

Fracture uneven. Effervesces rather more briskly in acid than No. 106, leaving much residue after solution, like that of No. 108.

No. 111 (Sp. 800).—*Rosy Talcosedolomite*.

Huronian.—Bed V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

Resembles No. 109 in color, and No. 108 in the arrangement of the talcosed films; but coarser and almost devoid of the siliceous laminæ, which are represented only by a few tiny bunches, hardly $\frac{1}{2}$ an inch long. Hence the lamination cannot be distinguished in the hand specimen. A few brownish-red spots on some of the talcosed seams.

Effervesces slightly with acid. The residue, insoluble in acid, contains many red particles.

Fracture uneven. Streak reddish-white and greenish-white.

In another specimen, 808, the plane of lamination certainly coincides with that of the talcosed seams, being revealed over the dirty light-brown weathered surface by the projection of the thin edges of innumerable, minute, siliceous laminæ. Rather brisker effervescence in acid than with No. 106.

No. 112 (Sp. 809).—*Mottled Dolomite*.

Huronian.—Bed V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

Greenish-gray, with shade of citrine-yellow, mottled throughout with flesh-red, and with irregular stripes of gray, brownish-gray, reddish-white, and reddish-brown.

A compact, tough, hard, coarsely granular Dolomite, made up of coarse layers, 1 to 3 inches thick, chiefly of a material similar to that of No. 111, but much coarser, partly of a finer material so traversed by talcosed and argillaceous films as to assume an obliquely laminated structure, and partly of a rather coarse aggregation of granules of Quartz and Dolomite, and of minute scales of gray Talc.

Fracture uneven. Streak usually reddish-white. Effervesces rather

more briskly in acid than No. 106, leaving a very large residue, chiefly white Quartz, with some red granules.

Weathers very roughly, the quartzose layers and laminæ projecting irregularly and considerably above those more calcareous.

No. 113 (Sp. 811).—*Rosy Talcosedolomite*.

Huronian.—Bed V.—Chocolate Marble Quarry, South of mouth of Carp, L. S.

Resembles No. 108 in color and material, and No. 110 in the abundance and arrangement of the Talc, and in the mode and color of weathering. Differs from both in the indescribably irregular distribution of the brown Dolomite and the somewhat rarer Chert, in broken seams and tiny bunches crossing each other at all angles and almost concealing the plane of lamination.

Fracture uneven. Streak reddish-white. Effervesces more briskly in acid than No. 106.

No. 114 (Sp. 688).—*Black Quartz-conglomerate*.

Huronian.—N. side Sect. 19—T. 47—R. 27.

Brownish-black, with grayish-white specks; glistening.

A very tough, hard and compact, coarse Quartzite, consisting of an aggregate of small, somewhat angular, fragments of smoky Quartz, about $\frac{1}{16}$ inch across, with similar fragments of colorless and milky Quartz, and small flattened particles of reddish-white Quartz, and bluish-brown, brick-red and reddish-brown Jasper, rarely $\frac{1}{2}$ inch in diameter, arranged in mostly parallel planes and so suggesting the plane of bedding.

Color chiefly due to the smoky Quartz, with slight mottling of the other varieties.

Fracture rather uneven. Streak grayish-white.

Weathering to a dark-brown in shade, but with smooth surface.

No. 115 (Sp. 715).—*Gray Quartz-conglomerate*.

Huronian.—Bed XIV.—Spurr Mountain, Sect. 24—T. 48—R. 31.

Grayish-white, mottled with olive-green and greenish spots.

A tough, hard, compact Quartz Conglomerate, chiefly made up

of about 7 parts of somewhat angular masses of milky Quartz, up to $\frac{1}{2}$ inch in diameter, with about 3 parts of white, fine-grained, laminated Quartz, soft, arenaceous Quartz, and green Chloritic Schist, in flat angular fragments, sometimes 1 inch across, with a little smoky Quartz and Chalcedony.

Fracture uneven. Scratches with difficulty. Streak grayish-white. Seams colored brownish by Ochre, apparently from decomposition of the Chlorite.

Weathered surface of the same color as the fresh fracture. Fragments of milky Quartz project decidedly, from the greater softness of the arenaceous Quartz and Chloritic Schist.

No. 116 (Sp. 716).—*Mottled Quartz-Conglomerate.*

Huronian.—Bed XIV.—Spurr Mountain, Sect. 24—T. 48—R. 31.

Grayish-green, mottled with greenish-white spots and small grayish-black glistening specks.

A tough, hard, compact, coarse Quartz-Conglomerate, of which about half the bulk is composed of rounded pebbles of white (sometimes slightly greenish), soft, arenaceous Quartz, up to 1 inch in diameter. The matrix is made up of about equal parts of milky Quartz, inclining to Chalcedony, and smoky Quartz, in small angular fragments. The pebbles sometimes contain minute particles of Pyrite.

Fracture uneven. Streak grayish and greenish-white.

Weathered surface of about the same color as the fresh surface, but a little roughened by the greater softness of the pebbles.

No. 117 (Sp. 717).—*Chloritic Quartz-Conglomerate.*

Huronian.—Bed XIV.—Spurr Mountain, Sect. 24—T. 48—R. 31.

Blackish-green, mottled with grayish-white and light-brown.

A rather tough, compact Conglomerate, of varying hardness and grain. About half its bulk is composed of rounded pebbles, sometimes $1\frac{1}{2}$ inch across, of white and reddish-white arenaceous Quartz. The matrix consists of small fragments of milky and smoky Quartz, mingled irregularly with a soft chloritic mineral, in blackish-green scales, having a light-green streak.

Fracture uneven. Streak greenish and reddish-white, light-green, and light brownish-yellow. Minute particles of Pyrite are disseminated through the pebbles and their matrix, but are mostly decomposed, imparting a brownish-red mottling to the pebbles, to the seams of the rock, and to its weathered surface. Some of the seams are lined with the chloritic mineral in thin fibrous sheets. The same was observed in No. 118. It also seems to occur sometimes in lenticular masses, nearly $\frac{1}{2}$ inch in thickness.

Weathers roughly and irregularly, the siliceous portion of the matrix generally projecting above the remainder of the rock.

No. 118 (Sp. 718).—*Greenish Quartz-Conglomerate.*

Huronian.—Bed XIV.—Spurr Mountain, Sect. 24—T. 48—R. 31.

Blackish-green, mottled with light yellowish-brown spots and small grayish and greenish-black shining specks.

A tough, hard, compact Quartz-Conglomerate of varying grain. About one-quarter of the bulk of the rock is made up of rounded pebbles of reddish-white, arenaceous Quartz, from $\frac{1}{4}$ to 1 inch in diameter. Matrix greenish-black, similar in composition to that of No. 114, but chiefly of much finer texture; is mottled by small angular fragments, principally of smoky Quartz, and occasionally of green Jasper, crystallized Pyrite, and blackish-green scales of the soft chloritic mineral which occurs in No. 117.

Fracture uneven, sometimes sub-conchoidal. Streak greenish-white; a few reddish-brown seams.

Weathered surface reddish-brown and pretty smooth.

In Sp. 719 the pebbles are very few and small, and contain a little more Pyrite; a very tough, and rather fine-grained rock.

Sp. 720 is more deeply decomposed by weathering (nearly $\frac{1}{2}$ inch) and perhaps contains more of the chloritic mineral in its matrix.

In Sp. 721, one of the pebbles reveals, far more decidedly than any in the previous specimens, that it is derived from a laminated material. It is made up of alternating layers of a white, rose-red, and dark-greenish, arenaceous Quartz, often colored and mottled reddish-brown—apparently by the decomposition of Pyrite.

Sp. 727 contains much more Pyrite, in particles sometimes $\frac{3}{4}$ inch across.

Weathers roughly, the grains of milky and smoky Quartz projecting above the reddish arenaceous grains and masses, the chloritic mineral being eroded the most deeply of all.

No. 119.—*Kaolinic Hematite-Breccia.*

Huronian.

Gray and dull, minutely speckled with grayish-white, and with large grayish-black spots; a few minute glittering points.

A compact, heavy, hard, coarse Breccia, made up of about equal parts of flattened angular grayish-black fragments, whose dimensions range from tiny flakes up to one inch in length, and $\frac{1}{4}$ inch thick, which have mostly a parallel arrangement, and thus impart a schistose structure—in a gray fine-grained paste, speckled throughout with grayish-white particles, some of which are over $\frac{1}{4}$ inch across and rectangular. The pebbles consist of a Jaspersy Hematite, generally of a minutely laminated structure, composed of a dull aphanitic material containing many glittering points, which are revealed under the lens to be octahedra of Martite; its hardness is so great that it gives a streak with a file, which is partly metallic, by abrasion, and partly brownish-red. The paste consists of about seven parts of similar octahedra of Martite, and perhaps scales of Micaceous-Iron, and of three parts of grayish-white Kaolin. Streak brick-red.

Fracture hackly. The specimen is not magnetic. Weathers unevenly and roughly to about the same color as the fresh fracture, covered with a film of brownish-red Ochre.

No. 120 (Sp. 875).—*Red Jasper-Conglomerate.*

Silurian.—Presqu'isle, Marquette, L. S.

Brownish-red and shining, mottled with greenish-gray.

A very hard, compact, tough Conglomerate, $\frac{3}{4}$ of whose bulk is made up of irregular nodules, 1 to 3 inches across, of brownish-red

Jasper, of impalpable texture, rarely crystalline, sub-conchoidal fracture, and hardly touched by the file, with much white Quartz disseminated throughout in tiny seams, bunches, and yellowish-brown drusy geodes, sometimes $\frac{1}{2}$ inch long. A few films of a reddish and yellowish-brown softer material, with light reddish-brown streak, also traverse the pebbles. The matrix consists of a soft, tough, greenish-gray, fine-grained aggregate, with uneven fracture, and greenish-white streak, of minute granules of white and greenish-white Jasper, smoky Quartz, grayish-white scales of silvery-gray Mica, tiny flat fragments of a brownish-black material, etc., with white and smoky Quartz dispersed throughout in bunches, usually $\frac{1}{4}$ to $\frac{1}{2}$ inch across.

Weathers unevenly, the nodules projecting roughly, unchanged in color.

No. 121 (Sp. 878).—*Brown Jasper-Conglomerate.*

Silurian.—Presqu'isle, Marquette, L. S.

Dark reddish-brown and dull (matrix), mottled with light reddish-brown and sometimes shining (nodules).

Resembles No. 120. The pebbles, however, rarely possess the brownish-red color, but are of a light reddish-brown, sometimes shining, variegated irregularly with specks of smoky Quartz, rarely $\frac{1}{2}$ inch across: under the lens the whole material is seen to be filled with minute particles of smoky Quartz; the color of the pebbles often becomes lighter towards their edges, and white or reddish-white in contact with the matrix. The latter constitutes $\frac{2}{3}$ of the bulk of the rock, and consists of a tough material, harder than the matrix of No. 120, very fine-grained, and sometimes of almost impalpable texture, having an uneven fracture, and light reddish-brown streak. It is also mottled with a very few round spots, $\frac{1}{16}$ to $\frac{3}{16}$ inch across, of a greenish-gray material, exactly like that of the matrix of No. 120, and is apparently only a decomposed variety of the same; shows about the same constituents under the lens, with a little more Mica, a few fragments of brownish Jasper, and a bright blue particle; is also traversed by a few irregular fissures stained blackish-brown, and is sometimes speckled with tiny particles of a soft, white, slightly greenish pow-

der. The bunches and geodes of white Quartz are absent from the rock.

No weathered surface on the specimen.

No. 122 (Sp. 1085).—*Micaceous Conglomerate-Schist*.

Huronian.—Bed XIV.—S. W. of the old Washington Mine.

Grayish-black, with irregular but parallel stripes of grayish-white and brownish-gray; glistening.

A compact, hard, fine-grained Mica-Schist, of a remarkably fibrous structure, which consists of about 7 parts of grayish-white, arenaceous Quartz, in minute granules and angular masses, $\frac{1}{16}$ to $\frac{3}{4}$ inch long, and 3 parts of a steel-gray mixture of black and white Mica, in silvery scales just distinguished by the lens, and whose elongated shape and parallel arrangement impart the fibrous structure. Smoky Quartz also occurs in bunches $\frac{1}{8}$ to $\frac{1}{4}$ inch across, and the rock probably contains a little Feldspar.

Fracture uneven. Streak grayish-white, purplish-gray on the micaceous films, suggesting that the black scales may consist partly or wholly of Micaceous-Iron. The cleavage surfaces are mostly stained brownish-gray.

Weathers unevenly, to a dirty iron-black, mottled by grayish-white and reddish-brown.

No. 123 (Sp. 693).—*Quartzose Feldspar-Breccia*.

Boulder from Jackson, Mich.

Greenish-black, with specks of yellowish-green and smoky-gray, and mottled with large salmon-colored spots.

A hard, compact, rather brittle, coarse Breccia, of porphyritic appearance. About 5 parts consist of angular fragments of crystals of a triclinic Feldspar, with good cleavage, usually from $\frac{1}{8}$ to $\frac{1}{2}$ inch across, and often minutely striated. This light salmon color contrasts finely with the darker matrix, and the frequent reddish-brown spots, on their planes of cleavage, are evidence of a process of alteration. Irregular angular fragments of smoky-gray Quartz, $\frac{1}{8}$ to $\frac{1}{4}$ inch across, and of yellowish-green crystalline Epidote, $\frac{1}{16}$ to $\frac{1}{8}$ inch across, are disseminated throughout, each

amounting to about 1 part. The matrix amounts to about 3 parts, and appears under the lens to consist chiefly of smoky-gray Quartz, with much greenish-black Epidote (possibly Actinolite?) disseminated throughout in minute needles, often arranged in radiating groups.

Fracture very uneven; streak grayish and reddish-white; effervesces slightly in acid.

Weathers unevenly, with a loss of lustre, and a deepening of the reddish-brown color in the Feldspar crystals.

(No material like that of this boulder has yet been found in place.)

No. 124 (Sp. 1487).—*Schistose Jasper-Breccia*.

Huronian.—Sunday Lake outlet series—W. side Sect. 18—T. 47—R. 45.

Greenish-white, mottled and speckled with greenish-gray.

A coarse, hard, compact Breccia, of a material resembling that of the granular layers of No. 167, but much coarser. It consists of angular, and often flat fragments, of greenish-gray Jasper, of all sizes up to $\frac{3}{4}$ inch in length, in a matrix of minute granules of grayish-white Quartz and greenish-gray Jasper. The parallel arrangement of the flat fragments produces a schistose structure.

Fracture sub-conchoidal. Too hard for the file.

Weathers smoothly, to reddish and yellowish-brown, to a depth of $\frac{1}{8}$ to $\frac{1}{2}$ inch.

No. 125 (Sp. 1490).—*Drusy Jasper-Breccia*.

Huronian.—Lowest bed, Sunday Lake outlet series—Sect. 13—T. 47—R. 46.

Reddish-brown spots, mottled with sparkling brownish-gray and grayish-white.

A hard, tough, cellular Breccia, made up of angular fragments, $\frac{1}{8}$ to 2 inches long, of the two varieties of Jasper of No. 173, partially cemented by glassy Quartz, massive and in tiny crystals, so that the rock is filled with small drusy geodes.

Fracture uneven. Streak on some fragments brownish-red and brownish-yellow.

Weathers unevenly, with a slight polish, and to a dirty cream color.