The porphyritic crystals are up to 10 or 15 mm. x 2 or 3 mm. at the beginning; at 168 appear a little coarser 25x5.

At 180, 200, 208, feet the mottles are
2–3, 2, 1-½ mm.

At base chloritic and numerous other seams.

In Mandan Hole 17. 28 or 62-105, the figure 62 being the lower amygdaloid in 18.51? or 84-135-½
in 19.35-89 (54) at a 60° dip, the hole beginning in amygdaloid.

Comparison of the thicknesses in the vertical hole and those at 60° would indicate a dip of 42°.

58. Wolverine sandstone. Marvine's No. 9 (9)

Sandstone passing into amygdaloid conglomerate d 6. 221-231

Dips noted were 55° (cross-bedding) 29.5°, 35°, 34° and 32°. Such a dip would imply a thickness of about 863 feet, from the base to the base of the Kearsarge, as against 982 at the Manitou and 752 at the Central.

Such a dip, proportionally greater thickness of section, and less thickness of individual beds is quite likely and has since been shown.

(801)

Central mine b.56
Manitou b. 78

59. Melaphyre (?) (7)
Trap 6. 231-239
Manitou b. 79 ?

60. Ophite 12 mm. (345?)
Amygdaloid d 6. 239-251 (10) (to 280)
With a clasolite in crack showing bedding at 45° dip (295)
The amygdaloid contact dips 28.5°.
Trap d 6. 251-649 (335)
The mottling is well-marked.

At 254, 267, 275, 281, 302, 314, 330, 340 ft.
2, 3, 3, 3 to 4, 5 to 6, 6, 7, 8,
359, 378, 393 ft.
9, 10, 12 mm.

At 400, 414, 430, 441, 457, 494, 524, 543,
12, 10, 9, 11? 7? 8, 7, 5mm.
547, 565, 584 to 586, 593, 602, 607, 609, 619,
4⅔, 3, 2, 2, 1½, 1, 1 to 2, 1½ mm.
632, 645
½ ⅓ mm.

The extra slow rate of increase in grain in what appears to be a normal ophite suggests that the bed is cut quite obliquely. This is presumably Central mine 58, occuring in Holes 2 and 8, 42-314. The rate of increase there is about 1 mm. in (10) feet thickness from the bottom, but here it is 1 mm. in 14 to 20 (about 18) indicating a dip of 30° to 45°. In the Manitou Section 3 it seems to be cut out by a fault. Cf. Beds 79 and 80. But in Manitou 7 it is plainly Bed 80, the increase of grain being about 1 mm. in 12 feet.

Cf. also Franklin Jr. 666, Hole 3, 451-535.

It does not seem to be coarser grained than at the Central and Manitou or at any rate much so. If its thickness is similar (250 to 280 feet) it must be cut by the hole at an angle of near 45°.

61. Amygdaloid 649-652. (3)

Perhaps just a gush of the great ophite or part of the conglomerate below.

62. Amygdaloid conglomerate d 6. 652-657 (5)

Band of indurated sandstone dipping 33° at the top, then a quite distinct conglomerate.
Base below base of Wolverine sandstone
Cf. Central mine d 6. 59 and 60
Manitou b 81
Franklin Junior 67 at d 3. 535′ 4″.

63. Amygdaloid melaphyre (16)
d 6. 657-676
Greyish, decomposed in appearance

64. Ophite (121)?
Amygdaloid d 6. 676-699 (21)
Amygdaloid trap and breccia
Trap d 6. 699-814 + (100) ?

Disturbed with laumontite, and copper seams at 33.5°, at 737 fluccan?, near 737 big perpendicular laumontite seam, at 750 and lower, prehnite and copper, also seams at 59° to core.

At 704, 712, 730, 737, 782-802, 814 feet the mottles are
1 to 2, 2 to 3, 3, 4? 3 to 2 mm. invisible, respectively.

Manitou b. 82? Central b. 61 to 62 does not show it. Is there a fault repetition, 58, 59, and 60 being repeated in 62, 63, 64? It is possible.

It will be noticed that Mandan Hole 6 has no good correlation in either direction and therefore might have the steeper dip which is found in this last hole. The fact that a flatter dip was found to the north influenced me, perhaps, in assuming a somewhat too flat dip in this hole. Subsequent work on the Kearsarge lode shows that it dips about 46° and the section should be amended accordingly (Fig. 25), lengthening the section in the ratio 7/5 and narrowing the individual beds.

Mandan drill hole 4. The indication of dip in the upper parts of the hole average 33°⅔. Such a dip would mean an overlap with Hole 6, and a reduction factor of 0.84. This is assumed, *but* the dip might be and probably is steeper.

1. Overburden 20
(64). Feldspathic ophite
Trap d 4. 28-49 (18)
Mottles 2-3 mm. at beginning, then finer.
Basal amygdaloid

Base below base of Wolverine, if this is 64 about (497)

(65). Sediment d 4. 49
Green epidotic dip (5:8) 32°

Cf. Mandan d 6. 652. This is the only correlation that can possibly be made for the hole in Bed 6 and is not impossible. The dip would then be 28.5°. But though not lithologically impossible it does not seem likely. If it does not appear in 6, however, there is no reason why the trap above should not be that at the base of Hole 6, the bottom of which is nearly reached. A dip of 33°¾ would be implied.

(66). Feldspathic ophite (33)
Amygdaloid d 4. 449-62 (11)
Green sedimentary contact dips 32°
Amygdaloidal trap d 4. 62-88 (13)
Coarse feldspathic, the amygdaloid bands dipping 33°⅔ to 35°⅔, at 91 and 93 feet, green amygdaloid inclusions or bands.
Trap d 4. 88-160 ?
At 98 there are 3-4 mm. mottles, at 117 calcite and laumontite seams at 45° and thence on. The trap becomes chloritic; reddish altered olivine is characteristic of the flow.

67. Feldspathic ophite, a glomeroporphyrite (40)
Amygdaloid d 4. 160-180 (17)
Looks like a basal amygdaloid, fine grained, glomeroporphyritic seams dip from 34° to 31, 28, 22°
Trap d 4. 180-208 (23)
Coarse, faintly mottled, with chloritic and altered olivine. There is a distinct tendency in these traps to feldspar phenocrysts with red porphyritic base. There is an amygdaloid streak, not a contact at 198-200.

68. Glomeroporphyrite, amygdaloidal (12)
Amygdaloid d 4. 208-223
Fine grained red porphyritic with small irregular amygdules and a well-marked basal contact dipping 28°.

69. Glomeroporphyrite. (54)
d 4. 223-277
At top poor with a glomeroporphyritic tendency, at 252 feldspathic, medium fine grained, growing finer, red and more markedly glomeroporphyritic.
Cf. Central mine Beds 97-115 and above.
Manitou d 7. d 6. 82-91. It is characteristic of this part of the column that the amygdaloids belong as much with the flow above as that below.

70. Amygdaloidal porphyrite (22)
d 4. 277-300 or 304
Coarse chloritic amygdaloid with fine grained porphyritic trap from 289 on.

71. Amygdaloidal porphyrite (43)
d 4. 304?-334? (25)
At 306 only a spot of amygdaloid, at 319-320 a green enclosure
At 328-334 glomeroporphyritic.

Here the hole crosses a much disturbed red belt or slide dipping 39° extending to 337 or 8. A calcite seam dipping about 28° is faulted by steeper seams. The motion seems both reversed and normal.

Trap d 4. 334-356 (18)
This may be some other bed.

72. Ophite (4 mm.)
Amygdaloid d 4. 356-364
Trap d 4. 364-460?
At 377, 381, 386, 391, 412, 418, 428,
1 to 2, 2 to 3, 2 to 3, 3 6 (prism) 4, 3½-4,
454
1–2 mm.

At 418, 423 and 428 are doleritic spots with copper.
Cf. contact Bed 72, 607 feet below the Wolverine sandstone.

73. Feldspathic ophite (790)
Amygdaloid d 4. 460-468 (7) (49)
From d 4. 462-65 epidote, then to 468 a dark and pink amygdaloid.
Trap d 4. 468-517 (42)

Coarse and faintly mottled (839)

74. Melaphyre (23)
Amygdaloid d 4. 517-522 (4)
Red and white
Trap d 4. 522-545 (19)

Fine grained (862)

75. Amygdaloidal melaphyre (8)
Amygdaloid d 4. 545-550 (4)
With chlorastrolite? thomsonite and calcite amygdules

Trap d 4. 550-556 (5) (870)

76. Amygdaloidal melaphyre (11)
Amygdaloid d 4. 556-565 (8)
Green with prehnite or thomsonite and copper
Trap d 4. 565-568 (3)

76. Amygdaloid d 4. 568-572 (3) (20)
Coarse, not a new flow and no contact, part of the trap, with open bubbles lined with crystals.
Trap d 4. 572-589 (14)

Amygdaloid base d 4. 589-592 (3) (901)

77. Amygdaloidal melaphyre (glomeroporphyritic) (39)
Amygdaloid d 4. 592-597 (4)
Trap d 4. 597-600 (3)
Glomeroporphyritic amygdaloid d 4. 600-603 (2)
Amygdaloidal trap d 4. 603-607 (3)
Amygdaloid d 4. 607-608 (1)
Trap d 4. 608-610 (2)
Amygdaloidal trap d 4. 610-612 (2)
Trap d 4. 612-635 (20)
Amygdaloid d 4. 635-638 (2)
Trap d 4. 637-638 (1)

Fine grained (940)

78. Amygdaloidal melaphyre (940)
Amygdaloid d 4. 638-640 (2) (13)
Green with white crystals
Trap d 4. 640-642 (2)
Amygdaloid d 4. 642-644 (2)
Trap d 4. 644-649 (5)
Amygdaloid d 4. 649-652 (3)
Trap d 4. 652-653 (1)
Contact appears to dip 55°. In general the apparent dip is near 45°. But in this part of the section not only is the dip steeper but the strike is not at right angles to the line of the section, which would tend to flatten the dip on that line.

79. Feldspathic ophite (4 mm.) (76)
Amygdaloid d 4. 653-654-666
Indications of 45° dip or more
Trap d 4. 666-743
With occasional amygdules of pink (copper bearing ?) prehnite as shown in the cuts back of R. C. Pryor's house, Houghton, near the Isle Royale lode.
At 675 feet a seam dipping 53° with calcite and copper.
At 686 a 2 to 5 mm. mottling, at 696 thomsonite, at 700 are seams at 71.5° to each other and at 28° and at right angles to each other. Then are specks of copper in a doleritic amygdaloid and at 707 a decomposed seam at 54°⅓ ?
At 686, 708, 718 feet the mottles are
2 to 5, 4, 3? mm. and then finer.

(953)

80. Amygdaloidal melaphyre (14)
Amygdaloid d 4. 743-745 (2)
Poor, red
Amygdaloid trap d 4. 745-760 (13)
Joints dip 64° and there are amygdaloid streaks at 749, 752 and to 756. From 756-759 it is brecciated and chloritic.

(967)

81. Feldspathic ophite (33)
Amygdaloid d 4. 760-765 (4)
Red above, changing to cold yellow or greenish grey at the bottom as is so common.
Trap d 4. 765-799 (29)
Faintly mottled, growing finer from 785 on.
Cf. Central mine b 179. (1000)

82. Feldspathic ophite (27)
Amygdaloid d 4. 799-814 (13)
With laumontite, red and white above passing into green and white below. Trend of amygdaloid lines at about 45° to the core well marked.
Trap d 4. 814-831
Faintly mottled (14) (1027)

83. Sediment at d 4. 831
Only two or three inches dip 39° but note that more appears for some distance below at 835, 907 etc.
According to the probable dip it is 800 to 900 feet below b. 657 or 1167 to 1267 below the Wolverine.
Cf. Manitou 7 beds 92 to 96
Cf. Bed 81 (1042) below the Wolverine at the Central mine.

From this point on a reduction factor of .78 dip 39° is used.

84. Amygdaloid gush (3)
Amygdaloid d 4. 831-835 ?
Sedimentary contact beneath dips 45° (1031)

85. Amygdaloid d 4. 835-840 (4) (14)
Amygdaloid trap d 4. 840-853 (10)
Amygdaloidal spot d 4. 840-843
Sedimentary contact beneath dips 49°

(1045)

With these three sediment contacts cf. in the Manitou 7 section Beds 92 and 96.

86. Feldspathic ophite (10)
Amygdaloid d 4. 853-857 (3)
Trap d 4. 857-866 (7)
Faintly mottled with poor amygdaloid at base.

87. Feldspathic ophite (1055)
Amygdaloid ? d 4. 886-869 (2)
All sludge, chloritic, perhaps a seam
Trap d 4. 869-918 (38)
Feldspathic, faintly ophitic at 908 a clasolitic seam crossing at 45°, slightly amygdaloidal at 914 to 916, at 900 minute specks of copper in the trap.

88. Melaphyre (1096)
Amygdaloid d 4. 918-931 (10)
Flow lines numerous and well-marked and dip at 45°. The amygdules are hard and either thomsonite or prehnite.
Trap d 4. 931-1003 (56)
Not mottled, at least plainly. There are occasionally brecciated and amygdaloid spots (961 and 986) but on the whole it is massive. At 964-965 it is veined (66)

89. Melaphyre (1162)
Amygdaloid d 4. 1003-1009 (5)
Green with pink bordered amygdules and a glomeroporphyritic tendency.
Trap d 4. 1019-1107 (1239)
Glomeroporphyritic with amygdaloid spots at 1015, 1020, 1023, 1050, 1062
Seamed at a 45° angle

90. Feldspathic melaphyre (77)
Amygdaloid d 4. 1107-1113 (5)
Black with red amygdules. Apparent dip 45° or so.
Trap d 4. 1113-1206 (73)
Massive feldspathic. At 1149 a fissure seam
Below Wolverine sandstone (1316)
We don't seem to have reached Central mine 96 or Manitou 7.
Mandan Holes 24 and 25 are in the shaft from the Medora to the Conglomerate.
Holes 10 (245 feet at 66°) and 13 (352 feet vertical) are about in the horizon of 12. Holes 11 (92 feet), 3 (1095 feet), 5 (405 feet) and 7 (732 feet) are about in the horizon of 12, looking at the Houghton conglomerate and Montreal lode. Hole 15 is about 4000 feet west of No. 10. Hole 22 (514 feet at 61° to S.) is about 1650 feet and No. 23 (551 feet at 62° ¼ to S.) about 3130 feet east.
Exploring the Calumet and Osceola horizon, Hole 21 (460 feet at

61.5°) is 650 east and 250 south. Nos. 17 (167 feet at 61°), 18 (173 feet at 61°), 19 (12 feet at 60.5°) and 20 (144 feet at 61°) test the Kearsarge lode and are along the Montreal River 800, 1400, 2100, and 3350 feet east of the section respectively.

Mandan drill hole 17. Began in Kearsarge amygdaloid; an upper, not typical bed

1. Drift (28)
2. First Kearsarge amygdaloid d 17. 28-41
   Large occasional amygdules, altered, light green, like altered prehnite, with 10 mm. phenocrysts. Seams at 26° to core.
   Trap d 17. 39-62
   With dips nearly parallel to core from d 17. 56-60
3. Main Kearsarge amygdaloid and foot
   Amygdaloid d 17. 62-78
   Trap d 17. 78-105
   With large phenocrysts and copper at 89, 105 and 121
4. Wolverine sandstone about 105?
5. Ophite d 17. 105-146
   At 146 a calcite vein with lots of copper. Dip against core 29°. There are also gaping cracks at 32°.

Mandan drill hole 18. A specimen gave a good illustration of the Kearsarge foot and is reproduced in Plate VII.

1. Overburden
2. Grey, not mottled trap d 18. 34-44
3. Feldspathic melaphyre d 18. 44-84
   Amygdaloid d 18. 45-51
   Trap d 18. 51-84
   Chlorite blotches and 1 mm. feldspar
4. Kearsarge amygdaloid and foot porphyrite ophite
   Amygdaloid d 18. 84-90
   Trap d 18. 90-135-½ (See Pl. VII, for d 18. 90)
   Phenocrysts up to 25 mm. long; some red, some green; the red does not show twinning, mottled at about 106 feet, and from 134-135½ amygdaloidal and fine.
5. Wolverine sandstone, only an inch or two, green epidotized
6. Amygdaloid d 18. 135-143
   Well-marked to 137 feet; spotty to 143 feet
   Trap d 18. 143-174
   With numerous brown specks of altered olivine

Mandan drill hole 19. Like 18. Dip 60°.

1. Overburden
2. Kearsarge amygdaloid and foot porphyrite ophite
   Amygdaloid d 19. 35-48
   From 35-43 is the amygdaloid proper with white amygdules of calcite,

PLATE VII.

Typical drill cores. Beginning from left to right, they are as follows:

20485 Manitou d. 3 at 122 feet represents amygdaloid conglomerate such as occurs at about the horizon of the Houghton conglomerate, Montreal lodes. Brown sedimentary matrix full of bubbles. Pebbles of amygdaloid with pink and white amygdules.

15295 (upper row) Isle Royale d. 7 at 295 feet. Cores from a "glomero-porphyrite," like the hanging of the Pewabic lode, near center of flow.

15384 (lower row) Is the same type near margin of flow.

17956 (upper row) Franklin Junior d. 3 at 345 feet. Kearsarge amygdaloid containing copper showing the difference between the round amygdules and the angular porphyritic feldspar in the center toward top of the core.

(lower row) Mandan d. 18, at 90 feet depth. Kearsarge amygdaloid foot—labradorite porphyrite, showing the pink and green phenocrysts of feldspar, characteristic of this flow, though the points where the two cores are taken are over twenty-five miles apart.

17999 (upper row) Mendota d. 3 4 N. at 460 feet. Poleritic texture.

20491 (lower row) Mendota d. 40 at 55½ feet. Smooth bit of fine grained felsite (should be somewhat redder in tone than the core immediately to the left, and should give impression of smoother or finer grain).

prehnite, quartz crystals and copper after the prehnite and in quartz crystals. It then passes into an amygdaloid trap with chloritic amygdules and copper. The phenocrysts of labradorite are 15 mm. long and speckled green.

Trap d 19. 48-89

With large phenocrysts and at the same time with augite mottles, 2 mm. at 77, finer at 86

A pink fissure at 26° to the core; probably nearly vertical cross-cut at 67.

3. Wolverine sandstone d 19. 89-90

A red basic, fine grained conglomerate or shale, about 11° from being perpendicular to core, indicating a 41° dip.

4. Ophite

Amygdaloid d 19. 90-96

Trap d 19. 96-114

Pink and blotched to 105

No. 26 was vertically north of No. 19 800 feet, while a pit on the Kearsarge lode was 100 feet south and found the Kearsarge amygdaloid so deep that a dip of some 46° was indicated.

In almost direct line with the Mandan section is the Mendota section beneath and the work of F. E. Wright (Annual report for 1908). Just how much of the Mendota section is cut out by the slide in Hole 4 is uncertain. Hole 4 should cover about half a mile south of the Montreal River. This would leave about half a mile uncovered to the Bohemia conglomerate, in the north part of Section 29,—the series of conglomerates and felsites which Hubbard has covered. (Vol. VI, Pt. II and above § 2). The section below, quite possibly beginning in the very bed in which Hubbard left off in the Montreal section, is given by the Mendota section (Fig. 26) which brings us down to a conglomerate under a heavy trap in which an acid rock is intrusive (Ss. 20487 to 20500)—a felsite porphyrite. In the Mendota section, 1400 feet of thickness = about 1600 feet horizontally. The Lac La Belle conglomerate, the first marked conglomerate beneath a heavy series of ophites, with a very heavy one (the Mabb ophite?) just above. This suggests, comparing the section at the Isle Royale (Fig. 44), that we have here the section above Conglomerate 3 with the beds thickened.

Mendota section. W. J. Penhallegon, Superintendent. Part of the Calumet and Hecla explorations. Fig. 26. Runs practically due north and the exact strike probably varies from 11 to 15° from the line of section.

The tangent of the dip should thus be increased by (cos 11° to 15° or possibly more) 2 or 3 % and all horizontal distances in the same proportion (97 to 98 % of these along the section) in order to get a section at right angles to the strike.

Thicknesses will be reduced in the ratio not far from cos x where tan x = tan 11° sin 40 therefore

x = about 8° and cos x = .99

The error is therefore probably insignificant. That the holes are nearly at right angles to the beds is also shown by the rapid increase in grain of the ophites.

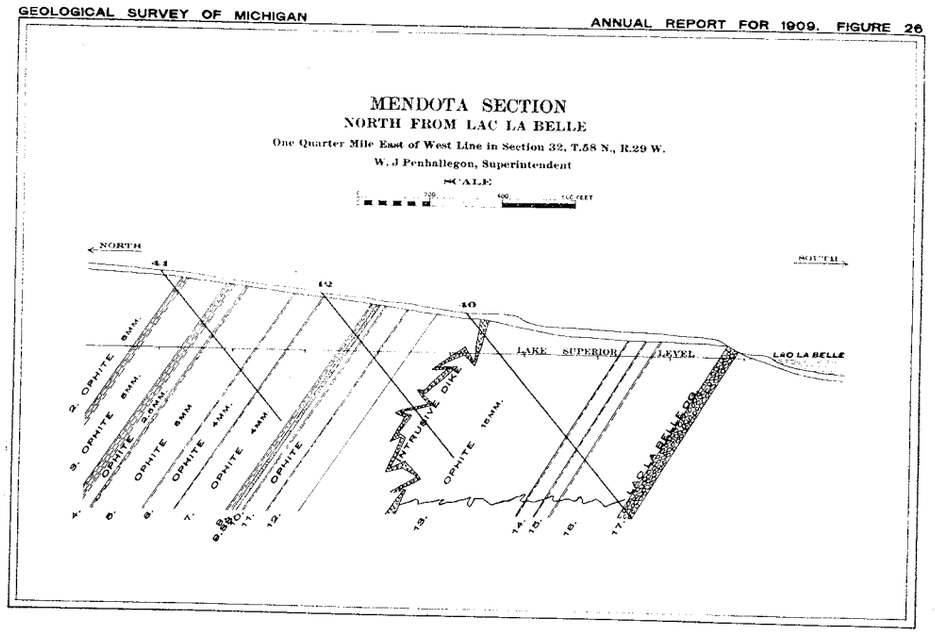

Fig. 26 Mendota cross-section north from Lac La Belle, $\frac{1}{4}$ mile east of west line in Section 32, T. 58 N., R. 29 W.

Mendota drill hole 44. 1680 feet north of Lac la Belle, $\frac{3}{4}$ mile west of east line of Section 32, T. 58 N., R. 29 W., 210 feet above Lake Superior. Dip of hole 50°, of strata probably 43°. The deviation of these strata from a line at right angles to the hole should not be over 10°. Thus no appreciable error is made in the thickness. The general character of the heavy ophite beds is much like that of the Atlantic crosscut on Section 18, but there are epidote tops instead of amygdaloid conglomerates. The heavy bed 13 may represent the ophite and the Lac la Belle conglomerates, Conglomerate 3, and the Baltic conglomerate.

1. Overburden 16 feet
2. Ophite (6 mm.+) (80-)
   Trap d 44. 16-59
   Grows finer; 20, 26, 40 to 43, 50 to 51 feet the mottles are
   4, 6, 2 to 3, 1 to 2 mm.
3. Ophite (5 mm.) (112)
   Amygdaloid d 44. 59-77
   At 59-60 and 67-68 light colored, yellow, grey and white, coarse epidotic generally

Trap d 44. 77 to 172
Seamed at 77 feet and at 134, at 30° at 84; faintly mottled from 166-172, on
at 86, 123 to 127, 153 feet the mottles are
3, 5, 2 to 3

4. Ophite 2-$\frac{1}{2}$ mm. (51)
   Amygdaloid d 44. 172-194
   Epidotic and chloritic to 179 or 188, continues with calcite and laumontite seams to base.
   Trap d 44. 194-223
   At 194, 204 to 205 feet the mottles are
   1, 2 to 3 mm., then finer.
5. Ophite (5 mm.) (124?)
   Amygdaloid d 44. 223-228
   From 223-225, apparently epidote and there are epidote streaks at 230 and 230 $\frac{1}{4}$. The epidotic chloritic amygdaloid seems, however, to go only to 228.
   Trap d 44. 228-347
   At 249 to 258, 287, 293 to 300, 337, 344, 354 feet mottles are
   3 to 4, 4, 5 3, 2–3, 1–2 mm.
   The formation is evidently disturbed, as the grain shows.
   Between 260 and 306 feet are seams, some presumably nearly vertical at 30° and at an angle of 71.5° to the core. We may interpret them that the north side of the core is moved east.
   At 340, 344 and 358 are epidote bands, at 344-347 is epidote and amygdaloid with fissures
6. Ophite (4 mm.) 78
   Amygdaloid d 44. 347-350
   Trap d 44. 350-421
   At 392 the mottles are 4 mm., then it is finer to 421
7. Ophite (4 mm?) (108?)
   Amygdaloid d 44. 421-444
   Alternating epidote and epidotic grey amygdaloid with laumontite seams, yellow epidotic 423-428
   Trap d 44. 444-529?
   Coarsest above 511. d 44. 511 matches well enough in grain d 42. 133. The mottling is banded in alternations of fine and coarse from 1 to 4 mm., at 459, at 467 it is 3 mm.
   At the end from 511 to 529 it is brecciated and very epidotic.
   On the whole the hole is unpromising. There is an unusually large amount of bright, yellow green epidote.

Mendota drill hole 42. 1236 feet from Lac la Belle, 156 above it, Lake Superior. Dip of hole 50°. It should lap the bottom of Hole 44 which it may very well do. Correlating d 42. 133 and d 44. 511 means a dip of 50°. A point 70 feet down in 44 is on a level with 42 and 399 feet from it.

Overburden 14-feet
? (7) Ophite (4 to 6 mm.) (117?)

Trap d 42. 14-133
Epidotic at 20 to 21 and 50, seamed at 75 to 87, at
56, 75, 87 feet the mottles are
2, 3 or 4 to 6 mm. and at 87 it is coarsest and grows finer below.
Nearly the whole flow must be represented.

No higher position or less dip can be allowed as the epidotized sandstone and amygdaloid conglomerates d 42. 140-155 is not represented in d 44.

8. Amygdaloid
Amygdaloid d 42. 133-146
Red and white

9. Sediment
Epidotized sandstone ? d 42. 146-155
Some amygdaloid conglomerate also

10. Melaphyre.
Trap d 42. 155-170
The relations of 8, 9 and 10 are not quite clear, one would suspect misplacement of core.

11. Amygdaloid d 42. 170-172
Trap d 42. 172-224
There are slickensided seams which make an angle of less than 12° with the hole. At 192-210 are faint 1 mm. mottles.

12. Amygdaloid d 42. 224-227½, and 230-235
Epidotic brecciated
There are also epidotic streaks at 240-242, 252½-253½, 254-260, 259-270, 280-284
Trap d 42. 235-302
This all appears fine grained and the change in grain at 302 is sudden as though there were a displacement there.

13. Ophite (12 mm.)
Trap (with intrusions) d 42. 302-577
At 302, 333, 382, 391 feet the mottles are
3, 7, 7 to 9, 9–10 mm.
At 400-405 is a felsitic intrusion with sulphides.
At 422, 440, 450 feet the mottles are
8 to 11, 9 to 10, 4 to 5 mm.
At 445 it is seamed parallel to the hole and the grain is coarser again; at 482 to 499 the mottles are 10 mm.
At 510 and 520 the mottles are
10 and 12 mm. respectively and as coarse at 577.
At 499-502 is a coarse feldspathic, that is, doleritic streak and again at 530 and 533.
Where it is seamed the pattern is sometimes plainer, sometimes fainter. At 529 in a seam practically parallel to the hole is chalcopyrite. The bed evidently occurs at the top of 40. While in a way d 42. 400-405 corresponds to d 40. 55 to 74½, one can not base any correlation on that as an intrusion, neither can one correlate by grain as there has been so much faulting.

Mendota drill hole 40. 340 feet from Lac la Belle, and 100 feet above it, the strong terrace there being about 110 feet above the lake.

A point 73 feet down in No. 42 and only (1236-840 difference in altitude (56) x cot 50°) 349 feet from the top of No. 1 is on a level with it. There must therefore be a great overlap of 40 and 42.

Overburden 19 feet

13. Ophite (15 + mm.) about (400)
Trap d 40. 9-435 (with intrusive felsite)
At 16 and 49 the mottles are 10 mm.
At 53 to 74½ is a compact felsite porphyrite, Ss. 20486-20500
At 81, 105-118, 172, 283, 330, 380 feet mottles are
9, 10-15, 15 +, 13 +, 10-12, (7 to 8) x 4 mm. prisms
At 403, 416, 434 feet the mottles are
4, 2, ½ mm.

The rate of increase of grain shows that this ophite is cut nearly at right angles. Hole 42 does not show any of the bottom finer grain and therefore can not correspond to any thing below say d 40. 330, nor can d 40 16 correspond to anything above d 42. 391. The dips, faulting apart, must then be between 23.5° and 57° (averaging 40°). Penhallegon told me that the dip from the outcrop of the conglomerates cut at d 40. 685 to that point was 62°.

At 106-110 it is chloritic, at d 40. 148 are crystals of a zeolite. Cf. this with the big ophites at Sand Bay, Mamainse.

This heavy ophite is of some especial interest. Its coarsest grain leads to knobs half an inch across, easily recognized in the field, and as a matter of fact both F. E. Wright, in his Mt. Bohemia work,[7] and Hubbard[8] mention it. The exposure which Irving refers to as in the south part of Section 4, T. 56, R. 31,[9] may refer to an exposure 1980 paces north and 550 paces west, i. e., close to Section 4, T. 57, R. 31, for the location given is surely a misprint.

Such a heavy flow should be fairly persistent and one is tempted to correlate it with the Mabb ophite, the heaviest flow at about this horizon in the Isle Royale section.

The intrusion into the ophite was of especial interest, and it seemed especially worth while to see whether it were connected with felsites like these of the Bare Hills or the red rock associated with the Mt. Bohemia Gabbro, described by F. E. Wright.

It is rather notable that in most cases intrusive red rocks seem to me to be associated with *large* masses of ophite.[10]

The specimens are 20486 to 20500. Cf. 16919, 525 N. 615 W. Section 29, T. 58 N., R. 29 W.

The rock proves to be like Hubbard's felsite porphyrite (Beds E and G of Volume VI) not like the gabbro aplites, having a ground mass of elongate sub-parallel orthoclase and oligoclase (about 0.2 mm. long and .05 wide) with magnetite (.025 mm.) chlorite, epidote, calcite and enclosures in which the feldspar is less parallel. One phenocryst has extinction angles 23°-10°. Comparing center and margin the main change is that at the center the crystals are broader.

Sp. 20486 (Mendota d 40. 74½) is a specimen of the ophite immediately adjacent to the red intrusion. The original mottles are pretty thoroughly altered to chlorite and calcite and appear lighter. Iron oxide appears to have been crowded out from them and the chlorite is less abundant. The mottles are from 5 to 10 mm. across averaging about 8 and about as coarse as at 16, 49 and 81 feet. It is

[7]Report for 1908.
[8]Vol. VI, Pt. II, Pl. IV, Fig. 8, pp. 72-73.
[9]Monograph V, Copper-bearing Rocks of Lake Superior, p. 176.
[10]For instance, at Mamainse both near Roussain's and near Sand Bay, Mt. Bohemia, Porcupine Mountains and south at Berglund, Bad River? Duluth?

noteworthy that this ophite does not have any uralite such as occurs in the ophite next to the gabbro aplite intrusions but Wright says that a direct change to chlorite, such as we have here, also occurs there. The feldspar extinctions lead to an andesite composition much such as Wright found for the red rock.

Sp. 20487 is also at 74½ feet and from the "red rock" immediately adjacent to the ophite. It is decidedly finer than 20494 but this is due not so much to the length of the feldspar as to their thickness. In extreme length there is no material difference though in average length 20494, near the center of the intrusion, is probably somewhat coarser.

Sp. 204891 (72 feet) is 2½ feet from the contact and is distinctly coarser and more crystalline than 20487 which is from the extreme edge. The oligoclase is from 0.1 to 0.3 mm. long by .02 to .03 across, occasionally .04 to .05 across. It will be noticed that the variation in coarseness of the feldspar is in thickness rather than in length. The needle-like character of the feldspar suggests rapid under-cooling. The iron oxides are very different from those in Sp. 24087, for they are in compact coarser dots, 0.01 to 0.02 mm. across.

Sp. 24093 at 67 feet, that is 7½ feet from the bottom, shows an enclosure of the fine grained margin as a fragment in the coarser grained middle type. There seem to be also long amygdules of calcite and chlorite. The oligoclase is mainly .1 to .2 mm. by 0.02 to 0.06. In the enclosed fragment they are about one third the size. Iron oxides run from 0.02 to 0.3. Chlorite is abundant.

Sp. 20494 at 64 feet is close to the middle. There are amygdules 1 to 8 mm. in length pulled out so that the longest direction is parallel to the feldspar flow lines. They have a chlorite margin and a calcite center. It shows the twinning and a sheaf-like parallel arrangement of the feldspar common in the trachytes. This is, however, perhaps not wholly flow arrangement but one of crystallization or of pressure and affected by the flow of heat to the margin. Yet since the length of the feldspar individuals was obtained before their breadth, their arrangement might be affected by the flow. This fine grained belt of microlitic, often forked, feldspar is largely not over .06 mm. x 0.003 mm. They rarely show twinning and the extinctions are between 0° and 4°. Occasionally there are larger rhyocrystals up to 0.25 mm. long x 0.02 to 0.03 mm. wide. There are numerous round forms about 0.06 mm. across, which may possibly represent altered phenocrysts, but look like minute bubble pores filled with secondary chlorite and quartz. The iron oxides are in tree-like forms 0.01 mm. x 0.05 mm. There are occasionally larger flecks of iron oxide up to 0.40 mm. Calcite occurs in patches. There is some epidote diffused in the larger feldspar. Probably much of the rock was glass which is now changed to a mosaic of quartz and chlorite (with the latter dominant) and a little epidote and iron oxides. The iron oxides are such as occur in glass. The feldspar seems to be Ab^3 An^2.

Of Sp. 20496 (Mendota d 40. 61) two sections were made to check. The oligoclase is very fine grained, mainly .1 to .15 x .01 to .02 mm. The iron oxides are .01 to .02 mm. Chlorite occurs and calcite and quartz amygdules are common. Epidote occurs and also fragments of the finer grained margin.

Ss. 20493, 20494 and 20496 are similar in grain and 20500 is nearly so. 20489 is fine but certainly not half so fine. 20487 shows distinctly a finer, glassy marginal facies but with the feldspar already developed in length. Our inference is that the grain of the center is not over .024 of what it would be were the rate at the margin continued through the whole thickness affected, but it is more than .02. The ratio, therefore, of the initial temperature or the temperature of consolidation would be between .9 and .8. This relatively high value, as well as the glassy margin and the amygdules, suggests that the consolidation was at no great depth so that

the gases were allowed to escape and the temperature of the surrounding rock was very considerably below the temperature of crystallization. I am inclined, therefore, to believe that this rock, as already suggested, is referable to the period of eruptive activity which led to the overflows at the top of the Bohemia Range group. It is, however, possible to believe that the greater distance from the Mt. Bohemia gabbro would lead to a colder country rock and a greater chance for gases to escape and so produce a rock of this type. I do not think it, however.

14. Melaphyre (44)
    Amygdaloid d 40. 435-439 (4)
    Epidotic
    Trap d 40. 439-479 (40)
    Fine grained with epidote streaks at 439 and 451
15. Melaphyre (36)
    Amygdaloid at d 40. 479½-480½, again at 508-510
    Trap d 40. 480 ½-515 near Baltic lode horizon (170)
16. Amygdaloid d 40. 515-517-521
    Epidotic d 40. 517-521
    Trap d 40. 521-685
    Faintly ophitic; with calcite and laumontite, the latter very abundant at 582.
    At 665 is an intrusion of red rock, gabbro aplite?
17. Conglomerate d 40. 685-720, (No. 3?)
    At 691 clay, at 696 seamed (9: 5 to 7) at 28° to 35° to hole, perhaps nearly vertical seams dip from outcrop 62° according to Penhallegon.

§ 5. MANITOU-FRONTENAC (FIGS. 27, 28 AND 29).

Passing on west from the Mandan section we cross a couple of topographically well-marked fissures on the old Resolute property, Section 18, T. 58 N., R. 29 W., which I think run clear across the point and have something to do with the location of Agate Harbor.

We come next to the old Delaware-Pennsylvania-Conglomerate Pawnee properties, (Fig. 27) which have had a long history of explorations, and have lately been taken under the wing of the Calumet and Hecla. Most of the mining exploration has been on veins close under the Greenstone. There were, however, a number of pits opened on a lode close to the Montreal River, hence called the Montreal amygdaloid, which close to a fissure was fairly well charged with copper. It did not, however, prove to be extensive. Then a few pits as shown in Figure 27 were opened on Section 24 near the horizon of the Kearsarge amygdaloid, one of which had a good showing of copper.

Beginning at the east we have the Section Manitou 7, which extends farthest south of any of the sections we have, and should, indeed, have gone to the Bohemia conglomerate, had it continued without deviation or faulting from an outcrop only a mile east. Judging from the beds of the Arcadian section in comparison with

these. I think it should have reached it soon anyway. It will be noticed that I believe there is a gap in the record caused by a fault crossing 7 Hole 4 S. This is not so far from being continuous with the strike fault found at Mandan. Of course, the same effect on the drill core record might be due to faults with many variations of strike.

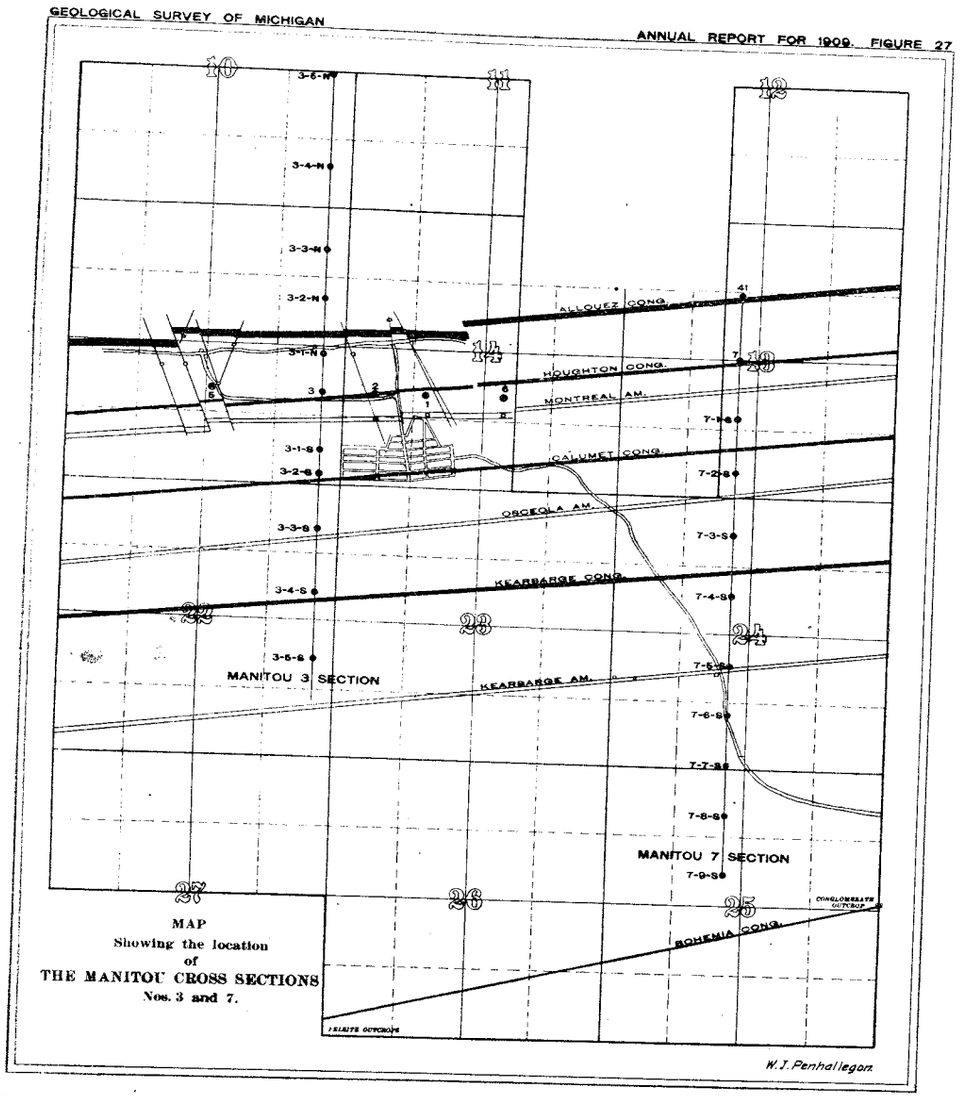

Fig. 27. Map showing location of Manitou-Frontenac section near Old Delaware and Pennsylvania properties.

Manitou Mining Co. Sec. 7. (See Fig. 28 in envelope). This section across the Manitou-Frontenac property was not looked over by Lane entirely, as W. J. Penhallegon had made a careful record.

The following is a record of the section, with the holes Lane examined underscored. The complete section from Penhallegon's notes is given in Fig. 28.

Hole No. 7	Feet from 0	Elevation	Angle
.0	300	520	60°
1	11 + 50	505	60.5°
2	22 + 02	515	65°
3	34 +	560	65°
4	46 +	575	65°
5	59 + 38	580	65°
6	68 + 60	565	60°
7	77 + 18	578	59°
Line S. 24 to 25	79 + 15		
8	86 + 84	570	55°
9	98 + 00	570	57°

In this part from the Calumet conglomerate down to the Kearsarge conglomerate the correlation of sections Manitou 7 and Manitou 3 is easy and can be made *almost bed for bed* the whole way, though the sections are a mile and a half apart.

Manitou 41 only 300 feet off the line may be used to complete the correlation and gives the position of the Medora and "Manitou" lodes.

Correlation with Manitou 3.

Manitou drill hole 41. Nearly in line with No. 7 section at an angle of 65°

(19) 1. The greenstone.
Trap d 41. 22 - 35
The mottles are 2 mm. (with chlorite slips) at 22.

(20) 2. Allouez conglomerate d 41. 35-57.
Base has a weathered (?) contact.

(21) 3. Melaphyre
Amygdaloidal trap d 41. 57-60
Trap d 41. 60 - 71.

(22) 4. Melaphyre.
Amygdaloid d 41. 71 - 75
Coarse
Trap d 41. 75 - 92.

(23) 5. Amygdaloidal melaphyre
Amygdaloidal trap d 41. 92 - 99
Contacts at d 41. 92, 92½ and 96
Trap d 41. 99 - 120.

(24?) or (25?) 6. Amygdaloid d 41. 120 - 124
Amygdaloidal trap d 41. 124 - 136, with copper
Trap d 41. 136 - 162
This is presumably just above the Medora lode, below base of Allouez conglomerate. (105)

(26) 7. Feldspathic ophite. Medora lode
Amygdaloid d 41. 162 - 169
Amygdaloid trap d 41. 169 - 188

With pink prehnitic copper-bearing spots.
Trap d 41. 188 - 217,
Faint coarse mottles.

(27) 8. Feldspathic ophite. Manitou lode
Amygdaloid d 41. 217 - 225
Trap with copper d 41. 225 - 252
Coarse, massive chloritic, faintly mottled.

The intermediate holes between drill hole 41 and drill hole 7.4.S., to wit, 7.1.S., 7.2.S., and 7.3.S., were not examined by me and their records ran very closely parallel to Manitou 3. Their position and the belts found in them as determined by Mr. Penhallegon are given in Figure 28.

Manitou drill hole Y. *4.S* at 4600 of section. Elevation 574. Dip 65°. This is an easily correlated hole as it shows the Wolverine sandstone at 641 feet. It is practically at right angles to the formation.

1. Overburden (18)
2. Feldspathic ophite (17)
3. Amygdaloid 7 d 4 S. 35-40 (5) (12)
Red glomeroporphyritic, with sediment, epidotic
Trap 7 d 4 S. 40-47 (7)
Amygdaloidal, fine grained
Cf. Manitou 3 beds 59 to 61

Corresponding belts in Manitou 3, Fig. 28.

4. 7 d 4 S. 47-48 (1–)

(63) 5. (75)
Amygdaloid 7 d 4 S. 48-55 (7)
Trappy, probably 3 to 5 are all one bed of amygdaloid with clasolitic sediment.
Trap 7 d 4 S. 55-123 (68)
Grows darker toward base, with amygdaloidal spots at 83, and a doleritic streak with a speck of copper at 90.

(65) 6. Ophite (59)
Amygdaloid 7 d 4 S. 123-125
Trap 7 d 4 S. 125-182 (57)
At 130, 150, 174, 177, 182 feet mottles are 1, 3, 2, 1½ mm. contact

66) 7. Feldspathic ophite (106)
Amygdaloid 7 d 4 S. 182-184
Red and white with prehnite and a little copper
Trap 7 d 4 S. 184-288
Down to 190 glomeroporphyritic, and from 199 - 252 all coarse feldspathic, coarsest (about 10 mm.) at about 231. At 250 and 270 3 mm. mottles; at 270 a chlorite seam at an angle of 16°½.
Beds 6 and 7 are the nearest match to the large ophite bed in M. Frontenac 3.4.S. 439-664.

(70) 8. Melaphyre (50)
Amygdaloid 7 d 4 S. 288-293 (5)
Trap 7 d 4 S. 293-296 ? (5)
Red porphyritic ? contact at 296 ?
Trap 7 d 4 S. 296-336 (40)
Coarser

(71) 9. Sandstone 7 d 4 S. 336-342 (6)
Cold, epidotic, grey-green color; bedding at right angles to the hole.

(72) 10. Melaphyre (11)
Amygdaloid 7 d 4 S. 342 - 347 (5)
Trap 7 d 4 S. 347 - 353 (6)
While 71 and 77 really match in the two sections, the intermediate beds do not. The fact that there are the same number of beds is purely accidental it would seem, and they are given the same numbers for convenience.

73? 11. Amygdaloidal melaphyre (54)
Amygdaloid 7 d 4 S. 353 - 375 (22)
Yellow, coarse
Trap 7 d 4 S. 375 - 407 (32)

74? 12. Feldspathic melaphyre (37)
Amygdaloid 7 d 4 S. 407 - 410 (3)
Amygdaloid trap 7 d 4 S. 410 - 444 (34)
Coarser to 429; then finer and seamed.

75? 13. Feldspathic melaphyre (69)
Amygdaloid 7 d 4 S. 444 - 446 (2)
Trap 7 d 4 S. 446 - 513 (67)
Coarser feldspathic amygdaloidal,
(possibly more than one flow)

76? 14. Feldspathic ophite (96)
Amygdaloid 7 d 4 S. 513 - 517 (4)
Red and white, passing into trap with chlorite amygdules
Trap 7 d 4 S. 517 - 609 (92)
Doleritic at 550 coarse and faintly ophitic from 553 down.

(77) 15. Kearsarge amygdaloid and foot (32)
Amygdaloid 7 d 4 S. 609 - 613 (4)
Well marked contact, black and white amygdaloid.
Trap 7 d 4 S. 613 - 641 (28)
Few porphyritic labradorite crystals, long, not very well marked.

(78) 16. Sediment. Wolverine sandstone ? 7 d 4 S. 641 - 649 (6)
Grey-green, epidotic, with fragments of red amygdaloid and at base a regular amygdaloid conglomerate with dark amygdaloid and red matrix.

(79) 17. Ophite variously mottled (50)
Amygdaloid 7 d 4 S. 649 - 654½
Trap 7 d 4 S. 654½ - 699?
The mottling is well marked but very various in size as in some of the Torch Lake beds, especially from 675 to 680. Does this mean irregular initial temperature or composition? The same range appears in 7 d 5 S. from 23 ½ feet down.

(80) 18. Ophite (part of bed above) (100 +)
Amygdaloid 7 d 4 S. 699-728
Trap 7 d 4 S. 728 - 743-797 +
Ophitic variously mottled up to 3 x 1 mm., amygdaloid spot at 743; grows finer at the end, fine grained and full of chloritic seams, many at 45° to core, also at other angles.

Manitou drill hole 7. 5. S.

1. Overburden

(77) 2. Kearsarge amygdaloid foot trap
Trap 7 d 5 S. 16 - 22 (6+)
The first three feet have large 16 x 4 mm. characteristic feldspar crystals of the Kearsarge foot trap.
The rest of the way the core was in small fragments and the rock evidently disturbed by the slide.

(78) 3. Slide cutting out Wolverine sandstone (1)
Clay fluccan 7 d 5 S. 22 - 23
Central mine b 56.

(79) 4. Ophite (31)
Amygdaloid 7 d 5 S. 23½ to 25½ (1½)
Trap 7 d 5 S. 25 - 54 (29)
At 25, 32, 47 feet the mottles are
1, 1 - 2, 2 - 3 and finer. There is considerable variation in size of mottling. Central mine b 57

(80) 5. Ophite (12 mm.) (279)
Amygdaloid 7 d 5 S. 54 - 58½ (4½)
Cf. Mandan d 6. 239
Trap 7 d 5 S. 58½ - 333 (274½)
At 66½, 75, 82, the mottles are
3 to varied, 3 to 1 irregular, 4,
106, 114, 163, 176, 220, 229, 277,
5, 7 to 10, 10, 12. 8, 8, 4,
285, 304, 312, 320
3, 2, 1½, 1
Central mine b (58)

(81) 6. Contact of sediment at 333
Cf. Mandan d 6. 649

(82) 7. Doleritic ophite (218)
Amygdaloid 7 d 5 S. 333 - 340 (7)
Coarse feldspathic
Trap 7 d 5 S. 340 - 551 (211)
Coarse ophitic
At 381, 382, 419, 439 feet the mottles are
3–4, 3 doleritic, 5 - 6, 8 mm. across
439 - 487, 521
10 + 3
It is coarser and doleritic at 411, and there are chlorite seams from 487 to 551.

(83) 8. Doleritic ophite
Amygdaloid 7 d 5 S. 551 - 555½
Trap 7 d 5 S. 555½ - 606
Marked feldspathic, doleritic.

Manitou drill hole 7. 6. S. at 68 + 60 of section. Elevation 565, dip 60° nearly at right angles to dip. No correlation for thickness necessary. It should overlap 5 considerably and either there is a steep dip or a faulting, for we do not find Bed (80).

If we assume the Central mine or some other section not to be badly faulted we can estimate the amount of throw. If Bed (80) = Central mine bed (58) and the sediment 7 d 6 S. at 56 to 60 feet = Central b (60) the section is continuous.

1. Overburden (17)

(82) 2. Glomeroporphyritic (4 mm.) ophite
Trap 7 d 6 S. 23 - 56 (33) (+ 30?)
Finer from 28½

3. Sediment with copper
Red, fissured 7 d 6 S. 56 - 60 (4)
Dip 10½ to 12° from right angles to core
Central mine b (60)

(83) 4. Melaphyre (70)
Amygdaloid with sediment 7 d 6 S. 60 - 76
Green sediment 7 d 6 S. 65 - 68, and 75 - 76, chloriti amygdules and breccia.
Trap 7 d 6 S. 76 - 128
Coarser to 112, then finer to 128

(84) 5. Melaphyre (57)
Amygdaloid ? 7 d 6 S. 128 - 145 (17)
128 to 130 epidote and datolite, at 145 amygdule with a speck of copper
Trap 7 d 6 S. 145 - 185 ? (40)
It is characteristic of these beds as of corresponding beds in the Central mine that the amygdaloids and contacts are ill defined.

(85) 6. Sediment at 185

(86) 7. Melaphyre (52)
Amygdaloid 7 d 6 S. 185 - 191 (6)
Trap 7 d 6 S. 191 - 237 (46)
Feldspathic to 200; at 202 green porphyritic; grows finer.

(87) 8. Melaphyre (20)
Amygdaloid 7 d 6 S. 237 - 239 (2)
Well-marked
Trap 7 d 6 S. 239 - 257 (18)

(88) 9. Melaphyre (49)
Amygdaloid 7 d 6 S. 257 - 267 (10)
Trap 7 d 6 S. 267 - 304 (37)
Green altered at 275, coarse feldspathic blotched with green at top, darker and finer toward the bottom.

(89) 10. Amygdaloid 7 d 6 S. 304 - 306
Amygdaloid trap 7 d 6 S. 306 - 311
Trap ? 7 d 6 S. 311 - 338

(90) 11. Feldspathic melaphyre (44)
Amygdaloid ? 7 d 6 S. 338 - 347 (9)
Red porphyritic base of bed above ?
Amygdaloidal trap 7 d 6 S. 347 - 353 (6)
Coarse feldspathic
Trap 7 d 6 S. 353 - 382 (29)
Massive feldspathic

(91) 12. Feldspathic melaphyre (13)
Amygdaloid 7 d 6 S. 382 - 385½ ? 13½
Mixed

Trap ? 7 d 6 S. - 395 10
Red, porphyritic from 392 - 94

(92) 13. Sediment 7 d 6 S. 395 - 399 (4)
Mixed and epidotic, perhaps a clasolite.

(93) 14. Ophite (3 mm.) (54)
Trap 7 d 6 S. 399 - 453
Mottling at 416 3 mm.; at 411 a laumontite seam, and at other places, laumontite seams parallel to the bedding; at 416 3 mm.; at 440 3 to 4 mm. mottles.

(94) 15. Ophite (4 mm.)
Amygdaloid 7 d 6 S. 453 - 457
Trap 7 d 6 S. 457 - 468
Trap fine grained but no marked contact 468 - 471
Trap 7 d 6. S. 471 - 536
Coarser at 484, 503, 516 feet mottles are
2, 4, 3 to 4 mm. across and pretty well marked.

(95) 16. Amygdaloidal melaphyre (23)
Amygdaloid 7 d 6 S. 536 - 545 (9)
Coarse
Amygdaloidal trap 7 d 6 S. 545 - 559 (14)
Trappy, then from 554 - 556 green and white amygdaloid, then coarse chloritic.

(96) 17. Sedimentary contact at 559
Cf. Central b (76)

(97) 18. Amygdaloid 7 d 6 S. 559 - 567
Chloritic and fine grained.

In this hole the group of beds characterized by a poor chloritic amygdaloid and red porphyritic foot is marked. 7 d 6 S. and 7 d 7 S. were intended to overlap but they do not appear to, unless 7 d 6 S. 471 = 7 d 7 S. 54 and that is not a very good match.

Manitou drill hole 7. 7. S at 77 + 18 of section. Elevation 578 A. L. S. Dip 59°. The line between Sections 24 and 25 is at 79 + 15 of section.

1. Overburden (19)

(96) 2. Ophite (4 mm.) (35 +)
Trap 7 d 7 S. 19 - 54

(97) 3. (63)
Amygdaloid 7 d 7 S. 54 - 61 (7)
Trap 7 d 7 S. 61 - 117 (56)
There is a green and white amygdaloid inclusion at 83.
The basal contact at 66° with core is well marked.

(98) 4. (18)
Amygdaloid 7 d 7 S. 117 - 127 (10)
Red and white marked
Trap 7 d 7 S. 127 - 135 (8)

(99) 5. (23)
Amygdaloid 7 d 7 S. 135 - 139 (4)
Trap 7 d 7 S. 139 - 158 (19)
With specks of amygdaloid

(100) 6. Amygdaloidal melaphyre
Amygdaloid 7 d 7 S. 158 - 179 (21)
With streaks of trap, fissured (pink) at 174

(101) 7. Ophite (4 mm.) (101)
Amygdaloid 7 d 7 S. 179 - 190 (11).
Trap 7 d 7 S. 190 - 280 (90), fine grained to 195, then a hard fine grained amygdaloid inclusion perhaps 195 - 197, then coarser.
At 223, 247, 258 feet the mottles are
3, 4, 3 mm. across
At 276 is a datolite seam, possible contact, cf. Central b 79.

(102) 8. Melaphyre 7 d 7 S. (19)
Amygdaloid 7 d 7 S. 280 - 289½ (9½)
Coarse, poor
Trap 7 d 7 S. 289½ - 299 (10)

(103) 9. Doleritic ophite (6 mm.) (82)
Amygdaloid 7 d 7 S. 299 - 310 (11)
Poor
Trap 7 d 7 S. 310 - 381 (71)
Ophitic, at 346 6 mm.; at 321 and 326 doleritic.

(104) 10. Melaphyre (111)
Amygdaloid 7 d 7 S. 381 - 395 (14)
Trap 7 d 7 S. 395 - 492 (97)
Much seamed at 399, some green sediment and epidotic clasolites, spots of amygdaloid at 429, 431, and 433 and 460; fissures parallel to the hole at 445, at 487 and 495, and a breccia at 483, which may be the main slip.

(105) 11. Melaphyre (58)
Amygdaloid 7 d 7 S. 492 - 515 (23)
Brecciated, prehnitic, with epidote and quartz
Trap 7 d 7 S. 515 - 550 (35)

(106) 12. Feldspathic (ophite ?) (122)
Amygdaloid 7 d 7 S. 550 - 567 (17)
With calcite, quartz, prehnite, and copper, seams inclined 15° to the hole.
Trap 7 d 7 S. 567 - 672 (105)
Rather fine grained with chloritic slips to 612 ft. About 640 a 5 mm. mottling appears?; a chloritic slip at 14° to core may be nearly vertical.

(107) 13. Amygdaloid 7 d 7 S. 672-686 (14)
Well marked brecciated, with pink prehnite and copper at 677.
The correlation of 7 d 7 S. at 672 feet with 7 d 8 S. at 170 feet implies a dip of 31.5°, just about at right angles to the hole.

Manitou drill hole 7. 8. S. at 86 + 84. Elevation 570 A. L. S., Dip 55°.

1. Overburden (13) (13)

(105) 2. Ophite
Trap 7 d 8 S. 13 - 41½
Faintly ophitic with chlorite seams

(106) 3. Feldspathic ophite (?) (129)
Amygdaloid 7 d 8 S. 41½ - 57 (16)
Spotty with pink prehnite
Trap 7 d 8 S. 57 - 170 (113)
Fine grained, grey epidote to 66, then massive with chloritic seams at 10°, 26° and 45° to core (probably columnar joints at right angles to the dip) and mottling barely perceptible.
This is presumably the same bed as 7 d 7 S. 550 - 672.

(107) 4. Feldspathic ophite (?) (102)
Amygdaloid 7 d 8 S. 170 - 177 (7)
Marked, with quartz crystals and prehnite
Trap 7 d 8 S. 177 - 272 (95)
Specked at 205, 216 - 234, faintly if at all mottled

(108) 5. Feldspathic ophite (132)
Amygdaloid ? 7 d 8 S. 272 - 294 (22).
To 277 specked, then glomeroporphyritic
Trap 7 d 8 S. 294 - 403 (109)
Similar beds are found in the Central mine Section Hole No. 4.
Many reddish seams at 32° to the core are probably nearly vertical.
From 338 - 364 it is very faintly mottled (3 mm.) and then grows finer to the base.
The tendency of the beds at this part of the column to be but little ophitic, and that only at the extreme bottom, with red glomeroporphyritic top was noted also at the Central mine flow 106.

(109) 6. Feldspathic ophite (4 mm.) (107)
Amygdaloid 7 d 8 S. 403 - 407 (4)
Pink seams here at 70.5° may be nearly parallel to bedding.
The amygdaloid is coarse, with chlorite and calcite.
Trap 7 d 8 S. 407 - 510 (103)
Faintly ophitic,—at 460 feet, 3 to 4 mm. mottles.

(110) 7. Feldspathic ophite 7 mm. (149)
Amygdaloid 7 d 8 S. 510 - 517 (7)
Poor
Trap 7 d 8 S. 517 - 659 (142)
This is doleritic at 555, and has veins and pink seams and is the first well marked ophite for several hundred feet above it.
At 563, 573, 600, 632 ft. the mottles are
4–5, 7, 6–9, 5 mm.
Comparing these drill holes 8, 7, and 6, we see a progressive decrease in the size of the flows and more sediment toward the top. The lower flows are heavier, but still of the same type, with relatively coarse faint mottles close to the bottom of the flow.
Cf. Central mine flow 107

(111) 8. Amygdaloid 7 d 8 S. 659-668 (9)
Coarse, lying just above a seam 663-668 at 15° to the hole.
The thicker character of the beds in Hole 8 is noteworthy.
The thick beds at the top of 7 d 9 and bottom of 7 d 8 should be a topographic feature and is slightly.

Manitou drill hole 7. 9. S. at 9800 of section. Elevation 580. Dip 57°.

(112) 1. Ophite (9 mm.) (167+20?)
Trap 7 d 9 S. 42-209 (167) (190)
At 45, 82, 98. 130, 149, 175 ft. mottles are
2, 6, 6, 8-10, 8-10, 6 mm.
180, 192
4, 2-3 mm.
This does not show the top of the bed for which safely 20 feet more can be allowed, as the bottom bed in 8 is more ophitic than those above and this is more ophitic yet. It is natural to assume it to be the bed below the last in hole 7 d 8, and the dip derived is consistent (32.5°).
At 149 is coarsest and then finer.

(113) 2. Melaphyre (54)
Amygdaloid 7 d 9 S. 209-215 (6)
Poor
Trap 7 d 9 S. 215-263 (48)
Fine grained

(114) 3. Melaphyre (23)
Amygdaloid 7 d 9 S. 263-265 (2)
Red and white
Trap 7 d 9 S. 265-296 (21)
Feldspathic, fine grained.

(115) 4. Feldspathic ophite (53)
Amygdaloid 7 d 9 S. 286-292 (6)
Red and white marked
Trap 7 d 9 S. 292-339 (47)
At 292 and 323 feet the faint mottles are
2 and 3 mm. respectively

(116) 5. Labradorite (?) ophite (41)
Amygdaloid 7 d 9 S. 339-345 (6)
Trap 7 d 9 S. 345-379 (35)
Fine grained with large phenocrysts that remind one of the Kearsarge foot, greenish, faintly ophitic.

(117) 6. Labradorite (?) ophite (48)
Amygdaloid 7 d 9 S. 379-385 (6)
Fine grained, with green pseudomorphs of porphyritic crystals apparently, many seams at 71.5°, some at 18.5°.
Trap 7 d 9 S. 385-427 (42)

(118) 7. Melaphyre (19)
Amygdaloid 7 d 9 S. 427-432 (5)
Chloritic and epidotic
Trap 7 d 9 S. 432-446 (14)
Base uncertain

(119) 8. Melaphyre (15)
Amygdaloid 7 d 9 S. 446-449 (?3)
Trap 7 d 9 S. 449-461 (12)
It is a question if this is a separate flow.

(120) 9. Feldspathic ophite (77?)
Amygdaloid 7 d 9 S. 461-462 (1)
No core 7 d 9 S. 462-463 (1)
Amygdaloid 7 d 9 S. 463-474 (11)
With spots of trap
Trap 7 d 9 S. 474-538 (64)
Many pink (laumontite?) seams at 45° or 50° with core.
Faintly mottled, up to 10 mm?
This bed is very likely disturbed and incomplete.

(121) 10. Melaphyre (24)
Amygdaloid 7 d 9 S. 538-550 (12)
Red and white to 541, then chloritic
Trap 7 d 9 S. 550-562 (12)
With pink seams nearly parallel to the hole.

(122) 11. Melaphyre (45)
Amygdaloid 7 d 9 S. 562-573 (11)
Only chloritic from 567-573
Trap ? 7 d 9 S. 573-607 (34)
(All fragments, probably the drill was following a chloritic seam.)

(123) 12. Amygdaloid 7 d 9 S. 607-617 (10) (33)
Red, white and green with pseudomorphs of phenocrysts, a chloritic amygdaloid.
Trap 7 d 9 S. 617-640 (23)

(124) 13. Amygdaloid 7 d 9 S. 617-640 (23) (48)
Red calcitic above, green chloritic below
Trap 7 d 9 S. 651-688 (37)

(125) 14. Melaphyre (13)
Amygdaloid 7 d 9 S. 688-693 (5)
Red and calcitic to 691, then green
Trap 7 d 9 S. 693-701 (8)

(126) 15. Melaphyre (21)
Amygdaloid 7 d 9 S. 701-706 (5)
Trap 7 d 9 S. 706-716 vein? or 722 (16)

(127) 16. (18)
Amygdaloid 7 d 9 S. 722-725 (3)
Trap 7 d 9 S. 725-740 (15)

(123) 17. Feldspathic ophite (43)
Amygdaloid 7 d 9 S. 740-746 (6)
Trap 7 d 9 S. 746-783 (37)
Faintly ophitic as at 519 from 766-775

(129) 18. (23)
Amygdaloid 7 d 9 S. 783-787 (4)
Trap 7 d 9 S. 787-806 (19)
Chloritic amygdules 7 d 9 S. 791-798

(130) 19. Amygdaloid 7 d 9 S. 806-811 (5)
Marked, with prehnite, calcite and feldspar
Trap 7 d 9 S. 811-850 (38)
Coarsest, faintly mottled at about 830 ft
Finer to 850, where there is a seam.

(131) 20. Amygdaloidal melaphyre (19)
Amygdaloid 7 d 9 S. 850-865 (15)
Trap 7 d 9 S. 865-869 (4)
Bottom contacts at 66°

(132) 21.
Amygdaloid 7 d 9 S. 869-889 (20)
Contact at (9:4) 66° to core
The Bohemia conglomerates should, with the strike given on Penhallegon's map, pass about 800 feet south of 7 d 9 S. The elevation where the railroad crosses the conglomerate at the center of Section 30 is 504, while the elevation of a point on the line of M. 7. west is 570. The non-appearance in Hole 9 implies a steeper dip or more southerly strike of the conglomerate. But the bottom of this hole 7 d 9 S. certainly cannot be far above it.

The No. 3 section supplements No. 7 very desirably to the north, and is the only one which gives a complete cross-section of the Greenstone, confirming my previous view as to the character of this as one immense flow.

Manitou Mining Co., Sec. 3. (See Fig. 29 in envelope). Runs S. from E-W center line of Section 10, T. 50 N., R. 30 W. 175 paces west of the east line of Sections 10, 15, 22. This is 6212 feet north of 0 of the line, and Section 7 runs south along a line 1140 paces west of the east lines of Sections 13, 24 and 25. The main examination has been of Section 3. The holes put down at a dip of about 70° to the south are so nearly at right angles to the formation that no correction from depths for thickness is needed.

Manitou 3 drill hole 5 N. Elevation 542 feet above Lake Superior. Di p69°. 6183′ N. of 0 of M. 3.
0-16 surface

1. Porphyrite 3 d 5 N. 16-53 (37)
Light colored, feldspathic, of "ashbed diabase." Tobin porphyrite type. A seam dips 75.5° with the hole (?36°).
2. Porphyrite
Amygdaloid 3 d 5 N. 53-56=3 (30)
Chloritic, open to 61 and from 70-79 but not a new flow.
Trap? 3 d 5 N. 56-83=27
3. Feldspathic ophite?
Amygdaloid 3 d 5 N. 83- (79)
With a little copper
Trap 3 d 5 N.-162
The trap is very solid with very few seams (at 26° or so to the hole, i. e., nearly vertical), from 116-137 a very faint coarse mottling like a feldspathic ophite, at 137 3 mm?, the base is red and glomeroporphyritic. Cf. Eagle River (Marvine) 82 and 84 (Fig. 34)
4. Sediment (sand) at contact 3 d 5 N. 162
Probably Marvine's Cg. 16, the Pewabic West. Cf. Eagle River 78 to 85.

Addition figures show thickness above Mesnard bed.

3. Porphyrite (11) (506)
Amygdaloid 3 d 5 N. 162-165
Trap 3 d 5 N. 165-173

6. Melaphyre
   Amygdaloid 3 d 5 N. 173-176 (11) (495)
   Prehnite and calcite
   Trap 3 d 5 N. 176-184
   Blotched.

7. Ophite
   Amygdaloid 3 d 5 N. 184-202 and at 204 and 222-226 (147) (484)
   Trap 3 d 5 N. 226-331
   At 232 to 241 there is fissuring about parallel to the hole and the trap looks decomposed. At 250 there are seams at 56.5° and 31° with the hole, at 263 there is a doleritic spot, at 313 there is a large rhyocrystal 10 x 5 mm. The mottling is 18, 10–12, 8?, 2–3 mm., and fine respectively at 280, 267, 313, 327, 324.

8. Amygdaloid 3 d 5 N. 331-337? (11) (277)
   Trap 3 d 5 N. 337-342
   Contact at 331, rhyocrystals at 334, amygdaloid at 337-338, just a spot?
   These remind one of beds just above the Quincy mine.

9. (8) (276)
   Amygdaloid 3 d 5 N. 342-344
   Trap? 3 d 5 N. 344-350
   A very marked contact with a dip of 71.5° against the core.

10. (19) (269)
    Amygdaloid 3 d 5 N. 350-363
    Trap 3 d 5 N. 363-369
    This is a very well marked amygdaloid with a dark green base, white and green amygdules, then redder.

11. Amygdaloid conglomerate?

12. Ophite
    Amygdaloid 3 d 5 N. 369-389 (101) 250
    Red, fine grained.
    Trap 3 d 5 N. 389-470?
    Fine grained, dark trap with chloritic slickensiding parallel to the hole and very fine mottling
    2, 2, 1½, 1, ½ mm.
    at 414, 426, 451, 461, 466 ft. respectively.

13. Glomeroporphyrite (30) (149)
    Amygdaloid and trap 3 d 5 N. 470-500. The amygdaloid is not well marked and the contact with the overlying uncertain. There are small chloritic amygdules about 4 mm. across and pink feldspar lath sections 2 mm. long up to 4 mm.

14. Feldspathic melaphyre (41) (119)
    3 d 5 N. 500-541
    The contact is marked, then there is a coarse reddish feldspathic bed with green amygdaloid spots.

15. Porphyrite (30) (78)
    Amygdaloid 3 d 5 N. 541-560
    Quartzose, glomeroporphyritic, streaked with trap.
    Trap 3 d 5 N. 560-571.
    Trap blotched with chlorite, with pink feldspar.

16. Porphyrite, amygdaloidal. (48) (48)
    Amygdaloid 3 d 5 N. 571-579-619
    Glomeroporphyritic, a sedimentary contact with an angle of 71.5° against the core at the base.

17. Sedimentary contact at 3 d 5 N. 619. Cf. the Mesnard epidote (0)

18. Amygdaloidal melaphyre gush of the underlying?
    Amygdaloid 3 d 5 N. 619-624 contact?
    " 624-629 (33)
    " trap 629-642
    Trap 642-794?
    Amygdaloidal spots at 654 and 657. Compact, getting darker, coarsest about 671 2 mm. ophite, then finer and darker to the end. Presumably the bottom of this bed and the top of the next are cut by numerous chlorite seams nearly parallel to the hole between 694 and 794, which imply faulting.

19. The Greenstone (1130)
    Top not visible, cut by fault?
    3 d 5 N. 794-833; 3 d 4 N.; 3 d 3 N. 1 to 616; 3 d 2 N. 1-296.
    This grows suddenly and irregularly very coarse, and the easy way to account for it is to suppose that a fault zone, such as is known to be heading this way from the Manitou No. 1 shaft, has crossed it. If it does belong to the No. 1 shaft fault set, it strikes 20° to 25° W. of N. and hades E. as usual, so that the hole is at first on the upper east side of the fault, then passing through in accordance with the more common rule that the east side is thrown down or back, the hole meets suddenly relatively deep horizons. A normal strike fault or slide would, however, produce the same effect, but the direction of the chlorite slips between 694 and 797 seems to rule this out.
    An almost identical change in grain with chlorite slips occurs just at the top of 3 d 4 N., and the fault at Manitou No. 1 shaft would, if it did not swerve, apparently run west of 3 d 4 N. But if we suppose that it is the same fault zone which disturbs 3 d 4. N. at 6-44 and 3 d 5 N. at 694-700, a hade of 45° to the E. would be indicated and that is hardly likely.
    Similar chlorite seams occur in the other holes, and as in 3 d 2 N. 249-257+ are often associated with abnormal changes of grain.
    This Greenstone also forms the whole of Hole 3 d 4 N. most of Hole M. 3. 3 N. and a large part of Hole 3 d 2 N. It is also touched in Manitou 39, 41, 43, and the Medora holes 13 and 14 traverse it in part. These correlations may be made very surely. But if we are not mistaken, it was also traversed in the Isle Royale drill cores, Hole 6, 91-363, and there are many field exposures. It therefore furnishes an unusual chance to study the variation of the grain. Beside the faulting above mentioned, however, there are other difficulties. When the size of the augite patches is more than half the width of the core, say over 10-15 mm., the predominance of sections not showing the full dimensions of a mottle becomes more marked, while at the same time the mottling itself becomes very much less defined. Estimates of the grain based on the mottling in drill cores are therefore less certain. Thin sections are, of course, out of the question, and pock marked weathered surfaces make the most pronounced and best defined pattern. (See Plates II and III.) I am not

sure, however, how my estimates of the coarseness with them compare with those obtained in other ways

We note in 3 d 5 N., chlorite seam at 694-794.

Grain 2, 4, 5, 6–7, 7, 8, 7–10 mm. respectively at 794, 808, 813, 818, 823, 828, 830 feet.

In 3 d 4 N., chlorite seam, 2–3, 3, 3–5, 7, 10–12, mm., respectively at 6–44, 56, 61, 65, 74–80, 99, feet and 30?, 12, 12? 8+, 10–12+ 8, 15, 25? mm. at 99, 113, 130, 161, 170, 218–222, 273, 342, ft. and 15, 16, 15–40? 20, 15 mm. at 403, 489, 554, 556 ft.

In 3 d 3 N. mm. 40–60, 40, 40, 45, 25? (or 50 center to center) respectively at 35, 52, 65–113, 113–156, 156–246, feet; also 30, 40, 30, 50? 20, 15, 12–15, mm. resp. at 240, 246–288, 288–332, 426–467, 469, 498, 511, feet; also 8, 8–10, 7, 5, 3, 2, ½, mm. 0 resp. at 525, 532, 550, 565, 589, 601, 606, 615 ft.

This would be a mean gradient in 3 d 3 N. of .00037, about 1 mm. in 9.1 ft., 1 inch knobs in 225 ft.

In 3 d 2 N. 30? 40? 12, 10, 8–4, 6, 3, 0 mm., resp. at 6–56, 104, 140, 180–188, 188–250, 250, 257, 290

This would mean a mean increase of about 1 mm. in 10 ft.

If we compare 3 d 3 N. with the Mandan holes we find that they have mean rates of increase (A) of 1 mm. in 8.6 ft. and 1 in 9.9 ft. respectively. This is quite as close an agreement as one would expect from the observations as the probable and possible error in each series is much greater than the difference in the different series. At the Isle Royale, however, the rate of increase I made from thin sections was only about half as great, .0002. This would indicate that the temperature of the magma at the time of coming to rest was higher[1] on the Isle Royale though still not over say 10% above the temperature of consolidation. It is possible that the very thick parts of the flow continued in motion and so stirred up to a lower mean temperature more readily than the thinner. Or it may be that the Greenstone, though thicker on the point, is farther from its source and so in flowing had more time to cool.

But on re-measuring the mottles on the Isle Royale drill cores with the eye, rather than the patches of augite in thin section, I find my results uniformly larger, especially for the coarser mottlings, where evidently the thin section does not give enough to show the pattern, and this will reduce the discrepancy very materially, perhaps entirely.

Manitou 3 drill hole 4 N. Elevation 573′ above Lake Superior. Dip 69°. 4,300′ N. of 0 of M. 3., and 440′ N. of the S. line of Sec. 10, T. 50 N., R. 30 W.

(19). All in the Greenstone. The mottling has been given above. Doleritic streaks occur at 74 (7 mm. augite, 3 mm. feldspar), at 99 (30 mm. augite, 6-8 mm. feldspar), at 161 (5 mm. feldspar), at 218-222 (6-8 mm. feldspar), at 250-257 (12 mm. feldspar), at 301, 421, 436, 457, 489 large porphyritic crystals (rhyocrystals) of fresh bytownite (labradorite) occur, at times not less than 15 mm. long.

The grain does not seem to vary from center to margin of a particular

[1]See Chapter IV.

doleritic streak (Marvine's light type of diorite) but does seem to be rather coarser in the thick streaks and in the center of the flow.

The chlorite slips occur at many points and in many directions, often nearly vertical, parallel to the hole, so from 6-44, again near 170, and at 285, 491-544 (prehnite,—at 382 is a prehnite seam also), and at 589.

Manitou 3 drill hole 3 N. Elevation 625′ above Lake Superior. Dip 67°. 2746′ N. of No. 3, 365′ S. of the N. line of Sec. 15.

(19). In the Greenstone 3 d 3 N. 1-615 (630+ (40 to 60 x 9) 1130

Occasional large feldspar crystals 21 x 4½ mm., 12 x 2 mm., at 57 is a seam at an angle of 24° with the hole, at 396-411 are heavy seams of chlorite, again at 543-545 is a chlorite seam which brings out the ophitic pattern beautifully, see photograph (Pl. IV. b) running nearly parallel to the core. From 1 to 467 the pattern is too coarse and faint to measure accurately. At 156-202 it is about 50 mm. from center to center of the faint mottles marked by an absence of coarser green spots, perhaps altered olivine. At the very beginning 35, the mottles are 40-60 mm. across.

If then we assume the center of the flow at 3 d 3 N. 120, 510 feet from the bottom, with mottles of say 56 to 46 mm. we have a thickness which agrees with the indications of the surface exposures and dips and the drill holes, a mottling which agrees with the indications in this hole and the one north so far as it can be made out at the center, with the pockmarking (Pl. III) due to weathering and also with general rate of increase assumed to continue uniformly to the center. This might imply that the lava temperature was not more than 10% above that of consolidation, while the exceptionally large rate of increase may show that the excess was even less, only about 2% above. The occasional sparse rhyocrystals of labradorite found show also that the temperature of the moving lava can not have been above 1400° C., while the temperature of consolidation was probably between 1000° and 1100° C.

(20). *Allouez conglomerate.* (25)

Clay fluccan slide at 615

Conglomerate 3 d 3 N. 615-640

Copper at 630. Shades off into a weathered and decomposed top of a trap.

(21). Trap not marked amygdaloidal 3 d 3 N. 640-657.

Manitou 3 drill hole 2 N. Elevation 638′ above Lake Superior. 1818′ N. of M. 3, 493′ N. of the crest of the Greenstone Range (which is 693′ A. L. S.) and 965 from the center line of Section 15. Dip 67°.

(19). The Greenstone (1130+)

Trap 3 d 2 N. 1-290+

Mottles (as given above) from 30 to 40 mm. down, porphyritic labradorite crystals 15 mm., in one case 35 mm. The chloritic seams occur at 100-145, 249, etc. Pink seams are more often nearly across core.

20. Allouez conglomerate

3 d 2 N. 290-315 (25)

Felsitic, dip 21.5°

21. Feldspathic melaphyre (15)
3 d 2 N. 315-330 Cf. Mandan d 14. 582-616
13. 220-

22. Ophite, feldspathic (80)
Amygdaloid 3 d 2 N. 330-349
Pink and white to 333 and occasional red bordered amygdules to 349.
Trap 3 d 2 N. 349-410
More or less seamed more or less parallel to the bedding. Mottles 3-4 mm. at 393.
Cf. Mandan d 14. 616-673
13. 220-310 (5 mm. at 280)
(95)

23. *Medora lode.* (26)
Amygdaloid 3 d 2 N. 410-414
Trap 3 d 2 N. 414-436
Fine grained, brecciated 3 d 2 N. 433-436
This may not be an independent flow, but cf.
Mandan d 14. 673-725
13. 310-326 (121)

24. Feldspathic ophite (100)
Amygdaloidal trap 3 d 2 N. 436-441 *Manitou lode?*
Trap 3 d 2 N. 441-536
Coarse feldspathic with faint mottles up to 5 mm., at 485 a spot of amygdaloid, toward base prehnite seams across the hole and finer.
(221)

25. (30+)
Amygdaloid 3 d 2 N. 536-538
Trap 3 d 2 N. 538-566+

Manitou 3 drill hole 1 N. Elevation 572′ above Lake Superior, 570′ N. of 3 and 370′ S. of the base of the Allouez which is 600′ above Lake Superior. It begins in an exposure made by the rather massive trap 24.

(24). Feldspathic ophite
3 d 1 N. 4-46. Coarse faint mottling 4 mm. at 23.
(221)

(25). Feldspathic ophite (38)
Amygdaloid 3 d 1 N. 46-48=M. 3 d 2 N. 536-538
Trap 3 d 1 N. 48-84?
Coarse mottled 5 mm. at 67-74
Perhaps not a separate flow. (259)

26. Feldspathic ophite (43)
Amygdaloid? 3 d 1 N. 84-85
Amygdaloid trap 3 d 1 N. 86-96
Trap 3 d 1 N. 96-127
Coarse, faintly mottled at 104, then finer, at 119 green forms like porphyritic crystals on a red ground, and a well-marked base (302)

27. Ophite Mandan ophite (a) (73)
Amygdaloid 3 d 1 N. 127-137
Marked, good looking, prehnitic.

Trap 3 d 1 N. 137-200
The mottles are 3, 5, 5 mm. respectively
at 149, 168, 178, feet.
The mottling is so coarse close to the base of this and the top of the next, I take them to be close following gushes representing the Mandan ophite, or else fault repetitions. (375)

28. Ophite Mandan ophite (b)
Amygdaloid 3 1 N. 200-203 (59)
Marked with prehnite and copper. (434)
Trap 3 d 1 N. 203-259
5 mm. mottles at 218

29. Ophite, feldspathic (32) (466)
Amygdaloid 3 d 1 N. 259-263
Trap 3 d 1 N. 263-291
Faintly mottled, coarsest about 276

30. Ophite, (36) (502)
Amygdaloid 3 d 1 N. 291-307½
Trap 3 d 1 W. 307½-337

31. Ophite (108) (610)
Amygdaloid 3 d 1 N. 337-339
Trap 3 d 1 N. 339-445
Grows coarser to 415 (5 mm. mottles)

32. The Houghton conglomerate 3 d 1 N. 445-473 (28) (638)
Rather basic, but with felsite pebbles to 446, then a regular felsite conglomerate. At 455 dips in shaly bands are at an angle with the core of 71.5° and 65.5°. It gradually passes into an amygdaloid conglomerate with a dark red matrix and dark fragments of scoria.
The distance below the Allouez is
at the Mandan and Medora (576)
at the Central (689)

33. Ophite (66)
Trap 3 d 1 N. 473-539
Cf. M. 3. 69-131 (62)
Amygdaloidal at top?
Cf. Mandan d 3. 190-265
1. 121-185
Mottling to 2-3 mm. at 500, then finer (66)

34. First belt below Houghton (11)
3 d 1 N. 539-550 (77)
Amygdaloid conglomerate and amygdaloid
Cf. M. d 3 131-141+

35. (24) (101)
Trap 3 d 1 N. 550-574
35, 36 and 37 belong together. Cf. Mandan d 3. 265-339. Cf. Mandan d 3. 141-202
Fine grained (61)

36. Ophite (31) (132)

Amygdaloid 3 d 1 N. 574-577. Second probably not independent flow.
Cf. M. 7 d 1 N. 125-133 (50)
Trap 577-605
Mottles 2 mm. at 590, then finer. 35, 36 and 37 are closely allied like 16, 17 and 18 at the Empire.

37. Ophite (84) (216)

Brecciated amygdaloid 3 d 1 N. 605-618. Third flow.
Cf. M. 7 d 1 N. 170-180+ (80)
M. 3 202-293 (91)
Trap 3 d 1 N. 618-689
Mottles are 2, 2 to 3, 1 mm. across respectively
at 646, 661, 676 ft.
Cf. Medora d 3. 339-461

(38). Montreal lode
Brecciated amygdaloid 3 d 1 N. 689-699
Cf. M. 7 d 1 N. 250-256
Brown and white.
This is the fourth amygdaloidal (or amygdaloid conglomerate) bed below the Houghton, or third if 574-577 be not counted, as may be more proper.

In the Montreal shaft No. 1 there was a pocket of rich copper rock at the top and 1st level, but at the 350-foot level there was nothing. The shaft was crossed by many seams down below and in the 1st level 390 feet to north. The accumulation of copper is then quite likely associated with a cross-fissure.

Manitou drill hole 3. 1780′ N. of the S. line of Sec. 15, T 58 N., R 30 W. 502′ above Lake Superior. Dip of the hole 65°. Dip of the bed on the Houghton 26°. On the Calumet 25¾°.

(31). Trap d 3. 25-53

(32). Houghton conglomerate d 3. 53-69
Felsitic 53-58, then red and white and black.
Amygdaloid conglomerates.

(33). Ophite 2 mm.
Trap d 3. 69-131
Mottles are 1, 2, { seamed } 1 mm. respectively
at 90, 104, { across core } 121 feet

(34). Amygdaloid conglomerate d 3. 131-141
Marked, brecciated, characteristic red or brown appearance.

(35 & 36). Ophite 2 mm.
Trap d 3. 141-202
There seem to be two beds in 3 d 1 N., and here it is finer with a seam of amygdaloid and *copper* at 190, but the mottling continues, being 2 mm, and 1 mm. at 174 and 197 respectively.

(37). Ophite 3 mm.
Amygdaloid and breccia d 3. 202-231
Trap d 3. 231-293
The mottles are 2 mm and 2-3 mm. at 257 and 273 respectively.

(38). Montreal lode and ophite foot { M. d 3. 293-331 } (73)
Amygdaloid and breccia { M. 3 d 1 N. 689-699+
Trap d 3. 331-366.
At 331 the change is rather sudden, (possibly due to faults on chloritic seams) to 2 mm. ophite mottling, increasing to 3 mm. at 345.

(39). Ophite 2-3 mm. (62)
Amygdaloid d 3. 366-382
Trap d 3. 382-428
Decomposed and seamed to 393. Mottles up to 2-3 mm.

(40). Ophite 3 mm. (82)
Brecciated amygdaloid d 3. 428-443
Well brecciated, perhaps even an amygdaloidal conglomerate, with much calcite.
Trap d 3. 443-510
The coarsest mottles (3 mm.) just above 488.

(41). Ophite (72)
Amygdaloid d 3. 510-512 poor
Trap d 3. 512-582. At 538 1-2 mm. mottles, *many chlorite seams.*

(42). Ophite 7 mm. (167)
Amygdaloid brecciated with trap d 3. 582-620
Trap d 3. 620-749
Ophite mottling varying from 1 to 3 mm. in the same core, at 645 3 mm., and between 651 and 693 coarsest, 6-7 mm.

43. Ophite (60+)
Amygdaloid d 3. 749-758
Well-marked brown and white, seam nearly parallel to hole between it and trap.
Trap d 3. 758-809. Mottles up to 3-5 mm.
3.18 219-271 (52) 3.2 332-86 (54); 7 d 1 S. 695-758 (63); 7 d 2 S. 200-250 (50); Empire flow 25 (63) etc.

44. Calumet conglomerate d 3. 809-816 (7)
With felsite and amygdaloid pebbles, and yellow epidote and calcite, gradually more basic.
Base below base of Houghton conglomerate (816 minus 69) (747)

45. To 829 decomposed fine grained trap with some amygdules and many chlorite slips.

Manitou 3 drill hole 1 S. of M. 3 1142′. 480′ above Lake Superior. Dip 65°; of the Calumet conglomerate 26°.

This exposes no beds not touched in d 3. or 3 d 2 S. We have simply:

(41). A 3 mm. ophite.

(42). 3 d 1 S. 52-74 Amygdaloid, then trap (mottling 7 mm. between 139 and 179) (167)

(43). 3 d 1 S. 219-235. Amygdaloid with *copper* in the hanging, then trap (52)

(44). 3 d 1 S. 271-275 Calumet conglomerate. Felsitic to 278, to 283 amygdaloid. (7)

(45). 3 d 1 S. 283-357 Epidotic, then ophite (4 mm. at 328)

(46). 3 d 1 S. 357-371 Amygdaloid, then ophite (3 mm. at 365) then nearly vertical seam to 390.

Manitou 3 drill hole 2 S. S. of M. 3. 1575′, 130′ N. of a small shaft striking the Calumet foot through 25′ of drift, and 215′ N. of the soutn line of sec. 15, T. 58 N., R. 30. W.; 480′ above Lake Superior. Dip of hole 65°, of beds about 26°, by correlation and observation.

(42). Fine grained trap seamed at an angle of 73.5°.

(43). Amygdaloid 3 d 2 S. 34-38 (54)

Brown and white, then green, brown and white, and at 41 in the foot, seams of prehnite with copper.

Trap 3 d 2 S. 38-86.

Mottles 3 mm. at 61, 2 mm. at 79, and redder toward base. A persistent and uniform bed here and elsewhere.

(44). Calumet conglomerate (14)

Felsitic 3 d 2 S. 86-88

Amygdaloid 3 d 2 S. 88-100

The dip is well marked 14. 7:30 exactly 26° agreeing with correlations.

(45). Ophite (72)

3 d 2 S. 100-172

A decomposed trap with a chlorite seam at 5° to 10° to hole at 134 and 168. Mottles 1 mm. at 116, 3 mm. at 134-147, then finer, 1 mm. at 168.

Cf. M. 3 d 1 S. 283-357 (74)
7 d 1 S. 260-320
M. d 3 S. 816-829+

Empire flow 27 (69)

Clark flow .29?

46. Amygdaloidal conglomerate and ophite (72)

(144)

Amygdaloid? 3 d 2 S. 172-175.

At the top a narrow band of amygdaloid conglomerate not found elsewhere, and the line between that and the amygdaloid not marked.

Trap 3 d 2 S. 175-244.

There is a prehnite seam nearly straight across the core (77.5°)

The coarsest mottling is 2-3 mm. near 214.

7 d 1 S. 320-390. Empire flows 28 & 29?

47. Amygdaloidal conglomerate and ophite (90)

(234)

Amygdaloid? 3 d 2 S. 244-250

Analcite occurs. Red and green fragments occur imbedded in a prehnitic ground. There may be a few inches of the amygdaloid conglomerate which is much like that at 172.

Trap 3 d 2 S. 250-334

Mottles are 3 mm. at 280; 4-5 mm. at 298; 1 mm. at 320, near which is a chlorite seam parallel to hole, near vertical?

7 d 1 S. 390-480 (90) Empire f. 29?

48. Ophite (Calumet amygdaloid and foot?) (125)

359

Amygdaloid 3 d 2 S. 334-338

Trap 3 d 2 S. 338-459 poor

Ophite up to 4-5 mm. mottles down to 376, at 408 7 mm. mottles matching Empire hole 4.880 f. 80, at 423 4 mm. At 380, 418 and beyond 423 are heavy chlorite seams and from 452 the base is much brecciated. 7 d 1 S. 480-587 (107)

Empire f. 30 (140), M. 7 d 2 S. 35-145 (110)

Mandan 10. 567-694 (6 mm.)

In the figure (29) the Calumet and Osceola amygdaloids are placed lower and there is some' uncertainty as to their exact correlation, depending somewhat upon whether one correlates from the Kearsarge conglomerate below or the Calumet conglomerate above.

49. Ophite (Osceola amygdaloid and foot .3). (86)

Amygdaloid 3 d 2 S. 459-467 (8)

Prehnitic, conglomeritic.

Trap 3 d 2 S. 467-545

Mottles 3–4, 1, ½ mm.
at 494–509, 526, 534 with brecciated base.

Cf. 7 d 1 S. 587-612 (25)
7 d 2 S. 145-160-255
Empire f. 31 (948-970+?) to f, 33
Mandan 10. 694-784 (83) a 3 mm. ophite with porphyritic feldspar?, a doleritic ophite

(50). Ophite

Amygdaloid 3 d 2 S. 545-559

Cf. 3 d 3 S. 73- 85-172 (91)
Mandan 694-784 (81)
Empire f. 34

Frontenac 3 drill hole 3 S. 2624′ S. of M. 3, 823′ S. of N. line of Sec. 22. Elevation 495′ above Lake Superior. Dip of hole 65°. Of beds 27°.

(445)

Surface 20

(49). Trap 3 d 3 S. 20-73 (53+40+)

Begins in bed 49 with a 4 mm. mottling at 25, 2-3 mm. at 49, 1 mm. at 65. From 71-73 is red and brecciated.

50. Feldspathic ophite. Osceola amygdaloid and foot.

Amygdaloid 3 d 3 S. 73-85 Cf. 3 d 2 S. 545-559 (91)

Prehnitic and conglomeritic.

Trap 3 d 3 S. 85-172 (536)

Mottles 2, 2–3, 3, 4?, 2 mm.
at 101, 115, 122, 140, 155

There are chloritic seams at 45° at 155, then it is finer and somewhat brecciated. For correlations see above 3 d 2 S. Do these chloritic seams mean dropping out beds corresponding to Empire 32 to 33?

51. Doleritic ophite (153)

(689)

Amygdaloid Frontenac 3 d 3. S. 172-175

Poor

Trap 3 d 3 S. 175-325

Coarse feldspathic faint 4 mm. mottles 197-247, at 230 5 mm, 257 7 to 12 mm., 275 7 mm. Doleritic at 203, 204, 209, 214-216 (feldspar 6 mm. with calcite and chloritic interstices), and 258. Cf. 7 d 2 S. 255-263-450 with a narrow amygdaloid reported at 340-345, probably one of the dole ritic streaks. Also Empire flow 35 (141), which is also doleritic and about the same size, and Mandan d 10. 784-925 (129).

52. Ophite (21)

(710)

Amygdaloid 3 d 3 S. 325-327

Calcareous amygdaloidal trap to 333.

Trap 3 d 3 S. 327-346. Mottling 1 mm. at 337.

53. Ophite (103)

Amygdaloid 3 d 3 S. 346-353 (813)
Marked brecciated numerous seams at an angle of 66° with core.
Trap 3 d 3 S. 353-449

At first fine grained with coarse chloritic, and calcite and laumontite amygdules, and remains apparently fine grained with occasional amygdaloid spots throughout, seams making an angle of 10° to the core, presumably nearly vertical, with pink laumontite or calcite fillings are displaced by others which are perpendicular to the core and presumably nearly parallel to the dip, the north or upper side being thrown west. This would be the effect of a down slide on a north or northeast striking vertical seam.

54. Doleritic ophite (181)

Amygdaloid 3 d 3 S. 449-451 (994)
Amygdaloidal trap 3 d 3 S. 451-471
Fine grained, spotted, with occasional red bordered amygdules.
Trap 471-630

Grows in general coarser but at 548, 500, 551 doleritic apparently finer, also at 565 and 584. Mottles 5 mm. at 585, 3 mm. at 628. Pink seams at 14°⅓ to core. If these are vertical also seams at 66° to core, may strike N. 70° W. dip 70° to N. nearly perpendicular to them. Much seamed near base.

This is the first bed in Hole 3 d 4 S. -66
It occurs also in 7 d 3 S. 165-303
Mandan 8. 48-158
10. 1050-1220?
Empire f. 36 and 37, especially 36.
Clark hole 4

Characteristic of this belt is its amygdaloidal character, and the doleritic streaks, while the mottling is ill-defined, so that there is a temptation to consider it several belts or flows.

55. Amygdaloidal melaphyre (independent?) (26)
Amygdaloid 3 d 3 S. 630-635
Trap 3 d 3 S. 635-640
Amygdaloid 3 d 3 S. 640-656

56. Kearsarge conglomerate (1010)
Felsitic conglomerate 3 d 3 S. 656-669 (13)
Foot brecciated, passing into fine grained ophite (1023)

For the distance to the Calumet compare:

Mandan d 10.	194-1230	(900-940)	distance in	thickness
Empire	(744)	"	"	"
Manitou 7	(1080)	"	"	"
Central	(1190)	"	"	"

Around Calumet the distance is commonly 930-994. Out to the Empire the distance is remarkably persistent. There is some loss at the Empire by faulting or otherwise, unless (as is quite likely, see Fig. 24.) Holes 2 and 4 do not lap, and the dip is about 45°. With such a dip the distance from the Calumet to the Kearsarge would be 1050.

Frontenac 3 drill hole 4 S. 3878′ S. of No. 3 hole and 2064′ S. of N. line of Sec. 22. El. 518′ above Lake Superior. Dip 65°; of beds 26.5°.

(54). Ophite at 37 3 mm. mottles, at 50 2 mm. mottles 30-66

(55). Amygdaloidal melaphyre (40)
Amygdaloid 3 d 4 S. 66-68
Trap 3 d 4 S. 68-106
Chloritic to 75, then faintly ophitic, growing finer.

(56). Kearsarge conglomerate 3 d 4 S. 106-121 (15)
The last foot is of basic material. At 118 a good dip is 80.5° against the core.

(57). Kearsarge foot ophite (83)
Trap 3 d 4 S. 118-201
Weathered from 150-158, much seamed at an angle with the core of 15°. The mottling is at 185 4 mm., at 197 1-2 mm. Usually thicker. Belts 58 and 59 probably often merge? Empire f. 39.

58. Ophite, feldspathic (91)
(174)
Amygdaloid 3 d 4 S. 201-202 Poor
Trap 3 d 4 S. 202-293
Faintly mottled (5 mm.) doleritic at intervals 223-244, with 3-4 mm. mottles at 270. Empire f. 40.

59. Sediment and trap? 3 d 4 S. (293-342-) (49) (223)

60. From 296-304 is much veined and probably a repetition of the bed above. At 324-326 is a sediment, a clasolite perhaps, but green, epidotic as well as red, with a dip of 80° to 77° against core.

61. Amygdaloid 3 d 4 S. 342-344 (5) (228)
Glomeroporphyritic base and amygdaloid.
Trap ? 3 d 4 S. 344-347.

62. Amygdaloid conglomerate 3 d 4 S. 347-350 (3) (231)

63. Feldspathic ophite 3 d 4 S. 350-376½ (26½) (257½)
3 mm. mottles at 367.

64. Sedimentary contact at 376½
From 293-376½ is not easy to define owing to the faulting and the irregular mixture of sediment and trap. Though it may be in part clasolitic, there is evidently at least one well-marked sedimentary horizon, a premonition of the Kearsarge. Cf. Empire f. 41, also Mandan d 8. 574.5-589, where the intervening traps are much thicker, also C. & H. D. flows 5 & 6.

65. Feldspathic melaphyre (62½) (320)
Amygdaloid 3 d 4 S. 376½-377
Trap 3 d 4 S. 377 -439
Seamed at 389, with a bomb near 406.

66. Ophite (10 mm.) (225) (545)
Amygdaloid 3 d 4 S. 439′-444′
Trap 3 d 4 S. 444′-664′
From 450-455 is a seam of calcite quartz and *copper* in the feldspathic ophite, which grows coarser up to 540-568, and grows darker green chloritic with *copper* in the chlorite at 575.
The mottles are up to 8, 10, 8, 5, 2 mm.
respectively at 503-513, 540-568, 575, 615, 659

This is at the top of 5, is also probably the same as Central f. 46 There is nothing so large at the Mandan except the flow directly under the Kearsarge. At the Empire section compare f. 42.

67. Sedimentary bottom contact (1)
Frontenac 3 d 4 S. 664-665 3 d 5 S. 71-74 (546)

68. Melaphyre
Trap 3 d 4 S. 665-700 (25)
Frontenac 3 d 5 S. 74-105 (31) (571)

69. Ophite (15+)
Amygdaloid Frontenac 3 d 4 S. 700-704
Trap 3 d 4 S. 704-715+
Mottled up to 2 mm.
Frontenac 3 d 5 S. 105-112-164 (59)

Frontenac 3 drill hole 5 S. Location 5150′ S. of No. 3 hole. El. 523′ above Lake Superior. Dip of hole 65°; of beds 27¼°. By correlations on the sediment at 72 a dip of even 34° might be inferred.

(66). Ophite
Trap Frontenac 3 d 5 S. 39-66
Poor amygdaloid 3 d 5 S. 66-71
Begins with 3 mm. mottles.

(67). Sediment 3 d 5 S. 71-74? (3?) (546)

(68). Amygdaloidal melaphyre (31)
Poor amygdaloid 3 d 5 S. 74-87 (571)
Amygdaloid trap 3 d 5 S. 87-105

(69). Ophite, feldspathic (59)
Amygdaloid 3 d 5 S. 105-112 (630)
Red and poor.
Trap 3 d 5 S. 112-164
Feldspathic with doleritic tendency, coarsest at 141-144.

70. Feldspathic melaphyre
Amygdaloid 3 d 5 S. 164-171 (38)
Contact near center? (668)
Trap 3 d 5 S. 171-202

71. Sediment
Chocolate color, dip 80.5°
The frequency of these sediments between the Kearsarge conglomerate and the Wolverine sandstone is noteworthy, though their thickness is usually insignificant.

72. (33)
Amygdaloid Frontenac 3 d 5 S. 202-205
Trap 3 d 5 S. 205-235

73. Ophite (23)
Amygdaloid 3 d 5 S. 235-239 Fissures at 30°.
Trap 3 d 5 S. 239-258
A seamed feldspathic ophite.
Top of Kearsarge lode below base of Kearsarge conglomerate (724)
(35)
(758)

74. Ophite, first of the Kearsarge lode group.
Amygdaloid 3 d 5 S. 258-272 with porphyritic feldspar?

Kearsarge lode.
Trap 3 d 5 S. 272-293
At 273 a seam of calcite and prehnite.

75. Ophite feldspathic (44)
Amygdaloid 3 d 5 S. 293-298
A feldspathic mottling
Trap 3 d 5 S. 298-337
(802)

76. Ophite with the Kearsarge amygdaloid (66)
Amygdaloid 3 d 5 S. 337-340
Coarse porphyritic feldspar crystals in fine ground growing coarser.
Trap 3 d 5 S. 340-403
Coarse ophite, at 375 4 mm., from 396 on, finer.

77. Ophite with a Kearsarge amygdaloid (24) (868)
Amygdaloid 3 d 5 S. 403-408
Trap 3 d 5 S. 408-427
Porphyritic crystals marked to 412.

Total of Kearsarge group with four amygdaloids 169 (982)
The upper two are not so certain; the top of 76 seems to be the main lode.

78. Horizone of Wolverine? Trap
The contact has a highly porphyritic amygdaloid with clasolitic red sandy matter (at 444 feet) which is all there seems to be of the Wolverine sandstone.
427-443

79. Ophite
Amygdaloid 3 d 5 S. 443-448
3 d 5 S. 450-452
Trap 3 d 5 S. 452-453+
Mottling 4 mm. at 508
Fault. From 511 to 523 are a lot of chlorite slips at 22.5° to the hole, and though the grain gets finer about 523 feet no amygdaloid comes in, so I think it is cut out by a fault, very likely one of the nearly vertical ones running across the range.

80. Ophite
Trap 3 d 5 S. 533
After 533 the mottles increase; from 1 mm. to 3 to 4 mm. at 547-557, then finer and full of chlorite slips from 567-575, then coarse 6-7 mm. at 583, then finer to 616.
This seems to be the disturbed representative of the big ophite that generally comes just below the Wolverine.

Cross-Section at Delaware mine. The data for a section here are

(1) The mine map as published by Lawton in the Report of the Commissioner of Mineral Statistics for 1885 near page 218 for instance.

(2) Marvine's statement that the Houghton conglomerate is 1563 (637) feet rom the Allouez.

(3) A sketch of the diamond drill explorations on the Delaware (File 10-12), see Volume V, Part I, page 130, where Rominger gives his idea of things. The dip of the Allouez at the Delaware he calls 23°.

(4) My own notes of Sept. 7, 1905. This is about a half mile east of Manitou 3 section, the bed numbers of which are given.

Fig. 29 The combination record will be somewhat as follows:

20 1. Conglomerate
Allouez (25)

22 2. Ophite Trap (100)

23 3. Amygdaloid (16) (278)

24 Trap
Sometimes doleritic with numerous inclusions as shown in contact
25 dividing in the lower part of the mine map into 123 feet trap 31
26 amygdaloids, 118 trap

4. Ophite (163)

27 Amygdaloid (28)
Trap (135)

31 5. Ophite (76)
Amygdaloid (31)
Trap (45)
Massive, well mottled 617

6. Houghton conglomerate No. 14 (20) (637)

?32 Marvine made this 1563 feet from the Allouez No. 1 horizontally. I find a well-marked upper amygdaloid contact of a flow about 1200 feet from and about 105 below the conglomerate on the old railroad cut, which seems to be the same horizon. Above it some distance is a well-marked ophite. Lawton's mine map doesn't show any amygdaloid close above the Houghton conglomerate. But unless accidentally omitted from the map, its absence in the 8th level would indicate a greater dip and therefore intervening thickness than Marvine assumed, not less than 710 feet, and I think somewhat *more* thickness is really more probable from the apparent thickness in the field of overlying flow, and the correlations elsewhere.

7. Underneath is not well exposed and not explored, 550 feet on and 40 feet lower down, or about (200) to (250)

38 8. The Montreal lode, brecciated with calcite, prehnite and copper, a scoriaceous conglomerate perhaps? (20) (290)

9. Unexplored, must belong in good part anyway to the underlying trap (163) (433)

Delaware drill hole No. 5 is 1025 S. and 42 ft. lower than the base of the Houghton conglomerate, at the level of the Montreal River, and foot of a steep bank.

10.
Trap at top of Hole No. 5 to 45 (37) 470
42. 11. (205) 675

Amygdaloid to 85=40 (37)
Trap to 268=183 (168)

43. 12. (64) (739)

Amygdaloid to 280=12 (11)
Trap to 338=58 (53)

(44) 13. Calumet conglomerate, as generally supposed—347=9 (8) (747)
(45)

14. Trap to bottom 438-½ ft. and at beginning of Holes 2, 3 and 4 (105) (105)

No. 2 is only 40 feet deep vertical and 900 ft. horizontally from No. 5
No. 3 is only 90 feet deep vertical and 910 feet horizontally from No. 5

No. 4 is 232 feet deep vertical and 930 feet horizontally from No. 5 perhaps 5 feet higher. Its record is trap to 38, amygdaloid to 65, trap to 145, amygdaloid to 160, trap to end at 232, when there follows another gap.

(46) 15. (99) (204)
Amygdaloid 65=27 (25)
Trap 145=80 (74)

(47) 16. (80) (282)
Amygdaloid 160=15 (14)
Trap 232=72+ (66)

Next follows a considerable gap No. 1 hole being 2230 feet from 5 and 42 feet above the base. This would make it 1563+1025+2230 feet or 4818 feet from the Allouez. About 220 feet down in it a conglomerate is reported which will then be 4818 feet from and about 320 feet+ below the Allouez. To assume this the same as the Kearsarge at the Central and at the same distance below the Allouez will be to assume a mean dip of 31°, a dip by no means improbable, since in the Central mine section we found steep dips to the south, and we found our correlation for the Houghton and Calumet both falling somewhat short of what we made them at the Central.

However, for the present we follow copy, with the comment only that very likely the unexplored thicknesses should be increased some 30%

17. Unexplored+ (290) (572)

Drill hole No. 1 is vertical, 37 feet above No. 4, 1280 feet from it. The record is overburden-32; trap-127; amygdaloid-140; Trap-220; South conglomerate-227; Trap-233-½.

(54) 18. (87+) (659)
Trap 32-127=95

(5) 19. Amygdaloid 140=13 (12)
Trap 220=80 (73)

(56) 20. South conglomerate (the Kearsarge?)-227-7 (6) 750

There is no conglomerate shown at any such position in any other section of which I know, and the inference is strong in my opinion that the dip should be increased somewhat, though there may be indeed be a thinning of the distance between the Calumet and the Kearsarge.

(57) 21. Trap.

§ 6. CENTRAL MINE AND ARNOLD (COPPER FALLS) (FIGS. 30 AND 31.)[1]

Next west of the Manitou is the old Connecticut property, Section 16, T. 58 N., R. 30 West., where the road to Eagle Harbor turns off through a gap which may be a fissure continuing to the Eagle Harbor fissure north of Section 9.

The next mile (Section 17) brings us to the old Waterbury. It is then nearly two miles to veins in Sections 18 (Summit) and 19, which seem to belong to a group of veins in the Arnold and Central mine. (Figs. 30 and 31.) In this belt two important mines have been worked for years, both in fissure veins and by exploration in them, and by combining them (Figs. 30 and 31) we are able to give a pretty complete section from the Lake Shore and the Great Conglomerate very nearly to the Bohemia conglomerate.

[1]Figures 30, 31, 32 and 33 are in envelope.

This section is that given on the old map of Keweenaw Point by Whitney, Hill and Stevens and is compiled from various old mine maps of Emerson and others but down to the Kearsarge conglomerate largely follows the work and notes and sections of Dr. L. L. Hubbard (File 7). Mr. W. W. Stockly has also been of help. The drill cores south from the Central were looked over by Mr. P. S. Smith and myself. Figures 30 and 31 are, however, built and adjusted to mine maps since through part of the section the mines had caved in and specimens could not be obtained. As the Owl Creek vein follows a cross-fault the beds on the two sides of the adit following the vein across the formations do not coincide. The strike here is N. 73° 51′ E. The section is mainly that of the west side of the vein, illustrated by Ss. 16780 to 16826.

The detailed measurements of the Owl Creek adit are as follows beginning on the east side.

		Width	Thickness
Amygdaloid	1–10	10	(4.3)
Amygdaloid Ss. 16781–2[1]	10–30	20	(8.6)
Sandstone Sp. 16783	30–258	228	(98.4)
Amygdaloid Sp. 16784	258–307	49	(21.1)
Trap Sp. 16785		49+	

These samples now change to the west side of the vein since the adit made an offset which would apparently be 98 feet horizontally along from the top of the last mentioned amygdaloid and 49 feet from its foot. At this point there is a—

Small sandstone seam Sp. 16786 5 in. (2 in.)

This may be a clasolite as it seems to be associated with the trap which is Sp. 16787. This continues for 115 feet beyond the sandstone seam or from the top of

Amygdaloid Sp. 16784	–213	115	(49.6)
Sp. 16788	213–230	17	(7.3)
Sandstone Sp. 16789	230–362	132	(57)
Amygdaloid or small flow Sp. 16790	362–375	13	(5)
Sandstone and conglomerate	375–463	88	(38)
(Fluccan) Sp. 16791		1¼	(½)
Amygdaloid Sp. 16792	463–490	27	(11.7)
Trap Sp. 16793	490–507	17	(7.3)
Amygdaloids Sp. 16794	507–605	98	(42.3)

Eagle River Beds 10 to 14 are amygdaloids, and amygdaloidal melaphyres, amygdaloid throughout

Trap Sp. 16795	605–666	61	(26.3)
Amygdaloid seam Sp. 16796	666–669	2½	(1)
Probably not top of separate flow			
Trap	669–816	147	(63.4)
Sandstone	816–1044	228	(98.4)

This is probably Eagle River Bed No. 17 and is almost the same number of beds from the beginning of the Owl Creek vein adit

[1]Or Collector's Nos. 2 and 2a.

Amygdaloid and trap Sp. 16798	1044–1110	66	(28.5)
Sandstone (Eagle River 20?)	1110–1130	20	(8.6)
Amygdaloid melaphyre and trap (Eagle River 21?) SS. 16799–16800	1130–1270	140	(60.4)
Sandstone (Eagle River 22?)	1270–1302	32	(13.8)
Trap Sp. 16801 Cf. Eagle River 25	1302–1464	162	(69.9)
Sandstone Sp. 16802 Cf. Eagle River 26	1464–1509	45	(19.4)
Amygdaloid and trap Sp. 16803	1509–1595	86	(37.1)
Sandstone Sp. 16804 Cf. Eagle River 28	1505–1647	52	(22.4)
Interval in which beds were not well made out, broken by seam of fluccan flanked by vein matter as shown SS. 16805–7	1647–2267	620	(267.6)

The seam of fluccan is 138 feet from the top of the bed and is about 1¼(6)

ASHBED GROUP

Amygdaloid distinctly of porphyrite type SS. 16808–9. Cf. Eagle River 44 to 45	2267–2324	57	(24.5)
More compact SS. 16810-12	2324–2378	24	(23.2)
Amygdaloid SS. 16812-3	2378–2423	45	(19.4)
Closer and more compact part of the same flow. SS. 16814-5 near top and bottom	2423–2590	167	(72.1)
Amygdaloid (really 5 feet wide) Sp. 16815	2590–2598	8 or 5	(2.2)

This is presumably Marvine's heavy bed 62. A little adjustment has been necessary to reconcile the measurements along the vein with the real location of the shaft, mine, etc. (See also section given in the Report of the Commissioner of Mineral Statistics (1888) 1889, p. 87) and has been made in this heavy bed and below. SS. 16816–20 2598–3103 505 (217.9)

Hubbard thought possibly there were two or more beds. The base is a series of slide fluccans which separate it from the Ashbed proper.

Fluccan slides. Cf. Eagle River 63	3103–3123	2½(1 in.)	(17 [7 in.)
Amygdaloid and trap of the Ashbed. Sp. 16822	3124–3149	25	(10.8)
More of the Ashbed Sp. 16823	3149–3183	34	
Porphyrite Sp. 16824 (lower part of the Ashbed)	3183–3338	155	(64)
Trap	3338–3879	(91 feet from N. side of Thomas shaft)	

Center of the Thomas shaft was at 3783 and at 3838 was a cistern beyond which

it was impossible to examine. The rest of the measurements are compiled from old mine maps. Hubbard's first estimates would make this trap 450+91.

i. e.		541	(228)
Amygdaloid	3879–3889	10	(4.3)
Trap	3889–4024	135	(58.3)
Amygdaloid	4024–4034	10	(4.3)
Trap	4034–4094	60	(25.8)
Amygdaloid	4094–4104	10	(4.3)
Trap	4104–4134 and 4279	30+145	(12.9)+(62.6)
Sandstone	4279–4284	5	(2.2)

This is evidently the first sandstone south of the Ashbed corresponding to the Eagle River 83 to 85 perhaps

Trap	4284–4524	240	(110.1)
Sandstone	4524–4534	10	(4.3)

This apparently corresponds to Eagle River Bed 85 and perhaps to the Pewabic West conglomerate, Marvine's No. 16 at Portage Lake and from here on the section must be patched a little, the position of the beds in Fig. 30 being taken from Manitou 3 section. It is said, however, that the unexplored part of the adit was continued something like 3500 feet beyond the Ashbed and reached the Greenstone.

Capt. Clark of the Arnold reports that "a dike 18 inches to 2 feet wide was met in the 9th level in the 'Pewabic belt' running a little north of east and south of west, nearly vertical, which threw the formation down on the north about 22 feet vertically."

"The Owl Creek vein was explored deeper north of or above the Ashbed than below where it was poorer. There are three veins west and two east of the Owl Creek vein that fault the Ashbed alternately in opposite directions," and three on the east that do not fault it. "The main vein has the east side 32 paces or so north." From notes by L. E. Emerson on an old map we have the following data, besides the distances to various contacts used in the section.

Ninth level adit measuring north from north wall of Spencer shaft at Ashbed.

At 1393 Feldspathic copper bearing belt.

At 2475, 2525, 2550, 2603, 2674, 2655, 2683, 2743, 2797, 2840 ("Silver bearing belt") contacts being beds called amygdaloids, bearing analcite, datolite, prehnite and calcite. Also at 320 to 350 feet south of Thomas shaft, mottled rock.

In Fig. 30 I have given numbers corresponding to belts in the Eagle River section down to Eagle River belt 87. Then for a part of the adit south of the Thomas shaft entirely unexplored and for which no data at all can be obtained from mine maps, I have

taken the liberty of patching in the belts from Manitou 3 (Fig. 27) as the Eagle River section is incomplete just here. The Eagle River section makes the interval from No. 85 to the Greenstone only 353 feet against 506 in Manitou 3 which is somewhat disturbed. Quite possibly then the section to the Greenstone is thinner than shown, and the Greenstone correspondingly thick. The section as drawn makes it 1,330 feet. Stockly reports mottles 3 inches across. I have seen them over two. This at a rate of increase of .000375 would mean 1,333 feet. It is safe, certainly, to allow over 1,000 feet above the Allouez with no amygdaloids.

South from the Greenstone to the Kearsarge conglomerate the section given in Figure 31 was shown in the works of the Central Mine on the vein of that name. The section is partly given in detail in Volume I, Part II, Chapter VI. It can be completed from later mine maps and investigations by Dr. Hubbard[1] down to the Kearsarge conglomerate.

At this point there is a slide displacing the vein 284 feet and apparently the country rock "above the conglomerate between the east and west veins has moved to the north, thus producing along the west vein the relations of a reverse fault and along the east vein those of a normal fault," as very carefully studied by Hubbard and shown in Plates I, II and III of the article referred to, which as they were prepared for the Michigan Geological Survey are herewith reproduced as Figures 31 and 32, the west vein below the Kearsarge conglomerate being the displaced east vein above it.

The detailed section follows: The core boxes were scattered and had to be studied at different times, but were among those most carefully examined. P. S. Smith examined 1 and 2. T. Dengler furnished the locations. When the drilling was done the increased dip to the south was not fully appreciated. Some of the holes, also, are on one side of the fissure, some on the other. Nos. 1 and 8 though nearly in line of strike do not at all correspond with each other. Thus in the section (Fig. 33) I have not tried to give 1 and 2 in their geographic position but rather in their geologic which as will be seen means a vertical displacement of some 680 feet.

If we may judge by the Frontenac section this fails by only about 700 feet to reach the Bohemia conglomerate. This agrees with the fact that it covers the ground down to the south line of Section 36, T. 58 N., R. 31 W. The Praysville porphyry and other exposures help us to locate and identify the Bohemia horizon as crossing the south line of Section 36.

[1]Lake Superior Mining Institute, Vol. III., p. 74.

Abstract of Central mine Cross-section.

Belt No.				
0.	Beginning at base of Allouez conglomerate, which is about (10) feet thick.			
13.	Melaphyres ophites—none over (75) feet thick. Dip about 24°			
14.	*Houghton* conglomerate felsitic (10) below the base of the Allouez (640) to (685)			
15.	Of ash bed type (61)			(730)
	Melaphyres up to 96 feet thick (probably including ophites)			
26.	*Calumet* conglomerate (15), base below Allouez base			(1500)
	Ophites mainly—some over 100 feet.			
31.	Ophite (108) base below Calumet 384 feet.			
39.	Ophite (10 mm. x 4 mm. augite) (194) base below Calumet			1020.
41.	Fault fluccan over Kearsarge base below Calumet			1128
	below Allouez			(2628)
	Dip about 27° according to Hubbard below Allouez			(2599)
42.	*Kearsarge conglomerate* (62),—from Houghton cg. (2021) below Allouez			(2690)
43, 44, 45.	(end of mine section) below Kearsarge (233) below Allouez			(2923)
(46 bis)	Cend. 2 base of first flow in Cend. 2 at 80			(3114)
50.	Red shaly sediment, below base of Kearsarge (469) below Allouez			(3159)
53.	Kearsarge hanging ophite (73) below base of Kearsarge			(587)
	below Allouez			(3277)
54, 55.	(90) and (75) Repetition or two flows of K. F. Kearsarge amygdaloid			
56.	*Wolverine sandstone*, below Kearsarge conglomerate (752)— below Allouez			(3442)
	below Wolverine sandstone			(281)
58.	Ophite big 2.442-498=8.42-314 (250)			
59.	Sc. Am. 60 choc. ss. (see Franklin J. 3.535)	(311)		(3752)
61–71	Small beds of feldspathic ophite type	(485)		
72.	Ophite (122)			
73–75.	Small beds 5.88=8.722 76 sediment 5.98-100	(641)		(4083)
77–79.	78 inclusion bed feldspathic doleritic datolite	(149)		
	79 feldspathic ophite (179)	(999)		
81.	Sandstone (7) 5.585-593	(1042)		(4484)
82–87.	Small feldspathic beds 5.807=3.182	(1216)		
88–93.	" " "	(1372)		
96.	Conglomerate 3.608-612=4.67-68	(1577)	(5019)	
97–101.	Glomeroporphyrites, red, gl. am. light fels. tr. chloritic, faint, or no mottles 4.675=6.39	(2072)		
102–107.	Glomeroporphyrites, heavier and more ophitic at base 107=6.352-544=6 A. 290-414	(2482)		
108–112.	Glomeroporphyrites, heavier and more ophitic at base, 112=6.650-801=7.37-257 (205)?	(2772)		
113.	Ophite (203)			
114–115.	Small flows glomeroporphyrite?	(2975)		
116.	Doleritic ophite.	(3284)		(6726)

The dip from Hole 2 to 7 is not far from 35 degrees.

This Central mine Cross-Section is in continuation of the section in Volume I, Part I, Chapter VI, of the Reports of the Geological Survey of Michigan, adding the results of the deeper mining, especially as given in the reports of the company, Dr. L. L. Hubbard's paper in the Transactions of the Lake Superior Mining Institute 1895, pages 74-83, and recent drilling. The whole figure (33) makes a fairly complete section from the Allouez conglomerate No. 15 nearly down to the horizon of Conglomerate No. 8. The upper belts are abstracted merely, those now published for the first time are given more fully. Mr. Philip S. Smith examined very carefully drill hole 1.

	Allouez conglomerate or Slide (No. 15)		10	Running Totals.
1.	Melaphyre			(36)
2.			(40)	
	Amygdaloid	(14)		
	Melaphyre	(26)		(76)
3.			(35)	
	Amygdaloid	(14)		
	Melaphyre	(21)		(111)
4.			(101)	
	Amygdaloid	(14)		
	Melaphyre C. 1[1] Trap			(212)
5.			(87)	
	Amygdaloid C 2	(18)		
	Chocolate brown, prehnitic, with copper[2] gradual transition to C. 3; the Medora lode?			
	Melaphyre C. 3	(45)		(275)
6.				
	Amygdaloid C. 4	(16)		
	Brown matrix, with prehnite, copper, calcite amygdules, laumontite veins, feldspar vugs.			
	Melaphyre C. 5	(55)		(346)
7.				(346)
	Amygdaloid C. 6	(15)		
	Brown matrix with delessite and calcite amygdules			
	Melaphyre C. 7	(40)		(401)
8.				
	Amygdaloid C. 10 and C. 11	(15)		
	Brown matrix.			
	Melaphyre C. 12 and C. 13	(60)		
	Very thick and uniform just like C. 5			
9.				(476)
	Amygdaloid C. 14	(15)		
	Brown matrix, with cupriferous prehnitic amygdules			
	Melaphyre C. 15	(37)		(528)
10.				
	Amygdaloid C. 16	(17)		

[1]Pumpelly's original number. See Vol. I., Pt. II.

[2]It must not be forgotten that samples are taken near the Central vein. Pumpelly calls only the trap or compact part melaphyre. In modern use of the term it is applicable also to the amygdaloid top.

Brown, very hard compact, with amygdules of prehnite, and calcite with green earth

Melaphyre C. 17 (45) (590)

11.

Amygdaloid C. 18 (22)

Melaphyre C. 19 (5) (617)

12.

Amygdaloid C. 20 (5)

Brown with amygdules of epidote, or delessite and red feldspar

Melaphyre C. 21 (5) (627)

13.

All the melaphyres so far said to be alike, like C. 5

Amygdaloid? C. 22, 23, 24. (12)

Melaphyre C. 25 (10) (649)

14. *Houghton conglomerate*

Porphyry conglomerate with epidote cement and disseminated copper in both pebbles and cement C. 26 to 34 (10) (659)

This is the Houghton conglomerate (14) and the vein in this conglomerate carries large crystals of calcite. Scaling the distance from the base of 15 to the base of 14, on the mine map it varies from (640′) to (685′). Marvine makes it 1685′ horizontal or (665) feet, implying a dip of 23°.

15.

Amygdaloid C. 35, 36 (16) (61) (720)

Said to be of Ashbed type, amygdules almost wholly calcite.

Melaphyre C. 37, 38, 39 (45)

Said to be fine grained, but the lower part is minutely mottled and hence an ophite. Altered olivine "copper colored micaceous"; delessite; "soft white" altered feldspar are mentioned.

16. (83)

Amygdaloid C. 40 (15) (803)

Brown with amygdules of green earth, green earth and calcite, and feldspar with copper

Melaphyre C. 42 (68)

Very fine grained with even fracture, containing small crystals of plagioclase and altered olivine.

By scaling from the mine map it appears that in continuous cross-section this should be a total of (830)

17. (54)

Amygdaloid C. 43 (20) (900)

Green and brown with amygdules of green earth, calcite, copper, analcite.

Melaphyre C. 44, 45, 47, 48. (34)

Harder than C. 5, with perfect conchoidal fracture.

18. (59) (962)

Amygdaloid C. 49 (16)

Brown, with prehnite and calcite and chlorite amygdules.

Amygdaloidal melaphyre C. 51

Melaphyre C. 52 (43)

Like C. 5.

19. (96) (1058)

Amygdaloid C. 53 (28)

Soft brown with calcite and altered prehnite

Melaphyre (68)

20. (70) (1128)

Amygdaloid (25)

Melaphyre (45)

21. (122) (1250)

Amygdaloid C. 54 (13)

Purple-brown amygdaloid with prehnite

Melaphyre C. 56 (15)

Hard, fine grained, with altered olivine.

Amygdaloid C. 57 (10)

"Probably not a persistent bed", brown, with isolated amygdules of prehnite and chlorite.

Amygdaloidal Melaphyre C. 58 (16) (50)?

Melaphyre C. 59 and 60 (68)

Same type as C. 5

22. (1289)

Amygdaloid C. 61 (9)

Soft brown with prehnite, analcite and copper

Melaphyre C. 62 (30)

By direct scaling (1300)

23. (39+?) (1328+?)

Amygdaloid (9)

Melaphyre C. 63 (30)+

From Belt 19 there is a short interval that can be filled only by a mine map (reproduced reduced in Lawton's report of the Commissioner of Mineral Statistics for 1899) which does not, however, agree at all closely with Marvine and Pumpelly's map, Plate 23 of Volume I. There may be 30 feet discrepancy. Yet all maps agree in bringing the next conglomerate, the Calumet & Hecla, at the intersection of No. 2 shaft and the 16th level, and the mine map gives two amygdaloids between that and the 13th level. We reckon accordingly.

24. (96) (1424)

Amygdaloid (16)

Melaphyre (80)

The second belt above the Calumet is often quite a thick one. Cf. Mandan 1. 668-835.

25.

Amygdaloid (15) (1493)

Melaphyre above the Calumet (54)

Hubbard gives this in figures subject to revision as (1474) feet.

26.

Conglomerate No. 13. The Calumet (15) (1500)

On the 13th level the base of this appears to be 546 feet south of No. 2 shaft. On the 21st level an inclined shaft which follows it down from the 20th level is 855 feet north of the shaft which is 12 feet wide. The apparent dip would be 23°⅔. According to Capt. M. Trethewey they drifted at the 190 fathom level to the east 1800 feet to the northwestern vein. The lode was rich for only 30 or 40 feet.

From the base of the Houghton to the base of the Calumet is (831)

Below this conglomerate the old mine map would give us Trap (62), Amygdaloid (22); Trap (100) to (184); Amygdaloid (14), Trap (120) to (418); Amygdaloid (10) feet, but from this point on the mine was

carefully examined and mapped by and under L. L. Hubbard, whose remarks in the mine are put in quotations.

Running totals from base of Calumet

27.

Amygdaloid (3) Sp. 16774
Trap (68) " 16773 (71)

"At about 31 to 34 paces from" the foot of this trap "there is a slide in the east wall of" the 21st "level running from N. W. to S. E. and nearly parallel with a vertical through this level; another like it occurs a few paces farther north. The conglomerate,—or rather the top of the amygdaloid under it, is about seven feet or more higher on the west side. We climbed up above the level just under the old inclined shaft. On the east side the vein wall is grooved and polished for 20 feet or more, the grooves having a northerly dip about 5°. This agrees with two other occurrences of the same kind that I have noticed previously in this mine".

From 685 to 858 N. on the 21st level.

28. Ophite. (98) (169)

Amygdaloid (16) Sp. 16772
Trap (82) Sp. 16771 just beneath the amygdaloid 16772
Sp. 16770 just above the amygdaloid 16769
16770 is finer grained than 16771
From 444 to 665 N. on the 21st level

It is possible that 28 with this makes up the single large flow that often occurs close under the Calumet conglomerate.

29. Ophite. (27) (196)

Amygdaloid Sp. 16769 (1)
Amygdaloidal melaphyre Sp. 16768 (9 paces) (12) (10)
Trap? Sp. 16767 (11) paces
From 377 to 444 N. on 21st level.

30. Ophite. (80) (276)

Amygdaloid Sp. 16766 (5)
Trap Sp. 16765, 16764 (70 paces) (75)
16765 is 1 to 2 mm. mottled?, 16764 is finer
From 182 N. to 377 N. on 21st level.

31. Ophite. (108) (384)

Amygdaloid Sp. 16763, 16762 (7-½)
Trap 16761, 16760 (95)
From 182′ north to 84′ south on the 21st level = 264′ x sin 24°

Total on 21st level from the base of the Calumet conglomerate 26. 858+84=942 x sin 24°=384. A dip of 27° would imply a thickness of 440 feet, and the mine map evidently assumes a steeper dip than 24°. This may be the hanging of the Osceola amygdaloid. It should be between this and flow 35.

32. (109) (492)

Amygdaloid Sp. 16759 at the end of 21st level (9)?
Trap ? (possibly two or more belts) (99)
From 84 S. in 21st level to 25′+N. in 23rd level

33. 59 (551)

Amygdaloid Sp. 16758 (7)
A brown amygdaloid, brecciated with chloritic amygdules
Trap From 25 N. in 23rd level to 103 S. (52)

34. (42) (593)

Amygdaloid (20)
from 103 to 153 S. of 23rd level
Trap (21)
from 153-205 S. in 23rd level

About here should be the horizon of the Osceola amygdaloid, above or below Belt 33.

35. Ophite. (141 say)

Amygdaloid
From 205-215 S. in 23rd level (5)
Trap Sp. 16750, 16751 (63)+(35?)=98+? (734)

To the caved-in end of the 23rd level South, 360′+ at which point the rock is still a well-marked ophite, Sp. 16750, and the mottling is 2 or 3 mm. across, so that the belt must be close to 100 feet thick, for this grain if below the center would be perhaps 35′ from the bottom.

Now the top of the northern-most amygdaloid in the 31st level at 1215, is by scaling at a dip of 24° just 100 feet below the top of this Belt 35. Above it to 1375 is trap. Ss. 16682 and 16681.

Sp. 16681 is fine grained massive ophite. Sp. 16682 is coarser than Sp. 16750, the mottling being estimated as 4 mm. across by the eye. This is about what might be expected over 40 feet above the bottom of the flow, and points to a flow over 80 feet thick. The Kearsarge conglomerate directly below dips 20°48′. The distance between the N. end of the 31st level and the S. end of the 23rd being 1800 feet more or less, a variation of a degree in the dip assumed will mean about 30 feet in the thickness of this belt. So, for instance, if we prolong the lower beds up straight we get a thickness of 220 feet as a maximum, and if we prolong the lower beds down we get 30 feet as a minimum. In such a case the grain indications are of much value. A thickness of 141 feet which we choose means a mean dip of slightly less than 23° and is probably nearer the truth for this bed at this depth. We take 141 feet, in order to make the totals by beds agree with the scaled distance from the Kearsarge to the Calumet at a dip of 24° from 858′ N. in the 21st level to 307′ N. in the 32nd.

36. (18)

Amygdaloid Sp. 16680 (3)
From 1215 to 1207 in the 31st level.
Trap 1170-1207 (15) (752)

37. Ophite. (48) (800)

Amygdaloid (1)
From 1167-1170 in the 31st level N.
Trap Sp. 16679
1055-1167 (47)

Sample of trap taken near lower contact, "the farther north it is the more mottled".

38. Ophite. (26) (800)
Amygdaloid Sp. 16678 (6)
Sample of amygdaloid near upper contact, 1055-1039 in 31st level N.
Trap Sp. 16677 (20) (826)
1039-987 in 31st level N.

39. Ophite. (194) (1020)
Amygdaloid Sp. 16676 (18)
Sample from near top 987-940
Trap Sp. 16675 (16674 bunch of Am.) 16673, 16672, 16671, (176)
Of the samples from this massive trap Sp. 16671 is the coarsest, the average diameter being about 6 mm. I think they tend to a prismatic form 10 mm. long x 4 across. It is supposed to be only 118 (48) feet below the top. Sp. 16674 is seamed and pseudoamygdaloid. 16673 is very full of irregular druses lined with epidote crystals. It may be doleritic but seems more like a vein. Ss. 16673 and 2 represent "seams of coarse rock" "the upper 1 to 2 feet wide, the lower 6 in." The two seams on the east side tend to form a lens although they do not meet in the level. On the east side they are 6 feet apart in the widest part, horizontally. The two thicker seams, 4 feet above the floor of the level are 32 feet apart horizontally, the west side being the farthest north. This, with the belt below, is perhaps the rather persistent heavy belt just above the Kearsarge conglomerate which often lies just between two heavy ophites.

40. Ophite. (103)
Amygdaloid Sp. 16670 (5)
493-505 in 31st level N.
Trap (mottled) Sp. 16669, 16668, 16667 (98) (1125)
Sp. 16669 is 93 feet from the conglomerate (38).
The mottling appears to be 3 to 4 mm.
The contact of the trap and underlying vein is in the roof at the beginning of the 31st level N., and the belt runs say from 230-493 in 31st level N. The amygdaloid at the top while fine grained does not seem to be a very pronounced belt.

41.
Fault fluccan just overlying Kearsarge conglomerate (3) (1128)
Sp. 16664 (Hubbard made the distance from the Calumet 1125' and the total distance from the Allouez 1474+1125= 2599 feet)
Sp. 16697, etc.

42. Kearsarge conglomerate (62)
From the Calumet conglomerate (1190)

Hubbard[1] discusses the identity of the "Kingston" conglomerate with the Kearsarge. This outcrop is really 500 feet (not paces, Irving) south of the quarter post of Section 33, T. 58 N., R. 31 W., and not the center as given by Marvin and Irving and followed by Hubbard, although Irving gives the distance from the Greenstone 4650 feet. Bringing this half a mile north, if we assume it to be the Kearsarge as I think we must, we must increase the dip accordingly to about 35°. There seems to be a number of misprints about this exposure.

As to the slide in the Central, see Hubbard in Lake Superior Mining Institute, 1895, as *corrected* in Volume VI, Part II, page 87. See also pages 85 to 96.

[1]Vol. VI., Pt. II., p. 85.

The Kearsarge conglomerate varies greatly in thickness and is very nearly wiped out by the slide above.

Capt. Tretheway says that the water above it was so salt that it caused itching and sores.

From the base of the Houghton (2021)
" " " " " Allouez (2690)
The 30th level continues the section below the Kearsarge conglomerate which in that level appears to be only 23 feet thick.

43. (136) (136)
Amygdaloid Sp. 16695
From 66.3 to 76 in the 30th level S. (4)
Trap Sp. 16698 (132)
From 76-402 in the 30th level S.
This belt is generally thicker.

44. (82) (218)
Amygdaloid Sp. 16699 (10)
From 402-427 in the 30th level S. grey-green with epidote, quartz, calcite.
Trap Sp. 16700, 16702
From 427-603 in the 30th level S. (72)
The contact between 41 and 42 occurs on both sides of the level and the west side is thrown farther forward, northward.

45.
Amygdaloid 16703, 16701 (8) (233)
From 603-610 in the 30th level S.
Trap 16702 (7) (15)
From 610-640 in the 30th level S.
Below the base of the Allouez conglomerate. (2923)

46. Ophite. (191) (3114)
Amygdaloid Sp. 16704 (20)
From 640-684 in the 30th level S.
Trap (platy) Sp. 16705
From 684-687 end of level which is 252 feet below the Kearsarge or about 2923 feet below the Allouez?

The section from this point is continued by drill holes (1) and (2), the cores examined by Lane, and that of No. 1 by P. S. Smith. Evidently in planning the holes the dip was assumed to continue about 24° as in the mine. In this case drill hole No. 2, the one farthest north, would begin only [6472.+ (184-61) x cot 24°] sin 24° = 2740 feet below the Allouez, that is to say, almost immediately beneath the Kearsarge conglomerate and lapping the belts of the 31st level S. But this dip is too small for:

1. Drill hole 2 and the belts of the 31st level South do not harmonize.

2. The distance from the Kearsarge conglomerate, and what we identify as the Kearsarge amygdaloid would be altogether too small (3073-2690 = 383 instead of 800 or 900 around Calumet or 500 or 600 farther out on the point).

3. Drill hole 2 should lap the top of drill hole 1 at a depth (840+ (61-46) cot 24°) sin 24° = 355 feet, and the belt 2.333-408 is a very characteristic one, the Kearsarge foot. This does certainly not appear in drill hole 1, which does not appear to lap drill hole 2 more than a trifle at most.

4. The holes put down at 66° do not appear to strike the sediments *exactly* at the right angles to the bedding, and the dips measured in vertical drill holes seem to be more. For instance the dip of the d 5 sandstone at 585 seems to be about 34°⅔.

The outcrop of the so-called Kingston conglomerate is wrongly given by Marvine, and following him Irving and Hubbard as Hubbard afterward found being half a mile further north, 500 paces S. of the N. quarter post (instead of center) of Sec. 33, T. 58 N., R. 31 W. This reduces the horizontal distance from the Greenstone and invalidates Hubbard's arguments as to dips in his Lake Superior Mining Institute paper 1895, p. 86.

6. In the Central mine itself we find the dip of the Kearsarge increasing toward the surface up to 27°.

7. All the correlations of the drill holes farther S. point to a dip in them not far from 35°.

The seven reasons given above are conclusive it seems to me as to the extreme probability that the section covered by the diamond drill cores dips considerably more than 24°. There is of course especially near a line of disturbance like the Central vein much possibility of errors due to unallowed faults and consequent throws.

Referring to the objections above listed:

Objection 1. will be obviated by any dip over 26°.
" 2. " " " " a dip of about 27°.
" 3. " " " " any dip over 35°.
" 4. " " " " dips from 30° to 40° apparently.
" 5. " " " " a steeper dip depending on the exact location and elevation of the outcrop in question, relative to the Greenstone opposite.
" 6. Will be obviated by a dip of 27° or a little more.
" 7. Will be obviated by a dip about half way between 24° and 35°.

On the whole it seems to me most fair in continuing the section to assume an average dip for the whole width from the Allouez thus far of 27°. This will satisfy objections 1, 2 and 6, and allow the indications of steeper dips in the drill holes to balance the flatter dips of the upper part of the mine.

In such case the top of drill hole No. 2 will be about 3064 feet below the Allouez conglomerate if the strike be N. 72° E., or if the strike is, as is most likely N. 80° E., 3034 ft. An average dip of 29° to 30° would make the distance 3300 feet or so. This would make the bottom of the first flow at 80 feet, 3114 feet below the Allouez conglomerate. If we suppose that the bottom of Belt 43 is the top of Hole 2 it would make it (3114-2923) = (191) feet thick.

Now the grain in drill hole 2 seems to decrease steadily from the first samples with a grain of 5 mm. so that the belt is not less than (81) feet thick, and there is nothing inconsistent in supposing it to be the lowest belt exposed in the mine. It is possible it represents the base of the large ophite under the Kearsarge conglomerate 250-300 feet thick (at the Mandan 268).

(46 bis) (continued) Ophite to Cend. 2.80
At 39, 48, 67, 71 feet, 5, 2-3, 2, and 1 mm. mottles.
0-39 is over burden of sand?
Base below base of Allouez conglomerate (3114)

47. Ophite. (16)
Amygdaloid d 2.80-86 (6)
With a little copper.
Trap d 2.86-96 (10)
Mottles up to 2 mm.

48. Ophite. (10)
Amygdaloid d 2.96-97 (1)
Trap d 2.97-106 (9)

49. Ophite. (16-½)
Amygdaloid d 2.106-115 (9)
Trap d 2.115-122'4. (7½)

50. Sediment d 2.122'4"-124'9". (2-½)
Red shaly sediment with amygdaloid scoria. The bedding is not over 5° to 10° from being at right angles to the hole.
Base below base of the Kearsarge conglomerate (469)
" " " " " Allouez " (3159)
Cf. F J d 4,463, and M 7 d 4 S. 336' which is about 1625' below the C. & H., and 470 below the top (?) of the Kearsarge, also R. 1, 4, 535 etc. Between this and the Wolverine there is generally a distinct tendency to be feldspathic.

51. (14)
Amygdaloid d 2.124'9"-129 (4)
Trap d 2.129-139 (10) (483)

52 Ophite (31)
Amygdaloid d 2.139-146 (7)
Coarse, feldspathic, with forms suggestive of porphyritic crystals, chloritic
Trap d 2.146-170 (24) (514)
The bottom contact makes an angle of 7:2 with the drill core. The dip inferred would be 40°.

53. Feldspathic ophite. (73)
Amygdaloid d 2.170-179 (9)
Rather coarse and feldspathic with rare amygdules at 179; copper at 202. This has rather the structure of the Kearsarge foot. Cend. 2179 = F. J. 4,608?
Trap d 2.179-243 (64)
At 204'6" though coarse only *faintly* ophitic. The mottling at 222 is uncertain, appearing to be about 5 mm. (much too coarse for the ordinary augite mottles. This mottling continued to 237).
Base below base of the Kearsarge conglomerate (587)
" " " " " Allouez " (3277)

54. Kearsarge (Foot)? a porphyritic ophite? (90)
Amygdaloid d 2. 243-247 a red amygdaloid with red feldspar phenocrysts and small red amygdules.
d 2. 247-251 similar with red bordered green centered amygdules
d 2. 253-257 hard fine grained amygdaloid

d 2. 257-259 coarser seamed?, with copper
d 2. 259-264 not very amygdaloid but very fine grained and porphyritic and brecciated.
d 2. 264-273 amygdaloid but coarser with much sludge and probably in or crossing a fissure.
d 2. 273-276 Heavily veined with calcite (33)
Trap d 2. 276-287 Slightly amygdaloid, but ophitic, 2 mm. mottling at 297.3 mm. mottling at 308 (a coarse ophite), and still markedly ophitic at 324, but growing finer. Then at 333+ very chloritic and full of slickensides, probably crossing a fault, not the bottom of the bed. But we have a return of amygdaloid (57) (677)

55. Kearsarge (a porphyritic) ophite. (75) (752)
Amygdaloid d 2.333-338. Well-marked with red amygdules and phenocrysts or porphyritic crystals and groups of plagioclase up to 20 mm. long (5)=?
Trap 338-408 (70)
Below 338 the regular Kearsarge trap comes in a relatively undisturbed state. At 348 mottlings 2 mm., phenocryst 6 mm., at 361 mottlings 2 mm., at 374 it appears finer grained, more feldspathic, faintly amygdaloid at 376-381.5, there is a little copper; at 396-400 the mottling is still about 2 mm.
It seems probable that here there is some disturbance, especially at 333 and consequent repetition. Pretty surely 333-408 does not show the top of the bed, nor does 243-333 show the bottom. There may here be two or three or more flows with marked phenocrysts, instead of the one often found farther south, or Belt 55 may be merely the lower part of 54 repeated. This I am really inclined to think, yet it is hardly safe as yet to strike out a number and the thickness corresponding from the column.

56. Sediment. Red sandstone or shale the Wolverine No. 9? (0)
There is a little sandstone at 408 and again a little below 411, associated with a fine grained well-marked bottom contact.
Base below base of Kearsarge conglomerate (752) ft.
" " " " Allouez " (3442) "
Cf. (853) from Kearsarge to Wolverine at Wolverine, (893) at the Arcadian, 689-750 at the Mandan, 825 at M 7 S.

57. Ophite.
Amygdaloid d 2. 411-415 (4)
Poor.
Trap d 2. 415-442 (27) (31)
Base below base of the Wolverine sandstone (31)
At 418 and 427 mottles 1-2 mm. and 2 mm.
Cf. at the Arcadian d 2.178-262

58. Ophite. (250) (281)
Amygdaloid d 2. 442-445 (3)
Amygdaloid ill-defined and brecciated with epidote seams.
Trap d 2. -498+=(43)?
At 457 the mottles are 2 mm. across
This we assume equals 8.42-314 letting 8.42=2.457, because

elsewhere we find a very heavy trap immediately under the Wolverine sandstone, e. g. Mandan 6.239-649 M. 7.5. S 58-333. Cf. Arc. Belt 68, 20.315-464.

Central mine, drill hole 1. 562 feet deep, dip 66° to S. 18° E., elevation (about 1291 A. T.) 46 feet above datum. This is probably so nearly at right angles to the beds that no correction for thickness is necessary. 840 feet horizontally below drill hole 2.

1. Ophite (overburden?) to 27 (27)
2. Breccia d 1. 27 to 28 (1)
3. Melaphyre d 1. 28 to 43 (15)
4. Amygdaloid d 1. (43-51) and
Ophite d 1. -67+? (24)
The amygdaloids above and below are scoriaceous; at 62 feet there is a 1 to 2 mm. mottling.
5. Confused scoriaceous conglomerate and green epidotic sandstone with sludge. (d 1. 68-120)? (52)
At 88 feet there is a sludge of calcite and epidote; at 93 fine grained trap; at 97 epidote and copper; at 108-112 a fine grained white banded sandstone which dips against the drill cores 2:8 so that the dip would appear to be (90-66°+14°) 38°? To 120 feet remains fine grained sandstone, and it occurs frequently in the next few feet below. I take this general horizon to be not far from that of the Wolverine sandstone No. 9.
6. Trap, boulder or wedge of ophite? d 1. 120-126 (6)
7. Sandstone and conglomerate. d 1. 126-130+ (4+)
126-130 sandstone, the conglomerates with red scoria and green sediment; at 130 a fine grained ophite; at 138 a fine grained sediment again; at 144 to 146 a fine grained green sandstone full of very fine copper; at 146-151 a fine grained trap; at 151-153 a fine grained green sediment with banding at 6:8 (i. e. 90°−37°) with the hole; at 153 to 158 trap again; 158-160 green sediment; to 162 green sediment and amygdaloid; to 166 trap and from here on it seems to be a normal ophite. The above may be more or less of fissure filling, the division is quite uncertain and resembles d 8. 314 to 350.
8. Ophite, etc. d 1. 130-158 (28)
9. Ophite with green sediment and amygdaloid top. Central d 1. 158-259 (101)
It is suggestive that something is wrong that the mottling is not as coarse as it should be for a bed this thick. The hole may have gone astray. We have at
171, 178, 188, 190 to 208 coarsest with mottles of
1–2, 2, 2 mm.
If the dip of the beds were steeper, say 60° to 70°, this would be quite normal.
From 244-246 brecciated epidotic.
10. Ophite, with a top of scoria and sediment.
d 1. 259-264 scoriaceous amygdaloid and conglomerate
d 1. 264-268 trap
d 1. 268-272 scoriaceous with red sediment

d 1. 272-282 amygdaloid
d 1. 283-285 sediment
d 1. 286-291 ophite 351 (92)

11. Sediment d 1. 354-357 (3)
12. Melaphyre d 1. 357-363 (6)
13. Ophite. Amygdaloid to 367
Trap to 371
Fissured somewhat amygdaloid to 385
Ophite growing finer to 314 (51)
14. Amygdaloidal melaphyre, d 1. 414-416 marked amygdaloid
-421 fine grained trap (7)
15. Ophite d 1. 421-456
A red amygdaloid with prehnite seams to 426, then more compact and at 445 faintly ophitic.
16. Ophite d 1. 456-500 (44)
Amygdaloid d 1. 456-459
459-461 Epidotic seam, more or less amygdaloidal to 446, then ophitic to 500 feet
17. Ophite. Inclusion bed? d 1. 500-550 (50)
d 1. 500-505 amygdaloid, and at 506, 511, and 515 to 522 more amygdaloid streaks, and at 529 a curious amygdaloid seam or bomb.
18. Ophite, beginning with scoriaceous amygdaloid.
d 1. 550-555 (3+)

The fuller descriptions of P. S. Smith follow. Most of the descriptions are brief and it may be well to give detailed descriptions of this one set.

Examination of Central mine drill cores, Hole No. 1, by Philip S. Smith.[1]

Label on Box, Hole No. 1, 0 to 112 feet. Stencil number No. 1.

The rock saved by the drill is a dark brown, moderately coarse grained trap showing some alteration and decomposition of the various constituents. Chlorite in small quantity is present. Following this is a gravelly sand which looks as though it might have been produced by rock very similar to the above, the larger fragments showing the same brownish, red trap characters. Calcite is seen also to be present in this sand. The lower end of this portion from the surface to 27 feet is represented by a particularly brecciated sort of rock, in which there is a considerable amount of epidote. The trap fragments which constitute part of this breccia are of a reddish color and portions of the trap show a considerable number of small, rather regular amygdules. These trap and amygdaloid fragments are seen to be abundant in a matrix of a lighter, reddish color which on fresh fracture appears as a lightish gray colored rock. The trap fragments are irregular in outline and the corners are sharp and angular.

27 to 28. The rock consists of a breccia the same as that previously described with the exception that the amygdaloidal fragments are much more scarce. The trap fragments are extremely angular and are surrounded by the same bluish gray matrix. This matrix in one instance has apparently split one of the trap pebbles in two and appears like a little sandstone vein in the drill core. Following this

[1]The terms horizontal and vertical as used of veins in this paper refer to the attitude with respect to the core. Thus a horizontal vein is understood to mean a vein parallel with the shorter axis of the core, thus running at right angles to the direction of the drill hole and parallel with the formation. By vertical vein we mean a vein cutting the drill core parallel with its longest axis, thus being parallel with the plane of the drill hole.

breccia is a dark, reddish-brown trap with ball-like segregations of chlorite. These balls of chlorite separate out from the ground mass on fracturing. Cross section of one of these chlorite aggregations shows in the center laumontite surrounded by chlorite.

28 to 29. This is the same sort of rock as the preceding, with the exception that the bunches of chlorite are less evenly dispersed throughout the mass and at the base the rock becomes more solid trap and free from this pseudoamygdaloidal character.

29 to 31. Practically the same kind of rock as the latter with the bunches of chlorite sparingly scattered throughout.

31. Three veins of a chloritic mineral intersect at varying angles from nearly horizontal to nearly vertical. The rock has practically the same character as the preceding with the bunches of chlorite becoming less frequent.

31 to 33. Shows a decreasing amount of chloritic material throughout the series.

33 to 43. Practically the same as preceding, the amount of chlorite in bunches varying greatly in different portions of the core. The color also varies somewhat but for the main part keeps its characteristic reddish brown iron stained character.

43 to 48. A breccia much the same as the one occurring at 27 feet, consisting of reddish brown trap fragments held in a bluish-gray, sandy ground mass. There is a considerable amount of calcite present in the trap, both as filling for small amygdules and as veins. The contact between the two is very rough and irregular. If the core portion is a sandstone it has been considerably baked by the presence of the trap. The texture of the sandstone is very fine grained. The character of the grain or its structure can not be determined. Chlorite is present to some extent in the trap fragments. Near the bottom of this member there is a distinctly chloritic band of an inch or so in width which occurs at an angle of about 45° with the core. The contact of this with the reddish trap which is adjacent to it is outlined by a thin film of calcite along it and the walls of the trap. This abundance of chloritic material persists nearly to 48 feet where the rock again becomes very similar to that from 30 to 43 feet, i. e., it is a reddish-brown trap with scattering bunches of chlorite throughout. Some of these chloritic masses also contain calcite of an earlier origin. Small veins of calcite ramify out from these bunches. Specimen No. 1 from this locality shows a small brecciated face to be about a quarter of an inch in diameter which is of a lighter color than the enclosing rocks. This portion is somewhat more porous than the hard, even textured trap on both sides. In this lighter colored portion are fragments of the wall rock from both sides. These fragments are very angular. Separated from this small brecciated band by several inches of a reddish trap already described is another band also of brecciated material. The main fragments here consist of the amygdaloidal fragments of trap and a considerable amount of calcite and epidote. Conspicuous in this fragmentary core is an amygdaloidal pebble which shows a coating of epidote around which is calcite. This may possibly be looked upon as amygdular filling. Drusy cavities occur in the chlorite portion which contain small indeterminate crystals. The rock below this becomes again a fine grained reddish trap but the chloritic masses are not nearly so abundant and the principal amygdules seen are filled with calcite. Some chlorite, however, is present. Separated from the preceding bed by presumably the same distance that separated that band from the preceding, is another brecciated band in which the characteristics are very much the same as those seen in the preceding; the cement in this case, however, is more of a calcitic material and the appearance of the rock leads to the belief that it is more of the type of vein breccia than igneous breccia. Underlying this breccia again occurs reddish brown trap

with a fair amount of chlorite and more amygdules filled with calcite. Veins filled with calcite also irregularly intersect the mass.

50 to 53. At 50 occurs a very reddish trap with numerous bunches of chlorite which stand out in prominent distinctness against the red back ground. There is also running through this reddish portion a greenish gray fine grained rock whose exact character is indeterminate. It irregularly intersects the reddish trap and the contact between the two shows numerous filaments of the greenish gray rock penetrating into the reddish brown. Horses of the reddish brown are also included in the greenish gray material. This gray rock appears to be similar to the greenish gray matrix of the breccia described near 27 feet. This band is presumably about six inches wide and is followed by a series of traps exhibiting much the same character as the preceding traps. Bands of chlorite, however, do not appear to be as large as the former.

53 to 58. The rock becomes somewhat less reddish than the preceding near the top and the cores are not in a much better state of preservation and the grain of the rock becomes slightly coarser. About in the center of this member the chloritic bands more or less completely disappear and the rock is much coarser grained allowing the determination of some of the constituent minerals but the rock shows considerable decomposition and the core reserved is quite broken up and remains only in small fragments. Towards the base it takes on a pseudoamygdaloidal structure for a few inches in which the amygdules are filled for the most part with chlorite and laumontite. Some calcite also appears and the area in which these amygdules are the most frequent is seen to be heavily charged with epidote and chlorite.

58 to 66. A dark moderately fine grained trap with a few chloritic bunches. Rock intersected by numerous small fragmentary veins of laumontite. In portions the chlorite has been altered into an iron compound which gives the reddish blotched appearance to the core.

66 to 68. About the same as preceding of slightly more reddish character. The base of this is represented by a sand which is too finely comminuted to make out the various minerals, but which has a very distinctly iron stained appearance giving it quite a red color.

68 to 78. At the very top of this member is an amygdaloidal trap, the amygdules being rather small and filled for the most part with a chloritic material. There appears to have been some brecciation in this case and the matrix which cements the various fragments together is of a lighter gray color than the trap fragments already mentioned. There is a considerable amount of chlorite, not only in the form of amygdules but also apparently in the lighter colored portion of the rock. Below this is a small band of dark, very massive trap of such fine grain that the various minerals are not distinguishable, which is followed by another brecciated band about the same as the preceding with a considerably greater amount of chlorite than that one. The cavities in the amygdaloidal portion are filled with quartz and calcite. The ground mass of the amygdaloidal fragments is of a very reddish color. This band is about 4 or 5 inches in width and is followed by a dark massive, slightly greenish band with some chlorite which in many instances has been altered to an iron mineral and appears as a reddish stain upon the rock. Succeeding this is a reddish brown trap with bunches of chlorite and sometimes calcite. This rock has about the same color as the fragments in the amygdaloid. There is a considerable amount of epidote and chlorite (principally the latter), present, and the whole series for a couple of feet shows more or less of the brecciated character, and the filling in many cases between the separate fragments is made up of greenish chlorite. In many places the rock becomes distinctly epidotic or chloritic and this is the only

mineral seen in may instances. The portion represented by this extremely epidotic part is perhaps eight inches in width. It is followed by a reddish brecciated band and then occurs some more epidotic rock for another foot. This in turn is again followed by a reddish brown trap moderately fine grained and then comes a third band of epidote of less width than either of the two preceding ones. This member is for the most part represented by small fragments from 68 to 78 feet, showing the fragmentary character of the rock and its inability to stand up under the influence of the drill.

78 to 88. The following series also consist of much broken up rock and the drill cores are in a very fragmentary condition. The top of this series is a reddish brown trap with the usual bunches of chlorite present. This is followed by reddish sand and fragments up to 81 feet where a brecciated rock, consisting of fragments of this same reddish trap, cemented together by chlorite and calcite, appears. The trap is seen to be broken across by numerous veins of calcite which may completely separate the various parts of a single fragment. This brecciated band contains a good deal of chlorite also and is succeeded by a very greenish layer composed almost entirely of epidote and chlorite. This is followed by another breccia band and this is underlain by another chlorite band which is of considerable thickness and alternates with various small portions of trap. This chloritic phase extends to nearly 88 feet; in portions being nearly all altered epidote, in other portions showing small brecciated bands. From 88 to 98 the top of this member consists of a much brecciated band, the various fragments being separated from each other by chlorite and calcite. In some portions there are drusy cavities in the chlorite in which small quartz needles protrude. The calcite seems to fill amygdules in this rock and the relative age of the two minerals is rather difficult to determine. This band extends for about four feet and is then underlain by a dark brown trap with a few small bunches of chlorite. The bulk, however, of the chlorite that occurs is disseminated in small fragments throughout the mass or does not appear in as large segregations as usual. About two feet from the bottom of this member occurs a highly epidotic band of about six inches in width which is underlain by dark brownish trap.

99 to 106. About the same as the preceding and with the amount of chlorite somewhat greater and collected together in larger bunches in the mass. The texture of this rock is moderately fine grained and the various members are not easily distinguished with the exception of the chlorite. Veins of calcite intersect this member in small number. At about 101 feet occurs a greenish chloritic rock with glittering faces of what is presumably calcite throughout it. The epidotic portion is represented by the core as about a foot in thickness. This is followed by a rock much the same as the preceding but with the chlorite in the upper portion in much greater excess than the former. The rest of this section is represented by comminuted fragments principally in the shape of sand which are barely determinable. The color of the sand is for the most part a brown, earthy color but it is in too small a state of subdivision to determine the various minerals.

106 to 112. A small band of chloritic material up to an inch or so in width followed by a brownish, much decomposed trap with some occasional bunches of chlorite. Following this nearly to the bottom of the member is a series of fine grained rocks which contain a considerable amount of epidote scattered with great evenness throughout the mass. This portion seems to show a distinct stratification which is due to a color banding depending upon the amount of iron present and the state of concentration with which the epidotic portion occurs and the so-called bands of stratification occur at a slight angle with the core, the angle of intersection varying considerably in different specimens. This member is cut by

numerous calcite veins of small size. The extreme bottom of this hole is made up of a dark fine grained trap with bands of chlorite. The trap has a slight bluish to purplish cast and contains quite a considerable amount of calcite. Calcite also is seen in small hair-like veins intersecting the ground mass. As a whole, all the cores from this hole have been very much broken up and many of them in the shape of sand. This may be due to the closeness to the surface, and is also in large part probably dependent upon the brecciated and fragmentary character of many of the members of the series.

Label on Box, Hole 1, 112 to 209. Stencil number, No. 2.

112 to 122. A grayish epidotic rock very similar to the one just preceding but not showing any of the stratification noted in the last. This extends for about a foot and a half and is then followed by a dark very fine grained trap with considerable amount of chlorite. This chlorite has in many instances been rubbed and the rock looks as though there had been some slickensiding through it. The bunches of chlorite are very irregular. This extends for about a foot and a half and then comes another chloritic or epidotic layer. On fresh fracture this rock shows areas of strong chloritization followed by darker layers in which there is not such an abundance of chlorite. The whole appears to show but slight tendency towards stratification as represented on cross-fracture. This stratification is seen to be due to the amount of epidote present. This yellow epidote band is rather thin and is followed by a brecciated band, the fragments of which are shown in an epidotic matrix. Succeeding this is a dark, very close, fine grained trap with some large calcite faces gleaming in cross-section. The sand from this rock is of a reddish color and much iron stained. Towards the base of this member the trap becomes more dark colored and the bands of chlorite somewhat increase in size.

122 to 132. The upper portion of this rock consists of a brownish trap with a considerable amount of chlorite scattered through the ground mass as well as appearing in local segregations of that mineral. This is followed by a greenish epidotic layer of two to three feet in thickness in which the epidote is seen to have been considerably altered towards a chlorite and to be in large part associated with calcite. The lower portion of this epidotic band runs into a brecciated portion which shows the same characteristics as many of the breccias previously described. The trap fragments included in this breccia are of a reddish color rather darker colored in the center than near the contact with the epidote. The epidote occurs for the most part as a matrix which holds the trap fragments. Calcite is also sparingly found throughout this portion. The epidote has numerous drusy cavities in which perfect crystal forms, both of quartz and epidote, are frequently noted. This brecciated band is about two feet in thickness and is followed by a small amount of epidotic trap which has a reddish green color due to the presence of the amount of epidote which is evenly distributed throughout this mass. Following this is a dark, moderately coarse grained trap which is succeeded by a lighter greenish gray sandstone-like rock which shows slight evidence of stratification. The contact between this part and the trap is seen to be very irregular, the trap entering it in irregular apophyses. The direct contact between these two members is marked by a reddish decomposed iron band which brings out the contact very prominently. The color of the underlying rock is considerably influenced by the amount of epidote which is present. Small secondary calcite faces appear in the lower part. This band is relatively thin, not exceeding two or three inches and is followed by a very dark trap.

132 to 142. A dark, rather fine grained, nearly black trap with few minerals

distinguishable in core, scattering bands of epidote present in the hand specimen. Thickness of this about three feet. Then comes a narrow band of epidote associated with some bluish gray rock previously noted in other breccias. This seems to be a thin brecciated band as shown by the presence of reddish amygdaloidal pebbles cemented together by a fine matrix of epidote and this gray sandy rock. The epidote occurs also in a band about an inch thick cutting obliquely across the core, then followed by dark, moderately fine grained trap similar to the preceding for about two feet where we again come into an epidotic horizon. The trap at this point is very greenish on account of abundance of epidote. In certain portions the epidote has become localized into large bunches, in some places forming the entire portion of the core. This is succeeded by a grayish brown trap with a few iron stains which probably remain pseudomorphic after some altered mineral. Chlorite although present is not very abundant. The bottom of this member is marked by the presence of another epidotic band.

142 to 154. A greenish, heavily impregnated epidotic rock cut by small veins of calcite, the texture of the whole being very massive and breaking with a subconchoidal fracture. Practically the only mineral distinguishable throughout this portion is the epidote and its alteration product chlorite. This is followed by a dark brown trap with a considerable amount of dark green chlorite present in large abundance. This chlorite is more abundant towards the top of the series than lower down. This reddish brown trap extends for about ten feet and is then followed by another epidotic portion to the bottom of the member. This epidotic portion is in all respects practically similar to the preceding but is cut by numerous calcite veins as well as a brownish vein which appears to consist of quartz or which may be calcite, as from it radiate out many small branch veins which are filled with calcite. There seems to be a slight color banding in the epidotic portion parallel to this brownish part which intersects the core at an angle of about 25°.

154 to 162. Grayish green, very fine textured rock in which the structure is not evident. The rock is a very dense, compact one and has been cut by some calcite veins which causes it to break into angular fragments. The thickness of this band as represented by the cores is only a few inches and it is succeeded by a dark brown trap with considerable epidote such as has been previously seen in this cross-section. This trap extends for a couple of feet and then is succeeded by another epidotic portion which extends for about one foot. The contact between this epidotic portion and the underlying rock is represented at 160 feet by specimen No. 1. The rock in contact with the epidotic portion is an amygdaloidal rock, the amygdules being of rather small size and somewhat irregular outline. Amygdules filled with calcite and laumontite. Considerable chlorite is present in the amygdaloid. The amygdaloidal portion is seen to extend into the trap for a distance of about one-half to three-fourths of an inch only. Away from the contact the rock rapidly becomes fine grained trap with a few scattered bunches of chlorite.

162 to 172. A very dark grained, massive rock considerably broken up as represented by the drill cores, containing only a small amount of chlorite, towards the base becoming somewhat luster mottled. Its poikilitic character is seen to be very fine in character, the small luster mottled portions being only a fraction of an inch in diameter.

172 to 190. Trap very much the same as preceding, slightly coarser grained with a dark reddish color or nearly black for the most part. The luster mottling is distinctly noticed throughout this series although still of a very small size. The cores representing this portion of the whole are considerably longer and stronger than those of the other portions but still the rock shows a decided tendency to break up. The lower portion of this member contains somewhat more chlorite than the

upper part but is considerably more broken up than the upper portion. Veins of calcite are practically wanting in this part and are only rarely seen cutting the core at a rather high angle.

190 to 209. Rock practically the same as preceding with a less decidedly black color, approaching nearer to a reddish brown. The upper portion of this series shows the same luster mottling on the same small scale throughout all the cores. In the central portion of this member the rock becomes slightly more epidotic, but the epidote appears to be a vein cutting across the formation. In some instances there is a large amount of chlorite and parts of this chlorite appear to afford a slickenside surface.

Label on box Hole No. 1, 210 to 299. Stencil number No. 3.

209 to 219. A dark trap somewhat more poikilitic than preceding with faces on which chlorite appears cutting the core at an angle of about 45° but with small amount of chlorite otherwise through the mass, succeeded by lighter brown trap (showing less poikilitic markings) most of which is preserved in the drill record merely as sand. This sand is of a light brown earthy color in which the fragments are seen to be of practically the same character as the faces of the rock immediately above. Towards the base the poikilitic structure again appears rather predominant but the size of the mottling is rather small. The trap grades towards the base into a darker, more compact trap in which about the only minerals recognizable are the cleavage faces of the augite. Chlorite is seen abundantly along joints on the face of this trap and towards the extreme base the rock takes on more of the greenish cast due to the presence of the evenly distributed epidote.

219 to 229. A somewhat coarser luster mottled trap than preceding with a dark, nearly black color. Considerable calcite, but few veins of calcite were seen cutting the mass. On fresh fracture the augite faces are about the only minerals to be distinguished. Chlorite is seen abundantly on joint faces of a black lustrous character. Towards the base of this member the sand derived from this rock is of the same greenish cast but the rock still appears to maintain its black color. Chlorite is seen abundantly throughout the ground mass of this rock.

229 to 230. Rock very similar to preceding but with the luster mottled areas much more closely crowded together and of smaller size. Seams of chloritic material cut the rock irregularly in all directions. Chlorite is also seen abundantly throughout the ground mass. Color on fresh fracture is dark, trap rather massive. The sand from the same from near the base of the series takes on a much lighter color but does not show the green tint noted in the preceding. Again all the drill record preserved in this part is in the shape of sand and small broken up fragments of core so that the record is very unsatisfactory for this portion of the whole.

239 to 249. A greenish much more epidotic trap, the epidote seeming to show rather a sharp line of demarkation from the preceding trap. The sand from the same is of very greenish color. Veins of quartz and calcite cut the bed rock and branching strings of the same material give the green epidote almost a brecciated appearance. These strings seem to radiate out in all directions, in some cases the vein filling enclosed portions of the green epidotic rock. The distinctly epidotic portion extends for about three or four feet and is then succeeded by a dark greenish trap but the presence of epidote is plainly to be noted in this rock and shows that it owes its color entirely to the presence of this mineral. Small amygdular cavities are noted being filled with calcite. These amygdules have a regular outline and vary considerably in size. The whole mass is seen to be cut up by a net-work of

calcite veins which as a general rule extend parallel with the longer axis of the core. This epidotic trap extends for about two or three feet and then the amount of epidote gradually diminishes and the trap becomes more of the ordinary dark brownish variety. Sand from this portion of the record shows a reddish iron stained character. Bands of more or less epidotic trap occur throughout this part separated from each other by bands of varying thickness of a reddish to a brownish trap. Below the epidotic portion, about 247 feet, is a dark, very fine grained, massive trap, nearly black in color, with a considerable amount of chlorite on fresh fracture. Succeeding this is a member of more or less luster mottled trap of much the same character as the preceding portion of the column. The luster mottling in this member is of rather small size and the various augite crystals are closely crowded together. Chlorite is abundantly present and seems to show that some slipping movement has taken place along it on account of the curving and striation on the surface. Bunches of chlorite occur localized throughout this member but for the most part it does not occur in the bed of the rock, being rather limited to joint faces and planes of this character.

249 to 259. The upper portion of this member consists of a trap of a general darkish color, the sand from which is a somewhat lighter rusty brown and the trap is moderately coarse grained and shows a slight luster mottling. The luster mottling is, however, very small in size. Towards the central portion of this part, the mottling becomes somewhat coarser and the rock is of a much darker color than the preceding and individual augite faces are easily distinguishable and the whole mass has a much coarser texture than the upper portion. The sand from this portion of the bed is of a brownish earthy color with considerable amounts of limonite, probably due to the alteration of some of the iron constituents throughout it. Calcite fragments are also to be distinguished in the sand; some chlorite is present throughout the cores, but it is seen in no large bunches. The amount of luster mottling seems to locally vary, here and there heavily luster mottled bands being separated by bands much less poikilitic. In the portions which do not exhibit the luster mottling the trap is seen to be a very hard, dense, black structureless trap.

259 to 268. At the extreme upper portion of this member the luster mottled trap gives place in large part to ordinary trap which seems to show considerable amount of irregular color banding. Portions of this dark, rather massive trap are seen to be cut by a lighter colored rock which cuts it in irregular apophyses. A light colored rock appears in No. 7 of this series to be indurated into the trap. This light colored rock is a very dense, massive rock showing no evidence of structure other than as stated. The presence of this lighter gray trap has in some instances given the darker trap the appearance almost of brecciation but they seem more like small dikes or veinlets cutting the mass than true breccia. This phase only extends for a foot or so, and then is succeeded by a very dark, rather massive trap with a few amygdules, the amygdules being filled with calcite for the most part. Very irregular blotchings are noted, however, on the shorter core which are filled with chlorite. Succeeding this portion comes another band very similar to the preceding and showing the same brecciated appearance. The dark trap in some cases in contact with the lighter rock shows amygdaloidal cavities near the contact and becomes, further removed from it, a dark massive trap. The fragments are rather irregular in shape and show sharp corners. This phase appears to persist to 264 feet, where it is underlain by a dark greenish, nearly black trap, with considerable amount of chlorite on jointed surface. Some chlorite is also present in irregular bunches throughout the mass. On the upper portion of this member the rock seems to be considerably decomposed and the minerals on the joint faces

exhibited are laumontite from which small strings of calcite radiate. These calcite veins often times appear to be also in the form of gash veins and some of them apparently show a slight off-set. There are a few irregular amygdules also which are filled with calcite.

Near the lower end of this member the trap becomes somewhat less dark in color but the amount of chlorite remains about the same and is easily recognized by its black shining color on many of the joint faces. Veins of calcite frequently intersect this member. At the extreme bottom of this member the rock becomes much more greenish and is cut by large veins of calcite and laumontite. Chlorite is abundantly present throughout this portion, both in regular fragments and also evenly distributed throughout the ground mass.

268 to 278. The upper portion of this member consists of a somewhat brecciated band in which the prevailing color is a reddish brown. Darker fragments of a somewhat amygdaloidal rock, with amygdules filled with calcite are seen, as well as fragments of a dark reddish trap. A considerable amount of calcite in small particles is also scattered throughout the matrix which is of a brownish red, sandy character. The thickness of this bed is only four or five inches, but it is succeeded by a very greenish amygdaloid. The contact between the amygdaloid and the breccia looks to be distinctly an igneous one. Masses of the greenish trap are included in the brown breccia and fragments of a brownish rock enter a greenish amygdaloid in many irregular apophyses. The filling of the amygdules of this amygdaloid consists principally of quartz. Almost all the specimens are intersected by numerous wide veins of quartz with a general direction parallel to the longer axis of the drill core. The thickness of this amygdaloidal band is somewhat under six inches and is followed by a brownish red breccia. The fragments in this breccia appear to be composed for the most part of irregular masses of trap which have been considerably decomposed and altered, the result being a decomposition of the iron minerals or their consequent remains in the shape of a limonitic stain. Calcite is also abundantly frequent throughout the mass. Small veins of calcite radiate out from the larger bands of the same mineral promiscuously cutting the rock in all directions. The texture is rather even and somewhat sandy. On fresh fracture the rock has much the appearance of an amygdaloid with a sandy matrix separating the various constituents. The thickness of this member is 8 to 10 inches and then a brownish green amygdaloidal rock succeeds it. This rock has a considerable amount of calcite as a filling for the amygdules and also some small hair-like veins cutting the rock generally in its longest direction. The color of this member varies considerably owing to the decomposition of the irons. The shape of the amygdules is rather regular but the amygdules are, all of them, small and sparingly disseminated throughout the specimen. In one portion a band about one-half inch wide of calcitic material, weathered to a rusty brown color, cuts the mass at right angles to the drill core. Below this comes a dark, nearly black, greenish trap with a few irregular amygdules of calcite in its upper portion and also a large amount of chlorite scattered in irregular bunches. The calcite seems to be both older and younger than the chlorite, probably marking two stages in the development. Laumontite is also seen on joint faces cutting the rock. The calcite appears in numerous small thread-like veins. Farther away from the contact of this rock with the overlying amygdaloid the rock becomes more distinctly a fine grained, dark trap with few amygdules, and grades from this type into a dark, nearly black, somewhat loosely luster mottled trap. The luster mottling, however, is seen to be rather in the form of local stages, being sometimes present and sometimes almost wanting. This rock is a reddish brown amygdaloid. Amygdules are filled with calcite almost entirely. Small veins of calcite also intersect the rock at a slight angle to its longest

direction. In some instances the amygdules are filled with chlorite and in this instance the chlorite seems to be in the form of little balls which on breaking the rock, leave the matrix and stand out as rounded pellets or leave bullet-like depressions in the matrix. At about 274 feet, the rock becomes much less amygdaloidal, although a few amygdules of small size, filled with calcite still persist. The rock has become somewhat darker colored and lost much of the reddish cast previously noted. Veins of calcite also intersect this member in much the same direction as noted in the preceding. The amygdaloidal portion dies out and the rock becomes dark greenish, nearly black trap with considerable chlorite represented on the joint faces, and also scattered in irregular masses through the mass. The powder from this member is of a somewhat lighter color of a dirty earthy brown in which a few minerals can be seen—specks of calcite and some of an iron silicate. Underlying this is a very massive dark greenish amygdaloid. The filling of these amygdules is in large part quartz, although some calcite is also present. Plates of calcite also glitter throughout the ground mass of this amygdaloid. Small thread-like veins of calcite are seen radiating from one group of amygdules into another and the whole system seems to be thus connected. This amygdaloidal portion seems to be of rather small width as represented by the core, not being over a couple of inches and is succeeded by a breccia in which various igneous fragments are cemented together by a brown sandstone. The sandy portion consists of a dark brownish, somewhat reddish, very fine grained massive rock which is impossible to determine on cursory examination. The fragments included in this consist of a dark reddish brown trap with a considerable amount of chlorite in irregular patches. The contact between these fragments and the sandy material is almost perfectly outlined by masses of calcite.

Reddish trap pebbles are also present. Where apophyses of this latter have extended out into the sandy material there seems to have been a great decomposition of the irons and there is a little halo around each division of a yellow band extending into the yellow color as the matrix. This portion is of rather small extent being indicated in a drill core as merely an inch or so in length occurring at about 277 feet, and then comes an amygdaloid with amygdules filled with quartz of somewhat greenish color, but slightly more reddish than the preceding amygdaloid. From here to the bottom of the member the rock is a trap of a somewhat open texture with amygdules in the upper portion filled with calcite, but passing in depth into a less amygdaloidal portion in which the rock is a greenish, nearly brownish black fine grained trap. Veins of calcite frequently intersect this member parallel with its longest axis. Bands of chlorite are frequent in this portion.

278 to 288. The upper portion of this member consists of a breccia very similar to those previously described which is intersected by numerous calcite veins of small width. The fragments seem to have less angular outline than those immediately preceding. This is of rather small extent and is followed by a dark reddish brown amygdaloid in which the filling of the amygdules is for the most part of calcite. Some prehnite is also present and chlorite is also observed in small quantity. The shape of these amygdules is rather regular. This has a thickness of about one and a half feet and is followed by a dark, rather massive, fine grained trap with bunches of epidote in large rounded fragments. Calcite is also present and where present is seen to be older than the chlorite. The chlorite exhibits the feature so often seen of splitting out of the matrix and leaving impressions in the shape of spheroidal dents in the place from which one of these chloritic balls has been knocked out. Calcite is also sometimes found in the scattered amygdules which occur throughout this mass. In character, however, the rock grades in depth into a dark trap with very few amygdules. At about 283 feet the record is represented solely

by a brownish red colored sand which is of such fine texture that it is impossible to state the rock from which it is derived.

This is immediately followed by a greenish sandstone of very fine texture. This is a questionable member as it is very highly charged with epidote and looks very similar to some of the felsites which were found near the location of the United States Mining Company. The contact between this member and the amygdaloidal portion of the trap which is not connected with it is marked by a reddish, much iron stained zone which extends from the trap into the sandstone. Veins of calcite are seen passing from the trap into the greenish brown rock into thread-like forms. The exact contact with the sandy material is represented by a thin one-sixteenth of an inch band of very massive trap. Above this occurs a line in which amygdaloidal cavities are very frequent. Beyond this amygdaloidal portion the rock appears to turn into a greenish chloritic trap which we have previously noted. The sandy portion is very much decomposed and many of the former minerals are represented by limonitic deposits throughout this mass. No evidence of stratification is observable and it seems highly probable to my mind that it is in reality a sandstone. The thickness of this bed is only about six to eight inches and the lower contact with the underlying trap is represented by a series of amygdules oriented nearly parallel with the contact. These amygdules seem to be confined not only to the trap but also to extend into the so-called sandy member. The amygdules are filled with calcite and are for the most part very small. Underlying this member is a dark, nearly black, rather massive, somewhat decomposed trap, showing almost no constituent minerals with the exception of chlorite. The core preserved from this dark trap is in a very fragmentary condition and shows to what an extent the decomposition had proceeded.

288 to 299. In the upper portion of this member, the trap becomes somewhat lighter although still of a very dark color. The texture remains about the same, very fine grained rock with none of the constituent minerals recognizable. This portion represents various phases, in which there is a more or less decided tendency towards a darker color, but this may be regarded merely as local stages and not as being of any particular importance. In portions of this rock there are small amygdules which are filled with calcite. The irregular blotches of chlorite which occur throughout this whole member appear to have been contorted somewhat parallel to the length of the drill hole. About in the center of this member they cut a small half-inch band heavily impregnated with calcite which has been decomposed into laumontite or possibly some of the zeolites.

Throughout this whole series from 210 to 299 the drill record has been very fragmentary, showing the rather broken up character of the rock. The drill cores are extremely fragmentary, seldom exceeding a couple of inches or so in length, and much is simply preserved in the shape of sand.

Label on Box, Hole No. 1, 299 to 342 feet. Stencil number, No. 4.

299 to 309. A brownish, moderately fine grained trap with some bunches of chlorite of small size. Rock intersected by a few veins running at right angles which show laumontite on joint faces. Also intersected by another series of veins running nearly parallel with the longer axis of the core. Chlorite is often seen on joint surface and some serpentine. Towards the lower portion of this member the rock becomes more dark colored and slightly coarser. In part this coarser textured trap shows slight luster mottling but the luster mottling is rather small in size and does not appear to be continuously distributed throughout the member,

being in patches here and there separated by bands of a grayish brown trap before mentioned.

309 to 317. A trap much the same as preceding but with a slightly more greenish tint. Luster mottling is apparently wanting in the upper portion of this member. The grain is rather fine, none of the minerals with the exception of chlorite being recognizable. Near the central portion of this member there is a four inch band of more distinctly greenish trap which is very fine grained and shows some sparkling calcite faces. Below this portion is a slightly amygdular part with rather large, irregular amygdules, filled for the most part with calcite but with some epidote associated with it. At about 313 the rock becomes much coarser grained and the luster mottling is of marked appearance. The mottled portions stand out in light color against the darker back ground. These luster mottled portions are much larger than any in the column heretofore described. Just below this central luster mottled portion is another slight amygdular band, amygdules of much smaller size and inconsiderate extent filled with calcite. Irregular veins of calcite intersect this member both horizontally and vertically, and oftentimes occur so close together that they have broken up to some extent the country rock, leaving it in horses surrounded by a vein filling. This luster mottled portion has a much more reddish brown tint than the preceding traps. Towards the lower portion of this member the luster mottling is less distinct and the trap is represented by a rather fine grained, very dark trap with a few small cavities filled with calcite. Numerous radiating veins of calcite also intersect the core. Some chloritic bands are observable on the polished surface of the core. The veins of calcite which intersect this member are small in size, rarely being much more than a hair's width in thickness and they seem to cut the rock in all directions and to make it much broken up.

317 to 327. The upper portion of this part is practically the same as the preceding, some laumontite being noted on joint surface or vein fillings, followed at 321 feet by a dark brown amygdaloidal rock, the amygdular cavities being rather of small size and of somewhat regular outline filled with calcite and laumontite. Calcite shows an alteration to the latter mineral. Following this is a luster mottled portion consisting of a dark brownish trap of moderately coarse grained texture with considerable amounts of chlorite present in various sized bunches scattered irregularly. The abundance of the chlorite present has given a somewhat greenish tinge to the rock. Veins of calcite are also noted here and some quartz veins. Scatteringly interspersed through this member occur moderately large, rather regular shaped amygdules filled with calcite. The veins which cut this member for the most part run horizontally with the core. The luster mottling is seen to be more or less of a localized feature, the more mottled portions being separated by bands of a reddish brownish green trap already described.

327 to 337. Much the same as preceding member with the mottling somewhat more pronounced than in the former. Veins of calcite also noted intersecting this member nearly parallel with the longer axis. These veins also carry some quartz. Originally the rock was rather high in epidote and its remnants are seen through the presence of chlorite pseudomorphic after it. Towards the center of this member the brownish color is somewhat less marked and the rock becomes of a decidedly more greenish color. The texture and general characteristics, however, remain practically the same. In cross-section some of these cores show a slight tendency towards banding through flow structure. In the lower portion of this member the mottled character disappears to a great extent and on fresh fracture shows a larger percentage of calcite than in the former portions. This calcite it must be understood does not occur in the form of veins but principally as secondary crystal