Feldspar 0.30x0.07
Augite 5 mm.

Sp. 15255. Hole 6 at 309 feet from surface. Feldspar extinctions 20°-23°-½. Distance from margin 15.9 meters ± .152.

Grain
Olivine .30
Feldspar 0.39x0.06 mm.
Augite 4 mm.

Sp. 15256. Hole 6 at 338 feet from surface. Distance from margin 7.35 meters ± .152.

Grain
Olivine .175
Iron oxide 0.12
Feldspar 0.38x0.04
Augite 2.5 mm.

Sp. 15257. Hole 6 at 362 feet from surface. Distance from margin .296 meters ± 0.152.

Grain
Iron oxide 0.08
Feldspar 0.19x0.03
Augite 1.25 mm.

Sp. 15258. Hole 6 at 363 feet from surface. Margin 363.

363-386; (Ss. 15259-66). Allouez CONGLOMERATE Marvine's 15; (22) (701)

at the top a fine grained "ashbed", with a vesicular texture that appears to be due to contact with the overlying Greenstone; below 374 ft. a more ordinary conglomerate, with acid pebbles of quartz porphyrites and felsites. There are also basic pebbles in it and the cement is calcareous. This must, according to our correlation, be the Allouez conglomerate, or the "slide" conglomerate, No. 15 of Marvine's plate, the most important datum plane referred to in most of the sections.

Base below base of the Mesnard (295).

Sp. 15259. Hole 6 at 364 feet from surface. Very amygdaloidal; chloritic; glassy microlitic; vesicular. Probably preliminary gush of this great flow above, or did not the great flow above heat up the preliminary aqueous or muddy matter, causing the formation of numerous steam bubbles?

Sp. 15260. Hole 6 at 372 feet from surface. Fine grained ash particles of altered glass.

Sp. 15261. Hole 6 at 374 feet from surface. Ash fragments and pumiceous fragments showing numerous small vesicles; not many conchoidal glass fragments.

Sp. 15262. Hole 6 at 377 feet from surface. Fragmental, with calcareous cement.

Sp. 15263. Hole 6 at 378 feet from surface. Fragmental, with calcareous cement and porphyrite pebbles.

Sp. 15264. Hole 6 at 379 feet from surface. Pebble in which there is a hypidiomorphic quartz feldspar ground upon which are sharp phenocrysts of acid oligoclase; along here the bed is very conglomeritic.

Sp. 15265. Hole 6 at 380 feet from surface. A pebble with microlitic ground mass and *plagioclase phenocrysts very distinct.*

Sp. 15266. Hole 6 at 386 feet from surface. Underlying trap? shows sharp brotocrysts of orthoclase? and oligoclase on a brown glass?

Sp. 15267. Hole 6 at 389 feet from surface. Fragments of porphyrite and quartz porphyry; microlitic ground mass changed to poikilitic; the line is not sharp; quite possibly there is some displacement of specimens or an erosion contact.

Grain
Iron oxide 6x4
Feldspar 10x2; 7x2; 20x2, av. .37x.06
Augite 0.

386-394; (Ss. 15268-9). MELAPHYRE. This is a fine grained (8) (8)
trap with no amygdaloidal top. It is somewhat porphyritic, but tends to be ophitic at the center.

Sp. 15268. Hole 6 at 393 feet from surface. Poikilitic augite; feldspar ex. 25°-28°w-17°.

Grain
Feldspar 10x1; 9x1.5; 11x1, av. .30x.03 mm.
Augite 25x25; 48x23; 30x20, av. 1.03x.68 mm.

Sp. 15269. Hole 6 at 394 feet from surface. Much decomposed; rather fine grained; slightly microlitic like 15222; calcite and chlorite interstices.

Grain
Olivine 6; 7; 10
Feldspar 13x3; 18x4; 10x2, av. .41x.09 mm.

394-448; (Ss. 15269-72). PORPHYRITE, amygdaloidal; more (53) (61)

or less amygdaloidal for 21 feet at the top and 12 feet at the bottom. This is really of the intermediate type with a doleritic texture in the middle.

Sp. 15270. Hole 6 at 405 feet from surface. Low angled feldspar? Feldspar very abundant. Ex. 12°-15°w-32°. Margin at 448 ft.

Grain
Olivine 12; 12; 12
Feldspar 30x3; 35x6; 26x5, av. .91x.14 mm.
Augite 25x12; 30x16; 20x16, av. .75x.44 mm.

Sp. 15271. Hole 6 at 415 feet from surface. Poikilitic augite feldspar laths, ex. 20°-24°w-40°, 28°-38°; 27°-28°; 23°-30°.

Grain
Olivine 10; 12; 15
Feldspar 20x3; 23x3; 24x4, av. .67x.10 mm.
Augite 75x56; 55x40; 60x50, av. 1.90x1.46 mm.

Sp. 15272. Hole 6 at 429 feet from surface. Very feldspathic; low angled feldspar? much altered olivine; augite all gone.

Grain
Olivine 6; 7; 9
Feldspar 23x2½; 18x2; 26x7, av. .67x.11 mm.

448-512; (Ss. 15273-7). MELAPHYRE, ophite; not a very (62) (123)

pronounced type; about 8 feet amygdaloidal with calcite veins; feldspathic; slight mottling. At this bed we probably pass over to the record of hole No. II.

Sp. 15273. This may be 15373. Hole 6 at 456 feet from surface. Marked porphyritic; low angled feldspar; little augite; microlitic ground.

Grain
Feldspar phenocrysts 57x43; 40x24; 30x23, av. 1.27x.90 mm.
Augite 2; 1; 1; 2; 3; 6; 5.

Sp. 15274. Hole 6 at 470 feet from surface. The feldspar between the augite patches is generally larger than that enclosed in them.; very poikilitic; labradorite ex.-37°w26°-17°; -13°w-28°; -36°w44°-43°; -11°w27°-37°; -14°w36°-38°. This appears to be an augite porphyrite.

Grain

Olivine 20; 30; 14

Feldspar 43x14; 56x7; 38x14, av. 1.37x.35 mm.

Augite 120x120; 80x80; 75x55, av. 2.75x2.55 mm.

Sp. 15275. Hole 6 at 478 feet from surface. Very coarse feldspar; augite idiomorphic in octagonal long prisms. There are also clouded interstices and an amygdule with laumontite? Feldspar ex. 18-18°; -4°w28°-31°.

Grain

Iron oxide 40x20; 30x25; 44x10, av. 1.14x.55 mm.

Feldspar 72x9; 43x9; 38x34, av. 1.53x.52 mm.

Augite 72x16; 50x7; 40x8, av. 1.62x.31 mm.

Sp. 15276. Hole 6 at 510 feet from surface. Labradorite extinction 24°-28°; 35°-27°w18°-; 20°-30°w42°-34°; 53°.

Grain

Olivine 9; 23x22; 20x10

Feldspar 45x4; 17x2; 20x2, av. .82x.08 mm.

Augite 16x15; 24x20; 23x10, av. .63x.45 mm.

Sp. 15277. Hole 6 at 512 feet from surface. Contact of porphyritic, glassy amygdaloids with underlying ash; the red, compact side is the bottom I presume. Distance from margin 0 feet.

Grain

Feldspar phenocryst 16x2; 11x3; 21x4, av. .48x.09.

The red bottom amygdaloid shows much of a red glass (decomposed, more or less polarizing) with numerous sharp porphyritic crystals running out into a fringe of feldspar trichites. There are numerous small vesicles lined with iron oxide. Trichites about 0.1 wide, 4 to 5 long at times. The rest is an amygdaloidal ash sediment (fragments and plates of iron oxide very common), with a number of amygdules filled with zeolites.

DRILL HOLE No. II.

As no conglomerate appears in drill hole No. II, its top bed, an ophite, must find its correlate at or below No. VI, 386 feet. Hence No. II must find for its first belt of amygdaloid, which occurs from 57 feet to 58 feet, a match in No. VI, not above 450 feet. The first such match is at No. VI, 512 feet, which we have adopted, since that will give us in each drill hole a heavy ophite above and a smaller one below. If we compute the dip from this correlation we find a dip, (12° 10′), nearly a degree flatter than the last computation. If the dip were the same as previously or even steeper, drill hole No. II, 0 feet, would find its correlate at No. VI, 489 feet, or lower, but to say nothing of the fact that the beds in this case would not match as well, observations at the surface show that No. II is close to the top of the Greenstone, or "backbone" ridge and cannot be very much below the great ophite, No. VI, 124-363 feet, which forms it. This of course favors as high a correlation in No. VI as we can get. The extra flat dip might be due to a fault throwing No. VI up, but whether the fault strikes with the strike of the beds, and produces the ridge on which No. VI stands, or runs north, throwing the east side to the south, as analogy would render likely, or runs to the east, throwing the south side up and to the west, is not certain. It might pass through No. VI, near 393 feet. The upthrow, if 13° is the true dip, would be 34 feet only.

2. 0-57; (Ss. 15067-9). MELAPHYRE, ophite; rather feldspathic; 6. 448-512; in the exposures around the drill holes there are agate and laumontite amygdules.

Sp. 15067. Hole 2 at 2 feet from surface. Poikilitic augite; labradorite; olivine

small, changed to *talc;* apatite needles; much iron oxide; feldspar ex. 21°-19°; 14°-11°w42°; 30°-32°w23°.

Grain

Olivine 6x6; 4; 4

Augite 100x95; 90x50; 160x40, av. 3.50x1.85.

Sp. 15068. Hole 2 at 24 feet from surface. Similar to 15067.

Grain

Olivine 6; 4

Augite 130x120; 120x100; 130x80, av. 3.80x3.00 mm.

Sp. 15069. Hole 2 at 56 feet from surface. Drusic; similar; contact possibly here.

Grain

Olivine 4; 5; 8; 4; 11; 7

Feldspar 22x4; 22x2; 22x3, av. .66x.09 mm.

Augite 36x32; 48x30; 60x40, av. 1.44x1.02 mm.

		(123)
57-64; (Ss. 15070-1). MELAPHYRE; fine grained, but of	(7)	(130)

ophite type, equivalent to No. VI, 512-523 feet, which may be more than one flow.

Sp. 15070. Hole 2 at 58 feet from surface. Thoroughly decomposed; amygdaloid a little finer grained. Margin at 57 ft.

Grain

Olivine pseudomorphs 4; 2; 5

Feldspar 18x3; 19x3; 23x3, av. .60x.09.

Sp. 15071. Hole 2 at 63 feet from surface. About same grain as 15067; same type. Distance from margin 64.

Grain

Olivine 6; 7; 6

Feldspar 22x2; 20x2; 21x2.5, av. .63x.06 mm.

Augite 16x14; 14x14; 24x8, av. .54x.36 mm.

64-136; (Ss. 15072-5). MELAPHYRE, Mandan (?) ophite.	(70)	(200)

Sp. 15702. Hole 2 at 78 feet from surface.

Grain

Olivine 14; 19; 18

Feldspar 22x1.5; 17x2; 20x4, av. .59x.07 mm.

Augite 60x40; 50x40; 70x40, av. 1.80x1.20 mm.

Sp. 15073. Hole 2 at 100 feet from surface. Poikilitic; similar to 15068.

Grain

Olivine 14; 9; 10

Feldspar 35x6; 24x4; 28x3, av. .87x.13 mm.

Augite 110x100; 110x90; 126x110, av. 3.46x3.00 mm.

Sp. 15074. Hole 2 at 133 feet from surface. Drusic and, as usual, chloritic.

Grain

Olivine 8; 10; 18x14

Feldspar 17x3; 23x5; 23x3, av. .63x.11 mm.

Augite 116x82; 100x86; 116x80, av. 3.32x2.48 mm.

Sp. 15075. Hole 2 at 136 feet from surface. Fine grained sediment in contact with much altered microlitic porphyrite; augite in granules. Section is of the base probably. The minute feldspar phenocrysts have microlitic trichitic forked additions. The sediment contains fragments of augite and porphyrite. At margin 136.

Grain
Feldspar 12x1; 15x2; 16x3, av. .43x.06.
136; (S. 15075). SEDIMENTARY seam.
136-175; (Ss. 15075-9). HOUGHTON CONGLOMERATE Marvine's 14? (38) (238)

The samples of this bed were but scant as it is described as very rotten, and much of it was lost. At 167 feet a clay seam was noted. The samples are not sufficient to determine surely whether we are dealing with an amygdaloid full of sandstone seams, or with a fault, or with a scoriaceous conglomerate. But this is the proper place for the Houghton conglomerate.

Sp. 15076. Hole 2 at 138 feet from surface. Basic sediment with microlitic porphyrite.

Sp. 15077. Hole 2 at 164 feet from surface. Very feldspathic; contact of fine grained amygdaloidal microlitic porphyrite with fine grained sedimentary tufa.

Grain
Olivine 15x11; 12x10; 10x8, av. .37x.29
Feldspar 5x1; 5x1; 8x2, av. .18x.04
Augite 1; 1; 1; 2; 3; 7.

Sp. 15078. Hole 2 at 167 feet from surface. Fine grained amygdaloid; very sharp olivine.

Grain
Olivine 13x12; 14x9; 9x9, av. .36x.30
Feldspar phenocrysts 30x15; microlites 8x1; 8x1; 7x1, av. .23x.03.

Sp. 15079. Hole 2 at 175 feet from surface. Sediment (in contact with fine grained amygdaloid) with fragments like 15078.

There is a very notable thinning in the distance from base of Allouez to base of Houghton Conglomerate, i. e. (238) as compared with the Central Mine section (p. 264) (640 to 685), but this is somewhat similar to the shrinking in the Greenstone itself.

175-214; (Ss. 15080-2). MELAPHYRE, ophite. There is some (38) (38)

doubt whether this is not one flow with the underlying.

Sp 15080. Hole 2 at 177 feet from surface. Fine grained poikilitic amygdaloid; some olivine green and black; also in little grains; also chloritic spots.

Grain
Olivine 16; 12; 9
Augite 14x13; 15x12; 20x12, av. .49x.37.

Sp. 15081. Hole 2 at 210 feet from surface. Poikilitic.

Grain
Iron oxide 5; 6; 5
Feldspar 17x3; 12x3; 16x3, av. .45x.09 mm.
Augite 47x35; 50x33; 33x30, av. 1.30x.98 mm.

Sp. 15082. Hole 2 at 214 feet from surface. Fine grained amygdaloid; phenocrysts of olivine. Margin at 214 feet.

Grain
Olivine 4x2; phenocryst 20x26; 13x12, av. .55x.63
Feldspar 11x1.5; 9x1; 12x1, av. .32x.17.
Augite 1 or 2?

From base of Houghton Conglomerate (38)
214-271; (Ss. 15083-5). MELAPHYRE, ophite; about 9 feet coarsely (56) (94)

amygdaloidal at the top, and 1 foot at the bottom.

Sp. 15083. Hole 2 at 263 feet from surface. Poikilitic; the olivine turns to dark

red, and finally becomes opaque like iron oxide,—the bowlingite type of alteration. The feldspar enclosed in the augite patches are smaller than that between them.

Grain
Olivine 10; 15x18; 3
Feldspar 30x6; 26x3; 22x7; 35x7; 23x3, av. .£0x.17
Augite 29x20; 63x44; 45x40, av. 1.37x1.04.

Sp. 15084. Hole 2 at 270 feet from surface. Fine grained poikilitic.

Grain
Olivine 15x13; 12; 5
Feldspar 12x2; 13x2; 16x3, av. .41x.07 mm.
Augite 30x20; 30x15; 30x15, av. .90x.50 mm.

Sp. 15085. Hole 2 at 271 feet from surface. Amygdaloid fine grained, *marked* altered yellow red olivine; feldspar seriate and tending to run into microlites near margin at 271.

Grain
Olivine phenocrysts 17x13; 22x20; 27x20, av. .66x.53 mm.
Feldspar 21x12
Augite 2-5?

271-325; (Ss. 15086-7). MELAPHYRE, ophite; about 14 feet of (53) (147)

amygdaloid at top; at 315 feet and 320 feet, seams of decomposition, and then more amygdaloidal to bottom; carries laumontite and calcite.

Sp. 15086. Hole 2 at 296 feet from surface. Poikilitic; altered olivine as in the bed above; polysomatic augite mottlings.

Grain
Olivine phenocryst 17; 2; 3 etc.
Feldspar 10x1; 16x7; 14x4; 23x3, av. .52x.12 mm.
Augite polysomatic aggregate 55x50; 45x45; 53x32, av. 1.53x1.27 mm.

325-365; (Ss. 15087-8). AMYGDALOIDS; probably more flows than one; base ill-defined.

Sp. 15087. Hole 2 at 325 feet from surface. Laumontite; amygdaloid; olivine as in sections above; amygdules not so fine as usual in contacts; this and the fact that the parting is not marked may be due to the fact that this and the overlying are immediately following gushes. At margin 325.

Grain
Olivine 18x10
Feldspar 18x4 and less
Augite 0.

Sp. 15088. Hole 2 at 340 feet from surface. Fine grained with altered olivine and small amygdules.

Grain
Olivine 10x8; 20x13; 11x10, av. .41x.31
Iron oxide 2; 2; 2 like small olivine
Feldspar ? 10x2? all altered
Augite 5; 5; 4; 7; 5; 7.

365-438; (Ss. 15089-91). MELAPHYRE, ophite; amygdaloidal at (71) (218)

top, grey, and apparently not very basic.

Sp. 15089. Hole 2 at 411 feet from surface. Poikilitic; olivine altered green to black.

Grain

Olivine 18x15; 13x10; 18x11, av. .49x.36

Feldspar 20x3; 33x3; 21x4, av. .74x.10

Augite 25x15; 20x18; 40x20, av. .85x.53.

The grain of the augite is illustrated by points q of Fig. 16 (of the Isle Royale Report).

Sp. 15090. Hole 2 at 426 feet from surface. Basic feldspar; poikilitic amygdaloid; chloritic interstices; olivine not so plain, iron oxide instead.

Grain

Olivine 4; 7; 8; 7

Feldspar 20x7; 13x7; 17x4 (somewhat larger than the average) av. .60x.18

Augite 140x100; 70x60; 80x70, av. 2.90x2.30 mm.

Sp. 15091. Hole 2 at 434 feet from surface. Similar; rather finer grained; olivine is once more conspicuous.

Grain

Olivine 12x10; 15x15; 15x14, av. .42x.39 mm.

Feldspar 22x4; 15x5; 22x4, av. .59x.13 mm.

Augite 55x30; 30x25; 45x30, av. 1.30x.85 mm.

438-475; (Ss. 15092-4). AMYGDALOIDS, brecciated; very soft, so (36) (254)

that we have only 17 feet of core for 38 feet of boring, probably a number of beds and possibly a fault. (Houghton conglomerate?).

Sp. 15092. Hole 2 at 438 feet from surface. Marginal microlitic porphyritic amygdaloid for a way; feldspar low angled and the phenocrysts run out into trichites. This is the first below the Greenstone to look like the Tobin or melaphyre porphyrite type.

Grain

Feldspar phenocrysts 17x3; 10x2; 20x10. av. .47x.15; microlites 6x.1; 5x1, av. .18x.01.

Sp. 15093. Hole 2 at about 450 feet from surface. Brecciated fine grained contact; it might be a fault breccia or fragments.

Sp. 15094. Hole 2 at about 460 feet from surface. Brecciated microlitic; fine grained; decomposed; similar to 15093.

Grain

Feldspar 25x9 and less.

475-556; (Ss. 15095-7). MELAPHYRE, ophite; top and bottom (79) (333)

quite uncertain, but the massive mottled center is quite distinct; at about 554 feet becomes much veined, disintegrated, and prehnitic, with some *copper*.

Sp. 15095. Hole 2 at 476 feet from surface. Poikilitic amygdaloid; much altered olivine. Margin at 475.

Grain

Olivine 12; 8; 9

Feldspar 20x3; 20x3.3; 15x3, av. .55x.09

Augite 43x35; 44x25; 35x30, av. 1.22x.90.

Sp. 15096. Hole 2 at 516 feet from surface. Poikilitic amygdaloid; with green altered olivine; chloritic interstices.

Grain

Olivine 6; 10; 10x10

Feldspar 36x10; 22x4; 17x4, av. .75x.18 mm.

Augite 60x53; 80x80; 55x43, av. 1.95x1.76 mm.

Sp. 15097. Hole 2 at 554 feet from surface. Fine grained microlitic, porphyritic, originally, but now all poikilitic quartz patches.

Grain

Feldspar phenocrysts pseudomorphs 13x2; 23x4; 20x9.

556-570; (Ss. 15098-9). AMYGDALOID, brecciated. (14) (347)

Sp. 15098. Hole 2 at 561 feet from surface. Brecciated; olivine marked; microlitic; melaphyre.

Grain

Feldspar seriate, from 20x3 to 3x.1

Augite 0.

Sp. 15099. Hole 2 at 570 feet from surface. Microlitic porphyritic. At margin 570.

Grain

Olivine 2; 3; 3

Feldspar 33x5; 15x4 and smaller

Augite 0.

570-600 (?). MELAPHYRE, ophite (?); amygdaloidal; core about (29) (376)

half ground away.

600-631; (Ss. 15100-1). MELAPHYRE, ophite. (30) (406)

Sp. 15100. Coarse grained olivinitic, somewhat porphyritic; no augite? much decomposed.

Grain

Olivine 15; 20; 4; 4; 5

Feldspar 20x4; 33x5; 27x4, av. .80x.13.

Sp. 15101. Hole 2 at 624 feet from surface. Poikilitic; ophite; melaphyre.

Grain

Olivine phenocrysts 22; 17; 18

Feldspar 12x6; 11x3; 16x5, av. .39x.14

Augite 1-2 mm. to the naked eye; 50x30; 46x25, av. 1.60x.91.

631-650+; (S. 15102). AMYGDALOID; at 650 feet very much (71) (477)

ground away and decomposed; a chance for a slide. Below this point No. II shows a massive, dictinctly mottled ophite, all the way down (chlorite vein from 697 feet down to 700 feet), so coarse at the bottom that it is evidently considerably thicker, upwards of 70 feet thick. If this is repeated above, it must be either at 64 feet (the beds above 64 feet are too massive) or at 365 feet, which is possible, though there are reasons brought out by the microscope for believing this also not to be the case; moreover, the beds above do not harmonize. While there are several disturbed zones in No. II, there is no pressing reason, microscopic or otherwise, for supposing that a repetition in the series is shown.

When we turn to drill hole No. IV, we find a similar melaphyre at the very top If we let No. II, 683 feet, be equivalent to No. IV, 0 feet (using the similar grain of the rock as an indication that the two samples have similar positions in the flow), we have for the dip 14° 30′. Thus, either the dip has become steeper or the correlation should be higher up in hole No. II, or a fault separates No. II and No. IV such that No. IV is thrown up. This last supposition I deem most likely, for there is a ravine just to the east of No. IV, through which such a fault, running north and south, might go. Moreover, tunnels No. II and III do not strike the same rock, as would otherwise be expected; the one is east and the other west of this supposed break. Drill holes Nos. V and II are about in the direction of dip from each other and the fault suggested would also throw up No. IV relative to No. V, which is what the topography and records suggest.

Tunnel No. VII is in ophite, with seams, red, white, clayey and chloritic, which

may be matched anywhere along the middle of hole No. II and do not throw much light on the correlations. Supposing the dip to be 13°, as it has been taken to be to the south, the corresponding up-throw of No. IV would be 52 feet.

Sp. 15102. Hole 2 at 639 feet from surface. Similar to 15101; fine grained. Distance from margin 650?

Grain

Olivine phenocryst 20x14; and small
Feldspar 70x3; 13x2; 20x1; 23x5, av. 1.05x.09
Augite 12x5; 20x15; 25x13, av. .57x.33.

From 2-4, 650 feet (Ss. 15103-A)

Sp. 15103. Hole 2 at 655 feet from surface. Much red olivine; very fine grained.

Grain

Olivine phenocryst 25; second generation 3; 5; 3; 5; 4; 3, av. 0.12 mm.
Feldspar 8x1; 13x3; 12x3, av. .33x.07 mm.

Sp. 15104A. Hole 2 at 683 feet from surface. Coarse grained poikilitic.

Grain

Olivine 9; 12; 10
Feldspar 30x4; 23x4; 15x4, av. .68x.12
Augite 2-3 mm. or 3.5 mm.; 145x100; 100x70; 110x90; 90x90, av. 3.55x2.60.

(477)

DRILL HOLE No. IV

4. 0-40 feet (Ss. 15155-7). MELAPHYRE, ophite.

Sp. 15155. Hole 4 at 0 feet from surface, appears a little coarser than 15104A, if anything. Altered, more green olivine.

Grain

Olivine phenocrysts 17; 17; 7 also some smaller grains
Feldspar 18x5; 12x2; 14x5, av. .44x.12 mm.
Augite 2-3 mm., 75x50; 120x70; 120x80, av. 3.15x2.00 mm.

Sp. 15156. Hole 4 at 36 feet from surface. Somewhat finer grained than 15156.

Grain

Olivine phenocryst 17x10; second generation 3; 6
Feldspar 14x3; 23x5; 23x3, av. .60x.11
Augite 80x63; 105x43; 80x70 (about 2 mm.).

Sp. 15157. Hole 4 at 40 feet from surface. Very fine grained with microlites of feldspar from the size measured below to smaller.

Grain

Feldspar 13x2; 15x3; 19x3, av. .47x.08 mm.
Augite ?

(477)

40-108; (Ss. 15158-60). MELAPHYRE, ophite; about 9 feet of (66) (543)

Amygdaloid at top, with calcite and chlorite—

Sp. 15158. Hole 4 at 51 feet from surface. Distinctly poikilitic, but the augite is long in clinopinacoidal sections, showing that it is not entirely without crystal form.

Grain

Olivine 4; 5; 7; 13; 6; 7
Feldspar 13x2; 13x2; 20x2, av. .46x.06
Augite 1 mm.?; 45x40; 45x30; 80x25, av. 1.7x0.95.

The grain of the augite is plotted as p in Fig. 16 of the Isle Royale Report, Vol. VI.

Sp. 15159. Hole 4 at 68 feet from surface. Coarser than 15158.

Grain

Olivine 5; 5; 7; 7; 5; 10
Feldspar 13x2; 11x1; 18x1, av. .42x.04 mm.
Augite 2-3 mm.; 63x55; 55x40; 160x65; 115x65, av. 3.27x1.88 mm.

Sp. 15160. Hole 14 at 100 feet from surface. Olivine red with iron oxide, the bowlingite alteration.

Grain

Iron oxide 7; 5; 8; 8; 7; 8, av. .21 mm.
Feldspar 13x2; 10x2; 12x15, av. .35x.19
Augite 1-2 mm.; 50x45; 85x30; 65x30, av. 2.00x1.05.

108; (S. 15161). SEDIMENT, basic; to the naked eye like (543)

a fine grained amygdaloid. Evidently connected with the sediment just below.

Sp. 15161. Hole 4 at 108 feet from surface. This may be partly ash but mainly real sediment of basic material such as labradorite sand, etc.

108-133; (Ss. 15162-3). MELAPHYRE, ophite; fine grained; 24 (567)

at 122 feet, fissure with quartz crystals.

Sp. 15162. Hole 4 at 110 feet from surface. 2 large phenocrysts of feldspar apparently orthoclase !; poikilitic texture just beginning; low angled feldspar.

Grain

Olivine 5; 4; 5; 3; 4; 5
Iron oxide 5x.2; 2; 4; 11x0.3; 2
Feldspar phenocrysts 115x60; second crop 14x2; 12x2; 13x2, av. .39x.06.
Augite 4x2; 5x4; 4x4, av. .13x.10.

Sp. 15163. Hole 4 at 126 feet from surface. Very chloritic; poikilitic also with large phenocrysts of feldspar. Magnetite and hematite occur.

Grain

Iron oxide 3; 4; 4; 10x.5
Feldspar first generation 47x42; 120x35; second crop (ex. 10°) 205x24 (ex. 18°.0) 15x3; 12x2; 12x2, av. .39x.07
Augite 40x30; 40x20; 40x30; av. 1.20x.80. See Fig. 16 of the Isle Royale Report, Vol. VI, the grain plotted as 0.

133-135; (Ss. 15164). SANDSTONE, basic; the CALUMET CONGLOMERATE (569)

(No. 13 of Marvine's table, opp. p. 60) should come about here. In the Central Mine (see p. 267), the Calumet is about 815 feet below the Houghton and 1500 ft. below the Allouez. This is not quite as much shrinkage as before. As the top of the bed below does not begin in an amygdaloidal streak, but is quite coarse, we must infer an erosion or a slide at this point.

Sp. 15164. Hole 4 at 133 feet from surface. Fine grained basic conglomerate; decomposed large phenocrysts of feldspar; the general impression of all these rocks is that the iron oxide is produced in resorption or decomposition of the olivine.

Grain

Olivine 11x6
Feldspar 20x2; 90x17, av. 1.83x.31.

135-227; (Ss. 15165-8). MELAPHYRE, ophite; very ferruginous. (90) (90)

Sp. 15165. Hole 4 at 135 feet from surface. Beginning to be poikilitic; red olivine; one big amygdule; feldspar ex. 23°-3°w14°-3°; this does not seem like the extreme margin of flow and one would say there was probably erosion here.

Grain

Olivine 8; 14; 10; 7; 10; 7

Feldspar 20x5; 26x5; 20x3, av. .55x.13
Augite 32x30; 60x17; 38x23, av. 1.30x.70
The augite grain is given as n in Fig. 16 of Vol. VI, Part I.

Sp. 15166. Hole 4 at 175 feet from surface. Poikilitic; unusually much iron; basic feldspar has higher birefringence. Ex. 60°; 60°; 35°-7°w40°-29°; 28°-5°w 55°-32°.

Grain
Olivine 18; 7; 10; 5; 10; 10
Augite to the naked eye 3-4 mm.; 100x70; 100x40; 80x70, av. 2.80x1.80.

Sp. 15167. Hole 4 at 225 feet from surface. Fine grained microlitic porphyrite; altered olivine; feldspar low angled.

Grain
Olivine 15; 13; 16
Iron oxide 4; 4; 4; 4; 4; 5
Feldspar (1) 15x3; 32x7; (2) 13x3; 12x3; 15x5
Augite 10x8; 25x12; 16x11, av. .51x.31 mm.

227-245; (Ss. 15168-9). AMYGDALOID, brecciated. (18) (108)

Sp. 15168. Hole 4 at 227 feet from surface. Contact of two flows; one has much more iron, and appears to be the lower since fragments of it are enclosed in the upper.

Grain
Olivine pseudomorphs perhaps 7? 4?
Iron oxide (much) dust.
Feldspar 11x2; 13x2; 17x2; 11x6, av. .43x.10 mm.
Augite 0.

Sp. 15169. Hole 4 at 245 feet from surface. Like the lower part of 15168; fragments of microlitic melaphyres with coarse calcareous cement; more or less iron oxide in the fragments.

Grain
Olivine 4; 5; 6; 7; 5; 14.

245-263; (Ss. 15170-1). AMYGDALOID. (18) (126)

Sp. 15170. Hole 4 at 262 feet from surface. One large phenocryst of olivine altered. See Fig. 16.

Grain
Olivine 11; 7; 4; 5; 9; 16
Feldspar 19x3; 14x4; 25x4, av. .58x.11 mm.
Augite 4x3; 6x3; 10x7, av. .20x.13 mm.

Sp. 15171. Hole 4 at 263 feet from surface. Well marked altered olivine.

Grain
Olivine 10; 6; 10; 15; 10; 9, av. 0.30 mm.
Iron oxide 12; 2; 2; 4, av. 0.11 mm.
Feldspar 22x5; 15x5; 10x7, av. .47x.17 mm.
Augite 2; 1; 2; 3; 5; 1, av. .07 mm.

263-280; (S. 15172). AMYGDALOID. (17) (143)

Sp. 15172. Hole 4 at 280 feet from surface. Same; well marked amygdaloid; feldspar smaller as well as of the size measured.

Grain
Olivine 12x10
Feldspar 35x7; 22x5; 22x5, av. .79x.17 mm.

280-304; (Ss. 15173). AMYGDALOID. (23) (166)

The above series of four amygdaloids are very much alike, very soft, veined, red, and so much ground away that only about half the core was left; consequently the limits of the various flows are very uncertain. Prehnite also occurs in them. This may be not far from the horizon of the Osceola and Calumet amygdaloids.

Sp. 15173. Hole 4 at 303 feet from surface. Very fine grained marginal amygdaloid?; feldspar often microlitic decomposed.

Grain
Feldspar phenocrysts 15; 25x5; 8.

304-424; (Ss. 15174-83). MELAPHYRE, ophite (117) (283)

Compare Central Mine belt 35, and the big ophite that comes between the Osceola and Calumet amygdaloids, p. 269.

Clay seam at 313 feet, near which the rock is much decomposed, fissured and seamed.

Sp. 15174. Hole 4 at 305 feet from surface. Much altered; fine grained; full of iron oxide dust.

The grain of the augite is given by points marked l in Fig. 16 of the Isle Royale Report, Vol. VI.

Sp. 15175. Hole 4 at 308 feet from surface. Coarser than 15174; reddened altered olivine; very basic feldspar.

Grain
Olivine 10; 15; 8, av. 0.33 mm.
Iron oxide 7; 9; 5, av. 0.21 mm.
Feldspar 30x3; 8x2; 20x3; 10x1, av. .56x.07
Augite 8x12; 7x8; 7x8, av. 0.28x0.23 mm.

Sp. 15176. Hole 4 at 313 feet from surface. Clay which may perfectly well be the fluccan of a slide fault.

Sp. 15177. Hole 4 at 336 feet from surface. Poikilitic; olivine altered to green mica; with strong birefringence; feldspar extinction 8°-6°w29°.

Grain
Olivine 7; 14; 9; 10; 7; 8; 40x40
Feldspar 12x3; 14x13; 12x3; 20x3, av. .48x.18
Augite 1-2 mm.; 39x32; 35x23; 30x30, i. e., av. 1.04x0.83.

Sp. 15178. Hole 4 at 345 feet from surface. Feldspar ex. 18°-3°w51°-18°; 26°-18°w48°-25°.

Grain
Olivine 10; 6; 23; 6; 12; 12
Feldspar 19x6; 19x2; 22x11, av. .60x.19 mm.
Augite 2-3 mm.; 90x80; 115x42; 80x64, av. 2.85x1.86 mm.

Sp. 15179. Hole 4 at 365 feet from surface. Feldspar ex. 20°-0°w49°-35°; 27°-14°w44°-30°.

Grain
Olivine only green 15; 6; 5; 11; 10; 8, av. .27 mm.
Feldspar 20x2; 18x6; 40x6, av. .78x.14 mm.
Augite 2-4 mm.; 110x90; 120x75; 110-95, av. 3.40x2.60 mm.

Sp. 15180. Hole 4 at 395 feet from surface. A vein of decomposition runs through the section. Feldspar ex. 26°-25°w40°-31°.

Grain
Olivine 7; 15; 15; 5; 7; 4
Feldspar 23x5; 23x2; 19x5, av. .65x.12 mm.
Augite 2-3 mm.; 115x65; 80x60; 65x60; av. 2.60x1.85 mm.

Sp. 15181. Hole 4 at 399 feet from surface. Olivine, mica, and iron oxide grown together are abundant.

Grain

Olivine 7; 6; 9; 10; 5; 6, av. 0.21 mm.

Feldspar 16x4; 25x6; 23x5, av. .64x.15 mm.

Augite 1-2 mm.; 60x50; 70x65; 50x45, av. 1.80x1.60 mm.

Sp. 15182. Hole 4 at 420 feet from surface. Poikilitic.

Grain

Olivine 18; 10; 9; 2; 5; 12, av. 0.40x0.16 mm.

Feldspar 12x2; 16x5; 12x4, av. .40x.11 mm.

Augite 1 mm.; 20x16; 15x12; 17x16, av. 0.52x0.44 mm.

Sp. 15183. Hole 4 at 423 feet from surface. Minute poikilitic texture. Distance from margin 1 ft.

Grain

Olivine 8; 10; 3; 15; 10; 8, av. 0.33x0.21 mm.

Augite 8x6; 15x12; 7x6, av. 0.30x0.24 mm.

424-434; (Ss. 15184-6). AMYGDALOID, chloritic and laumontite. (10) (293)

Sp. 15184. Hole 4 at 424 feet from surface. Similar but more feldspathic; contact apparently right in the section, at any rate trichitic. Distance from margin 0.

Grain

Olivine 10x8; 6x5; 6x4, av. 0.22x0.17 mm.

Feldspar 15x4; 16x3; 13x4, av. .44x.11 mm.

Augite 0.

The grain is given by points marked m of Fig. 16 in Vol. VI, Part I.

Sp. 15185. Hole 4 at 431 feet from surface. Quite feldspathic; poikilism faint if present.

Grain

Feldspar 43x4; 24x3; 32x4; 18x3, av. .97x.11 mm.

Augite 42x40; 25x23; 40x36, av. 1.07x.99 mm.

Sp. 15186. Hole 4 at 434 feet from surface. Fine grained microlitic porphyrite; trichitic and the phenocrysts whose dimensions are given have trichitic additions.. Distance from margin 0.

Grain

Olivine 5; 7; 5; 13

Feldspar 15x4; 43x6; 35x6, av. .93x.16 mm.

434-450; (Ss. 15187-8). AMYGDALOID; porphyritic texture, (16) (309) which is common in the other amygdaloids, with *copper*, laumontite and prehnite. Compare Osceola amygdaloid.

Sp. 15187. Hole 4 at 438 feet from surface. Like 15186 but coarser.

Grain

Olivine 7; 5; 7; 6; 3; 7; 6; 15; 5, av. 0.20 mm.

Feldspar 12x2; 30x6; 20x3, av. .62x.11 mm.

Augite 0.

Sp. 15188. Hole 4 at 450 feet from surface. Microlitic porphyritic brecciated. There may be a contact of two flows? Distance from margin 450.

Gra n

Olivine 4; 7; 4; 5; 5; 5, av. 0.15 mm.

Feldspar 20x4; 40x7; 30x5, av. .90x.16 mm.

Augite 0.

1. 450-605½; (Ss. 15189-96). MELAPHYRE, ophite; very feld- (152) (461) spathic; the bottom of bed not reached at the end of the hole, but the grain has become finer, indicating that we are close to the foot. With this flow we pass to drill hole No. V, and the latter must overlap unless the dip is 20°, or unless there is a fault of about 150 feet. With a dip of 13° we should expect to find No. V, 0 feet, at No. IV, 436 feet; if the dip is 14°, then at No. IV, 462 feet, etc. But the ophites around the top of No. V are judging either from their thickness as measured in the section, which might be affected by the numerous seams in No. V, or from the coarseness of grain, not as thick as the bottom flow in No. IV. Nor are they quite as feldspathic. The bottom of No. V, though it lies in a fissure, and the record cannot be made out clearly, is in coarse feldspathic ophite, which corresponds both to the bottom of No. IV and also to the top of No. I. Drill hole No. I lies on the northwest side of a ridge which rises from Washington River, and is composed of ophites like the Greenstone. No. I is 30 feet lower than No. IV and 2092 feet+1293 feet, i. e., 3385 feet from it to the northwest, at right angles to the strike. Thus at 14° dip the top of No. I would be (846+30=876) feet below the top of No. IV; at 13° dip (782+30) 812 feet below it. Thus there would be a gap of something over 200 feet between the bottom of No. IV and the top of No. I. But as No. IV ends in a coarse ophite and No. I begins in one, and as field observations show all the intervening rocks to be coarse ophite, and as drill hole No. V is altogether in the same, we may be sure that the apparent intervening gap, if any there be, is composed of ophite. It is doubtful if there be really any such gap. The topography of the Island conforms in general closely to its geological structure, and the thick ophite of the bottom of No. II could hardly fail to make a ridge. The only ridge with which it might be correlated, is directly on the southeast side of No. I. Again, in No. V the only ophite equally coarse is just above 344 feet, and if we assume No. IV, 610 feet, to correspond to No. V, 344 feet, the difference in level in the geological column would be only 128 feet, whereas if the dip is 14°, there should be a difference of level of 324 feet, indicating an up-throw of No. IV of (196 feet) about 200 feet. If the same amount of up-throw existed between No. I and No. IV, the gap in the record between them would be practically wiped away, leaving room for not more than one large ophite flow, which might be the one which occurs at and above the top of No. I.and at the bottom of No. V. Since No. V and No. I are 2092 feet apart, at right angles to the strike, and No. V is 108 feet the lower, the top of No. I, with dip=13° would correspond to (483-108) 375 feet, or with dip=14° to (523-108) 415 feet, in No. V, and the two holes would barely overlap. This is probable, as the bottom of No. V and the top of No. I are very similar; so that if not exactly the same horizon, they are probably from the same flow. If we can consider them identical, we can also assume that the top of No. I makes a continuous record with No. IV (No. IV, 606 feet=No. I, 0 feet). This seems on the whole the best plan, as drill hole No. V crosses and recrosses a fissure and there is no guarantee that the different parts of it are in any fixed relation to each other. But at the same time we must remember that in thus allowing about 270 feet of upthrow, we may be shortening our column too much. We may be reasonably confident that the beds we may have thus omitted are two or three large flows of ophite. There are certain reasons which make a fault of the nature we have described probable. The line of strike of such a fault may be marked by the Washington harbor depression. Plate I.

Sp. 15189. Hole 4 at 458 feet from surface. Fine grained poikilitic.

Grain

Olivine 4; 9; 11, av. 0.24 mm.

Feldspar 32x5; 25x5; 22x4; 20x5, av. .82x.15

Augite 30x22; 40x25; 40x23, av. 1.10x.60.

Sp. 15190. Hole 4 at 478 feet from surface.
Grain
Olivine 20x7; 12x10; 10x10; av. 42x.27.
Feldspar 32x6; 30x4; 38x4, av. 1.00x.14
Augite 60x45; 55x40; 60x52, av. 1.75x1.37.
Sp. 15191. Hole 4 at 486 feet from surface.
Grain
Olivine 31x24; 9; 13; 10; 15
Feldspar 25x4; 31x5; 22x5, av. .78x.14
Augite 90x50; 155x90; 110x50, av. 3.55x1.90.
Sp. 15192. Hole 4 at 503 feet from surface. Very feldspathic; drusic; faintly poikilitic; put down with naked eye as coarsest!
Grain
Olivine 12?
Iron oxide 16; 7; 11
Feldspar 40x3; 23x3; 38x4, av. 1.01x.10
Augite 23x20; 50x40?; 50x18, av. 1.23x.78.
Sp. 15193. Hole 4 at 509 feet from surface. Markedly poikilitic, with green olivine; feldspar extinction -15°w42°-35°; 21°-28°.
Grain
Olivine 12x10; 8x14; 15x10, av. .35x.34 mm.
Feldspar 40x3; 37x6; 26x5; 43x8, av. 1.21x.18 mm.
Augite 130x105; 160x100; 130x120, av. 4.20x3.25 mm.
Sp. 15194. Hole 4 at 536 feet from surface. Doleritic interstices; feldspar interstices 17°-22°w56°-35°.
Grain
Olivine 13x13; 9x13; 16x9
Feldspar 25x5; 58x6; 26x3, av. 1.09x.14
Augite 3-4 mm.; 80x65; 160x116; 110x100, av. 3.50x2.81.
Sp. 15195. Hole 4 at 564 feet from surface. Vein.
Sp. 15196. Hole 4 at 595 feet from surface. Note how the chlorite seam winds around the augites and none? of them lie on both sides of it.
Grain
Olivine 24; 15; 15; 15; 10; 12
Feldspar 47x6; 20x3; 34x3, av. 1.01x.12
Augite 63x50; 50x40; 80x40, av. 1.93x1.30.

DRILL HOLE No. V.

We give the record of No. V, though not included in the general section, and owing to the faulting the grain observations are of more importance in indicating displacements than in any other way.

0-104; (Ss. 15197-203). MELAPHYRE, ophite; veined, decomposed with laumontite; at 18 feet about 2 feet of brecciated vein matter, with white and chloritic seams in the neighboring rock.

Sp. 15197. Hole 5 at 1 foot from surface. Very coarse grain.
Grain
Augite patches 3-4 mm.
Sp. 15198. Hole at 18 feet from surface. Fine grained vein stuff with fragments, augite, etc.
Sp. 15199. Hole 5 at 26 feet from surface. Green and red olivine; poikilitic.

Grain
Olivine 25x13; 10x10; 11x11, av. .46x.34 mm.
Feldspar 27x4; 16x6; 26x5; 23x5, av. .68x.16 mm.
Augite 90x80; 170x80, av. 4.5x2.6 mm.
Sp. 15200. Hole 5 at 50 feet from surface. Finer grained than 15199; green olivine; talc?; poikilitic.
Grain
Olivine 10x7; 14x19; 10x24, av. .44x.50 mm.
Feldspar 13x2; 40x4; 20x3, av. .73x.09 mm.
Augite 70x50; 85x80; 65x60, av. 2.20x1.90 mm.
Sp. 15201. Hole 5 at 64 feet from surface. Green; fine grained drusic; feldspar ex. 16°-43°-32°.
Grain
Olivine 10x10; 15x8; 15x20, av. .40x.38 mm.
Feldspar 45x6; 13x3; 17x3, av. .75x.12 mm.
Augite 2-4 mm.; 85x60; 90x60; 100x100, av. 2.75x2.20 mm.
Sp. 15202. Hole 5 at 100 feet from surface. Green; fine grained drusic; coarse.
Grain
Olivine 15x5; 10x6; 7x7, av. .32x.18 mm.
Feldspar 15x5; 32x4; 34x5, av. .81x.14 mm.
Augite 80x40; 65x50; 60x43, av. 2.05x1.33 mm.
Sp. 15203. Hole 5 at 104 feet from surface. Fine grained poikilitic. Margin at 105+.
Grain
Olivine 8x4; 10x10; 12x8, av. .30x.22 mm.
Augite 43x40; 40x28; 54x40, av. 1.37x1.08 mm.
Sp. 15204. Hole 5 at 105 feet from surface. Very fine grained; *not* microlitic; this appears to be rock like a "slide"; a vein is crossed here as is shown by the sudden change in coarseness, as well as other things.
105; (S. 15205). "Slide" rock, fine grained. Hole 5 at 115 feet from surface. Fine grained poikilitic.
Grain
Olivine 12x11; 13x18; 12x10, av. .37x.39 mm.
Feldspar 16x3; 22x4; 30x8, av. .68x.15 mm.
Augite 1 mm.; 30x27; 28x10; 53x42, av. 1.11x0.79 mm.
130. A similar belt of fluccan to 105.
150-152. Thoroughly decomposed; vein.
188. A thin *fissure;* a red, calcareous, decomposed belt, very prehnitic, possibly also a contact of flows.
105-188; (Ss. 15205-10). MELAPHYRE, ophite; coarsest near 163 feet. (81)
Sp. 15206. Hole 3 at 132 feet from surface.
Grain
Olivine 7x12; 10x7; 16x11, av. .33x.30 mm.
Feldspar 24x5; 23x9; 30x7, av. .77x.21 mm.
Augite 2-3 mm.; 90x60; 150x80; 130x110, av. 3.70x2.50 mm.
Sp. 15207. Hole 5 at 150 feet from surface. Thoroughly decomposed; no perceptible grain, like 15204; full of bodies like those in the Arran pitch? stone; vein material?
Sp. 15208. Hole 5 at 163 feet from surface. Poikilitic.
Grain
Olivine 8x20; 15x10; 10x16, av. .33x.46 mm.

Feldspar 11x4; 25x5; 31x4, av. .67x.13 mm.
Augite 2-3 mm.; 110x100; 80x70; 95x75, av. 2.85x2.45 mm.
Sp. 15209. Hole 5 at 177 feet from surface.
Grain
Feldspar 35x7; 22x3; 22x4, av. .79x.14 mm.
Augite 50x30; 60x40; 40x40, av. 1.50x1.10 mm.
Sp. 15210. Hole 5 at 188 feet from surface. Much decomposed; very prehnitic; about here change in character of flows; less ophitic; more feldspathic.
188-210; (Ss. 15210-3). FELDSPATHIC, ophite; first five feet amygdaloidal; mottling not prominent.
Sp. 15211. Hole 5 at 193 feet from surface. Decomposed fine grained poikilitic.
Sp. 15212. Hole 5 at 196 feet from surface. Slightly coarser.
Sp. 15213. Hole 5 at 210 feet from surface. Sandy vein or clasolite in contact with coarse rock.
210. CLAY seam.
231. Finer grained.
210-343; (Ss. 15214-9). MELAPHYRE, feldspathic ophite. Mottling not prominent, but rather a diabasic texture of feldspar laths; occasional amygdules, seams and veins; toward the bottom the mottling becomes more marked.
Sp. 15214. Hole 5 at 214 feet from surface. Poikilitic; with 2 mm. augite.
Sp. 15215. Hole 5 at 231 feet from surface.
Grain
Augite 1-2 mm.
Sp. 15216. Hole 5 at 231 feet from surface.
Grain
Augite 2-3 mm.
Sp. 15218. Hole 5 at 285 feet from surface. Poikilitic; olivine present. Augite 5-6 mm. patches.
Sp. 15219. Hole 5 at 333 feet from surface. Poikilitic.
Grain
Augite 2-3 mm.
343. Enter *fissure;* rock much decomposed, fine grained and prehnitic.
344. CLAY seam.
346; (Ss. 15220). Feldspathic AMYGDALOID, not far from contact.
365. "Leave fissure," i. e., the amygdaloidal zone?
344-376. Perhaps one small MELAPHYRE, ophite.
375. "Cross fissure" (?).
Sp. 15221 at 367 feet is a pretty feldspathic ophite with 1 mm. augite.
376-415. MELAPHYRE, ophite; amygdaloidal at top. (38)
Sp. 15222 at 376 feet is an amygdaloid; the top of a heavy bed at the lower end of the hole.
Sp. 15223 at 377 feet is quite decomposed.
15224 at 391 feet is very feldspathic and rather even.
397. Cross fissure again (?).
15225 at 410 feet is also quite feldspathic and distinctly poikilitic.
Grain
Olivine 10x10; 15x15; 12x6, av. .37x.31
Feldspar 15x5; 17x6; 32x7, av. .64x.18
Augite 63x35; 110x20; 40x40, av. 2.13x.95.

DRILL HOLE No. I.

Hereafter, in reducing from VERTICAL depth along drill hole to THICKNESS, 1/30 is taken off.

No. I, 0 feet is taken as equivalent to No. IV, 606 feet. This corresponds very nearly to a dip of 14° 20′ which is what we have by correlation of No. I and No. III.

(461)
0-63; (Ss. 15001-4). MELAPHYRE, ophite; mottled, feldspathic. (61) (522)

and slightly amygdaloidal.
Sp. 15001. Hole 1 at 8 feet from surface. Slightly poikilitic, but feldspathic like the beds at the bottom of Hole V.
Sp. 15002. Hole 1 at 25 feet from surface. Similar to 15001.
Sp. 15003. Hole 1 at 50 feet from surface. More poikilitic, but also quite feldspathic.
Sp. 15004. Hole 1 at 6 feet from surface. Distance from margin 63. Not so poikilitic; sedimentary contact.
63-153; (Ss. 15005-10). MELAPHYRE, ophite; amygdaloidal (87) (609)

at top; darker, black, and mottled at bottom. *Copper* and prehnite seams and spangles of *copper* on chloritic joints. In this bed appear the first signs of copper which continue at intervals down to 302 feet.
Sp. 15005. Hole 1 at 87 feet from surface. Contact of amygdaloid and sand.
Sp. 15006. Hole 5. Much feldspar like previous sections, with augite wedged in between.
Sp. 15007. Distinctly poikilitic with 3 mm. augite patches.
Sp. 15008. Hole 1 at 113 feet from surface has an interesting illustration of a big amygdule around which the coarser feldspar becomes porphyritic and interstitial glass and iron oxides appear, largely hematite.
Sp. 15009. Hole 1 at 138 feet from surface. Poikilitic with 3 mm. patches of augite.
Sp. 15010. Hole 1 at 148 feet from surface. Fine grained microlitic; porphyritic; amygdaloidal.

(609)
153-227; (Ss. 15011-6). MELAPHYRE, ophite; amygdaloidal (76) (681)

for the first 10 feet, which character fades out in the next 9 feet; chlorite and calcite amygdules and veins.
Sp. 15011. Hole 1 at 153 feet from surface. Fine grained, microlitic porphyritic amygdaloid, very black with iron oxides.
Sp. 15012. Hole 1 at 158 feet from surface. Coarser, not so porphyritic.
Sp. 15013. Hole 1 at 174 feet from surface. Slightly poikilitic with 1 mm. augite patches.
Sp. 15014. Hole 1 at 197 feet from surface (sections misnumbered).
Sp. 15015. Hole 1 at 213 feet from surface. Fairly coarse, showing a vein.
Sp. 15016. Hole 1 at 226 feet from surface. Fine grained poikilitic.
227-275; (Ss. 15017-20). MELAPHYRE, ophite; 5 feet of amygdaloid (46) (727)

at top, with a little *copper*.
Sp. 15017. Hole 1 at 228 feet from surface. Microlitic porphyritic, glassy amygdaloid.
Sp. 15018. Hole 1 at 254 feet from surface. Margin at 227. Poikilitic patches; olivine present with 2-3 mm. augite.

Sp. 15019. Hole 1 at 264 feet from surface. Poikilitic about as coarse as 15018 with 2 mm. augite patches.

Sp. 15020. Hole 1 at 275 feet from surface. Fine grained.

275-298; (Ss. 15021-5). MELAPHYRE; fine grained, somewhat (22) (749)

ophitic, amygdaloidal for 4 feet at top and 3 feet at bottom; with prehnite, calcite and laumontite.

Sp. 15021. Hole 1 at 278 feet from surface. Fine grained amygdaloid.

Sp. 15022. Hole 1 at 293 feet from surface. Coarser, somewhat poikilitic.

Sp. 15023. Hole 1 at 295 feet from surface.

Sp. 15024. Hole 1 at 297 feet from surface. Trace of poikilitic structure, about like 15020.

Sp. 15025. Hole 1 at 298 feet from surface. Fine grained amygdaloid like 15021.

298-362; (Ss. 15026-37). MELAPHYRE, ophite; amygdaloidal (62) (811)

for about 10 feet at the top, with chlorite and a little *copper;* at 316 feet vein of datolite (?) and *copper*, and at 321 feet *copper* again. It is equivalent to the flow, from the top of No. III down to 44 feet, which is also a veined ophite with a seam containing *copper*, at 19 feet.

At the very bottom of the bed are some tubular amygdules running lengthwise of the drill cores, i. e., perpendicular to the contact, which contain some calcite, chlorite, and *copper*. This horizon deserves farther attention.

Sp. 15026. Hole 1 at 298 feet from surface. Coarser than 15025 which may belong with this flow. Distance from margin 298.

Sp. 15027. Hole 1 at 298? feet from surface. Medium fine grained amygdaloid; iron oxide characteristic of ground near amygdules; calcite patches.

Grain

Olivine 5x7; 6x5; 5x7, av. .16x.19 mm.
Feldspar 26x3; 20x2; 13x3, av. .59x.08 mm.

Sp. 15028. Hole 1 at 301 feet from surface. Coarser with a trace of poikilism.

Grain

Olivine 8x6; 5x7; 6x7, av. .19x.20
Feldspar 27x4; 32x4; 30x5, av. .89x.13
Augite 17x12; 15x10; 18x13, av. .50x.35.

Sp. 15029. Hole 1 at 308 feet from surface. Similar; very feldspathic.

Grain

Olivine 8x8; 8x9; 7x15, av. .23x.32
Feldspar 20x3; 27x4; 35x4, av. .82x.11
Augite 43x25; 25x20; 30x15, av. .98x.60.

Sp. 15030. Hole 1 at 316 feet from surface. Similar; poikilitic; sand in the pores; much decomposed; all pseudomorphic feldspar.

Grain

Olivine 14; 9; 7
Iron oxide 12; 12; 10
Feldspar 30x3; 18x2; 20x3, av. .68x.08 mm.
Augite 60x30; 50x23; 77x43, av. 1.87x.96 mm.

Sp. 15031. Hole 1 at 318 feet from surface. Hardly poikilitic; very feldspathic; augite much cut up by feldspar.

Grain

Olivine 15x10; 10x10; 12x13, av. .37x.33
Feldspar 27x3; 42x3; 22x2, av. .91x.08
Augite 65x45; 30x23; 25x23, av. 1.20x.91.

Sp. 15032. Hole 1 at 320 feet from surface. Similar; rather decomposed; polysomatic? augite, hard to define.

Grain

Olivine 6; 11; 15x15; 22x3, av. .43x.29 mm.
Feldspar 30x4; 25x3; 20x3, av. .75x.10 mm.
Augite 70x40; 43x30; 120x55, av. 2.33x1.25 mm.

Sp. 15033. Hole 1 at 330 feet from surface. Slightly poikilitic.

Grain

Olivine 8; 17; 12; 20; 13; 11
Feldspar 30x5; 25x4; 53x3, av. 1.08x.12 mm.
Augite 2-3 mm.; 265; 115; 125x90, av. 5.8x3.0 mm.

The grain of the augite from 15033 to the base is plotted as k in Fig. 16 of the Isle Royale report, Vol. VI.

Sp. 15034. Hole 1 at 344 feet from surface.

Grain

Olivine 14; 5; 15; 14; 9; 10
Feldspar 32x4; 40x4; 27x6, av. .99x.14 mm.
Augite 105x100; 125x55; 105x85, av. 3.35x2.40 mm.

Sp. 15035. Hole 1 at 345 feet from surface. More markedly poikilitic.

Grain

Olivine 30x12; 20x7; 20x10, av. .70x.29 mm.
Feldspar 27x6; 25x5; 40x3, av. .92x.14 mm.
Augite 3-4 mm.; 100x80; 110x100, av. 3.5x3.00 mm.

Sp. 15036. Hole 1 at 357 feet from surface. Finer grained.

Grain

Olivine 6x10; 5x9; 7x10, av. .18x.29
Feldspar 25x4; 20x2; 20x2, av. .65x.08 mm.
Augite 10x7; 5x5; 6x11, av. .21x.23 mm.

Sp. 15037. Hole 1 at 362 feet from surface. Fine grained amygdaloid; glassy microlitic, porphyritic; N. B. There are long irregular amygdules parallel to boring the so-called pipe amygdules. Distance from margin 361½.

Grain

Feldspar phenocrysts 22x2; 21x7; 15x5, av. .85x.14 mm.
Augite 0.

362-377; (Ss. 15038-9). MELAPHYRE, amygdaloidal. Equivalent (15) (826)

to drill hole No. III to 44-59.

Sp. 15038. Hole 1 at 368 feet from surface. Rather fine grained; with red olivine this time; low angled feldspar; polysomatic augite, much larger; change in character of flow.

Grain

Olivine 6x7; 5x6; 7x13, av. .18x.26 mm.
Feldspar 15x2; 22x2; 23x3, av. .60x.07mm.
Augite 12x10; 12x12; 35x5, av. .59x.27 mm.

Sp. 15039. Hole 1 at 377 feet from surface. Very fine grained, black amygdaloidal microlitic. At margin 377?

Grain

Olivine 3x5; 2x4; 3x5; av. .08x.14 mm.
Feldspar 7x3; 16x1½; 17x3, av. .40x.07 mm.

377-386; (Ss. 15040-1). MELAPHYRE, amygdaloidal. Equivalent (91) 835

in drill hole No. III to 59-67 feet.

Sp. 15040. Hole 1 at 381 feet from surface. Two different grains of coarse

amygdaloid; low angled fine grained amygdaloid; sedimentary filling to amygdaloid? from the conglomerate close below.

Grain

Olivine 6x4; 5x5; 12x4, av. .22x.13 mm.

Feldspar 25x2; 40x4; 30x5, av. .95x.11 mm.

Augite 0.

Sp. 15041. Hole 1 at 386 feet from surface. Very fine grained microlitic; porphyritic much forked.

Grain

Olivine 9x5; 5x5; 5x6, av. .19x.16 mm.

Feldspar 7x2; 15x2; 10x1, av. .32x.05 mm.

Augite 0.

Top below base of Calumet Conglomerate?		(835)
386-426; (Ss. 15041-5). Kearsarge conglomerate fine grained	(38)	(873)

amygdaloids and scoriaceous beds with basic sediment mixed and at the bottom. This is equivalent to the beds No. III, 67-110 feet, but the trap and sediment being both fine grained, it is difficult to separate them. We may be sure of having quite a marked scoriaceous CONGLOMERATE here. There is a noteworthy amount of the felsitic debris, the first such occurrence under the Allouez conglomerate, No. VI, 363 feet, and there are also agate pebbles.

I take this to be the Kearsarge conglomerate, for reasons mentioned below in connection with the Minong porphyrite. Together with the characteristic beds below it is one of the most persistent horizons of the island, and they can be traced from one end of it to the other and so might well be formed equally far away on Keweenaw Point where the Kearsarge conglomerate is very persistent also. Not all of the 38 feet assigned to this is sediment. But on the other hand the distance from this to the supposed Calumet does not show the usual shrinkage.

Sp. 15042. Hole 1 at 402 feet from surface. Open amygdaloid; glassy? chloritic. This may be a pebble, a mistake or a small overlying flow.

Grain

Olivine 5x9; 10x12; 14x13; 5x12; 9x14; 20x13, av. .34x.41 mm.

Feldspar 40x4; 43x3; 30x2, av. 1.13x.09 mm.

Augite 70x60; 120x100, av. 2.85x2.40.

Sp. 15043. Hole 1 at 412 feet from surface. Distance from margin 412. Rolled granules of augite, etc.; a calcareous sediment. Sediment=3.98 No. 15114. This is the one sedimentary section.

1. 426-456; (Ss. 15044-50). Minong PORPHYRITE; equivalent	(29)	(29)

to No. III, 100-134 feet. This is quite acid, probably not belonging to the melaphyres at all, but rather a felsite porphyrite. No olivine can be recognized in it with certainty, either microscopically or otherwise. The character is more distinct under the microscope, but the extreme fineness of grain, the scoriaceous, porous and brecciated appearance, peculiar in that the pores are fine and irregular, can be recognized with the naked eye. We shall call this the Minong porphyrite. Elsewhere as near Todd Harbor it appears to be distinctly a felsite porphyrite, but the unaided eye could hardly distinguish it as such in the drill cores. Now we find under the lowest conglomerate in the Central mine, which Hubbard has correlated with the Kearsarge (Proc. L. S. M. I., Vol. III, 1895, p. 75) a trap which appears to be of similarly acid character, and I know of none such either on Isle Royale or in the Central mine, below the Allouez conglomerate. In the Manitou section the bed immediately beneath the Kearsarge is feldspathic but yet ophitic. But 61 is glomeroporphyritic. The mottling is, however, faint. The chances are that the more salic beds are not so wide spread.

More nearly similar beds are found in the Torch Lake section (Fig. 38 beds 10 to 59) and Central Mine section much lower down, and the possibility of a big gap in the Isle Royale section between the Allouez and Minong must be kept in mind. Now as to the relative position, the Kearsarge conglomerate varies from (2599) feet below the Allouez at the Central mine according to Hubbard or as I make it (2628) to (2690) to (2,239) feet at Calumet. According to our reckoning, on Isle Royale it is (from base to base) (1670) feet. This is (0.615) not far from two-thirds the thickness of the intervening beds at the Central mine, and on page 68 of the Isle Royale report we found the ratio of the distances between Marvine's No. 43 and No. 65 to be 396÷573=0.69, very much the same. As to its relations with other conglomerates, the distance between the Kearsarge conglomerate, Marvine's No. 11, and the Allouez conglomerate, his No. 15, (2599 feet) is about cut in two (1128) by th Calumete conglomerate, No. 13, and we have No. IV 135 feet, a basic sandstone about 873 feet above this conglomerate which may represent the Calumet conglomerate. At any rate a period of slackened eruptive activity in that portion of the series is marked.

Then nearer the Allouez conglomerate than the Calumet is the Houghton conglomerate, No. 14, and of that we find traces in Hole 2 at 175 feet (569) feet higher than the Calumet as compared with (815) feet at the Central. These two intermediate beds, the Calumet and the Houghton conglomerates, are much thinner and more basic in character than along Keweenaw Point, but that is what we should expect from the general thinning out of all the rocks, the ratio of thinning being similar for all these correlations. The correlation is then fairly satisfactory, and the more so, because in constructing our column we have, between drill holes No. IV and No. I, allowed for 270 feet of faulting on other grounds than these correlations. That our correlations come out thus well, strengthens our confidence that we were right in allowing for that fault.

Sp. 15044. Hole 1 at 425 feet from bed rock surface. Very fine grained; microlitic. Distance from margin 0 ft.

The variation in grain from this point down is shown in Fig. 21 of Vol. VI, Part I, both for the feldspar and the augite.

Sp. 15045. Hole 1 at 426 feet from bed rock surface. Very fine grained.

Sp. 15046. Hole 1 at 436 feet from surface. 2 large phenocrysts, ground mass very fine grained and ferruginous.

Grain

Iron oxide 2; 3; 3

Feldspar phenocryst 62x45, av. .15x.03; microlites 4x1; 4x1; 7x1, av. .15x.03.

Sp. 15047. Hole 1 at 440 feet from surface. Very fine grained; large feldspar phenocrysts.

Sp. 15048. Hole 1 at 444 feet from surface. Very fine grained; a curious scoriaceous streak; cf. 15112; feldspar with low angled ex. and many unstriated perhaps orthoclase.

Grain

Feldspar 4x1; 6x1; 9x1, av. .19x.03 mm.

Sp. 15049. Hole 1 at 449 feet from surface. Very fine grained, yet uniform and not amygdaloidal.

Sp. 15050. Hole 1 at 456 feet from surface. Amygdaloid.

Grain

Iron oxide dust

Feldspar phenocryst 13x10; microlites 5x1; 5x1; 7x1.

1. 456-536; (Ss. 15051-5). MELAPHYRE, porphyrite, the Minong (77) (106)

trap; equivalent to No. III, 135-415 feet. It is sometimes faintly mottled toward the lower third of its thickness, but in general it is much finer grained for its size than the ophites. It is compact and has a clean conchoidal fracture, and tends to basaltic jointing. Occasional fair-sized carnelian agates are a feature of this bed. On the other hand it differs from the porphyrites above the Greenstone aside from microscopic characters by being much darker—black, rather than grayish green. It can be traced almost continuously the full length of the island, from a projecting point on the north line of Sec. 35, T. 64, R. 39, through the Wendigo property, where the trail running from Sec. 20 to Sec. 15 (Pl. III) is nearly along its outcrop. Its lower contact was opened up by numerous costeans on the northwest side and by tunnel No. 5. It runs along the south side of Todd Harbor, where it was again developed by costeans (I and II), and at McCulloch's mine (p. 5). Passing near the west quarter post of Sec. 27, T. 66, R. 35, it formed the foot of the more extensive workings of the Minong mine (though there was also some test-pitting under it), and thence may be followed to the north side of Locke Point. It appears to be good road metal, and is much like a bed in the Torch Lake section No. 59 (Hole 5) and some of the beds from 81 to 115 in the Central Mine section (Fig. 33.) Compare especially bed 96 and 97. I am more inclined to think now than when writing Vol. VI that the line of Washington Harbor may not only mark a fault (I have indicated that) but a considerable one, cutting out a good bit of the series. If this is bed 97 of the Central Mine section instead of 43 some (2329) feet of that section would be omitted here. Such a fault would be of the slide fault nature a strike fault with the down throw on the south side. This bed is notably feldspathic and remarkably fine grained for so thick a flow, another sign of its salic character.

At the bottom of this flow we pass from the record of drill hole No. 1 to that of No. III. No. I, 536 feet, is equivalent to No. III, 215 feet, i. e., 321 feet higher. Adding the excess of elevation of No. III over No. I (231-164=67 feet) we have 388 feet difference in level, which divided by 1,518 feet, the distance between the two holes in the direction of the cross-section, gives a dip of 14° 20′. This is the most accurately determined dip that we have, and we get the same result by supposing that the bottom of No. V just laps the top of No. I, and again by correlating No. III and No. XIII. Stockly's determination from the outcrop at the surface near tunnel No. 5, was practically the same (14¼°). There is no indication of a fault between No. 1 and No. III, and there is no possibility of much of a fault.

Sp. 15051. Hole 1 at 460 feet from surface. Coarse, yet still fine grained and amygdaloidal.

Grain

Iron oxide dust

Feldspar 8; 1; 4; 1; 7; 1, av. 0.19x.03 mm.

Sp. 15052. Hole 1 at 483 feet from surface. Streaks with coarser feldspar and glass mixed with finer shale? One corroded phenocryst or brotocryst is shown in Fig. 6, Plate VI, Vol. VI which also shows the general texture and a blotchy intermixture of coarser and finer textures. The augite is sharply idiomorphic in small square shaped granules.

Grain

Augite 2; 1; 3; 2; 3; 3; 3; 2.

Sp. 15053. Hole 1 at 500 feet from surface. Fine grained poikilitic; much iron oxide; very feldspathic.

Grain

Olivine 4x4; 9x4; 9x5; 7, av. .22x.13

Feldspar 7x1; 13x1; 10x2, av. .30x.04

Augite 40x25; 32x22; 35x23, av. 1.07x0.70 and observations with the naked eye also give 0.7, 0.8, 1.0 about 1 mm.

Sp. 15054. Hole 1 at 512 feet from surface. Very fine grained, poikilitic; with a little olivine.

Grain

Olivine 4x5; 5x5; 3x5, av. .12x.15

Feldspar 7x2; 9x1; 11x2, av. .27x.05

Augite 25x11; 14x11; 40x33, av. .79x.55.

Sp. 15055. Hole 1 at 536 feet from surface. Contact of two traps; little sediment in the amygdules of the upper one; microlitic and trichitic; black; upper one probably more glassy and finer grained. At margin 536 ft.

Grain

Feldspar phenocrysts 12x8; 10x4; 24x4, av. .46x.20; microlites 6x1; 4x2; 6x1, av. .16x.04

Compare Sp. 15122.

Sp. 15056. Hole 1 at 538 feet from surface. Large and small olivine; amygdaloidal.

Grain

Olivine phenocrysts 23x10; 20x15; smaller size 3x3; 6x4; 6x7, av. .15x.14

Feldspar 18x5; 23x4; 8x1, av. .49x.10 mm.

Augite 0.

Sp. 15057. Hole 1 at 539 feet from surface. Slightly poikilitic.

Grain

Olivine phenocrysts 12x10; 8x10, av. .33x.33

Smaller size 10x5; 5x9; av. 25x23.

Feldspar 12x2; 12x2; 19x4, av. .43x.08

Augite 18x13; 20x15; 20x18, av. .58x.46.

Sp. 15058. Hole 1 at 573 feet from surface. Rather porphyritic; average labradorite feldspar smaller and coarser; and more poikilitic than 15057.

Grain

Olivine 12x6; 9x5; 6x7, av. .27x.18 mm.

Feldspar 10x5; 18x6; 23x7, av. .51x.18 mm.

Augite 80x50; 95x80; 85x80, av. 2.60x2.10 mm.

Sp. 15059. Hole 1 at 580 feet from surface. Still coarser; feldspar still abundant; really coarser than 15058 but more polysomatic.

Grain

Olivine 6x12; 6x10; 7x13, av. .19x.35 mm.

Feldspar 15x5; 27x3; 13x3, av. .55x.11 mm.

Augite 65x33; 80x70; 63x55, av. 2.08x1.58 mm.

Sp. 15060. Hole 1 at 600 feet from surface. Drusic chlorite cavities; semi-amygdaloidal; feldspar extinction angles 25°-30°; 28°-32°w5°.

Grain

Olivine 15x12; 11x14; 11; 9, av. .38x.33 mm.

Feldspar 14x3; 17x2; 22x3, av. .53x.08 mm.

Augite 2-4 mm. by eye; 90x80; 96x75; 130x80, av. 3.16x2.45 mm.

Sp. 15061. Hole 1 at 627 feet from surface. Microlitic; finer grained than 15060; irregular contact with sediment which may be a clasolite.

Grain

Olivine 5x13; 4x10; 3x7, av. .12x.30 mm.

Feldspar 19x2; 14x2; 24x4, av. .57x.08 mm.

Sp. 15063. Hole 1 at 635 feet from surface. About the same grain as 15062.

Grain

Olivine 7x6; 4x9; 5x10, av. .16x.25 mm.

Feldspar 11x2; 20x2; 24x2, av. .55x.06 mm.

Sp. 15064. Hole 1 at 666 feet from surface. Much reddish olivine.

Grain

Olivine 6x9; 6x5; 7x9, av. .19x.23 mm.

Feldspar 16x4; 15x2; 20x2, av. .51x.08 mm.

Sp. 15065. Hole 1 at 670 feet from surface. Fine grained sediment; rounded grains (4, 3, 25 thirtieths of an mm.) of augite and feldspar.

Sp. 15066. Hole 1 at 695 feet from surface. Poikilitic.

Grain

Olivine 12x7; 12x7; 11x10, av. .35x.24 mm.

Feldspar 16x4; 12x3; 18x3, av. .46x.10 mm.

Augite 2-3 mm. by eye; 40x26; 100x70; 70x60, av. 2.10x1.56 mm.

Sp. 15104. Hole 3 at 2 feet from surface.

Sp. 15104-15105 are from bed III down to 44 equivalent to the lower part of I. 298 to 362 feet. The rock at the beginning is coarse enough to indicate 20 or 30 feet more of the flow above it. Poikilitic. Coarser feldspar and vein. Contact of two flows.

Grain

Augite 2-3 mm.

Sp. 15105. Hole 3 at 17 feet from surface. Decomposed poikilitic augite in large patches but much feldspar.

Grain

Olivine 5x10; 8x14; 5x15, av. .18x.39 mm.

Feldspar 43x8; 35x5; 38x6, av. 1.16x.19 mm.

Augite 53x42; 48x42; 57x25, av. 1.58x1.09 mm.

Sp. 15106-15107 are from the bed III 44-59 feet equivalent to I 362-377.

Sp. 15106. Hole 3 at 44 feet from surface. Brown glass at margin; yellow olivine; is this brown glass found at margins higher in series?

Grain

Olivine 6x15; 8x8; 6x14, av. .20x.37 mm.

Feldspar 22x3; 16x3; 12x3, av. .50x.09 mm.

Sp. 15107. Hole 3 at 46 feet from surface. Microlitic amygdaloid with coarser spots; numerous small feldspars.

Grain

Olivine 4x4; 5x5; 4x4, av. .13x.13 mm.

Feldspar phenocrysts 13x3; 10x1; 9x2, av. .32x.06 mm.

Sp. 15108-15109 are from the bed III 59-67 feet equivalent to I. 377-386.

Sp. 15108. Hole 3 at 56 feet from surface. Not very fine grained; very feldspathic; andesite feldspar.

Grain

Olivine 17x17; 14x9; 13x10, av. .44x.36 mm.

Feldspar 33x2; 16x1; 25x2, av. .74x.05 mm.

Augite 10x9; 30x12; 18x16, av. .58x.37 mm.

Sp. 15109. Hole 3 at 60 feet from surface. Somewhat poikilitic.

Grain

Olivine 11x9; 10x9; 11x10, av. .32x.28 mm.

Feldspar 23x4; 21x5; 30x4, av. .74x.13 mm.

Augite 25x13; 30x26; 33x30, av. .88x.69 mm.

Sp. 15110 to 15113 are from the bed 3.67-110 equivalent to 1.386-426.

Sp. 15110. Hole 3 at 68 feet from surface. Brown glass; phenocryst amygdaloids; the microlites are 2 to 3x.1.

Grain

Olivine 7; 6

Feldspar phenocrysts 18x2; 13x2; 13x3, av. .44x.07.

Sp. 15111. Hole 3 at 77 feet from surface. Coarser; low angled; feldspathic; slightly amygdaloidal.

Grain

Olivine 8x7; 6x9; 10x10, av. .24x.26 mm.

Feldspar 28x4; 23x4; 22x4, av. .73x.12 mm.

Augite 10x10; 18x10; 20x13, av. .48x.33 mm.

Sp. 15112. Hole 3 at 88 feet from surface. Curious drawn out cavities; not very fine grained; cf. 15048; low angled feldspar.

Grain

Olivine 6x9; 4x8; 7x4, av. .17x.21 mm.

Feldspar 16x3; 18x2; 18x2, av. .52x.07 mm.

Augite 12x5; 11x8; 10x4, av. .33x.17 mm.

Sp. 15113. Hole 3 at 93 feet from surface. Somewhat poikilitic; chloritic.

Grain

Olivine 10x7; 12x9; 15x9, av. .37x.25 mm.

Feldspar 34x4; 16x3; 18x5, av. .68x.12 mm.

Augite 30x27; 25x18; 25x25, av. .80x.70 mm.

Sp. 15114 (Hole 3 at 98 ft.-100?) is perhaps the Kearsarge Conglomerate, anyway=1. somewhere between 386 and 426.

Sp. 15114. Hole 3 at 98 feet from surface.

(A) Sediment not very fine grained 2, 2, 10, 12.

(B) Melaphyre not very fine grained

Grain

Olivine 10

Feldspar 20x3

Augite 2.

(C) Melaphyre finer grained; brown glass.

Grain

Olivine 4

Iron oxide 4x.1

Feldspar 15x2.

Sp. 15115-15118 may be a separate flow or combined with 15122 in the porphyrites.

Sp. 15115. Hole 3 at 100 feet from surface. Fine grained amygdaloid with flow lines.

Grain

Olivine 2x3; 2x1; 2, 1

Feldspar 5x1; 15x1.5; 7x1, av. .27x.03 mm.

Sp. 15116. Hole 3 at 110 feet from surface. Very fine grained with minute irregular amygdules suggestive of a salic rock; ground mass of low angled feldspar.

Grain

Olivine?

Feldspar 7x1; 8x1; 5x1, av. .20x.03 mm.

Augite 1?

Sp. 15117. Hole 3 at 122 feet from surface. Vitreous; minute pores; around them in some parts finer grained so that even the feldspar measured seems porphyritic. They have black borders and the irregular shape of acid pores.

Grain

Olivine 0?

Iron oxide .2; .3; .4; .5; 3; 3; 1, av. .07x.01 mm.

Feldspar 5x1; 7x1; 7x1, av. .19x.03 mm.

Sp. 15118. Hole 3 at 134 feet from surface. Very light color and very fine grained.

Grain

Feldspar 7x2; 8x1; 8x1, av. .23x.04 mm.

Augite 1x1; 1x1; 2x1, av. .04x.03 mm.

Sp. 15119. Hole 3 at 148 feet from surface. Fine grained iron oxide dots.

Grain

Iron oxide 4x4; 4x6; 8x6, av. .16x.16 mm.

Feldspar 12x1; 14x2; 9x1, av. .35x.04 mm.

Augite 1x2; 5x1; 2x2, av. .08x.05 mm.

Sp. 15120. Hole 3 at 150 feet from surface. Fine grained; very curious contact with chalcedonic layer of coarser grain; datolite.

Grain

Iron oxide 4x4; 4x5; 6x5, av. .14x.14 mm.

Feldspar 8x1; 11x1; 7x1, av. .26x.03 mm.

Augite 7x4; 1x1; 6x4, av. .14x.09 mm.

Sp. 15121. Hole 3 at 187 feet from surface. Somewhat poikilitic; some olivine, labradorite extinction angles 35°-32°; 13°-12°w3°.

Grain

Olivine 7; 7

Iron oxide 8x4; 5x7; 6x9, av. .19x.20 mm.

Feldspar 9x2; 12x1; 12x1, av. .33x.04 mm.

Augite 42x30; 65x40; 30x30, av. 1.37x1.00 mm.

Sp. 15122. Hole 3 at 215 feet from surface. Very fine grained.

Grain

Iron oxide 1x1; 2x2; 1x1, av. .04x.04 mm.

Feldspar 5x1; 8x1; 10x1, av. .23x.03 mm.

Augite 1x2; 1x1; 1x2, av. .03x.05 mm.

DRILL HOLE No. III

III. 215-309; (Ss. 15123-8). MELAPHYRE, ophite; equivalent (91) (197)

to No. I, 536-630 feet (Ss. 15056-61); quite amygdaloidal at top, with traces of a sedimentary parting.

The grain of the augite of this bed is given by h in Fig. 16 of Vol. VI, Part I. The rate of increase and coarseness of the augite at the bottom are exceptionally large. It thus stands in marked contrast to the beds above.

Sp. 15123. Hole 3 at 216 feet from surface. Fine grained amygdaloidal with blacker spots.

Grain

Olivine 1? 1; 2; 2

Feldspar 6x1; 5x1; 6x0.5.

Sp. 15124. Hole 3 at 223 feet from surface. Much decomposed; augite in queer aggregates.

Grain

Olivine 5x5; 18x4; 5x5, av. .28x.14 mm.

Feldspar much decomposed 18x4

Augite 20x4; 35x30; 40x35, av. .95x.69 mm.

Sp. 15125. Hole 3 at 230 feet from surface. Poikilitic; olivine plain.

Grain

Olivine 20x9; 15x10; 20x13, av. .55x.32 mm.

Feldspar 16x7; 19x4; 18x4

Augite 44x28; 80x70; 55x40, av. 1.79x1.38 mm.

Sp. 15126. Hole 3 at 254 feet from surface. Very coarse poikilitic; this corresponds to Marvine's light type of diorite, that is has a doleritic texture; labradorite extinction 16°-13°w41°-36°; 31°-40°w21 (larger extinction at center).

The interstices are filled with irregular probably secondary quartz shot through with apatite needles. The augite is not so thoroughly moulded upon the feldspar as usual. It has more of its own form and cuts into the feldspar. The magnetite is unusually coarse.

Grain

Olivine none.

Iron oxides 16x10; 18x13; 25x22, av. .60x.45 mm.

Feldspar 56x9; 90x24; 75x7, av. 2.21x.40 mm.

Augite 80x45; 42x25; 50x50, av. 1.72x1.20 mm.

Sp. 15127. Hole 3 at 285 feet from surface. Marked poikilitic.

Grain

Olivine 5x8; 9x9; 7x6, av. .21x.23

Feldspar 20x11; 12x4; 22x4, av. .54x.19

Augite 2-3 mm. (with naked eye); 130x115; 160x90; 130x130, av. 4.20x3.35 mm.

Sp. 15128. Hole 3 at 307 feet from surface. Finer grained poikilitic.

Grain

Olivine 9x18; 12x15; 12x13, av. .33x.46

Feldspar 20x6; 18x4; 10x3, av. .48x.13

Augite with naked eye 1-2 mm.; 25x20; 36x21; 40x40, av. 1.01x0.81 mm.

309; (S. 15129). Sediment, i. e., SHALE; mainly composed (0?) (197)

of plagioclase feldspar, but there is some quartz in it; cf. No. I, 630 feet; may perhaps be two or three feet thick. Cf. Wolverine sandstone, a wind blown deposit (?) since it seems to show much mechanical very little chemical action.

309-339; (Ss. 15130-3). MELAPHYRE, amygdaloidal. Veined (29) (226)

and seamed; very feldspathic; corresponds to No. I, 630-662 feet (Ss. 15062-15066).

Sp. 15130. Hole 3 at 311 feet from surface. Thoroughly decomposed? contact of sediment and glassy ground mass?

Sp. 15131. Hole 3 at 312 feet from surface. Coarse amygdaloid; olivine plain.

Grain

Olivine 10x5; 10x6; 9x9, av. .29x.20 mm.

Feldspar 15x3; 11x2; 17x3, av. .43x.08 mm.

Sp. 15132. Hole 3 at 326 feet from surface. Coarser; very feldspathic.

Grain

Olivine 9x8; 10x6; 11x11, av. .30x.25 mm.

Feldspar 19x2; 22x2; 15x3, av. .56x.07 mm.

Augite 7x5; 9x8; 10x9 and at times larger, but hardly porphyritic, av. .26x.22.

Sp. 15133. Hole 3 at 339 feet from surface. Feldspathic, olivine changes to magnetite. Margin at 339 ft.

Grain

Olivine 8x5; 10x8; 8x4, av. .26x.17 mm.

Feldspar 16x2; 13x1; 19x2, av. .48x.05 mm.

Augite 2; 1; 2x2, av. .05 mm.

3.339-363; (S. 15134). MELAPHYRE, amygdaloidal; drill hole (23) (249)

1,602-700 ?

No. I extends down to 700 feet, but is much decomposed in the lowest part, and the beds there are not easily separable. Poikilitic, basic feldspar.

Grain
Olivine 6x9; 9x10; 8x10, av. .23x.29 mm.
Feldspar 21x2; 15x3; 25x10, av. .61x.15 mm.
Augite 28x25; 17x17; 50x30, av. .95x.72 mm.
363-410; (Ss. 15135-8). OPHITE, amygdaloidal; possibly (45) (294)

two flows, separated at 380 feet. Compare bottom of Hole 1.

Sp. 15135. Hole 3 at 367 feet from surface. Rather fine grained; slightly poikilitic.
Grain
Olivine 4x5; 7x4; 6x2, av. .17x.11 mm.
Feldspar 20x1; 18x2; 15x3, av. .53x.06 mm.
Augite 12; 13x8; 34x22.

Sp. 15136. Hole 3 at 376 feet from surface. Marked poikilitic but in polysomatic aggregates; basic feldspar.
Grain
Olivine 15x12; 9x8; 14x10, av. .38x.30
Feldspar 14x3; 28x4; 19x5, av. .61x.12 mm.
Augite 40x40; 70x25; 40x30, av. 1.50x.95 mm.

Sp. 15137. Hole 3 at 380 feet from surface. Similar; rather finer.
Grain
Olivine 8x7; 7x7; 11x7, av. .26x.21 mm.
Feldspar 20x2; 16x3; 19x3, av. .55x.08 mm.
Augite 43x28; 48x32; 54x13, av. 1.45x.73 mm.

Sp. 15138. Hole 3 at 393 feet from surface. Similar; coarser; feldspar extinctions 27°-21°.
Grain
Olivine 12; 13; 6
Iron oxide 12; 12; 10
Augite 65x55; 40x40; 63x53, av. 1.68x1.48 mm.
410-453; (Ss. 15139-42). MELAPHYRE, ophite (42) (336)

Sp. 15139. Hole 3 at 410 feet from surface. Marked microlitic porphyritic. Near margin 410 ft.
Grain
Olivine 6x2; 10x6; 4x3, av. .20x.11 mm.
Feldspar phenocrysts 10x1; 15x3; 13x10, av. .38x.24 mm.
Augite 0.

Sp. 15140. Hole 3 at 420 feet from surface. Very feldspathic.
Grain
Olivine 11x4; 10x8; 15x7, av. .36x.19 mm.
Feldspar 15x3; 19x3; 12x2, av. .46x.08 mm.
Augite 2x3; 3x8; 2x3, av. .14x.07 mm.

Sp. 15141. Hole 3 at 424 feet from surface. Thoroughly decomposed; traversed by prehnite vein.
Grain
Olivine 6x3; 7x5; 4
Feldspar 15x4? augite and feldspar are all decomposed.

Sp. 15142. Hole 3 at 440 feet from surface. Poikilitic.
Grain
Olivine 16x8; 15x8; 10x7, av. .41x.23 mm.
Feldspar 24x3; 14x1; 23x4, av. .61x.08 mm.
Augite 47x42; 90x60; 66x45, av. 2.03x1.47 mm.

453-473; (Ss. 15143-4). MELAPHYRE, feldspathic (19) (355)

Sp. 15143. Hole 3 at 453 feet from surface. Little augite; mostly feldspar.
Grain
Olivine 8x7; 7x6; 12x7, av. .27x.20 mm.
Feldspar 15x2; 19x3; 17x7, av. .51x.12 mm.
Augite 12x13; 6x5; 14x6, av. .32x.24 mm.

Sp. 15144. Hole 3 at 464 feet from surface. Rather feldspathic.
Grain
Olivine 8x7; 9x6; 13x9, av. .30x.15 mm.
Feldspar 33x4; 24x3; 21x3, av. .78x.10 mm.
Augite 18x18; 30x22; 60x50, av. 1.08x.90 mm.
473-562; (Ss. 15145-51). MELAPHYRE, ophite; at 497 feet (86) (441)

the drillers are said to have struck a vein and to have followed it for 82 feet. They may have approached it at 424. S. 15149 at 496 feet and S. 15150 at 545 feet show a prehnite and calcite vein with crystallized copper.

Sp. 15145. Hole 3 at 473 feet from surface. Fine grained with a certain amount of glass; feldspar (seriate) varying in size.
Grain
Olivine 4x3; 7x4; 6x4, av. .17x.11 mm.
Feldspar 13x3; 18x3; 20x3, av. .15x.09 mm.
Augite 0.

Sp. 15146. Hole 3 at 478 feet from surface. Slightly augitic; feldspar low angled.
Grain
Olivine 6x5; 9x8; 10x6, av. .25x.19 mm.
Feldspar 18x2; 18x2; 20x3, av. .56x.07 mm.
Augite 20x8; 30x20; 18x15, av. .68x.43 mm.

Sp. 15147. Hole 3 at 490 feet from surface. Poikilitic; low angled feldspar.
Grain
Olivine 10x9; 12x8; 7x5, av. .29x.24 mm.
Feldspar 21x3; 23x3; 21x3, av. .65x.09 mm.
Augite 40x31; 60x60; 54x50, av. 1.54x1.41 mm.

Sp. 15148. Hole 3 at 496 feet from surface. Coarse feldspar; doleritic texture like Marvine's light type of diorite, augite and olivine if present largely altered to serpentine; feldspar ex. angles 7°-8°, 12°-16°; olivine is therefore uncertain.
Grain
Olivine ? (25)
Iron oxide 25x3
Feldspar 32x10; 49x10; 44x14, av. 1.25x.34 mm.
Augite 80x20; 65x40; 28x30, av. 1.73x.90 mm.

In one place there is a nest of augite like a fragment of a pyroxenite.

Sp. 15149. Hole 3 at 498 feet from surface. A little finer; feldspar very low angled; augite somewhat poikilitic but much cut up by feldspar; prehnite vein with crystals of copper; augite.
Grain
Olivine 10x5; 7x6; 9x7, av. .26x.18 mm.
Feldspar 22x4; 18x2; 11x8; 22x5, av. .60x.16 mm.
Augite 90x60; 65x40; 100x60, av. 2.55x1.60 mm.

Sp. 15150. Hole 3 at 545 feet from surface. Vein matter; calcite and prehnite gangue with copper, and much iron oxide.

Sp. 15151. Hole 3 at 561 feet from surface. Somewhat poikilitic.

Grain

Olivine 9x6; 7x4; 7, av. 0.23x0.15 mm.
Iron oxide 12; 7; 11; 8
Feldspar 28x3; 23x4; 20x3, av. .71x.10 mm.
Augite 70x15; 54x13; 45x30, av. 1.69x.58 mm.

Sp. 15152. Hole 3 at 563 feet from surface. Rather fine grained; amygdaloidal.

Grain

Feldspar 19x2; 21x1; 13x3, av. .53x.06.

Sp. 15153. Hole 3 at 583 feet from surface. Quite feldspathic; with red and white olivine pseudomorphs.

Grain

Olivine 15x7; 15x14; 18x12, av. .48x.33 mm.
Feldspar 24x4; 38x6; 32x5, av. .94x.15 mm.
Augite 13x12; 16x14; 20x13, av. .49x.39 mm.

Sp. 15154. Hole 3 at 619 feet from surface. Well marked poikilitic; green olivine; feldspar has very marked zonar extinctions.

Grain

Olivine 17x18; 19x15; 13x10, av. .49x.43 mm.
Iron oxide 25x3; 16x2; 10x6, av. .51x.11 mm.
Feldspar 58x11; 47x7; 70x14, av. 1.75x.32 mm.
Augite 92x74; 100x79; 80x75, av. 2.72x2.28 mm.

DRILL HOLE XIII.

At this point it seems best to pass to drill hole No. XIII, whose beginning is in a band of very chloritic amygdaloid close to the north of some bluffs of ophite. Two holes were put down here, one vertical and the other, No. XIIIA, at an angle of 45° to the east. Drill hole No. XIII is somewhat farther from tunnel No. 5, which is in the foot of the Minong trap (drill hole No. I, 536 feet=No. III, 215 feet), than the tunnel is from drill hole No. I. The distance from No. III to No. XIII is 1775 feet and the top of No. III is (231-216) 15 feet the lower. Hence, allowing the dip slope to be 1:4 (tan 14-½°) the top of No. XIII, in the absence of faults, would correspond to No. III, 459 feet. The first samples of the vertical hole No. XIII were accidentally mixed from 31 feet to 113 feet, so that we shall have to use the record of No. XIIIA for this part of our section. In hole No. XIII the rock grows less amygdaloidal after the first 17 feet and in hole No. XIIIA after the first 35 feet (reduced to the vertical which we will indicate by prefixing v, e. g. v. 25), then the hole passes into a uniform looking gray ophite which begins to be finer grained about 79 feet (v. 56 feet), but we do not reach its bottom, for at 86 feet (v. 61 feet), we cross a fissure, which this hole intended to cut. Only such holes show veins at right angles to the strike. Then, at 132 feet (v. 93 feet), comes a marked contact of two quite amygdaloidal flows, with copper and prehnite in the amygdules. The impregnation of copper and prehnite here and in Hole III may be from this fissure. From this point the rock is once more a massive ophite down to 208 feet (v. 147 feet), where there is another contact, with a band of basic sandstone. In No. XIII we have no distinct record until after 113 feet; then we meet a contact with a little sandstone at 125 feet. After this the rock is coarse grained down to 166 feet, when it becomes finer and grows amygdaloidal with vertical clay seams, down to 240 feet. At 230 feet we find a foot of sandstone like that at 125 feet. There are petrographic reasons, in the nature of the feldspar in the adjoining flows, for thinking that No. XIIIA (v. 93 feet) corresponds to No. XIII, 125 feet. If we suppose, as indicated

by the dip, that the amygdaloid at the top of No. XIII is that which occurs in No. III, 453 feet, then the first 17 to 25 feet of amygdaloidal rock will correspond to a point in No. III, down about 473 feet. Then for the bottom contact of the big ophite next below, at No. III, 562 feet, our first match will be No. XIII, 125 feet, and No. XIIIA (v. 93 feet). If we compute the dips from these correlations, we find that we have from No. XIII to No. III, tan 13° 20′; or tan 14° 20′.

It is not likely that the dip is becoming flatter as we go northwest from this point, for in general it grows steeper in that direction, and the dip about No. III was determined with the aid of No. 5 tunnel, as 14° 15′. It is therefore probable that the lower part of No. XIIIA is more nearly in undisturbed relations with No. III, 562 feet, than is No. XIII, though the dip may be steeper than thus indicated. Then the fault which cuts No. XIIIA at 86 feet must separate No. III, 562 feet, from No. XIII, 125 feet. It has an upthrow of (125-93) 32 feet, and in that case the amygdaloid at the top of No. XIII should correspond to No. III, 437 feet, but this is not a good correlation at all. The correlation found by assuming that the ground between the top of No. XIII and No. III is undisturbed, i. e., that No. XIII, 0 feet, is equivalent to No. III, 468 feet, is much better. If we accept this correlation, we must imagine that the fissure vein which crossed No. XIIIA crosses No. III also, probably being the vein entering at No. III, 497 feet, and throwing the part above up. Now drill holes Nos. XII, XIV, XIII, tunnel No. 5 and drill holes Nos. III and I, were all located near a supposed fault or vein which is indicated by a topographic break that runs a little east of north. A vein in about this position was indicated on Hill's map, 1871. Such a fault, if a normal fault with a hade slightly to the west, is just the one to have done the work we have attributed to it, passing a little to the east of No. XIII and No. III, but cutting into No. III at 497 feet. Figure 11 of the Isle Royale Report illustrates it, looking in the direction of the strike of rocks. There is a fissure that comes into No. XIII at about 252 feet or a little higher, and in that report is computed what the dip of the *fault* would be if the latter were a continuation of the former.

It is then quite likely that this *fault* has cut 31 feet out of the thickness of the ophite No. III, 473-562, and a corresponding amount out of No. III near No. XIII, 252 feet. Following our general rule, however, that we shall make the series as short as possible, we shall make no additions for this in our geological column. This is the third time at least that there is reason to believe this column as given is somewhat short of the truth.

The record of drill hole No. XIII is then as follows:

Sp. 15706. Hole 13 at 21 feet from surface. Amygdaloidal or merely drusic?; low angled feldspar.

Grain

Olivine 6x5; 7x6; 10x5, av. .23x.16 mm.
Feldspar 20x2; 18x1; 25x2, av. .63x.05 mm.
Augite 25x12; 25x23; 40x10, av. .90x.45 mm.

Sp. 15707. Hole 13 at 25 feet from surface. Poikilism more marked; irregular cavity lined with chloritic fibres; low angled feldspar.

Grain

Iron oxide 9x9; 5x9; 9; 12, av. .23x.3 mm.
Feldspar 24x2; 18x3; 21x1.5, av. .63x.06 mm.
Augite by eye 3 mm.; 155x100; 130x80; 210x80, av. 4.95x3.60 mm.

Sp. 15708. Hole 13A at 74 feet from surface. Finer grained than No. 15707 but similarly poikilitic; moderately low angled andesite feldspar.

Sp. 15709. Hole 13A at 79 feet from surface. Still finer than 15708; low angled feldspar. Olivine reddened.

Sp. 15710. Hole 13A at 85 feet from surface. Much serpentinized olivine and feldspar; big feldspar phenocrysts; low angled andesite feldspar.

Sp. 15711. Hole 13A at 87 feet from surface. Coarser; low angled feldspar.

Grain

Olivine 20

Feldspar 30x8

Augite 23x18.

Sp. 15712. Hole 13 at 89 feet from surface. Like Sp. 15711 but slightly coarser; low angled feldspar and much of it.

Grain

Olivine 10x10; 10x13; 7x14, av. .27x.37 mm.

Feldspar 53x5; 50x4; 36x5, av. 1.39x.14 mm.

Augite 78x55; 120x60; 110x85, av. 3.08x2.00 mm.

Sp. 15713. Hole 13A at 123 feet from surface. No coarser than Sp. 15711 much olivine; feldspar extinction angles 45°-45°; anorthite 29°-0°; 23° labradorite.

Sp. 15714. Hole 13A at 132 feet from surface. Marked contact; rock microlitic porphyritic with brown glass; probably bottom. Feldspar phenocrysts 32x13 with trichitic additions.

Sp. 15715. Hole 13A at 133 feet from surface. Microlitic amygdaloid; coarser; very feldspathic originally; all prehnite now. Is this the Kearsarge lode?

Sp. 15716. Hole 13A at 135 feet from surface. Coarser; small chlorite pores; low angled feldspar.

Sp. 15717. Hole 13A at 137 feet from surface. Finer grained; thoroughly decomposed.

Sp. 15718. Hole 13 at 100 feet from surface. Coarse green olivine and marked augite; feldspar a basic labradorite near anorthite; feldspar extinction angles 12°-24°w39°-37°; 12°-16°w22°-34°; 0°-27°w50°-30°; 43°-40°; 17°-8°-32°.

Grain

Olivine 15x10; 22x15; 18x15, av. .55x.40 mm.

Feldspar 53x9; 30x4; 63x5, av. 1.46x.18 mm.

Augite with naked eye 3 mm.; 140x80; 80x80; 95x65, av. 3.15x2.25 mm.

Sp. 15719. Hole 13A at 160 feet from surface. Coarse poikilitic; not so much olivine; feldspar extinction angles 21°w31°-41°; 32°-16°w22°-34°.

Grain

Augite 60x60; 70x60, av. 2.1x2 mm.

Sp. 15720. Hole 13 at 117 feet from surface. Coarse poikilitic very basic feldspar.

Grain

Olivine 10x13; 7x7; 23x15, av. .40x.35 mm.

Feldspar 18x4; 23x5; 38x7, av. .79x.16 mm.

Augite 130x70; 70x65; 75x60, av. 2.75x1.95 mm.

Sp. 15721. Hole 13 at 125 feet from surface. Slightly amygdaloidal; idiomorphic augite prisms; extra reddish.

Grain

Olivine 9x11; 7x10; 8x8, av. .24x.29

Feldspar 12x4; 10x2; phenocrysts 40x15!

Augite 33x10; 46x7; 52x20, av. 1.31x.37.

If the sandstone below is as suggested in the Isle Royale report Marvine's slaty sandstone No. 9, this bed just above it would correspond to the foot of the Kearsarge lode which is characterized by being at the same time somewhat ophitic and having large feldspar phenocrysts. This section 15721 seems to show one of these phenocrysts.

The copper at 3.496 and 545 feet may remind one of the Kearsarge lode. Compare also Sp. 15714 and 15715.

(441)

13. 125-126; (S. 15722) SANDSTONE, the Wolverine, (1) (442)

Marvine's No. 9? basic and red.

Sediment is made up of granules of augite and plagioclase? with a few of ground mass about 2x3 to 6x5 thirtieths of a mm.

See remarks above and on the bed at 13.229 feet.

126-184; (Ss. 15723-41). MELAPHYRE, ophite (56) (498)

Sp. 15723. Hole 13 at 127 feet from surface. Microlitic; porphyritic; feldspar not very basic.

Grain

Olivine 11x10; 11x7; 12x8, av. .34x.25 mm.

Feldspar 12x2; 15x3; 14x3, av. .41x.08 mm.

Augite 0.

Sp. 15724. Hole 13 at 137 from surface. Non-poikilitic yet very feldspathic; feldspar not very basic, low angled.

Grain

Olivine 27x18; 15x12; 13x13, av. .55x.43 mm.

Feldspar 55x5; 39x5; 60x6, av. 1.54x.16 mm.

Augite 70x36; 38x25; 80x36, av. 1.88x.97 mm.

Sp. 15725. Hole 13A at 175 feet from surface. Ophitic; labradorite extinction 22° to 38°-34°?; mostly iron oxide instead of olivine.

Sp. 15726. Hole 13A at 197 feet from surface. Similar extinction angles 4°-4°; 12°-0°. Perhaps the two sections interchanged.

Sp. 15727. Hole 13A at 204 feet from surface. Similar; (coarser); low angled?

Sp. 15728. Hole 13A at 208 feet from surface. Microlitic, porphyritic contact with basic sediment. Basic sediment is like that at 125-126 feet, but on account of the fact that above and below are andesitic beds the original correlation of 13A-133-135 with 13.125-127 is probably better. It matches 3.563 well.

Sp. 15729. Hole 13A at 214 feet from surface. Feldspar not very basic; extinctions 8°w9°-13°; 15°-15°; 10°-7°.

Olivine is altered,—red with green center.

Sp. 15730. Hole 13A at 218 feet from surface. Fine grained amygdaloid with finer grain around amygdules andesite 19°-8°; 15°-0°.

Sp. 15731. Hole 13A at 219 feet from surface. There is a change of about a quarter of the olivine to serpentine and mica. Very feldspathic; low angled andesite; extinctions 11°-6°.

Sp. 15732. Hole 13A at 234 feet from surface. Very fine grained, but like 15730; very feldspathic and microlitic.

Sp. 15733. Hole 13 at 146 feet from surface.

Sp. 15734. Hole 13 at 156 feet from surface. Quite feldspathic; slightly poikilitic; feldspar extinction angles 15°-15°; 0°w13°-9°.

Grain

Iron oxide 10x12; 10x11; 20x21, av. .40x.44

Feldspar 30x3; 30x3; 30x7, av. .90x.13

Augite 45x18; 48x25; 60x20, av. 1.53x.63.

Sp. 15735. Hole 13 at 160 feet from surface. Poikilitic; much green olivine; feldspar extinctions 24°-21°; 9°; 3°; 12° with 47°-38°; 10-17°w35° in Baveno twins.

Grain

Iron oxide 10x9; 10x10; 16x12, av. .36x.31 mm.

Feldspar 40x?; 40x7; 42x4, av. 1.22x.20 mm.
Augite 120x120; 85x75; 102x70, av. 3.07x2.65 mm.

Sp. 15736. Hole 13 at 171 feet from surface. Green mica after olivine; similar to 15735; feldspar extinction angles 6°-0°w26°-19°; 40°-42°; 25°-21°w41°-41°.

Sp. 15737. Hole 13A at 245 feet from surface. Poikilitic; greened olivine; low angled feldspar.

Sp. 15738. Hole 13A at 256 feet from surface. Pretty thoroughly changed to prehnite.

Sp. 15740. Hole 13 at 183 feet from surface. Fine grained; somewhat amygdaloidal.

Grain
Iron oxide 7x10; 7x8; 9x10, av. .23x.28 mm.
Feldspar 20x6; 24x7; 35x5, av. .79x.18 mm.
Augite 14x14; 15x10; 32x30, av. .61x.54 mm.

Sp. 15741. Hole 13 at 184 feet from surface. Microlitic, porphyritic.

Grain
Iron oxide 11x9; 11x7; 9x8, av. .31x.22 mm.
Feldspar phenocrysts 10x2; 14x4; 31x5, av. .55x.11 mm., smaller sized 2-3x0.1.
Augite 0.

(498)

184-229; (Ss. 15742-5). MELAPHYRE, feldspathic ophite (43) (541)

Sp. 15742. Hole 13 at 189 feet from surface. Amygdaloidal; slightly microlitic; much decomposed olivine; andesite.

Grain
Iron oxide 7x8; 7x8; 7x8, av. .21x.24 mm.
Feldspar 18x4; 27x3; 24x2, av. .69x.09 mm.
Augite 12x2; 12x6; 20x15, av. .44x.23 mm.

Sp. 15743. Hole 13 at 210 feet from surface. Coarser with symmetrical vein of calcite and quartz filling.

Grain
Iron oxide 9x7; 12x5; 12x5, av. .33x.17 mm.
Feldspar 25x4; 24x3; 29x3, av. .78x.10 mm.
Augite 25x10; 33x17; 18x14, av. .76x.41 mm.

There is a finer grain near the crack filled by the vein, which must be contemporaneous like an amygdaloid. Near the crack the augite is only 8x1, the feldspar 6x2.

Sp. 15744. Hole 13 at 222 feet from surface. Poikilitic.

Grain
Iron oxide 14x7; 12x11; 16x10, av. .52x.28 mm.
Feldspar 21x3; 25x4; 32x5, av. .78x.12 mm.
Augite 70x55; 80x47; 65x40, av. 2.15x1.42 mm.

Sp. 15745. Hole 13 at 229 feet from surface. Microlitic; almost glomeroporphyritic but of the type common near bottom of flows; fairly large olivines; andesite feldspar.

Grain
Olivine 6x9; 5x7; 13x22, av. .24x.38 mm.
Feldspar 25x12; 31x8; 24x6, av. .80x.26 mm.

229-230; (Ss. 157646). SANDSTONE, basic, associated with (1) (542)

clay veins running into hanging and foot. This or the bed at 125 feet may represent Marvine's slaty sandstone, No. 9; at least either of them is in about the right position for it, if the Minong conglomerate is the same as the Kearsarge conglomerate—for they would be 441 feet respectively 542 feet below.

If we depend on the coarse phenocrysts of the bed above the upper bed at 125 feet is the best match, and a number of sediments come shortly below the Wolverine. Compare Central Mine section (56) and (59) (Fig. 33), or 50 and 56, or also Manitou Frontenac (71) and (78) (Fig. 29).

Sp. 15746. Hole 13 at 230 feet from surface. Basic sediment like that at 125-126 feet; granules of augite, microlitic glass; feldspar; magnetite; calcareous cement. Margin 230.

230-252; (Ss. 15747-51). MELAPHYRE, amygdaloidal, fine (21) (563)

grained; red, with clay veins from the top and the bottom; brecciated and prehnitic. Seems to be of the porphyrite type.

Sp. 15747. Hole 13 at 232 feet from surface. Microlitic porphyrite in contact with clasolite; much like 15745.

Grain
Curious alteration of olivine 20x10?
Feldspar 33x11; 12x6; 36x7, av. .81x.24 mm.

Sp. 15748. Hole 13 at 233 feet from surface. Looks like glomeroporphyrite in contact with sediment; low angles. This glomeroporphyrite is something like Huginnin porphyrite and Minong trap. Compare also beds 82 to 112 in the Central Mine section above mentioned, and 10 to 59 of the Torch Lake section (Fig. 38).

Sp. 15749. Hole 13 at 236 feet from surface. Microlitic porphyrite in contact with sediment.

Grain
Olivine 14x12; 12x10; 15x11, av. .41x.33 mm.
Feldspar 45x6; 48x15; 28x3, av. 2.21x.24 mm.

Sp. 15750. Hole 13 at 245 feet from surface. Very little augite; much low angled andesite; feldspar; extinctions often near 0° but up to 22°-11°; much olivine.

Grain
Olivine 10x11; 13x9; 8x6, av. .31x.26 mm.
Feldspar 23x6; 27x9; 44x6, av. .94x.21 mm.
Augite 13x7; 7x4; 6x7, av. .26x.18 mm.

Sp. 15751. Hole 13 at 252 feet from surface. Very prehnitic; fragments of porphyritic microlitic amygdaloid. At margin 252 feet.

252-342; (Ss. 15752-61). MELAPHYRE, ophite; feldspathic (87) (650)

Sp. 15752. Hole 13 at 257 feet from surface. Much decomposed; not very much augite; feldspar inclined to vary in size, low angled; it is characteristic of the poikilitic or ophitic texture here that the augite is badly cut up. This group of feldspathic ophites between conglomerates 9 and 8 is quite persistent on Keweenaw Point.

Grain
Olivine 18x15; 9x9; 11x11, av. .38x.35 mm.
Feldspar 12x4; 28x7; 22x10, av. .62x.21 mm.
Augite 17x14; 22x14; 30x12, av. .69x.40 mm.

Sp. 15753. Hole 13 at 262½ feet from surface. Similar poikilitic patches of augite, but feldspars very predominant.

Grain
Olivine 9x6; 13x12; 8x7, av. .30x.25 mm.
Feldspar 35x4; 35x11; 20x3, av. .90x.18 mm.
Augite 70x45; 46x45; 46x34, av. 1.62x1.24 mm.

Sp. 25754. Hole 13 at 271 feet from surface. More markedly poikilitic; feldspar extinctions 28°-12°w36°-30°; 17°-19°; 21°-16°w43°-36°.

Grain

Olivine 26x20; 11x10; 15x8, av. .52x.38 mm.

Feldspar 24x6; 24x3; 32x7, av. .80x.16 mm.

Augite with naked eye 2-3 mm.; 50x30; 80x65; 50x40, av. 1.80x1.35.

Sp. 15755. Hole 13 at 275 feet from surface. Similar to 15754, coarser; the feldspar in the patches is smaller than that between them; extinction angles 25°-13°; 49°-42°; 21°-8°w31°-31°.

Grain

Olivine 10x9; 5x7; 5x10, av. .20x.26 mm.

Feldspar 24x6; 27x5; 26x8, av. .77x.19 mm.

Augite with naked eye 3 mm.; 83x70; 80x56; 120x60, av. 2.83x1.86 mm.

Sp. 15756. Hole 13 at 299 feet from surface. More augitic; feldspar extinction angles 16°w40°-38°; 19°-16°w40°-41°.

Grain

Olivine 11x11; 15x8; 10x8; 7

Feldspar 42x11; 24x6; 30x5, av. .96x.22 mm.

Augite with naked eye 3+ ?; 105x75; 110x85; 160x72, av. 3.75x2.32 mm.

Sp. 15757. Hole 13 at 314 feet from surface. Similar to 15756 feldspar extinction angles 14°-20°w43°-44°.

Grain

Olivine 11x9; 17x13; 13x11, av. .41x.33 mm.

Feldspar 35x7; 24x6; 35x5, av. .94x.18 mm.

Augite with naked eye 4 mm.; 100x100; 110x100; 110x55, av. 3.20x2.55 mm.

Sp. 15758. Hole 13 at 323 feet from surface. Similar to 15757 feldspar extinction angles 19°-13°w44°-40°.

Grain

Olivine 25x21; 14x11; 14x13, av. .53x.45 mm.

Feldspar 27x12; 36x10; 22x6, av. .85x.28 mm.

Augite 77x70; 80x57; 120x70, av. 2.77x1.97 mm.

Sp. 15759. Hole 13 at 333 feet from surface. Feldspar extinction angles 23°-19°w43°-38°.

Grain

Olivine 5x14; 9x10; 15x6, av. .29x.30 mm.

Feldspar 33x5; 35x5; 36x9, av. 1.04x.19 mm.

Augite with naked eye 1-2 mm.; 27x22; 27x20; 57x30, av. 1.11x0.72 mm.

(650)

342-349; (Ss. 15761-2). MELAPHYRE, amygdaloidal (7) (657)

Sp. 15761. Hole 13 at 342 feet from surface. Porphyritic much decomposed amygdaloid.

Grain

Olivine 13x14

Feldspar 15x3; 15x4; 14x4, av. .44x.11 mm.

Augite 12x6; 9x7; 12x7, av. .33x.20 mm.

Sp. 15762. Hole 13 at 349 feet from surface. There is a bottom amygdaloid, very black; very fine grained microlitic, feldspar extinction 20°, 33°, 28°. Margin at 347½.

Grain

Feldspar 18x4; 9x3; 17x5, av. .44x.12.

Beside this there is the top of the next flow, more feldspathic,—the feldspar so decomposed that its extinctions are doubtfully representative 14°-10°; 15°; 8°-0°; 12°-2° somewhat agglomerated grains 19x6; 30x10; 16x7.

349-359. (S. 15763). MELAPHYRE, amygdaloidal with prehnite (10) (667)

Sp. 15763. Hole 13 at 359 feet from surface. Microlitic, porphyritic with prehnite.

Grain

Olivine 7x7; 10x10; 32x17, av. .49x.34 mm.

Feldspar 24x4; 12x3; 15x3, av. .51x.10 mm.

359-447.5; (Ss. 15764-72). MELAPHYRE, ophite; amygdaloidal (86) (753)

for the first 8 or 9 feet. All along in this flow there is not a clearly marked tendency to glomeroporphyritic character or separation of feldspar into two sizes.

Sp. 15764. Hole 13 at 364 feet from surface. Chalcedonic amygdaloid; almost glomeroporphyritic; very feldspathic.

Grain

Olivine 12x11; 29x17; 17x10, av. .58x.38

Feldspar 13x6; 20x7; 20x3, av. .63x.16

Augite 7x3; 8x5; 8x6, av. .23x.14.

Sp. 15765. Hole 13 at 370 feet from surface. More augite but still very little; low angled; feldspar extinctions 9°-7° etc.

Grain

Olivine 15x14; 30x18; 25x18, av. .70x.50 mm.

Feldspar 37x8; 25x9; 38x9, av. 1.00x.26 mm.

Augite 30x30; 50x16; 37x23, av. 1.17x.69 mm.

Sp. 15766. Hole 13 at 382 feet from surface. Usual poikilitic type; feldspar extinctions 22°-24°w27°-30°w40°; 23°-0° and 43°-37°; 38°.

Grain

Olivine 18x9; 16x9; 20x10, av. .54x.28 mm.

Feldspar 40x5; 40x13; 30x8, av. 1.10x.26 mm.

Augite 70x60; 50x30; 55x30, av. 1.75x1.20 mm.

Sp. 15767. Hole 13 at 403 feet from surface. Usual poikilitic type, feldspar extinctions slightly varying in concentric zones alternating more or less; extinction angles 26°-26°w42°-40°; 11°-10°[1]w38°-35°.

Grain

Olivine 11x9; 18x14; 14x10, av. .43x.33

Feldspar 50x15; 38x8; 26x10, av. 1.14x.35

Augite 90x55; 75x70; 80x80, av. 2.45x2.05.

Sp. 15768. Hole 13 at 410 feet from surface. Usual poikilitic type; extinction angles 29°-21°w33°; 21°-19°w45°; 30°-16°w46°-31°; 28°-25°w37°-34°; 25°-44° w11°-46° (varying in zones).

Grain

Olivine 20x12; 30x19; 20x18, av. .70x.49 mm.

Feldspar 38x20; 20x8; 25x7, av. .83x.35 mm.

Augite 45x40; 50x35; 70x45, av. 1.65x1.20 mm.

Sp. 15769. Hole 13 at 420 feet from surface. Usual poikilitic type; feldspar extinctions 45°-42°w13° and 32°-29, 18°-19°w41°-42°.

Grain

Olivine 15x14; 15x15; 10x10, av. .40x.39 mm.

Feldspar 30x8; 31x8; 34x12, av. .95x.28 mm.

Augite 74x40; 50x55; 80x72, av. 2.04x1.67 mm.

Sp. 15770. Hole 14 at 426 feet from bed rock surface. Usual poikilitic type; much feldspar still; a coarse part has more olivine and augite more by itself; feld-

[1]This 10° extinction is somewhat more in zones toward the center but alternates somewhat.

spar extinctions 28°-28°w?46°-37°; 34-36w39. In the basic coarse spot which may be doleritic there is more olivine and the feldspar is not so much enclosed in the augite. The feldspar extinctions are 17°w35°-30°; 22°-17°w41°-42°; 18°w35°-18°; 0°-13°.

Grain

Olivine 11x10; 14x10; 10x10; 20x21; 23x23; 22x15, av. .35x.30 and .65x.59 mm.

Feldspar 28x6; 31x9; 30x5; 45x7; 43x7; 38x7, av. 1.1x.2 mm.

Augite 60x45; 30x25; 35x30; 70x30; 150x50; 60x50, av. 1.25x1.00 and 2.80x 1.30 mm.

Sp. 15771. Hole 13 at 438 feet from bed rock surface. Finer grained amygdules in small interstices, patchy; feldspar extinctions 10°-17°w32°-35°.

Grain

Olivine 8x17; 10x7; 21x22, av. .39x.46 mm.

Feldspar 16x6; 25x10; 23x8, av. .64x.24 mm.

Augite 10x10; 12x12; 25x15, av. .47x.37 mm.

Sp. 15772. Hole 13 at 447 feet from bed rock surface. Feldspar seriate, but beginning to be hiatal; extinctions 8°-12°w35°-34°; chloritic amygdules.

Grain

Olivine 12x7; 13x10; 25x20, av. .50x.37 mm.

Feldspar 22x7; 24x9; 17x5, av. .63x.21; smaller one 7x2; 15x3; 10x2, av. .32 x.07 mm.

Augite 11x8; 13x8; 10x6, av. .34x.22 mm.

447.5-503; (Ss. 15773-9). MELAPHYRE, porphyrite; has a (44) 797

peculiar character microscopically, which we find again in the bed at the top of No. XIV; red; fine grained; laumontitic with chlorite and calcite; very feldspathic, with little augite visible, even under the microscope. Compare Central Mine beds 97-112. This flow has the very rare feature of a tendency to a double crop of augite as well as olivine and feldspar.

With this bed we pass to the record of drill hole No. XIV. If we compute where, in No. XIII, the top bed of No. XIV would be, with the dip that we have hitherto used, we find that it would correspond to No. XIII, 406 feet, right in the middle of a big ophite, whereas as a matter of fact the top of No. XIV lies under and to the north of an ophite bluff, and begins in beds like those at the bottom of No. XIII as already stated. There is therefore little doubt that the top of No. XIV corresponds to beds near the bottom of No. XIII. The exact correlation is uncertain, the range being between No. XIII, 503 feet, and No. XIII, 448 feet, with No. XIV, 11 feet. The correlation may possibly be No. XIII, 493 feet, to No. XIV, 22 feet, an intermediate and otherwise most plausible correlation. This corresponds to a dip of 16° 40′ here. If this steeper dip were due to a fault, it would mean that No. XIV was on the up-throw side, and the bottom of No. XIII on the down-throw side, but there is no reason to think that there is any such fault but rather to believe that this is the normally increasing true dip. *Consequently for No. XIV we use the factor 0.0438, to reduce from* VERTICAL *width along hole to true* THICKNESS.

For the next flow we have, from No. XIII, 447.5 to 493 feet, already given, 45.5 feet, lapping over on the first 22 feet of No. XIV.

Sp. 15773. Hole 13 at 447½ feet from bed rock surface. Olivine is often bastite; more amygdaloidal than 15772; augite granules in ground mass; porphyritic feldspar extinctions 0°-17°; 0°-20°; 0°-18°.

Grain

Olivine 10x9; 8x6; 8x7, av. .26x.22 mm.

Feldspar phenocrysts 24x7; 26x10; 20x9, av. .70x.26 mm.

Augite 2, 2, 1, 1, 4x2, av. .05 mm.

Sp. 15774. Hole 13 at 450 feet from bed rock surface. Much olivine; feldspathic amygdaloidal; extinction angles 6°-12°; 10°; 8°-6°; 16°-11°.

Grain

Olivine 19x14; 9x8; 13x12, av. .41x.34 mm.

Feldspar phenocrysts 14x4; 18x6; 20x8, av. .52x.18 mm.

Augite 6x4; 6x6; 10x4, av. .22x.14 mm.

Sp. 15775. Hole 13 at 462 feet from bed rock surface. Augite granules in two sizes, this is rare!; feldspar not sharply separated; extinction angles 45°-16°; 13°-14°; 24°-16°; all along here much olivine and traces of a small generation.

Grain

Olivine 18x15; 25x13; 40x20

Feldspar 20x4; 18x2; 22x3; 30x5; 23x13; 25x9, av. .6x.2

Augite phenocrysts 30x11; 7x7; 8x7; 10x8, av. .4x.2.

Sp. 15776. Hole 13 at 473 feet from bed rock surface. Microlitic porphyrite with augite granules, two sizes of not widely separated feldspar; finer grained than Sp. 15775.

Grain

Olivine 7x10; 7x12; 13x16, av. .27x.38 mm.

Feldspar larger 28x9; 22x7; 30x7, av. .70x.23 mm.; smaller 8x3.

Augite 4x4; 7x6; 4x2, av. .15x.12 mm.

Sp. 15777. Hole 13 at 492 feet from bed rock surface. Porphyritic microlitic; much decomposed.

Grain

Olivine 16x13; smaller generation of olivine 8x7; 5x2

Feldspar larger 33x11; 30x10; 20x5; smaller about 4 or 5x1; av. .83x.26

Augite 3x1; 2x2; 2, 1.

Sp. 15778. Hole 13 at 500 feet from bed rock surface. Calcite veins; amygdules; basic feldspar; extinction angles 23°-32°w18°-11°; 25°-23°w45°-36°.

Grain

Olivine 10x5; 15x12; 15x10; 10x13

Feldspar phenocrysts 33x7; 42x15; 23x7, av. .98x.29 mm.

Augite 6x4; 5x2; 4x3, av. .15x.09 mm.

Sp. 15779. Hole 13 at 503 feet from bed rock surface. Feldspar in two sizes; augite in grains; glomeroporphyritic texture not marked; extinction angles 32°-30°w15°; 20°-32°w17°.

Grain

Olivine 15x10; 15x14; 12x8, av. .42x.32 mm.

Feldspar phenocrysts 33x12; 33x14; 33x10, av. .99x.36 mm.

Augite 6x4; 5x5; 7x5; 10x6, av. .23x.16 mm.

22-138; (Ss. 15780-9). MELAPHYRE, porphyrite; the last 10 (111) (908)

feet of No. XIII are equivalent to this; at 30-33 feet was a seam of prehnite with numerous *copper* crystals; at 90 feet and again at 123 feet a chloritic seam with *copper* and calcite.

This is also of the porphyritic type with a tendency to idiomorphic augite and two generations of feldspar always, augite at times. Compare the beds in holes 4 and 6 of the Central Mine section 97-112.

Sp. 15780. Hole 14 at 11 feet from bed rock surface. Very prehnitic; microlitic porphyritic; augite granules; extra feldspathic with extinction angles 6°-10°w10°-15°; phenocryst 7°-12°w-20°.

Grain

Olivine 4? ?

Iron oxide 2; 3; 2

Feldspar 23x15; 30x13; 22x10; av. .75x.38 mm.
Augite 5x4; 3x2; 4x3, av. .12x.09 mm.

Sp. 15781. Hole 14 at 15 feet from bed rock surface. Glomeroporphyritic feldspar; extinction angles 9°-8°w21°; idiomorphic augite granules; sp. 15749 is like it.

Grain
Iron oxide ?2; 3; 4
Feldspar phenocrysts 35x10; smaller 11x2; 7x1; 10x1, av. .28x.04 mm.
Augite 8x9; 1x1; 10x10; 15x10, av. .28x.25 mm.

Sp. 15782. Hole 14 at 22 feet from surface. Glomeroporphyritic; augite in grains; low angled feldspar.

Grain
Olivine 7x7? 9x8; 6x6, av. .22x.21 mm.
Iron oxide 9x9; 12x10; 10x5, av. .31x.24 mm.
Feldspar phenocrysts 35x15; smaller size 12x1; 12x1, av. .59x.17 mm.
Augite 12x8; 22x11; 11x5, av. .45x.24 mm.

Sp. 15783. Hole 14 at 29 feet from bed rock surface. Feldspar coarser low angled; augite grains; red and green olivine.

Grain
Olivine 10x8; 6x6; 15x8, av. .31x.22 mm.
Iron oxide 17x15; 4x4, av. .35x.31 mm.
Feldspar 52x12; 20x10; 15x15, av. .87x.37 mm.
Augite 10x8; 20x10; 15x15, av. .45x.33 mm.

Sp. 15784. Hole 14 at 46 feet from bed rock surface. Augite still in grains. Glomeroporphyritic; feldspar appears more basic; very little olivine; extinction angles 42°-39°w7°; 44°-41°w19°; w35°-57°; 31°-17°w50°; 34°-46°; 19°-28°w.49°.

Grain
Olivine 8x7; 5x4; 4x4, av. .17x.15 mm.
Feldspar 35x15; 15x2; 20x2, av. .70x.19 mm.
Augite 25x20; 12x8; 14x5, av. .51x.33 mm.

This section also shows very well a feldspar cut nearly parallel to m (010).

Sp. 15785. Hole 14 at 65 feet from surface. Basic feldspar with extinction 45°-45°w60°-46°; 32°-35°w47°-47°; augite in grains; greened olivine.

Grain
Olivine 12x9; 10x8; 9x6, av. .31x.23 mm.
Feldspar phenocrysts 42x12; 30x11, av. 1.2x.38 mm.; smaller 10x1
Augite 19x19; 16x13; 20x17, av. .55x.49 mm.

Sp. 15786. Hole 14 at 90 feet from bed rock surface. Similar to 15785; feldspar extinction angles 45°-45° and 30°-25°; 26°-27°; 37°.

Grain
Olivine 5x4; 10x9; 11x11, av. .26x.24 mm.
Feldspar 33x11; 30x11; 8x2, av. .71x.24 mm.
Augite 11x9; 17x10; 13x13, av. .41x.32 mm.

Sp. 15787. Hole 14 at 120 feet from bed rock surface. Similar to 15786; 21°-22°w33°-37°; 13°-16°w35°-41°; 28°-33°; 30°-6°w50°-38°.

Grain
Olivine 9x8; 8x6; 10x8; 15x9, av. .35x.25 mm.
Feldspar 43x11; 30x17; 27x10, av. 1.00x.38 mm.
Augite 15x10; 15x14; 20x8, av. .50x.32 mm.

Sp. 15788. Hole 14 at 123 feet from bed rock surface. Similar; augite fine; much decomposed.

Grain
Olivine 9x8; 15x8, av. .4x.31 mm.
Iron oxide 7
Feldspar 57x30? 28x12; 20x5, av. 1.05x.47 mm.
Augite 20x10; 9x9; 12x7, av. .41x.26 mm.

Sp. 15789. Hole 14 at 138 feet from surface. Much decomposed; similar to 15788; in contact with very prehnitic belt; porphyritic; very feldspathic. Distance from margin 1 ft.

A. Appears to show the decomposed top of a flow with worn off fragments or ash embedded in a fine grained altered mud.

Feldspar 30x5.

B. Has well defined structure, but the feldspar is all changed to prehnite. It is in two generations and the augite is more idiomorphic than often.

Grain
Olivine?
Iron oxide 4?
Feldspar phenocrysts 17x8; 60; 55; 10; 10
Augite 10; 7; 13; 5; 8; 7.

139-200; (Ss. 15790-7). MELAPHYRE, ophite; feldspathic, 58 (966)

first 9 feet amygdaloidal; toward the bottom, veins with prehnite and *copper*.

Sp. 15790. Hole 14 at 140 feet from surface. Large phenocrysts of feldspar much changed to prehnite; reddened amygdaloidal; porphyritic feldspathic; scanty idiomorphic augite.

Grain
Feldspar phenocrysts 30x5; 41x8; 44x11, av. 1.15x.24 mm.
Augite 5x2; 6x5; 7x7, av. .18x.14 mm.

Sp. 15791. Hole 14 at 150 feet from surface. Very feldspathic with phenocrysts; augite granules; rather low angled feldspar extinctions.

Grain
Olivine 16x11; 13x11; 12x7, av. .41x.28 mm.
Feldspar phenocrysts 40x17; 25x12; 31x30, av. .96x.59 mm.
Augite 14x13; 10x10; 8x7, av. .32x.30 mm.

Sp. 15792. Hole 14 at 159 feet from surface. Poikilitic; low angled feldspar; extinction angles 8°-8°w0°.

Grain
Olivine 21x15; 11x9; 13x12, av. .45x.36 mm.
Feldspar 27x7; 40x8; 32x10, av. .99x.25 mm.
Augite 60x57; 72x40; 50x36, av. 1.82x1.33 mm.

Sp. 15793. Hole 14 at 170 feet from surface. Poikilitic; feldspar extinction angles 42°-48°w14°-14°; 43°-49°w12°.

Grain
Olivine 13x13; 17x16; 10x10, av. .40x.49 mm.
Iron oxide 15x15
Feldspar 34x11; 23x10; 55x20, av. 1.12x.41 mm.
Augite with naked eye 2-3 mm.; 80x56; 65x60; 55x52, av. 2.01x1.67 mm.

Sp. 15794. Hole 14 at 179 feet from surface. Poikilitic; feldspar extinction angles -0°-12°-32°w14°-24°; 30°-31°+w10°-8°; 30°-45°w16°-21°.

Grain
Olivine 13x11; 12x12; 22x22, av. .37x.55 mm.
Feldspar 25x6; 40x13; 33x13, av. .98x.32 mm.
Augite 85x65; 80x60; 85x85, av. 2.50x2.10 mm.

Sp. 15795. Hole 14 at 189 feet from surface. Microlitic porphyrite; reddened olivine (iddingsite); the microlites are low angled and forked in the ground mass.

Grain

Olivine 8x7; 22x20; 10x9, av. .40x.36 mm.

Feldspar phenocrysts 15x2; 33x9; 40x8, av. .88x.19 mm.

Augite less than 0.5.

Sp. 15796. Hole 14 at 199 feet from surface. Feldspathic; partly idiomorphic augite grains.

Grain

Olivine 10x9; 10x9; 15x12, av. .35x.30 mm.

Feldspar 22x7; 31x9; 33x3, av. .86x.19 mm.

Augite 16x13; 23x4; 25x20, av. .64x.37 mm.

Sp. 15797. Hole 14 at 200 feet from surface. Microlitic; porphyritic.

Grain

Olivine 7x6; 12x10; 7x6; 7x8; 7x8, av. .33x.31 mm.

Feldspar 19x7; 28x4; 11x3, av. .58x.14 mm.

Augite?

200-202; (S. 15798). SANDSTONE, basic; with amygdaloidal 2 (968)

fragments. This is hardly in the right place for Marvine's conglomerate No. 8. Compare rather Central Mine 96. There are a number of very minor sedimentaries between Marvine's conglomerate 8 and 9. (See Fig. 33).

Sp. 15798. Hole 14 at 202 feet from surface. Section shows contact with basic sediment enclosing fragments of amygdaloid with low angled feldspar; much olivine in sediment.

202-367; (Ss. 15799-810). MELAPHYRE, ophite; amygdaloidal the (159) (1127)

first 9 feet; seamed near 299 feet; a typical coarse ophite which helps to form the northwest front of the island, and is quite persistent along the strike. Compare Central Mine beds 107-116.

Sp. 15799. Hole 14 at 203 feet from surface. Poikilitic augite; also somewhat glomeroporphyritic low angled feldspar.

Grain

Olivine 7; 12x7; 6x5; 5

Feldspar 14x3; 20x8; 25x22, av. .59x.33 mm.

Augite 17x15; 33x20; 33x17, av. .83x.52 mm.

The variation in grain is particularly well shown and is illustrated by Figures 14, 15 and 18 of the Isle Royale Report, Vol. VI.

Sp. 15800. Hole 14 at 212 feet from surface. Poikilitic; low angled feldspar 0°-12° etc.

Grain

Olivine 6x6; 15x10; 10

Feldspar 16x4; 26x5; 32x10, av. .74x.19 mm.

Augite 48x35; 57x40; 62x22, av. 1.67x.97 mm.

Sp. 15801. Hole 229 feet from surface. Poikilitic; feldspar extinction angles 24°; 19°; 17°-10°w31°-32°, in a Baveno twin 23°-14° with 37°-15°.

Grain

Olivine 11x8; 11x7; 10x10, av. .31x.25 mm.

Feldspar 21x6; 28x5; 40x5, av. .89x.16 mm.

Augite 62x42; 90x65; 50x40, av. 2.02x1.47 mm.

Sp. 15802. Hole 14 at 266 feet from surface. Not glomeroporphyritic; feldspar extinctions 24°-16°; 13°-9°w40°-40°; 20°-17°w42°-38°w16°?-11°; 11°-7°w35°-9°.

Grain

Olivine 19x15; 13x13; 13x10, av. .45x.38 mm.

Feldspar 11x4; 28x7; 24x5, av. .63x.16 mm.

Augite 220x340; 160x170; 175x240, av. 5.55x7.50 mm.

Sp. 15803. Hole 278 feet from surface. Poikilitic; feldspar extinction angles 0°-15°w22°-30°; 20°w31°-31°; 14°-2°w28°-19°.

Grain

Olivine 10x10; 16x15; 15x10, av. .41x.35 mm.

Feldspar 21x3; 27x8; 60x5 (nest), av. 1.07x.16 mm.

Augite 140x120; 100x90; 130x95, av. 3.70x3.05 mm.

Sp. 15804. Hole 14 at 294 feet from surface. Poikilitic; much decomposed; micaceous; this is from a peculiar seam a foot or two wide, perhaps originally an olivine band like that which occurs in the Palisade trap described by Volney Lewis.[1]

Olivine 20x17; 30x20; 14x11, av. .64x.48 mm.

Feldspar 12x1; 18x3; 42x7, av. .72x.11 mm.

Augite 230x190; 210x140; 120x80, av. 5.60x4.10 mm.

Sp. 15805. Hole 14 at 304 feet from bed rock surface. Poikilitic; feldspar extinction angles 29°-31°w18°; 20° to 24°-36°w37°-48°; 28°-33°; 19°-16°.

Grain

Olivine 16x15; 14x13; 18x17, av. .48x.45 mm.

Feldspar 33x8; 22x4; 34x8, av. .89x.20 mm.

Augite by naked eye 7 mm.; 140x130; 250x160; 205x140; 210x140, av. 6.04 x4.28 mm.

Sp. 15806. Hole 14 at 320 feet from bed rock surface. Nests of feldspar replacing poikilitic augite patches; extinction angles 20°-18°; 44°-37°w10°; 47°-38°w 22°-17°; 27°-35°w43°.

Grain

Olivine 10x9; 11x10; 19x18, av. .40x.37 mm.

Feldspar 25x12; 20x5; 15x8, av. .60x.25 mm.

Augite 180x120; 180x175; 130x90, av. 4.90x3.85 mm.

Sp. 15807. Hole 14 at 329 feet from bed rock surface. 15805 to 15808 are very similar; poikilitic; fresh olivine!; also much feldspar; extinction angles 15°-22°?w 44°-44°; 30°-38°.

Grain

Olivine 25x18; 15x15; 14x10, av. .54x.43 mm.

Iron oxide 18x17

Feldspar 22x5.5; 37x7; 37x12, av. .96x.24 mm.

Augite 155x120; 105x90; 85x85, av. 3.45x2.95 mm.

Sp. 15808. Hole 14 at 348 feet from bed rock surface. Similar; finer; feldspar slightly nested; extinction angles 11°-11°w40°-37°.

Grain

Olivine 16x12; 20x16; 9x6, av. .45x.34 mm.

Feldspar 13x5; 17x4; 32x10, av. .62x.19 mm.

Augite to naked eye 2-3 mm.; 90x45; 73x60; 80x72, av. 2.43x1.77 mm.

Sp. 15809. Hole 14 at 359 feet from surface. Augite more or less polysomatic finer grained; feldspar phenocrysts extinction angles 16°-15°w43°-42°.

Grain

Olivine 4x6; 6x6; 10x8, av. .20x.20 mm.

Feldspar 17x3; 20x4; 16x4, av. .43x.11 mm.

Augite 37x20; 40x35; 50x20, av. 1.27x.75 mm.

[1]Petrography of the New Igneous Rocks of New Jersey by J. Volney Lewis, Annual Report of the State Geologist, 1907, pp. 115, 127.

Sp. 15810. Hole 14 at 367 feet from surface. 27x8 olivine or enstatite? microlitic porphyritic; amygdaloid chloritic with quartz; low angled feldspars.

Grain

Olivine 3x3; 3x7; 4x4, av. .10x.14 mm.

Feldspar phenocrysts 16x7; 16x5; 13x7, av. .46x.19 mm.

Augite 0.

367-436; (Ss. 15811-9). The Huginnin porphyrite. This very (67) (1194)

marked and peculiar bed has a fine grained red ground-mass, in which are large crystals of whitish feldspar, frequently about a fifth to a half of an inch long. It is not uniformly amygdaloidal, but has streaks of half-filled vesicles with chlorite and *copper* and prehnite and *copper* veins. It has distinct lines of flow and the upper 10 feet may be an independent flow. The prehnite and *copper* veins and laumontite seams occur throughout the bed to the bottom. This porphyrite outcrops in the bed of Huginnin Creek about 50 feet from the shore of Huginnin Cove and about 200 feet from the mouth of the creek; whence its name. Lying as it does, between two more resistant big sheets of ophite, and having sediment under it, but little is seen of it in spite of its very peculiar and easily marked character, for there is no flow just like it in the whole series. We do, however, catch another glimpse of it near the mouth of McCargoe Cove, about 500 paces north and 1,300 paces west of the southeast corner of Sec. 13, T. 66, R. 35, where it occurs with a similar environment. It seems to have caught Foster and Whitney's eyes. Fig. 5 of Plate VI, and Fig. 20, p. 140 of the Isle Royale Report, illustrate the grain.

There is a porphyritic bed under the Copper Point ophite at Mamainse which may possibly be correlated with this Huginnin Porphyrite.

Sp. 15811. Hole 14 at 370 feet from surface. Fine grained; very feldspathic; has finer and more ferruginous borders to amygdules.

Iron oxide 3x2; 2x4; 3x4

Feldspar 10x1; 10x2; 8x15.

Sp. 15812. Hole 14 at 373 feet from bed rock surface. Contact with fine grained sediment with similar rock on each side, or is the sediment a mere clasolite?

Grain

Olivine 0?

Iron oxide 3x0.2

Feldspar 9x1; 8x3; 9x15, av. .26x.19 mm.

Augite 0?

Sp. 15813. Hole 14 at 379 feet from surface. Contact with a sediment; low extinction angle, plagioclase.

Grain

Olivine 0?

Iron oxide 2x5; 2x4; 2x3, av. .06x.12 mm.

Feldspar 12x1; 11x1; 11x2, av. .34x.04 mm.

Augite 0?

Sp. 15814. Hole 14 at 379 feet from surface. Contact with a clasolitic vein; feldspathic trap.

Grain

Feldspar 9x2; 10x2; 8x2, av. .27x.06 mm.

Sp. 15815. Hole 14 at 384 feet from bed rock surface. Very feldspathic, (low angled); no olivine? augite only in idiomorphic granules.

Grain

Olivine 0?

Feldspar 16x2; 23x4; 11x2, av. .50x.08 mm.

Augite 7x3; 2x3; 3x1.5, av. .12x.07 mm.

Sp. 15816. Hole 14 at 393 feet from bed rock surface. Feldspar brotocrysts i. e., large corroded porphyritic crystals 180x100; low angled feldspar; small augite granules; no olivine.

Grain

Feldspar 15x2; 12x1; 15x1; 16x1, av. .40x.04 mm.

Augite 2, 3, 4, 11x1, 8x2, 3x2.

Sp. 15817. Hole 14 at 416 feet from bed rock surface. Similar to 15816. The large feldspar phenocrysts look like orthoclase and are 80x35 and 80x42 and hardly twinned; low angled extinctions; micaceous alteration.

Grain

Iron oxide 5x6; 4x5; 4x10, av. .13x.21 mm.

Feldspar 9x1.5; 11x1; 13x2, av. .33x.04 mm.

Augite 2; 2; 3; 5x.6; 8x1.5; 4x2.

Sp. 15818. Hole 14 at 435 feet from bed rock surface. 11-0; 16; low angled.

Grain

Olivine 0

Iron oxide 4x3; 6x1; 3x2, av. .13x.06 mm.

Feldspar phenocrysts 7x4mm. with naked eye or 40x28; 205x147; smaller 12x4; 8x1; 7x1; 12x1, av. .30x.07 mm.

Augite 8x1; 6x1; 5x2, av. .19x.04 mm.

Sp. 15819. Hole 14 at 436 feet from bed rock surface. Feldspathic often glomeroporphyritic; porphyritic and other feldspar low angled; microlitic porphyritic; much olivine; augite granules; low angled feldspar.

Grain

Olivine 22x15; 13x7; 8x6

Feldspar 65x20; 30x12; 30x6, av. 1.25x.38 mm.

Augite 3x2; 3x1; 2x1, av. .08x.04 mm.

436-440; (Ss. 158-20). Ash, brecciated. The microscope (4) (1198)

shows conchoidal glass forms in this rock. It is suggestive in this connection that the bed above is salic such as is more likely to come with ash-producing explosions.

Sp. 15820. Hole 14 at 438 feet from bed rock surface. Epidote and quartz amygdules, also olivine plagioclase aggregate; margin of porphyrite in contact with prehnitic belt; ash fragments with conchoidal outlines.

Grain

Olivine 13x7; 10x8; 14x11, av. .37x.26 mm.

Feldspar phenocrysts 18x7 microlites at 4x1 and less

Augite 8x5.

There are what look like aragonite fibres here.

440-605; (Ss. 15821-34). Melaphyre, ophite. This big (158) (1356)

flow rivals the "backbone" greenstone. It appears to be remarkably olivinitic and to have more iron than the latter. (Compare beds above the Isle Royale Lode). It is so much finer grained toward the bottom of the hole that we must infer that there are not more than 10 more feet of it. This big ophite being beneath the porphyrite at Huginnin Cove, will be expected to make the front range of the northwest coast. It seems to me there is a tendency for salic beds like the Huginnin Porphyrite to come after a very big ophite as a sort of skimming. Now along this coast three holes were put down, Nos. XII, XV, and XVI. They are all about on the same line of strike, No. XV about 10 feet lower than No. XVI and No. XII about half-way between them in position. The samples from No. XII were thrown into confusion by fire, but we have a few that are well authenticated, from the bottom beds and from some other characteristic beds, and we have Stockly's record.

We find in the field that drill hole No. XV lies on the east or upthrown side of the fault already mentioned. No. XVI on the west; No. XII is very near the break, but apparently also to the east of it. On comparing records, however, we find that No. XII is much more nearly in accord with No. XVI, at least in the lower part indicating either that the fault is east of that part of No. XII or that the character of the upthrow has changed. Field observations above No. XV show a series of amygdaloids capped by an ophite under which we get a good contact, and a dip 18° to N, 26° W. This contact is about 87 feet above the lake, on a slope whose angle is 28°, while No. XV is only a little above the lake and close to it.

Fig. 12 of the Isle Royale Report shows the section at No. XV, and shows that the top of No. XV appears to be something over 100 feet lower than the big ophite at the bottom of No. XIV. If, therefore, we suppose that the record of No. XVI begins where that of No. XIV leaves off, we shall be in harmony with the observed dips, and not be in danger of leaving out more than some 50 feet of amygdaloids such as are exposed above the top of No. XV. It should be said, however, that the nearer the top we compare No. XV and No. XVI the less faulting there seems to be between them. But the records of the upper parts are not very clear, and I fear the samples were not carefully arranged in the boxes.

There is another difficulty and uncertainty attending the construction of this end of our column. We have seen that the dip seems to be increasing faster and faster. Now we have no outcrops nor drill holes farther to the north to guide us as to the rate at which this increase progresses as we go down or to the north, and the north side of the Isle may be upturned close to a large fault. Consequently the amount of allowance for reduction from vertical width to thickness is much more uncertain. We have to guide us only dips measured on drill cores which are not very safe guides, and also dips exposed on Amygdaloid Island, and on adjacent islands, toward the other end of the Isle Royale, which correspond to these lower beds. Both these dips and the dips on the drill cores agree in indicating an increase over the dips observed higher in the series, i. e., toward the southeast. In such a case the allowances for dip, and the dips assumed, are matters of general judgment rather than of precise calculation. We will continue to assume the 18° dip down to the first conglomerate at No. XVI, 437 feet, *which involves taking off 1-20 to reduce* from VERTICAL *width* to THICKNESS.

We base our description here on record of No. XVI, as it is the deepest hole from which we have a full set of cores.

Sp. 15821. Hole 14 at 440 feet from bed rock surface. Microlitic porphyrite; much olivine and apparently a younger generation; feldspar groups.

Grain

Ol vine phenocrysts 12x10; 15x6; 15x12; av. .42x.28 mm. smaller ones? 2, 3, 2;

Sp. 15822. Hole 14 at 449 feet from surface. Feldspar groups; no augite? very feldspathic; not very olivinitic; trichitic.

Grain

Olivine 3x7; 4x7; 5x6, ax. .12x.20.

Feldspar phenocrysts 29x16; 22x8; 30x9; .81x.33; smaller trichites 2 to 3 long.

Sp. 15823. Hole 14 at 462 feet from bed rock surface. Marked poikilitic; olivine nests; labradorite feldspar.

Grain

Olivine phenocrysts 13x10; 15x10; 16x14, av. .44x.34 mm.

Feldspar 18x5; 18x4; 14x2, av. .50x.11 mm.

Augite 57x52; 65x48; 40x43, av. 1.62x1.43 mm.

Sp. 15824. Hole 14 at 471 feet from bed rock surface. Olivine nests; labradorite coarser; nested feldspar extinction angles 34°-34°w23°-24°; 36°-40°w21°-19°; 36°-22°; 32°-30°; 40°-30°; 41°-21°.

Grain

Olivine phenocrysts 23x10; 20x18; 18x13, av. .61x.41

Iron oxide 4x5; 4x7; 7x17, av. .15x.29

Feldspar phenocrysts 14x4; 18x6; 11x2; 12x1, av. .55x.13 mm.

Augite 65x55; 90x85; 85x57, av. 2.40x1.97 mm.

Sp. 15825. Hole 14 at 476 feet from surface. Green micaceous olivine; grain about 14 in 15 mm.; poikilitic augite, feldspar extinction 35°-36°w27°-20°; 39°-19°w14°-8°.

Grain

Olivine 22x13; 25x17; 32x20, av. .79x.50 mm.

Feldspar 16x5; 15x6; 15x3, av. .46x.14 mm.

Augite 100x95; 80x80; 100x70, av. 2.80x2.45 mm.

Sp. 15826. Hole 14 at 492 feet from surface. Poikilitic, coarser augite; about 5 in 20 mm.; feldspar extinction 36°-30°w25°-16°; 45°-45°w13°.

Grain

Olivine 23x18; 26x20; 20x16, av. .69x.54 mm.

Feldspar 22x11; 13x3; 18x7, av. .53x.21 mm.

Augite 85x80; 157x130; 140x75, av. 3.82x2.85.

Sp. 15827. Hole 14 at 514 feet from bed rock surface. Fresh olivine! poikilitic; coarser; augite has about 4 mottles in 20 mm., generally 2 feldspars in each mottle, extinction angles 32°-25°; 41°-45°w10°.

Grain

Olivine 10x7; 18x11; 14x14, av. .42x.32 mm.

Feldspar 16x6; 13x3; 19x6, av. .48x.15 mm.

Augite 180x90; 140x110; 130x100, av. 4.50x3.00 mm.

Sp. 15828. Hole 14 at 531 feet from bed rock surface. Zonal extinction angles larger at center; 7x1 is nearer the size of the feldspars enclosed in the augite mottles of which there are about 3½ in 20 mm.; ex. 30°-25°.

Grain

Olivine 52x30; 32x20; 25x23, av. 1.09x.73 mm.

Feldspar 20x5; 20x8; 20x5, av. .60x.18 mm.

Augite 220x185; 180x175; 180x140, av. 5.80x5.05 mm.

Sp. 15829. Hole 14 at 552 feet from bed rock surface. Poikilitic; finer grained than 15828; ex. 42°-32°w5°-15°; grain of augite very uncertain, mottles ? 4 to 20 mm.

Grain

Olivine 15x12; 44x27; 31x19, av. .90x58.

Feldspar 16x7; 20x5; 33x7, av. .69x.19

Augite 130x120; 180x160; 160x110, av. 3.70x3.90

Sp. 15830. Hole 14 at 568 feet from bed rock surface. About=15827; feldspar semi-poikilitic; most of them about 7-8x1; 4 mottles in 18 to 16 mm.; ex. -40°w 15°-27°; 40°-30°; 33°-22°.

Grain

Olivine 9x8; 17x16; 25x16; 26x23, av. .57x.48

Feldspar 28x7; 36x6; 12x5; 8x3; 16x2; 20x6, av. .60x.15

Augite 120x120; 130x110; 135x120; 120x100; 140x110; 140x120, av. .39x3.4.

Sp. 15831. Hole 14 at 580 feet from bed rock surface. Olivine altered to magnetite aggregate; poikilitic; 6 mottles to 18 mm.; ex. 47°-42°w-29°; 27°-23°w-35°.

Grain

Iron oxide 14x12; 19x18; 22x16, av. .55x.46

Feldspar 20x7; 15x7; 20x7, av. .55x.21
Augite 60x55; 67x60; 80x68, av. 2.07x1.83.

Sp. 15832. Hole 14 at 588 feet from bed rock surface. Poikilitic; finer; 8-20, 10°-3°w39°-19°.

Grain

Iron oxide 15x13; 18x10; 24x20, av. .57x.43
Feldspar 17x3; 17x4; 22x6, av. .56x.13
Augite 45x42; 64x37; 53x44, av. 1.62x1.23

Sp. 15833. Hole 14 at 593 feet from bed rock surface. The feldspars measured are semi-porphyritic, the extinctions are 4° to 8°-1°; 13° or 14° to 20°; 44°-42°w 18°; 31°-24°; 39°-28°; much iron in this flow, more than in "Greenstones." Cf. 15906-15918, also 15166.

Grain

Iron oxide 12x10; 22x7; 15x13; 11x9, av. .45x.29
Feldspar 22x8; 23x7; 16x4; 20x5, av. .61x.18
Augite 35x33; 50x40; 70x32, av. 1.55x1.05.

Sp. 15834. Hole 14 at 605 feet from bed rock surface. Ophitic augite in long prisms; 34°-31°; 35°-36°w28°; 44°-36°.

Grain

Feldspar 35x3; 24x5; 27x3, av. .76x.11
Augite 75x24; 40x23; 60x13; 42x24; av. 1.62x.63

(1356)

DRILL HOLE No. XVI

0-39; (Ss. 15835-7). MELAPHYRE, ophite; chloritic amygdules (38) (1394)

at top of bed.

Sp. 15835. Hole 16 at 9 feet from bed rock surface. Very feldspathic augite tends to be in granules; moderate extinction angles 6°-7°; 11°; 7°-0°; 10°-8°.

Grain

Olivine 10x8; 13x10; 17x8, av. .40x.26 mm.
Feldspar 19x4; 26x7; 21x4, av. .66x.15 mm.
Augite 24x20; 20x10; 24x4, av. .68x.34 mm.

Sp. 15836. Hole 16 at 19 feet from bed rock surface. Much very basic feldspar, extinction angles 3°; 43°-38°; 19°-15°w36°-23°; 26°-29°w10°-16°; little olivine; poikilitic; augite may be taken too large.

Grain

Olivine 15x10; 12x11; 8x7, av. .35x.28 mm.
Iron oxide 19x13; 15x12; 18x11, av. .52x.36 mm.
Feldspar 27x5; 21x4; 32x7, av. .80x.16 mm.
Augite 40x35; 50x42; 35x12, av. 1.25x.89 mm.

Sp. 15837. Hole 16 at 34 feet from bed rock surface. Yellow green large olivine; poikilitic.

Grain

Olivine 13x11; 15x13; 17x12, av. .45x.36 mm.
Feldspar 23x6; 23x3; 20x6, av. .66x.15 mm.
Augite 48x43; 70x50; 110x45, av. 2.28x1.38 mm.

39-54; (Ss. 15838-40). MELAPHYRE; streak of green prehnitic (14) (1408)

amygdaloid at top.

Sp. 15838. Hole 16 at 39 feet from bed rock surface. Porphyritic microlitic; with prehnite; feldspar decomposed; marginal; like 15843.

Grain

Feldspar phenocrysts 22x2; 21x4; 23x3, av. .66x.09 mm.

Sp. 15839. Hole 16 at 50 feet from bed rock surface. Much feldspar; low extinction angles 0°w11°-8°.

Grain

Olivine 11x8; 15x11; 8x8, av. .34x.27 mm.
Feldspar 19x4; 18x2; 25x5, av. .62x.11 mm.
Augite 20x9; 30x10; 17x7, av. .67x.26 mm.

54-81; (Ss. 15840-2). MELAPHYRE; red and amygdaloidal (26) (1434)

for the first 6 to 8 feet, with calcite and laumontite (?) in amygdules.

Sp. 15840. Hole 16 at 54 feet from bed rock surface. Very dark red microlitic-porphyritic amygdaloid; calcite and laumontite generally.

Grain

Olivine 5x2; 6x4; 4x4, av. .15x.10 mm.
Feldspar phenocrysts 22x5; 14x2; 18x4, av. .54x.11 mm.
Augite 0?

Sp. 15841. Hole 16 at 70 feet from bed rock surface. Very low angled feldspar.

Grain

Olivine 7x5; 10x9; 11x10, av. .28x.24 mm.
Feldspar 24x6; 16x4; 25x4, av. .65x.14 mm.
Augite 30x20; 25x14; 17x12, av. .72x.46 mm.

Sp. 15842. Hole 16 at 72 feet from bed rock surface. Low angled feldspar.

Grain

Olivine 8x8; 11x8; 12x6, av. .31x.22 mm.
Feldspar 30x5; 25x3; 25x5, av. .80x.13 mm.
Augite 22x15; 27x13; 13x10, av. .52x.38 mm.

81-114; (Ss. 15843-7). MELAPHYRE, amygdaloidal; at the (31) (1465)

top the bed is a green prehnitic amygdaloid like that at 39 feet, which I suppose to crop out under the lake. From 88-99 feet it is much broken and shattered and appears amygdaloidal.

Sp. 15843. Hole 16 at 81 feet from bed rock surface. Crops out under lake. Distance from margin 81.

Grain

Feldspar phenocrysts 16x2; 15x2; 18x3, av. .49x.07 mm.
Thickness at cross section 77.

Sp. 15844. Hole 16 at 86 feet from bed rock surface.

Grain

Olivine 22x17; 14x13; 14x10, av. .50x.40
Feldspar 22x4; 23x5; 20x5, av. .65x.14
Augite 10x10; 23x13; 22x10, av. .55x.33

114-153; (Ss. 15848-50). MELAPHYRE, feldspathic; intermediate (38) (1503)

between porphyrite and ophite.

Sp. 15848. Hole 16 at 140 feet from bed rock surface. Very feldspathic; xenomorphic augite; feldspar extinction angles 42°-38°w13°; 34°-33°w19°-16°; 40°-38°w20°-18°.

Grain

Olivine 17x15; 13x10; 13x10, av. .53x.35 mm.
Feldspar 18x2; 16x3; 28x3, av. .62x.08 mm.
Augite 22x20; 32x30; 32x17, av. .86x.67 mm.

Sp. 15849. Hole 16 at 145 feet from bed rock surface. Slightly poikilitic; much feldspar; extinction angles 37°-32°w15°-0°; 31°-25°.

Grain

Olivine 10x8; 14x9; 9x8, av. .33x.25 mm.
Feldspar 21x2; 21x2; 20x6, av. .62x.10 mm.
Augite 50x50? 23x18; 33x20, av. 1.06x1.03 mm.

Sp. 15850. Hole 16 at 153 feet from bed rock surface. Porphyritic; fine grained microlitic amygdaloid; much green serpentinized olivine; feldspar extinction angles 12°; 0°; 0°.

Grain

Olivine 6x3; 4x2; 5x4, av. .15x.09 mm.
Feldspar 6x1; 9x1½; 15x1, av. .30x.03 mm.

153.5-165 (Ss. 15851-3). MELAPHYRE, amygdaloidal; at the (11) (1514)

top there is a green decomposed seam; laumontitic amygdules.

Sp. 15851. Hole 16 at 154 feet from bed rock surface. More amygdaloidal than 15850 and more feldspar; much green serpentized olivine; a very little augite also.

Grain

Olivine 9x6; 7x5; 6x5, av. .22x.16 mm.
Feldspar 15x3; 10x2; 10x1, av. .35x.06 mm.
Augite 8x6; 5x1; 7x1½, av. .20x.08 mm.

Sp. 15852. Hole 16 at 159 feet from bed rock surface. Similarly feldspathic; more xenomorphic augite; low angled feldspar, centers decomposed.

Grain

Olivine 8x6; 5x4; 10x8, av. .23x.18 mm.
Feldspar 15x1; 18x3; 11x2, av. .44x.06 mm.
Augite 17x10; 10x6; 10x5, av. .37x.21 mm.

Sp. 15853. Hole 16 at 165 feet from bed rock surface. Microlitic porphyritic; dark red decomposed amygdaloid.

Grain

Olivine 9x8; 6x5; 7x7, av. .22x.20 mm.
Feldspar 21x7; 13x3; 15x2, av. .49x.12 mm.
Augite 18x8; 13x8; 20x12, av. .51x.28 mm.

165-174; (Ss. 15854-5). MELAPHYRE, amygdaloidal. (9) (1523)

Sp. 15854. Hole 16 at 170 feet from bed rock surface. Coarser; very feldspathic; granular augite?

Grain

Olivine 12x12; 10x7; 12x9, av. .34x.28 mm.
Feldspar 16x3; 20x5; 21x3, av. .57x.11 mm.
Augite 21x15; 18x13; 20x13, av. .59x.41 mm.

Sp. 15855. Hole 16 at 174 feet from bed rock surface. A little finer; much decomposed; much olivine.

Grain

Olivine 8x5; 11x10; 7x5; 3x1; 4x3; 7x2, av. .22x.14 mm.
Feldspar 18x2; 13x3; 13x3; 12x2; 20x3; 12x3, av. .48x.08 mm.

174-186; (S. 15856). AMYGDALOID. (11) (1534)

Sp. 15856. Hole 16 at 182 feet from bed rock surface. Coarser feldspar; xenomorphic augite; much low angled feldspar; compact again.

Grain

Olivine 13x9; 20x14; 10x10, av. .43x.33 mm.
Feldspar 15x3; 20x4; 16x3, av. .51x.10 mm.

Augite 13x6; 18x18; 19x10, av. .50x.34 mm.

186-201; (Ss. 15857-8). MELAPHYRE, amygdaloidal; at (14) (1548)

201 feet there is a decomposed green seam, which may be a vein, an inclusion or bomb, or a decomposed margin between two flows.

Sp. 15857. Hole 16 at 186 feet from bed rock surface. Finer grained in contact with prehnitic crack; low angled feldspar.

Grain

Olivine 8x5; 6x5; 6x5, av. .20x.15 mm.
Feldspar 15x3; 15x2; 15x3, av. .45x.08 mm.
Augite 0.

Sp. 15858. Hole 16 at 194 feet from bed rock surface. Very feldspathic; poikilitic augite (?); low angled feldspar.

Grain

Olivine 10x9; 9x7; 8x6, av. .27x.22 mm.
Feldspar 17x3; 13x3; 17x2; 22x3, av. .57x.09 mm.
Augite 20x15; 20x5; 16x13, av. .56x.33 mm.

201-226; (Ss. 15859-62). MELAPHYRE, amygdaloidal. All (24) (1572)

the above series of amygdaloidal melaphyres are small flows of the feldspathic ophite type.

Sp. 15859. Hole 16 at 201 feet from bed rock surface. Vein? or much decomposed margin of two flows; cf. 15843.

Sp. 15860. Hole 16 at 204 feet from bed rock surface. Poikilitic augite; much green olivine; much decomposed feldspar with low or moderate extinction angles.

Grain

Olivine 8x8; 8x7; 10x7, av. .26x.22 mm.
Feldspar 15x3; 16x2½; 13x2, av. .44x.07 mm.
Augite 15x13; 23x16; 15x15, av. .53x.44 mm.

Sp. 15861. Hole 16 at 209 feet from bed rock surface. Prehnitic decomposed; slightly poikilitic.

Grain

Olivine 9x5; 9x6; 9x7, av. .27x.18 mm.
Feldspar 21x5; 18x2; 24x3, av. .63x.10 mm.
Augite 22x20; 24x8; 20x18, av. .66x.46 mm.

Sp. 15862. Hole 16 at 226 feet from bed rock surface. Microlitic porphyritic amygdaloid.

Grain

Olivine?
Feldspar 13x3; 10x2; 10x1, av. .43x.06 mm.

226-258; (Ss. 15863-7). MELAPHYRE, feldspathic (30) (1602)

Sp. 15863. Hole 16 at 231 feet from bed rock surface. Like 15860; low angled feldspar.

Grain

Olivine 9x612x7; 7x7, av. .28x.20
Feldspar 17x3; 27x4; 20x4, av. .64x.11
Augite 18x13; 28x8; 22x20, av. .68x.41

Sp. 15865. Hole 16 at 241 feet from bed rock surface. Fine grained; feldspathic; greenish highly decomposed.

Grain

Feldspar 13x3; 17x2; 20x4, av. .50x.09 mm.

Sp. 15866. Hole 16 at 253 feet from bed rock surface. Quite feldspathic; xenomorphic augite; low angled feldspar.

Grain

Olivine 8x8; 10x9; 9x7, av. .27x.24 mm.
Feldspar 25x2; 16x2; 22x5, av. .63x.09 mm.
Augite 32x13; 24x14; 35x23, av. .91x.50 mm.

Sp. 15867. Hole 16 at 258 feet from bed rock surface. Marked red microlitic porphyritic amygdaloid; very black ground.

Grain

Olivine 10x5; 8x5; 6x5, av. .24x.15 mm.
Feldspar phenocrysts 12x2; 12x2; 15x3, av. .39x.07 mm.
Augite 0.

258-275; (S. 15868). MELAPHYRE. (16) (1618)

Sp. 15868. Hole 16 at 270 feet from bed rock surface. Quite feldspathic; xenomorphic augite.

Grain

Olivine 12x11; 8x8; 9x9, av. .29x.28 mm.
Feldspar 26x4; 19x4; 20x4, av. .65x.12 mm.
Augite 18x17; 26x17; 16x12, av. .60x.46 mm.

275-297; (15869-71). MELAPHYRE, amygdaloidal. (21) (1639)

Sp. 15869. Hole 16 at 275 feet from bed rock surface. Decomposed microlitic.

Grain

Feldspar phenocrysts 19x2; 13x2; 21x3, av. .53x.07 mm.
Augite 0.

Sp. 15870. Hole 16 at 275 feet from bed rock surface. Feldspathic; xenomorphic augite.

Grain

Olivine 6x4; 6x5; 7x5, av. .19x.14 mm.
Feldspar 15x3; 16x4; 20x4; 15x3, av. .55x.11 mm.
Augite 19x19; 12x8; 25x10, av. .56x.37 mm.

Sp. 15871. Hole 16 at 296 feet from bed rock surface. Microlitic porphyritic amygdaloid.

Grain

Olivine 3x3; 5x5; 8x5, av. .16x.13 mm.
Feldspar 20x2; 16x2; 17x3, av. .53x.07 mm.

297-320; (Ss. 15872-3). MELAPHYRE, ophite, amygdaloidal. (22) (1661)

Sp. 15872. Hole 16 at 298 feet from bed rock surface. Microlitic porphyritic amygdaloid; feldspar low angled; much decomposed.

Grain

Olivine 9x6; 4x4; 5x4, av. .18x.14 mm.
Feldspar 13x2; 20x2; 16x2, av. .49x.06 mm.

Sp. 15873. Hole 16 at 307 feet from bed rock surface. Ophitic poikilitic.

Grain

Olivine 7x7; 8x8; 11x10, av. .26x.25 mm.
Feldspar 20x4; 20x3; 11x3, av. .51x.10 mm.
Augite 30x26; 20x18; 43x15, av. .93x.59 mm.

320-348; (Ss. 15874-7). MELAPHYRE; ophite; for the first 13 feet (27) (1688)

vesicular and amygdaloidal with laumontite.

Sp. 15874. Hole 16 at 320 feet from bed rock surface. Decomposed feldspathic amygdaloid.

Grain

Feldspar 13x2½; 17x4; 13x3, av. .43x.09 mm.

Sp. 15875. Hole 16 at 333 feet from bed rock surface. Feldspathic; xenomorphic augite.

Grain

Olivine 7x6; 8x7; 8x6, av. .23x.19 mm.
Feldspar 23x3; 19x2; 20x3, av. .62x.08 mm.
Augite 40x22; 23x20; 22x13, av. .85x.55 mm.

Sp. 15876. Hole 16 at 338 feet from bed rock surface. Poikilitic augite. The grain of the augite is given in Fig. 15 on p. 128 of the Isle Royale report (Vol. VI) by points marked c, the rate of increase being normal.

Grain

Olivine 14; 8; 8; 7; 8; 7
Feldspar 22; 3; 26; 4; 14; 4
Augite 35; 25; 40; 25; 32; 32.

Sp. 15877. Hole 16 at 343 feet from bed rock surface. Finer grained than 15876.

Grain

Olivine 6x4; 8x5; 7x6, av. .21x.15 mm.
Feldspar 15x2; 14x3; 17x4, av. .46x.09 mm.
Augite 5x5; 6x3; 11x5, av. .22x.13 mm.

348-391; (Ss. 15878-82). MELAPHYRE, ophite. (41) (1729)

Sp. 15878. Hole 16 at 348 feet from bed rock surface. Decomposed like 15874.

Grain

Olivine?
Feldspar 15x4; 14x4; 16x3, av. .45x.11 mm.
Augite none.

Sp. 15879. Hole 16 at 351 feet from bed rock surface. Slightly poikilitic augite; labradorite extinction angles 22°-20°w40°-39°; 20°-27°w33°-40°.

Grain

Olivine 10x11; 14x11; 16x5, av. .40x.27 mm.
Feldspar 12x4; 27x3; 18x5, av. .57x.12 mm.
Augite 12x7; 17x10; 17x12, av. .46x.29 mm.

Sp. 15880. Hole 16 at 355 feet from bed rock surface. Very feldspathic but poikilitic still.

Grain

Olivine 13x11; 8x8; 12x6, av. .33x.25 mm.
Feldspar 19x3; 29x3; 18x4, av. .66x.10 mm.
Augite 27x22; 33x22; 25x18, av. .85x.62 mm.

Sp. 15881. Hole 16 at 375 feet from bed rock surface. Coarser; labradorite extinction angles 27°-18°w37°-35°; 21°-23°.

Grain

Olivine 10x8; 10x8; 12x11, av. .32x.27 mm.
Feldspar 12x4; 16x5; 21x3, av. .59x.12 mm.
Augite 130x120; 135x120; 105x80, av. 3.70x3.20 mm.

391-410; (Ss. 15882-4). MELAPHYRE, amygdaloidal. (18) (1747)

Sp. 15883. Hole 16 at 392 feet from bed rock surface. Feldspathic not very fine grained amygdaloid; microlitic.

Grain

Olivine 5; 4; 5
Feldspar 12x3; 16x4; 10x5, av. .38x.12 mm.

Sp. 15884. Hole 16 at 405 feet from bed rock surface. Somewhat poikilitic; feldspathic; low angled.

Grain

Olivine 9x5; 8x6; 8x4, av. .27x.15 mm.
Feldspar 30x6; 15x4; 15x4, av. .60x.14 mm.
Augite 30x25; 32x20; 18x18, av. .80x.63 mm.

410-438; (Ss. 15885-7). MELAPHYRE, ophite (27) (1774)

Sp. 15885. Hole 16 at 410 feet from bed rock surface. Microlitic; porphyritic; very amygdaloidal decomposed.

Sp. 15886. Hole 16 at 416 feet from bed rock surface. A good deal decomposed; poikilitic.

Grain

Olivine 10x9; 9x9; 8x7, av. .27x.25 mm.
Feldspar 17x4; 28x5; 15x2, av. .60x.11 mm.
Augite 86x80; 70x60; 60x50, av. 2.10x1.90 mm.

Sp. 15887. Hole 16 at 437 feet from bed rock surface. Much finer grained; augite patchy; low angled feldspar.

Grain

Olivine 5x5; 4x4; 7x4, av. .16x.13 mm.
Feldspar 11x3; 8x2; 14x3, av. .33x.08 mm.
Augite 2x3; 1x2; 2x1, av. .05x.06 mm.

438-447; (Ss. 15888-96). BRECCIA OR SCORIACEOUS CONGLOMERATE; 10 1784

BOHEMIAN RANGE GROUP.

a mixture of fine grained sandstone and of a porphyrite like the Huginnin porphyrite.

From this point we shall take off .06 to reduce from VERTICAL *width to* THICKNESS, *implying a dip of about 20°.*

Sp. 15888. Hole 16 at 438 feet from bed rock surface. Contact very fine grained with basic sediment. Distance from margin 438.

Grain

Feldspar phenocrysts 20x3; microlites 4x1; 5x0.5, av. .29x.04 mm.

Sp. 15889. Hole 16 at 439 feet from surface. Large fragment of fine grained porphyrite like Huginnin porphyrite.

Sp. 15890. Hole 16 at 440 feet from surface. Similar pebble.

Sp. 15891. Hole 16 at 441 feet from surface. Similar pebble.

Sp. 15892. Hole 16 at 442 feet from surface. Similar pebble.

Sp. 15893. Hole 16 at 443 feet from surface.

Sp. 15894. Hole 16 at 444 feet from surface. Basic sediment; augite and feldspar.

Sp. 15895. Hole 16 at 445 feet from bed rock surface. Interlocking of sediment with a porphyrite which is very ferruginous but otherwise like the pebbles.

Sp. 15896. Hole 16 at 448 feet from bed rock surface. Sediment and porphyrite with one brotocryst of quartz also plagioclase and microfelsite.

455-475; (Ss. 15897-8). PORPHYRITE; like the Huginnin (19) (19)

porphyrite. No. XIV, 367-436 feet.

Sp. 15897. Hole 16 at 445 feet from bed rock surface. Porphyrite with feldspar brotocrysts like pebbles.

Sp. 15898. Hole 16 at 467 feet from bed rock surface. Slightly coarser with augite granules, and larger magnetite.

475-487; (Ss. 15899-906). CONGLOMERATE, red, with numerous (11) (30)

cavities, and much basic debris, but also with a good deal of quartz porphyry which

is sometimes spherulitic; cement largely calcareous. This conglomerate which occurs in No. XII from 471 feet to 493 feet, and in No. XV from 429 feet to 444 feet, being the first bed that can be identified with absolute certainty in all the holes, is said by Stockly to contain *copper* in No. XII. This is natural, as drill hole No. XII seems, as we have said, to lie nearer the fault. This conglomerate would seem to be thickening toward the northeast, and while occurring at practically the same level in both No. XII and No. XVI, is 40 to 50 feet higher in No. XV, as already remarked, thus indicating the fault already mentioned. This is really the first well-marked conglomerate with porphyry pebbles that we have met below the Allouez conglomerate, No. VI, 363-386 feet. It is about (5879-2332) 3547 feet below the latter, and in the remainder of the record we find four considerable conglomerates and at the bottom a porphyry. Now we see in Marvine's table of conglomerates facing p. 60, that after a considerable gap devoid of conglomerates, we have a group, Nos. 8-4, opposite or east of the Isle Royale mine, and Nos. 6-4, opposite or east of the Kearsarge mine, about 6529 feet below the Allouez conglomerate. Now the ratio 3547:6529 is not far from similar ratios already found for other parts of the series; (see Vol. VI, Pt. I, p. 105). On Keweenaw Point, moreover, porphyries are evidently quite persistent in connection with a lower group of conglomerates, as brought out by Hubbard in the second part of Vol. VI, and as shown also in the recent Indiana drilling, and the porphyries found around Bare Hill and Mt. Houghton, which are much like the Isle Royale occurrence in question. We have no marked change in the character of the lavas at this point as we have above the Greenstone, by which we can make an exact and certain identification, but we may with much certainty say that we have arrived at the top of the lower group of felsitic conglomerates, and as Marvine's No. 8 is the first one which he makes continuous, we will provisionally correlate this Isle Royale bed, or that a few feet above, with it, for thus we best express its position at the top of a group of four closely associated conglomerates. Of course the scoriaceous bed at 438 feet might be taken as Marvine's No. 8, and I have put the bottom of the Central Mine group and top of the Bohemian Range group at that point.

Sp. 15899. Hole 16 at 475 feet from bed rock surface. Microlitic porphyritic with poikilitic quartz porphyry sediment.

Sp. 15900. Hole 16 at 480 feet from bed rock surface. Similar calcareous cement; microlitic fragments changed to poikilitic quartz patches.

Sp. 15901. Hole 16 at 481 feet from bed rock surface. Pebbles of poikilitic quartz porphyry and porphyrite?

Sp. 15902. Hole 16 at 482 feet from bed rock surface. Pebbles of spherulitic porphyry; quartz porphyr; quartz keratophyre; plagioclase feldspar phenocrysts have extinction angles 5°w11°-22°.

Sp. 15903. Hole 16 at 483 feet from bed rock surface. Spherulitic porphyry, porphyrites and fragments of tufa.

Sp. 15905. Hole 16 at 486 feet from bed rock surface. Not very fine grained porphyrite with calcite veins.

487-611; (Ss. 15906-18). MELAPHYRE, ophite; amygdaloidal (117)

at the top; has much more magnetite than, for example, the "backbone" Greenstone. Cf. Pumpelly, Geol. Sur. Mich., I Pt. II, p. 17 and some of the lower beds of the Mass Mine section.

Sp. 15906. Hole 16 at 487 feet from bed rock surface. Calcareous and ochreous, with a brecciated vein; sedimentary or thoroughly decomposed contact with trap.

Sp. 15907. Hole 16 at 490 feet from bed rock surface. Rather fine grained feldspathic porphyrite; calcite cavity; feldspar decomposed; probably low angled.

Grain

Olivine 5x2; 3x2; 3x1½, av. .11x.05 mm.

Iron oxide 3x5; 5x5; 5x4, av. .13x.14 mm.
Feldspar 11x3; 10x2; 18x5, av. .39x.10 mm.
Augite 4x1; 3x2; 4x2.5, av. .11x.05 mm.

Sp. 15908. Hole 16 at 494 feet from bed rock surface. Similar but becoming slightly poikilitic; low angled feldspars (up to 20°).

Grain

Olivine 5x5; 5x5; 5x4, av. .15x.14 mm.
Feldspar 18x3; 15x2; 18x5, av. .51x.10 mm.
Augite 35x22; 24x12; 45x45, av. 1.04x.79 mm.

Sp. 15909. Hole 16 at 524 feet from bed rock surface. Marked poikilitic, but has also a marked nest of coarse feldspar and olivine indicating a troctolite either as an included fragment or early stage of crystallization.

Grain

Olivine 15x15; 17x13; 4x4; 5x3; 3x3, av. .29x.25 mm.
Iron oxide (much) 11x8; 17x14; 60x27; 83x20; 70x17, av. 2.13x.64 mm.
Feldspar 18x2; 20x3; 26x3, av. .46x.36 mm.; av. .64x.08 mm., in the coarse nest.
Augite 60x55; 40x37; 70x47, av. 1.70x1.39 mm.

Sp. 15910. Hole 16 at 531 feet from bed rock surface. Well defined poikilitic but with *much magnetite;* feldspar extinctions, zones 38?°-41°-w19°-15°.

Grain

Olivine 10x6; 6x5; 7x6, av. .23x.17 mm.
Iron oxide 13x10; 13x13; 18x14, av. .44x.37 mm.
Feldspar 25x5; 39x23; 27x5, av. .91x.33 mm.
Augite 72x60; 75x60; 80x55, av. 2.27x1.75 mm.

Sp. 15911. Hole 16 at 539 feet from bed rock surface. Marked poikilitic, very ferruginous; feldspar extinction angles 0°w25°-28°; 30°-16°; 13°w25°-30°.

Grain

Olivine 12x9; 7x6; 12x11, av. .31x.26 mm.
Iron oxide 8x7; 12x11; 11x11, av. .31x.29 mm.
Feldspar 23x3; 36x4; 30x5, av. .89x.12 mm.
Augite 110x80; 53x50; 80x45, av. 2.43x1.75 mm.

Sp. 15912. Hole 16 at 553 feet from bed rock surface. Coarse type with larger feldspar; zonar feldspar extinction angles 19°-12°w28°-23°; 32°-31°w8°-8°; 36°-32°w16°-14° in a large feldspar; both poikilitic and doleritic type of texture with cavities lined with chlorite.

Grain

Olivine 28x20; 30x18, av. .8x.63 mm.
Iron oxide hematite or ilmenite 40x4 and 25x23
Augite 76x60; 70x60; 76x70, av. 2.22x1.90 mm.

Sp. 15913. Hole 16 at 554 feet from bed rock surface. Altered olivine plainer; feldspar extinction angles 6°-11°w28°-23°; 12°-12°w29°-29° in Baveno crystals at right angles.

Grain

Olivine 14x7; 9x9; 9x8; nest 32x4, av. .32x.24 mm.
Iron oxide octahedra 10x9; 6x6, av. .26x.25 mm.
Feldspar 14x3; 18x2; 18x3, av. .50x.08 mm.
Augite 122; 160x75; 80x75; 150x70, av. 3.9x2.2. mm.

Sp. 15914. Hole 16 at 560 feet from bed rock surface. Coarse poikilitic; feldspar extinction angles 6°; 40°-23°; 23°-17°w36°-38°; 19°-24°w37°-45°.

Olivine 8x8; 12x8; 8x8, av. .28x.24 mm.
Iron oxide 12x11; 10x8; 15x12, av. .37x.31 mm.
Feldspar 11x3; 23x2.5; 18x3, av. .52x.08 mm.
Augite with naked eye 3 mm.; 140x80; 110x80; 100x70, av. 3.50x2.30 mm.

Sp. 15915. Hole 16 at 564 feet from bed rock surface. Extinction angles 23°-32°; 23°-20°; 17°w31°-30°; feldspar crystallization far advanced before final vent; nests 35x8.

Grain

Olivine 13x12; 10x8; 11x11, av. .34x.31 mm.
Feldspar 20x5; 13x3; 16x3, av. .49x.11 mm.
Augite with naked eye 3 mm.; 85x60; 105x40; 145x80, av. 3.35x2.05 mm.

Sp. 15916. Hole 16 at 591 feet from bed rock surface. Feldspar extinction angles 15°-26°w32°; 38°-30°w30°.

Grain

Olivine 5x14; 6x7; 9x11, av. .20x.32
Iron oxide 20x12; 10x8; 19x10, av. .49x.30 mm.
Feldspar 15x5; 14x3; 20x5; some big feldspars about 35x9, av. .49x.12 mm.
Augite with naked eye 2 mm.; 85x60; 80x73; 80x60, av. 2.45x1.93 mm.

Sp. 15917. Hole 16 at 607 feet from bed rock surface. Finer grained than 15916, feldspar extinction angles 19°-25°; 17°-26°; 0° and 17°-7°w35°-33°.

Grain

Olivine 5x5; 6x6; 8x3, av. .19x.14 mm.
Feldspar 13x2; 15x2; 10x2, av. .38x.06 mm.
Augite ? 37x32; 31x27; 60x56, av. 1.28x1.15 mm.

Sp. 15918. Hole 16 at 611 feet from bed rock surface. Fine grained amygdaloid?; glomeroporphyritic; large calcite amygdule; feldspar extinction angles 12°-15°; 13°-14°; 3°; 22°-12°; there is one big feldspar and feldspar nests are segregated.

611-618; (Ss. 15919-23). CONGLOMERATE; with basic and acid pebbles; dips observed 21°, 26°, 27°. (7) (124)

Hereafter 1-10 will be taken off to reduce from VERTICAL *width to* THICKNESS, *corresponding to dip of 26°.*

Sp. 15919. Hole 16 at 612 feet from bed rock surface. Poikilitic keratophyric porphyrites, etc., calcite cement.

Sp. 15920. Hole 16 at 613 feet from surface. Sediment largely basic with calcite cement but also quartz and porphyry fragments.

Sp. 15921. Hole 16 at 615 feet from bed rock surface. Very calcareous; a few fragments of porphyries.

Sp. 15922. Hole 16 at 616 feet from bed rock surface. Calcite cement; porphyry, quartz porphyry and keratophyre and spherulitic pebbles.

Sp. 15923. Hole 16 at 617 feet from bed rock surface. Various klastic fragments as above.

618-663.5; (Ss. 15924-8). PORPHYRITE. (42) (42)

Sp. 15924. Hole 16 at 618 feet from bed rock surface. Amygdaloidal microlitic porphyrite with red ground; mostly low angled feldspar.

Grain

Olivine 0
Feldspar 9x1; 9x0.5; 8x1, av. .26x.02 mm.
Augite 0, very black.

Sp. 15925. Hole 16 at 619 feet from bed rock surface. Coarser; olivinitic; low angled feldspar.

Grain

Olivine 2x2; 3x4; 2x2, av. .07x.08 mm.
Feldspar 15x1; 6x2; 15x10, av. .36x.13 mm.
Augite?

Sp. 15926. Hole 16 at 625 feet from bed rock surface. Trifle coarser, shredded augite; extinction angles moderately low; 0°; 16°.

Grain

Olivine?
Iron oxide 1x2; 4x4; 3x4, av. .08x.10 mm.
Feldspar 11x2; 13x1; 10x3½, av. .34x.06 mm.
Augite 6x4; 6x6½; 4x4, av. .16x.09 mm.

Sp. 15927. Hole 16 at 637 feet from bed rock surface. Augite in sharper interstitial granules; moderately low extinction angles 0°, 13°.

Grain

Olivine 3x3; 3x3; 4x4, av. .10x.10 mm.
Iron oxide 3x3
Feldspar 20x2; 31x3; 19x2, av. .70x.07 mm.
Augite 6x4; 9x8; 4x3, av. .19x.15 mm.

Sp. 15928. Hole 16 at 663 feet from bed rock surface. Fine grained chloritic amygdaloid.

Grain

Olivine 2
Iron oxide 2x2; 5x2; 3x0.1, av. .10x.04 mm.
Feldspar 22x2; 6x1; 10x2, av. .38x.05 mm.

663.5-697; (Ss. 15929-38). CONGLOMERATE, scoriaceous; (30) (72)

like 438-445 feet in its character and in its pebbles. It is not at all unlikely that similar conglomerates, which are a brecciated mixture of sandstone and trap, represent real though perhaps slight erosion unconformities, the underlying bed having been eroded. They may also be a sign of terrestrial formation of the series. Dips 28°, 29°.

Sp. 15929. Hole 16 at 667 feet from bed rock surface. Coarse sandstone; grains largely of salic, felsitic rocks; this is very like the bed from 438-445 ft. in character.

Sp. 15930. Hole 16 at 670 feet from bed rock surface. Finer grained but with one large fragment of microlitic porphyritic amygdaloid.

Sp. 15931. Hole 16 at 672 feet from surface. Fine grained microlitic amygdaloid such as occurs near margins of flows.

Sp. 15932. Hole 16 at 674 feet from surface. Shows contact of two flows.

Sp. 15933. Hole 16 at 675 feet from surface. Microlitic amygdaloid, not equally fine grained.

Sp. 15934. Hole 16 at 676 feet from surface. Fine grained basic sediment; basic conglomerate?

Sp. 15935. Hole 677 feet from surface. Fragments of dark ferruginous more or less microlitic porphyrites; cement largely calcareous.

Sp. 15936. Hole 16 at 692 feet from surface. One large similar fragment.

Sp. 15937. Hole 16 at 694 feet from surface. Similar.

697 (or 696)-786; (Ss. 15939-45), MELAPHYRE, ophite; the (80) (80)

bottom five feet are a fine grained brecciated black trap, the dip of the lines of amygdules being 27°.

Sp. 15939. Hole 16 at 697 feet from bed rock surface. Evidently of fragments, but coarser; augite in small patches.

Grain

Olivine 2x1; 3x2; 2x1, av. .07x.04 mm.
Iron oxide 3x2; 5x1; 3x2, av. .11x.05 mm.
Feldspar 10x1; 5x1; 10x1, av. .25x.03 mm.
Augite 15x10; 18x9; 10x7, av. 0.42x0.26 mm.

The grain of this bed is illustrated in Figures 14, 15 (a) and 18 of the Isle Royale report, Vol. VI, Pl. I.

Sp. 15938. Hole 16 at 696 feet from bed rock surface. Similar to 15937; all these sections are similar. Compare the Huginnin porphyrite, in which however the phenocrysts are more distinct.

Grain

Iron oxide 1x2; 2x2; 2x1, av. .06x.04 mm.
Feldspar 10x1; 12x1; 15x9, av. .37x.11 mm.

Sp. 15940. Hole 16 at 700 feet from bed rock surface. Marked poikilitic; much olivine.

Grain

Olivine 5x4; 10x8; 6x5, av. .21x.17 mm.
Feldspar 8x2; 14x4; 12x7, av. .34x.13 mm.
Augite 53x40; 80x80; 115x75, av. 2.48x1.95 mm.

Sp. 15941. Hole 16 at 727 feet from bed rock surface. Marked poikilitic; much olivine; labradorite extinction angles 23°-23°; 21°-18°w33°-28°.

Grain

Olivine 6x5; 8x7; 9x6, av. .23x.18 mm.
Feldspar 13x2; 16x2; 12x2, av. .41x.06 mm.
Augite 105x67; 67x60; 105x85, av. 2.17x2.12 mm.

Sp. 15942. Hole 16 at 739 feet from bed rock surface. Marked poikilitic; much augite; feldspar extinction angles 28°-23°; 21°-18°; 33°-28°.

Grain

Olivine 5x3; 8x7; 7x7, av. .20x.17 mm.
Feldspar 10x2; 11x2; 12x2, av. .32x.06 mm.
Augite 85x85; 100x90; 80x65, av. 2.65x2.40 mm.

Sp. 15943. Hole 16 at 748 feet from bed rock surface. Marked poikilitic; coarser; labradorite extinction angles 24°-19°; 32°-18°w46°-34°; 33°-30°.

Grain

Olivine 8x7; 10x8; 10x7, av. .28x.22 mm.
Feldspar 10x2; 10x1; 12x2, av. .32x.05 mm.
Augite 73x60; 110x65; 52x45, av. 2.35x1.70 mm.

Sp. 15944. Hole 16 at 773 feet from bed rock surface. Marked poikilitic; finer grained feldspar extinction angles 25°-21°w4°-10°; 33°-25°.

Grain

Olivine 4x4; 5x4; 6x4, av. .15x.12 mm.
Feldspar 11x1; 14x1; 11x1, av. .36x.03 mm.
Augite 60x42; 85x65; 52x45, av. 1.97x1.52 mm.

Sp. 15946. Hole 16 at 788 feet from bed rock surface. Calcite and iron oxide. This must be from a vein. Thickness at cross section 732.

786-910; (Ss. 15946-85). SANDSTONE, passing into (112) (192)

CONGLOMERATE and PORPHYRY TUFF. Dips: at 796 feet, 52°?; at 803 feet, 50°; at 808 feet, in a sandstone streak, 63°; at 817 feet, 40°?; at 830 feet, with signs of unconformity and cross-bedding, 35°; at 850 feet, 37°. This bed is very largely of fragments such as the underlying rock might furnish, and largely in the concave forms of ash or glass fragments, which do not imply an erosion of the source, but at the top of the bed there is sediment proper, some of which may have been derived from other rocks than the underlying felsite. At the bottom of this conglomerate the passage into felsite is so gradual that I at first fixed the dividing line at 924 feet, and I think the conglomerate may be considered practically contemporaneous, that is immediately subsequent to the felsite, which was at once subject to erosion, as a land formation quite likely. Chalcedonic dots are characteristic of the whole

formation and a bluish fluorite, first noticed under the microscope, was visible also to the unaided eye. The tufa is sometimes dark, but often light, often greenish, with sandstone boulders, or brecciated with angular green spots.

Sp. 15947. Hole 16 at 789 feet from bed rock surface. Calcite sediment crushed.

Sp. 15948. Hole 16 at 792 feet from bed rock surface. Corroded feldspar! ash fine grain.

Sp. 15949. Hole 16 at 794 feet from surface. Corroded feldspar; spherulitic quartz.

Sp. 15950. Hole 16 at 795 feet from surface. Spherulites; corroded feldspar; long pores with quartz fillings and dark borders.

Sp. 15951. Hole 16 at 803 feet from bed rock surface. Corroded orthoclase feldspar; pores with dark borders.

Sp. 15952. Hole 16 at 805 feet from bed rock surface. Sediment and fragments with fluidal texture.

Sp. 15953. Hole 16 at 807 feet from bed rock surface. Small grains, including plagioclase, green matter, etc., cement micaceous.

Sp. 15954. Hole 16 at 808 feet from bed rock surface. Similar; but with large fragments; some dark; showing flow lines, with spherulites.

Sp. 15955. Hole 16 at 808 feet from surface. Porous brown rock with porous orthoclase.

Sp. 15956. Hole 16 at 812 feet from surface. Plagioclase and spherulites and sediment and rhyolite fragments.

Sp. 15957. Hole 16 at 813 feet from bed rock surface. Microlitic amygdaloid; trichitic pebbles; porphyrite.

Sp. 15958. Hole 16 at 817 feet from bed rock surface. Has curious red and white spots.

Sp. 15959. Hole 16 at 817 feet from surface. Very ferruginous, decomposed.

Sp. 15960. Hole 16 at 822 feet from rock bed surface. Shows perlitic structure outlined by iron oxide.

Sp. 15961. Hole 16 at 823 feet from bed rock surface.

Sp. 15962. Hole 16 at 824 feet from bed rock surface. Porphyry fragments; quartzose or micaceous cement; every fragment outlined by a white line; ash forms.

Sp. 15963. Hole 16 at 827 feet from bed rock surface. The same; more ferruginous.

Sp. 15964. Hole 16 at 829 feet from bed rock surface. Tufa, micaceous; quartzose chloritic?

Sp. 15965. Hole 16 at 830 feet from bed rock surface. Greenish quartzose with reddish spherulite spots.

Sp. 15966. Hole 16 at 836 feet from bed rock surface. Fine grained quartzose mass.

Sp. 15967. Porphyry fragments; quartzose cement; green matter in interstices.

Sp. 15968. Hole 16 at 841 feet from bed rock surface. Similar; green grains in irregular forms representing altered ash?

Sp. 15969. Hole 16 at 842 feet from bed rock surface. White flecks and red flecks are characteristic through this series of rocks.

Sp. 15970. Hole 16 at 842 feet from bed rock surface. Porphyry tuff.

Sp. 15971. Hole 16 at 847 feet from bed rock surface. Porous; pores lined with quartz and filled with chlorite.

Sp. 15972. Hole 16 at 849 feet from bed rock surface. Corroded feldspars; tufaceous; *fluorite* with calcite; isotropic; in blue spots; cleavage good; refraction lower than either refraction of calcite!

Sp. 15973. Hole 16 at 850 feet from bed rock surface. Tufa as usual.

Sp. 15974. Hole 16 at 853 feet from bed rock surface. Perlitic fragments; corroded orthoclase.

Sp. 15975. Hole 16 at 863 feet from bed rock surface. Feldspar; well marked fragments.

Sp. 15976. Hole 16 at 865 feet from bed rock surface. *Fluorite,* glass fragments well-marked.

Sp. 15977. Hole 16 at 867 feet from bed rock surface. Corroded feldspar; rounded, dotted glass fragments.

Sp. 15978. Hole 16 at 870 feet from bed rock surface. More micaceous.

Sp. 15979. Hole 16 at 875 and 878 feet from bed rock surface. Micaceous; fragments of spherulites.

Sp. 15981. Hole 16 at 882 feet from bed rock surface. Calcite in spherulitic form.

Sp. 15982. Hole 16 at 891 feet from bed rock surface. Well marked fragments with white margins as illustrated in I. R. report, Vol. VI, Part 1, Plate VI, Fig. 2.

Sp. 15983. Hole 16 at 896 feet from bed rock surface. Poikilitic ash fragments; chalcedonic dots.

Sp. 15984. Hole 16 at 899 feet from bed rock surface. Similar to 15983.

Sp. 15985. Hole 16 at 903 feet from bed rock surface. Very ferruginous.

Sp. 15986. Hole 16 at 910 feet from bed rock surface. Porous, full of chalcedonic spots, calcite, etc.

910-1000+; (Ss. 15986-98). FELSITE, very fine grained; a typical felsite; porphyritic crystals, extremely small and rare; quartz not certainly visible. This, with the Minong felsite porphyrite may seem to meet Irving's anticipation (*loc. cit.*, p. 331) of red acid rocks on the north side of the island. We have already called attention to the felsites that occur at various points in the series on Keweenaw Point. But by far the closest lithological resemblance of this bed is to the felsites of Bare Hill, Sec. 29, T. 58, R. 28, and to those that occur near the mouth of the Little Montreal River on Sec. 26, and Sec. 27, T. 58, R. 28, which are described by Hubbard. It also resembles some of the Mamainse felsites, near Sand Bay.

Sp. 15986. Hole 16 at 910 feet from bed rock surface. Porous full of chalcedonic spots, calcite, etc.; beginning of porphyry here.

Thickness at cross section 822.

Sp. 15987. Hole 16 at 916 feet from bed rock surface. Big corroded feldspar brotocryst; very calcareous and quartzose.

Sp. 15988. Hole 16 at 922 feet from bed rock surface. Open pores; calcareous; quartzose confused porphyry ground mass.

Sp. 15989. Hole 16 at 923 feet from bed rock surface. Calcareous pores; porphyry ground mass with brotocrysts.

Sp. 15990. Hole 16 at 924 feet from bed rock surface. Similar; more compact.

Sp. 15991. Hole 16 at 926 feet from bed rock surface. Similar; less calcareous; I at first thought the beginning of the tufa was here.

Sp. 15992. Hole 16 at 928 feet from bed rock surface. Similar.

Sp. 15994. Hole 16 at 935 feet from bed rock surface. Similar.

Sp. 15995. Hole 16 at 936 feet from bed rock surface. A curious eye is perhaps a brotocryst of feldspar; otherwise similar.

Sp. 15996. Hole 16 at 953 feet from bed rock surface. Distinctly poikilitic with quartz patches.

Sp. 15997. Hole 16 at 964 feet from bed rock surface. Similar.

Sp. 15998. Hole 16 at 1000 feet from bed rock surface. Small corroded quartz brotocryst.

For records of hole XII and XV see Isle Royale Report, Vol. VI. Part I, pp. 95-97.

§ 35. MAMAINSE.

One further section with which I am familiar may have a word of mention. At the east end of Lake Superior north of the Sault Ste. Marie Keweenawan rocks are found. Here we find the thickest section perhaps at Cape Mamainse.[1] Here we find 2000 or 3000 feet of not very thick flows of ophitic type and conglomerates subordinate with a heavy 20 mm. ophite at the bottom. Under this is a set of beds with five important conglomerates and felsitic beds near the top. Next comes a very heavy conglomerate 680 feet thick, and then several thousand feet of not very thick flows with occasional diabase dikes, numerous amygdaloids, and no important conglomerates. Felsites occur from very near the top down and are often intrusive. In one place the upturned lower beds are overlain with an entire unconformity of strike and dip by sandstone that we may identify with the Lake Superior sandstone.

It seems as though the Central and Bohemian Range groups were represented.

This report has so extended that I will not try to give details of the section for which see Bull. 6 cited above. The important features for comparison are that we have here conditions very similar to those on Keweenaw Point or Isle Royale. The dips vary from about 24° to N. 35° W. at the top of the series to 42° or more toward the base. The formation is a good deal disturbed by faults which are, however, not so predominantly vertical as on Keweenaw Point. The main set strike nearly north, to east of north, and dip 45° to 65° E., thus making southward pitching troughs with which the occurrence of copper is associated. Not only are the beds as already mentioned similar to those of Keweenaw Point but they are markedly similar in the occurrence of copper. Native copper occurs in some of the conglomerates. It is more abundant in some cases, at any rate, near the cross-fissures as it was, for instance, at the Central mine on Keweenaw Point. It seems, however, to be rather more often a sulphide. In the cross-fissures both chalcocite and chalcopyrite occur. In one place one of these fissures had at the center nearly four solid chalcocites but masses of native copper also occur in the fissures.

Finally, in connection with the probably intrusive felsites disseminated pyrite occurs. We have practically the same secondary fillings of agates, prehnite, etc., that we have on Keweenaw Point. The occurrence of copper in so similar surroundings at the other end of Lake Superior suggests how intimately its occurrence is bound up with the Keweenaw formation itself.

[1]See various reports of the Canadian Survey, and Ontario Bureau of Mines; also Bulletin 6, Department of Mines, Ottawa, Canada.

CHAPTER VI.

TEMPERATURE OF THE COPPER MINES.

§ 1. IMPORTANCE OF THE SUBJECT.

In Fernekes' and Stokes' experiments on the deposition of copper leading to the formation of native copper very analogous to that found in the mines, the solution was unequally heated, copper being deposited in the lower or hotter end. It will be quite fitting, therefore, to discuss what effect the fact that the mines are hotter at the bottom has had on the deposition of copper and for that reason alone to gather facts as to the temperatures prevailing in the copper mines, but these temperatures have also a bearing on the solubility of various substances, and on the probable circulation of water. From a practical point of view, also, they are of importance as they might limit depth in mining. Too great heat decreases the efficiency of men, though it increases that of compressed air machines. It might, therefore, involve an extra expense in ventilation, which might turn a proposition from a profitable to an unprofitable one. However, at what seems to be the actual rate of increase, 1°F for each 100 feet or more, beginning at a temperature of 43°F, it is probable that the increased cost of hoisting and keeping up the roof will be more vital factors.[1]

§ 2. MEAN ANNUAL TEMPERATURE OF AIR.

The average mean temperatures of the Upper Peninsula, according to the map (Fig. 1) furnished by the State Weather Bureau for U. S. Geol. Sur., Water Supply Paper 31, would be 38° to 42° F. Calumet is about 1200 A. T. (See Pl. IX.) The record of temperature at Calumet is not quite so long as that at Marquette. The former runs only from July, 1887 to March, 1910 and the average for the various months and for the year are, as given by the State Weather Survey, C. F. Schneider, director, as follows:

[1]See "Mineral Industry," 1895, p. 767, "How Deep can we Mine?" A. C. Lane.