

enough the beds are not actually continuous, and will not be found between Portage Lake and the Ontonagon River.

On the road north from Ironwood about one-half mile (2,800 feet) north of Section 2, T. 47 N., R. 47 W., is a diabase dike striking north 25° east, dipping 25° only to south (so that though 80 steps broad, it is but 30 or 40 feet thick) and is cutting labradorite porphyrites. We are safe then in assuming that at least this far and probably to the D. S. S. and A. track just above the north line of the section belong to the Bohemian Range group.

These labradorite porphyrites which mark the lowest group of the Bessemer Section, which I take perhaps to be the Bohemian Range group I have traced into Wisconsin where a little exploring was done about 300 paces north, 500 paces west in Section 16, T. 46 N., R. 2 E. The plagioclase phenocrysts are up to 15 mm. long, and the agate amygdules and pipe amygdules at base are all like the beds between Bessemer and North Bessemer.¹

§ 33. SOUTH TRAP RANGE.

There is one occurrence of Keweenaw Rocks that deserves farther study. I refer to that which lies south of the Great Keweenaw fault. Gordon has given a pretty close study of it north of Bessemer. It branches from the Main Trap Range near Abitosse. It shows at the Castile mine, Section 10-13, T. 47 R. 46, where it seems to roll up onto an eroded surface of the iron formation with flatter dips at the upper levels, and the labradorite porphyrites are close to the iron formation north of Sunday Lake, showing a heavy pre-Keweenaw erosion of the Animikie.

East of Lake Gogebic in Sections 5, 4 and 9, 10, 11, 12 and 13, T. 46 N., R. 41 W., the traps appear and seem to have nearly flat dips, judging by the steepness of the south scarp and the course of the outcrops curving around the east and west ends. The jointing is nearly vertical (columnar and horizontal). Bands of amygdules are probably parallel to the bedding, and very rarely interbedded sandstones are found. I judge that the dips were often less than 10° to the north. On Section 11 a contact with sandstone showed 14° dip. (See Ss. 14119-14124.) On Section 13, there seems to be a feeder neck of diabase. A. E. Seaman studied this region in 1891. (Note book 85.) Some of these beds are labradorite porphyrites and they look like the lowest group. Pipe amygdules at base and agates (datolite) are not really important but suggestive. They are probably quite unconformably overlapped by the Jacobsville or

¹Farther description of the Keweenaw rocks and of detailed work to the west will be found in a report by F. T. Thwaites to the Wisconsin Geological Survey.

Eastern sandstone, for not only do patches occur along the edge of these Sections (1 to 18, T. 46 R. 39 to Section 29, T. 48, R. 37) but they appear through it.

The most famous case of this kind is the so-called Silver Mountain Sec. 1, T. 49 N., R. 36 W., and Secs. 6 and 7, T. 49 N., R. 35 W., described by Foster and Whitney² but this only dips 10° to 20°. The dike observed by Foster and Whitney at Silver Mountain suggests that it belongs in the lower third of the Keweenaw. Seaman also noticed chalcocite, chalcopyrite and bornite. Another exposure³ not far off is on the Sturgeon River in Section 16, T. 49 N., R. 35 W., where the river cuts a deep valley with amphitheatres a mile across and 250 feet deep. Both these are typical Keweenaw amygdaloid and trap flows. None of these are known close to the Great Keweenaw fault, however. Whether the disturbances like those of Limestone Mountain, Fig. 48, and Traverse Island, and one-half mile from the south line of T. 50 (F. & W., p. 69) have any connection with similar, not uncovered, phenomena remains to be seen.

§ 34. ISLE ROYALE. (Pl. I³ and Fig. 56.⁴)

This was the first and most completely studied section, especially microscopically. Since Volume VI is out of print I hardly think an apology is needed for presenting this one section on the north shore of the basin. It will be noticed that the section may be closely matched with the Central, Ashbed and part of the Eagle River groups, that the Lake Shore traps cannot be identified, and that the Central group is relatively thin, while the Ashbed group and the Greenstone are well developed, the latter being much thicker to the north where around the head of Rock Harbor are suggestions of a buried felsite laccolite above the Greenstone, i. e., in the position of the Chippewa and Porcupine Mountain felsite.

The drill hole record has to be supplemented by field observations which were roughly as follows:

Red sandstone of Point Houghton.

This has also been called Siskowit Point and an analysis of the sandstone which was quarried on this point is given in the table of analyses (XIX No. 4, p. 118.) The rock was quarried and used in Duluth and that is the reason the Minnesota Survey made a test. Owing to the fault shown in the geological map of Isle Royale the thickness of this formation is uncertain. A very considerable dip is shown, however, at Point Hough-

¹Part I, 1850, p. 68. See also Seaman's note book 85 and Ss. 14000-14047.

²For some of the other outcrops see the map of Michigan in the report for 1901.

³Pl. I is a combination of Pl. I of Vol. VI and Pl. I of the Biological Report for 1908. Fig. 56 is a reproduction of Pl. II of Vol. VI.

⁴Plate I and Fig. 56 are in envelope.

ton where the dips are decided,—about $20\frac{1}{2}^\circ$. The dips of the minor islands of Siskowit Bay are considerably less. I refer to Wright Island and similar islands but it is not at all impossible that these represent an unconformable overlap of the Lake Superior or Freda or Saint Croix sandstone upon the Lower Keweenaw. At the same time the dip of the Keweenaw, as shown in the conglomerate of the north side of Siskowit Bay, is not very great, being about 12° . I assume for these deep maroon red sandstones a thickness of (2000) ft.

Between the Point Houghton sandstone which would correspond to the Freda sandstone in appearance and stratigraphic relation, though possibly not in age and drill hole XI, comes conglomerate. The cement is often very calcareous; the color is prevailingly bright red. Pebbles of various types of Keweenaw lavas such as melaphyres and porphyrites are quite common and pebbles of agate such as the agates that grow in the Minong trap and other of the Keweenaw lava flows are not rare. The thickness I took to be (600) ft.

(See Isle Royale report, page 56).

EAGLE RIVER GROUP.

Marvine's (c)

Isle Royale Section abstracted from Volume VI, with additional notes.

The reasons for the dip and correlations assumed will be found in Vol. VI. The *vertical* width of the beds, i. e., along the drill holes, is given in feet in the right hand column without parentheses (N. B. not the *horizontal* width which Marvine gives) and under it in parentheses is given the true thickness as found by subtracting a correction equal to (vertical width) \times (1-cos dip). In the main body of the text appears first, numbers that denote the limits, in feet, of the several beds below the tops of the respective drill holes. Then follow, in parentheses, high numbers which refer to the thin-sections of rocks from the respective beds; collection of Michigan Geological Survey.

To this are added the petrographic notes and notes on the grain. The dimensions of the grains are given in terms of an eye piece micrometer, the divisions of which represented a length of about 1/30 mm. By adding the observations on three grains and pointing off two places one obtains directly an average value in mm. In giving the extinction angles of the feldspar, those of the two halves of an albite twin are separated by a dash thus $0^\circ-15^\circ$, while the conjunction or w joins them to the extinction of a Karlsbad twin which is compounded with them.

DRILL HOLE No. XI.¹

0-17; (Ss. 15544-5). OPHITE; fine grained, massive, with red and white fine grained veins; lustre-mottlings visible. This is near Marvine's bed No. 7, Eagle River section.

Sp. 15544. Hole 11 at 143 feet from surface. Augite patches, sharp feldspar imbedded; labradorite ($24^\circ-23^\circ$ and 30° ; $16^\circ-2^\circ$ and 46° ; $39^\circ-30^\circ$ and 16° albite and Karlsbad extinction). Olivine all green with iron oxide borders secondary; also chloritic areas; little or no feldspar in them; hematite plates whose primary character is doubtful; biotite secondary in with the chlorite; the chlorite appears

¹Top of No. XI, dip assumed $12^\circ 20'$; cos dip=0.9763.

to either fill interstices or replace glass. It contains most of the altered olivine, vein serpentine occurs in fine grained mosaic and in fibres parallel and normal to vein. Distance from margin-14.5 feet.

Grain

Olivine 8; 13; 10; 10; 9; 4; av. .26
Iron oxide 5x0.5; 12x1; av. .28x.02
Feldspar (15 to 20)x5
Augite 40x70; 60; 55; 70; 73

Sp. 15545. Hole 11 at 143 and 144 feet from surface. Much plagioclase; augite less conspicuous; altered olivine altered to red oxide, much viridite after olivine and glass? in fibrous coating covering the carbonates and feldspars where they project into probably original cavities; augite shows traces of idiomorphism. Distance from margin 1 \pm

Grain

Olivine 7, 7, 8, 7, 5
Iron oxide, of various size, hard to distinguish primary and secondary dust.
Feldspar 7x2, 10x2, 9x2 av. .26x.06
Augite 14x5m, 15x8 av. .48x.21
Thickness (2600+17)

17-90; (Ss. 15546-63). CONGLOMERATE; red with calcareous cement and a great variety of pebbles; the acid quartz porphyry predominates, but felsites, porphyrites and melaphyres are also present. Marvine's bed No. 8 Eagle River.

Sp. 15546. Hole 11 at 18 feet from bed rock surface; calcareous cement with twinning lines; rounded pebbles:

(1) Quartz in the form of porphyry phenocrysts, poikilitic quartz additions, probably secondary, in the conglomerate.

(2) Feldspar porphyry pebbles, patchy poikilitic ground mass, orthoclase phenocrysts.

(3) Porphyry with mosaic ground, very reddish with oxide dots.

(4) Porphyrite; angular iron oxides, feldspar laths with extinction angles near 0° otherwise seems very like 15545.

(5) Porphyritic; angular iron oxides, minute feldspar laths but in polarized light patchy poikilitic texture secondary. Cf. Bascom, J. G. I. (1893) p. 814.

Sp. 15547. Hole 11 at 20 feet from bed rock surface. Calcareous cement, grains like 15546 but smaller; in the porphyrite grains the feldspars are changed to some zeolite, twin striations rare; low extinction angles.

Sp. 15548. Hole 11 at 24 feet from surface. Slightly glomeroporphyritic (Extinctions $6^\circ-4^\circ$, $6^\circ-6^\circ$, $2^\circ-3^\circ$, $17^\circ-10^\circ$) oligoclase; ground mass of minute feldspar trichites; iron oxide arranged in concentric rings around certain spots; apatite well marked; other phenocrysts decomposed. Distance from margin 7.

Grain

Iron oxide 6, 5, 4, 7
Feldspar 82x10, 35x13, 43x7, av. 1.10x.25
Feldspar trichites 2x0.2, 3x0.2

Sp. 15549. Hole 11 at 28 feet from bed rock surface. Pebbles of hornblende porphyrite like 15548 of augite, porphyrite; ground mass of quartz porphyry and poikilitic patchy ground masses; calcareous cement; conglomerate (with altered rhyolite, trachyte, andesite and basalt pebbles). Distance from margin 11.

Sp. 15550. Hole 11 at 32.5 feet from bed rock surface. Phenocrysts of corroded feldspar with numerous narrow striations $12^\circ-4^\circ$; $16^\circ-4^\circ$; not sharp margins; ground mass patchy, poikilitic, mass of smaller feldspar laths mottled with iron

oxide; little quartz veins; more decomposed than 15548. Distance from margin 15.

Sp. 15551. Hole 11 at 37 feet from bed rock surface. Porphyry and porphyrite pebbles. Distance from margin 19.

Sp. 15552. Hole 11 at 43 feet from bed rock surface. Pebble much like 15548; Manebach twin phenocrysts but ground apparently microlitic; really secondarily poikilitic; phenocrysts corroded; one grain like altered olivine; conglomerate. Distance from margin 25.

Grain

Olivine 27? 20?

Iron oxide 5, 4 and dust <.1

Feldspar 45x15, 80x35, 80x50, av. 2.05x1.00 mm.

Sp. 15553. Hole 11 at 46 feet from bed rock surface. Rounded fragments quartz porphyry etc., poikilitic and microlitic ground mass; calcareous cement. Distance from margin 28 feet from bottom, 43 from top.

Sp. 15554. Hole 11 at 61 feet from bed rock surface. Quartz porphyry with microfelsitic and poikilitic ground mass and other fragments. Distance from margin 28.

Sp. 15555. Hole 11 at 63 feet from bed rock surface. Oligoclase porphyry, poikilitic ground, other phenocrysts decomposed. Distance from margin 26.

Sp. 15556. Hole 11 at 68 feet from bed rock surface.

Sp. 15557. Hole 11 at 71 feet from bed rock surface. Finer grained calcareous cement; numerous grains dark with iron oxides. Distance from margin 21 ft. and 17 ft. respectively.

Sp. 15558. Hole 11 at 76 feet from bed rock surface. Chalcedonic fragments also. Distance from margin 14 ft.

Sp. 15559. Hole 11 at 78 feet from bed rock surface. Decomposed melaphyre pebble. Distance from margin 12 ft.

Sp. 15560. Hole 11 at 80 feet from bed rock surface. Poikilitic (patchy) felsite; no phenocrysts, fluidal texture. Distance from margin 10 ft.

Sp. 15561. Hole 11 at 83 feet from bed rock. Fragments porphyry and porphyrite with much secondary poikilism. Distance from margin 7.

Sp. 15562. Hole 11 at 88 feet from bed rock surface.

Sp. 15563. Hole 11 at 89 feet from bed rock surface. Some epidote; various pebbles; one shows spherulitic porphyry. Distance from margin 2 ft. and 1 ft. respectively.

Thickness of cross-section

(2600+86)

The large number of these sections of this conglomerate were made to identify the pebbles with underlying beds. Almost all the material was derivable from Keweenaw lavas.

90-96; (Ss. 15565-6). MELAPHYRE, thin and amygdaloidal, (6) with chloritic amygdules; slightly ophitic; small flow perhaps a mere gush of the underlying.

Sp. 15565. Hole 11 at 94 feet from bed rock surface. Slightly ophitic, pores full of delessite fibres (+ ex. o. biref. .008+), feldspar extinction angles 15° and 26° 35°, 15°-31°, 12°-15°, 29°-41°, 35°-25° and 17°, 20°-22° and 33°-37° labradorite; olivine changed to serpentine, coated with red oxide; carbonates. Distance from margin 42.

Grain

Olivine 8, 4, 5, 5, 6

Iron oxide much red secondary 3-4

Feldspar 17x2, 20x2, 24x4, 18x2, av. .65x.16

Augite 26x10, 20x18, 40x20, 25x8, av. .89x.47

Sp. 15566. Hole 11 at 96 feet from bed rock surface. Marginal plagioclase much decomposed, in small forked and skeletal trichites and larger crystals (all sizes) on a glassy decomposed ground, stained red brown and opaque with rust; calcite amygdules; no augite visible; primary iron oxide not recognized; iron oxide of ground tends to gather in little knots, around which is a lighter halo; primary vein amygdules with calcite; altered olivine? and rare small amygdaloid pores. Distance from margin 0.

Grain

Olivine 5x3, 7x6, 9x6 (? double)

Feldspar from 3x.02 up to (porphyritic) 30x6, 12x1, 15x1, 25x3, 17x4, 42x16, av. .66x.10.

(2600+92)

96-103; (Ss. 15567-8). MELAPHYRE, amygdaloidal. White (7) not coarse enough, that is not thick enough flows to show the characteristic texture to the naked eye, these two small beds appear to belong to the ophites, with calcite, quartz and zeolite amygdules.

Sp. 15567. Hole 11 at 97 feet from bed rock surface. Very calcareous amygdaloid and feldspathic; small extinction angles 2° to 6°; possibly a few augite granules but cf. epidote; altered olivine? augite porphyrite. Distance from margin 1.

Grain

Olivine 2; 3; 4x5? 7x5; 8x6

Iron oxide 5?

Feldspar 22x1; 18x3; 20x8, av. .60x.12

Augite not clearly recognizable.

Sp. 15568. Hole 11 at 98 feet from bed rock surface. Very amygdaloidal, calcite, quartz and some zeolite; feldspar (0° with 14°-12°) and two types of ground mass one near 15566, the other to 15567; augite decomposed (?); very trichitic.

Grain

Feldspar 10, 9, 8, 10, 10, 13x1

Augite 45?

(2600+99)

103-124; (Ss. 15569-72). MELAPHYRE, ophite. The upper 5 (21) feet are amygdaloidal, and make, with the above two small (20) (2600+119)

flows, one amygdaloid belt. A very thin sediment with a calcareous cement underlies this bed. 0

Sp. 15569. Hole 11 at 107 feet from bed rock surface. Like 15570 but finer grained. Altered olivine is heavily coated with iron oxide. Distance from margin 4 ft.

Grain

Olivine 9x8; 7x7; 14x10, av. .30x.25

Feldspar 25x2

Augite 30x30 30x30; 30x14, av. .90x.74

Sp. 15570. Hole 11 at 114 feet from bed rock surface. Like 15571. Distance from margin 11.

Grain

Olivine 14x10; 9x5; 7x5; crowded between the patches of augite. Av. .30x.20

Feldspar 20x2; 20x2, av. .66x.06

Augite 80x45; 50x35; 45x40, av. 1.75x1.20

Sp. 15571. Hole 11 at 120 feet from bed rock surface. Poikilitic augite; olivine changed to talc; abradorite extinctions (23° - 45° and 35° - 22° ; 24° - 17° and 42°). Distance from margin 17 feet to top and 4 to bottom.

Grain

Olivine 10; 10; 10

Feldspar 22x4

Augite 65x40; 100x40; 50x35, av. 1.15x1.15

Sp. 15572. Hole 11 at 124 feet from bed rock surface. Glass like 15566, feldspars less microlitic, more basic; rests on fine grained ash or clay bed; poikilitic calcite cement; contact of melaphyre and sandstone; probably a very short break between this flow and the next above. Margin.

Grain

Olivine

Augite

Iron oxide

} not clear

Feldspar 23x4; down to minute microlites 2x2; 7x5; 5x2

124-137; (Ss. 15573-5). MELAPHYRE, amygdaloidal. Marvine's 13 bed No. 16. This bed is so glassy that it shows it was not only thin but in a cold place as indicated by the thick conglomerate over which it flowed, whereas the bed above may have almost immediately succeeded and hence cooled more from top than bottom.

Sp. 15573. Hole 11 at 127 feet from bed rock surface. Much calcite, much decomposed olivine, trichitic feldspar. Distance from margin 3 feet to top, 6 feet to bottom.

Grain

Olivine 11; 8; 7

Sp. 15574. Hole 11 at 133 feet from bed rock surface. Porphyritic and trichitic; olivine decomposed; various sized; distance from margin 9 feet to top, 4 to bottom.

Grain

Olivine 7; 4

Feldspar 27x2 and trichites 4x0.1 etc.

Sp. 15575. Hole 11 at 136 feet from bed rock surface. Very amygdaloidal; trichitic; decomposed; calcareous; slightly coarser than 15574. Distance from margin 3 ft.?

Grain

Olivine 4; 6; 6; 5

Feldspar 17x2

Thickness in cross section

137-146; (Ss. 15576-9). CONGLOMERATE; r d, with the usual
porphyry and felsite pebbles. Perhaps equivalent to Marvine's bed No. 17. (2600+132) 9

Sp. 15576. Hole 11 at 137 feet from bed rock surface. Rather coarse cement; decomposed orthoclase. Poikilitic quartz ground section is probably of a pebble?

Sp. 15577. Hole 11 at 138 ft. from surface. Fragments (1) trichitic porphyrites like augite porphyrites, (2) glass with iron oxide hairs, (3) poikilitic ground masses of quartz, (4) chloritic porphyrite, (5) quartz porphyry with calcareous cement. Conglomerate. Distance from margin 1 ft.

Sp. 15578. Hole 11 at 140 feet from surface. Spherulitic quartz porphyry with Manebach oligoclase phenocrysts, also some augite; porphyrite fragments. Distance to top 3 ft., to bottom 6 ft.

Sp. 15579. Hole 11 at 143 feet from bed rock surface. Oligoclase porphyrite, poikilitic ground mass.

Sp. 15580. Hole 11 at 146 feet from surface. Various sized down to trichitic feldspar (extinction 0° - 10° in Baveno twin cut nearly perpendicular to symmetry plane) ferruginous base. Distance from margin 0.

Grain

Feldspar 18x1, 12x2.

Sp. 15581. Hole 11 at 147 feet from bed rock surface. Epidote vein; oligoclase phenocrysts, flow structure apparently; bits of porphyry ground mass, also poikilitic with secondary quartz, oriented after trichitic feldspar, as described by Bascom sedimentary granules of porphyry ground mass. Distance from margin 1.

Grain

Feldspar phenocrysts 25x10, 30x10, 30x20, 6, 4, 7 trichites. (2600+141) 8
146-154; (Ss. 15582-3). PORPHYRITE (?), amygdaloidal. I think it is not impossible that this is merely a boulder in the conglomerate, as we have the conglomerate again interrupted by something similar (S. 15585).

Sp. 15582. Hole 11 at 149 feet from bed rock surface. Calcareous decomposed; glassy, diabasic; much feldspar. Olivine not apparent, nor augite. Distance from margin above, 3/5 below.

Grain

Iron oxide 5x5; 4x4; 3x2; 11x1; 12x1; 9x1. av. 24x.05.

Feldspar 42x2; 25x3; 40x9, av. 1.07x.14

Sp. 15583. Hole 11 at 153 feet from bed rock surface. Amygdaloid; fine grained diabasic porphyrite; augite porphyrite pebble? Distance from margin 1.

Grain

Iron oxide 4x8, 5x4, 7x2 or dust av. .16x.14

Feldspar 7x1, 7x1, 8x1, av. .22x.03

(2600+149)

154-159; (S. 15584). CONGLOMERATE, as above

5

Sp. 15584. Hole 11 at 155 feet from bed rock surface. Contains pebbles of oligoclase porphyry and semi-spherulitic porphyry like 15578 and 15581, with calcareous cement. (2600+153)

159-161; (S. 15585). PORPHYRITE, like S. 15583

2

Sp. 15585. Hole 11 at 160 feet from bed rock margin. Just like 15583. All low angled. Distance from margin 161?

Grain

Feldspar 10x1; 13x1; 15x3, av. .38x.05.

(2600+155)

161-198; (Ss. 15586-99). CONGLOMERATE; continued, growing finer and passing into red sandstone in the last 7 feet. (36)

It seems to me quite possible that we have in these last 59 feet only one bed of conglomerate which will correspond about to Marvine's bed No. 17, but his sandstones, Nos. 17, 19 and 21, are separated by single flows, and more or less conglomeritic, and our conglomerate may represent the whole of them.

Sp. 15586. Hole 11 at 164 feet from bed rock margin. Oligoclase porphyrite, (apatite?). No phenocrysts, partly microlitic and hypidomorphic ground mass; brown and white flecks.

Sp. 15587. Hole 11 at 165 feet from bed rock surface. Pebbles; spherulitic quartz porphyry, like 15578; poikilitic oligoclase porphyry like 15579; diabasic andesite porphyrites like 15582; calcareous cement.

Sp. 15588. Hole 11 at 168 feet from bed rock surface. Conglomerate like 15587; porphyry with apatite.

Sp. 15589. Hole 11 at 170 feet from bed rock surface. Quartz porphyry; poikilitic.

Grain

Quartz 17x12; 23x24; 27x33, av. .67x.69

Feldspar aggregates 80x80; 60x70, av. 2.3x2.5

Sp. 15590. Hole 11 at 180 feet from bed rock surface. Forms like olivine in porphyry, pebbles of porphyry as above, chalcedony.

Sp. 15591. Hole 11 at 181 feet from bed rock surface. Fine grained quartz porphyry; glass; spherulites; chalcedony; biotite.

Sp. 15592. Hole 11 at 184 feet from surface. One big pebble; porphyrite; rest is quartz porphyry, calcareous cement.

Sp. 15593. Hole 11 at 188 feet from surface. Diabase porphyry; oligoclase porphyrite; ground mass delessite.

Sp. 15594. Hole 11 at 191 feet from bed rock surface. Usual fragments, in coarse calcareous cement. 191 is bottom of conglomerate, beneath is sandstone.

Sp. 15595. Hole 11 at 192 feet from surface. Calcite appears to be a secondary infiltration but see also clastic type of calcite 8x8.

Sp. 15596. Hole 11 at 192.5 feet from bed rock surface. Calcite with small rounded and green grains of altered olivine?

Sp. 15597. Hole 11 at 194 feet from bed rock surface. Down to fine grained shale.

Sp. 15598. Hole 11 at 195.5 feet from bed rock surface. Fine grained calcite and chalcedony with clastic fragments larger, about 23 to 30.

Sp. 15599. Hole 11 at 198 feet from bed rock surface. Quartz, feldspar, chalcedony, labradorite porphyrite and green fragments. (2600+191)

198-209; (Ss. 15600-4). MELAPHYRE, amygdaloidal 11

Sp. 15600. Hole 11 at 199 feet from bed rock surface. Amygdules; finer grain around them; much decomposed; diabasic to trichitic texture; olivine? decomposed to sericitic (talcose) or isotropic matter. Distance from margin 1.

Grain

Olivine 13x5, 13x5, 12x8, av. .38x.18

Feldspar near amygdules 7x0.5, 5x0.5, 3x0.2, 10, 14x3, 15x2.

Sp. 15601. Hole 11 at 204 feet from bed rock surface. Coarser; much labradorite, ext. 21°-23° and 37°; some augite left; numerous olivine pseudomorphs. Distance from margin 5.

Grain

Olivine 12x10, 14x11, 10x7, av. .36x.28

Feldspar 12x3, 22x3, 23x5, av. .57x.11

Augite 13x12, 23x21, 22x9, av. .58x.42

Sp. 15602. Hole 11 at 206 feet from surface. Growing finer grained trichitic with quartz and calcite amygdules; in contact with fine grained sediment; arrangement perpendicular or parallel to contact and growing coarser away from it; trichites often arranged \perp to the contact; feldspar extinction angles trifling at contact. This flow is more compact at 206 feet with an enclosure or vein of sandstone in trap. The sandstone is bedded with the laminae curving relative to the wall.

Grain

Olivine not plain

Feldspar 5x0.5, 2x0.2, 6x0.2, av. .13x.09

Augite not plain.

Sp. 15603. Hole 11 at 207 feet from bed rock surface. Like 15601, labradorite ex. 26°-21° Coarsest part of belt? Distance from margin 2.

Grain

Olivine 20x8; 17x17; 13x12, av. .50x.37

Feldspar 12x3; 20x2; 16x2, av. .48x.07

Augite 30x22; 20x20; 27x23, av. .77x.65

(2600+202)

UNCERTAIN.

Sp. 15605. Hole 11 at 212 feet from bed rock surface. Amygdaloidal; decomposed glass and sandstone contact; no trichites; only phenocrysts; like 15605; very irregular contact— Feldspar phenocrysts like 15604 groups. (2600+204)
212-222; (Ss. 15606-9). MELAPHYRE, ophite; amygdaloid and 10
feldspathic.

Sp. 15606. Hole 11 at 215 feet from bed rock surface. Porphyritic, amygdaloidal, with fine grained zone of forked trichite; feldspar about andesite? Rock highly feldspathic varying rapidly in character in belts (as the samples indicate) of more and less amygdaloid. Distance from margin small.

Grain

Olivine 10x10; 20x12; 20x15, av. .50x.37

Feldspar trichites 3x0.1; 4x0.2; 2½x0.1, av. .09x.004. Porphyritic 15x4; 14x4; 22x4, av. .51x.12.

Sp. 15607. Hole 11 at 216 feet from bed rock surface. Probably the same bed with decomposed olivine; glomeroporphyritic feldspar?

Grain

Olivine 14x12; 13x8; 11x9, av. .38x.29

Feldspar phenocrysts 16x3; 20x2½; 22x4, av. .58x.08.

Sp. 15608. Hole 11 at 217 feet from bed rock surface. Amygdaloid with much red altered olivine; feldspar extinctions 9°½-7° with 14°-14°½ then latter with lower birefringence 28°-15° with 5°; red altered olivine.

Grain.

Olivine 10x9; 8x6; 12x9, av. .30x.24

Feldspar varied, the larger 21x2, 12x1.5, 25x4, av. .58x.07.

Sp. 15609. Hole 11 at 221 feet from bed rock surface. Fresher though altered olivine; labradorite extinctions 30° and 26°-16°; anorthite 21°-30° and 45°-45°, 29°-32° and 35°.

Grain

Olivine 9x4; 13x8; 16x13, av. .38x.25

Feldspar 25x7; 12x3; 22x4, av. .59x.14

Augite 18x5; 20x15; 65x17 (extra large), av. 1.03x.37 (2600+214)

222-266; (Ss. 15610-19). MELAPHYRE, ophite; about 17 feet of 44
amygdaloid at top and 9 feet at the bottom. Perhaps they are (43)
two minor flows. We have distinct SEDIMENTARY matter in the parting at bottom.

Sp. 15610. Hole 11 at 223 feet from bed rock surface. Amygdaloidal; trichitic; decomposed olivine; small amygdules.

Grain

Olivine 10; 9; 5

Feldspar 8x1; 16x2; 13x3, av. .37x.06.

Sp. 15611. Hole 11 at 226 feet from bed rock surface. Olivine, augite, labradorite, ex 29° and 35°-37°.

Grain

Olivine 14x8; 13x8; 16x8, av. .43x.24

Feldspar 20x2; 25x3; 40x7, av. .85x.12

Augite 37x33; 60x30; 40x30, av. 1.37x.93.

Sp. 15612. Hole 11 at 228 feet from bed rock surface. Fine grained amygdaloid; trichitic; thoroughly decomposed, with calcite.

Grain

Olivine 15x12; 13x10; 13x12, av. .41x.34
Feldspar 30x8; 20x4; 21x3, av. .71x.15.

Sp. 15613. Hole 11 at 232 feet from bed rock surface. Decomposed olivine; labradorite; ex 24°-21° and 31°, fresher augite.

Grain

Olivine 8x6; 12x5; 12x6, av. .32x.17
Feldspar 11x2; 20x3; 40x3, av. .71x.08
Augite 30x20; 23x10; 24x22, av. .77x.52.

Sp. 15614. Hole 11 at 235 feet from bed rock surface. Amygdaloid; decomposed trichitic around the amygdaloid. If a real gap here the overlying flow must have followed soon as the coarse zone lies so near the top. Distance from margin 24 ft. from below, at upper margin?

Grain

Olivine 16x15; 19x16; 16x13, av. .51x.44
Feldspar 22x3; 26x4; 18x3, av. .66x.10.

Sp. 15615. Hole 11 at 239 feet from bed rock surface. Decomposed olivine; augite; groups of (ex 11°-24° and 34°-39°) labradorite; iron oxide largely secondary? around decomposed olivine; apatite needles in interstices. Distance from margin 4 from above, 20 from below.

Grain

Olivine 4; 21; 13x8
Iron oxide 22x15; 20x15; 7x17, av. .59x.47
Feldspar 28x4; 24x4; 40x3, av. .92x.11
Augite 130x50; 80x70; 80x60; 70x53, av. 3.00x1.11.

Sp. 15616. Hole 11 at 251 feet from bed rock surface. Like 15615 (labradorite or anorthite ex 30°-24° and 43°-38°) iron oxides associated with olivine. Coarsest along here. Distance from margin above 16, 8 ft. below.

Grain

Olivine 18x13; 14x10; 10x8, av. .42x.31
Feldspar 25x2; 30x4; 60x4, av. 1.15x.10
Augite 70x45; 70x40; 70x30, av. 2.10x1.15.

Sp. 15617. Hole 11 at 257 feet from bed rock surface. Like 15616; anorthite with extinction angles 41°-44°; 37°-43°; 23°-22°. Distance from margin 2.

Grain

Olivine 20x13; 15x12; 23x12, av. .58x.37
Feldspar 20x4; 22x4; 20x3, av. .62x.11
Augite 35x25; 30x18; 30x20, av. 95x.63.

Sp. 15618. Hole 11 at 259 feet from bed rock surface. Arborescent augitic amygdaloid with calcareous and chalcidonic trichitic zone around amygdules, labradorite (ex 44°-37°), augite not as solid as above; more fibrous and twisted. Melaphyre.

Grain

Olivine 12; 11; 8; 7
Iron oxide 3; 4; associated with olivine
Feldspar 30x4; 30x3; 30x4, av. .90x.11
Augite 30x20; 35x20, loose texture, av. 1.08x.66.

Sp. 15619. Hole 11 at 264 feet from bed rock surface. Like 15618; amygdaloid clusters; corroded olivine.

Grain

Olivine 9x4; 25x15; 14x10
Feldspar 24x4; 25x7; 20x4

Augite 30x8; 12x10 loose texture. (2600+258)
266-275; (Ss. 15620-1). MELAPHYRE, amygdaloidal; from 272 (9)
to 275 the amygdules are not so prominent.

Sp. 15620. Hole 11 at 266 feet from bed rock surface. Fine grained; marginal porphyritic, mixed in with sediments.

Grain

Olivine 11x9
Feldspar porphyritic 58x68 and ground indefinitely small to 8x2.

Sp. 15621. Hole 11 at 268 feet from bed rock surface. Augite; labradorite; altered reddened olivine; delessite. Distance from margin 2 above, 7 below.

Grain

Olivine 8x8; 9x4, av. .28x.20
Feldspar 20x5; 20x4; 30x4, av. .70x.13
Augite 33x10; 30x12; 28x5, av. .91x.27.

(2600+267)

275-283. (Ss. 15622-3). MELAPHYRE, amygdaloidal; 2 feet (8)
amygdaloidal at top, the rest compact. It is really a fine grained ophite, as most of these beds are, but they are too thin for the structure to develop so as to be visible to the unaided eye.

Sp. 15622. Hole 11 at 26 feet from bed rock surface. Very fine grained nearly amygdaloidal, trichitic, augite tends to be sheaf like. Decomposed olivine; much interstitial; quartz or feldspar. Distance from margin 1 foot.

Grain

Olivine 8x9; 13x13; 9x8, av. .30x.30
Feldspar 28x7; 50x7; 13x3, av. .91x.17
Augite 35x10; 30x6; 22x5, av. .87x.21.

Sp. 15623. Hole 11 at 280 feet from bed rock surface. Serpentine after olivine; poikilitic augite; labradorite (ex 36°-36° and 27°-16°). Augite not typical, pink, broken into patches too much. Distance from margin 5 ft. above, 3 below.

Grain

Olivine 10x8; 16x10; 12x8, av. .38x.26
Feldspar 20x3; 30x5; 20x4, av. .70x.12
Augite 10x4; 30x20; 30x15, av. .70x.39.

(2600+275)

283-302.5; (Ss. 15624-6). MELAPHYRE, amygdaloidal; the upper 9 feet amygdaloid, with *copper* (at 289 feet), prehnite and quartz. (18)

Sp. 15624. Hole 11 at 284 feet from bed rock surface. Fine grained decomposed porphyritic amygdaloid like 15622 "283-293 Amygdaloid" *copper*, prehnite, quartz. Distance from margin 1 ft.

Grain

Olivine 12x8
Feldspar 33x8; 25x2; 25x5, av. .83x.15.

Sp. 15625. Hole 11 at 295 feet from bed rock surface. Augite, labradorite, decomposed olivine; less amygdaloid than 15624 augite small.

Distance from margin 12

Grain

Olivine 15x11; 16x10; 14x12, av. .45x.33
Feldspar 35x12

Augite 10x8 10x4, av. .33x.20.

Sp. 15626. Hole 11 at 302.5 feet from bed rock surface. Augite in minute granules, labradorite, decomposed olivine; occasional large feldspar.

Grain

Olivine 12x8; 10x9, av. .36x.28

Feldspar 40x10; 30x4; 18x4, av. .88x.18.

(2600+293)

302.5-305; (Ss. 15627-8). SHALE, red, indurated; in vein-contact with trap. Dip measured on drill cores, 14°.

(2)

Sp. 15627. Hole 11 at 304.5 feet from bed rock surface. Bands of finer grained sediment cemented by coarser 2 to 3/32nds mm., all red; quartz and feldspar with iron oxides.

Sp. 15628. Hole 11 at 305.0 feet from bed rock surface. Light colored; yellowish skined; sedimentary; apparently indurated.

(2600+296)

305-311; (Ss. 15629-33). CONGLOMERATE, with pebbles of melaphyre (6) as well as of felsite; toward the bottom fine-grained and epidotic.

Dips measured on the cores 18° and 14°. This is about the same distance above the bed that we correlate with Marvine's Eagle River bed No. 53, as is Marvine's No. 21. The very fine and partly indurated character of Marvine's bed No. 21 accidentally matches our two feet of red shale.

Sp. 15629. Hole 11 at 305.5 feet from bed rock surface. Labradorite, augite prisms, decomposed olivine, much augite; small grains not marked

Grain

Olivine 15x11; 20x13, av. .75x.40

Feldspar 20x2; 24x6; 22x7, av. .66x.15

Augite 16x10; 12x10; 8x4, av. .36x.24.

Sp. 15630. Hole 11 at 307 feet from bed rock surface. Conglomerate largely felsitic debris, poikilitic orthophyre? also some porphyrite. Distance from lower margin 3 ft.

Sp. 15631. Hole 11 at 307 feet from bed rock surface. Sedimentary, quartz grains from quartz porphyry; serpentine (?) cement.

Sp. 15632. Hole 11 at 308 feet from bed rock surface. (Melaphyre pebble, augite, labradorite decomposed, olivine). Distance from margin 2.

Grain

Augite 3x2; 7x4; 7x3, av. .17x.09.

Sp. 15633. Hole 11 at 310 feet from bed rock surface. Fragmental, fragments epidotic; calcareous cement.

(2600+303)

311-327.5; (Ss. 15634-8). MELAPHYRE, ophite; amygdaloidal; 16.5 is markedly amygdaloidal for about 4 feet, then mildly spotted—somewhat more so at the bottom. The contact with the conglomerate dips 19°. If the overlying bed is the same as Marvine's No. 21, this may represent bed No. 22, which is mentioned by Irving as a typical representative of his ordinary diabases. In this flow the olivine grains are notably small.

Sp. 15634. Hole 11 at 311 feet from bed rock surface. Very fine grained, trichitic, decomposed; decomposed olivine; iron oxide in lines as it occurs in glass. Distance from margin 0.

Grain

Olivine 14x8; 3x3; 6x3; 5x3, av. .23x.14

Feldspar 3x0.2; 6x0.2; 8x0.5, av. .17x.009.

Sp. 15635. Hole 11 at 317 feet from bed rock surface. Coarser,—tends to poikilism. Distance from margin 6.

Grain

Olivine 6x4; 3x3; 7x7, av. .16x.14

Augite 33; 20; 15

Sp. 15636. Hole 11 at 321 feet from bed rock surface. Augite poikilitic; labradorite; serpentine after olivine associated with iron oxide. Distance from margin 10 above, 6.5 below.

Grain

Olivine 7; 10; 10; 10x18

Feldspar 15x6; 13x2; 13x2, av. .41x.10

Augite 70x60; 45x40; 40x40, av. 1.55x1.40.

Sp. 15637. Hole 11 at 326 feet from bed rock surface. Fine grained, somewhat amygdaloidal. Distance from margin 1.5.

Grain

Olivine 5; 4; 9

Feldspar 20x1; 10x3; 12x2, av. .42x.06.

Sp. 15638. Hole 11 at 327½ feet from bed rock surface. Still finer grained and darker; olivine absent from the finer grained halos around amygdules. Distance from margin 0.

Grain

Olivine 4; 6; 7

Feldspar 13x2; 13x4; 20x3, av. .46x.09.

(2600+319.5)

327.5-344; (Ss. 15639-42). MELAPHYRE, ophite; amygdaloidal for the first 7 feet. (16)

Sp. 15639. Hole 11 at 329 feet from bed rock surface. Distance from margin 1.5.

Sp. 15640. Hole 11 at 333 feet from bed rock surface. Amygdaloid; sedimentary coating peeled off by secondary calcite veins. Distance from margin 5.5.

Grain

Olivine 2-3?

Iron oxide club shaped 10x1

Feldspar 20x2; 24x2, av. .73x.66

Augite 34x30.

Sp. 15641. Hole 11 at 338 feet from bed rock surface. Poikilitic augite, much magnetite associated with it. Distance from margin 10.5 ft. above, 6 below.

Grain

Olivine 12; 12; 8

Feldspar 14x2; 20x2; 15x1.5, av. .49x.05

Augite 85x45; 43x40; 48x42, av. 1.76x1.27.

Sp. 15642. Hole 11 at 343 feet from bed rock surface. Fine grained trichitic, porphyritic; very ferruginous. Distance from margin 1.

Grain

Olivine 5x4, 10x8?, av. .25x.50

Feldspar 8x0.2 and larger and smaller.

(2600+335.5)

344-349; (Ss. 15643-4). MELAPHYRE, amygdaloidal (5)

Sp. 15643. Hole 11 at 348 feet from bed rock surface. Coarser, somewhat poikilitic, augite is larded with labradorite. Distance from margin 4 ft. above, 1 below.

Grain

Olivine 7x4; 15x6, av. .36x.16

Feldspar 15x8 and smaller
Augite 22x10; 10x10; 17x13, av. .49x.33.

(2600+341.5)

349-362; (Ss. 15644-6). MELAPHYRE, ophite; about 7 feet
at the top and 1 foot at the bottom are amygdaloidal. Sp. 15644. Hole 11 at 349
feet from bed rock surface. Fine grained; very amygdaloidal; trichitic contact.
Distance from margin 0.

Grain

Olivine 3x4?

Sp. 15645. Hole 11 at 356 feet from bed rock surface. Much serpentinized
olivine; poikilitic augite; labradorite; much like part of 44. Distance from margin
7.

Grain

Olivine 5; 10; 9

Feldspar 25x2 and smaller

Augite 30x12; 37x18; 23x13, av. .90x.43.

Sp. 15646. Hole 11 at 358 feet from bed rock surface. Like part of 44, poikilitic
augite; grouped individuals in patches; larded with labradorite (ex 23°-25° and
33°-35°). Distance from margin 9 ft. above, 4 ft. below.

Grain

Olivine 12; 10

Augite masses 65; 55; 60; 70x53; 40x38; 50x43

(2600+354)

362-370. (Ss. 15647-50). MELAPHYRE, ophite; about 3 feet at
the top are amygdaloidal.

Sp. 15647. Hole 11 at 363 feet from bed rock surface. Altered olivine; augite;
andesite, fine grained, small irregular amygdules, slightly porphyritic. Distance
from margin 1.

Grain

Olivine 5x4; 7; 17x10

Feldspar 34x8 and trichites

Augite 3x4; 7x5; 2x3, av. .12x.12.

Sp. 15648. Hole 11 at 364 ft. from bed rock surface. Labradorite larded in
poikilitic augite; altered olivine, much delessite. Distance from margin 2 above,
6 below.

Grain

Olivine 12x10; 8; 13x9

Feldspar 30x3; 30x2, av. 1.00x.08

Augite 90x70; 77x45; 70x50, av. 2.37x1.65.

Sp. 15649. Hole 11 at 368 feet from bed rock surface. Much serpentinized
olivine; augite small; labradorite. Distance from margin 2.

Grain

Olivine 6x5; 7x5; 7x7, av. .20x.17

Feldspar 15x2; 11x2; 10x2, av. .36x.06

Augite 40x20; 10x10; 45x40, av. .95x.70.

Sp. 15650. Hole 11 at 370 feet from bed rock surface. Patches of augite, fine
grained porphyritic.

Grain

Olivine 9; 6; 5

Feldspar 16x7,—mainly much finer

Augite 20x20, 10x8, 8x8, av. .38x.36

2600+362

Comparing these sections there is no noticeable gathering of iron at the bottom.

370-384 (Ss. 15651-5). MELAPHYRE, amygdaloidal; possibly 14 376
two flows.

Sp. 15651. Hole 11 at 370½ feet from bed rock surface. Very fine grained
trichitic, porphyritic; amygdaloid; in the filling the amygdules show horizontal
plane; top of flow red.

Grain

Olivine 7, 5, 4

Feldspar phenocryst 30x27; ground 8x1; 6x0.5; 9x2 and smaller, av. .23x.03.

Sp. 15652. Hole 11 at 373 feet from bed rock surface. Decomposed olivine;
augite; feldspar, ex 30°-36° and also low angles; tends to poikilitic texture. Dis-
tance from margin 2½ above, 3 below.

Grain

Olivine 5; 5; 4

Feldspar 20x5

Augite 30x30; 20x13; 33x6, av. .83x.49.

Sp. 15653. Hole 11 at 376 feet from bed rock surface. Fine grained glomero-
porphyrite with feldspar; no augite? amygdaloid; trichitic feldspar. Distance from
margin 0. Apparently margin 15653 and 15654 may have been changed.

Grain

Olivine 15x12; 8x7; 5x2

Feldspar phenocrysts 9x0.5; 47x11; 12x1.5, av. .68x.13.

Sp. 15654. Hole 11 at 381 feet from bed rock surface. Poikilitic augite; de-
composed olivine; calcite; labradorite. In my original description of the hand
specimens, 15654 is said to be amygdaloid, but it is not so much so as 15653. Dis-
tance from margin 5 ft. from above, 3 from below.

Grain

Olivine 6; 4; 7

Augite 23x23; 35x22; 18x13, av. .76x.58.

Sp. 15655. Hole 11 at 382 feet from bed rock surface. Fine grained marginal;
slightly porphyritic in feldspar. Distance from margin 2.

Grain

Olivine 2½; 4; 5x4

Feldspar 23x5; 10x2; 4x0.1, av. 37x.07.

(2600+376)

384-389; (Ss. 15656-7). MELAPHYRE, amygdaloidal. All these amygdaloids
show great variety in size of feldspar without any sharp dividing line, that is they
are "seriate porphyritic" of Iddings (Igneous Rocks, p. 196).

Sp. 15656. Hole 11 at 385 feet from bed rock surface. Decomposed olivine;
augite; ground amygdaloid; trichitic and seriate porphyritic feldspar. Distance
from margin 1.

Grain

Olivine 9x7; 6x4; 10x10, av. .25x.21

Feldspar from 45x16; to 9x2; 8x2, av. .62x.20

Augite 9x4; 13x4; 20x8, av. .42x.16.

Sp. 15657. Hole 11 at 387 feet from bed rock surface. Poikilitic augite; ser-
pentinized olivine; labradorite. Distance from margin 3 above, 2 below.

Grain

Olivine 7; 6; 10x4

Feldspar 11x1; 15x2; 12x2, av. .48x.05

Augite 25x17; 30x25; 25x20, av. .80x.62.

(2600+381)

389-396; (Ss. 15658-60). MELAPHYRE, amygdaloidal.

(7)

Sp. 15658. Hole 11 at 389 feet from bed rock surface. Porphyritic feldspar; marked amygdules; trichitic. Small angles feldspar (andesite) around them; (decomposed olivine?). Distance from margin 0.

Grain

Feldspar 90x45; to 0.3.

Sp. 15659. Hole 11 at 390 feet from bed rock surface. Amygdaloid with secondary poikilitic texture; quartz patches, melaphyre. Distance from margin 1.

Grain

Olivine 4x4; 3; 2; 7; 5

Feldspar 15x1, 10x1, 8x1, av. .33x.03.

Sp. 15660. Hole 11 at 394 feet from bed rock surface. Much decomposed olivine; augite more abundant in part of section is from melted enclosure; 7°-7° low angled andesite. Distance from margin 5 above, 2 below.

Grain

Olivine 7x6; 8x5; 8x5; av. .25x.18

Feldspar 10x1; 9x2; 24x12; 14x1

Augite 20x8; 80x70; 37x30, av. 1.37x1.08.

396-457; (Ss. 15661-8). MELAPHYRE, ophite; first 20 feet 61 386?
or more amygdaloidal, then a fine grained black trap, with (59)
the lustre-mottling showing somewhat.

Sp. 15661. Hole 11 at 396 feet from bed rock surface. Amygdaloid; andesite; altered olivine; augite? Distance from margin 0.

Grain

Olivine 8x3

Feldspar 14x2; 12x3; 2x.1, av. .28x.06.

Sp. 15662. Hole 11 at 403 feet from bed rock surface. Amygdule; poikilitic augite; olivine; feldspar. Distance from margin 7.

Grain

Olivine 7; 5; 6

Feldspar 17x1.2; 12x4.0; 15x2.5, av. .44x7.7

Augite 22x13; 40x30; 120x45, av. 1.82x88.

Sp. 15663. Hole 11 at 411 feet from bed rock surface. Well marked poikilitic (7 mottles in 15 mm.). Distance from margin 14.

Grain

Olivine 12x7; 7; 5

Feldspar 13x1.5; 14x6; 23x2, av. .54x.09

Augite 80x70; 100x55; 84x55, av. 2.64x1.80.

Sp. 15664. Hole 11 at 420 feet from bed rock surface. Decomposed; only a little augite left. Distance from upper margin 23 ft.

Grain

Feldspar 25x2; 25x2; 10x2, av. .60x.06.

Sp. 15665. Hole 11 at 426 feet from bed rock surface. Poikilitic augite; feldspar much decomposed; decomposed olivine. Distance from margin 30 ft. above, 31 below.

Grain

Olivine 9x8; 9; 11x7

Feldspar 60x30?, 14x10, av. 1.23x.66

Augite 70x70; 70x70; 66x50, av. 2.06x1.90.

Sp. 15666. Hole 11 at 439 feet from bed rock surface. Porphyritic Bytownite (ex 45°-42° and 33°, 43° and 10°). Poikilitic augite, decomposed olivine. Distance from margin 18.5.

Grain

Olivine 10; 6; 4

Iron oxide 6x2; 6x1, av. .20x.05

Feldspar 26x6; 36x16; 70x36, av. 1.32x.58

Augite 115x40; 108x80; 104x66, av. 3.27x1.86.

Sp. 15667. Hole 11 at 455 feet from bed rock surface. Labradorite ex 30°-29° with 15°-8° and elongate chloritic pipe amygdule showing an undoubted bottom; much altered olivine. Distance from margin 2.5.

Grain

Olivine 9x5; 3 x3, av. .20x.13

Feldspar 15x1.5; 12x1; 8x2, av. .35x.045.

Sp. 15668. Hole 11 at 457 feet from bed rock surface. Amygdaloid; calcite and chlorite; feldspar very much decomposed, trichitic. Distance from margin 0.5 ft.

Grain

Olivine 7x7; 5x4; 7x4, av. .19x.15

Feldspar 7; 9; 16; phenocrysts 75x24

(2600+445)

457-458; (Ss. 15669-71). SANDSTONE, dark, basic; 1
porphyry fragments not marked. This may represent Marvine's bed No. 26.

Sp. 15669. Hole 11 at 457.5 feet from bed rock surface. About a foot of sandstone underlain by andesite and datolitic fragments of porphyrite, epidote, plagioclase, augite; porphyry fragments absent or not marked; cement not calcareous. Distance from margin 0.

Sp. 15670. Hole 11 at 457.5 feet from bed rock surface. Basic sandstone.

(2600+445.5)

458-482; (Ss. 15671-6). MELAPHYRE, ophite; first 6 feet an (24) 445.5
amygdaloid with datolite, then a fine grained black trap, finally distinctly mottled. At the base there is a sediment. Compare Marvine's bed No. 27.

Sp. 15671. Hole 11 at 457.5 feet from bed rock surface. Contact of melaphyre with thoroughly altered sediment. Distance from margin 0.

Grain

Olivine 12x7; 14x12; 8x8, av. .34x.27

Feldspar—smaller 2x0.1; 3; larger 43x5; 18x5; 17x4, av. .78x.14.

Sp. 15672. Hole 11 at 458 feet from bed rock surface. Decomposed olivine; and plagioclase. Distance from margin 0.5.

Grain

Olivine 9x8; 13x8; 11x5, av. .33x.21

Feldspar 20x2; 25x5; 25x4, av. .70x.11.

Sp. 15673. Hole 11 at 463 feet from bed rock surface. Poikilitic augite, olivine changed into bowlingite or material between serpentine and mica. Distance from margin 5.5.

Grain

Olivine 14x13; 12x7; 17x12, av. .43x.32

Feldspar 20x5; 25x4; 18x4, av. .63x.13

Augite 45x45; 65x50; 60x40, av. 1.70x1.35.

Sp. 15674. Hole 11 at 475 feet from bed rock surface. (Bowlingite or idding-site) mica and serpentine after olivine; poikilitic augite, each mottle made up of parts of slightly different orientation; chloritic cavities corresponding to acid interstices; labradorite, ex 28°-32° and 39°-; 36°-40° and 30°. Distance from margin 17.5.

Grain

Olivine 15x8; 15x12; 17x16, av. .47x.36

Feldspar 21x12; 18x3; 24x12, av. .63x.27

Augite 60x50; 50x40; 80x60; 90x45, av. 2.33x1.62.

Sp. 15675. Hole 11 at 476 feet from bed rock surface. Fine grained amygdaloid; decomposed feldspar and olivine; augite?

Grain

Olivine 13x9; 17x10; 12x10, av. .42x.29

Feldspar 17x8, and down to trichites.

Sp. 15676. Hole 11 at 482 feet from bed rock surface. Very fine grained marginal amygdaloid; amygdulose in part filled with sand, trichitic; large decomposed olivine; plagioclase.

Grain

Olivine 7x7; 13x12; 17x12, av. .37x.31

Feldspar 22x4, down to trichites. (2600+469.5)

482-492; (Ss. 15677-9). MELAPHYRE, ophite; first 5 feet (10) (479.5) amygdaloidal; below that a fine grained trap, the bottom of the bed apparently gone.

Sp. 15677. Hole 11 at 485 feet from bed rock surface. Beginning of poikilitic bed; much altered olivine; labradorite ex 23°-23° and 40°-39°.

Grain

Olivine 13x10; 12x8; 18x12, av. .43x.30

Feldspar 23x2; 10x1; 15x2, av. .48x.05.

Sp. 15678. Hole 11 at 487 feet from bed rock surface. Poikilitic, clasolite vein but not an intrusive contact as the grain is too coarse. It might be erosion contact.

Grain

Augite 22x17; 13x12; 25x23, av. .60x.52.

Sp. 15679. Hole 11 at 491 feet from bed rock surface.

Grain

Olivine 15x14; 12x10; 26x25, av. .53x.49

Feldspar 30x4; 23x5; 17x6, av. .70x.15

Augite 40x40; 55x45; 45x22, av. 1.40x1.07

(2600+479.5)

The coarseness of the grain here is decidedly in favor of a fault beneath.

492-493; (Ss. 15680-1). Seam of red CLAY FLUCCAN, perhaps (1) (480.5) marking a fault. A fault throwing the south side down, and hading to the south "a so-called slide" would make a gap which we could not detect (see p. 35, Fig. 5 of Vol. VI, Part I, Mich. Geol. Sur.), but we may be reasonably sure that there is no fault which would lead to a repetition farther north of the beds we have already described, for these consist of a number of sandstones and conglomerates with thin basic melaphyres of the ophite type, whose texture is sometimes coarse enough to be recognized, and these we do not again encounter. After two more conglomerates, we come to a series of somewhat less augitic flows, with nonfelsitic conglomerates.

Sp. 15680. Hole 11 at 492 feet from bed rock surface. Very fine grained red shale; almost no action on polarized light, i. e., no quartz; regular fluccan.

Sp. 15681. Hole 11 at 493 feet from bed rock surface. Thoroughly decomposed; fine grained, microlitic; with pseudomorph of olivine phenocrysts.

Grain

Olivine 13x12; 17x13; 15x14, av. .45x.39

Feldspar 13x4.

(2600+480.5)

Sp. 15682. Hole 11 at 493 feet from bed rock surface. Microlitic porphyritic; evidently under contact; margin very dark; feldspars arranged with reference to it; magnetite ground.

Grain

Olivine 24x15; 20x16; 18x14, av. .62x.45

Iron oxide 5x0.1; 4x0.1; 2x0.1, av. .11x.003

Feldspar 2 to 3x0.1 and more.

493-499; (Ss. 15683-89). CONGLOMERATE, with porphyry (6) (487.5) felsite, and trap pebbles, and not much calcareous cement; dip about 13°-14°.

499-500. CLAY; another seam, which may indicate a fault. Thus, as the conglomerate may be bounded by possible fault planes above and below, we cannot be certain of its correlation, and it may be a repetition of some higher or lower conglomerate, but relatively to our general correlation it is nearly in the position of Marvine's No. 28.

Sp. 15683. Hole 11 at 494 feet from bed rock surface. Fragments of quartz porphyry, with microlitic and poikilitic ground mass.

Sp. 15684. Hole 11 at 498 feet from bed rock surface. Mainly one pebble of orthophyre, more oligoclase phenocrysts; poikilitic; with altered biotite.

Sp. 15685. Hole 11 at 496½. Orthophyre; porphyrite and spherulitic porphyry pebbles.

Sp. 15686. Hole 11 at 498 feet from bed rock surface. Orthophyre pebbles.

Sp. 15687. Hole 11 at 499 feet from bed rock surface. Pebbles of ophitic melaphyres, poikilitic andesitic porphyrites?, quartz porphyry and calcite cement.

Sp. 15688. Hole 11 at 499 feet from bed rock surface. All carbonates nearly.

Sp. 15689. Hole 11 at 499 feet from bed rock surface. No section—perhaps a slide here?

(2600+487.5)

500-507.5; (Ss. 15690-2). MELAPHYRE, amygdaloidal. 7.5

Sp. 15690. Hole 11 at 499½ feet from bed rock surface. (7) 494.5

Mainly carbonates, here and there shreds showing texture of fine grained trap microlitic erosion contact? or pebble?

Grain

Feldspar 18x2; 10x1.

Sp. 15691. Hole 11 at 504 feet from bed rock surface. Contact of sandstone vein with original margin of trap but coarse; yet there is a continuous black wavy fine line, wrapping projecting feldspar at margin.

Grain

Olivine 7x6; 6x6; 5x4, av. .18x.16

Iron oxide 7x6 4x4, av. .18x.16

Feldspar 27x2; 24x1; 14x2, av. .65x.05

Augite 50x15; 52x13; 18x12, av. 1.20x.40.

Sp. 15692. Hole 11 at 507.5 feet from bed rock surface. Amygdaloid; microlitic; porphyritic evidently marginal; olivine decomposed; quite red.

Grain

Olivine 5x5; 6x5; 7x7, av. .18x.17

Feldspar 18x5; 10x2; 11x3, av. .39x.13

Augite ? not over 4 or 5.

(2600+494.5)

507.5-511; (S. 15693). AMYGDALOID; may belong to the flow above or to that below. 3.5

(3)

Sp. 15693. Hole 11 at 511 feet from bed rock surface (2600+497.5)
10. bed rock surface -113.

11. 511-525; (Ss. 15694-6) MELAPHYRE, ophite; more or less 14
amygdaloidal, especially the first two feet. 2600+ (511)

Here we pass from hole No. XI to hole No. X. Assuming that hole No. XI at 525 feet is equivalent to hole No. X at 113 feet, which will make a difference of 412 feet; adding the excess of altitude of No. X over No. XI (206.7-143=64 feet), makes 476 feet, and dividing by the distance between them, 2,191 feet, we have 0.218 as tan of dip; i. e., the dip is 12° 20'.

The rest of No. XI we correlate as follows:

Hole No. XI at 532 feet, contact, is equivalent to hole No. X at 123 feet, difference, 409 feet. Hole No. XI at 536 feet, contact, is equivalent to hole No. X at 133 feet; difference, 403 feet and the characters of the beds assumed to be equivalent harmonize very well. Full arguments for the correlation are found in the Isle Royale report.

If the dip is steeper than we assume and the two holes do not overlap at all, we have made the column too short.

Sp. 15694. Hole 11 at 512 feet from bed rock surface. Fine grained chloritic; patches of decomposed olivine granules as if derived from breaking up of a large grain; low angled feldspar.

Grain

Olivine 5; 5; 7x7
Feldspar 10x1; 10x2; 14x1, av. .34x.04.

Sp. 15695. Hole 11 at 520 feet from bed rock surface. Largely decomposed; begins to be ophitic.

Grain

Olivine 5; 5; 8; 8; 3; 7x9
Feldspar 12x2; 10x2; 12x1; 14x2; 24x3; 10x2, av. .45x.06
Augite 10x10.

Sp. 15696. Hole 11 at 522 feet from bed rock surface. Labradorite extinction angles 25°-19°; 15°-21° with 35°-21°; 30°-40° and 28°. Distance from margin below 4 ft.

Grain

Olivine 5; 4; 5
Augite 70x50; 50x30; 30x20, av. 1.50x1.00

Sp. 15462. Hole 10 at 109 feet is probably from the same flow as Sp. 15696 perhaps 4 feet from the bottom at 113 ft. It should then correspond in texture pretty closely to Sp. 15696. Being nearer the surface of bed rock, however, it is more altered. The olivine is turned to ferric oxide. The labradorite feldspar is also much attacked, but the extinctions fit so far as they can be made out (28° and 15°-20°, 18°-24° and 36°). There is a heavy impregnation of carbonates. The augite is poikilitic.

Grain

Olivine magnetite pseudomorphs as a unit—6; 7; 8; 10x6
Feldspar (phenocrysts 55x7) 8x2; 20x1.5; 14x2
Augite 35x35; 75x50; 57x47.

		(2600+511)
		direct computation
Hole 11. 525-532 (Ss. 15697-8)	(10)	(512)
Hole 10. 113-123; (Ss. 15463-5). MELAPHYRE		(2600)+(522)

Sp. 15463. Hole 10 at 113 feet from bed rock surface. Fine grained; amygdaloidal decomposed. Distance from margin 0?

Grain

Olivine 7x5; 6x4; 8x5, av. .21x.14
Feldspar 5x0.5; 10x2; 15x1, av. .30x.03
Augite 12x8; 16x15, av. .46x.38.

Sp. 15697. Hole 11 at 525 from surface. Microclitic; porphyritic, rather low angled feldspar; ex. angles 0°; 6°-7°; 16-13°; 0°; 7°; 0°; calcareous amygdaloid redder. Distance from margin 0.

Grain

Olivine 5; 5; 5
Feldspar 4½x.1 microlites; 7x1.

Sp. 15464. Hole 10 at 118 feet from bed rock surface. Labradorite extinction 35 and 19-22°; 54-20°; 30-28°; 22-21° and 35-41°. Distance from margin 5 feet each way.

Grain

Olivine 8x6; 8x7; 8x7, av. .24x.20
Feldspar 10x2; 12x2; 14x2, av. .36x.06
Augite 26x10; 10x9; 12x8, av. .48x.27.

Sp. 15698. Hole 11 at 527 feet from surface. Coarser again; redder than 15696

Grain

Olivine 8; 8x6; 10x6
Feldspar 8x1; 16x2; 15x2, av. .39x.05
Augite 4x4; 26x13; 20x17; av. .50x.34.

Sp. 15465. Hole 10 at 121 feet from surface. Decomposed; no finer than 15464; andesite extinction angles 0, 0, 0, 0, 0. Distance from margin 2.

Grain

Olivine 8x5; 8x5, av. .26x.16
Feldspar 7x1; 14x2; 12x2, av. .33x.05
Augite 7x4.

11. 532-536; (Ss. 15699-15702 or 3).

10. 123-135; (Ss. 15466-9). MELAPHYRE, amygdaloidal; a trace (12) (2600+534) of sand at lower contact.

Sp. 15466. Hole 10 at 123 feet from bed rock surface. Finer amygdaloid; also trichitic; andesite extinction angles 0, 0, 6-6, 1, 0, 0; no augite. Distance from margin 0.

Grain

Olivine 5x3; 7x6; 9x6, av. .21x.15
Feldspar 15x2; 15x2; 13x1, av. .43x.05.

Sp. 15699. Hole 11 at 532 feet from surface. Amygdaloid; fine grained porphyritic; calcite; very thin section.

Grain

Olivine 3; 10x5?; 8x3
Feldspar 5x2; 3x.2; 6x.1, av. .14x.02.

Sp. 15467. Hole 10 at 124 feet from bed rock surface. Amygdaloid coarser grained; plagioclase extinctions 13-0; 1-2; 0-7; 8-5; 12-20; 0. Distance from margin 1.

Grain

Olivine 8x4; 12x5; 6x4, av. .26x.13
Feldspar 9x1; 15x2; 15x2, av. .39x.05
Augite 2x1; 2x1; 3x2, av. .07x.04.

Sp. 15700. Hole 11 at 533 feet from surface. Fine grained; decomposed with decomposed calcite.

Grain

Olivine 4; 5x4; 6x5

Feldspar 8x2 and varied.

Sp. 15701. Hole 11 at 534 feet from surface. Amygdaloidal; decomposed olivine; small not well marked amygdules.

Grain

Olivine 2; 3; 8; 9x7

Feldspar 12x1; 10x1; 15x2, av. .37x.04.

Sp. 15702. Hole 11 at 534½ feet from surface. Decomposed, slightly coarser; augite has a spherulitic habit. Feldspar ex. angles 17°-28°; 18°-20° and 3°-5°.

Grain

Olivine 7; 3; 3; 7

Feldspar 12x2; 6x1; 14x1, av. .32x.04

Augite 7x5; 4x2, av. .18x.11.

Sp. 15703. Hole 11 at 536 feet from surface. Porphyritic; microlitic, evidently marginal; glassy; trichitic. Distance from margin 0.

Grain

Feldspar ex. angles 18°-28°; 10°-8°; 15°-10°

Olivine 6x3?

Feldspar 10x2; 10x2; 10x3, av. .30x.07.

Sp. 15468. Hole 10 at 133 feet from bed rock surface. Poikilitic polysomatic augite; labradorite extinctions 29°; 17°-14°; 33°-25° and 9°. Distance from lower margin 2 ft.! The grain is extra coarse for this distance and suggests some error.

Grain

Olivine 7x7; 9x4; 9x6, av. .25x.17

Feldspar 18x3½; 20x2; 17x2, av. .55x.07

Augite 20x18; 30x25; 3x18, av. .53x.59.

Sp. 15704 at 542 feet in No. 11 corresponds in some respects to this but the plagioclase seems a little more basic and I think it belongs to the next flow.

Sp. 15469. Hole 10 at 135 feet from bed rock surface. Pipe amygdule; porphyritic, microlitic; contact shows trace of sand. Distance from margin 0.

Grain

Olivine 7x4; 9x7; 6x3, av. .22x.14

Feldspar 12x2; 6x1,

Augite none.

This specimen shows the contact,—being divided into two parts with sandstone between. The one part is not so red and has one phenocrysts 36x12. The other (lower?) is blacker especially around the very numerous small amygdules.

11. 536-550½ (Ss. 15703?-15705) (13) (2600+547)

10. 135-148; (Ss. 15469-72). MELAPHYRE, amygdaloidal ophite; more compact in the lower 4 feet.

Sp. 15470. Hole 10 at 138 feet from surface. Granules of altered yellow red olivine; plagioclase extinctions 0-6°; 0; 0. Distance from margin 3.

Grain

Olivine 10x8; 10x9; 12x9, av. .32x.26

Feldspar 16x2; 16x1.

Augite 12x11; 13x8; 12x4; .37x.23,

Sp. 15704. Hole 11 at 542 feet from surface. Poikilitic augite; feldspar ex. angles 26°; 39°; 17°-13° and 42°-41°; 39°-44° and 27°; 30°-32° and 41°. Distance from margin 6.

Grain

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

Feldspar 13x2; 12x2; 9x1.25, av. .34x.05

Augite 10x5; 10x10; 13x9; 18x12, av. .42x.30.

Sp. 15471. Hole 10 at 144 feet from surface. Poikilitic ophite 20 and 35-36; labradorite extinction 15-17° and 35-39°; 31-32° and 43°. Distance from margin 4 ft. from below?

Grain

Olivine 10x5; 9x6; 10x5, av. .29x.11

Feldspar 15x2; 17x2; 14x3, av. .46x.07

Augite 65x30; 32x25; 50x25, av. 1.47x80.

Sp. 15472. Hole 10 at 148 feet from surface. Sand seam; margin porphyritic; feldspar extinctions generally very small in this section; 18-20; 0. Distance from margin 0.

Grain

Olivine 8x4; 8x7; 9x9, av. .25x.20.

Sp. 15705. Hole 11 at 550 feet, the bottom of the hole being at 550½ feet, looking as though also near bottom of flow. Much decomposed poikilitic calcite and olivine. Distance from margin 14 above.

Grain

Olivine 8; 5; 6; 9x4

Feldspar 23x2; 18x2; 14x4, av. .55x.08

Augite decomposed.

148-169; (Ss. 15473-8). MELAPHYRE, ophite; upper 9 feet (20) (2600+567) amygdaloidal, then more massive.

Sp. 15473. Hole 10 at 153 feet from surface. Slightly poikilitic.

Grain

Olivine av. 10x8

Feldspar 18x2; 20x2; 22x4, av. .60x.08

Augite 30x12; 40x30; 60x12, av. 1.30x.54.

Sp. 15474. Hole 10 at 158 feet from surface. Poikilitic; much calcite replacing or interstitial; very feldspathic, extinction 24°-26° and 38°-35°; 4°-6° and 31°-35°. Distance from upper margin 10 ft., lower 11?

Grain

Olivine 8; 9; 9, av. .26

Feldspar 16x3; 23x2; 18x3, av. .57x.06. Also lamellae with same ex. but greater refringence 19°-13° w 42-36; 20-21 w 30-35; 18-18 w 40°-41; 21-25 w 39-37

Augite 34x40; 80x60; 30x25; 44x40, av. 1.46x1.19.

Sp. 15478. Hole 10 at 169 feet from surface. Contact with sediment very calcareous. Distance from margin 0.

10. 170-193; (Ss. 15478-88). (22) (2600+589)

This conglomerate contains abundant acid pebbles, of porphyry and felsite, and of melaphyre as well. This bed I took to be the conglomerate opened by the Island mine, as the two have a similar lithological look or character, and lie nearly in line of strike from each other. The Island mine conglomerate runs about 500 feet south of the north quarter post of Sec. 29, T. 64, R. 37, and has, considering its position, a steep dip (from 19° to 25°). Again, near Siskowit Lake, 50 steps north of the southwest corner of Sec. 26, T. 65, R. 36, and down to the corner, we find along the same line of strike a conglomerate which I take to be the same. So it continues on, but does not pass through to Conglomerate Bay, but like other beds in this vicinity veers a little to the north and goes through the trough of Rock Harbor. It is barely conceivable that, if we turn and go in the other direction, by the time we shall have

come to Grace Harbor all the overlying traps will have run out, and that this conglomerate will have merged in the general conglomerate of Cumberland Point. This conglomerate in drill hole No. X differs from those above it in that it carries a greater proportion of basic pebbles, especially of the immediately underlying melaphyre porphyrites, but it differs still more decidedly from any conglomerate within the first thousand feet beneath it, in that it still contains a considerable proportion of felsitic debris—more perhaps at the Island mine than at the drill hole. This contrasted relation of the conglomerates above and below this horizon holds good, so far as the meagre facts indicate, for the corresponding beds at the other exposures above mentioned. All these exposures, moreover, lie on the southeast flank of a fairly continuous ridge which is principally made up of the rocks which we have described as melaphyre porphyrites, the "ashbed" type of diabase. Northwest of this porphyrite ridge we find a still more continuous ridge, the "backbone" of the island, which is made up of very coarsely lustre-mottled ophites. It will be noticed, from what we have said, that not only the sedimentaries but the eruptives change their character, above and below the conglomerate horizon which we are studying. Above it we have a series of thin flows, generally largely amygdaloidal, but when coarse enough showing the mottling of the ophites, and interstratified with them numerous beds of silicious sedimentary rocks. Below it, as we shall see, the beds are in general thicker and more massive, and less augitic (porphyrites, that is sodic melaphyres), and the interstratified sediments and amygdaloids resemble those which form the hanging of the Ashbed type.

Now we have on Keweenaw Point at Eagle River and elsewhere (Figures 23-38) a series precisely similar in stratigraphic order, only with the order from southeast to northwest reversed. I used mainly for comparison Marvine's Eagle River section, Fig. 34, as it was the most complete section made when I did my Isle Royale work, and I went over and revised it and collected specimens from it expressly for this purpose. Beginning from the uppermost trap bed actually noted (Geol. Sur. of Mich. I, Pt. II, p. 112) Marvine counts ten sandstone in the first 2,300 feet of the section horizontally, (i. e., 1,272 feet thick; *loc. cit.*, p. 24) to bed No. 35. This is the greater part of his series (c) which he however carries down somewhat farther to the first scoriaceous amygdaloid. In this part of the series the beds incline to be lustre mottled when at all thick, and the character of the formation generally matches the beds above the Island mine conglomerate. It will be noticed that for this part of the section we have on Isle Royale but half the thickness represented at Eagle River, the thickness to the bottom of the Island mine conglomerate being but 589 feet, but on the other hand we have six to eight representatives of the ten conglomerates and sandstones.

Beginning with the flows immediately below Marvine's bed No. 35 and the Island mine conglomerate, we find a distinctly less augitic character in the flows as a whole, while the base of each flow remains somewhat ophitic in texture; we can recognize this change under Marvine's bed No. 35, (Fig. 34), in the Copper Falls adit, Fig. 30, in the Tamarack mine No. 5 shaft section at 185 feet? (Belt 4) Fig. 37, and elsewhere. In my re-examination of the Eagle River section I observed the change there at the point indicated. Then in all cases the first sedimentary bed we meet below the Island mine conglomerate, respectively below Marvine's bed No. 35, Tamarack belt 5 is distinctly of the Ashbed type, e. g., at 415 feet in No. X, Marvine's bed No. 44. Below this bed the traps are still less augitic, and they, together with their associated scoriaceous conglomerates, have in each case about the same thickness. Under this complex we find also, both on Isle Royale and on Keweenaw Point, the largest flow of the coarsest ophite that occurs anywhere in the series, the Greenstone.

Now I am well aware of the danger of purely lithological correlations, but in view

of the fact that beds of the series which we have been studying have been followed for a distance along Keweenaw Point equivalent to that across the lake, in view of the fact that a basic lava sheet like the "Greenstone" of 200 feet, yes, in some places as in the Manitou section (Fig. 29) of 1,130 feet thickness and more, may be expected to spread a great distance, with some uniformity of lithological character, and in view of the general parallelism both in sedimentaries and in traps, both above and below, there seems to be no reasonable doubt that the Island mine conglomerate is equivalent to Marvine's bed No. 35, or is, at least, at very nearly the same horizon, and marks the same moment of quiescence in volcanic activity.

Sp. 15479. Hole 10 at 170 feet from surface. Pebble? with spherulitic open textures.

Sp. 15480. Hole 10 at 172 feet from surface. Pebble; quartz porphyry, with poikilitic ground mass very calcareous and oligoclase phenocrysts.

Sp. 15481. Hole 10 at 174 feet from surface. Pebbles of quartz porphyry with aureoles in the ground mass, or possibly secondary micropoikilitic quartz oriented with the phenocrysts.

Sp. 15482. Hole 10 at 177 feet from surface. Pebbles of andesitic porphyrite with altered olivine? microlitic. This is a basic type of rock not noticed in the conglomerates above.

Sp. 15483. Hole 10 at 181 feet from surface. Oligoclase porphyrite; poikilitic ground, i. e., felsitic.

Sp. 15484. Hole 10 at 182 feet from surface. Pebble of altered fine grained melaphyre.

Sp. 15485. Hole 10 at 186 feet from bed rock surface. Microlitic, oligoclase porphyrite pebble.

Sp. 15486. Hole 10 at 188 feet from surface. Decomposed glass! Phenocrysts of oligoclase, this type of pebble not noticed above. Olivine.

Sp. 15487. Hole 10 at 191 feet from surface. Poikilitic quartz porphyry and porphyrite fragments.

Sp. 15488. Hole 10 at 192½ feet from surface. Quartz porphyry with micropoikilitic ground.

193-306; (Ss. 15489-15501). MELAPHYRE, porphyrite. This is a (110) fpseudamygdaloid for the first 20 feet, that is, the amygdules are indistinguishable from decomposition spots. It is different from the ophites above, most markedly in microscopic characters, but also to the naked eye, for the feldspar is much more conspicuous and there is no lustre-mottling, as there would be very plainly in a bed of ophite of equal thickness. In other words the feldspar is large in proportion to the size of the augite. Light greenish seams and spots, and a generally lighter, more greyish green color may be noted on comparison. This would correspond to Marvine's bed No. 36.

The grain of the augite is plotted as *t* in Fig. 16 of the Isle Royale Report. It will be noticed how low the rate of increase is,—about 1 mm. in 50 feet or 0.000065.

It will be noticed in Marvine's description of bed No. 36 that the scoriaceous character of the amygdaloid is mentioned which is characteristic of the less augitic melaphyres. This has just about the same thickness and petrographic character with T. 5 b. 8. Annual Report for 1903, p. 254. The feldspar is oligoclase instead of labradorite.

Sp. 15489. Hole 10 at 193 feet from bed rock surface ex. 0; 0; 12°-12°; 0; 0; Not exactly at margin; large olivine; decomposed, little augite; oligoclase very decomposed. Distance from margin 0.5? ft.

Grain

Olivine 23x18; 16x10; 8x4; 17x12 av. .56x.40;

Iron oxide growth?, also Octahedra 1. and 2.5

Feldspar 16x4; 22x6; 36x6, av. .74x.16.

Sp. 15490. Hole 10 at 198 feet from bed rock surface. Magnetite apparently surrounded by zones of altered olivine? Olivine and augite really count as a unit in texture; chalcedonic cavities; feldspar Ab_6 , An_3 extinctions 10° - 12° ; 9° - 8° w 1° . Distance from margin 5.5.

Grain

Olivine 7; 8; 17, av. .32

Iron oxide 2.5; 10x9; 8x7; 17x15, av. .35x.31

Feldspar 40x5; 40x7; 28x6, av. 1.08x.18

Augite 9x5; 12x7; 15x6; 12x5; 16x8, av. .42x.20.

Sp. 15491. Hole 10 at 214 feet from surface. Zeolitic amygdaloid; so little augite that it is discontinuous; andesite feldspar extinctions 6° - 10° ; 7° - 7° ; 9° - 8° ; 5° - 4° .

Grain

Olivine 10; 7x3; 8x7; 16x9

Iron oxide 7x6; 9x9; 14x12, av. .30x.27

Augite 23x12; 13x12; 46x13, av. .82x.37.

The augite is not far from the same size as 16834 at 15665, the olivine larger but not apparently more abundant.

Sp. 15492. Hole 10 at 224 feet from bed rock surface. Very coarse; augite patches are discontinuous; porous texture with secondary filling; the cavities have very sharp feldspar? crystals; the olivine is decomposed to bowlingite (see Fig. 23, p. 155 of Isle Royale report repeated here as Fig. 16), as A. N. Winchell thinks it should be called rather than iddingsite¹; feldspar much altered.

Grain

Olivine 23x22; 30x16; 32x27, av. .85x.65

Iron oxide 30x20; 14x12; 25x15, av. .69x.47

Feldspar 60x12; 70x10; 65x11, av. 1.95x.33

Augite 30x28; 55x40; 45x30, av. 1.30x.98.

Sp. 15493. Hole 10 at 225 feet from surface. Olivine and magnetite make up grains together in apparently primary intergrowth; porous to the naked eye; feldspar appears 2-3 mm. long; extinction angle 0-5, w10-8.

Grain

Olivine 30x17; 17x12; 28x28, av. .75x.59

Iron oxide 23x22

Feldspar 79x10; 70x10; 65x5, av. 2.14x.25

Augite 54x32; 73x47; 68x45, av. 1.95x1.24.

See I. R. report Plate VI (p. 162) Fig. 3. This section well in from the margin and coarse illustrates the doleritic texture in which chlorite coatings seem to wrap around the feldspar and line the walls of cavities.

Sp. 15494. Hole 10 at 231 feet from surface. Sharp crystals of Manebach and Karlsbad twins combined with the Albite law. Extinction angles 12 - 8° with 16° - 12° ; 9 - 12° w 14 - 15° and 19 - 3 w 13 - (-1°); andesite Ab_{60} An_{40} augite in patches of granules; the olivines are larger and fewer, the augite less and the feldspar less basic than in the beds above the Island Mine Conglomerate. Distance from upper margin 37.

Iron oxide 20x15; 30x23; 25x23, av. .75x.61

¹American Geologist 23 (1899) p. 43; id. 1900, p. 211-212; Optical Mineralogy, p. 359.

Feldspar 87x7; 70x8; 90x8, av. 2.47x.23

Augite 35x20; 40x30; 44x40, av. 1.19x.90.

Sp. 15495. Hole 10 at 233 feet from surface. Albitic margin zones; Karlsbad twins abundant; ex. 13° - 4° ; 4° - 6° w 14° ; the augite less, the feldspar generally less basic. Distance from margin 39.

Grain

Olivine 40x20; 80x38; 50x20, av. 1.70x.78

Feldspar 130x10; 150x16; 140x30, av. 4.20x.56

Augite 150x70; 84x50; 40x36, av. 2.74x1.56.

Sp. 15496. Hole 10 at 243 feet from surface. Mainly changed to a green stuff, see discussion of chloritic alteration, augite left in patches through the chlorite. Distance from margin 48 ft. from above.

Grain

Olivine 20x16; 30x20; 24x24, av. .74x.60

Iron oxide 26x26; 16x14, av. .70x.66

Feldspar 130x10; 30x16, av. .10x.46.

Sp. 15497. Hole 10 at 250 feet from surface. Olivine changed to iron oxide and it is hard to tell if the iron oxides are not all after olivine. Distance from margin 54 (about middle).

Grain

Olivine 38x18

Iron oxide 40x28

Feldspar 58x3; 70x15; 53x10, av. 1.81x.28

Augite 28x25; 54x34; 45x27, av. 1.27x.86.

Sp. 15498. Hole 10 at 260 feet from surface. More compact; feldspar extinctions 17° - 11° ; 0° ; 11° . Distance from lower margin 44 ft.

Grain

Olivine 18x12 12x9; 11x8, av. .41x.29

Feldspar 60x12; 60x5; 35x5, av. 1.55x.22

Augite 29x18; 35x18; 28x18, av. .92x.54.

Sp. 15499. Hole 10 at 272 feet from surface. Many miarolitic cavities filled with chalcedonic quartz, chlorite, etc., like the photograph of 15490. Of this section a large number of extinction angles for albite—Karlsbad twins were measured together with their birefringence. This varied sometimes from center to margin, but characteristic extinctions were 17° on each side for one and 36° on each side for the other set of lamellae in a compound albite Karlsbad twin. The feldspar must be near Ab_{40} An_{60} , distinctly more limey than at the top. This is in harmony with the tendency elsewhere noted for the lime to segregate into the lower and later cooled part of a flow.

Distance from margin 33.

Olivine 19x11; 12x12; 13x13, av. .44x.36

Feldspar 30x8; 43x10; 35x5, av. 1.08x.23

Augite 20x20; 15x12; 20x8, av. .55x.40.

Sp. 15500. Hole 10 at 284 feet from surface. Though the feldspar is getting basic the augite is still small in quantity; the rock coarse grained with coated cavities lined with chalcedony and chlorite; of a large number of extinction angles measured 9° - 13° with 12° - 25° may be taken as representative. The feldspar is near Ab_{50} An_{50} . Distance from margin 21.

Grain

Olivine 14x13; 25x20; 12x10, av. .51x.43

Augite 37x20; 26x18; 20x11, av. .83x.49.

Sp. 15501. Hole 10 at 299 feet from surface. Feldspar extinctions 19° - 17° ; 12° - 9° ; 5° - 13° w 0° ; 8° - 11° ; 9° - 8° ; 6° - 4° ; 16° - 16° w 10° . Distance from margin 7.

Grain

Olivine 20x18; 30x20; 13x10, av. .63x.48

Augite 10x7; 18x10; 7x5, av. .35x.22.

306-322; (Ss. 15502-5). AMYGDALOID. This is a fine grained (16) (126) red amygdaloid, apparently the same kind of rock as the bed above, but a thinner flow.

Among the drillings at 321 feet were 2 inches; at 322 feet, 4 inches; at 323.3 feet $\frac{1}{2}$ inch of a basic SANDSTONE. The driller's record threw no light on the occurrences, but from the gradually finer grain of the traps above and below them, I am led to believe that they all really belong at 322 feet, and that there is a bed of fine grained dark red basic sandstone there. Dip 14° . They may, however, be clasolitic in nature and similar material is found in T. 5 b. 11, and T. 5 b. 12 is a conglomerate. This must nearly correspond to T. 5 b. 11, Marvine's bed 36.

Sp. 15502. Hole 10 at 306 feet from bed rock surface. Microlitic porphyritic amygdaloid with sand in cavities also glass fragments. Feldspar extinctions 9° - 8° ; 8° - 8° ; 12° - 18° .

Sp. 15503. Hole 10 at 308 feet from surface. Pretty thoroughly decomposed; there is a secondary poikilitic texture visible in polarized light; without the analyzer it appears a microlitic amygdaloid.

Sp. 15504. Hole 10 at 311 feet from bed rock surface. Coarser somewhat and with very little augite; olivine rare; same type as flow above; feldspar extinctions 15° - 11° ; 14° - 8° w 5° - 8° .

Grain

Olivine 8x7; 7x4; 8x7; 14x10, av. .30x.23

Feldspar 40x4; 25x6; 30x4, av. .95x.14

Augite 12x11; 30x7; 18x10; 25x15, av. .70x.35.

Sp. 15505. Hole 10 at 321 feet from bed rock surface. Sediment; basic; poikilitic cement; at 321, 2 in., 322, 4 in., 323 $\frac{1}{2}$ of what looks to me tufaceous material. SANDSTONE. Compare T. 5 p. 12.

322-325; (S. 15506). Perhaps another bed of Melaphyre. At (3) (129) 325 a narrow seam is noted which may be a small fault.

Sp. 15506. Hole 10 at 325 feet from surface. Abundant altered olivine; much marked poikilitic augite; feldspar ex. 13° - 17° w 33° - 38° ; 28° - 26° ; 20° - $w28^{\circ}$ - 34° ; 18° - 19° ; 35° - 35° ; 41° w 29° - 16° ; 12° - 24° w 29° - 42° ; this section is distinctly a lime melaphyre and not close to the margin either, (at least 10 or 20 feet from it). So that if there is not a mistake in the drill samples we must assume a fault here. Compare 16401 to 16403 of the Tamarack section; ophite.

Grain

Olivine 12x9; 13x8; 15x9; 5x5, av. .37x.25

Feldspar 22x2; 20x3; 24x3, av. .66x.08

Augite 62x40; 56x35; 120x70, av. 2.38x1.45.

325-332; (Ss. 15506-8). AMYGDALOID; at 332 feet highly amygdaloidal (7) (136) brecciated, and mixed with finer grained sediment; quite likely a slip. Compare Eagle River bed 37.

Sp. 15507. Hole 10 at 329 feet from bed rock surface. Similar to 15506 but finer grained as to the augite and more feldspathic; feldspar ex. 11° - 13° w 38° - 30° ; 10° - 27° ; 18° - 23° ; 34° - 32° w 31° - 18° ; 30° - 30° w 20° - 20° ; 12° - 8° w 4° .

Grain

Olivine 22x10; 22x8; 22x19, av. .66x.37

Feldspar 32x3; 25x5; 28x4, av. .85x.12

Augite 30x18; 30x14; 50x30, av. 1.10x.62.

Evidently, comparing 15506 and 15507, we have but the bottom of a flow represented.

Sp. 15508. Hole 10 at 332 feet from bed rock surface. All altered; a contact of two flows; (1) amygdaloid and porphyritic in a glassy not microlitic ground; (2) sandstone streak between; (3) amygdaloidal microlitic and porphyritic.

Grain

Olivine 12x8? none; 28x17; 20x12, av. .60x.37

Iron oxide much

Feldspar 20x4; 12x2; 30x12, av. .62x.18

Augite none; glass.

In this section were sharp crystals of prehnite in an amygdule as shown in Fig. 24 of Vol. VI, Part I). It has high refringence, birefringence at least as great as quartz, and ex. 0° . The whole rock below is thoroughly altered to prehnite, the feldspar forms being replaced by it.

332-338; (Ss. 15508-12). AMYGDALOID.

(6) 140?

The probability is that this horizon which is that of Eagle River beds 36-43, grouped by Marvine together for description, was one of those porous beds particularly likely to be crushed and faulted, for in the various sections one cannot make close correlations and yet there is a general similarity. Even the prehnitic alteration of 15508 and 15509, we find not only here but also mentioned by Marvine.

Sp. 15509. Hole 10 at 333 feet from surface. Microlitic porphyritic amygdaloid in contact with sandstone; There are olivine pseudomorphs probably but the rock is all changed to prehnite.

Grain

Olivine? 27x23, 25x15, av. .86x.63

Feldspar? 40x20; 15x5, av. .91x.50.

Sp. 15510. Hole 10 at 336 feet from surface. Very little augite left; altered olivine; much feldspar, extinctions 9° - 27° w 2° ; 7° all; 11° - 4° ; 6° - 4° ; 10° - 5° w 4° ; 10° - 8° and 12° ; 13° - 14° ; 16° - 12° ; there appears to be bastite after olivine, good cleavage + ex 0° , but compare bowlingite.

Grain

Olivine 8x5; 8x6; 19x8, av. .35x.19

Feldspar phenocrysts 36x15; 34x4; 50x16, av. 1.10x.35 mm.

Augite 14x12? av. .42x.36?

Sp. 15511. Hole 10 at 337 feet from surface. Altered olivine as before; andesite ex. 20° - 10° ; 15° - 5° and 4° ; 18° - 12° w, 16° ; 2° , 8° .

Grain

Olivine 17x10; 22x18; 12x10, av. .35x.19.

Feldspar phenocrysts 32x10; 32x8; 13x13, av. .77x.31 mm.

Sp. 15512. Hole 10 at 338 feet from surface. *Porphyritic*; secondary poikilitic; microlitic; andesite ex. 17° - 11° .

Grain

Olivine 10x10; 13x9; 14x10, av. .33 mm.

Feldspar phenocrysts 12x3; 25x17; 26x18, av. .63x.38 mm.

338-415; (Ss. 15513-24). MELAPHYRE; of the porphyrite type (77) 217 at the top, but becoming darker and approaching the ophite type at the bottom. It is somewhat amygdaloidal down as far as 352 feet, beginning as a fine grained red porphyrite with amygdules of chlorite and a few of agate at the top. At 344 feet and 377 feet green rock was cut which would in the field prove, I feel sure, to be either rounded masses ("inclusions" or "bombs") or irregular skeins, which are characteristic of this group, and are slightly more likely to be amygdaloidal than the

adjacent rock. They are more decomposed, though this decomposition doubtless follows some primary feature, and they are permeated with cavities lined with crystals of quartz and chlorite.

As we get toward the bottom the rock, which is firm and compact, and yields long drill cores and would make good road metal becomes darker, and finally somewhat lustre-mottled. This is true not only on Isle Royale, but at Eagle River and in the Tamarack shaft. *Copper* appears in paper-like sheets in the chlorite seams. This is probably the Eagle River beds Nos. 40-43. Compare T. 5 b 9-10 flow 6. Analyses of this bed will be found in Tables XII and XIII of Chapter II, and illustrates again the tendency toward accumulation of lime in the lower and last crystallized part.

Sp. 15513. Hole 10 at 339 feet from surface. Like 15512 but red microlitic; 339-415 trap.

Grain

Olivine 12x10; 13x10, av. 0.33 mm.

Feldspar porphyrite 20x10; 30x10; 30x10, av. 0.80x0.30 mm.

The grain of the augite and feldspar of this sheet are illustrated in Fig. 22 of the Isle Royale Report and the variation in the character of the feldspar in Plate V of that report.

Sp. 15514. Hole 10 at 344 feet from surface. Microlitic; porphyritic; much decomposed; well marked grains of altered olivine.

Grain

Olivine 13x8; 10x10; 10x8, av. 0.30

Feldspar phenocrysts 49x10?; 25x5; 30x25, av. 0.98x0.40.

Sp. 15515. Hole 10 at 350 feet from surface. Somewhat patchy augite but much feldspar, ex. 0-11°; 8-7°; 15-5°; 0-0; more basic at bottom of flow. Distance 9 feet from top?

Grain

Olivine 28x16; 16x5; 18x10, av. 0.46

Feldspar phenocryst 30x10; 32x9; 37x8, ave. 0.94x0.27

Augite 40x30; 30x20; 28x15, av. 0.64.

The feldspar is shown on Plate V of Vol. VI as a. It is $Ab_{85} An_{15}$.

The analysis by F. P. Burrall is given in Chapter II.

The proportion of different minerals were compiled by me on the basis of minerals actually seen in Vol. VI, p. 146. They were recalculated by A. N. Winchell¹.

	W.	L.
Ortho	6.12	3.47 + 2.6
Ab.	28.82	34.06
An.	24.19	18.07
Nephelite	2.84	0.
Diopside	3.80	10.35
Hypersthene		5.14 fassaite
Olivine	23.25	17.44
Magnetite	3.94	3.94
Hematite	0	0
Ilmenite	0	0
Apatite	0	0
Calcite		.90
H ₂ O	5.01	
	98.87	

¹Jour. Geol. XVI. (1908) p. 771.

The main difference comes from my allowing a certain amount of alumina in the augite so that Winchell gets 61.97% of silic minerals including a little nephelite, while I got 55.60 of feldspar including no nephelite.

Sp. 15516. Hole 10 at 354 feet from surface. Thoroughly decomposed; about same grain as 15515. Distance 16 feet from top.

Grain

Olivine?

Feldspar 30x15; 25x7; 23x8, av. 0.78x0.30

Augite 30x20; 40x35?; 25x20, av. 1.48 to .78.

The augite is shown merely by scattered fragments left in alteration and may be coarser. The alteration is into a mass of minute yellow epidote prisms.

Sp. 15517. Hole 10 at 358 feet from surface. Poikilitic augite; slightly decomposed; andesite ($Ab_{60} An_{40}$) extinction angles (see Plate V letter b) 21-16° and 3°; 6-5° and 16°; 0; 0°; 6; 12°; 13°; 4-5. Distance from margin 20 ft.

Grain

Olivine 15x12; 19x16; 20x15, av. 0.48 mm.

Feldspar 50x4; 40x4; 35x8, av. 1.25x0.16 mm.

Augite 80x40; 23x22; 80x47, ave. area (.47)² or (1.43 mm.)²

There is not much augite and this is of the feldspathic ophite type.

Sp. 15518. Hole 10 at 365 feet from surface. Poikilitic augite; much decomposed olivine; feldspar abundant; augite much cut up; very small extinction angles 0°, 0°, 0°, 0°, 0°. Distance from top 27 ft. from bottom 50 ft.

Grain

Olivine 33x18; 16x10; 40x18, av. 0.67 mm.

Feldspar 42x5; 35x8; 37x4, av. 1.14x0.17 mm.

Augite 150x80; 40x40; 100x65, av. (2.3)² mm.

Sp. 15519. Hole 10 at 372 feet from surface. Very poikilitic augite; low angled feldspar. Distance from lower margin 40½ ft.

Grain

Olivine 25x15; 18x8; 25x20, av. 0.55 mm.

Feldspar 28x8; 40x10; 40x10, av. 1.08x0.28

Augite 50x50; 260x260; 120x90, av. (4.45 mm.)²

See Vol. VI, Pt. I, p. 130 fig. 16

See Vol. VI, Pt. I, p. 144 fig. 22

From this point on the grain of the augite is plotted on Fig. 16 of the Isle Royale report, as well as on Fig. 22; under the letter s. The rate of increase from the bottom up is well up to the high figures of 1 mm. in 10 feet, or .00033. The composition is that of a lime melaphyre as shown by the analysis by F. P. Burrall¹.

It may be a coincidence that this specimen which has the coarsest augite has also the most lime, since it also has most (CO₂) but it quite harmonizes with my theory of the concentration of lime in the last formed rock.

Sp. 15520. Hole 10 at 378 feet from surface.

Pretty much all decomposed; coarse; chloritic like 15519. Distance from lower margin 36 feet.

Grain

Iron oxide 32x32; 27x25; 14x14, av. 0.72 mm.

Feldspar 92x10; 120x8; 80x8, av. 2.92x0.26 mm.

In this section there was no olivine but there were beautiful triangular iron oxide skeletons which replace it as an element of the fabric.

Sp. 15521. Hole 10 at 380 feet from surface. Prehnite vein; labradorite. ex.

¹Vol. VI., p. 143, and above Chapter II, p. 114.

2w24-29°; 22-23; 6-6w23-23 letter c of Plate 6 of the Isle Royale Report; decomposed but high angled feldspar; chloritic rinds around feldspar. Distance from lower margin 25 feet.

Grain

Olivine 43x40

Iron oxide 42x30; 40x25, av. 1.00 mm.

Feldspar 50x13; 42x6; 42x9, av. 1.34x.28 mm.

Augite 120x80; 100x86; 180x120 av. area 3.4 mm. by micrometer. The patches look about 2 to 3 mm.

Sp. 15522. Hole 10 at 403 feet from surface. Contact of poikilitic melaphyre with fine grained sediment (8, 4, 4, 2, 2, 2) or clasolite which the grain shows is evidently infiltrated into a crack of the lava. Labradorite extinctions 10°-w33°-34°; 11°-18°-w29°-34°. Distance from margin 12.

Grain

Olivine 27x22; 24x15; 20x20, av. .61

Feldspar 40x15; 38x7; 30x4, av. 1.08x0.26

Augite 90x56; 160x50; 100x75, av. area (2.6 mm.)².

Sp. 15523. Hole 10 at 406 feet from surface. Labradorite ex. 24°-20°-w42°-39°; 24°-23°; 19°-18°; 37°-33°; 24°-20°-w-32°; 28°-w40°-37°. Distance from margin 9. The grain is plotted in Figures 16 and 22 of the Isle Royale Report.

Grain

Olivine 40x30?; 40x30; 24x18, av. 0.91 mm.

Feldspar 22x3; 40x10; 40x8, av. 1.02x0.21 mm.

Augite 120x80; 110x84; 160x100, av. (2.2 mm.)²; apparently 2-3 mm. patches to the eye.

The composition of this has been subject of analysis by F. P. Burrall and of study by Winchell and myself. Winchell gives the norm. I estimate the mode.

	W	L
Orthoclase	6.12	1.87+1.2
Albite	23.58	21.48
Anorthite	30.30	34.19
Nephelite	4.26	
Diopside	18.41	19.50
Fassaite		5.62
Olivine	2.10	6.02
Magnetite	11.14	6.72
Ce	2.30	
H ₂ O	3.49	

We both agree in making a decided increase in augite as compared with 15515.

Sp. 15524. Hole 10 at 415 feet from surface. This like 15522 shows sediment, yet the grain is so coarse that it is not a normal margin. There must either be faulting or some sediment enclosed from the bed below. The augite is, however, so much finer in grain that less than 10 feet need be allowed for margin planed away. a. poikilitic; with olivine; b. sediment. Distance from margin 0+?

Grain

Feldspar 32x7; 40x5; 30x7, av. 1.02x0.19 mm.

Augite 30x20; 20x20; 24x1.6 av. (0.65 mm.)². The augite patches appear about 1 to 2 mm. across to the eye.

(217)

415-426; (Ss. 15525-30). CONGLOMERATE 17. This bed is the first of (11) (228) the scoriaceous or amygdaloid conglomerates, otherwise known as ashbeds or scoriaceous amygdaloids. The matrix is very dark, of a deep maroon shade, generally

speaking, very fine grained and argillaceous, and the pebbles are irregular masses of amygdaloid, like the beds with which they are associated. The line between the conglomerate and the underlying amygdaloid is extremely difficult to draw. This is the reason why these scoriaceous beds have been considered as extreme forms of amygdaloid, but there is no doubt that in the beds which I am now considering there is a large amount of detrital matter, almost exclusively from basic rocks. They are very calcareous.

This conglomerate corresponds very nicely to Marvine's Conglomerate 18, Eagle River bed No. 44- as well, indeed, as his bed No. 35 corresponds to the Island mine conglomerate, also to T. 5 b 4 of (Fig. 37). The underlying rock corresponds to Marvine's bed No. 45, being a melaphyre porphyrite, with a clean conchoidal fracture, as we shall see, and the immediately overlying bed is in each case a mottled opHITE below, a porphyrite above. Marvine allowed eight beds between No. 35 and No. 44, but two numbers were allowed for beds unobserved, and none of the observations showed that Nos. 42 and 43 were separate beds, and in fact I inferred from the coarseness of grain and other things that in reality from No. 39 down to No. 43 was all one large flow (184 feet) corresponding so closely to our melaphyre in No. X (338-415, i. e., 75 feet thick) as probably to be the same flow. That left four beds in the Eagle River section, between No. 35 and No. 44, to correspond to our six beds, in each case with a thick flow at the base. From the top of Marvine's bed No. 35 to the top of his bed No. 44 is, according to Marvine, 273 feet. The corresponding distance in our column of rocks is (806-567) 239 feet, which is quite as close a correspondence to the general ratios as could be expected, 50 miles away, and eminently satisfactory. The correlation is made much stronger by the study of the comparative coarseness of grain, and the change in the character of the feldspar. Marvine's Conglomerate 18 is by his Portage Lake section (atlas Plate XIX) 370 feet above the Hancock West or No. 17. In the Eagle River section there is (86+1810=1503) 383 feet. Here the distance is 239 to 283 feet,—in harmony with the general shrinkage of the beds on Isle Royale. This would then mark the line between Marvine's group (b), and his group (c) the Eagle River group, and the Ashbed group.

Sp. 15525. Hole 10 at 416 feet from surface. Poikilitic, calcareous sediment; altered ash?

Sp. 15526. Hole 10 at 417 feet from surface. Poikilitic; calcareous cement; small grains.

Sp. 15527. Hole 10 at 418 feet from surface. Margin composed of material as in 15526 with large red stained fragments of microlitic amygdaloid.

Sp. 15528. Hole 10 at 419 feet from surface. Mixed sediment and amygdaloid; this corresponds to the ashbed.

Sp. 15529. Hole 10 at 425 feet from surface. Probably contact of underlying flow; fragments porphyritic amygdaloid, microlitic; this corresponds to the ashbed.

ASHBED GROUP.

Marvine's (b)

10. 426-483; (Ss. 15531-7). MELAPHYRE, or olivinitic augite, porphyrite, Tobin Porphyrite. This is one of the most acid of the melaphyres, really of the type of an olivinitic augite andesite. The smoother fracture, generally lighter, green color, abundance of not very large white porphyritic feldspar aggregates, and compact texture are well marked. This is the bed that we seem to find at the top

of drill hole No. IX. and have called the Tobin porphyrite, Eagle River bed 45. It is also well defined in the Tamarack shafts T 5, No. 5 of Fig. 37.

We assume that No. X, 483 feet, is equivalent to No. IX, 49 feet, a difference of 434 feet. Subtracting the excess of altitude of No. X over No. IX (206.7-202.5), 4.2 feet, we have 430 feet, which divided by the distance between them along the line of cross-section, 1973 feet, gives 0.217, the tan $12^{\circ} 20'$. This is the same dip we had before.

Sp. 15530. Hole 10 at 426 feet from surface. Scoriaceous; the same as No. 15529; porphyritic feldspar crystals have extinctions 15° - 12° ; 6° - 7° ; 14° - 4° .

Grain

Feldspar 40x28 and 8x1, av. .80x.48.

However, we should point out the strong resemblance of the rocks around No. X, 483 feet; No. IX, 385 feet; No. VIII, 47 feet, in order that any one may, if he choose, try his hand at making them the same horizon repeated. I have been unable to do so without assuming arbitrary and unnecessary faults *ad libitum*.

Sp. 15531. Hole 10 at 431 feet from surface. Almost no olivine; microlitic amygdaloid such as the fragments in the conglomerate above; porphyritic crystals have extinctions 26° - 4° ; 18° - 11° ; 0; 0; 16-7; 4-6; 14-13; augite in grains; ground mass microlites.

Grain

Olivine 30x30; 32x23, av. 1.1x.88

Feldspar porphyritic crystals 32x17; 30x10; 30x17, microlites 8x1.5; 8x1.

Augite 1; 1; 1; 2x1.

Sp. 15532. Hole 10 at 432 feet from surface. Similar to 15531; olivine in occasional porphyritic grains; porphyritic feldspar extinctions are 16° - 7° - 15° ; 6° - 6° ; 0; 11° - 18° and with higher birefracton 0° ; glomeroporphyrite.

Grain

Augite 28x20; 17x7; 24x16, av. .59x.43

Iron oxide 5x4; 5x5; 6x1, av. .16x.10

Feldspar phenocrysts 20x3; 33x8; 40x18, av. .93x.29; microlite 10x2; 8x1; 8x1, av. .26x.04

Augite 10x3; 3x2; 3x3; 4x2, av. .16x.09.

Sp. 15533. Hole 10 at 445 feet from surface. Similar to 15531; markedly porphyritic; olivine in scattered grains only; a little augite in idiomorphic granules; glomeroporphyritic andesite ex. 12° - 12° - 4° - 5° .

Grain

Olivine 28x20; 17x7; 24x16, av. .69x.43

Iron oxide 5x4; 5x5; 6x1, av. .16x.10

Feldspar phenocrysts 20x3; 33x8; 40x18, av. .93x.29; microlites 10x2; 8x1; 8x1, av. .26x.04

Augite 10x3; 3x2; 3x3; 4x2, av. .16x.09.

Sp. 15534. Hole 10 at 452 feet from surface. All altered, leucocoxene?, viridite? (+ ex. 0), prehnite (-ex 0) and amphibole? faint outlines of small and large feldspar.

Grain

Olivine 8x7? 10x9, av. .3x.26.

Sp. 15535. Hole 10 at 463 feet from surface. Andesite extinctions 14° - 11° ; 0; 0; 16-7; 15-5. Distance from lower margin 19 feet.

Grain

Olivine 15x7; 45x33; 21x20, av. .81x.60

Feldspar phenocrysts 70x15; 40x13; microlite 12x2

Augite 7x5; 6x2.5; 8x1.5, av. .21x.09.

Sp. 15536. Hole 10 at 475 feet from surface. Much more ferruginous; feldspar extinctions 24° - 15° ; 12° - 10° - 26° - 32° ; prismatic augite. Distance from margin 10 feet.

Grain

Olivine 12x10; 17x10, av. .65x.33

Feldspar 50x20; 50x7; 40x10, av. 1.40x.37

Augite 6x2; 6x2; 6x5, av. .18x.09.

Sp. 15537. Hole 10 at 483 feet from surface. Olivine very rare; andesite extinctions 8° - 8° ; 10° - 4° ; 24° - 11° ; 15° - 0° ; 15° - 13° ; 13° - 7° ; augite in dishevelled sheaves.

Grain

Olivine 39x22; 22x20; 10x7, av. .71x.49

Feldspar phenocrysts 35x10; 45x8; 43x15, av. 1.63x.33

Augite 9x3; 6x5; 12x3, av. .27x.10.

Ss. 15386-9 from the top of No. 9 also belong to this flow. Sp. 15387 has feldspar whose extinction angles definitely indicate Ab An. Sp. 15388 seems less basic and augitic than 15387 and has some red smaller feldspar (3x.5) 2x.1). Sp. 15389 is similar.

There are scarce and not uniform distributions of pseudomorphs of olivine.

DRILL HOLE IX

We then correlate the first 49 feet of No. IX with the bed of melaphyre already described (Ss. 15386-9)

Sp. 15386. Hole 9 at 6 feet from surface. Low angled feldspar; ex. angles 9° ; 0° ; 14° ; 0° ; 0° ; 0° ; 22° - 27° ; 0° ; 8° - 15° - 22° ; two generations of olivine?

Grain

Olivine 33x20; .5x3; 7x6, av. .40x.29 mm.

Iron oxide 3x2; 5x6; 6x4, av. .14x.12 mm.

Feldspar phenocrysts 17x14; 36x14; 37x11, av. .90x.39 mm.

Augite 4x1; 10x4; 3x4, av. .17x.09 mm.

Sp. 15387. Hole 9 at 23 feet from surface. Low angled feldspars; phenocrysts 4° - 4° - 1° ; 9° - 9° ; 5° - 3° ; 24° - 20° ; 23, -18; 33° - 24° ; small decomposed olivine quite abundant?

Grain

Olivine 4x2; 5x5, av. .15x.11 mm.

Iron oxide 13x12; 15x12, av. .46x.40 mm.

Feldspar phenocrysts 100x15; 55x20; 54x30, av. 2.09x.65 mm

Augite 11x3; 18x9; 11x12, av. .40x.24 mm.

Sp. 15388. Hole 9 at 46 feet from surface. Low angled feldspars; ex. angles 9° - 6° ; 7° - 0° ; 0° ; 0° ; 11° - 17° - 0° ; 11° - 12° ; 16° ; rather less basic and augitic.

Grain

Olivine 28x25; 30x25, av. .96x.83 mm.

Iron oxide 3x1; 2x1; 3x2, av. .08x.04 mm.

Feldspar phenocrysts 22x16; 26x14; 43x30, av. .91x.60 mm.

Augite 2x1; 4x3; 3x2, av. .09x.06 mm.

Sp. 15389. Hole 9 at 48 feet from surface. Still finer grained microlitic porphyritic; very ferruginous amygdaloid. Distance from margin 49.

Grain

Olivine 80x45; 30x27; 38x28; 33x26, av. 1.5x1.05 mm.

Iron oxide growth

Feldspar phenocrysts 28x12; 30x13; 32x16, av. .90x.41 mm.

49-103; (30 feet of drift not counted) (Ss. 15390-7); (53)
corresponds to No. X, 483-508; (Ss. 15540-3). MELAPHYRE, porphyrite; red, finely porphyritic, with an almost felsitic matrix; with chloritic amygdules for the first 15 feet, then a gray trap like the flow above.

Below base of Conglomerate No. (8) (109)
This should be Eagle River bed 46. At this point Marvine found on Eagle River 10 thin, but as he says well defined, beds amounting in all to 147 feet, beds 46 to 55. Just what the correlation may be cannot be determined.

Sp. 15390. Hole 9 at 49 feet from surface. Low angled feldspar.

Grain

Olivine? 4x4; 1.5
Iron oxide 2x2; 2x2; 12x10, av. .16x.14 mm.
Feldspar phenocrysts 37x14; 24x20; 33x12, av. .94x.46 mm.
Augite 5x1; 1x1; 2x0.5; 0.5x1.5, av. .08x.04 mm.

Sp. 15391. Hole 9 at 57 feet from surface. Large amygdules and phenocrysts,—can they be olivine? Also small low angled feldspar; ex. 7°-5°.

Grain

Olivine 48x20; 33x20; 33x22, av. 1.14x.62 mm.
Iron oxide 3; 2; 2
Augite 13x10; 12x10; 9x9, av. .34x.29 mm.

Sp. 15392. Hole 9 at 64 feet from bed rock surface. Feldspar ex. angles, phenocrysts 13°-4°; 9°-14°w3°; 8°-0°; microlites 17°-0°-9°; 13°; 3°; 7°.

Grain

Olivine 4x4; 6x4; 5x4, av. .15x.12 mm.
Iron oxide 4; 6; 6x3; 7x6
Feldspar phenocrysts 15x9; 24x15; 40x12; 43x14, av. 1.01x.41 mm.
Augite 13x5; 13x9; 10x5, av. .36x.19 mm.

Sp. 15393. Hole 9 at 77 feet from surface. Large feldspar very abundant, no sharp distinction between them and the smaller; ex. angles 0°; 10°-12° 0°-9°; 8°-5°; 10°-15°. In this specimen the augite is not so idiomorphic and there begins to be a transition toward the glomeroporphyrite and feldspathic melaphyre type.

Grain

Olivine 3; 3x3; 7x5
Iron oxide 2; 5; 5
Feldspar phenocrysts 28x12; 32x13; 40x12, av. 1.00x.37 mm.
Augite 11x9; 13x9; 15x6, av. .39x.24 mm.

Sp. 15394. Hole 9 at 92 feet from surface. Feldspar ex. angles 0°; in thin microlites; 0°. Distance from lower margin 11.

Grain

Olivine 3x2; 3x2; 2x2, av. .08x.06 mm.
Iron oxide 20x15; 8x8; 10x2, av. .38x.25 mm.
Feldspar phenocrysts 30x23; 45x30; 40x10, av. 1.15x.63 mm.
Augite 2x1; 2x2; 2x1, av. .06x.04 mm.

Sp. 15395. Hole 9 at 100 feet from bed rock surface. Porphyritic microlitic; the low angled feldspar is porphyritic and distinctly corroded; feldspar ex. 10°-1°; 0°-0°; microlitic 25°-23°; 26°-28°; 9°w26°-16°; 29°-30°; 24°-26°w24°-26°.

Distance from margin 3.

Grain

Iron oxide 25x17; 19x11; 40x39, ave. .84x.67 mm.
Feldspar phenocrysts 36x14; 76x32; 32x10, ave. 1.02x.56 mm.
Augite 3x3; 5x4; 4x1, ave. .1x.08 mm.

Sp. 15396. Hole 9 at 102 feet from surface. Feldspar phenocrysts ex. 0°; 0°; 0°; 0°-3°; 6°-6°; 0°; 0°; microlites 12°; 0°; 0°; 0°; 0°-8°; 0°; 7°; 0°; 3°; 0°. Distance from margin 1.

Grain

Olivine 23x12; 15x14; 22x18, av. .60x.44 mm.
Iron oxide 2; 3; 2
Feldspar 30x9; 75x16; 53x15, av. 1.58x.40 mm.
Augite 3x1; 2x2; 3x1, av. .08x.04 mm.

Sp. 15397. Hole 9 at 103 feet from surface. Mainly sediment; amygdaloidal porphyritic; microlitic; prehnitic; dark borders to amygdules. Distance from margin 0.

(109)

103-152; (Ss. 15398-402). MELAPHYRE, porphyrite; to the naked eye much like the two flows above, though not so acid; at the top about 20 feet are somewhat amygdaloidal (chloritic) (48) (157)

Sp. 15398. Hole 9 at 113 feet from surface. Considerable altered olivine; little augite; low angled feldspar ex. angles 7°-0°; 0°; 14°-9°w0°; 0°; 0°.

Grain

Olivine 18x13; 22x16; 23x22, av. .59x.51 mm.
Iron oxide 9x5; 9x5; 8x6, av. .26x.16 mm.
Feldspar 23x8; 38x8; 26x8, av. .87x.24 mm.
Augite 30x10; 15x12; 16x6; 17x15, av. .65x.53 mm.

Sp. 15399. Hole 9 at 122 feet from surface. Altered olivine; augite slightly poikilitic not abundant; labradorite extinction angles 33°-37°; 30°-37°; 27°-39°.

Grain

Olivine 20x7; 18x12; 15x13, av. .53x.32 mm.
Iron oxide 8x8; 9x5; 9x1, av. .26x.14 mm.
Feldspar 30x6; 48x23; 48x14, av. 1.26x.43 mm.
Augite 40x30; 18x15; 37x35, av. .95x.80 mm.

Sp. 15400. Hole 9 at 129 feet from surface. Pretty thoroughly decomposed.

Grain

Olivine 15x9; 9x8; 7x6, av. .31x.23
Iron oxide 15x2; 10x4; 14x2, av. .39x.08
Feldspar 22x4; 25x8; 33x4, av. .80x.16.

Sp. 15401. Hole 9 at 144 feet from surface. Little or no augite; olivine abundant; andesite ex. angles 0°-2°w3°-1°; 5°-4°; 20°-8°; 22°w14°-15°.

Grain

Olivine 17x15; 44x18; 23x10, av. .84x.43 mm.
Iron oxide 16x8
Feldspar 43x10; 42x17; 32x10, av. 1.17x.37 mm.
Augite 23x10.

Sp. 15402. Hole 9 at 151 feet from surface. Somewhat amygdaloidal; a little decomposed olivine; porphyritic microlitic; extinction angles 10°-10°. Distance from margin 1.

Grain

Olivine 16x15; 6x6; 6x4, av. .28x.25 mm.
Feldspar phenocrysts 67x17; 31x29; 26x10, av. 1.24x.56 mm.

(157)

152-170; (Ss. 15403-6.) MELAPHYRE, porphyrite; first ten feet red porphyritic amygdaloid. This bed has (at 164 feet) the same (18) (175)

decomposed green, light-colored spots, as in No. X at 344 feet.

Sp. 15403. Hole 9 at 154 feet from surface. Amygdules, porphyritic; microlitic; very low angled feldspar ex. angles 8° - 8° w 6° .

Grain

Olivine 33x24; 12x8; 22x18, av. 67x.50 mm.

Iron oxide 3x1; 9x1; 6x5, av. .18x.07 mm.

Sp. 15404. Hole 9 at 160 feet from surface. All very low angled feldspar, ex. angles 7° - 15° - 0° ; coarser than 15403; many olivine pseudomorphs, but little augite.

Grain

Olivine 29x10; 20x8; 10x7, av. .59x.25 mm.

Iron oxide 3; 4x2; 7x6

Feldspar phenocrysts 38x25; 28x13; 50x15, av. 1.16x.53 mm.

Sp. 15405. Hole 9 at 164 feet from surface. Thoroughly decomposed; same texture but originally more glassy?

Grain

Olivine 10x10; 20x18; 16x14, av. .46x.42 mm.

Feldspar phenocrysts 32x18; 30x? 22x16.

Sp. 15406. Hole 9 at 170 feet from surface. Microlitic porphyritic; very close to the margin; sharp epidote; very ferruginous; very amygdaloidal.

Grain

Olivine 8x5; 7x5; 6x5, av. .21x.15 mm.

Feldspar 11x5; 10x8; 30x11, av. .51x.24 mm.

170-214; (Ss. 15407-8). MELAPHYRE, porphyrite; not very salic (43) (218)

diabasic texture often conspicuous; red and amygdaloidal porphyrite at the margins.

This may well be T 5 b 18 and 19 (flow 12, on p. 256 of report for 1903 and Fig. 37.)

Sp. 15407. Hole 9 at 193 feet from surface. More olivine pseudomorphs than augite; feldspar ex. angles 0° - 0° ; 12° ; 0° - 10° ; 0° - 16° ; 17° - 10° ; 15° - 6° ; 5° - 4° . Distance from margin 23 above, 21 below.

Grain

Olivine 25x15; 20x18; 25x23, av. .70x.56 mm.

Iron oxide 23x1; 11x1; 21x2, av. .55x.04 mm.

Feldspar 34x6; 50x20; 53x10, av. 1.37x.36 mm.

Augite 35x18; 38x18, av. 1.01x.54 mm.

214-222; (Ss. 15408-10). AMYGDALOID; epidote needles, etc., in the half-filled amygdules. (8) (226)

Sp. 15408. Hole 9 at 214 feet from surface. Porphyritic, microlitic, same kind of feldspar as in flows above; 10° - 6° ; 17° - 11° ; 0° - 4° . Fine grained belts at 214 ft. and 215 ft.,—successive gushes?

Grain

Olivine 12x10; 25x21; 20x18, av. .57x.49

Iron oxide 2; 1; 3

Feldspar 25x11; 30x12; 26x18, av. .81x.41.

Sp. 15409. Hole 9 at 215 feet from surface. Shows flow texture; a much decomposed and altered top of flow?; amygdaloid with green epidote needles.

Grain

Olivine 10x8?; 7x6, av. .28x.23 mm.

Iron oxide 2x0.1; 2x1; 2x1, av. .06x.02 mm.

Feldspar 8x2; 6x1; 17x3, av. .31x.06 mm.

Sp. 15410. Hole 9 at 222 feet from surface. Amygdaloidal fine grained microlitic round amygdules; very much decomposed. Margin here at 222.

Grain

Olivine 10x7; 7x7; 6x5, av. .23x.19 mm.

Iron oxide 3x2; 4x3; 5x4, av. .12x.09 mm.

Feldspar phenocrysts 27x6; 20x7; microlites 10x1, av. .57x.14 mm.

Sp. 15411. Hole 9 at 228 feet from surface. Microlitic porphyritic, amygdaloidal; low angled feldspar; iron oxide pseudomorph, after olivine?

Grain

Olivine 32x20; 5; 27x20

Iron oxide 8x6; 11x7; 7x6, av. .26x.19

Feldspar phenocrysts 32x10; 60x35; 30x11, av. 1.22x.56.

222-235; (Ss. 15411-2) AMYGDALOID. Seam or separation line of fine grained SEDIMENT. at base (13) (239)

Compare the covered belt above belt 58 on Eagle River and also the sandstone seam, belt 63.

Sp. 15412. Hole 9 at 235 feet from surface. Fine grained sediment. Compare Eagle River No. 63 and T. 5 b 20.

235-279; (Ss. 15413-6). MELAPHYRE; more or less amygdaloidal, with laumontite and datolite. (44) (283)

Compare T. 5 flow No. 7 and Eagle River 60-62 (Fig. 37).

Sp. 15413. Hole 9 at 246 feet from surface. Much altered olivine; poikilitic augite scarce; feldspar ex. 7° - 2° w 4° ; 4° - 2° .

Grain

Olivine 36x22; 30x26; 20x17, av. .86x.65 mm.

Iron oxide 34x3; 9x5; 8x2, av. .51x.10 mm.

Feldspar 32x8; 25x8; 51x5, av. 1.08x.21 mm.

Augite 75x45; 55x50; 84x40; 70x70, av. 2.37x1.70 mm.

Sp. 15414. Hole 9 at 259 feet from surface. Much decomposed, with seam that appears to contain sediment.

Grain

Olivine 30x20; 17x15; 20x20, av. .67x.55 mm.

Iron oxide 8x6; 21x2, av. .28x.13 mm.

Feldspar 45x10; 10x4.

Sp. 15415. Hole 9 at 275 feet from surface. Poikilitic augite; much decomposed olivine; high angled feldspar ex. 10° - 23° w 32° - 41° ; 32° - 23° ; 11° - 20° w 34° ; 16° - 24° w- 34° .

Grain

Olivine 45x25; 15x10; 43x23, av. 1.03x.58 mm.

Iron oxide 8x5; 25x5; 14x2, av. .47x.12 mm.

Feldspar 17x5; 28x9; 25x15, av. .70x.29 mm.

Augite 35x30; 40x33; 53x40, av. 1.28x1.03 mm.

Sp. 15416. Hole 9 at 279 feet from surface. Decomposed olivine; no augite visible; low angled feldspar ex 7° ; 0° ; 0° ; 0° ; -0° ; 7° - 4° ; 5° - 1° .

Grain

Olivine 15x14; 9x8; 24x12, av. .48x.34 mm.

Iron oxide 3; 5x4; 15x2, av. .13 mm.

Feldspar 20x6; 32x14; 53x6, av. 1.05x.26 mm.

Sp. 15429. Hole 9 at 309 feet from surface. Feldspar extinctions 0° ; 14° ; 0° - 10° ; 8° ; 0° ; 0° ; 0° . Distance from margin 4 ft.

Grain

Olivine 2; 2; 5x3, av. .08 mm.

Feldspar 8x0.2; 7x0.5; 8x1, av. .23x.01 mm.

Augite 8x7; 5x4; 9x4; 13x7, av. .29x.19 mm.

270-231; (Ss. 15417-24). Ash bed and scoriaceous CONGLOMERATE. (12) (285)
The top of this bed is a very fine grained genuine ash, under which for a foot or more it is like a dark red sandstone. Lower we encounter a lot of laumontitic amygdaloid, and some samples which show more clearly its characters as a volcanic breccia, with intermingled sediment and scoria. It is much decomposed. Marvine's bed No. 63? Dips on drill cores 25°, 23°, with signs of cross-bedding.

Sp. 15417. Hole 9 at 279 feet from surface. Contact of microlitic porphyrite with ashbed; 10°-6°; 0°; 0°; 0°; 0°; microlites are 5x0.1 etc. Distance from margin 0.

Grain

Olivine 8x5; 4x4; 6x5, av. .18x.14 mm.

Iron oxide dust

Feldspar 13x12; 12x8; 17x7, av. .42x.27 mm.

Figure 1 of Plate VI of the Isle Royale report is a photograph of part of this bed. It is of interest as showing unquestioned ash, in view of the fact that Irving had doubted the existence of genuine ash. At the very top of the photograph the contact with the overlying trap is shown. A little below the center is a rather large grain which is very vesicular.

Sp. 15418. Hole 9 at 279 feet from surface. Ashbed.

Sp. 15419. Hole 9 at 280 feet from surface. Ashbed.

Sp. 15420. Hole 9 at 281 feet from surface. Fine grained microlitic amygdaloid; feldspar extinctions 2°; 0°; 8°; 3°; 0°; 0°; 0°-11°; 11°-7°; 6°; 2°; 0°.

Grain

Feldspar 6x1; 8x1; 7x0.5, av. 0.21x0.02.

Sp. 15422. Hole 9 at 285 feet from surface. Very fine grained amygdaloid; sediment in one corner.

Sp. 15423. Hole 9 at 287 feet from surface. Fine grained amygdaloid; one large brotocrystal, i. e., corroded; extinction angles 7°-18°; 6°; 0°; 7°-12°; 0°.

Grain

Feldspar phenocrysts 32x17; 6x12, av. .63x.48.

Sp. 15424. Hole 9 at 290 feet from surface. Coarser grained phenocrysts; much of the older and larger feldspar is andesite; 5; 15°-11°w6°-2°; 6°-3°; 3°-11°; 7°-0°. Margin is at 291 feet.

291-313; (Ss. 15425-9). AMYGDALOID. Some of the specimens (21)

look like ophites. They are all much decomposed, and it is (316)
barely possible that they may all be part of the bed of scoriaceous conglomerate which occurs above and below.

Sp. 15425. Hole 9 at 291 feet from surface. Fine grained microlitic porphyrite and sediment; no phenocrysts; feldspar ex. 25°; 33°-26°; 30°-26°; 21°; 36°; 28°-31°. Distance from margin 0. Augite granular? very fine.

Sp. 15426. Hole 9 at 291 feet from surface. Fine grained microlitic; granules of augite or olivine; feldspar ex. 15°; 26°; 15°-26°; 0°.

Grain

Olivine 2; 2; 3x2; 4x4, av. .08 mm.

Feldspar 3x.2; 4x0.2, av. .11x.006 mm.

Augite granular?

Sp. 15427. Hole 9 at 294 feet from surface. Very fine grained, small microlites; altered olivine; feldspar extinctions 0°; 0°; 28°-26°; 19°-18°.

Grain

Olivine 2x1; 2x2; 2x2, av. .06x.05 mm.

Feldspar 4x0.3; 3x0.2; 8x1.0, av. .15x.005 mm.

Sp. 15428. Hole 9 at 296 feet from surface. The augite is *extra coarse* along one amygdaloidal vein; decomposed.

Grain

Olivine 3x3; 3x2; 5x5; 10x3, av. .17x.10 mm.

Feldspar 12x1; 15x3 extra; 15x2, av. .42x.06 mm.

Augite 84x40; 80x38; 30x30, av. 1.94x1.08 mm.

9.313-328; (Ss. 15430-6). CONGLOMERATE, scoriaceous. This (15) (331)

contains green decomposed ash, and a calcareous cement. The three beds just described bear a striking analogy, in lithological character and stratigraphic position to Marvine's beds No. 63 to No. 65, the "Ashbed" *par excellence*.

One of the conglomerates would be No. 17 of Marvine's plate, i. e., the Hancock West conglomerate. There is, however, a fault in the Eagle River series at this point, and I think that No. 64 and No 65 are really the same bed. Marvine applies one and the same number to cover both the Ashbed and the underlying melaphyre. The relative position to the beds already correlated is as it should be. The only question is as to the relation of this and the beds just above. This horizon may be recognized in the Arcadian section (Fig. 41) and the Winona (Fig. 50) as well as near Portage Lake as described by Marvine.

Sp. 15430. Hole 9 at 313 feet from surface. Very amygdaloidal; mass of fragments charged with calcite and characteristically filled with a large number of very small amygdules; 13°-1°; 0°; 0°; 0°; 0°; 9°-16°; 0°; 0°; 14° feldspar ex.

Grain

Feldspar 2x1; 8x2; 2x5, av. .12x.08.

Sp. 15431. Hole 9 at 315 feet from surface. Very calcareous; fragments of similar microlitic porphyrite; feldspar extinction angles 0°; 0°; 13°-2°.

Grain

Feldspar 3x.1; 3x.2, av. .10x.005 mm.

Sp. 15431 a. In this section comes a glomeroporphyrite. The fragments in the bed above are *not* glomeroporphyritic; sediment with microlitic fragments.

Sp. 15432. Hole 9 at 316 feet from surface. Ash bed of microlitic porphyry; feldspar extinctions 10°; 0°; 13°-0°; 0°; 11°-7°; very fine grained.

Grain

Olivine 15x13;

Feldspar 2.5x0.2.

Sp. 15433. Hole 9 at 317 feet from surface. Glassy porphyritic amygdaloid; feldspar extinction angles 17°-15°w6°-6°; 7°-7°; 18°-12°; 0°. The driller reported rock like No. 15430 to continue down to 329 feet where we have rock like 15428.

Grain

Olivine 17x17; 12x8; 10x8, av. .39x.33 mm.

Feldspar phenocryst 37x6; microlite 6x3; 12x3, av. .55x.12 mm.

Sp. 15434. Hole 9 at 319 feet from surface. Amygdaloid mixed with sediment; decomposed porphyritic with prehnite; very fine grained.

Sp. 15435. Hole 9 at 321 feet from surface. Secondary poikilitic epidotic amygdaloid; microlitic. The epidote is in very pretty sharp crystals.

Sp. 15436. Hole 9 at 323 feet from surface. Fragments of microlitic amygdaloid; irregular with fragmental cement; may be replacement. Margin at 328.

Grain

Iron oxide granules, very abundant

Feldspar 26x10; 40x25; 15x1; 10x1, av. .75x.30 mm.

(331)

FIRST BED OF MARVINE'S SERIES A.

328-385; (Ss. 15437-41). MELAPHYRE, porphyrite (THE ASHBED); like the (56) porphyrite above 485 feet in No. X, already described, I think it is the same (56) bed as the one at the top of No. VIII down to 47 feet. We pass then at this point from the record of No. IX to that of No. VIII. But there is a peculiarity about the rest of the record of No. IX that deserves mention. After some feet of amygdaloids and clayey seams with some *copper* at 413 feet, No. IX finishes below 427 feet in a large bed of ophite, the like to which we do not find in No. VIII until we get down to 196 feet. Either, therefore, one of these two correlations (that of 385 feet in No. IX to 47 feet in No. VIII or that of 427 feet in No. IX to 196 feet in No. VIII) must be given up, or we must suppose a remarkable wedging out of intermediate beds, or lastly we must suppose that a fault has cut out part of the record of No. IX. But the correlations are—microscopic evidence and all else considered—very good. Moreover, in the interval, drill hole No. IX showed marked signs of disturbance, especially between No. IX, 385 feet, and No. IX, 427 feet. At 408 feet there is some kind of a break with much decomposed and prehnitic rock; at 413 feet there is a seam with *copper*; at 420 feet a datolite vein; at 430 feet a brecciated amygdaloid. Therefore the last supposition seems most probable—that there is a fault. The character of a fault like the one here supposed depends upon whether the upper or the lower correlation gives the normal dip. If we assume as undisturbed the correlation 385 feet in No. IX, with 47 feet in No. VIII, and add to the difference (338 feet) the excess of elevation of No. VIII over No. IX (376.3-202.5 the altitude of the rock at No. IX; the surface of the ground is 30 feet higher) 174 feet, and divide by the distance between the holes along the section (2,218 feet) we shall have 0.231, i. e., $\tan 13^\circ$, about half a degree steeper than the dips we have computed thus far in our section south of this point, but the same as dips computed at points further north. On the other hand the deeper of the two correlations, 427 feet in No. IX with 196 feet in No. VIII, would give us $0.183 = \tan 10^\circ 20'$. This is much flatter than anything we have reason to expect, and the inference is that the fault affects this correlation rather than the other. Thus we are led to the conclusion that if there is a fault it cuts No. IX, raising the lower part of it but not the upper. Hence it is a normal fault with northerly or westerly hade. Fig. 8 of the Isle Royale Report may represent it.

According to our correlation, the distance from the bottom of the bed corresponding to Marvine's No. 43, to the bottom of this bed corresponding to his No. 65, is (1202-806) (or $331 + 56 + 11$) 396 feet, while the corresponding distance in the Eagle River section is 573 feet—thicker in about the usual ratio, i. e., about 3:2. The running distances above are from the base of (44). This is the melaphyre part of Marvine's bed 65 of the Eagle River section of which an analysis has recently been made, Table XII, No. 1.

Prof. A. N. Winchell permitted me to examine a section of the specimen analyzed. My notes follow:

Coll. 607. Section 4607 U. of Wis. See Journal of Geol., 1908, p. 772 analysis. Is too thick. Augite color up to .000948 \div .029 = .033 mm. +. Ashbed diabase. Bed 65 Eagle River section, sample No. 7 of Rohms collection.

Augite is in granules generally, here and there in patches beginning to be "poikilophtic." The granules are .10 to .05 mm. in size and smaller. A few large pieces apparently left from an early coarser crystallization run up to .2-3 mm.

Feldspar is quite varied in size, glomeroporphyritic, largest aggregate is 3.5 mm. x 2; composed of laths each about 1.2×0.3 , $4-7.3 = 2$ (5.6) $E = 338$ and 64.18. Albite twin parallel M (010) ex. $25.5^\circ - 21.5^\circ$ and Karlsbad twin ex. $14.2^\circ - 16.5^\circ$. Bire-

fringence highest for Karlsbad 16.5° , others slightly lower. The largest grain is $Ab_{7.5} An_{25}$. The small feldspar laths probably nearly at r. a. to P. and to M are ab. $.15 \times .03$ mm. Ex. 4° , $3^\circ - 6^\circ$, $4^\circ - 5^\circ$, 0, 1, 3. ave. 3° which, supposing them perpendicular to P and M, indicate $Ab_3 An_1$, between that and $Ab_3 An_3$. Olivine pseudomorphs into green serpentine and red iron oxides are generally irregular and not very common. 0.5 mm. is the largest. They are probably corroded remnants.

Iron oxides magnetite are in triangular octahedral sections up to about .35 mm. It is quite abundant original. There is some secondary.

Green substances replace olivine and feldspar phenocrysts and possibly fill microlitic interstices.

This is an (oligoclase) melaphyre porphyrite of the ashbed type. As A. N. W. says it is related to Irving's bed 87. Compare 15515 (a) of Volume VI, Pl. V. Sp. 15438 is figured in Pl. VI, Fig. 4, p. 67, which is as I made it, the equivalent flow on Isle Royale. It is a lucky coincidence that I figured just this flow. See also pp. 159, 167, 170. This is probably near the center of the flow, at any rate quite augitic and not near the top.

Sp. 15437. Hole 9 at 329 feet from surface. Porphyritic microlitic amygdaloid; sharp difference between porphyritic and ground feldspars; low angled feldspars; extinction angles $20^\circ - 10^\circ$ phenocrysts $26^\circ - 10^\circ$ $w10^\circ - 1^\circ$; 23° ; $9^\circ - 0^\circ$; $10^\circ - 0^\circ$; $13^\circ - 6^\circ$; microlites 0° ; 0° ; $0^\circ - 15^\circ$; $0^\circ - 20^\circ$; 0° ; $10^\circ - 4^\circ$.

Grain

Feldspar phenocrysts 33×30 ; 33×23 ; 55×7 , av. $1.21 \times .60$; microlites 5×1 ; 5×0.2 ; 8×1 , av. $.18 \times .02$.

Sp. 15438. Hole 9 at 348 feet from surface. Glomeroporphyritic low angled feldspar; 0° ; 0° ; 0° ; porphyritic feldspar $7^\circ - 6^\circ$.

Grain

Olivine 5×4

Feldspar ground mass 7×2 ; 12×2 ; 17×2 , av. $.36 \times .06$ mm.

Augite 3×1.5 ; 5×4 ; 4×4 ; 4×3 , av. $.12 \times .10$ mm.

The structure is illustrated by Fig. 4 of Plate VI, the variation in grain by the points marked (a) in Fig. 19 of the Isle Royale report. The specimen from Bed 65 of the Eagle River section 4607 University of Wisconsin is similar to this section.

Sp. 15439. Hole 9 at 360 feet from surface. Phenocryst extinction angles $33^\circ - 24^\circ$; microlites 0° $w13^\circ - 23^\circ$; $25^\circ - 20^\circ$; $17^\circ - 21^\circ$.

Grain

Feldspar ground mass 8×1 ; 8×2 ; 8×1 , av. $.24 \times .04$ mm.

Augite 2×1 ; 2×1 ; 3×2 , av. $.07 \times .04$ mm.

Sp. 15440. Hole 9 at 383 feet from surface. Extinctions near 0° .

Grain

Olivine 20×20 ; 24×19 ; 19×18 , av. $.63 \times .57$ mm; younger olivine 2; 2; 5?

Feldspar phenocrysts 24×8 ; microlites 4×1 ; 3; 4×1

Augite 0.5×0.5 ; 1×1 ; 1.5×1.5 , av. $.02 \times .03$ mm.

Sp. 15441. Hole 9 at 385 feet from surface. Similar low angled feldspar in three generations or sizes; extinction angles 11° $x9^\circ$; 0° ; 0° ; phenocrysts 12° $w5^\circ - 4^\circ$.

Grain

Olivine 25×14 ; 5

Iron oxide 17×10 ; 8×6 , av. $.41 \times .26$ mm.

Feldspar phenocrysts 30×4 ; 43×11 ; 25×24 ; 58×14 , av. $1.30 \times .44$ mm.

Augite 1; 1.5; 3×1 ?

Sp. 15442. Hole 9 at 385 and 386 feet from surface. Microlitic porphyritic amygdaloid; occasional large olivine; phenocrysts 7-5; 18-16; 15-5; 6; 12-0.

Grain

Olivine 18x10; 18x14; 24x30, av. .60x.54 mm.

Feldspar phenocrysts as before; ground mass 7x1; 12x1; 11x1, av. .30x.03 mm.

Sp. 15443. Hole 9 at 388 feet from surface. Coarser.

Grain

Iron oxide 3x5; 4x2; 5x2, av. .12x.07 mm.

Feldspar phenocrysts 32x17; 34x8, av. 1.11x.41 mm.

Augite 10x5; 7x5; 13x10; 14x11; 8x6, av. .34x.35 mm.

Sp. 15444. Hole 9 at 400 feet from surface. Coarser yet low angled feldspar, the larger ones becoming prevalent; very big.

Grain

Augite 15x13; 23x25; 23x19, av. .61x.57 mm.

Sp. 15445. Hole 9 at 408 feet from surface. Poikilitic augite; much low angled feldspar; part microlitic feldspar; extinction angles 0; 0; 0; 7°; 10°; 0; 5°.

Grain

Olivine 2; 4x2; 3; 44x36

Iron oxide 7x.7; 4; 2

Feldspar 10x2; 8x2; 13x5, av. .31x.09 mm.

Augite 16x12; 30x22; 18x11, av. .64x.45 mm.

Sp. 15446. Hole 9 at 408 feet from surface. Fine grained microlitic contact with sediment and ash fragments; prehnitic.

Grain

Feldspar microlites 5x.2; 5x.1; 10x2?, av. .20x.02 mm.

Sp. 15447. Hole 9 at 411 feet from surface. Abundant glomeroporphyritic low angled feldspar; altered olivine; small augite?

Grain

Olivine 4x4; 6x5; 15x9, av. .25x.18 mm.

Feldspar 8x1; 5x1; 11x1, av. .24x.03 mm.

Augite 7x1; 8x5; 12x10, av. .27x.16 mm.

Sp. 15448. Hole 9 at 413 feet from surface. Amygdaloid of some zeolite (+2V small R > V, good cleavage, moderate refringence, ex. generally—especially for the sections with stronger birefringence. Cf. pectolite) glassy contact with sediment.

Grain

Olivine 6x6; 7x7; 5x5, av. .18x.18

Feldspar 16x5; 16x4; 12x4, av. .44x.13

Augite dust.

Sp. 15449. Hole 9 at 418 feet from surface. Porphyritic, microlitic amygdaloid with chloritic amygdaloid and altered olivine; small amygdules.

Grain

Olivine 15x13; 20x12; 19x13, av. .54x.38 mm.

Feldspar phenocrysts 30x9; 39x37, av. 1.15x.76 mm.; microlites 6x.1; 3x.1; 5x.1, av. .14x.003.

Sp. 15450. Hole 9 at 420 feet from surface. Glomeroporphyritic; coarser long laths in ground; olivine altered to micaceous bowlingite? extinction angles 5-7; 18-8-1w5-26.

Grain

Olivine 4; 7x6; 9x7

Feldspar phenocrysts 30x25; 20x7; 34x10; 38x32, av. 1.16x.61 mm.

Augite dust up to 1?

Sp. 15451. Hole 9 at 421 feet from surface. Sediment mainly; rarely prehnitic granules; 2x3; 4x3; 15x15, av. .21x.21 mm.

Sp. 15452. Hole 9 at 423 feet from surface. Olivine very sharp; much porphyritic, microlitic; much altered olivine; feldspar extinction angles 6°-4°; 0; 0; 0.

Grain

Olivine 12x5; 10x3; 22x13, av. .44x.21 mm.

Feldspar 25x15; 43x15, av. 1.10x.50 mm.

Sp. 15453. Hole 9 at 427 feet from surface. Very complex interlocking combination of sediment and marginal microlitic porphyrite.

Grain

Feldspar phenocrysts 25x10; 13x1; 12x1; 9x1; 8x.1; 24x2, av. .50x.02

Augite none.

Sp. 15454. Hole 9 at 430 feet from surface. Slightly coarser amygdaloids with sediment in some amygdules; very prehnitic; feldspar decomposed.

Grain

Olivine 6; 20x5; 7x5

Feldspar 18x4; 22x3, av. .66x.11

Augite 15x11; 20x10, av. .58x.35.

Sp. 15455. Hole 9 at 433 feet from surface. Little poikilitic augite; low angled feldspar; altered olivine; ilmenite?

Grain

Olivine 35x17; 9x9; 27x25, av. .71x.51 mm.

Iron oxide thin laths

Feldspar 50x6; 45x15; 43x10, av. 1.38x.31mm.

Augite 50x35; 70x45; 46x18, av. 1.66x.98 mm.

Sp. 15456. Hole 9 at 446 feet from surface. Similar to 15457.

Grain

Olivine 30x14; 23x22; 33x25, av. .86x.61 mm.

Feldspar 30x5; 33x9; 48x15, av. 1.11x.29 mm.

Augite 35x35; 78x45; 52x40, av. 1.65x1.20 mm.

Sp. 15457. Hole 9 at 452 feet from surface. Similar to 15455 but distinctly coarser; large altered olivine; feldspar extinction angles 6-8°; 12°-11°w18°-2°; 6°-4°w14°-8°; 16-6°.

Grain

Olivine 30x25; 25x20; 48x23, av. 1.03x.68 mm.

Feldspar 42x17; 40x9; 55x18, av. 1.37x.44 mm.

Augite 130x55; 80x80; 80x66, av. 2.90x2.01 mm.

Sp. 15458. Hole 9 at 456 feet from surface. Much decomposed large poikilitic patches of augite, feldspar all corroded.

Grain

Olivine 28x20

Iron oxide 12x1; 9x1, av. .25x.03 mm.

Augite 100x70; 120x70; 90x65, av. 3.10x2.05 mm.

Sp. 15459. Hole 9 at 462 feet from surface. Poikilitic and a trace of more idiomorphic augite and more basic feldspar than above; extinction angles 35°-27°-w19°-14°; 11°-11°w41°; 12°-15°; 10°-20°.

Grain

Olivine 30x15; 45x30; 35x18, av. 1.10x.63 mm.

Feldspar 53x11; 30x7; 42x12; 25x4, av. 1.25x.28 mm.

Augite 190x80; 115x95; 125x120, av. 4.30x2.95 mm.

Sp. 15460. Hole 9 at 467 feet from surface. Much decomposed; augite all gone; low angled feldspar extinction angles 9°-14°-26°; 8°; 0; 14°.

Grain

Olivine 18x13

Iron oxide 22x1; 7x6; 15x15, av. .44x.22 mm.

Feldspar 40x9; 44x7; 53x12, av. 1.37x.28 mm.

Sp. 15461. Hole 9 at 468 feet from surface. Very coarse poikilitic augite; large decomposed olivine grains; extinction angles 19° - 19° ; 29° - 35° w 14° - 11° ; this is probably halfway down in the flow as it is getting basic but as it is very coarse, there must be at least 30 feet more.

Grain

Olivine 17x15; 20x20; 22x10, av. .59x.45 mm.

Feldspar 30x10; 43x17; 34x8, av. 1.07x.35 mm.

Augite 250x160; 80x80?; 80x80?, av. 4.10x3.20 mm.

Sp. 15328. Hole 8 at 2 feet from surface. Porphyritic; decomposed olivine; idiomorphic augite granules; mainly low angled feldspar like 15439 (ex. 31° - 14° ; 0° ; 0° - 22° ; 20° - 9°), but in one place a basic addition (46° - 31°).

Grain

Olivine 15x12; 20x10

Feldspar microlites 7x1; 10x2; 8x6, av. .25x.09 mm.

Augite 4x2; 3x1; 2x1, av. .09x.04 mm.

Sp. 15329. Hole 8 at 27 feet from surface. Feldspar ex. angles 31° - 14° ; 0° ; 0° - 20° ; 10° - 2° ; 0° ; 46° - 31° ; basic addition; similar to 15328.

Grain

Olivine 10x7; 9x7, av. .31x.23 mm.

Iron oxide 12x11; 14x10; 8x6, av. .34x.27 mm.

Feldspar, phenocrysts 3x10; a glomeroporphyritic group 80x75; microlites 5x1; 12x2; 10x2, av. .27x.05 mm.

Augite 2x1; 3x1; 3x2, av. .08x.04.

Sp. 15330. Hole 8 at 29 feet from surface. Similar to 15329; feldspar ex. angles 0° - 16° ; 3° w 27° - 22° ; 25° ; 10° w 31° - 27° ; 33° - 33° nearly; 18° - 18° w 18° - 18° ; changing into a more basic feldspar? with ex. 17° - 17° and 40° - 25° .

Grain

Olivine 5x4; 4x3; 1x17, av. .28x.24 mm.

Iron oxide 4x2; 7x5; 8x4, av. .19x.11 mm.

Feldspar phenocrysts 43x19; 35x8; 47x12, av. 1.25x.39 mm.

Augite 4x2; 2x2; 4x1, av. .10x.05 mm.

Sp. 15331. Hole 8 at $37\frac{1}{2}$ feet from surface. Similar to 15329; feldspar extinction angles 8° - 15° ; 20° - 8° ; 7° - 6° ; 10° - 1° .

Grain

Olivine 10x8; 16x13; 10x9, av. .36x.30 mm.

Iron oxide 9x1; 6x1; 7x5; 8x7, av. .25x.11 mm.

Feldspar phenocryst 30x10; microlites 6x1; 5; 9x0.5

Augite 3x2; 5x3; 2x2, av. .10x.07 mm.

Sp. 15332. Hole 8 at 38 feet from surface. Similar to 15329; the two kinds of chlorite.

Grain

Olivine 30x23; 22x15; 10x7, av. .62x.45 mm.

Iron oxide 10x6

Feldspar phenocrysts 30x9; 46x10; 42x17, av. 1.18x.36 mm.; microlites 5x1, 6x1, av. .18x.03 mm.

Augite 2x1; 2x1; 2x2, av. .06x.04 mm.

Sp. 15333. Hole 8 at 45 feet from surface. Feldspar ex. angles 0° ; 0° ; 0° ; 10° - 5° .

Grain

Olivine none?

Iron oxide 5x5; 21x10; 10x8, av. .36x.23 mm.

Feldspar phenocryst 36x15; microlites 8x1; 7x1; 4x1, av. .19x.03 mm.

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

Sp. 15334. Hole 8 at 47 feet from surface. Abundant porphyritic microlitic; low angled feldspar in skeleton forms with breadth only a fraction of a thirtieth of a mm. These skeleton forms are those mentioned by Tammann in case of considerable undercooling D below that of maximum velocity of crystallization. Feldspar ex. angles 5° - 0° ; 14° - 10° ; 27° - 6° ; 0° ; 0° .

Grain

Olivine 7x5; 8x5; 17x12, av. .32x.22

Iron oxide dust

Feldspar phenocrysts 15x5; 20x11; microlites 3x0.1, av. .58x.26

Augite dust.

The grain of the above sections is plotted in the points marked b of Fig. 19 of the Isle Royale Report.

(56)

8.47-71; (Ss. 15335-7). Feldspathic MELAPHYRE; the top 13 feet (22) (78) amygdaloidal; intermediate type between ophite and porphyrite, not markedly belonging to any subdivision of the melaphyre; like the flows just below. It is correlated with and just about the size of No. IX, 385-418. (Ss. 15442-15448).

Sp. 15335. Hole 8 at 51 feet from surface. Poikilitic augite, patchy; feldspars (seriate) run gradually down and it looks as though the magma came to rest only toward the end of feldspar formation; ex. 7° - 14° - 4° ; 10° - 6° w 20° ; 21° - 18° .

Grain

Olivine 8x6; 15x7; 20x19, av. .43x.32 mm.

Iron oxide with olivine

Feldspar (larger) 45x17; 30x10; 23x10, av. .98x.37 mm.

Augite 17x15; 12x12; 16x14, av. .45x.41 mm.

Sp. 15336. Hole 8 at 63 feet from surface. Feldspar much decomposed; remnants do not appear high angled.

Grain

Olivine 3x3; 5x4; 7x5, av. .15x.12 mm.

Iron oxide 21x12; 5x5; 5x5, av. .31x.32 mm.

Feldspar 30x13; 18x8; 31x8, av. .79x.29 mm.

Augite 25x20; 35x25; 23x15, av. .83x.60 mm.

Sp. 15337. Hole 8 at 71 feet from surface. Microlitic porphyritic; hardly any augite is visible; extinction of phenocrysts 13° - 12° w 4° - 5° .

Grain

Olivine 14x9; 10x8; 14x12, av. .38x.29

Iron oxide dust

Feldspar 44x27; to 10x1 in a pretty continuous series from phenocryst to microlite.

These sections do not match very well those of Hole 9 at 385-408, for though the feldspar and the thickness is similar, that has much more augite. The fault mentioned in No. 9 may account for it.

71-89; (Ss. 15338-9). MELAPHYRE, fine grained and amygdaloidal. (18) (96)

In No. IX the records are much mixed along here. There are slide or flow contacts at 408 feet, 413 feet, 421 feet, with fine grained, red, chloritic, datolitic and prehnitic amygdaloids. Here is where I have supposed that a fault goes through No. IX.

Sp. 15338. Hole 8 at 75 feet from surface. Plagioclase ex. 6° - 4° ; 6° - 5° and similar in other half of a Karlsbad twin.

Grain

Iron oxide 8x0.6; 8x0.4; 8x2. av. .24x.12 mm.

Feldspar 18x7; 20x19; 46x17. av. .84x.43 mm.

Augite 22x13; 23x17; 20x10. av. .65x.40 mm.

Sp. 15339. Hole 8 at 89 feet from surface. Much microlitic decomposed amygdaloid mixed with sediments. Close to margin.

Grain

Olivine 10x6

Iron oxide secondary dust

Feldspar microlites 16x2; 11x2; 11x1.5. av. .38x.05 mm.

89-103; (Ss. 15340-1). MELAPHYRE, amygdaloidal. (14) (110)

Sp. 15340. Hole 8 at 96 feet from surface.

Grain

Olivine 46x40; 40x20; 32x20, av. 1.18x.80 mm.

Iron oxide 8x8; 7x6; 20x3, av. .35x.17 mm.

Feldspar 23x7; 41x15; 31x9, av. .95x.31 mm.

Augite 30x20; 30x28; 34x29, av. .94x.77 mm.

Sp. 15341. Hole 8 at 103 feet from surface. Phenocrysts very numerous; seriate, i. e., no sharp line in size; ex. 3° - 11° w 15° - 18° ; 20° - 18° w 4° - 4° .

Grain

Olivine 5x4; 4; 3; 11x5

Iron oxide 15x1; 5x2, av. .33x.05 mm.

Feldspar phenocrysts 22x13; 33x18; 25x10; 43x25, av. 1.02x.55 mm.

Augite 5x5; 4x3; 15x12, av. .24x.20 mm.

103-135; (Ss. 15342-4). MELAPHYRE, amygdaloidal (31) (141)

Sp. 15342. Hole 8 at 111 feet from surface. Much decomposed.

Grain

Olivine 20x12; 22x17, av. .70x.48 mm.

Iron oxide associated with olivine

Feldspar 27x5; 24x5, av. .85x.41 mm.

Augite 45x15; 30x30; 215x60, av. 2.90x1.05 mm.

Sp. 15344. Hole 8 at 135 feet from surface. Feldspar extinctions 8° - 4° w 8° ; 17° - 10° ; 12° w 5° - 5° .

Grain

Olivine 20x11; 10x9; 8x6; 10x9, av. .40x.27 mm.

Iron oxide 4x4; 7x7; 6x5, av. .17x.16 mm.

Feldspar 20x7; 14x5; 36x5, av. .70x.17 mm.

Augite 10x9; 15x6; 17x15, av. .42x.30 mm.

135-146; (Ss. 15345-7). MELAPHYRE, amygdaloidal 11 (152)

Sp. 15345. Hole 8 at 135 feet from surface. Porphyritic feldspar has low angles; microlites of ground mass also; there are chlorite and prehnite amygdules.

Grain

Olivine 20x15; 11x6; 13x11, av. .44x.32 mm.

Iron oxide 4x0.6 in secondary dust

Feldspar phenocrysts 24x20; 24x8; 26x9, av. .74x.37 mm.; microlites 10x2; 9x0.6; 10x1, av. .29x.03 mm.

Augite 8x8; 3x3; 10x10.

Sp. 15346. Hole 8 at 140 feet from surface. Big altered olivine; large low angled feldspar; a little fibrous augite.

Grain

Olivine 20x13; 28x18; 26x22, av. .74x.53 mm.

Iron oxide in dust and with olivine pseudomorphs.

Feldspar 30x17; 26x1.5; 35x8, av. .91x.26 mm.

Augite 10x4; 10x2; 8x1, av. .28x.07 mm.

Sp. 15347. Hole 8 at 146 feet from surface. Very little augite; low angled seriate feldspar ex. 0; 0; 0; 8° - 11° ; amygdaloid. At margin.

Grain

Olivine 7x7; 12x10; 9x7, av. .28x.24 mm.

Feldspar 15x2; 12x7; 13x8, av. .40x.17 mm.

Augite 2x1; 1x1; 1.5x1.5, av. .04x.03 mm.

146-164; (Ss. 15348-9). MELAPHYRE, amygdaloidal. (18) (170)

Sp. 15348. Hole 8 at 146 feet from surface. Very fine grained microlitic amygdaloid; ex. 0° ; 14° ; 4° ; 8° ; 6° - 8° ; 8° - 11° ; 8° - 7° .

Grain

Olivine 20x5; 12x5; 15x12, av. .47x.22

Feldspar phenocrysts 10x3 to 2x0.1; 3; 4

Augite none.

Sp. 15349. Hole 8 at 151 feet from surface. Long, patchy half idiomorphic augite; low angled feldspar; ex. 4° - 2° - 15° ; 0° ; 15° - 10° ; 7° - 9° ; 0° ; 8° ; 10° ; small altered olivines as usual. Margin at 164.

Grain

Olivine 18x13; 24x19; 10x8, av. .52x.40 mm.

Iron oxide around the altered olivine

Feldspar 21x9; 34x14; 32x7, av. .87x.30 mm.

Augite 7x7; 31x13; 40x10, av. .78x.30 mm.

164-196. Ss. 15350-3. MELAPHYRE, amygdaloidal, perhaps (31) (201)

largely pseudamygdules, of laumontite, chlorite and prehnite.

The flows above are all of moderate size and, though varying somewhat, have the general habit of the less augitic melaphyres, i. e., the melaphyre porphyrites. The microscope shows that they carry oligoclase feldspar. Compare T. 5 b 18-20.

Sp. 15350. Hole 8 at 164 feet from surface. Altered glass very scoriaceous; microlitic; the phenocrysts run out into fibres; 0° - 0° - 8° ; 0° - 7° - 12° .

Grain

Olivine 13x12

Feldspar 22x12 down to tufted microlites.

Sp. 15351. Hole 8 at 167 feet from surface. Large altered olivine is much corroded; a microlitic amygdaloid very fine grained around amygdules; feldspar extinction 7° - 8° w 4° .

Grain

Olivine 2; 7x5; 16x14

Feldspar 14x8; 20x12; 20x2, av. .54x.22.

Sp. 15352. Hole 8 at 180 feet from surface. Decomposed coarser but little augite left, laumontite!

Grain

Olivine 17x14; 13x13; 34x32, av. .74x.59 mm.

Iron oxide with olivine

Feldspar replaced by laumontite

Augite 32x20; 25x20, av. .95x.66 mm.

Sp. 15353. Hole 8 at 196 feet from surface. Very fine grained; microlitic amygdaloid; laumontite and chlorite in amygdules and prehnite. Margin.

Grain

Olivine 5x2; 7x7; 4x3, av. .16x.12 mm.
Iron oxide 10x1; 9x1; dust
Feldspar 12x2; 13x3, av. .41x.08 mm.

(201)

S.195-273; (Ss. 15354-8). MELAPHYRE, ophite. This bed (75) (276)

for 3 feet is very amygdaloidal, then coarser, with occasional chloritic amygdules, and becoming still coarser it shows the rusty specks of micaceous altered olivine; toward the base it is fine grained with datolite veins. This matches very closely No. IX, 427-468+, which is so coarse when the hole ends that the latter evidently stops in the middle of the flow. This, which is a well marked ophite, the fourth bed above a sandstone at 369 feet, should correspond to some bed in the Tamarack shaft 5 below flow 12, probably flow 13, T 3 b 9, which is a fresh black ophite quite different from the porphyrites above. Compare also Eagle River bed 72.

Sp. 15354. Hole 8 at 223 feet from surface. Poikilitic augite; not abundant (large olivine pseudomorph?) low angled feldspar.

Grain

Olivine 35x20; 38x26; 30x17, av. 1.03x.63 mm.
Feldspar 28x8; 23x8; 27x6, av. .78x.22 mm.
Augite 26x20; 42x40; 21x15, av. .89x.75 mm.

Sp. 15355. Hole 8 at 235 feet from surface. Rather low angled feldspar; 0°; 0°-12°; olivine changed into mica-like substance streaked with matter nearer chlorite (bowlingite?).

Grain

Olivine 17x10; 38x28, av. .91x.63 mm.
Feldspar 22x4; 22x7; 63x16, av. 1.07x.27 mm.
Augite 63x30; 52x45; 80x40, av. 1.95x1.15 mm.

Sp. 15356. Hole 8 at 250 feet from surface. Poikilitic augite; more basic feldspar; ex. 11°-8°; 36°-20°; 18°-16°w37°-39°; 20°-30°w13°; 15°w33°-36°, i. e., labradorite. Distance from margin—upper 52 feet, below 22 feet.

Grain

Olivine 78x40?; 70x35; 42x35; 61x30, av. 2.05x1.16 mm.
Feldspar 22x6; 30x7; 28x5, av. .80x.18 mm.
Augite 75x65; 140x135; 190x140, av. 4.05x3.40 mm.

Sp. 15357. Hole 8 at 258 feet from surface. One big phenocryst of feldspar and large altered olivine.

Grain

Olivine 32x25; 25x25; 30x15, av. .87x.65
Feldspar 230x55; 15x5; 23x6; 27x6, av. 2.45x.60
Augite 80x70; 105x80; 140x60, av. 3.25x2.10.

Such occasional large phenocrysts of feldspar are found rarely in the greenstone, also on the S. side of Washington Island at the end of Isle Royale and near the horizon of the Pewabic Lode both at the Quincy and Franklin Junior Mines. It is evidently an eocrystal.

Sp. 15358. Hole 8 at 270 feet from surface. Poikilitic; feldspar altered and changed to greenish fibres.

Grain

Olivine much decomposed

Feldspar 20x6; 23x5; 18x7; 20x5, av. .62x.19.
273-330; (Ss. 15359-64). MELAPHYRE, ophite; like the flow (56) (332)

above. Compare Eagle River 73 and T. 5 flow 14.

Sp. 15359. Hole 8 at 273 feet from surface. Fine grained microlitic amygdaloid glassy. At margin 273.

Grain

Feldspar phenocrysts 11x3; 21x3.5; 27x5, av. .56x.11 mm.

Sp. 15360. Hole 8 at 280 feet from surface. Dubious olivine pseudomorphs of clustered iron oxides. Labradorite extinctions 16°-w41°-36°; 32°-24°; 23°-w40°-36°.

Grain

Olivine 22x18; 62x53?; 27x27, av. 1.11x.98 mm.
Feldspar 14x2; 35x4; 30x5, av. .79x.11 mm.
Augite 120x60; 192x120; 265x168, av. 5.77x3.48 mm.

Sp. 15361. Hole 8 at 300 feet from surface. Labradorite extinctions 27°-26°-38°-36°; 19°-27°-27°; 14°-12°w34°-24°.

Grain

Olivine 24x20; 30x27; 40x25, av. .94x.72 mm.
Iron oxide little, mainly with olivine
Feldspar 19x6; 28x3; 40x15, av. .87x.24 mm.
Augite 120x80; 160x90; 125x120, av. 4.05x2.50 mm.

Sp. 15362. Hole 8 at 309 feet from surface. Poikilitic, labradorite extinction 14°-20°w23°-32°.

Grain

Olivine 20x15; 37x32; 28x22, av. .85x.69
Feldspar 24x5; 20x9; 24x5, av. .68x.19
Augite 120x60; 168x110; 100x83, av. 3.88x2.53.

Sp. 15363. Hole 8 at 326 feet from surface. Some other mineral beside augite is poikilitic some secondary mineral; labradorite extinctions—Baveno twin 48°-46°w18°-18°; 20°-20°; 43°-48°w23°-22° to 27°; 18°-25°; 36°-37°; 5°-10°w29°-40°.

Grain

Olivine 17x10; 20x10; 20x15, av. .57x.35 mm.
Feldspar Baveno twin 45x40; 18x7; 21x3; 20x4, av. .97x.45 mm.
Augite 30x17; 45x15; 30x28, av. 1.05x.50 mm.

Sp. 15364. Hole 8 at 330 feet from surface. Microlitic porphyritic amygdaloid; some feldspar much smaller with 0 ex.; this is probably merely an overlap or gush of the same flow. At margin 330.

Grain

Olivine 24x25; 20x19; 26x26, av. .70x.70 mm.
Feldspar phenocrysts 16x3; 15x4; 17x5, av. .48x.12 mm.
330-362; (Ss. 15365-6). MELAPHYRE (31) (363)

Compare Eagle River 74, and T. 5 flow 15

Sp. 15365. Hole 8 at 332 feet from surface. Feldspar largely low angled; but partly at least labradorite, ex. 20°-24°; 4°-6°; 31°w14°-14°; not much augite.

Grain

Olivine 20x14; 16x10; 20x18, av. .56x.42 mm.
Feldspar 18x3; 17x4; 15x4, av. .50x.11 mm.
Augite 15x10; 17x15; 17x12, av. .49x.37 mm.

Sp. 15366. Hole 8 at 362 feet from surface. Yellow or glassy, microlitic, porphyritic; contact with sediment; extinction angles 42°-46°w25°; 27°-35°; 22°-15°; Baveno 34°-30°. At margin 362.

Grain

Olivine 30x15; 29x14; 20x15, av. .79x.44 mm.

Feldspar phenocrysts 7x3; 10x2; 10x2; also fibres, av. .27x.07 mm.

Augite none.

362-377; (Ss. 15367-8). MELAPHYRE

(15) (378)

The above four flows steadily increasing in their relative thickness toward the top flow, seem to belong to the same type. Though belonging to the ophites rather than to the porphyrites, they have peculiar microscopic characters of their own, and are not very ophitic. The same group of feldspathic ophites are noticeable in the Tamarack shafts above the Conglomerate T 5-b 23 which we call the Pewabic West. The Eagle River beds 70 to 79 almost certainly represent the groups.

Sp. 15367. Hole 8 at 375 feet from surface. Decomposed.

Grain

Olivine 15x15; 12x10; 20x10, av. .47x.35 mm.

Feldspar 19x2; 14x4; 21x2, av. .54x.08 mm.

Augite 10x8; 7x7; 10x5, av. .27x.20 mm.

Sp. 15368. Hole 8 at 377 feet from surface. Microlitic porphyritic with skeleton feldspar; ex. 26°; 31°; 6°; 21°. At margin 377 ft.

Grain

Olivine 30x22; 20x16; 17x14, av. .67x.52 mm.

Feldspar 5x0.1; 7x0.2; phenocryst 7x2.

d 8.377-419; (Ss. 15369-73). Pewabic West, (Conglomerate No. 16) 41 (419)

SANDSTONE; red, with 1 foot of conglomerate at the bottom; in general quite uniform in grain; dark chocolate red; sometimes brecciated, with small red veins; the conglomerate at the base contains some felsitic debris.

Dips measured on drill cores 13°, 14½°, 15°, 16°, 15° cross-bedding of 23°. It is noticeable that the dips thus obtained from drill cores tend to be larger than those from correlations, and this fine grained sandstone furnishes some good observations. Three explanations for this want of agreement are possible,—

(1) The drill holes may curve to the north. They are not likely under the circumstances, however, to curve in this particular way, if they do, the effect should regularly be more marked toward the bottom.

(2) The conditions of deposit may have been such that the sandstone was formed in some measure by accretions, building from northwest to southeast, so that each of the laminae of which a bed was composed had originally a slight dip to the south greater than that of the bed itself as a whole. This is quite likely and is in harmony with the geological position of Isle Royale, with a mass of Archean land to the northward of it and with Chamberlin's explanation of the apparently great thickness of the Keweenaw.

(3) The difficulty may be with the correlations, which may have been made to give too flat dips by faults not otherwise to be detected, which run between the drill holes and throw the south side up. This is quite within the range of possibilities.

This sandstone is a more thorough sandstone than any other of like size in the series, and its course seems to be marked by a line of depression from Grace Harbor and its creek through to the northeast end of the island, as indicated on the map Plate I. The base of this bed is about (750) feet below the top of the bed (10,426) that we have correlated with Marvine's bed, No. 45, and would appear to represent the "first sandstone below the ashbed," which Marvine supposes to lie in a covered place (506) feet stratigraphically below bed No. 65, (983 feet below 45) which is about the usual rate of shrinkage between Isle Royale and Keweenaw Point.

On this assumption the sediment at No. VIII, 440 feet, just below, would do well for No. 85 of the Eagle River section, which Marvine seems to correlate with the "Pewabic West," and says is 767 feet below the slide above the Ashbed, and is No. 16 of his plate of conglomerates facing p. 60. It is probably more nearly true to the facts, to correlate both our sandstones together as indicating a weakening in igneous activity represented by sandstones in the Eagle River section scattered from bed No. 76 to bed No. 85. There can be little doubt that it corresponds, too, to that Conglomerate T. 5 b 23 which is so persistent in the Tamarack shafts and as here is generally sandy on top.

Sp. 15369. Hole 8 at 380 feet from surface. Fine grained sediment, rounded grains of augite, etc.

Grain

Augite 34x16; 16x12, av. .83x.46.

Sp. 15370. Hole 8 at 397 feet from surface. Similar; sandstone.

Sp. 15371. Hole 8 at 415 feet from surface. Similar, with fragments of micro-litic porphyrite.

Sp. 15372. Hole 8 at 419 feet from surface. Coarser, calcareous cement, poikilitic and microlitic fragments; oligoclase brotocrysts; one quartz phenocryst; conglomerate.

Sp. 15373. Hole 8 at 420 feet from surface. Calcareous with zeolites and calcite vein streaked into prehnite; decomposed top of flow below perhaps. This may be 15273.

420-431; (Ss. 15374-5). MELAPHYRE, porphyrite; about 4 feet (11) (11) amygdaloidal at the top (we are back to the porphyrites once more), dark green, with reddish porphyritic crystals. Matches Marvine's bed No. 82, T. 5 b 25 flow 18.

Sp. 15374. Hole 8 at 423 feet from surface. Glomeroporphyritic feldspar; little or no augite; microlitic base; ex. 6°-8°w-13°; 4°-10°-6°; 3°-0°w17°.

Grain

Olivine 0

Iron oxide 9x4

Feldspar phenocrysts 40x30; 40x20; 47x35, av. 1.27x.85.

Sp. 15375. Hole 8 at 431 feet from surface. Glass base; contact with a sediment; perhaps a calosilite. Margin at 431 ft.

Grain

Olivine?

Feldspar phenocrysts 48x30; 70x(20-40); 50x25, av. 1.68x?

431; SEDIMENT; contact; Marvine's bed No. 83? (11)

431-440; (S. 15376) MELAPHYRE, porphyrite; about 2 feet (9) (20)

amygdaloidal at top; matches Marvine's bed No. 84, except for size.

Sp. 15376. Hole 8 at 436 feet from surface. Glomeroporphyritic chloritic; irregular amygdaloidal; coarse grained cavities; nevaditic ex. 13°-4°-4°.

Grain

Olivine (rare) 10x5

Iron oxide 20x1; 13x1; 20x1 in chlorite, av. .53x.03 mm.

Feldspar phenocrysts 25x16; 42x25; 42x20, microlites 12x1.5; av. 1.09x.61 mm.

Augite 6x6; 4x3; 6x2; 5x4, av. .17x.12 mm.

440-444; (Ss. 15377-9). SHALE, red. The grain is so fine (4) (24)

that this bed was taken to be a fine grained trap until the microscope revealed its character. Marvine's Eagle River bed 85.

Sp. 15377. Hole 8 at 440 feet from surface. Fine grained sediment; clasolite? Margin 440.

Grain

Augite granules 3x2.

Sp. 15378. Hole 8 at 443 feet from surface. Fine grained sediment; red shale (ash bed) ? or sandstone.

Sp. 15379. Hole 8 at 444 feet from surface. Fine grained sediment. Margin at 444.

444-486? (Ss. 15380-1). MELAPHYRE, porphyrite; very acid (41) (65)

specimen; little olivine or augite, and might be classed with more salic rocks; amygdaloidal for 5 feet at the top, then a typical greenish gray trap. The exact bottom of this flow is a little uncertain. It lies on another flow of similar lithological character (both remarkable, under the microscope, for the scarcity of olivine), both of which appear to occur at the top of drill hole No. VII, to which we therefore pass, making No. VIII, 486 feet equal to No. VII, 10 feet. It is obvious that as the sandstones above No. VIII, 444 feet, do not appear in No. VII, the correlation of the top of No. VII cannot be sought above these sandstones. If we figure out the dip as before¹ we find it differs only .002 from the tangent of the dip as computed between Nos. VIII and IX.

Sp. 15380. Hole 8 at 450 feet from surface. Glomeroporphyritic idiomorphic augite like 15376; the apparently porphyritic grain of iron oxide has bands of different lustre of iron hydrate and hematite? like an agate?; feldspar ex. 5°-9°w5°; 0°-6°.

Grain

Iron oxide 80x75; 9x1; 5x4; 9x1, av. .85x.77 mm.

Feldspar 105x105; 40x17; 66x23; microlites 5x1; 5x1, av. 1.43x.98 mm.

Augite 5x1; 4x3; 7x3; 5x2, av. .17x.07 mm.

Sp. 15381. Hole 8 at 471 feet from surface. Rather decomposed; at 486 ft. was amygdaloidal bottom.

Grain

Olivine 10x8; 10x7, av. .33x.25

Feldspar 65x32; 50x27; 10x1; 10x1, av. 1.2x.50

Augite 2x2; 4x3; 5x3, av. .11x.08.

Sp. 15282. Hole 7 at 2 feet from surface. Glomeroporphyritic with microlitic ground and low angled feldspar, little augite.

Feldspar phenocrysts 55x45; 63x30; 80x35, av. 2.09x1.10 mm.; microlites 5x1; 7x1; 7x1, av. .19x.03 mm.

Augite 6x3; 3x2; 2x2, av. .11x.07 mm.

Sp. 15382. Hole 8 at 491 feet from surface. Glomeroporphyritic; fine grained amygdules; microlitic base; small angled feldspar; extinction angles 14°-11°; 4°; 26°-12°; 7° (-2°); 12°-13°-17°. At margin.

Grain

Feldspar phenocrysts 40x8; 37x20, av. 1.2x.46 mm.; microlites 4x1.

The amygdules contain prehnite, which is illustrated in Fig. 24 of Volume VI, Part I.

Sp. 15383. Hole 8 at 496 feet from surface. Glomeroporphyritic as before with sandstone with poikilitic calcite cement, very ferruginous.

¹(486-10)=476 minus the excess of altitude of No. VIII over No. VII (262.6-376.3) 114=362 feet, which divided by the distance, 1,584 feet, is 0.229, again the tangent of about 13°, (really about 0.5 less).

Grain

Feldspar 35x15; 65x52; 26x13, av. 1.26x.80 mm.

Augite?

Sp. 15384. Hole 8 at 504 feet from surface. Glomeroporphyritic feldspar but little augite in ground mass; feldspar extinction angles 8°-1°; phenocrysts 29°-16°; 14°-0°; 22°; 0°.

Grain

Iron oxide 3x2

Feldspar (Baveno twins) 34x15; 90x60; 80x60, av. 2.04x1.35 mm.

Augite 7x6.

Sp. 15385. Hole 8 at 505 feet from surface. Distinctly finer grained and more decomposed; prehnite (R<V, +2 V small).

DRILL HOLE No. VII.

10?-83?; (Ss. 15283-8). PORPHYRITE; like the flow above, about 6 feet at the top amygdaloidal; has irregular amygdaloidal streaks, and occasional seams of laumontite; the porphyritic feldspar groups are very well marked.

Sp. 15283. Hole 7 at 12 feet from surface. Similar to 15382.

Grain

Feldspar 7x1; 8x1; 8x1, av. .23x.03 mm.

Augite 2x2; 2x2, 3x1, av. .07x.05 mm.

Sp. 15284. Hole 7 at 25 feet from surface. Coarser and more decomposed; 'reddish specks' are probably altered olivine (bowlingite?)

Grain

Feldspar 8x1; 10x1; 12x2, av. .30x.04

Augite grain unrecognizable.

Sp. 15285. Hole 7 at 32 feet from surface. Feldspar more uniform in grain; much iron oxide; altered olivine?

Grain

Feldspar phenocrysts and microlite shade into each other (seriate)

Augite 4x4; 10x10; 5x3; 8x5, av. .22x.18.

Sp. 15286. Hole 7 at 36 feet from surface. Glomeroporphyritic feldspar; idiomorphic augite.

Grain

Feldspar 10x2; 12x2; 14x2, av. .36x.06 mm.

Augite 6x5; 10x3; 4x3, av. .20x.11 mm.

Sp. 15287. Hole 7 at 60 feet from surface. Similar; somewhat decomposed and finer.

Grain

Feldspar 6x2; 7x1; 9x1.5, av. .22x.04 mm.

Sp. 15288. Hole 7 at 68 feet from surface. Similar but finer grained; ground mass feldspar not marked; much large feldspar; olivine probably. Margiu at 83 ft.

Sp. 15292. Hole 7 at 109 feet from surface. Very fine grained microlitic amygdaloid; contact with a sediment, the grains of which can be seen in ordinary light but in polarized light they have no individuality (except in the distribution of iron oxides) hence perhaps originally glass.

Grain

Iron oxide 2x1; 1x1; .2x.2, av. .03x.02

Feldspar 5x0.2; 7x1; 6x0.5, av. .18x.01.

Sp. 15291. Hole 7 at 94 feet from surface. Much porphyritic low angled feldspar; ex. 0° - 23° ; 0° - 0° ; 0° - 12° ; 15° - $w5^{\circ}$ - 4° .

Separation of phenocrysts and ground mass in grain is not practicable; feldspar of ground mass $7x2+?$

Augite decomposed or very small; not large.

83-109; (Ss. 15289-92). PORPHYRITE, amygdaloidal; *copper* (26) (91)

in amygdules (at 83 feet), and in veins with prehnite (at about 90 feet); analcite and chlorite also occur in amygdules; the amygdules are often but partly filled, and lined with tufted chlorite and white crystals. Laumontite also occurs. Though the appearance of copper may be accidental and due even to the presence of a transverse vein, it is worth noting that we are getting near to the horizon of the "Pewabic Lode" worked in the Quiney Mine.

Sp. 15289. Hole 7 at 83 feet from surface. Prehnitic amygdaloid; fine grained.

109; Seam of SEDIMENTARY matter 0 (91)

102-130; (Ss. 15293-4). PORPHYRITE, amygdaloidal; like the (20) (111)

flow above, with alternating bands more or less conspicuously porphyritic; possibly more than one flow; at 127 feet narrow vein of *copper*, prehnite and quartz.

Sp. 15293. Hole 7 at 119 feet from surface. Much of the large low angled feldspar; slightly amygdaloid.

Grain

Olivine $6x5$; $8x4$; $8x6$, av. $.22x.15$

Feldspar phenocrysts $38x17$; $80x27$; $33x25$, av. $1.51x.69$ mm.; microlites very small.

Sp. 15294. Hole 7 at 130 feet from surface at margin. Prehnite; very amygdaloidal; contact with sediment.

Grain

Feldspar microlites $3x0.1$.

At 130 seam of SEDIMENTARY matter or flucan; much prehnite.

130-162; (Ss. 15295-6). PORPHYRITE, amygdaloidal, as above; (31) (142)

at 160 feet seam of *copper* in cubes, with prehnite and quartz.

Sp. 15295. Hole 7 at 144 feet from surface. Delessite and amygdules.

Grain

Olivine $11x10$; $10x10$, av. $.35x.33$ mm.

Iron oxide $11x1$; $5x6$; down to 0

Feldspar various sizes, ground mass glass.

Sp. 15296. Hole 7 at 153 feet from surface. Augite greenish, more idiomorphic; low angled feldspar; apparently some interstices with fine grained feldspar.

Olivine $10x8$; $30x25?$; $10x10$; some olivine smaller; av. $.55x.21$ mm.

Iron oxide $10x10$; $23x3$, av. $.55x.21$ mm.

Feldspar phenocrysts $30x35$; $43x18$, av. $1.21x.88$ mm—; and smaller

Augite $28x13$; $57x25$; $53x42$, av. $1.38x.80$ mm.

162-197; (Ss. 15297-8). MELAPHYRE, porphyrite (34) (176)

Sp. 15297. Hole 7 at 162 feet from surface. Marginal porphyritic amygdaloid; all impregnated with quartz. Margin at 162 ft.

Grain

Iron oxide makes a black ground mass

Feldspar $7x1$; $8x2$; $8x2$, av. $.23x.05$.

The section just above is so coarse that there are possibly some misplaced samples here, and from 130 ft. to 197 ft. may be one flow.

Sp. 15298. Hole 7 at 180 feet from surface. Low angled andesite feldspars, idiomorphic augite, altered olivine with iron oxide grains.

Grain

Olivine (altered) $25x10$; $24x17$; $12x10$, av. $.61x.37$ mm.

Iron oxide $12x1$; $15x15$, av. $.45x.26$ mm.

Feldspar $68x30$; $45x15$; $26x25$, av. $1.39x.70$ mm.

Augite $45x25$; $9x6$; $17x3$; $16x12$, av. $.72x.38$ mm.

197. Flinty-looking epidotic seam, a mass of BRECCIATED prehnite and quartz. It will be observed that copper has been noted in four places in the beds immediately above, and that the amygdaloids are quite rich in minerals. It seems quite possible that here at 197 feet is the center of the VEIN which has been a channel for this impregnation. There may be a fault here.

In such case the copper would come from a cross fissure, but it must not be forgotten that we are just about at the horizon here of the PEWABIC LODE, and it at least suggestive to find copper. Farther testing would seem desirable.

197-199; (Ss. 15299-300). AMYGDALOID. (2) (178)

Sp. 15299. Hole 7 at 197 feet from surface. Brecciated mass of prehnite and quartz; appears almost sedimentary in places; there are numerous outlines of glass fragments.

Sp. 15300. Hole 7 at 198 feet from surface. Porphyritic microlitic amygdaloid; skeletal feldspars; one feldspar proto-cryst has ex. 2° - 4° with 11° in altered part.

This is the characteristic texture of thin flows and margins long narrow feldspars, folded and in sheaves.

Grain

Iron oxide black dust

Feldspar phenocrysts $40x22$, microlites $10x1$; $12x.2$; $10x.1$, av. $.32x.01$ mm.

199; (S. 15301). Seam of SEDIMENTARY matter; apparent dip (0) (178) 21° .

Sp. 15301. Hole 7 at 199 feet from surface. Bands of stratified and clastic fragments but full of epidote and chlorite and altered contact sediment; not so markedly ashy as No. 15299.

199-210; (Ss. 15301-3). AMYGDALOID; much decomposed, with (11) (189)

zeolites, etc.

Sp. 15302. Hole 7 at 200 feet from surface. Perhaps triple generation of feldspar ex. 18° - 20° ; 13° - 10° ; 6° - 5° - $w11^{\circ}$; 6° - 8° - $w19^{\circ}$ -?

Grain

Feldspar phenocrysts $60x15$; microlites $11x1$; $?9x1$; $12x1$.

Sp. 15303. Hole 7 at 210 feet from surface. Very amygdaloidal; porphyritic; zeolites and calcite. Margin at 210 ft.

Grain

Feldspar phenocrysts $23x16$; microlites $10x1.2$; $10x1$; $11x1$, av. $.32x.03$

Augite probably too fine grained for observation and also decomposed

210-221; (Ss. 15304-5). PORPHYRITE, amygdaloidal; like the (11) (200)

rocks above near 130 feet.

Sp. 15304. Hole 7 at 215 feet from surface. Low angled feldspar; altered olivine? very little augite; very chloritic. The feldspar is in aggregates and very coarse. Is this one of the green nodules?

Grain

Olivine $15x15$; $7x6$; $11x8$, av. $.33x.29$ mm.

Iron oxide $19x1$; $18x.5$; $7x.2$, av. $.44x.03$ mm.

Feldspar phenocrysts 67x42; 53x34; 128x52, av. 2.48x1.28 mm.

Augite (2x1; 2x1; 1x1 questionable), av. .05x.03 mm.

Sp. 15305. Hole 7 at 215 feet from surface.

221-302; (Ss. 15306-15). Feldspathic ophite; intermediate type, (79) (279)

quite feldspathic, yet in traces ophitic, with red feldspathic seams, and like Marvin's bed No. 87, which is one of Irving's types of the "ordinary olivine-free" diabase (Copper-Bearing Rocks, Mon. V. U. S. Geol. Sur., p. 65) and is analyzed above. It is quite likely to be the foot of the Pewabic Lode (see Fig. 40).

Sp. 15306. Hole 7 at 221 feet from surface. Porphyritic with altered glassy pumiceous; note chloritic base; cf. 15295 secondary additions to porphyritic feldspar in ground small feldspars only around amygdaloid.

Grain

Feldspar phenocrysts 48x42; 22x25; ground mass 2 to 3x0.1

Augite 0.

Sp. 15307. Hole 7 at 230 feet from surface. Much feldspar; ex. 23°-17°; 18°-12°; 18°-18°; coarse grained and not porphyritic except around amygdules; elsewhere microlitic chloritic. Distance from margin 9.

Grain

Olivine 10x8; 11x10; 12x11, av. .33x.29 mm.

Iron oxide 13x1; 10x1, av. .38x.03 mm.

Feldspar microlites 12x1; phenocrysts 70x40, av. 1.36x.68 mm.

Augite 15x12; 10x10; 12x12, av. .37x.34 mm.

Sp. 15308. Hole 7 at 237 feet from surface. Similar. Distance from margin 16.

Grain

Olivine 28x25; 15x7; 12x9, av. .55x.41 mm.

Iron oxide 13x1; 17x3; 18x1.5, av. .58x.05 mm.

Feldspar phenocrysts 32x6; 44x6; 43x8, av. 1.19x.20 mm.

Augite 35x20; 18x10; 53x13, av. 1.06x.43 mm.

Sp. 15309. Hole 7 at 246 feet from surface. Very coarse and augitic; very much decomposed, probably doleritic. Distance from margin 25.

Grain

Iron oxide 45x2; 40x1½; 57x2, av. 1.42x.05 mm.

Feldspar 30x5?

Augite 45x40; 27x25; 80x23, av. 1.52x.88 mm.

Sp. 15310. Hole 7 at 258 feet from surface. Feldspar ex. 17°-18°w0°; poikilitic augite.

Grain

Olivine 16x18; 24x10, av. .60x.46 mm.

Iron oxide 12x4; 12x1; 24x13, av. .48x.18 mm.

Feldspar 47x22; 42x10; 68x20, av. 1.57x.52 mm.

Augite 190x150; 200x70; 160x80, av. 5.50x3.00 mm.

Sp. 15311. Hole 7 at 262 feet from surface. Coarse; much decomposed; presence of olivine doubtful; prehnitic.

Grain

Olivine 15x13?

Iron oxide 10x1

Feldspar 42x17

Augite 65x35; 80x10, av. 2.41x.75.

Sp. 15312. Hole 7 at 264 feet from surface. Still coarser decomposed; poikilitic; hard to make out, is there possibly a contact or slide here?

Grain

Olivine 20x15?

Iron oxide 35x5; 13x10; 14x15, av. .62x.30 mm.

Feldspar 40x15

Augite 65x53.

Sp. 15313. Hole 7 at 268 feet from surface. Low angled feldspar ex. 2°-8°w0°-7°; 10°-3°w5°; poikilitic augite.

Grain

Olivine 24x16; 15x14; 40x21, av. .79x.51 mm.

Iron oxide 30x2; 24x2; 23x1, av. .77x.05 mm.

Feldspar 43x17; 50x40, av. 1.53x.95 mm.

Augite 105x100; 100x95; 112x60, av. 3.17x2.55 mm.

The grain of 15313 to 15315 is plotted under 2 in Fig. 16 of the Isle Royale Report. It is exceptionally coarse at the bottom.

Sp. 15314. Hole 7 at 290 feet from surface. Labradorite ex. 9°-4°w24°-26°; 40°-34°w18°-15; more basic at center; poikilitic augite. These and the following specimens appear more red and ferruginous as is often true near the base.

Grain

Olivine 20x18; 20x15; (43x35?)

Iron oxide 18x1; 15x2; 12x2, av. .45x.05 mm.

Feldspar 36x13; 20x6; 40x15, av. .96x.34 mm.

Augite 125x60; 66x60; 105x85, av. 3.96x2.05 mm.

Sp. 15315. Hole 7 at 302 feet from surface. Much altered olivine which at one side becomes fine grained; microlitic augite small. At margin 302.

Grain

Olivine 15x12; 12x8; 17x9, av. .44x.29

Feldspar phenocrysts 30x15; 37x15; 40x5, av. 1.07x0.35 mm.; final generation of microlites 2x0.2.

302-324; (S. 15316). AMYGDALOID. (21) (300)

Sp. 15316. Hole 7 at 302 feet from surface.

324; (S. 15317). VEIN; carries *copper* crystals, prehnite and quartz.

Sp. 15317. Hole 7 at 324 feet from surface. Thoroughly decomposed; quartz, prehnite and poikilitic quartz replacing microlitic fragments.

324-337. AMYGDALOID. (13) (313)

337-375; (Ss. 15318-20). PORPHYRITE, amygdaloidal; fine (37) (350)

grained and full of small chloritic amygdules and chloritic seams, which simulate bedding and may mark flow lines. Dip 17° to 18° at 371 feet, 23° at 373 feet.

Sp. 15318. Hole 7 at 337 feet from surface. Rather decomposed with microlitic texture.

Grain

Olivine 12x8; 17x12; 16x15, av. .45x.35 mm.

Iron oxide 3x3; 8x7; 5x4, av. .16x.14 mm.

Feldspar phenocrysts 25x10; 25x10; 40x20, av. .90x.40 mm.

Augite none visible.

337; (S. 15319). Vein and perhaps contact; carries *copper*, etc.

Sp. 15319. Hole 7 at 371 feet from surface. Fine grained microlitic amygdaloid.

Grain

Iron oxide 4x2; 7x5; 2x1, av. .13x.08 mm.

Feldspar 8x1; 10x2; 3x.2, av. .21x.03.

375-394; (Ss. 15320-1). PORPHYRITE, amygdaloidal; analcite (19) 350
(369)

in cavities at 375 feet; generally fine grained with chloritic amygdules.

Sp. 15320. Hole 7 at 375 feet from surface. Contact of porphyritic microlitic scoriaceous margin with sediment.

Grain

Feldspar apparently low angled; size of microlites 3x.2; 6x.2; 2.5x.1; phenocrysts? 9x3, av. .16x0.02, often larger.

394-423; (Ss. 15321-4). MELAPHYRE; intermediate form, more (28) (397)

basic than adjacent flows, and somewhat ophitic.

Sp. 15321. Hole 7 at 394 feet from surface. Apparently contact of two microlitic flows, with a seam of sediment between.

Grain

Feldspar microlites 24x.1; 9x4; 27x2 or 3x.5.

This shows well the contrast between top and bottom of a flow. Note the fragment enclosed in the sediment.

Sp. 15322. Hole 7 at 403 feet from surface. Poikilitic but with low angled feldspar and semi-idiomorphic augite.

Grain

Olivine 12x9; 25x20; 20x13, av. .57x.42 mm.

Iron oxide 9x2; 16x1; 15x1, av. .40x.04 mm.

Feldspar 25x8; 15x8; 31x8, av. .71x.24 mm.

Augite 43x13; 30x28; 40x30, av. 1.13x.71 mm.

Sp. 15323. Hole 7 at 415 feet from surface. Big aggregates of altered olivine; delessite and microlitic texture with interstices lined with radiating chloritic fibres. Olivine 62x60±, 20x15.

Grain

Iron oxide 21x2; 7x3; 22x2, av. .50x.07 mm.

Feldspar 30x5; 20x4; 20x6, av. .70x.15 mm.

Augite 80x60; 80x60; 60x50, av. 2.20x1.70 mm.

Sp. 15324. Hole 7 at 423 feet from surface. Microlitic, porphyritic, chloritic and prehnitic amygdaloid. At margin.

Grain

Feldspar, phenocryst 10x2; microlites 5x.2, 9x1; av. .24x.03 mm.

(7) (404)

423-430. AMYGDALOID. (It is not certain that S. 15324 does not belong to this flow). I take this bed to be equivalent to No. VI, 74-81 feet, and we pass from No. VII, 430 feet, to the record of No. VI. While immediately below these points, in No. VII and in No. VI respectively, there is a very peculiar bed of porphyry and felsite tufa, which makes the correlation a good one, the beds above this bed (i. e., above No. VI, 81 feet and No. VII, 430 feet) do not match very well. This bed of porphyry tufa is without doubt the "Mesnard epidote" which lies directly over the Greenstone and may be recognized as a red jasper looking rock in many cross-sections in the Franklin Mine Fig. 40 and was also struck in Tamarack shaft 1 at 460 feet, and presumably goes through the "covered" gap just above. It is taken by us as the base of the "ashbed" series. Hence we should be at a point which according to our correlations should correspond to 1030 feet below the "slide" at Marvine's bed No. 63 and 334 feet more or less below the sandstone of Marvine's bed No. 80, while the corresponding thicknesses in our Isle Royale column are about 900 feet

and 404 feet rather greater than we should expect, for the increase in thickness of Keweenaw Point over Isle Royale is generally greater than this indicates. We are led then to suspect faulting in No. VII, by which the series may have been duplicated and copper segregation aided. There are a number of places where faulting might occur in No. VII, but we have no means of determining its amount. Such faulting might account for the disparities between drill holes Nos. VI and VII.

W. W. Stockly reports a "break" as apparent near No. VII, running nearly south (and thus liable to pass between No. VI and No. VII), and throwing the east side down. Such a fault as that would, if it were a normal fault, hade to the east, and if it passed through the middle of drill hole No. VII, would not disturb the correlations and dips at all, but would cause us to leave out some beds unawares. In No. VII however, the column as we have seen seems to be exceptionally full, so that we cannot attribute any great effect to such a fault. If it did not pass through the bottom of No. VII, and according to its strike it should not, the effect of such a fault would be to make the dip derived from correlations between Nos. VII and VI greater than it really is.

But the dip derived from the correlation No. VII, 430 feet, with No. VI, 81 ft., is 13°, practically the same dip as found between No. VIII and No. VII.

Sp. 15325. Hole 7 at 435 feet from surface. Epidote and quartz; very fine grained; contact; concave ash forms.

Sp. 15326. Hole 7 at 435 feet from surface. Sediment of brecciated quartz porphyry; not plain. A fragment of microlitic porphyrite and of a quartz phenocryst enclosed. This I am inclined to correlate with the felsite of the Porcupine Mountains or Chippewa felsite, which extends at least from south west of Black River (Fig. 55) to the Fire Steel River (Plate XII), and may well be expected to scatter its ash as far again.

Sp. 15327. Hole 7 at 435 feet from surface. Quartz porphyry tufa, not fluidal; traces of original perlitic texture; ash and sediment forms.

DRILL HOLE No. VI

Above the correlation line we have—

0-17; (Ss. 15226-8). MELAPHYRE; shows occasional large porphyritic plagioclase crystals; such crystals occur not only in the "Greenstone" but above it on the S. side of Washington Island and near the Pewabic lode; is in general of intermediate type, like No. VIII, 221-302 feet.

Sp. 15226. Hole 6 at 8 feet from surface. Poikilitic augite; much feldspar, ex. 10°-9°w33°-37°; 12°-2°w34°-38°.

Grain

Olivine 11x9; 45x23; 24x9, av. .80x.41 mm.

Iron oxide 15x13?

Feldspar 42x17; 36x16; 60x20, av. 1.38x.53 mm.

Augite 75x50; 140x120; 105x105, av. 3.20x2.75 mm.

Sp. 15227. Hole 6 at 15 feet from surface. Similar to 15226.

Grain

Olivine 12x10; 13x8; 30x10, av. .55x.28 mm.

Feldspar 78x20; 25x13; 40x7, av. 1.43x.40 mm.

Augite 220x100; 64x40; 50x20, av. 3.34x1.60 mm.

Sp. 15228. Hole 6 at 17 feet from surface. Porphyritic microlitic amygdaloid; moderate angled feldspars.

Grain

Iron oxide from dust to 9x1.

Feldspar 11x1; 12x2; 11x3, av. .34x.06 mm.

Augite or olivine granules 2-3.

17-25; (Ss. 15229-30). PORPHYRITE, amygdaloidal; chloritic and laumontitic.

Sp. 15229. Hole 6 at 20 feet from surface. Little poikilitic amygdaloid; feldspar rather decomposed and in this Sp. 15230 seriate; chalcedonic druses.

Grain

Iron oxide and altered olivine associated, 4x6?

Feldspar 14x6; 40x12; 42x11, av. .96x.29 mm.

Augite 80x50; 25x20; 22x12, av. 1.27x.82 mm.

Sp. 15230. Hole 6 at 25 feet from surface. Fine grained amygdaloid; low angled feldspar of various sizes; not markedly porphyritic.

Grain

Iron oxide 4-5; 4?

Feldspar 17x2; 15x2; 30x7, av. .62x.11.

25-59; (Ss. 15231-3). PORPHYRITE, amygdaloidal; with (30) chlorite or laumontite amygdules on red ground; occasional large porphyritic plagioclases; tubular amygdules at the bottom of bed.

Sp. 15231. Hole 6 at 32 feet from surface. Finer grained with various spots of finer grain. It has a very rare and peculiar texture growing coarser radially away from frequent centers.

Grain

Iron oxide 3x2; 4x4, av. .03x.03 mm.

Feldspar 58x19; 38x14; 20x9; 7x5, av. .76x.29 mm.

Sp. 15232. Hole 6 at 47 feet from surface. Much altered olivine and feldspar; little augite.

Grain

Olivine 10x10; 13x13; 10x13, av. .33x.36

Iron oxide 14x2; 9x0.5; 10x2, av. .33x.04

Feldspar 46x15; 42x5; 33x5, av. 1.21x.25

Augite 20x8; 20x9; 7x4, av. .47x.21.

Sp. 15233. Hole 6 at 58 feet from surface. Finer grained and especially around amygdaloid; low angled feldspar; this is the bottom and there are pipe amygdules.

Grain

Olivine 42x33

Iron oxide 12x1, fine grained but the long iron oxide may be a secondary formation.

Feldspar phenocrysts 58x17; 12x7; 13x5; 13x7, av. .80x.30.

59-67 or 72; (Ss. 15234-5?). PORPHYRITE, amygdaloidal; very porous; cavities lined with crystals.

Sp. 15234. Hole 6 at 59 feet from surface. Contact.

Grain

Feldspar 3 to 4x0.1.

Sp. 15235. Hole 6 at 72 feet from surface. Very much decomposed; fine grained amygdaloid.

72-81; (Ss. 15235-6). AMYGDALOID. Cavities with fillings of radiating chlorite fibres.

Sp. 15236. Hole 6 at 81 feet from surface. Contact of glassy, fine grained microlitic amygdaloid and a sediment of black fragments with the concave splintery forms of ash. Distance from margin 0.

Grain

Olivine none?

Iron oxide red to opaque

Feldspar phenocrysts 20x3; 25x5; 17x7, av. .62x.15 mm.

Augite none.

(404)

6. 81-91; (Ss. 15237-42); 7. 430-435; (Ss. 15325-15327).

(10) (414)

PORPHYRY TUFF. The Mesnard "epidote" bed. At the top there is a bed showing under the microscope the conchoidal forms of glass ashes, but in general the signs of sedimentation are very obscure, so much so that from mere inspection with the unaided eye I could hardly be sure that I was not examining a brecciated porphyry flow with some enclosures. This does not appear like a water-worn conglomerate, but like a contemporaneous tuff. It may be correlated with the "jasper," 67.7 feet above the Allouez conglomerate at the Franklin Junior Mine Franklin 11, Fig. 40 (Hubbard, Proc. L. S. Mining Institute, 1894, p. 93), Arcadian 16, Fig. 41, and 460 feet down in Tamarack No. 1 shaft (Geol. Sur. of Mich., Vol. V, Pt. I, p. 112), and I think with the Chippewa felsite of the Porcupine Mountains Figs. 52-55.

Sp. 15237. Hole 6 at 83 feet from surface. Quartz porphyry and quartz? and oligoclase brotocrysts; faint signs of brecciation or sediment.

Sp. 15238. Hole 6 at 84 feet from surface. Similar to 15237.

Sp. 15239. Hole 6 at 86 feet from surface. Similar to 15238.

Sp. 15240. Hole 6 at 88 feet from surface. Quartz porphyry, perhaps pebble or possibly thin representative of Chippewa felsite.

Sp. 15241. Hole 6 at 89 feet from surface. Microlitic porphyrite with green amygdules, pebble?

Sp. 15242. Hole 6 at 90 feet from surface. Quartz porphyry or porphyrite with quartz and oligoclase phenocrysts passing into a microlitic porphyrite, something like 15241.

BEGINNING OF THE CENTRAL GROUP.

(32) (446)

91-124; (Ss. 15243-7). OPHITE, top gush? of the greenstone, but at the Franklin and numerous other sections there is a bed Franklin 12 between the Mesnard and the Greenstone. This may be Marvine's Eagle River Bed 90.

Sp. 15243. Hole 6 at 91 feet from surface. Microlitic, not porphyritic; amygdaloid; small altered olivine; not very low angled andesite feldspar; a little fresh olivine in this flow.

Grain

Olivine 3; 3x2; 2

Iron oxide 3x1; about size of olivine

Feldspar 5x1; 8x2; 8x1.5, av. .21x.045.

Sp. 15244. Hole 6 at 99 feet from surface. Microlitic fine grained; occasionally amygdaloid.

Grain

Olivine 2½; 2x3; 2, av. .06 mm.

Iron oxide 1.5; 4x1; 2, av. .045 mm.

Feldspar 8x1; 9x1; 7x1, av. .24x.03 mm.

Augite 4x3; 8x5; 4x4, av. .16x.12 mm.

Sp. 15245. Hole 6 at 111 feet from surface. Labradorite extinction angles 34°-33°w-16°; 10°w36°-25°; 21°-17°w38°-35°?

Grain

Olivine?

Iron oxide 5x5; 5x5; 5x4, av. .15x.14 mm.

Feldspar 12x2; 6x1; 9x2, av. .27x.05 mm.

Augite 62x30; 30x23; 35x35, av. 1.27x.88 mm.

Sp. 15246. Hole 6 at 116 feet from surface missing.

Sp. 15247. Hole 6 at 124 feet from surface. Labradorite extinction angles 24°-25°-w?-34.

Grain

Olivine in all these sections probably, about size of iron oxides

Iron oxides 4; 9; 4

Feldspar 13x1½; 14x3; 17x2, av. .44x.065 mm.

Augite 16x10; 10x10; 11x5, av. .37x.25 mm.

12(?) -363; (Ss. 15248-58). ОРНТЕ, the Greenstone. This is the (233) (679)

largest single flow that we meet. It makes the "backbone" of the island extending from Card Point to Blake Point in an almost uninterrupted ridge. Judging from the mottlings which are larger as we go northeast, (see Plate VII of Vol. VI, Part I, which is at the base of Monument rock (Plate VIII)) and from the greater height of the ridge in that direction and from other reasons, the sheet thickens toward the northeast as it does also on Keweenaw Pt. This bed is distinctly lustre-mottled, and in sharp contrast with the series of porphyrites which overlie it and make a parallel ridge that extends from a low outcrop on the south side of Grace Harbor (including also part of Washington Island, further west), north of the Island mine, Siskowit Lake and Lake Richie, to the east end of Scovill Point. The backbone ridge thus agrees in every way with the great corresponding ridge on Keweenaw Point, which is included in Marvine's beds of "diorite" (not having the use of the microscope Marvine mistook augite for hornblende) Nos. 91 to 108, from (2927) feet to (4120) feet of the Eagle River section which after personal inspection I pronounce a unit, the lighter and darker types being merely differentiations in the same flow. This is a colossal thickness for one flow (1193 ft.), but I could find no finer grained band such as would mark a contact. Moreover, if we compare the size of the coarsest mottlings near Eagle River with those of the much thinner (233 feet) section of Isle Royale, some such great thickness (see p. 147) is indicated. The drilling at the Manitou and Mandan properties (Figs. 25 and 29) confirms this diagnosis. That we should find it thinner on the island is moreover in harmony with what we have hitherto found. This same Greenstone also thins very much toward the southwest along Keweenaw Point, as shown by Marvine and by Hubbard (loc. cit p. 95). Moreover, both on Keweenaw Point and on Isle Royale, we shall find, in the series below it, similarly basic ophites predominating, while on the other hand the porphyrite type which has been so dominant above, from d X. 193 ft. down (1446 feet, approximately equal to Marvine's 1272-2840, or 1568 feet) occurs only at intervals.

Sp. 15248. Hole 6 at 139 feet from surface.

Grain

Iron oxide 4; 3; 4

Feldspar 10x2; 19x2; 14x1.5, av. .43x.05

Augite 8x5; 10x6; 18x9, av. .36x.20.

See I. R. report p. 125 Fig. 14.

See I. R. report p. 134 Fig. 18.

The grain of this flow has been the most carefully studied. That on Isle Royale is shown in Fig. 14 and Fig. 18 of the Isle Royale Report. Further observations

will be found on p. 208 of my report for 1903 from which we infer that the rate of increase of augite grain is at the margin $C'=.00422$ while for the central part it approaches $0.000213x^1+.883$. This indicates exterior heated zone of only 2,400 mm. indicating that the rock was very fluid and cooled nearly to crystallization point before coming to rest.

Further observations on the grain of this flow will be found in most of the cross-sections north of Portage Lake. In some cases A is as high as .0003 to .0004.

Sp. 15249. Hole 6 at 163 feet from surface. Labradorite extinctions 17°-15°; 15°-8°w40°-35°.

Grain

Olivine 6; 6; 10

Iron oxide 5x1; 5x0.5, av. .16x.02 mm.

Feldspar 10x1.5; 10x2; 14 x3, av. .34x.06 mm.

Augite 60x50; 55x45; 65x50, av. 1.80x1.45 mm.

Sp. 15250. Hole 6 at 164 feet from surface. Chlorite coated cavities, somewhat doleritic? Distance from margin 194.

Grain

Olivine 9; 8; 8

Iron oxide 4x1; 4x5; 5x1, av. .13x.07 mm.

Feldspar 11x1.5; 10x2; 10x2, av. .31x.05 mm.

Augite 100x80; 120x80; 100x90, av. 3.20x2.50 mm.

Sp. 15251. Hole 6 at 216 feet from surface.

Grain

Olivine 5; 7; 10x6; 12x6, av. .29x.17 mm.

Iron oxide 7x2; 10x5; 9x2, av. .26x.09

Feldspar 10x4; 9x3; 14x3, av. .33x.10

Augite 120x120; 195x160; 140x140, av. 4.55x4.20.

Sp. 15252. Hole 6 at 240 feet from surface. Labradorite extinctions 19°-19°w4°; 30°-28°w37°; 34°-24°w38°; 31°-23°w23°; 39°-34°w6°-2°. Distance from margin 36.5 meters ± .152.

Grain

Olivine 0.25 mm.

Iron oxide 0.15 mm.

Feldspar 0.56x.094 mm.

Augite (9.1 to 6.5) (or 7.6).

Sp. 15253. Hole 6 at 265 feet from surface. One big anorthite phenocryst (such as are in most exposures found in the Greenstone, yet in every place rare) ex. 43°-43°; regular feldspar; 14°-14°; 28°-30°; 24°-36°; 33°-37°; grain. Distance from margin 28.9 meters ± .152.

Grain coarsest

Olivine .285

Iron oxide 0.24

Feldspar 0.46x0.13

Augite 7 ± (½)

Sp. 15254. Hole 6 at 288 feet from surface. Labradorite extinction angles 25°-27°w9°-4°. Distance from margin 22.1 meters ± .152.

Grain

Olivine .33

Iron oxide 0.11

¹Where x is the distance from margin in mm.