Prepared for the
United States National Science Foundation
Office of Polar Programs

New Zealand Department of
Scientific and Industrial Research
Antarctic Division

Japan National Institute of Polar Research

# DRY VALLEY DRILLING PROJECT

Bulletin No. 3

June 1974

Cover Photograph: Don Juan Pond in the south fork of western Wright Valley. View looking west up-valley. The Don Juan Pond drill site is located on the west side of the pond. See pages 75-91. Photo by Y. Yoshida.

# Geologic Log of the Lake Vida Core - DVDP 6

by

Hajime Kurasawa, Y. Yoshida and M. G. Mudrey, Jr.

## ABSTRACT

Continuous coring to 305.79 m with 98.9 percent recovery at the west end of Lake Vida (DVDP 6), Victoria Valley, recovered three lithologic intervals. The 10.52 m of sands and gravels near the surface represent deposits derived from glacial action and reworking. The individual units within this interval may represent the two older of four glacial advances in this valley. Biotite granite gneiss in the basement is correlated with the Olympus Granite Gneiss and exists to 155.96 m. Above a fault at 88 m, this gneiss is massive, below 88 m the gneiss is cut by meter-thick tongues of massive biotite granite, passing into massive granite at 155.96 m. The massive granite is correlated with the Vida Granite.

## INTRODUCTION

Diamond drilling with continuous core recovery with diesel fuel arctic (DFA) as the drilling fluid at the Lake Vida site (DVDP 6) commenced the afternoon of 10 December 1973 and terminated the evening of 20 December 1973 at a depth of 305.79 m with the recovery of 302.55 m of 63.5 mm

diameter permafrost core. The drill site is located along the north shore at the west end of Lake Vida, Victoria Valley (Figure 1). Geographic coordinates are approximately $77^{o}22'$ S. latitude, $161^{o}51'$ east longitude, 349.2 m above sea level.

Water pipe of 3.175 cm inside diameter was inserted down the hole and filled with DFA, thus permitting long-term access for geophysical measurements. The pipe and the hole are capped.

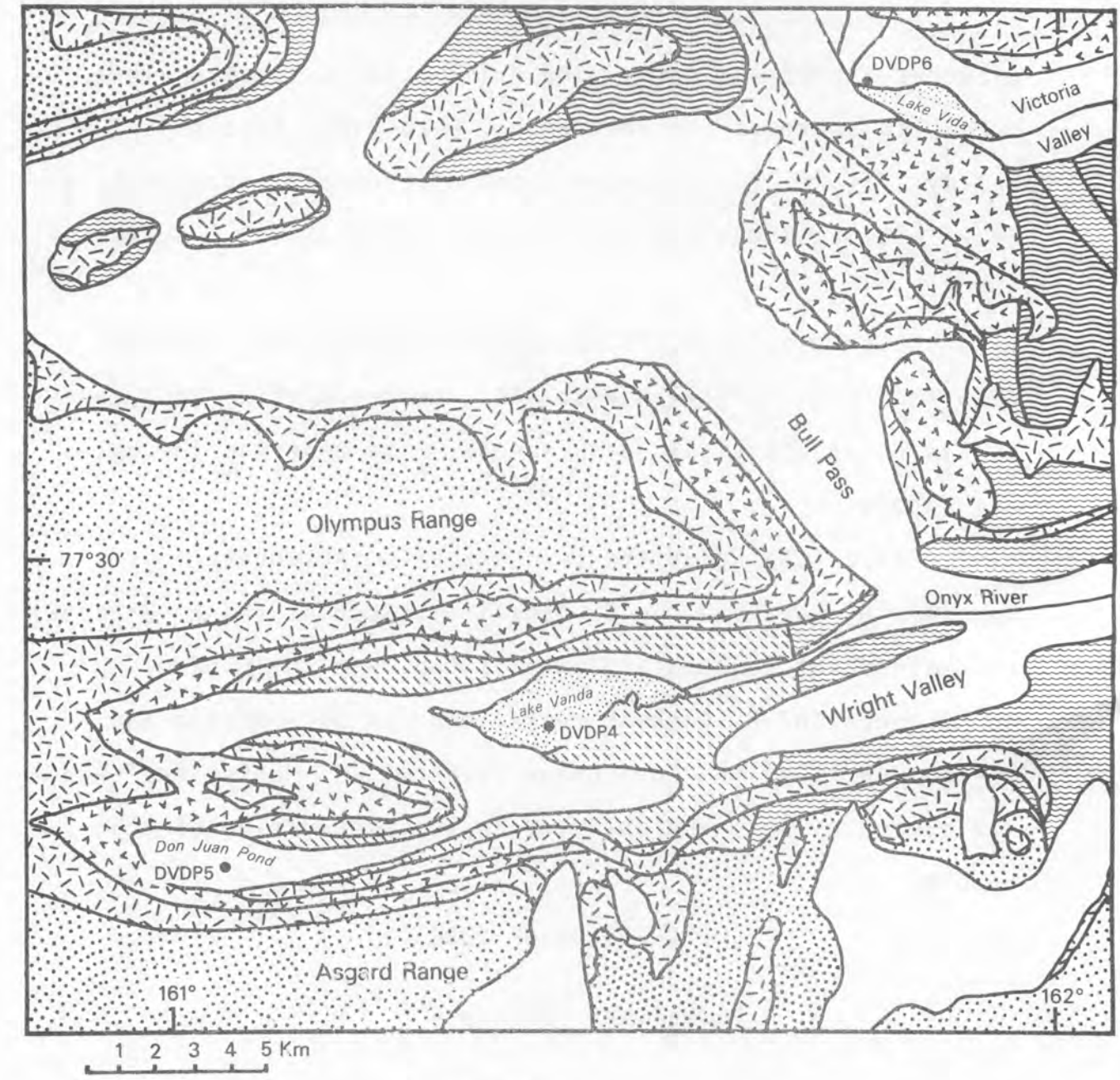
Field logging of the core was by G. Ankenbauer, J. Gumbley, H. Morikawa and N. Nakai. Y. Yoshida and K. Watanuki reexamined the sedimentary part of the core to 10.52 m, and H. Kurasawa and P. Luckman reexamined the metamorphic and igneous parts of the core below 10.52 m. M. Mudrey reviewed the geologic logs, and assisted in the preparation of this report.

## DESCRIPTION OF CORE

### Permafrost Sediments

Geologic description of the upper part of the Lake Vida core, DVDP 6, was prepared by Yoshida and Watanuki, and was based on hand specimen identification. Therefore, classifications of rock units and textural constituents are tentative.

Crystalline basement was encountered after drilling 10.52 m below the surface with the recovery of 8.27 m of permafrost sediments. The sediments in DVDP 6 are poorly sorted sands and gravels of outwash origin, and all are cemented




EXPLANATION

Ice covered lakes

Ice & Quaternary deposits

*Devonian to Jurassic*

Ferrar dolerites

Beacon sandstone

*Late Precambrian or Early Paleozoic*

Vida Granite

Dias Granite

Olympus Granite Gneiss

Asgard Formation

● DVDP drill site

Figure 1. Geologic sketch map of Victoria and Wright Valleys. Modified from McKelvey and Webb (1962).

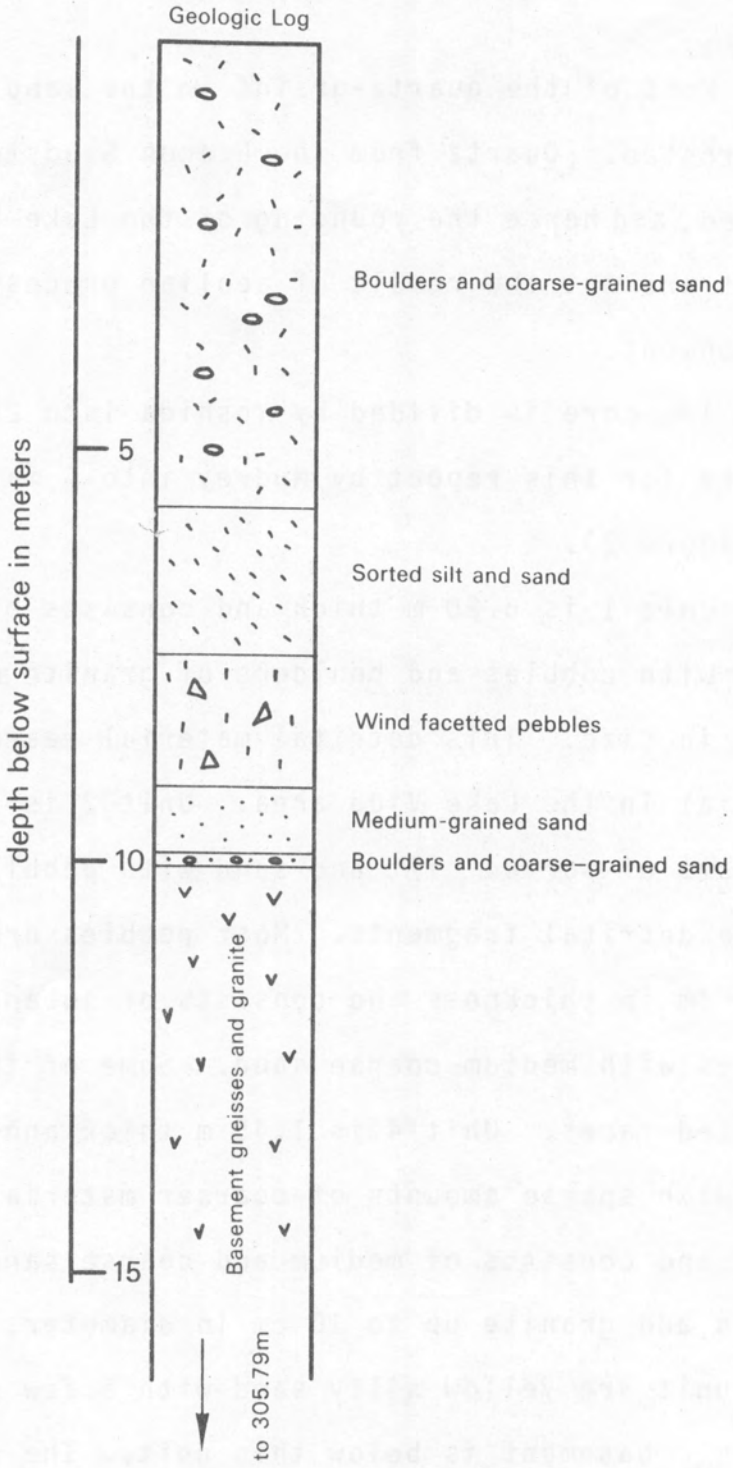
with ice. The gravels are rounded, sub-rounded and angular. Very small amounts of silt occur with the sand, although certain units within the sedimentary sequence contain more silt.

Most of the quartz-grains in the sand are well-rounded and frosted. Quartz from the Beacon Sandstone also are well rounded, and hence the rounding of the Lake Vida sand may be relict and not the result of aeolian processes and a dry environment.

The core is divided by Yoshida into 26 units, and re-grouped for this report by Mudrey into 5 main units (Appendix 1 and Figure 2).

Unit 1 is 6.20 m thick and consists of medium and coarse sands with cobbles and boulders of granite and diorite up to 35 cm in size. This detrital material resembles the surface material in the Lake Vida area. Unit 2 is 1.73 m thick and consists of sorted silt and sand with pebbles as the most coarse detrital fragments. Most pebbles are rounded. Unit 3 is 25 cm in thickness and consists of subangular and angular pebbles with medium-coarse sand. Some of the pebbles have wind facetted faces. Unit 4 is 1.45 m thick and consists of medium sand with sparse amounts of coarser material. Unit 5 is 89 cm thick and consists of medium and coarse sand with cobbles of gneiss and granite up to 10 cm in diameter. The lower parts of this unit are yellow silty sand with a few granitic pebbles. Gneissic basement is below this unit. The uppermost part of unit 7, the basement gneisses, locally has joints that are filled with ice-cemented sand.

**FIGURE 2. Graphic geologic log for permafrost sediments from DVDP6.**



## Permafrost Basement Complex

Geological description of the basement rocks in DVDP 6 was prepared by H. Kurasawa and P. Luckman by hand specimen identification and was augmented by a few thin sections. The secondary minerals lining the joint faces are briefly discussed later by Watanuki and Morikawa (this issue). Recovery of 295.27 m of basement core represents 99.67 percent of the cored hole.

The basement complex consists of three intervals, which are divided into 13 units (Appendix 1). The uppermost interval consists of 77.48 m of banded and massive biotite gneisses, and is separated from the middle interval by a 1.5 m-thick brecciated zone with 6 cm of ice found at a depth of 88 m. This zone is interpreted as a fault. The middle unit consists of 67.96 m of biotite gneiss cut by five, meter-thick tongues of massive biotite granite. This interlayered sequence is cut out entirely at 155.96 m, and the remaining 149.83 m of hole consists of massive biotite granite. Because of the similar nature of the rock types, all gneissic rocks will be described together, as will all massive granite, including the lenses of granite found within the gneiss.

The biotite gneiss is a banded rock of alternating leucratic zones of quartz and K-feldspar, and mafic bands of biotite schist and locally amphibolite, which are up to 40 cm in thickness. Feldspar is subordinate to quartz in the mafic bands, but exceeds quartz in the leucocratic bands. Fractures

and joints are locally filled with ice, and secondary minerals. Some of the biotite is chloritized, especially adjacent to the fault at 88 m, and along minor shear zones. Amphibolitic bands are highly chloritized adjacent to the fault, and epidote is developed.

Banding of the gneiss adjacent to the contact with the granite is weak, suggesting recrystallization. In addition, potassium feldspar porphyroblasts are well developed in the gneiss within 16 m of the contact with the granite. Biotite is extensively altered to chlorite in this zone.

The massive body of granite in the bottom of the hole differs only slightly from the lenses and tongues that are found intruded into the gneiss. This is a medium grained (2-6 mm), hypiodiomorphic, two-feldspar, biotite granite with accessory magnetite, zircon and apatite. Clearly defined, centimeter-sized inclusions are found in the massive granite; a fine-grained sandstone at 218.13 m, metadiabase at 283.85 m, and an amphibolite at 298.09 m.

## CORRELATION AND DISCUSSION

Bull and others (1962) recognize the second of four glacial deposits in the Lake Vida drillsite area. This suggests that sediments of the first glacial episode may underlie surface materials. The consequent inter-glacial episode may be represented by Unit 3 from the core, and Unit 4 may represent outwash from the first glacial advance. Unit 5 would then

represent glacial deposits related to the first major advance in this area.

Available geologic maps recognize glacial deposits in the immediate vicinity of the drill site, and thus offer little assistance in correlating the gneiss in the core with surficial geology. Petrographic criteria suggest correlation with the Olympus Granite Gneiss of McKelvey and Webb (1962). This correlation suggests that a large raft of the Olympus rocks was caught up in the younger granite, or that severe structural complications are buried beneath the glacial deposits in Victoria Valley. Schists within the older Asgard Formation are not reasonable for correlation, as those schists are considerably more mafic than the borehole gneisses.

Geographic relations and petrographic criteria dictate correlating of the massive granite in the borehole with the Vida Granite of McKelvey and Webb (1962), or the Taylor Pluton of the Irizar Granite of Gunn and Warren (1962, p. 95). These rocks are of late Precambrian or early Paleozoic age. All available information indicates that the eastern boundary of this pluton dips at a low angle to the west. Along the southern margin of this pluton in the vicinity of the Dias, small zenoliths of the older Dias Granite occur in the chilled and gneissic border phase of the Vida Granite. Similar petrographic features characterize the contact in the core.

The main fault in the core at 88 m is near vertical. Because the granite intrudes the gneiss beneath the fault and not within the cataclastic zone itself, faulting was probably post-emplacement of the Vida Granite.

## REFERENCES CITED

Bull, C., McKelvey, B. C., and Webb, P. N., 1962, Quaternary glaciations in Southern Victoria Land, Antarctica: Jour. Glaciol. v. 4, no. 31, p. 63-78.

Gunn, B., Warren, G., 1962, Geology of Victoria Land between the Mawson and Mullock Glaciers, Antarctica: New Zealand Geol. Survey Bull. 71.

McKelvey, B. C. and Webb, P. N., 1962. Geological investigations in Southern Victoria Land, Antarctica, Part 3--Geology of Wright Valley: New Zealand Geol. Geophys. v. 5, no. 1, p. 143-162.

Table 1. Summary of Geologic Units Penetrated in DVDP 6

| Unit | Description | Position in Core (m) | Thickness (m) |
|---|---|---|---|
| | Permafrost Sediments | | |
| 1. | Boulders and coarse grained sand | 0 - 6.20 | 6.20 |
| 2. | Sorted silt and sand | 5.70 - 7.93 | 1.73 |
| 3. | Wind facetted pebbles | 7.43 - 8.18 | .25 |
| 4. | Medium grained sand | 7.68 - 9.63 | 1.45 |
| 5. | Boulders and coarse grained sand | 9.13 - 10.52 | .89 |
| | Basement Complex | | |
| 6. | Biotite Gneiss | 10.52 - 88.00 | 77.48 |
| | Fault | 88.00 | |
| 7. | Biotite Gneiss | 88.00 - 88.00 | 16.58 |
| 8. | Microgranite tongue | 104.58 - 106.77 | 2.19 |
| 9. | Biotite Gneiss | 106.77 - 115.50 | 8.73 |
| 10. | Microgranite tongue | 115.50 - 117.96 | 2.46 |
| 11. | Biotite Gneiss | 117.96 - 131.20 | 13.24 |
| 12. | Granite tongue | 131.20 - 131.35 | 0.15 |
| 13. | Biotite Gneiss | 131.35 - 134.00 | 2.65 |
| 14. | Granite tongue | 134.00 - 135.89 | 1.89 |
| 15. | Biotite Gneiss | 135.89 - 143.12 | 7.23 |
| 16. | Granite tongue | 143.12 - 144.31 | 1.19 |
| 17. | Biotite Gneiss | 144.31 - 155.96 | 11.65 |
| 18. | Biotite Granite* | 155.96 - 304.80 | 148.84 |

*Xenolith inclusions at 218.13 m, 283.85 m and 298.09 m.

Table 2. Disposition and Meterage of Boxes for Sedimentary Part of DVDP 6

| Box | Position in Log |
|---|---|
| | Ending |
| 1 | 4.30 m |
| 2 | 6.70 |
| 3 | 9.34 |
| 4 | 10.88 |

Appendix 1. Summary Description of the Lake Vida Core

| Unit | Sub-unit thk. (cm) | Cum thk. (cm) | Core depth (cm) | Description |
|---|---|---|---|---|
| | | | | Permafrost sediments by Y. Yoshida and K. Watanuki |
| 1A | 4 | 4 | 0-4? | Pebbly coarse sand; brownish gray (5Y 4/1); largest pebbles 2.5 x 1.5 cm; exact depth unknown. |
| B | 31 | 35 | 4-35? | Medium sand with small amount of pebbles, coarse sand and fine sand; light olive gray (5Y 5/2); largest pebble 0.8 x 0.4 cm; slightly sorted; exact depth unknown. |
| C | 23 | 58 | 35-58? | Coarse sand with granule and pebbles; light olive gray (5Y 5/2). |
| D | 35 | 58 | ---- | A boulder of dioritic rock, 35 cm in length; greenish black (5G 2/1); the core between depths 58 and 178 cm not being recovered except the boulder; exact depth unknown. |
| E | 60 | 238 | 178-238? | Coarse sand with granule and pebbles, occasionally associated with cobbles; light olive gray (5Y 5/2); granite cobbles 10 x 6 cm; exact depth unknown. |
| F | 34 | 272 | 238-272? | Gravelly (pebble dominant) coarse sand; granite pebble, max. 6 x 5 cm; light olive gray (5Y 5/2). |
| G | 19? | 325? | 325? | Dioritic cobble, fractured into four pieces; greenish black (5G 2/1); exact depth unknown. |
| H | 36? | 380? | 344-380? | Very coarse sand with granule and pebbles; largest pebble 3.5 cm in length; light olive gray (5Y 5/2); exact depth unknown. |
| I | 87 | 504 | 467-554 | Very coarse sand with granule and small amount of pebbles; light olive gray (5Y 5/2); largest pebble (granite) 3.8 x 1.5 cm; rather uniform in grain size; this unit probably being the continuation of unit 8. |

| | | | | |
|---|---|---|---|---|
| J | 25 | 529 | 554-579 | Granite boulder, fractured into three pieces (total length, at least, 25 cm), associated with coarse sand, pebbles, and small amount of silt. |
| K | 41 | 570 | 579-620 | Medium sand with pebbles; light olive gray (5Y 5/2); pebble size 1 cm. |
| 2A | 21 | 21 | 620-641 | Medium sand containing silt; almost pebble-free; yellowish brown (10YR 5/2); this layer may represent the old lake level or old ground surface. |
| B | 29 | 50 | 641-670 | Coarse and medium sand with small amount of granule; rather uniform in grain size; light olive gray (5Y 5/2), but olive gray (5Y 3/2) in the lower 18 cm. |
| C | 70 | 120 | 670-740 | Coarse and medium sand with small amount of pebbles; well-rounded sand grain; light olive gray (5Y 5/2). |
| D | 11 | 131 | 740-751 | Pebbly zone; gradual transition to the above and the below; pebble 1.2 cm. |
| E | 42 | 173 | 751-793 | Coarse and medium sand with small amount of pebbles. |
| 3 | 25 | 25 | 793-818 | Sub-angular and angular pebbles with medium and coarse sand; pebbles of gneiss, quartzite, etc., 3-5 cm in length; some of pebbles showing wind-facetted surface. |
| 4A | 50 | 50 | 818-868 | Medium sand with coarse sand; rather uniform in grain size; light olive gray (5Y 5/2). |
| B | 12 | 62 | 868-880 | Medium sand with coarse sand, containing fine material; the color of fine material being yellowish orange (10YR 7/6); pebbly at the top; largest pebble 1.7 1.2 cm. |
| C | 54 | 116 | 880-934 | Medium sand with coarse sand, containing pebbles of sub-round sparsely; light olive gray (5Y 5/2); pebble 5.5 cm. |
| C | 29 | 145 | 934-963 | Medium sand with coarse sand; pebbles 1.2 0.8 cm; light olive gray (5Y 5/2). |

| | | | | |
|---|---|---|---|---|
| 5A | 45 | 45 | 963-1008 | Coarse and medium sand, containing pebbles and cobbles; cobble 9.5 cm. |
| B | 5 | 50 | 1008-1013 | Gneiss cobble. |
| C | 22 | 72 | 1013-1035 | Silty sand with cobble and pebble; dusky yellow (5Y 6/4); includes thin layers of ice. |
| D | 5 | 77 | 1035-1040 | Gneiss. |
| E | 12 | 89 | 1040-1052 | Silty sand and pebbles; dusky yellow (5Y 6/4). |
| | | | below 1052 | Fractured and coarse grained gneiss with ice in joint cracks. |

---

Basement Complex by H. Kurasawa and P. Luckman

| | | | in meters | |
|---|---|---|---|---|
| 6A | 998 | | 20.00 | Biotite gneiss, grayish olive green (5GY 3/2), banded; oxidized and chloritized on cracks and/or in quartz-K-feldspar band (1 cm-40 cm); chief constituents are a deep brown biotite and quartz, feldspar being only subordinate except in the band of quartz-feldspar; high-grade regional metamorphism; ice-filled cracks with rare secondary minerals. |
| | 400 | | 24.00 | Biotite gneiss, grayish olive green (5GY 3/2), banded; coarse-grain band in part, ice-filled cracks. |
| | 565 | 1963 | 29.65 | Biotite gneiss, grayish olive green (5GY 3/2), banded, oxidized on crack and in quartz-K-feldspar band, chloritized in part, ice-filled cracks; chlorite vein (1 cm) present. |
| B | 525 | | 34.90 | Biotite gneiss, greenish black (5 GY 2/1), massive; abundant quartz veins. |
| | 290 | 815 | 37.80 | Biotite gneiss, grayish olive green (5GY 3/2), massive; oxidized and chloritized on cracks; mostly highly chloritized; coarse-grain granitic texture in the middle part, quartz and quartz-feldspar bands present. |
| C | 3320 | 3320 | 71.00 | Biotite gneiss, greenish black (5GY 2/1), banded, abundant quartz veins and quartz-K-feldspar bands (1 cm-40 cm); oxidized and chloritized along the quartz vein and K-feldspar band, and on fracture zone; secondary minerals on cracks and fracture zone. |

| | | | | |
|---|---|---|---|---|
| 6D | 108 | | 72.08 | Biotite gneiss, greenish black (5GY 2/1), banded, with coarse-grain pegmatitic band (30 cm, grayish orange pink K-feldspar 5YR 7/2); secondary minerals on cracks. |
| | 292 | | 75.00 | Biotite gneiss, greenish black (5GY 2/1), massive; oxidized on cracks. |
| | 1300 | 1700 | 88.00 | Biotite gneiss, greenish black (5GY 2/1), banded, mostly medium-grain; abundant coarse-grain granitic and pegmatitic bands (4 cm-40 cm); oxidized some granitic band, chloritized in granitic band; quartz vein and quartz-K-feldspar band present. |
| -- | -- | -- | 88.00 | Fault; ice-filled in 6 cm fault-crack. |
| 7A | 100 | 100 | 89.00 | Biotite gneiss; abundant fractures, ice and epidote in cracks. |
| B | 450 | 550 | 93.50 | Mostly biotite gneiss with amphybolitic part of top (grayish black hornblende (N2), highly chloritized with epidote; secondary minerals (zeolite-loumontite) on cracks. |
| C | 640 | 1190 | 99.90 | Biotite gneiss, greenish black (5GY 2/1), banded; quartz vein (1 cm-3 cm) and quartz-K-feldspar band (1 cm-7 cm); ice-filled cracks. |
| D | 310 | 1500 | 103.00 | Biotite-hornblende gneiss (amphybolitic), grayish black (N2)-greenish black (5GY 2/1), massive; ice-filled cracks with secondary minerals (zeolite and calcite), quartz-K-feldspar band (1 cm-2 cm). |
| E | 158 | 1658 | 104.58 | Biotite gneiss, shear zone (∿1.5 m); greenish black (5GY 2/1); quartz-K-feldspar band; ice with secondary minerals on cracks. |
| 8 | 219 | 219 | 106.77 | Biotite microgranite-tongue (fine-grain granite, 2.19 m), massive; K-feldspar rich in bottom; ice and secondary minerals on cracks. |

| | | | | |
|---|---|---|---|---|
| 9A | 348 | 348 | 110.25 | Biotite gneiss, chloritized, banded; quartz-K-feldspar band (10 cm-20 cm), shear zone in top; ice on cracks. |
| B | 102 | 450 | 111.27 | Hornblende-biotite gneiss (∿amphybolitic), grayish black (N2), massive; quartz-K-feldspar band (15 cm). |
| C | 423 | 873 | 115.50 | Biotite gneiss, greenish black (5GY 2/1), banded, shear zone, many cracks with secondary minerals. |
| 10 | 246 | 246 | 117.96 | Biotite microgranite-tongue (fine-grain granite, 2.46 m), massive; fractured at bottom. |
| 11 | 1324 | 1324 | 131.20 | Biotite gneiss, greenish black (5GY 2/1), banded; abundant quartz-K-feldspar bands (1 cm-10 cm); highly chloritized zones (depth: 122.15 m-123.70 m and 128.55-129.72 m, fine-grain, grayish green 5GY 5/2); at about 1 m from the granite-tongue the gneiss is sheared. |
| 12 | 15 | 15 | 131.35 | Biotite granite-tongue (15 cm), massive; very small amount of ice-filled bottom, cracks with secondary minerals; oxidized on cracks. |
| 13 | 265 | 265 | 134.00 | Biotite gneiss, greenish black (5GY 2/1), banded; shear zone (5 cm-10 cm) at top as a contact with granite-tongue. |
| 14 | 189 | 189 | 135.89 | Biotite granite-tongue (1.89 m), massive; moderate orange pink (10R 7/4) K-feldspar; partly oxidized. |
| 15A | 338 | 338 | 139.27 | Biotite gneiss with K-feldspar-porphyroblasts (ca. 3 cm long very pale orange (10YR 3/2)), banded, oxidized cracks. |
| B | 385 | 723 | 143.12 | Biotite gneiss, greenish black (5GY 2/1), banded; shear zone (140.04 m-140.68 m) highly chloritized. |
| 16 | 119 | 119 | 144.31 | Biotite granite-tongue (1.19 m), massive. |

| | | | | |
|---|---|---|---|---|
| 17A | 90 | 90 | 145.21 | Biotite gneiss, greenish black (5GY 2/1), banded; highly chloritized cracks. |
| B | 1075 | 1075 | 155.96 | Biotite migmatitic gneiss, weakly banded (mostly massive); brownish black (5YR 2/1) biotite, highly chloritized base. |
| 18A | 794 | 794 | 163.90 | Biotite-oligoclase-quartz-orthoclase granite, massive; moderate orange pink (10R 7/4) orthoclase (K-feldspar, 2 mm-4 mm), medium gray (N5)-medium dark gray (N3) quartz (3mm-6 mm), white (N9)-very light gray (N8) oligoclase (2 mm-5 mm), bright grayish black (N2)-bright black (N1) biotite (1 mm-3 mm). |
| B | 1010 | 1804 | 174.00 | Slightly chloritized granite, same as above, massive, abundant cracks at bottom. |
| C | 13080 | 14884 | 304.80 | Biotite-oligoclase-quartz-orthoclase granite, massive; three xenolith-inclusions, fine-grain sandstone at 218.13 m, diabase (4 cm diam) at 283.85 m, amphybolite (15 cm diam) at 298.09 m depth; highly chloritized shear zone (brecciated) 187.00 m-187.20 m depth with orthoclase (pale reddish brown-red (10R 5/3)). |