

**910.4'-953' T.D. Mainly mesocratic gabbro with graded layering of olivine. Intercalation of cataclastic and brecciated epi-metamorphic zones showing growth of pink feldspar, secondary Fe-Mg hydrosilicates, quartz veins and granitized zones are found at 925.6'-947'.**

The foliation makes an angle of 70-80° to the core axis. The felsic veins and dikes make angles of 20-80° to the core axis with a tendency toward smaller angles at the lower part of the section.

## PETROGRAPHY DDH NR-1

The vast majority of the laminated melanocratic rocks found in this drill hole are medium-grained weakly magnetic olivine and oxide-bearing gabbros, with conformable plagioclase-rich lenses. Lamination is caused by parallel orientation of plagioclase prisms and tablets. The average mineral composition of these rocks is 50-60% plagioclase, 30% clinopyroxene, 0-3% olivine and 7-15% oxide, with traces of chalcopyrite. The olivine content seems to reflect a crude layering which disappears near the top of the layers. Mesocratic varieties are frequently non-olivine bearing and have a thickness of up to about 30'.

Weakly layered olivine-bearing oxide gabbro members occur as intercalations up to 13' thick and constitute about 13% of the rock. The lowermost contacts of the members are sharp and coincide with reappearance of olivine. The uppermost contacts are gradational. The average mineralogical composition of these rocks is 25-45% plagioclase, 30-55% clinopyroxene, 2-5% olivine and 20-25% oxide.

Strongly magnetic oxide-rich varieties are closely associated with oxide gabbro found at the base, or as intercalations, with a thickness varying from 0.5 to 16' making up to 2.2% of the section. The average mineralogical composition of these rocks is 10-25% plagioclase, 30-45% clinopyroxene, 5-15% olivine and 35-40% oxide. The copper and vanadium content of these rocks assay respectively up to 1250 ppm and 3600 ppm at 704.3'-705.3'.

**PLAGIOCLASE** cumulus crystals are developed as prisms and tablets and may reflect compaction on **CLINOPYROXENE** cumulus crystals or clusters of finer grained crystals of **PLAGIOCLASE**, **OLIVINE** and **OXIDE** minerals. Compaction along larger **CLINOPYROXENE** cumulus crystals gives rise to deformation of plagioclase lamellae and breaking-up of crystals in sections made up by individuals showing acline simple twins following the (001) plane. The anorthite content varies from 40-55%, with a concentration of values around 50%, especially between 500 and 900'. The crystals are twinned following albite, Carlsbad and acline laws. Smaller, partly cumulus, subhedral to anhedral crystals occur as well, and have a ragged outline against **CLINOPYROXENE**. Purple-pink titaniferous **AUGITE** is found as anhedral, partly flattened larger crystals, within cumulus layering and as smaller equant clusters with **PLAGIOCLASE**, **OLIVINE** and **OXIDE**. The crystals are characterized by simple twinning and inclusions of reddish brown **BIOTITE**. Cumulus **OLIVINE** occurs as larger anhedral to subhedral slightly flattened crystals, paralleling lamination, as smaller equant cumulus crystals, and as rims on **MAGNETITE** in oxide-rich gabbros.

**ORTHOPYROXENE** is occasionally observed as relicts in **CLINOPYROXENE** having ragged outlines. Subhedral to equant **APATITE** may occur in certain layers as part of the cumulus assemblage. **ILMENITE**, the most frequently occurring **OXIDE** is partly surrounded by **MAGNETITE**. In the vanadium-rich variety, however, the **MAGNETITE-ILMENITE** ratio is 3:1. The **OXIDES** are intergrown with **CLINOPYROXENE** and enclose sinuous **PLAGIOCLASE** tablets and prisms in the oxide-rich varieties. **MAGNETITE** shows exsolution lamellae of **ILMENITE** following crystallographic directions and patterns of cracks, and may have inclusions of a variety of **SPINEL**. **CHALCOPYRITE**, in lamellar intergrowth with **BORNITE**, is mostly observed in oxide-rich gabbros as minute specks in **CLINOPYROXENE**, along the fringes in **ILMENITE**, and occasionally with **PYRITE** and **ARSENOPYRITE**(?). These rocks can be labeled as plagioclase-clinopyroxene-olivine cumulates with oxide postcumulus. Conformable and cross-cutting brown-green and deep blueish-green **AMPHIBOLE** bearing syenite, granophyric and granite veins with euhedral **APATITE** prisms are observed throughout the core. These felsic rocks alter the layered rock through growth of spherulitic **CHLORITE**, **EPIDOTE** in **PLAGIOCLASE** and replacement of **CLINOPYROXENE** by greenish **HORNBLende** and greenish **BIOTITE**. The very fine-grained to medium-grained alkali syenite has an **ALKALIFELDSPAR**, resembling that of syenite veins and intergranular feldspar of the clastic metasediments described in DDH FHL-1.

## Acid Tests Results

Footage	Angle from Horizontal
233'	54½°
533'	53°
833'	58°

**Notes:** Ten polished thin sections and one thin section were made. Ten core samples were assayed. A detailed graphic log is available for study. The analytical results follow in Table NR-1.

## CONDENSED GEOLOGIC LOG FOR DDH NE-1

The hole was drilled at an angle of 50° and an azimuth of 210°.

**0'-36' Overburden.**

**36'-191.9' Medium to coarse-grained laminated troctolitic anorthosite and anorthositic troctolite with evenly dispersed olivine concentrations up to 3 mm and plagioclase tablets of up to 0.1'.** Olivine contents vary between 10 and 20% and define a crude layering. Troctolite is present in layers up to 6' thick. These layers have sharp upper and lower contacts. Olivine-rich segregations and Fe-Mg hydrosilicates occur as scattered lenses throughout the interval.

**191.9'-210.6' Anorthosite with sharp upper and lower contacts.**

**210.6'-278.4' Troctolitic anorthosite and anorthositic troctolite with crude layering due to variations in olivine content ranging from 10 to 20%.** Olivine-rich and olivine-pyroxene-rich lenses are scattered throughout the interval. Intercalations of hornblende granite and diorite veins oriented 30° to 70° core axis occur at 235.3'-353.1'.

**278.4'-315' Troctolite.**

**315'-331' T.D. Troctolitic anorthosite and anorthositic troctolite.**

The dip of these strongly laminated rocks is rather consistently oriented 45° to the core axis.

### Acid Test Result

<u>Footage</u>	<u>Angle from Horizontal</u>
330'	53°

**Notes:** A detailed graphic log is available for study. Ten heels were cut.

## CONDENSED GEOLOGIC LOG FOR DDH SR-1

The hole was drilled at a 90° angle (vertical).

**0'-230' Overburden.**

**230'-356.2' Layered olivine-bearing and olivine-free oxide gabbros with oxide-rich intercalations (303'-305').**

**356.2'-392' Oxide gabbro with oxide-rich intercalations at 376'-382' and 389'-392'** containing conformable amphibole-bearing syenite veins and dikes up to 1' thick, which gradually increase downhole until they appear to digest the country rock, forming a mixed rock.

**392'-600' T.D. Layered olivine-bearing and olivine-free oxide gabbros and olivine melagabbro with oxide-rich intercalations at 402.4'-403' and 418'-419'.** Downhole there is a decrease in thickness of the olivine-bearing stretches from 31' down to about 1'. Intercalations of fine-grained norites occur at 432.6'-437.5', 441.4'-444.5', (478'-479.6' with oxide-rich ultramafic rock present at 479.6'), 513'-515', 523.4'-526', 528.6'-533.6', 558.2'-559.3' and 570'-570.3'. Medium-grained to coarse-grained intrusions of syenite and granodiorite up to 7' are observed more or less evenly distributed, including mixed zones at 437.5'-441.4', 528.6'-531.1' and 573.6'-576'.

The layering and lamination are at an angle of 20-30° with the core axis in the upper 470'. Below this depth the angle varies between 45° and 60°. Alkalifeldspar granite and syenite veins have angles varying from 20-80° to the core axis.

### PETROGRAPHY SR-1

The major rock type found in this drill hole is a sequence of fine to medium-grained layered oxide-bearing and oxide gab-

bro, with intercalations of oxide-rich units. Plagioclase lamination is apparent in these rocks. The crystals are twinned following albite, Carlsbad and simple acline laws. Layering is enhanced by zones of olivine with sharp lower contacts. Small-scale layering is reflected by varying colour index due to modal variations of oxide and pyroxene. Amphibole pseudomorphs after clinopyroxene have a characteristic dull greenish colour. Steeply cross-cutting fine-grained norites and oxide rich ultramafites are observed from 432.6' downwards. Both conformable and cross-cutting veins of alkali granite, syenite, granodiorite, and epi-metamorphic gabbro occur all through the drill core, with the highest density between 360' and 390'. These constitute about 30% of the rock. The zones having a high concentration of felsic rock result in a mixed rock composed of uraltized oxide gabbro xenoliths digested to varying degrees by amphibole-bearing syenite.

### The oxide gabbros

This rock unit comprises oxide-bearing gabbros (5-15% oxide), oxide gabbros to olivine melagabbro (15-30% oxide) and oxide-rich gabbro (30-50% oxide) with or without olivine.

The *PLAGIOCLASE* of the former two subunits has an An content of 40-54% and has a subparallel to subophitic texture. Coarse-grained euhedral cumulus crystals can be distinguished from a sub- to anhedral fine to medium-grained matrix. Beautiful compaction textures of tabular *PLAGIOCLASE* or prisms on equant *CLINOPYROXENE* are present. *SAUSSURITIZATION* is observed in altered varieties.

Purple-pink titaniferous *AUGITE*, is simple twinned and locally strongly altered into masses of fibrous greenish *AMPHIBOLE* with blastic growth of *ACTINOLITE* and off shoots of secondary silicates extending into the surrounding fractured *PLAGIOCLASE*. *OLIVINE* may occur as larger, slightly flattened crystals, conformable to the layering. *ILMENITE* and *MAGNETITE* are found as lamellar and complex coarse intergrowths, *MAGNETITE* dominating over *ILMENITE*. *CHALCOPYRITE* is found as specks in *CLINOPYROXENE* and *PLAGIOCLASE*. The composition of the oxide gabbros averages plagioclase 15-55%, clinopyroxene 30-50%, olivine 0-25% and oxides 15-25%. The oxide-rich gabbros have the same mineral composition as the oxide-bearing and oxide gabbros. *CLINOPYROXENE* occurs as clusters with *OLIVINE*. The *OXIDES* show some flattening between *PLAGIOCLASE* laminae. *OLIVINE* is developed both as larger cumulus crystals and as rims on *OXIDE*. The *OXIDES* form a continuous network with roughly equal amounts of *MAGNETITE* and *ILMENITE* as part of the layering. Total oxide content may amount to 60%. *CHALCOPYRITE* and *BORNITE* occur as intergrowths and discrete crystals in *CLINOPYROXENE* and *PLAGIOCLASE* and along the fringes of *ILMENITE* and *MAGNETITE* grains. The average composition of these rocks is in the order of 30% plagioclase, 25-30% clinopyroxene, 0-10% olivine and 35-40% oxide. The oxide rocks are plagioclase-clinopyroxene (olivine) cumulates with post cumulus oxide.

### Fine-grained norite and oxide ultramafic rocks.

The *PLAGIOCLASE* of these rocks has an An content of 52%. The larger prismatic or tabular crystals are strongly