6. SITE 510

Shipboard Scientific Party  

HOLE 510

Date occupied: November 29, 1979
Date departed: November 30, 1979

Time on hole: 26 hr., 45 min.
Position (latitude; longitude): 1°36.79’N; 86°24.60’W
Water depth (sea level; corrected m, echo-sounding): 2780.8
Water depth (rig floor; corrected m, echo-sounding): 2790.8
Bottom felt (m, drill pipe): 2795.5
Penetration (m): 132.5 (sediment: 111.5; basalt: 21)
Number of cores: 11
Total length of cored section (m): 75.5
Total core recovered (m): 62.96
Core recovery (%): 83

Oldest sediment cored:
Depth sub-bottom (m): 111.5
Nature: Diatom nannofossil ooze
Age: 2.6-3.0 x 10^6 yr.
Measured seismic velocity (km/s): 1.52

Basement:
Depth sub-bottom (m): 111.5-132.5
Nature: Basalt
Seismic velocity range (km/s): 5.54-6.03

Principal results: One hole was cored at Site 510. Spot coring was carried out to 67 meters penetration, and from this depth to the basement continuous coring of sediment was done (93-100% recovery). Eighteen meters of basement were penetrated with 27% recovery. The sediments consist of diatom nannofossil ooze throughout. The biogenic silica content of the sediment is higher than at any other of the sites (506-509), and no decrease in silica content occurs at depth. Microseismic evidence suggests that the Pliocene/Pleistocene boundary occurs at 90 meters sub-bottom depth. Site 510 pore waters have Ca enrichments and Mg depletions up to 15%; extremely high SiO_2 concentrations (up to 1100 µM), reflecting biogenic silica dissolution; and NH_4 and H_2S concentrations that indicate the production of about 400 µM of CO_2 by sulfate reduction.

The basalt recovered at this site differ from those of Sites 506-509. Plagioclase phenocrysts are larger and more abundant, olivine phenocrysts occur, and primary Fe-Ti oxides are only half as abundant as at Sites 506-509. Alteration is also more pervasive than at Sites 506 and 508.

BACKGROUND AND OBJECTIVES

Site 510 is located at 1°36.79’N latitude and 86°24.60’W longitude in a moderately high heat-flow region (4-5 HFU). The site (Fig. 1) is about 90 km north of the Galapagos Spreading Center and 38 km west-northwest of Leg 54, Site 425. The sediment cover is about 115 meters thick. The site is near magnetic anomaly 2’ and, assuming a 3.25 cm/y spreading rate, the crust should be 2.7 m.y. old.

The main objective of Site 510 was to test the basement drilling capacity of a region of the Galapagos Spreading Center older than the three mounds fields previously studied.

OPERATIONS

Site 510 is located to the north of the Galapagos Spreading Center magnetic anomaly 2’ over crust about 2.7 m.y. old. The Glomar Challenger traveled on a course heading of about 344° true from Site 509 beginning at 2048 hours (L), November 29, 1979, with all underway systems on line (12- and 3.5-kHz echo sounding, 5- and 40-in. air-gun seismic profiling, magnetometer). The exact site was selected over the only relatively flat seafloor and basement, with about 0.15-s reflection time between seafloor and basement (Fig. 2). Several internal reflectors within the sediment column were seen at 0.03, 0.06 (multiple?), and 0.125 s below the seafloor reflection. A beacon was dropped at 0338 hr. (local time) on November 29. After settling over the beacon, the drill string with the conventional rotary drill bit was lowered (0712 to 1430 hr.). No detailed site survey was performed. Site 510 is located on the beacon. We spudded in at 1430 hours, November 29, 1979.

The 115-meter thick sediment column was spot cored, mostly by punch coring through soft sediments without rotation of the bit (Table 1). Intermeshed with the sediment coring program were three in situ temperature measurements and pore-water samples at sub-bottom depths of about 38.5 meters, 67 meters, and 95 meters. Hard rock drilling for 9.3 hr. followed, during which the drill bit penetrated 19.0 meters into the basement, while 5.2 meters of basalt were recovered. The bit plugged at 1900 hr. (L), November 29, 1979, after Core 11 was taken, and the core barrel could not be recovered. The drill string was pulled and the site abandoned because of poor drilling conditions in the hole.
Figure 1. General site locality map, Site 510.

Figure 2. Seismic reflection profile in the vicinity of Site 510. (Horizontal lines spaced at 0.5-s intervals.)
Work at the site was completed and we were underway to Site 504B at 0341 hr. on December 1, 1979.

**SEDIMENT LITHOLOGY AND STRATIGRAPHY**

Our primary objective at Site 510 was to drill basement. Consequently, apart from a spot core at the mudline and one between 38.5 meters and 48 meters, only the last 50 meters above the basement (encountered at 111.5 m sub-bottom) were continuously cored (Fig. 3). The sediment throughout consists of a pale olive green (2.5Y 6/2) to light greenish gray (5GY 8/1) diatom nanofossil ooze.

The major and minor constituents of the sediments, determined from smear slides, are: nanofossils, 20-65%; foraminifers, 2-10%; diatoms, 15-50%; unspecified carbonate, tr.-10%; radiolarians, 2-20%; silicoflagellates, tr.-10%; and sponge spicules, tr.-10%.

The sediment between 38.5 meters and 48 meters is lighter in color (light greenish gray) than in the lower 47 meters, where olive green predominates. The upper unit has fewer siliceous microfossils (~20%) than the lower unit (>30%). Throughout the entire hole, diatoms are the most abundant siliceous biogenic component. The higher biogenic silica content of these sediments distinguishes them from pelagic oozes recovered at Sites 506 through 509.

All the recovered rotary drilled cores were highly disturbed. Some sections showed a little mottling, but in only one case (510-2-4, 80 cm) was evidence of burrowing preserved.

Traces of volcanic ash are present throughout the sequence. In Core 7, three thin and highly disturbed ash layers occur (Section 5, 50-60 cm) and Section 6, 20-35 cm and 50-60 cm). The ash in these layers is colorless.

Traces of pyrite occur in most cores below 67 meters. When split, all cores from this depth to the basement smelled of H$_2$S, indicating that reducing conditions are present throughout this interval. No induration of the sediments immediately overlying basement was observed.

**BIOSTRATIGRAPHY**

Since our primary objective was to recover basement material, conventional drilling techniques were used to penetrate the overlying sediments. In the top 67 meters of sediment, spot cores were taken only between 0.0 to 0.5 meters and 38.5 to 48.0 meters. Below 67 meters the sediments were continuously cored until basement was reached.

A sample from the core catcher of each core was examined for calcareous nanofossils, foraminifers, diatoms, radiolarians, and silicoflagellates in order to determine their abundance (see core description). Calcareous nanofossils and planktonic foraminifers were used for age determinations. Ages determined by the use of calcareous nanofossils are based on the standard calcareous nanoplankton zonation by Martini (1971) and the revised zonation of the Pleistocene by Gartner (1977). The occurrence of Discoaster brouweri, Reticulofenestra pseudoumbilica, and Ceratolithus rugosus in the basal sediments indicate an early Pliocene age (Reticulofenestra pseudoumbilica Zone, 2.6 to 3.0 Ma). The presence of the planktonic foraminifers Globigerinoides fisticulosus, G. extremus, and G. obliquus support the early Pliocene age. The Pliocene/Pleistocene boundary is located approximately 75 meters sub-bottom.
Calcareous Nannofossils

Calcareous nannofossils are abundant and moderately preserved throughout the section. The core-catcher samples are assigned to the following zones: Core 1—Emiliania huxleyi Zone, Core 2—Gephyrocapsa oceanica Zone, Core 3—Pseudoemiliania lacunosa Zone, Core 4—Helicotyphlosphaera selli Zone, Cores 5 and 6—Discoaster brouweri Zone, Core 7—Reticulofenestra pseudoumbilica Zone.

Calcareous nannofossils in the basal sediments include, D. brouweri (common), R. pseudoumbilica (few), Ceratolithus rugosus (rare), H. kamptneri (common), and Cyclococcolithina leptopora (common).

Planktonic Foraminifers

Planktonic foraminifers are common and moderately preserved in Cores 1 through 5. Foraminifers in Cores 6 and 7 are poorly preserved and reduced in number. Selective dissolution of the planktonic foraminifers had artificially increased the percentage of benthic foraminifers in these cores. The basal assemblage of foraminifers includes: Globorotalia dutertrei (common), G. tosaensis (rare), G. scitula (few), G. tumida (few), Globigerinoides fistulosus (rare), G. obliquus (rare), G. extrems (rare), Sphaeroidinella dehiscens (rare), and P. obliquiloculata (few). The majority of the planktonic foraminifers are warm-water tropical to sub-tropical forms.

X-RAY DIFFRACTION ANALYSIS

The results of the X-ray diffraction analysis for Site 510 are given in Table 2.

Two samples of gray volcanic ash were analyzed from Core 7, Section 5. Volcanic glass was positively identified from smear slides along with minor calcareous components. Calcite was the only mineral identified by X-ray diffraction.

SEDIMENTATION RATES

Table 3 summarizes the sedimentation and accumulation rates estimated from ages based on paleontologic and paleomagnetic data. The rate estimates agree well between the two methods. At previous sites the paleontologic age (age of lowermost sediments) and the magnetic age (age of crust) did not agree. This discrepancy may result from an incomplete biostratigraphic record,

<table>
<thead>
<tr>
<th>Hole</th>
<th>Site</th>
<th>Sedimentation Rate (cm/10^3 y)</th>
<th>ρp (%)</th>
<th>Sediment Accumulation Rate (cm/10^3 y)</th>
<th>Average Grain Density (g/cm^3)</th>
<th>Accumulation Rate (g/cm^3/10^3 y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>510</td>
<td>A</td>
<td>114.5</td>
<td>3.81</td>
<td>4.19</td>
<td>79.37</td>
<td>0.79</td>
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<tr>
<td></td>
<td>B</td>
<td>114.5</td>
<td>0.91</td>
<td>2.55</td>
<td>2.55</td>
<td>2.22</td>
</tr>
</tbody>
</table>

Note: Columns lettered "A" show, respectively, minimum and maximum values based on paleontological evidence. Paleontological evidence places the estimated age at the bottom of each hole at 2.6 to 3×10^3 y. Spreading rates (columns lettered "B") are based on an estimated age of 2.73 m.

SEDIMENTATION RATES

Table 1. Sedimentation rates, Site 510.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth (m)</th>
<th>SiO2 (µM)</th>
<th>NHO3 (µM)</th>
<th>S2O3--I6HCO3-- (µM)</th>
<th>Ca2+ (µM)</th>
<th>Mg2+ (µM)</th>
<th>Cl (‰)</th>
<th>S (%)</th>
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</thead>
<tbody>
<tr>
<td>2-1</td>
<td>161</td>
<td>39.89-40.00</td>
<td>859</td>
<td>38</td>
<td>140</td>
<td>10.88</td>
<td>53.63</td>
<td>19.34</td>
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<tr>
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<td>825</td>
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<td>10.75</td>
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<td>19.24</td>
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<tr>
<td>3-1</td>
<td>163</td>
<td>60.89-69.00</td>
<td>969</td>
<td>59</td>
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<td>19.47</td>
</tr>
<tr>
<td>3-5</td>
<td>164</td>
<td>14.39-15.00</td>
<td>960</td>
<td>49</td>
<td>220</td>
<td>11.22</td>
<td>52.26</td>
<td>19.47</td>
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<tr>
<td>4-2</td>
<td>165</td>
<td>79.39-80.50</td>
<td>1060</td>
<td>63</td>
<td>180</td>
<td>10.90</td>
<td>52.55</td>
<td>19.34</td>
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<tr>
<td>4-5</td>
<td>166</td>
<td>93.39-94.60</td>
<td>1090</td>
<td>67</td>
<td>130</td>
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<td>51.54</td>
<td>19.32</td>
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<tr>
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<td>130</td>
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<td>51.54</td>
<td>19.32</td>
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<td>1110</td>
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<td>11.24</td>
<td>51.54</td>
<td>19.32</td>
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<td>51.54</td>
<td>19.32</td>
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<td>19.32</td>
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<td>14.89</td>
<td>51.89</td>
<td>19.18</td>
<td>35.8</td>
</tr>
</tbody>
</table>

PORE-WATER GEOCHEMISTRY

Pore-water results are presented in Tables 4 and 5, and Figure 4. Three in situ samples were collected. The in situ chemistry agrees well with centrifuge-sample chemistry except that centrifuge Ca concentrations are approximately 0.5 mM less than in situ Ca concentrations (see Site 509 pore-water summary).

In pore waters from Site 510, the signal for diagenesis of biogenic debris is larger than in any of the Galapagos mounds area holes. NH3 concentrations rise to about 60–70 µM. Measured H2S concentrations are erratic, probably as a result of partial oxidation before or during pore-water sampling, but reach 360 µM. These constituents undoubtedly record SO42− reduction by organic matter according to the following reaction:

\[
(CH_2O)_{106} (NH_3)_6 (H_3PO_4) + 53SO_4^{2−} \rightarrow 106HCO_3− + 16NH_3 + H_2PO_4 + 53H_2S
\]
It is not possible to infer the metabolic CO$_2$ content of the pore waters from the NH$_3$ and H$_2$S data, since both chemicals may be incorporated into solids (NH$_3$ may go into clay mineral ion-exchange positions and S$^{2-}$ may form iron sulfides).

SiO$_2$ concentrations reach high levels—about 1100 µM. The source of this Si is undoubtedly dissolution of the biogenic silica making up about half the sediment.

Calcium concentrations increase downhole and magnesium concentrations decrease. The gradients are greatest in the lower part of the hole and clearly imply coupled downhole Mg diffusion and uphole Ca diffusion, as the result of seawater-basalt reactions in the basement. The magnesium-depth profile shows the Mg gradient to be much greater at depth than in the top part of the sediment, and thus cannot be explained by simple magnesium diffusion from seawater to basalt through sediments having a constant diffusion rate. The shape of the magnesium profile may be explained by the following hypotheses (none of which appears particularly attractive): nonsteady-state conditions in the pore waters; diffusion coefficients in the bottom half of the hole an order of magnitude lower than in the upper half of the hole; occurrence at 40 to 60-meter depths of reactions in the sediments which produce magnesium and consume calcium; extremely slow advection down through the sediment (on the order of 0.05 cm y.$^{-1}$). The last possibility is favored, but it is untestable.

**PHYSICAL PROPERTIES**

The wet-bulk density of sediments from this site ranges from 1.24 to 1.49 g/cm$^3$, porosity from 71.5 to 84.5%, sonic velocity from 1.49 to 1.54 km/s, and thermal conductivity from 0.79 to 1.08 W/m·K.

The depth gradients of physical properties are very small down to 80 meters sub-bottom depth, becoming larger in the deeper part of the sedimentary layer (80 to 110 m).

The drilled thickness of sediments (115 m), combined with the observed seismic-reflection delay of the basement's reflection behind the bottom reflection (0.150 ± 0.005 s), give an average sound velocity of 1.53 ± 0.07 km/s through the sediment column. The deepest seismic reflection above basement (0.125 s) may correspond to the increased gradients in physical properties a few tens of meters above basement.

**HEAT FLOW**

Three lowerings of the temperature probe were made at Site 510, to sub-bottom depths of 39½ meters, 67 meters, and 95½ meters. The observed temperature gradient was fairly linear. Since the thermal conductivity data (Karato and Becker, this volume) was better fit by a mean value than an increase with depth, the temperature gradient was taken to be the best linear fit to the temperature data, 0.22°C/m.

Using the average conductivity value of 0.89 W m$^{-1}$ K$^{-1}$, we obtain a heat-flow value of 190 mW/m$^2$. Judging from the linearity of temperature vs. depth, the heat flow at this site is nearly all conductive, which is not unexpected since the sediment cover (~115 m) may be sufficiently thick to close off convective exchange between the basement pore water and the bottom water. (See Becker et al., this volume.)
IGNEOUS PETROLOGY AND LITHOSTRATIGRAPHY

At Site 510, 21 meters of igneous rock were cored with 6 meters recovered (29% recovery). Recovery and initial penetration were better than at previous Galapagos sites; however, after 21 meters of penetration, hole conditions deteriorated and drilling was halted.

Although only one lithostatigraphic unit of medium-grained, moderately plagioclase phyric basalt was recognized within this rock unit, 11 separate cooling units were tentatively defined on the basis of textural criteria (such as glassy rinds, vesiculation, and grain-size variation, Table 6). The multiplicity of cooling units may be the result of our having cored a sequence of very thin flows or a pillow basalt unit. Although alteration of the basalt will be described in a following section, it should be noted that some phenocrysts megascopically appeared to be clinopyroxene, though in thin sections they were seen to be smectite pseudomorphs after olivine. Thus, these basalts might also be classified as sparsely olivine phyric. Site 510, then, was the only Galapagos site of Leg 70 to contain basalt with substantial quantities of olivine phenocrysts.

Vesicles are generally rare to absent, but they do occur in areas of finer-grained texture and in glassy rinds. Interiors of the pillows (or flows) are essentially free of vesicles.

Many of the basalt pieces are angular to subangular, nearly equant, and thus unorientable. Additionally, alteration rinds often parallel surfaces on these cobble-sized pieces. The rubble-like nature of these samples is consistent with a sequence of cored basalt pillows.

In thin section, the basalts are medium-grained, hyalopilitic to variolitic with plagioclase (2.1 mm) and olivine (0.8 × 0.6 mm) phenocrysts. The interstitial material in the hyalopilitic textural group has quenched to variolites of plumose or sheaf textures composed of intergrown plagioclase and clinopyroxene. A few fresh olivines were observed; however, most of the olivine phenocrysts were replaced by smectite and iddingsite(?). Samples from the variolitic textural group displayed plagioclase phenocryst laths and skeletal plagioclase laths, serving as sites for preferred nucleation of microclines. Vesicles and voids are rare in both textural groups, but when they occur are often filled with green smectite.

Titanomagnetite is less abundant in Site 510 basalts than at previous Leg 70 Galapagos sites (ranging from 3 to 8% at Site 510). The sizes of these crystals all average less than 20 µm in diameter or across the longest axis. The magnetites are skeletal to anhedral in morphology. Primary sulfide spheres of pyrrhotite and chalcopyrite compose less than 1% of the rock and are commonly less than 5 µm in diameter. Secondary pyrite occurs as grains in glassy areas and as vein fillings with smectite. These secondary sulfides compose as much as 3% of some thin sections. In one sample (Sample 510-9-1, 50–52 cm), chalcopyrite occurs as a bleb or anhedral crystal in secondary pyrite replacing mesostasis.

Basement Alteration

Megascopically, most of the pieces are surrounded by a thin (<0.5 mm) coating of green, blue, and yellow-brown material. On the sawn surfaces, a thick (5–40 mm) altered rim occurs, which is darker than the fresh core of the pieces. Alteration also appears to be controlled by cracks, fissures, and exposed surfaces. Vesicles and more frequent voids seem empty or, more often, filled by blue and green clay.

Microscopic examination shows that these vesicles and microlitic voids are coated and sometimes filled by different kinds of smectite and more sparsely by calcite and pyrite. The following paragenetic succession from the rock interior through an alteration rim was observed adjacent to a smectite veinlet: (1) orange-brown smectite(?) with iron oxyhydroxides, (2) mixed orange-brown and green smectites (and possible calcite), (3) green smectite, and (4) very light-brown smectite.

Cracks are generally filled by green smectite. In some areas, smectite seems to replace glass. In the glassy rim of Sample 510-11-1, 40–43 cm, the formation of fibropalagonite from the glass (devitrification process) on each side of a smectite veinlet: (1) orange-brown smectite(?) with iron oxyhydroxides, (2) mixed orange-brown and green smectites (and possible calcite), (3) green smectite, and (4) very light-brown smectite.

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Thus, the alteration of the basalts from Site 510 chiefly differs from that of Sites 506, 507, and 508 in the thickness of the altered rim, which can be explained by a longer interaction of basalts with seawater. Smectite is the most common mineral, with calcite and pyrite oc-

Table 6. Cooling units, Site 510.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Depth (m)</th>
<th>Piece No.</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>114.5–114.95</td>
<td>53–57</td>
<td>Medium-grained moderately to highly plagioclase phyric basalt</td>
</tr>
<tr>
<td>2</td>
<td>114.95–115.10</td>
<td>58–59</td>
<td>Fine-grained aphyric basalt</td>
</tr>
<tr>
<td>3</td>
<td>115.10–116.10</td>
<td>60–70</td>
<td>Medium-grained moderately to highly plagioclase phyric basalt</td>
</tr>
<tr>
<td>4</td>
<td>116.10–116.65</td>
<td>71–79</td>
<td>Fine-grained moderately plagioclase clinopyroxene phyric basalt</td>
</tr>
<tr>
<td>5</td>
<td>116.65–117.95</td>
<td>80–97</td>
<td>Fine- to medium-grained moderately plagioclase clinopyroxene phyric basalt</td>
</tr>
<tr>
<td>6</td>
<td>117.95–118.05</td>
<td>98–99</td>
<td>Fine-grained moderately plagioclase phyric basalt</td>
</tr>
<tr>
<td>7</td>
<td>118.05–118.35</td>
<td>100–106</td>
<td>Medium-grained moderately plagioclase phyric basalt</td>
</tr>
<tr>
<td>8</td>
<td>123.5–124.4</td>
<td>107–117</td>
<td>Fine-grained aphyric to plagioclase clinopyroxene phyric basalt</td>
</tr>
<tr>
<td>9</td>
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<td>118–122</td>
<td>Medium-grained moderately plagioclase phyric basalt</td>
</tr>
<tr>
<td>10</td>
<td>128.3–128.4</td>
<td>123</td>
<td>Fine-grained moderately plagioclase phyric basalt</td>
</tr>
<tr>
<td>11</td>
<td>128.4–129.0</td>
<td>124–133</td>
<td>Medium-grained moderately plagioclase phyric basalt</td>
</tr>
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</table>
curing less frequently. As at previous sites, this type of alteration is the result of low temperature weathering.

PHYSICAL PROPERTIES (BASEMENT)

Physical properties of six samples were measured. Wet-bulk density ranges from 2.91 to 2.96 g/cm$^3$, porosity from 2.7 to 5.0%, sonic velocity from 5.53 to 5.85 km/s. Basalts from Site 510 have higher sonic velocity than do those from Sites 506, 507, 508. This probably results from the difference in their grain density (3.00 g/cm$^3$ for Site 510; 3.05 g/cm$^3$ for Sites 506, 507, and 508).

BASEMENT PALEOMAGNETISM

Site 510 is about 89 km north of the Galapagos Spreading Center, on basement whose age is approximately $2.73 \times 10^6$ years, based on a half-spreading rate of 3.25 cm/y. (Sclater and Klitgord, 1973). Basement penetration and recovery at Site 510 were only a little better than at Sites 506, 507, and 508. Seventeen oriented plus one unoriented minicore were sampled for shipboard paleomagnetic studies. The paleomagnetic measurements and the discussions associated with the results are essentially identical to those of Site 506. The uncertainties below, associated with the values of the magnetic parameters, represent one standard deviation.

$J_{NRM} = 6 \pm 4 \times 10^{-3}$ gauss (G). This value is less than one-third of the value at Sites 506–508. This decrease in $J_{NRM}$ may be the result, in part, of progressive low-temperature oxidation of the titanomagnetites. However, the decrease in $J_{NRM}$ may also be related to a decrease in total iron content at Site 510. This is suggested by the more common occurrence of olivine phenocrysts in thin sections from Site 510 than from Sites 506–508. Furthermore, preliminary observations of the opaques while on board the Glomar Challenger indicated a lesser abundance of titanomagnetite grains at Site 510 than at Sites 506–508. Thus, it might be that Site 510 is just outside the region of unusually high-amplitude magnetic anomalies. For example, if

$$\chi = 0.97 \pm 0.35 \times 10^{-3} \text{ G/Oe},$$

then $Q = 22 \pm 14$, illustrating the dominance of the remanence relative to induced magnetization and consis-

$$Q = J_{NRM} \chi H,$$

where $\chi$ is the low-field susceptibility and $H = 0.33$ Oe is the intensity of the geomagnetic field at the sampling site.

REFERENCES


SITE 510 HOLE

CORE

1. CORED INTERVAL 0.0-0.5 m

LITHOLOGIC DESCRIPTION

A greenish gray to light greenish gray diatom-nannofossil ooze. The sediment is intensely disturbed by drilling.

SMEAR SLIDE SUMMARY (%)

COMPOSITION:
- Volcanic glass (dark)
- Carbonate unspec.
- Foraminifers
- Calc. nannofossils
- Diatoms
- Radiolarians
- Sponge spicules
- Silicoflagellates

CARBON-CARBONATE (%):
- Organic Carbon
- Total Carbonate

SITE 510 HOLE

CORE

2. CORED INTERVAL 38.5-48.0 m

LITHOLOGIC DESCRIPTION

Greenish gray to light greenish gray siliceous nannofossil ooze. The core is intensely disturbed by drilling. No biogenic sedimentary structures are observed except for possible halo burrow in Section 4 at 80 cm.

SMEAR SLIDE SUMMARY (%)

COMPOSITION:
- Volcanic glass (dark)
- Carbonate unspec.
- Foraminifers
- Calc. nannofossils
- Diatoms
- Radiolarians
- Sponge spicules
- Silicoflagellates

CARBON-CARBONATE (%):
- Organic Carbon
- Total Carbonate

SITE 510 HOLE

CORE

3. CORED INTERVAL 58.5-68.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

4. CORED INTERVAL 78.5-88.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

5. CORED INTERVAL 98.5-108.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

6. CORED INTERVAL 118.5-128.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

7. CORED INTERVAL 138.5-148.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

8. CORED INTERVAL 158.5-168.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

9. CORED INTERVAL 178.5-188.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

10. CORED INTERVAL 198.5-208.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

11. CORED INTERVAL 218.5-228.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

12. CORED INTERVAL 238.5-248.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

13. CORED INTERVAL 258.5-268.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

14. CORED INTERVAL 278.5-288.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

15. CORED INTERVAL 298.5-308.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

16. CORED INTERVAL 318.5-328.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

17. CORED INTERVAL 338.5-348.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

18. CORED INTERVAL 358.5-368.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

19. CORED INTERVAL 378.5-388.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

20. CORED INTERVAL 398.5-408.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

21. CORED INTERVAL 418.5-428.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

22. CORED INTERVAL 438.5-448.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

23. CORED INTERVAL 458.5-468.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

24. CORED INTERVAL 478.5-488.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

25. CORED INTERVAL 498.5-508.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

26. CORED INTERVAL 518.5-528.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

27. CORED INTERVAL 538.5-548.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

28. CORED INTERVAL 558.5-568.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE

29. CORED INTERVAL 578.5-588.5 m

LITHOLOGIC DESCRIPTION

SITE 510 HOLE

CORE
**Lithologic Description**

**SITE 510 HOLE**

**CORE 3**

**CORED INTERVAL** 67.0–76.5 m

**DIATOM-NANOFOSIL Ooze**

Middle to pale olive green to greenish gray diatom-nannofossil ooze. There are possible minor drilling and biogenic structures but this high degree of drilling disturbance has destroyed much of the detail. A strong smell of H₂S occurred when each section was split.

**Lithologic Description**

- 2.5Y 5/2
- 5GY6/1
- 2.5Y 5/2

**Summary**

<table>
<thead>
<tr>
<th>%</th>
<th>1-90</th>
<th>2-90</th>
<th>3-85</th>
<th>4-70</th>
<th>5-66</th>
<th>6-62</th>
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<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Composition:**

- Pyrite: -
- Volcanic glass (light): -
- Zeolite: -
- Micrite: -
- Pyroclasts: -
- Volcanic glass (dark): -
- Nannofossils: -
- Foraminifers: -

**Carbonate (wt%)**

- Organic Carbon: 2.15
- Total Organic Carbon: 4.03

---

**SITE 510 HOLE**

**CORE 4**

**CORED INTERVAL** 76.5–86.0 m

**DIATOM-NANOFOSIL Ooze**

A pale olive green diatom-nannofossil ooze. Very little recording and no biogenic sedimentary structures are observed. Much of the detail is destroyed by intense drilling disturbance. A strong smell of H₂S occurred when each section was split.

**Summary**

<table>
<thead>
<tr>
<th>%</th>
<th>1-71</th>
<th>2-71</th>
<th>3-71</th>
<th>4-65</th>
<th>5-66</th>
<th>6-62</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Composition:**

- Pyrite: -
- Volcanic glass (light): -
- Zeolite: -
- Micrite: -
- Pyroclasts: -
- Volcanic glass (dark): -
- Nannofossils: -
- Foraminifers: -

**Carbonate (wt%)**

- Organic Carbon: 3.72
- Total Organic Carbon: 4.03

---
DIATOM-NANNOFOSSIL OOZE

Other press during core retrieval. No mention of
interlayer is observed. The strong odor of H₂S
was detected when each section was split. Inside drilling
data frame occurs throughout the core.

SMEAR SLIDE SUMMARY (N)

COMPOSITION:
- Quartz = 5 30
- Feldspar = 3 5
- Heavy minerals = 2 3
- Clay minerals = 2 3
- Quartzose grains = 2 1
- Concretionary = 2 1
- Detrital quartz = 2 1
- Detrital feldspar = 2 1
- Carbonate = 2 1
- Fish debris = 2 1
- Silicoflagellates = 2 1
- Discoasters = 2 1
- Foraminifera = 2 1
- Radiolarians = 2 1
- Sponge spicules = 2 1
- Diatoms = 2 1
- Total Carbonate = 2 1

DIATOM-NANNOFOSSIL OOZE
Light greenish gray to light gray argillaceous
sedimentary rock. Some rock sections highly disturbed
don't have an odor of H₂S detected when
each section was split.

SMEAR SLIDE SUMMARY (N)

COMPOSITION:
- Pyrite = TR TR
- Volcanic glass (light) = TR TR
- Carbonate = 40 35
- Foraminifera = 40 35
- Shells = 40 35
- Sedimentary = 2 1
- Diatoms = 2 1
- Foraminifera = 2 1
- Total Carbonate = 40 35
SITE 510 HOLE 7 CORED INTERVAL 105.0-111.5 m

LITHOLOGIC DESCRIPTION

DIATOM-NANNOFOSSIL Ooze
Light greenish gray to light olive gray diatom-nannofossil ooze. Some deformed wisps of dark gray material are present throughout Section 2. Three thin ash layers occur; Section 5, 50-60 cm, Section 6, 20-30 cm, and Section 8, 30-50 cm. The layers were probably about 1 cm thick but are very deformed by the high degree of drilling disturbance. No biogenic sedimentary structures are visible. There was an odor of H2S when each section was split.

Note: Only 6 m penetration was recorded for this core. The top 3.5 m of the core may therefore represent a repetition of the sequence due to caving in of the hole.

SMEAR SLIDE SUMMARY (%)

<table>
<thead>
<tr>
<th>Composition</th>
<th>1-80</th>
<th>2-80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay minerals</td>
<td>2 2 3 3</td>
<td></td>
</tr>
<tr>
<td>Volcanic glass (light)</td>
<td>TR TR TR TR</td>
<td></td>
</tr>
<tr>
<td>Micromeres</td>
<td>1 1 1 1</td>
<td></td>
</tr>
<tr>
<td>Carbonate unspec.</td>
<td>4 4 4 4</td>
<td></td>
</tr>
<tr>
<td>Foraminifers</td>
<td>10 10 5 8</td>
<td></td>
</tr>
<tr>
<td>Ostracodes</td>
<td>40 40 40 40</td>
<td></td>
</tr>
<tr>
<td>Diatoms</td>
<td>30 30 30 30</td>
<td></td>
</tr>
<tr>
<td>Radiolarians</td>
<td>5 5 5 5</td>
<td></td>
</tr>
<tr>
<td>Sponge spicules</td>
<td>1 1 1 1</td>
<td></td>
</tr>
<tr>
<td>Silicoflagellates</td>
<td>1 1 1 1</td>
<td></td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>1.48</td>
<td></td>
</tr>
<tr>
<td>Total Carbonate</td>
<td>57.0</td>
<td></td>
</tr>
</tbody>
</table>

SITE 510 HOLE 8 CORED INTERVAL 111.5-114.5 m

LITHOLOGIC DESCRIPTION

DIATOM-NANNOFOSSIL Ooze
Light greenish gray diatom-nannofossil ooze. Two patches of olive gray ooze in Section 1 at 94-96 cm and 144-151 cm. No other structure seen due to intense drilling disturbance. Basalt was recovered in the bottom of Section 2. The individual pieces are described in the igneous rock core barrel summary.

SMEAR SLIDE SUMMARY (%)

<table>
<thead>
<tr>
<th>Composition</th>
<th>1-99</th>
<th>2-76</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volcanic glass (light)</td>
<td>TR TR</td>
<td></td>
</tr>
<tr>
<td>Carbonates</td>
<td>3 4</td>
<td></td>
</tr>
<tr>
<td>Foraminifers</td>
<td>5 5</td>
<td></td>
</tr>
<tr>
<td>Ostracodes</td>
<td>40 40</td>
<td></td>
</tr>
<tr>
<td>Radiolarians</td>
<td>5 5</td>
<td></td>
</tr>
<tr>
<td>Sponge spicules</td>
<td>1 1</td>
<td></td>
</tr>
<tr>
<td>Silicoflagellates</td>
<td>1 1</td>
<td></td>
</tr>
<tr>
<td>Organic Carbon</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>Total Carbonate</td>
<td>61.0</td>
<td></td>
</tr>
</tbody>
</table>

SITE 510 HOLE 8 CORED INTERVAL 111.5-114.5 m

LITHOLOGIC DESCRIPTION

DIATOM-NANNOFOSSIL Ooze
Light greenish gray diatom-nannofossil ooze. Two patches of olive gray ooze in Section 1 at 94-96 cm and 144-151 cm. No other structure seen due to intense drilling disturbance. Basalt was recovered in the bottom of Section 2. The individual pieces are described in the igneous rock core barrel summary.
Dominant Lithology: Moderately plagioclase-clinoxyro×ene phyric basalt.

Macroscopic Description: Moderately-plagioclase-clinoxyro×ene phyric basalt. Phenocrysts are from 1–5 mm in length. Alteration rims are present. Numerous tiny, irregularly shaped solids, often coated wth a blue clay matrix are present. Other voids are filled with green smectite. The filled voids are associated wth basalt in the alteration rims.

Thin Section Descriptions

8-2, 100–102 cm (Piece 48):
Name: Medium-grained plagioclase phyric basalt (flow interior)
Texture: Intersertal to hyaloophitic—glass phase showing quenched texture
Phenocrysts: Olivine, 1%, 0.4x0.4 mm, euhedral; Plagioclase, 12%, 5.0x3.0 mm, euhedral
Groundmass: Plagioclase, 30%, 0.04 mm, anhedral; magnetite, 7%, < 0.008 mm, skeletal; Plagioclase and pyroxene, 40%, < 0.008 mm, skeletal-like clusters
Alteration: Smectite — gneis and breccia, iddingsite and talc replacing olivine

8-2, 104–106 cm (Piece 48):
Name: Moderately plagioclase-olivine phyric basalt
Texture: Hyalopilitic
Phenocrysts: Olivine, 1-2%, 0.2x0.2 mm; Plagioclase, 7-10%, 0.6x0.4-1.2x0.8 mm; blocky, euhedral
Groundmass: Plagioclase, 20-25%, 0.36x0.05 mm, skeletal laths; magnetite, 8%, skeletal; glass, 60%, pyrite, ~ 3%, secondary voids
Alteration: Smectite, 8-10% replacing glass; talc and iddingsite, 1-2%, pseudomorphs after olivine

8, CC, 14–16 cm (Piece 51):
Name: Medium-grained plagioclase phyric basalt (flow interior)
Texture: Hyaloophitic
Phenocrysts: Plagioclase, 7%, 1.2x0.8 mm, euhedral
Groundmass: Olivine, 6%, 0.12x0.1 mm, subhedral; Plagioclase, 20%, 0.25x0.01 mm, microlites; magnetite, 3%, < 0.008 mm; texture
Vesicles: Voids, 3%, filled with orthoclase, irregular shape
Alteration: Iddingsite and talc, 3%, replacing olivine

9-1, Pieces 58–59 (Unit 2)
Dominant Lithology: Moderately plagioclase-olivine phyric basalt (next to glassy margin)
Name: Moderately plagioclase-olivine phyric basalt (next to glassy margin)
Texture: Variolitic to hyalopilitic
Phenocrysts: Olivine, < 1%, 0.5x0.5 mm, subhedral; Plagioclase, 2-4%, 1.0x2.0 mm, laths
Groundmass: Olivine, 3-6%, 0.06x0.06 mm, anhedral; Plagioclase, 20%, 0.03x0.03 mm, skeletal laths; Magnetite, 2%, < 0.008 mm; skeletal, clinopyroxene and plagio×ene, 55%, matrix/detrital texture
Vesicles: Voids, 3%, filled with orthoclase, irregular shape
Alteration: Iddingsite and talc, 3%, replacing olivine

9-1, Pieces 60–62, Piece 79 (Unit 3)
Dominant Lithology: Medium-grained moderately to highly plagioclase phyric basalt.
Macroscopic Description: Medium-grained moderately to highly plagioclase phyric basalt. Large plagioclase phenocrysts are present. Alteration rims (5–10 mm thick) are common wth associated voids filled wth smectite and blue clay mineral.
Thin Section Descriptions

9-1, 76-79 cm (Plate 61):
Name: Medium-grained moderately plagioclase phyric basalt (flow interior)

Thin Section:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.05-0.1 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.01-0.1 mm, euhedral

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass

Vesicles; Voids, 2%, filled with colorless and brown clay

9-2, Pieces 71-79 (Unit 4)

Dominant Lithology: Very fine-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 12%, 0.3x0.1 mm, euhedral
- Groundmass: Plagioclase, 88%, 0.01-0.1 mm, euhedral

Groundmass:
- Plagioclase, 32%, 0.04-0.08 mm, euhedral; clinopyroxene, 2%, < 0.008 mm, skeletal; glass, 66%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-1, Pieces 110-122 (Unit 9)

Dominant Lithology: Medium-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 10%, 0.8x0.2 mm, euhedral
- Groundmass: Plagioclase, 90%, 0.01-0.1 mm, euhedral

Groundmass:
- Plagioclase, 7%, 0.36x0.02 mm, acicular; magnetite, 3%, < 0.008 mm, skeletal; glass; 90%, microcrystalline texture

Vesicles; Voids, 1%, 0.01 mm, filled with colorless clay

Alteration: Iddingsite and talc, 1-5%, replacing glass and filling voids

11-2, Pieces 65-69 (Unit 4)

Dominant Lithology: Very fine-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-3, Pieces 71-109 (Unit 4)

Dominant Lithology: Medium-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 12%, 0.3x0.1 mm, euhedral
- Groundmass: Plagioclase, 88%, 0.01-0.1 mm, euhedral

Groundmass:
- Plagioclase, 32%, 0.04-0.08 mm, euhedral; clinopyroxene, 2%, < 0.008 mm, skeletal; glass, 66%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-4, Pieces 65-69 (Unit 4)

Dominant Lithology: Very fine-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-5, Pieces 71-109 (Unit 4)

Dominant Lithology: Medium-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-6, Pieces 65-69 (Unit 4)

Dominant Lithology: Very fine-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-7, Pieces 71-109 (Unit 4)

Dominant Lithology: Medium-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-8, Pieces 65-69 (Unit 4)

Dominant Lithology: Very fine-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-9, Pieces 71-109 (Unit 4)

Dominant Lithology: Medium-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-10, Pieces 65-69 (Unit 4)

Dominant Lithology: Very fine-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-11, Pieces 71-109 (Unit 4)

Dominant Lithology: Medium-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-12, Pieces 65-69 (Unit 4)

Dominant Lithology: Very fine-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids

11-13, Pieces 71-109 (Unit 4)

Dominant Lithology: Medium-grained moderately plagioclase phyric basalt

Thin Section Description:
- Textural: Ophitic
- Phenocrysts: Plagioclase, 20%, 0.15x0.08 mm, subhedral
- Groundmass: Plagioclase, 80%, 0.06x0.06 mm, subhedral

Groundmass:
- Plagioclase, 3%, 0.15x0.08 mm, subhedral; magnetite, 5%, 0.01 mm, skeletal; glass, 65%, microcrystalline texture

Alteration: Calcite, 1%, brown smectite, 10-15%, replacing glass and filling voids