HOLE 562

Date occupied: 21 October 1981
Date departed: 24 October 1981
Time on hole: 80 hr.
Position (latitude; longitude): 33°08.49' N, 41°40.76' W
Water depth (sea level; corrected m, echo-sounding): 3172
Water depth (rig floor; corrected m, echo-sounding): 3182
Bottom felt (m, drill pipe): 3182
Penetration (m): 331
Number of cores: 11
Total length of cored section (m): 90
Core recovery (%): 50
Total core recovered (m): 44.9
Core recovery (%): 50
Oldest sediment cored:
Depth sub-bottom (m): 268
Nature: Limestone-interpillow breccia
Age: middle Miocene
Basement:
Depth sub-bottom (m): 240
Nature: Basalt

Principal results:
Hole 562 was drilled on the west flank of the Mid-Atlantic Ridge south of the Hayes Fracture Zone on Magnetic Anomaly 5D (Fig. 1). The sediments were washed down to the basement, which was felt at 240 m sub-bottom depth.

The basement, cored for 90 m, consisted of sparsely plagioclase phyric pillow basalts. Two chemical groups have been recognized on the basis of major and trace elements. Fresh glasses at the margins of pillows are very common. Despite some altered parts, the bulk of the crystalline basalts is fairly fresh. The magmaphile elements show a typically depleted distribution with the following average figures: Nb = 3 ppm, Zr = 95 ppm, Ti = 9300 ppm, Y = 41 ppm, V = 325 ppm, and (Nb/Zr)A = 0.3. This result is consistent with the precurse hypothesis of a depleted mantle source south of the Hayes Fracture Zone.

No samples were taken for pore-water chemistry analysis, and no downhole measurements were taken at this site.

OPERATIONS

Approach to Site
It was decided to drill Site 562 (MAR-10) near Anomaly 5D and south of the Hayes Fracture Zone. The available geophysical data in the area, including a recent SEABEAM survey by Centre National pour l'Exploitation des Oceans (now IFREMER) of the area near Anomaly 5 (MAR-9), indicated that there were several small fracture zones that had to be avoided. A tentative site was located midway between two small fracture zones about 50 and 75 miles respectively, south of the Hayes Fracture Zone. From Site 561, the track of the Challenger headed southwest and intersected a flow line passing through the proposed site about 40 miles east of the site. The track then followed the flow line in a northwesterly direction, crossing Anomalies 5B to 6 (Fig. 2). The identification of Anomaly 5B is not clear, and this anomaly could also be either Anomaly 5A or even Anomaly 5. Between 2330Z, 20 October and 0030Z, 21 October (Fig. 3), a low ridge was crossed with several potential drill sites. After steaming for two hours past this feature, no better sites were observed and we decided to drill on the site crossed at 0030Z. The course of the Challenger was reversed and the beacon was dropped on the site at 0412Z. The seismic profiler record indicated approximately 0.3 s of sediments above a strong basement reflector. The site is probably on Magnetic Anomaly 5D.

On-Site Operations
Hole 562 was spudded at 1053Z, 21 October and washed to basement. No mudline core was taken. Hard rock was hit at 240 m sub-bottom depth. Between 1400Z, 21 October and 2200Z, 23 October, 11 cores were cut penetrating 90 m of basement with 50% recovery without major incident (Table 1). Drilling was halted for time considerations; also, the diameter of the final cores was diminishing, indicating that bit failure was near. The drill string was pulled and the Challenger was under way to Site 563 at 1018Z, 24 October.

SEDIMENT LITHOLOGY
The sedimentary section drilled at Site 562 consists of 241 m of calcareous pelagic deposits, represented by one wash core (Core H1), in which 3.1 m of siliceous foraminiferal-nannofossil ooze and foraminiferal-nannofos-
Figure 1. Site location map, Leg 82.

Figure 2. Approach and site survey track for Site 562. Heavy line is the ship's track with hours marked in GMT. Thin line is magnetic anomaly projected perpendicularly from the ship's track. Circled numbers are magnetic anomalies based on work at Lamont-Doherty Geological Observatory.
two pillows, is dated at 15 to 17 Ma, which agrees with the basement age at this site.

The siliceous foraminiferal-nannofossil ooze is very pale brown (10YR 7/3) with rare mottling. The core is highly disturbed, so no sedimentary structures are evident. The bedding is massive. A smear-slide estimate indicates that this lithology contains about 15% clay and 13% siliceous fossils in addition to the principal calcareous components. The age range represented by the 2 m of this sediment lithology is late Pliocene to Pleistocene.

The foraminiferal-nannofossil ooze (represented by 1 m of sediment) is white (2.5Y 8/2 to 2.5YN 8), with possible faint massive bedding. We observed no mottling or bioturbation in this highly disturbed core. The principal component of this lithology is calcareous nannofossils. The oldest fauna in the core is from the early middle Miocene or late early Miocene.

The intrapillow limestone is white to pale grayish tan micrite. At 562-1-3, 112-120 cm (245 m sub-bottom) the limestone is cross laminated and contains abundant foraminifers. A slightly lower occurrence appears to be bioturbated. A similar limestone at 562-2-3, 80-88 cm (254 m sub-bottom), which fills a space between pillow margins, appears to have graded bedding (geopetal texture?).

The intrapillow limestone breccias are pinkish white to white, with either rounded or angular clasts of black basalt and/or glass.

**BIOSтратigraphy**

Hole 562 was washed down to 241 m. Lower Pleistocene to lower middle-upper lower Miocene sediments were retrieved. At this site both the calcareous nannofossils and the foraminifers agree on this age for basement.

**Calcareous Nannofossils**

On the basis of *Discoaster quinqueramus*, *Amaurolithus primus*, *S. amplificus*, *A. delicatus*, and *Triquetrirhabdulus rugosus*, 562-H1, CC is assigned to the upper Miocene *D. quinqueramus* Zone (NN11). Sediment contained within the first piece of basalt indicates a middle Miocene basement at this site. The included sediment contains *Sphenolithus heteromorphus*, which indicates either the *S. heteromorphus* Zone CN4 (NN3-NN4) or the *Helicosphaera ampliaperta* Zone CN3 (NN3-NN4). Because of poor nannofossil preservation, a more refined zonation of this interval was not possible.

**Foraminifers**

The core catcher of Core H1 is a white nannofossil-foraminiferal ooze with well-preserved, diverse foraminifers. Although Pliocene elements are present in the section, the oldest fauna in the core is Miocene. The sample is assigned to lower middle or possibly upper lower Miocene.

Sample 562-H1-2, 31-33 cm contains a lower Pleistocene fauna and 562-H1-3, 2-4 cm is upper (?) Miocene. A piece of bedded limestone found between two basalt flows in Section 562-1-3 (241–250 m) has abundant planktonic foraminifers that indicate a lower-middle or possibly upper-lower Miocene assignment.
SEDIMENT ACCUMULATION RATES

Although we cannot calculate detailed sedimentation rates at this site, an overall average sediment accumulation rate of 15 m/Ma (241 m in 16 Ma) seems consistent with those calculated for calcareous pelagic sedimentation during similar time periods at other sites.

IGNEOUS PETROLOGY AND GEOCHEMISTRY

Hole 562 reached basement at 241 m sub-bottom and penetrated 90 m into a sequence of plagioclase phryic pillow basalts interrupted by two massive flows of very similar lithology (Fig. 4). Two chemical groups have been recognized within this sequence.

Lithology (Fig. 4)

Basalts of Site 562 are for the most part sparsely to moderately plagioclase phryic with fine-grained groundmass. They range from fresh to moderately altered. Pillow diameters vary from a few tens of centimeters to about 1.5 m. Most pillows have fresh glass rinds less than 15 mm thick separated from fine-grained pillow cores by variolitic zones only a few millimeters thick. Varioles range from about 0.5 to 1 mm in diameter. Thicker glass rinds, up to 5 cm thick, are also present in several places, but generally detached from pillows (by drilling?). Glass clasts are also common in interpillow breccias, usually cemented with a fine-grained limestone matrix.

Plagioclase phenocrysts (2-5%) are mostly scattered uniformly throughout the rock, but in some places—mainly in the lower drilled portion—abundances may locally increase to as much as 15% or decrease to zero. Plagioclase phenocrysts range in size from about 1 to 10 mm and in shape from subhedral to rounded, possibly as a result of resorption. Glomerophyric clusters of plagioclase (about 15 mm in diameter) occur throughout the section.

Olivine microphenocrysts are sometimes observable, generally replaced by brown clay materials.

Vesicles are rare to absent (less than 1%), and commonly rounded, although some irregular ones do occur; they range from less than 1 mm to 2 mm in diameter. In the more altered parts of the basalt, vesicles are mainly clay filled, but calcite filling is also common. In fresh material close to pillow margins, most vesicles remain unfilled.

Massive lava flows were encountered at 268 m (3.7 m thick) and at 279 m (5.1 m thick). They are lithologically, petrographically and chemically very similar to the pillow basalts, although slightly coarser grained. The upper flow is almost nonvesicular. It has an aphyric upper margin about 50 cm thick becoming sparsely phryic to moderately phryic downhole. Plagioclase phenocrysts increase in abundance from 0 to 10% and in size from 2 to 10 mm. An aphyric basalt margin about 25 cm thick with a narrow glass selvage marks the base of this flow. The lower flow has a narrow glass rim underlain by a narrow variolitic zone at its upper margin. It is sparsely to moderately plagioclase phryic (2-5%) throughout with no apparent systematic variation in phenocryst size or abundance. The lower boundary is not clearly defined and may not have been recovered. Vesicles are abundant.

Figure 4. Basement lithology column, Hole 562.
Petrography

The two chemical groups of Site 562 cannot be distinguished petrographically—all pillow basalts are very similar, with only minor variations in texture and grain size. The two massive flows differ from flows in other sections only in their slightly larger grain size and their almost complete lack of interstitial glass.

Site 562 basalts are characterized by the presence of three distinct generations of plagioclase. They also differ from basalts of previous sites in the rounded, possibly resorbed appearance of olivine. In their mineralogy, Site 562 basalts are remarkably uniform throughout the hole, with approximately 45% plagioclase, 35% clinopyroxene, 2-3% olivine, 5-10% magnetite, and 10-15% mesostasis. Plagioclase occurs in three distinct generations which are, in order of crystallization, as follows:

1. Large prismatic phenocrysts are generally 2-3 mm, rarely up to 10 mm. They are typically subhedral (resorbed) and complex in internal structure, frequently with corroded cores. Small glass inclusions are also common. Few grains suitable for optical determination were observed; most yielded compositions close to A_{0.9} with a few higher, but this figure may not be reliable.3

2. Elongate, hollow laths, generally about 1 mm long, but ranging up to 3 mm, form radiating clusters, generally centered on olivine, or parallel growths from the ends of prismatic, Type 1 phenocrysts. Compositions of laths and overgrowths appear to be 5-10 wt.% lower in An than Type 1. Type 2 generally makes up 10 to 20% of all plagioclase.

3. Plagioclase in the form of fine laths less than 0.2 mm long and of anhedral intergrowths with fine, prismatic clinopyroxene makes up about 50% of the groundmass of most samples.

Clinopyroxene occurs mainly as small (less than 0.5 mm, generally less than 0.2 mm) prismatic or granular grains intergrown with Type 3 plagioclase and interstitial to Type 2 plagioclase. In samples close to pillow margins, this intergrowth has the appearance of devitrified glass, giving rise to a hyalophitic or hyalophilitic texture when viewed at low magnification. Such samples are, however, almost holocrystalline, with only about 10% of interstitial glass remaining. Fine granular magnetite (about 0.05 mm) is associated with clinopyroxene and glass.

Olivine, as small (0.1-0.6 mm), rounded, anhedral microphenocrysts, forms 2-3% of these basalts. In one sample (562-3-3, 103-106 cm) from close to a pillow margin, quench chains of olivine are present along with sheaves of skeletal plagioclase (Type 2). Individual olivine crystallites in the chains appear corroded, suggesting resorption of olivine by liquid or during subsequent, plagioclase-dominated crystallization. The rounded shapes of olivine phenocrysts at this site contrast with the euhedral, prism-shaped, diamond-shaped, and lantern-shaped microphenocrysts of previous sites. These, too, may suggest that olivine is unstable relative to the liquids that formed these rocks.

In these rocks, plagioclase has begun to crystallize earlier in the cooling history, and has persisted longer throughout that history than at any previous Leg 82 site. Type 1 plagioclase phenocrysts clearly formed before eruption and were subsequently corroded. Olivine appears to be later that Type 1 plagioclase, but is earlier than Type 2, and may have been resorbed during crystallization of Type 2.

Finally, with the entry of clinopyroxene as a crystallizing phase, crystallization became more rapid. Type 3 plagioclase precipitated together with clinopyroxene, whereas magnetite crystallized at grain boundaries and with the small remaining amounts of interstitial liquid (glass).

Geochemistry

Twenty-six basalts samples were analyzed for major and trace elements at Site 562. Two distinct chemical groups can be recognized (Fig. 5), although the lithology and petrology are relatively homogeneous. On an extended Coryell-Masuda plot (Fig. 6), all samples analyzed display a depleted magmaphile element signature. Within Chemical Group II, a small subgroup occurs as a consequence of sampling within an aphyric region of the otherwise slightly to moderately plagioclase phytic pillow sequence.

Chemical Group I is represented by 19 samples from Sections 562-1-1 through 562-6-3 (Table 2). Samples from Sections 562-4-1 and 562-4-3 are the only visibly altered samples analyzed, but an examination of Sr and K2O abundances suggests that the majority of samples have undergone some degree of alteration. Figure 7 shows the very scattered relationship of Sr values to CaO content. In an attempt to further assess the effects of alteration, we can assume that in a suite of fresh samples Sr and CaO should show a reasonably coherent, positive correlation and that seawater addition increases Sr content with little effect of CaO. The lower bound of the field of values in Figure 7 is a straight line passing through samples from Sections 562-2-1, 562-2-2, 562-2-3, 562-2-4, and 562-3-2. The slope of this line is the same as that derived in the same way for samples from Site 559. It seems reasonable to assume that these five samples are unaltered and that all other samples have undergone some Sr addition. When these samples are plotted on Figure 8 (K2O versus Sr) they occupy a separate field at low K2O and Sr values (along with other samples lying close to the Sr versus CaO line). Those samples that appear to have had Sr added have also had K2O added.

In order to assess the effects of alteration on other elements, we take the average composition of the five unaltered samples (562-2-1 to 562-2-4 and 562-5-2), express it in mole %, and compare it to the compositions of vis-

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3 Preliminary shore-based microprobe studies suggest a plagioclase phenocryst core composition close to about An_{0.9}, zoned to a marginal composition of about An_{0.5}. Type 2 plagioclase compositions are An_{0.5}.
Figure 5. Downhole variations in chemical abundances, Hole 562.

Chemical Group II is composed of the remaining samples from Site 562. Relative to Chemical Group I, Group II is lower in TiO$_2$, Fe$_2$O$_3$ (total iron), P$_2$O$_5$, V, Y, and Zr and higher in Al$_2$O$_3$ and CaO. Samples from Sections 562-8-2 and 562-9-1 form a separate subgroup; higher in TiO$_2$, Fe$_2$O$_3$ (total iron), V, Y, and Zr and lower in Al$_2$O$_3$ and CaO relative to the remainder of Chemical Group II. However, the two samples of this subgroup are aphyric whereas the remainder of Group II samples are sparsely to moderately plagioclase phryic. The geochemical differences between the subgroups are readily explained by this difference in plagioclase phenocryst content. Calculations presented in Table 4 are for a mixture of one part liquid having a chemical composition equal to the average of samples from Sections 562-8-2 and 562-9-1 with 8% added plagioclase phenocryst. Two plagioclase compositions were used, An$_{90}$ and An$_{75}$ (Deer et al., 1976). The composition resulting from An$_{90}$ addition is remarkably similar to that of Section 562-7-2; the addition of An$_{75}$ to the average liquid results in a composition almost exactly that of Sections 562-7-2 and 562-8-1. This calculated composition also approximates Sections 562-

Figure 6. Extended Coryell-Masuda diagram for averages of chemical Groups I and II Hole 562 basalts.
6-4, 562-7-1, and 562-10-2, except that CaO and/or MgO concentrations are higher than calculated. Hence, this chemical subgroup is an artifact of sampling in a non-uniform sequence and not of petrogenetic significance.

K₂O and Sr abundances of Group II rocks also show a wide scatter indicating widespread alteration with this group (Figs. 7 and 8).

MAGNETICS

Basalt Paleomagnetism

At this site, 90 m of basalt were cored and 33 oriented minicores were taken for on-board study of paleomagnetic properties. The normal remanent magnetization (NRM) and susceptibility were routinely measured, and then each sample was subjected to alternating field (AF) demagnetization at various steps until the remanent magnetization value was 5% of the NRM intensity. The NRM, susceptibility, median demagnetizing field (MDF), and the results of AF demagnetization are given in Table 5. The typical results of demagnetization (Figs. 9, 10) separated two types of basalt.

Type A basalt has high susceptibility (more than 200 \( \times 10^{-6} \) emu/cm³) and mostly around 600 \( \times 10^{-6} \) emu/cm³) and low MDF (less than 200 Oe, and mostly less than 100 Oe). This suggests that the magnetic mineral in the basalt is of low coercivity, which might be the result of the larger grain size of titanomagnetite or the presence of magnetite.

Type B basalt has low susceptibility (less than 200 \( \times 10^{-6} \) emu/cm³, and mostly less than 100 \( \times 10^{-6} \) emu/
Table 3. Effects of alteration on chemical composition Group I, Hole 562.

<table>
<thead>
<tr>
<th>Element</th>
<th>Average Measured T Change (%)</th>
<th>Measured T Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major elements (mole %)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiO₂</td>
<td>56.51</td>
<td>-2</td>
</tr>
<tr>
<td>TiO₂</td>
<td>1.33</td>
<td>+1</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>9.97</td>
<td>-2</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>5.05</td>
<td>-2, +1</td>
</tr>
<tr>
<td>MnO</td>
<td>0.17</td>
<td>-5</td>
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<tr>
<td>MgO</td>
<td>12.30</td>
<td>+4</td>
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<tr>
<td>CaO</td>
<td>14.30</td>
<td>-1</td>
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<tr>
<td>Na₂O</td>
<td>0.11</td>
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<td>K₂O</td>
<td>0.07</td>
<td>0</td>
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<td><strong>Trace elements (ppm)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ti</td>
<td>93.36</td>
<td>+2</td>
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<tr>
<td>V</td>
<td>327</td>
<td>+1</td>
</tr>
<tr>
<td>Sr</td>
<td>95</td>
<td>+16</td>
</tr>
<tr>
<td>Y</td>
<td>14.5</td>
<td>+2</td>
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<tr>
<td>Zr</td>
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<tr>
<td>Nb</td>
<td>3.0</td>
<td>+7</td>
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<tr>
<td>Note: Average is average composition of the five least altered basalts from Group I; T is normalized composition with respect to TiO₂ = 1.33 wt. %; change (%) is change relative to average basalt composition. Total Fe as Fe₂O₃; Mg is the atomic ratio of 100 × (Mg/(Mg + Fe)) calculated using an assumed Fe₂O₃ ratio of 0.15.</td>
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PHYSICAL PROPERTIES

The hole was washed to basement with no recovery of undeformed sediment. Velocity and density measurements were made on basalt cores as shown in Table 6.

The results are remarkable only for densities and velocities that are generally higher than for average basalts from this leg. The specimen from Core 3 with a velocity of 5.98 km/s and density of 2.91 Mg/m³ is the highest of these, and well above a mean value for ocean basalts at laboratory temperature and pressure. The basalts recovered are from a massive flow unit, in contrast to the predominance of pillow basalts in the previous holes of this leg. The variation in properties downhole does not reveal any systematic pattern.

SUMMARY AND CONCLUSIONS

Hole 562 was drilled on Anomaly 5D about 60 miles south of the Hayes Fracture Zone, the first site on the southernmost flow line. The sediments were washed down and the bottom felt at 240 m.

The basement, cored for 90 m, consisted of sparsely plagioclase phryic pillow basalts. Fresh glasses at the margins of the pillows are very common. Despite some altered parts, the bulk of the crystalline basalts are fairly fresh. The macro-description and micro-description of recovered samples show one petrographic unit, but both major and trace element data show two different chemical groups. The first chemical group in the basement is fairly homogeneous even though a downhole gradient is observed for Al₂O₃ (from 14.6 at the top to 15.2 in the lower region). The second chemical group is less homogeneous, because of variable plagioclase phenocryst distribution. The two chemical groups show a depleted character for magmaphile elements, with (Nb/Zr)ch of ~ 0.3.

It would have been ideal to drill a second hole in the area to obtain a more extensive sampling of basalt material, but we decided to save time for the last hole at Anomaly 13, where logging and piston coring were planned.

REFERENCE


Table 4. Effect of plagioclase phenocryst addition on chemical composition, Group II, Hole 562.

<table>
<thead>
<tr>
<th>Element</th>
<th>Liquid (average composition of samples from Sections 562-9-2 and 562-9-1)</th>
<th>Composition of plagioclase An₆₀</th>
<th>Composition of plagioclase An₇₅</th>
<th>1 part liquid + 0.08 plagioclase</th>
<th>Composition of plagioclase An₇₅</th>
<th>1 part liquid + 0.08 plagioclase</th>
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<tr>
<td>SiO₂</td>
<td>49.98</td>
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<td>49.06</td>
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<td>TiO₂</td>
<td>1.26</td>
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<td>Al₂O₃</td>
<td>15.13</td>
<td>29.72</td>
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<td>Fe₂O₃</td>
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<td>MgO</td>
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<td>P₂O₅</td>
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Note: Plagioclase An₆₀ and An₇₅ compositions from Deer et al., 1976.
Table 5. Paleomagnetics properties of Site 562 basalts.

<table>
<thead>
<tr>
<th>Core-Section (interval in cm)</th>
<th>JNRM (× 10^-3 emu/cm^3)</th>
<th>NRM inc. (°)</th>
<th>Stable inc. (°)</th>
<th>X (× 10^-6 emu/cm^3 Oe)</th>
<th>MDF (Oe)</th>
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<tr>
<td>1-2, 28-30</td>
<td>16.77</td>
<td>-27.4</td>
<td>-34.3</td>
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<td>90</td>
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<td>2-1, 64-71</td>
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<td>65</td>
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<td>2-2, 142-144</td>
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<td>-29.4</td>
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<td>-40.0</td>
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<td>490</td>
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<td>2-5, 9-11</td>
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<td>-34.4</td>
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<td>-19.1</td>
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<td>-36.4</td>
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Note: JNRM = intensity of natural remanent magnetization (NRM); inc. = inclination; X = susceptibility; MDF = median demagnetizing field.

Figure 9. Percent natural remanent magnetization (NRM) versus peak alternating field curves for Type A basalt (562-5-4, 29-31 cm) and Type B basalt (562-7-1, 26-28 cm). MDF = median demagnetizing field.
Figure 10. Vector diagrams showing the change of NRM after alternating field demagnetization for Type A basalt (562-5-4, 29-31 cm) and Type B basalt (562-7-1, 26-28 cm). Solid circles are plotted on the horizontal plane and open circles are plotted on the vertical plane. NRM = natural remanent magnetization.

Table 6. Physical properties, Hole 562.

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<tr>
<th>Core-Section (interval in cm)</th>
<th>Sub-bottom depth (m)</th>
<th>Sonic velocity (km/s) (horizontal)</th>
<th>Temperature (°C)</th>
<th>GRAPE density (g/cm³) (horizontal)</th>
<th>Gravimetric density</th>
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</table>

Note: Water content is corrected; phi = porosity; Plag. = plagioclase. All values measured at laboratory temperature and pressure. For details of techniques, see Explanatory Notes chapter (this volume).
SITE 562 HOLE CORE H1 CORED INTERVAL 0.0-241.0 m

LITHOLOGIC DESCRIPTION

Very pale brown (10YR 7/3)
Highly disturbed by drilling
FORAMINIFER NANNOFOSSIL OOZE
White (2.5Y 8/2-2.5Y N8I
Possible faint bedding

SMEAR SLIDE SUMMARY (%):
Composition:
- Feldspar
- Clay
- Palagonite
- Foraminifers
- Calc. nannofossils
- Diatoms
- Radiolarians
- Sponge spicules
- Silicoflagellates
- Other

Tr 15 15 15 57 2 2 3 5
Tr 5 Tr 5 Tr 10 84

SITE 562 HOLE
CORE H1
CORDED INTERVAL
0.0-241.0 m

LITHOLOGY
Basal, basal, basal.
Basalt
Basal, basal, basal.
Basalt
Basal, basal, basal.
Basalt

LITHOLOGIC DESCRIPTION

36-42 cm: White with black clasts.
65-70 cm: Pinkish white basalt.
White basalt, white limestone.
VARIOLITIC BASALT

Depth 0.0-241.0

SITE 562, CORE H1

Core-Catcher

Crysts, dark gray (7.5Y N4/0), fine grained, plagioclase, < 1%, anhedral, 2-10 mm, olivine (relic), subhedra <1 mm. Moderately altered, variolites are brown (10YR 5/3). Vesicle percentage 10% in unchilled areas only.

0-10 cm: There is a rind (2 cm width) of fresh black basalt glass which grades into a metallic zone. There is a trace of sediment in the glass, which consists of 1-2 mm dark flint. Glass shards.

Depth 241.0-250.0

SITE 562, CORE 1

SECTION 1

PLOIOCLASE PHYRIC PILLOW BASALT

0-22, 28-42, and 65-160 cm: Plagioclase moderately phyric basalt, dark gray (2.5Y N4) in fresh parts and gray (2.5Y 5/2) in altered parts. Interbedded, Plagioclase phenocrysts (2-3%), 3 mm-4 cm moderately altered to gray brown (2.5Y 5/2), < 1% rounded and irregular vesicles (< 1 mm). Filled with light green clay.

30-38 and 45-65 cm: Glass clasts (black) in limestone matrix, mostly fresh with alteration to dark brown (2.5Y 3/2) around edge of clasts.

SECTION 2

PLOIOCLASE PHYRIC PILLOW BASALT

22-96 and 111-138 cm: Plagioclase moderately phyric basalt (2.5Y N6), fresh to slightly altered, < 1% rounded and irregular vesicles filled with dark to light green clay (2.5Y 5/4-6). Plagioclase phenocrysts (2-5 mm). Unlike the last two basalt in Section 1.

0-22 and 87-110 cm: Glass clasts (black) in limestone matrix, mostly fresh with alteration as in Section 1. Limestone with locally altered glass (2.5Y 5/6).

SECTION 3

PLOIOCLASE PHYRIC PILLOW BASALT

0-113 and 125-150 cm: Moderately plagioclase phyric basalt, dark gray (2.5Y N4/1), fresh to medium altered, plagioclase phenocrysts, 2-3%, anhedral, 1-10 mm. Fresh clasts to moderately altered clasts, white to light green clays. Plagioclase phenocrysts, 2-3%, anhedral, 1-10 mm.

0-113 and 125-150 cm: Moderately plagioclase phyric basalt, dark gray (2.5Y N4/1), fresh to medium altered, plagioclase phenocrysts, 2-3%, anhedral, 1-10 mm. Fresh clasts to moderately altered clasts, white to light green clays. Plagioclase phenocrysts, 2-3%, anhedral, 1-10 mm.

SECTION 4

PLOIOCLASE PHYRIC PILLOW BASALT

0-10 cm: Limestone matrix (2.5Y 5/1) graded undetached form beds, red mudstone (2.5Y 5/1) with interbedded iron oxide, dolomite (2.5Y 5/1).

SECTION 5

PLOIOCLASE PHYRIC PILLOW BASALT

0-10 cm: Limestone matrix (2.5Y 5/1) graded undetached form beds, red mudstone (2.5Y 5/1) with interbedded iron oxide, dolomite (2.5Y 5/1).
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<td></td>
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<tr>
<td>3</td>
<td>Section 2, 20–40 cm: Intercalated dolomitic limestone (white) with thin beds of marl. Small areas of interbedded dolomitic limestone.</td>
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<tr>
<td>4</td>
<td>Basef.</td>
</tr>
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<td>5</td>
<td>Basef.</td>
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SECTION 1
Plagioclase phyric pillow basalt
0-20 cm: Sparsely plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
20-40 cm: Sparsely plagioclase-plagioclase phyric pillow basalt, dark gray (7.5YR 5/3) to dark gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
40-100 cm: Sparsely plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
100-500 cm: Sparsely plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.

SECTION 2
Sparse plagioclase phyric pillow basalt
0-40 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
40-80 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
80-120 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
120-160 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.

SECTION 3
Sparse plagioclase phyric pillow basalt
0-10 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
10-50 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
50-100 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
100-150 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.

SECTION 4
Sparse plagioclase phyric pillow basalt
0-10 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
10-50 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
50-100 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
100-150 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.

SECTION 5
Sparse plagioclase phyric pillow basalt
0-10 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
10-50 cm: Sparse plagioclase phyric pillow basalt, gray (7.5YR 5/4) to light gray (5Y 7/2), fine-grained, with sparse prisms and altered olivine. Glass altered brown (10YR 6/3) to green. Vesicles show irregular shapes.
SECTION 1
SPARSELY PLAGIOCLASE PHYRIC PILLOW BASALT
0-40 and 70-80 cm: Sparsely phyric, fine-grained basalt — pillow interiors as in Core 2, Section 1.
40-60 and 80-90 cm: Sparsely phyric, aphanitic and vesicular basalt and glass — pillow margin material as in Core 2, Section 2.
60-70 and 110-120 cm: Calcareous interbeds, with calcite in lower interval.
110-120 cm: Limestone; few grains; light yellowish brown (10YR 6/4).

SECTION 2
GLASS AND SPARSELY PLAGIOCLASE PHYRIC PILLOW BASALT
47-147 cm: Zones wide, few cm thick.
Vesicles are present and rounded 0.2-2 mm in diameter.

SECTION 3
SPARSELY PLAGIOCLASE PHYRIC PILLOW BASALT
43-49 and 65-105 cm: Sparsely phyric, fine-grained basalt — pillow interiors as in Core 2, Section 1 and Core 3, Section 4.
0-40 and 50-65 cm: Sparsely phyric aphanitic and vesicular basalt and glass — pillow margin as in Core 2, Section 2 and Core 3, Section 4.

SECTION 4
SPARSELY PLAGIOCLASE PHYRIC PILLOW BASALT
90-125 cm: Sparsely phyric, fine-grained basalt — pillow interiors as in Core 2, Section 1 and Core 3, Section 1.
0-10 and 125-135 cm: Basalt chips.
SECTION 1
APHYRIC TO SPARSELY PLAGIOCLASE PHYRIC BASALT (MASSIVE FLOW)
0-150 cm: Aphyric, fine-grained basalt becoming sparsely plagioclase phyric downhole. Fine-grained basalt.
gray (7.5YR 6/7) with scattered (<30%) sparsely long plagioclase needles to 3 mm (maximum oriented). Fine
(<1 mm) matrix, plagioclase needles (70-75%) in matrix, sparse. Plagioclase phenocrysts, both prisms
and rounded granophyres. Fibrous to 3 mm, some to 1 cm. Average 0.3-0.5 cm. Base 1.3 cm below 80 cm.
3-30 cm: Black red, fine-grained basalt as mini and irregular laths with basalt (light red - 7YR 5/6),
light brown (5YR 6/3).
Calcite 10% (white, 4.5%)

SECTION 2
SPARSELY TO MODERATELY PLAGIOCLASE PHYRIC BASALT (MASSIVE FLOW)
0-130 cm: Fine-grained, massive basalt becoming more sparsely plagioclase phenocrysts.
30-40% elongate (3-5 mm) plagioclase needles (max oriented). Fine, fresh, brown, sparsely altered
(<15%) in weathered zone. Plagioclase phenocrysts, both prisms and rounded granophyres. Fibrous to 3 mm,
some to 1 cm. Average 0.3-0.5 cm. Base 1 cm below 80 cm.
Calcite 10% (white, 4.5%)

SECTION 3
SPARSELY TO MODERATELY PLAGIOCLASE PHYRIC PILLOW BASALT (MASSIVE FLOW)
0-150 cm: Moderately plagioclase phyric basalt, gray (7.5YR 5/8), fine-grained as in Section 1.
30-40% elongate (3-5 mm) plagioclase needles (max oriented).
White calcite phenocrysts 2 mm, rare.
3-13 cm: Dark gray (7.5YR 5/8) to light brown-gray (7.5YR 6/2).
Fibrous white calcite phenocrysts to 3 mm, rare.
Veins of calcite and laths of limestone, light reddish-brown (7.5YR 6/2).
Glass only slightly palagonitized.

SECTION 4
PLAGIOCLASE PHYRIC PILLOW BASALT AND GLASS CLASTS IN LIMESTONE - CALCITE MATRIX
10-56, 66-75, and 90-130 cm: Basalt pillows with variolitic zone grading into aphanitic black basalt with
glass rims. As in Section 3, 94-150 cm, Fairly fresh to moderately altered. <1% rounded and irregular vesicles
(<1 mm) in variolitic zone or pillow margin.
9-16, 58-75, and 77-90 cm: Fresh to moderately altered basalt pillows with variolitic zone and light reddish-brown (7.5YR 6/2)
Veins of calcite and glass clasts in limestones, light reddish-brown (7.5YR 6/2).
Glass only slightly palagonitized.

SECTION 5
PLAGIOCLASE PHYRIC BASALT PILLOW
3-13 cm: Moderately, fine-grained plagioclase, gray, 7.5YR 6/8, fine-grained, sparsely plagioclase phenocrysts,
3-50, altered (light red), 1-10 mm, fresh to moderately altered (<1%), and without vesicles in altered veins, 2Y 6/1
1-5 and 15-42 cm: Vesicles, white.
SECTION 1

FLAGOECLASS; PHYSIC PILLOW BASALT

9-14 cm: Moderately plagioclase-phyric fine-grained basalt, color dark gray (7.5YR 4/0). Subhedral to rounded, resorbed plagioclase (~2-5 vol. %), size up to 1 cm. Rock is fresh to moderately altered. Vesicles are absent in upper part of pillow. Small, elongate, and scattered in clay, size ~1-3 mm. Subhedral to rounded plagioclase phenocrysts are present in the upper part (10-14 and 104-127 cm) of the pillow, only weakly palagonitized along fractures. Vesicles are filled with glass and are moderately altered (color brown - 2.5YR 7/2). Few calcite-filled vesicles occur in Pieces 1, 2B, and 1D.

SECTION 2

0-38 cm: PLAGIOCLASE-PHYRIC (PILLOW?) BASALT. Moderately plagioclase-phyric basalt, color dark gray (7.5YR 5/3); contains subhedral to rounded plagioclase phenocrysts (size: <1 cm; abundance: ~3 vol. %). Calcite-filled vesicles increase at bottom (Pieces 2B and 1D). Pieces 2C shows irregular vesicles (<1 cm), partly calcite-grained. Color dark gray (7.5YR N4/0). Subhedral to rounded, resorbed plagioclase phenocrysts (~2-4 vol. %), size up to 1 cm. Basalt is fresh to moderately altered. Vesicles are present in the upper part (30 to 65 cm) and decrease to bottom. They are mainly open or just coated with some clay material. 30-40 cm: At the top of Piece 2B exists a 5-10 cm layer of pinkish-gray (7.5YR 7/2) limestone with angular plagioclase fragments (size: 1-5 mm). The basalt in Piece 2D shows variable transition from fresh to grayish-brown (5YR 5/2) basalt (commem.) from 30 cm downward. Basalt is moderately altered near the bottom.

SECTION 3

MODERATELY PLAGIOCLASE; PHYSIC MASSIVE BASALT

0-12 cm: Gray (7.5YR 5/2), fine-grained plagioclase-phyric basalt (size: <1 cm; abundance: ~3 vol. %). Subhedral to rounded, resorbed plagioclase phenocrysts (~3 vol. %), size up to 1 cm. Basalt is fresh to moderately altered. Vesicles are present in the upper part (30 to 65 cm) and decrease to bottom. They are mainly open or just coated with some clay material. 30-40 cm: At the top of Piece 2B exists a 5-10 cm layer of pinkish-gray (7.5YR 7/2) limestone with angular plagioclase fragments (size: 1-5 mm). The basalt in Piece 2D shows variable transition from fresh to grayish-brown (5YR 5/2) basalt (commem.) from 30 cm downward. Basalt is moderately altered near the bottom.

SECTION 4

MODERATELY FLAGOECLASS; PHYSIC MASSIVE BASALT

Similar to Section 3. Generally more altered than Section 3, but otherwise similar. 78-90 cm: Vein filled with pinkish-gray (7.5YR 5/2) limestone. Little calcite veins.

SECTION 5

0-117 cm: PLAGIOCLASE-PHYRIC BASALT. Moderately plagioclase-phyric fine-grained basalt. Description as above. Few plagioclase phenocrysts larger than 1 cm (~5 vol. %). No calcite veins at 65 cm vertical distance between sparry calcite and basalt. At 117 cm end of massive basalt.

118-129 cm: BASALT BRECCIA PIECE. Highly fractured and calcite cemented plagioclase-phyric basalt and plagioclase-facies breccia. Varieties include clayey (7.5YR 2/1). Fine grained, calcite-filled vesicles filling 120-132 cm. PLAGIOCLASE-PHYRIC BASALT. Moderately plagioclase-phyric, fine-grained, dark gray (5YR 5/5), 5 cm plagioclase phenocrysts. They are subhedral to rounded, resorbed. No vesicles.

SITE 562, CORE 5
Depth: 277.0-286.0 m
SECTION 1

SPARSELY PLAGIOCLASE PHYRIC PILLOW BASALT SEQUENCE

0-150 cm:
Sparsely plagioclase phyric pillow basalt in sequence with glass — aphanitic plagioclase phyric — variolitic — plagioclase-phyric basalt. Generally gray (2.5YR 6/4). Alternating present in fractures and pillows rims. Alternating phases are present in various degrees of frequency; from nearly absent (Pieces 2, 8B, and 9A) to totally (Pieces 1 and 4). Overall, core is sparsely phyric:

- glass concentrated in Pieces 3, 4, 5A, and B, 8A, and 9A. Centimeters and or volume.

SECTION 2

SPARSELY PLAGIOCLASE PHYRIC PILLOW BASALT

Sparsely plagioclase phyric pillow basalt sequence gray (2.5Y N5). Same as in Section 1. Exceptions noted.

Glass as indicated (Pieces 5A and 6A strong glass rims).

SECTION 3

MODERATELY PLAGIOCLASE PHYRIC PILLOW BASALT

0-150 cm:
Sparsely plagioclase phyric pillow basalt, fine grained. Colors gray (2.5Y 6/3) with rare (2-3 mm) zones of black aphanite and/or very tiny (<0.1 mm) matrix (or no aphanite at all). Alternating phases are present in various degrees of frequency; from nearly absent (Pieces 2, 8, and 9A) to totally (Pieces 1 and 4). Overall, core is sparsely phyric:

- glass concentrated in Pieces 3, 4, 5A, and B, 8A, and 9A. Centimeters and or volume.

SECTION 4

SITE 562, CORE B

Depth 304.0-313.0 m

SPARSELY TO MODERATELY PLAGIOCLASE PHYRIC BASALT PILLOWS

0-113 cm:
Sparsely plagioclase phyric pillow basalt, fine grained. Colors gray (2.5Y 6/3) with rare (2-3 mm) zones of black aphanite and/or very tiny (<0.1 mm) matrix (or no aphanite at all). Alternating phases are present in various degrees of frequency; from nearly absent (Pieces 2, 8, and 9A) to totally (Pieces 1 and 4). Overall, core is sparsely phyric:

- glass concentrated in Pieces 3, 4, 5A, and B, 8A, and 9A. Centimeters and or volume.

SECTION 5

MODERATELY PLAGIOCLASE PHYRIC PILLOW BASALT

0-150 cm:
Sparsely plagioclase phyric pillow basalt, fine grained. Colors gray (2.5Y 6/3) with rare (2-3 mm) zones of black aphanite and/or very tiny (<0.1 mm) matrix (or no aphanite at all). Alternating phases are present in various degrees of frequency; from nearly absent (Pieces 2, 8, and 9A) to totally (Pieces 1 and 4). Overall, core is sparsely phyric:

- glass concentrated in Pieces 3, 4, 5A, and B, 8A, and 9A. Centimeters and or volume.

SECTION 6

MODERATELY PLAGIOCLASE PHYRIC PILLOW BASALT

0-150 cm:
Sparsely plagioclase phyric pillow basalt, fine grained. Colors gray (2.5Y 6/3) with rare (2-3 mm) zones of black aphanite and/or very tiny (<0.1 mm) matrix (or no aphanite at all). Alternating phases are present in various degrees of frequency; from nearly absent (Pieces 2, 8, and 9A) to totally (Pieces 1 and 4). Overall, core is sparsely phyric:

- glass concentrated in Pieces 3, 4, 5A, and B, 8A, and 9A. Centimeters and or volume.
**SITE 562, CORE 10**
Depth: 313.0-322.0 m

**SECTION 1**
**PLAGIOCLASE PHYRIC PILLOW BASALT**
0-150 cm: Moderately plagioclase phyric to aphyric, fine-grained basalt; color gray (7.5YR N5/0); plagioclase phenocrysts up to 1 mm. Subrounded to rounded. Vesicles only occur between 40-50 cm. Calcite-filled, and <1 mm.

- Fresh glass at 38-39, 39-41, 63-65, 82-84, and 133-135 cm.

**SECTION 2**
**MODERATELY PLAGIOCLASE PHYRIC PILLOW BASALT**
0-150 cm: Fine-grained, gray (2.5Y N5) moderately plagioclasephyric pillow basalt.
- ~5% Plagioclase phenocrysts (2-10 mm), fairly fresh (gray as above) basalt to moderately altered (light olive brown - 7.5Y 4/2) along edges of fractures and some pillows around.
- Calcite and pink (5YR 7/4) limestone in veins.
- Fresh glass at 26-28, 32-34, 66-74, 84-91, and 104-105 cm.

**SECTION 3**
**PLAGIOCLASE PHYRIC BASALT**
0-62 cm: Moderately to sparsely plagioclase-phyric basalt, fine-grained, color gray (7.5YR N5/0).
- Fresh glass at 55-58 cm.

**SITE 562, CORE 11**
Depth: 322.0-331.0 m

**SECTION 1**
**PLAGIOCLASE PHYRIC PILLOW BASALT**
0-150 cm: Moderately plagioclase phyric to aphyric, fine-grained basalt; color gray (7.5YR N5/0). Plagioclase phenocrysts up to 1 mm. Subrounded to rounded. Vesicles only occur between 40-50 cm. Calcite-filled, and <1 mm.
- Fresh glass at 38-39, 39-41, 63-65, 82-84, and 133-135 cm.

**SECTION 2**
**MODERATELY PLAGIOCLASE PHYRIC PILLOW BASALT**
0-150 cm: Fine-grained, gray (2.5Y N5) moderately plagioclasephyric pillow basalt.
- ~5% Plagioclase phenocrysts (2-10 mm), fairly fresh (gray as above) basalt to moderately altered (light olive brown - 7.5Y 4/2) along edges of fractures and some pillows around.
- Calcite and pink (5YR 7/4) limestone in veins.
- Fresh glass at 26-28, 32-34, 66-74, 84-91, and 104-105 cm.

**SECTION 3**
**PLAGIOCLASE PHYRIC BASALT**
0-62 cm: Moderately to sparsely plagioclase-phyric basalt, fine-grained, color gray (7.5YR N5/0). Plagioclase phenocrysts (2-4 mm), but traces of altered. Fresh glass at 55-58 cm.