40. BASALT FROM 22°-23°N, MID-ATLANTIC RIDGE MEDIAN VALLEY

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INTRODUCTION

In this chapter, we summarize the petrography and major element chemistry of basalt collected by *Atlantis* II at 23°N, and compare these data with published data for 22°N and with the preliminary shipboard data for Sites 395 and 396, in order to define the regional petrologic setting of the Leg 45 basalts.

The petrography and chemical composition of basalt, dolerite, and greenstone from the median valley at 22°N were reported by Melson et al. (1968). The samples were dredged from various levels on the inner walls of the valley, and included significant amounts of mylonitized basalt, greenstone, and dolerite. Melson et al. (1976) reported major element data for basalt glasses selected from these same dredge stations. During *Atlantis* II Cruise 92, four additional dredge stations were successfully completed at about 23°N. Station 28 was in the rift mountains west of the median valley; Station 29 was on the lower slope of the west wall of the valley, and Stations 30 and 31 represent material recovered on the eastern and western floor of the valley, respectively. The positions of these stations are shown in profile in Figure 1. A selection of glass chips representing basalts from each of these stations was analyzed by electron microprobe at the Department of Mineral Sciences, Smithsonian Institution, according to procedures described by Melson et al. (1976).

PETROGRAPHY

About 100 pounds of basalt was recovered at Station 28; it consists of one very large piece and several smaller fragments of sparsely phyric, holocrystalline basalt. The fragments are rounded or subangular with no freshly broken surfaces, and probably were sifted out of sediment-covered talus by the dredge. Although no glass selvages are present, the aphanitic groundmass approaches a spherulitic texture, suggesting rapid quenching. Thin sections show phenocrysts of olivine, often partly serpentinized, and both subhedral plagioclase phenocrysts and larger, rounded plagioclase resembling the xenocryst plagioclase described by Melson et al. (1968).

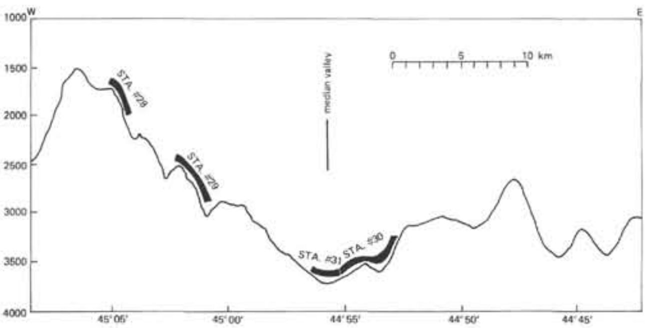

Figure 1. *Bathymetric profile of median valley at about 23°02′N, showing positions of bottom contact of dredge Stations 28, 29, 30, and 31. Vertical exaggeration 8.85×.*

At Station 29, about 200 pounds of slightly weathered pillow fragments were recovered. These also show few freshly broken faces, are slightly weathered, and have thin manganese coatings, again suggesting recovery of loose talus or broken fragments on an older, degraded flow surface. Rounded plagioclase xenocrysts up to 6 to 8 mm in diameter are common in these fragments. The aphanitic groundmass shows quench olivine with typical "lantern and chain" morphology.

At Station 30, the dredge touched bottom in a depression at the base of the eastern valley wall and was towed west over two apparent volcanic hills on the east central part of the valley floor. The dredge recovered about 150 pounds of relatively fresh pillow basalt with little or no manganese coating or palagonite development on glass. Many of the fragments are slabs, some of which can be assembled into what are clearly portions of larger blister pillows or layered lava tubes. These samples do not contain xenocryst plagioclase, but do show development of small euhedral plagioclase phenocrysts or microphenocrysts. Olivine also appears as subhedral, skeletal phenocrysts and as "lantern and chain" forms in spherulitic, glassy margins.

At Station 31, *Atlantis* II continued the traverse across the western half of the valley floor on very subdued terrain. About 400 pounds of slabby and keystone-shaped pillow lava were recovered, including very fresh unweathered fragments and old pieces with moderate weathering and thin manganese crusts. Plagioclase xenocrysts and phenocrysts are common in most samples, and more rarely are accompanied by olivine. Extinction angles indicate plagioclase compositions in the bytownite range. Euhedral plagioclase and olivine appear as microphenocrysts. Pyroxene very rarely appears as the "knot" in "bow-tie" intergrowths with plagioclase.

Basalts from all four stations show some vesicularity, on the order of 2 to 5 per cent, and in all, plagioclase is dominant over olivine as a phenocryst or xenocryst phase. Pyroxene is typically a quenched groundmass phase, but rarely appears as a microphenocryst. Spinel was not identified in the samples examined. Plagioclase as large rounded xenocrysts is most abundant in samples from the western valley floor and lower western wall. The freshest samples, but also some of the older and more weathered samples, were recovered from the western valley floor.

CHEMICAL COMPOSITION

Typical microprobe analyses are given in Table 1. The glass data from Stations 29, 30, and 31 are plotted along with glass data from Melson et al. (1976) in terms of FeO*/MgO and TiO_2 in Figure 2. These parameters have proved useful for comparison of seafloor basalt glasses. The figure shows a close correspondence between the glass data and the field of plotted points for the aphyric basalts from Sites 395 and 396. The phyric basalts from those sites, in contrast, fall outside the range of the glass data, but conform well to the dolerite and basalt reported by Melson et al. (1968). The glass data correspond to the most iron- and titanium-enriched basalts from the FAMOUS area, and overall appear somewhat more "fractionated" than typical oceanic basalt. In terms of the criteria discussed by Bryan et al. (1976), the median valley basalts at 22°-23°N would be characterized as moderately fractionated group I, on the basis of relatively high TiO_2 and FeO*/MgO, moderate K_2O,

TABLE 1
Selected Basalt Glass Analyses from 22°-23°N, Mid-Atlantic Ridge Rift Valley

	1	2	3	4	5	6	7	8
SiO_2	51.01	50.61	50.02	50.49	50.68	51.02	50.94	50.15
Al_2O_3	14.97	16.56	16.04	15.13	15.73	14.94	15.20	15.46
FeO*	10.02	9.69	9.80	10.72	9.96	10.09	10.35	10.30
MgO	7.13	7.97	7.36	7.26	7.52	7.12	7.10	7.05
CaO	12.42	11.52	11.17	10.87	11.01	11.00	11.13	10.84
Na_2O	2.53	2.76	2.84	2.97	2.85	3.05	3.19	2.99
K_2O	0.13	0.09	0.13	0.14	0.11	0.12	0.13	0.11
MnO	–	–	–	–	–	–	–	–
TiO_2	1.34	1.44	1.68	1.95	1.47	1.65	1.70	1.88
P_2O_5	0.09	0.12	0.16	0.15	0.15	0.18	0.18	0.19
Total	99.64	100.76	99.20	99.68	99.48	99.17	99.92	98.97

Note: Columns 1-4, Melson et al., 1976. FeO* represents total iron as FeO. All analyses by electron microprobe, Department of Mineral Sciences, Smithsonian Institution.

1, 22.17°N; 2, 22.52°N; 3, 22.19°N; 4, 22.52°N; 5, AII92-31-31E; 6, AII92-30-37; 7, AII92-30-8; 8, AII92-29-64.

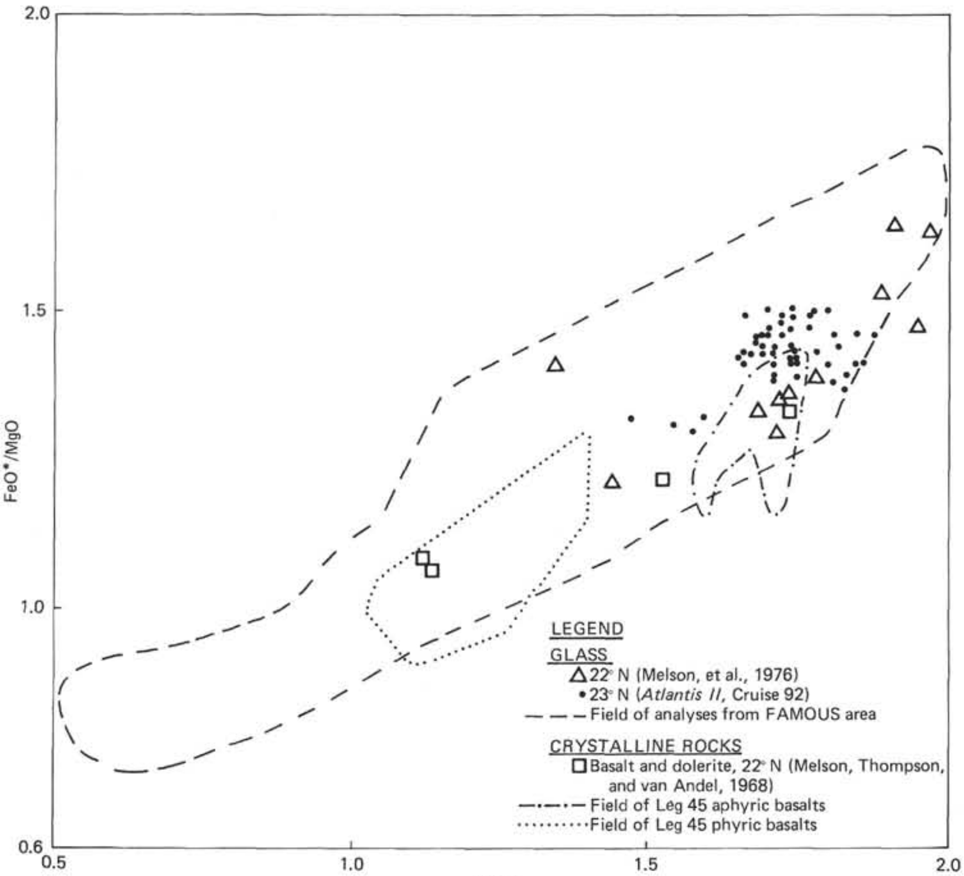

Figure 2. *Plot of FeO*/MgO vs. TiO_2 for analyzed basalt, and dolerite from the median valley 22°-23°N. Data from Melson et al., 1968, 1976; and from* Atlantis II *Cruise 92.*

and lack of conspicuous liquidus pyroxene. This is also supported by limited trace element data reported by Melson et al. (1968), showing Ba 3 to 9 ppm and "typical" levels for other elements.

REGIONAL COMPARISONS

Melson et al. (1968) cite phenocrysts of plagioclase and olivine as the typical liquidus phases and also in some samples, as rounded and partly resorbed xenocrysts. The petrographic characteristics and major element chemistry of the samples from 23°N are very similar to those at 22°N, and appear to be characteristic of the modern median valley. The dredges at Stations 30 and 31 crossed the valley floor, but recovered basalt very similar to that from the walls reported by Melson et al. (1976). Highly mafic basalt similar to that on the central hills in the FAMOUS area (Bryan and Moore, 1977) has not been recovered in this part of median valley. Most of these basalts are similar to the iron- and titanium-rich type which is common on the East Pacific Rise (Melson et al., 1976).

In terms of petrography and major element chemistry, then, the median valley basalts at 22°-23°N correspond to the more "fractionated" or "geochemically evolved" of the ridge-derived basalts. They appear to be a relatively coherent group, compared with the broad spectrum of compositions recovered in the FAMOUS area. They share these characteristics with the basalts from Sites 395 and 396.

There is, however, an indication that the eruptive evolution of the median valley may be similar to that in the FAMOUS area. In both locations, highly phyric basalts with xenocryst plagioclase are situated along the western side of the valley floor. Bryan and Moore (1977) suggest that in the FAMOUS area the zone of extrusion is presently moving toward the west, and that the plagioclase has been concentrated by flotation in a cupola region at the top of the chamber. If this interpretation can be applied to the Leg 45 sites, the alternation of phyric and aphyric basalt could be a result of small shifts in the position of the axis of extrusion.

Although more complete mineralogical and geochemical data will be required to model petrogenetic processes, the data presented above suggest some generalities that may help to clarify the evolution of Leg 45 basalts. First, the main compositional distinctions appear to be related to textural differences, and not to association with a particular geographic location. This suggests that magmatic processes and source areas have been broadly constant during the past 13 m.y. Both the glasses and the aphyric and phyric basalts lie within the range of TiO_2 and FeO^*/MgO of other ocean ridge basalt glasses, which suggests that even the phyric basalts are not far from possible liquid compositions. The high Al_2O_3 contents of some Leg 45 phyric basalts does, however, exceed that of most analyzed basalt glasses, which rarely exceeds 17.0 wt per cent (Melson et al., 1976). This suggests some accumulation of plagioclase in excess of its normal magmatic proportions in the phyric basalts.

REFERENCES

Bryan, W. B. and Moore, J. G., 1977. Compositional variations of young basalts in the Mid-Atlantic Ridge rift valley near 36°49'N, *Geol. Soc. Am. Bull.*, v. 88, p. 556-570.

Bryan, W. B., Thompson, G., Frey, F. A., and Dickey, J. S., 1976. Inferred geologic settings and differentiation in basalts from the Deep Sea Drilling Project, *J. Geophys. Res.*, v. 81, p. 4285-4304.

Melson, W. B., Vallier, T. G., Wright, T. L., Byerly, G., and Nelen, J., 1976. Chemical diversity of abyssal volcanic glass erupted along Pacific, Atlantic, and Indian Ocean seafloor spreading centers, *In The Geophysics of the Pacific Ocean Basin*, Geophys. Monograph series, v. 19: Washington (Am. Geophys. Union), p. 351-368.

Melson, W. G., Thompson, G., and van Andel, Tj. H., 1968. Volcanism and metamorphism in the Mid-Atlantic ridge, 22°N latitude, *J. Geophys. Res.*, v. 73, p. 5925-5941.