

41. DATA REPORT: TRACE ELEMENT ANALYSIS OF CLASTS AND MATRIX IN SEDIMENTARY AND VOLCANICLASTIC BRECCIAS AT SITE 786¹

Catherine A. Rigsby²

INTRODUCTION

Shipboard examination of volcanic and sedimentary strata at Site 786 suggested that at least four types of breccias are present: flow-top breccias, associated with cooling and breakup on the upper surface of lava flows; autobreccias, formed by *in-situ* alteration at the base of flows; fault-gouge breccias; and true sedimentary breccias derived from weathering and erosion of underlying flows. It is virtually impossible to assess the origin of breccia matrix by textural and mineralogical analyses alone. However, it is fundamental for our understanding of breccia provenance to determine the source component of the matrix material. Whether the matrix is uniquely clast-derived can be determined by geochemical fingerprinting. Trace elements that are immobile during weathering and alteration do not change their relative abundances. A contribution to the matrix from any source with an immobile trace element signature different from that of the clasts would appear as a perturbation of the trace element signature of the matrix.

Trace element analysis of bulk samples from clasts and matrix material in individual breccia units was undertaken in a fashion similar to that used by Brimhall and Dietrich (1987) in analyzing soil provenance: (1) to help distinguish between sedimentary and volcanic breccias, (2) to determine the degree of mixing and depth of erosion in sedimentary breccias, and (3) to analyze the local provenance of the individual breccia components (matrix and clasts).

The following elements were analyzed by X-ray fluorescence (XRF): Rb, Sr, Ba, U, Zr, Cu, Zn, Ti, Cr, and V. Of these elements, Zr and Ti probably exhibit truly immobile behavior (Humphris and Thompson, 1978). The remaining elements are useful as a reference for the extent of compositional change during the formation of matrix material (Brimhall and Dietrich, 1987).

METHODOLOGY

The analyses were performed using the XRF facility in the Department of Geological Sciences, California State University, Long Beach. A manually operated GE SPG-3 vacuum spectrometer with an LiF(200) analytical crystal was used for all analyses. Emissions from long-wavelength elements (Zn, Ni, Cr, V, Ti, and Ba) were detected using a 9A-SPG flow-proportional detector. An SPG-10A sealed detector was used for the shorter wavelength elements (Zr and Sr).

The samples were separated into clast and matrix fractions and the fractions were ground in a Spex tungsten carbide shatterbox using one drop of ethylene glycol per gram of sample as a binding agent. Approximately 2.5 g of each sample was pressed into a disk for a three-stage analysis in the spectrometer.

Experimental conditions for stage I of each sample run were as follows: W target, 55 kV, 45 mA, LiF(200) crystal, 9A-SPG detector/1540 V, vacuum = 0.5 mm Hg, baseline = 0.4, window = out, gain = 256, scale = 100 cps with a 3% error, starting $2\theta = 35^\circ$, ending 2θ

= 90° , scan speed = $2^\circ 2\theta/\text{min}$. The elements detected in stage I were Cr, Ni, Ti, V, and Zn.

Experimental conditions for stage II of each sample run were as follows: W target, 55 kV, 45 mA, LiF(200) crystal, detector = SPG-10A (sealed)/2400 V, vacuum = 0.5 mm Hg, baseline = 0.4, window = out, gain = 256, scale = 100 cps with a 3% error, starting $2\theta = 20^\circ$, ending $2\theta = 28^\circ$, scan speed = $2^\circ 2\theta/\text{min}$. The elements detected in stage II were Sr and Zr.

Stage III experimental conditions were as follows: Cr target, 55 kV, 35 mA, LiF(200) crystal, 9A-SPG detector (flow proportional)/540 V, vacuum = 0.5 mm Hg, baseline = 0.4, window = out, gain = 256, scale = 500 cps with a 3% error, starting $2\theta = 71^\circ$, ending $2\theta = 75^\circ$, scan speed = $0.4^\circ 2\theta/\text{min}$. This stage was used to detect Ba.

The analysis of Cu was not possible because of contamination from tube scatter and because of the slight W contamination that resulted from the grinding process. Basalt NBS-688 was used as a calibration standard. Because the NBS-688 basalt is similar in composition to the Hole 786A samples, no correction factors were necessary for analyzing trace elements. (Equivalent absorption of X-rays by sample constituents allowed simple ratio analysis of peak intensities.) Where peak overlaps occurred, the following corrections were made:

$$\begin{aligned} \text{Ti}_{\text{K}\beta 1} &\text{ at } 77.26^\circ \text{ under } V_{\text{K}\alpha} \text{ at } 76.93^\circ, \\ V_{\text{K}\beta 1} &\text{ at } 69.12^\circ \text{ under } \text{Cr}_{\text{K}\alpha} \text{ at } 69.35^\circ, \\ \text{Sr}_{\text{K}\beta 1} &\text{ at } 22.42^\circ \text{ under } \text{Zr}_{\text{K}\alpha} \text{ at } 22.51^\circ. \end{aligned}$$

Standards were compared to determine the ratio of K_{β} to K_{α} peaks and peak heights were prorated before converting to parts per million. A summary of the results of these runs (in terms of limits of detection for each element) is given in Table 1.

RESULTS

Results of the analyses of Hole 786A clast and matrix samples are presented in Table 2.

DISCUSSION

Analysis of additional clasts and matrix materials from Hole 786A is under way. The data obtained from all analyses will be used to construct a detailed provenance history of the sediments and sedimentary breccias within this volcanic sequence. This history will provide

Table 1. Limits of detection for analyzed elements.

Element	Line	Crystal	Detector	Peak angle (degrees)	Limit of detection (cps)
Ba	LB2	LiF(200)	9A-SPG	73.30	100
Cr	K α	LiF(200)	9A-SPG	69.35	50
Ni	K α	LiF(200)	9A-SPG	48.66	50
Sr	K α	LiF(200)	SPG-10A	25.15	25
Ti	K α	LiF(200)	9A-SPG	86.13	50
V	K α	LiF(200)	9A-SPG	96.93	50
Zn	K α	LiF(200)	9A-SPG	41.80	20
Zr	K α	LiF(200)	SPG-10A	22.55	25

¹ Fryer, P., Pearce, J. A., Stokking, L. B., et al., 1992. *Proc. ODP, Sci. Results*, 125: College Station, TX (Ocean Drilling Program).

² Department of Geological Sciences, California State University, Long Beach, CA 90840, U.S.A.

Table 2. Trace element composition (ppm) of selected clast and matrix materials from Hole 786A.

Core, section, interval (cm)	Type	Zr	Sr	Zn	Ni	Cr	V	Ti	Ba
125-786A-									
16X-CC, 7-9	Clast	62	168	30	198	487	116	2038	<100
19X-CC, 11-13	Matrix	88	98	30	439	1125	60	1890	<100
125-786B-									
1R-1, 14-15	Clast	60	175	26	145	405	100	1506	<100
1R-1, 58-59	Clast and matrix	76	196	22	123	293	82	1300	<100
3R-1, 36-38	Matrix	110	133	34	150	275	54	1240	<100
5R-1, 59-61	Matrix	88	224	23	118	250	101	1831	<100
6R-1, 31-34	Matrix	168	224	11	64	<50	111	2097	<100
10R-1, 15-16	Clast	50	175	22	198	560	114	1536	<100
10R-1, 35-37	Matrix	90	84	19	182	567	<50	1418	<100
12R-1, 47-49	Clast	58	140	26	193	473	<50	1506	<100
12R-1, 47-49	Matrix	-	-	26	193	477	<50	1506	<100
12R-1, 83-86	Clast	112	210	26	129	400	<50	1300	<100
12R-1, 83-86	Matrix	62	168	38	198	633	71	1595	<100
15R-2, 146-148	Matrix	166	238	30	43	<50	86	2333	<100
16R-1, 105-108	Clast	86	238	23	32	<50	137	2186	<100
16R-1, 120-121	Clast	92	252	26	21	<50	119	2008	<100
17R-1, 31-34	Matrix	-	-	38	43	<50	<50	2363	<100
19R-1, 58-60	Matrix	74	336	38	80	116	82	3072	<100
21R-1, 65-68	Matrix	38	182	23	37	<50	<50	1713	<100
22R-3, 121-123	Clast	88	224	30	43	<50	189	1861	<100
27R-1, 15-18	Clast	168	231	23	43	<50	77	2422	<100
27R-2, 17-20	Matrix	72	210	49	193	629	<50	1565	<100
41R-1, 52-55	Clast	78	224	15	37	<50	157	1979	<100
41R-1, 52-55	Matrix	104	161	26	43	<50	168	2244	<100
41R-2, 77-79	Matrix	62	119	15	21	<50	155	1300	<100
41R-4, 35-37	Clast	72	210	26	96	228	107	1418	<100
42R-1, 25-28	Clast	70	217	30	150	255	154	1654	<100
42R-1, 25-28	Matrix	70	266	23	193	367	173	1831	<100
46R-2, 89-91	Clast	138	182	23	75	101	131	1536	<100
48R-2, 120-124	Clast	44	203	68	139	1032	167	1890	<100
49R-2, 29-31	Clast	70	217	19	187	1098	350	1860	<100
49R-3, 87-91	Matrix	58	182	30	118	391	137	2008	<100
49R-4, 60-64	Clast	96	196	23	80	91	136	1861	<100
49R-4, 60-64	Matrix	46	196	30	236	502	68	1270	<100
52R-1, 90-93	Clast	94	161	19	225	521	85	1093	<100
52R-1, 90-93	Matrix	62	119	15	300	689	65	1477	<100
55R-1, 101-105	Clast	48	140	34	182	599	131	1536	<100
56R-2, 100-103	Clast and matrix	280	392	23	2251	6961	202	1359	<100
62R-1, 49-52	Clast and matrix	160	259	34	3431	10191	204	1713	<100

a detailed sedimentologic and stratigraphic understanding of the Eocene source terrane—an understanding that will be advantageous in analyzing the regional provenance data obtained from the classical petrographic and microprobe analyses of strata recovered at the other sites.

ACKNOWLEDGMENTS

Elihu Goldish and Michael Tye supervised the laboratory procedures for this project. Jill Segawa prepared samples and assisted with data analysis.

REFERENCES

- Brimhall, G. H., and Dietrich, W. E., 1987. Constitutive mass balance relations between chemical composition, volume, density, porosity, and strain in metasomatic hydrochemical systems: results on weathering and pedogenesis. *Geochim. Cosmochim. Acta*, 51:567-587.
- Humphris, S. E., and Thompson, G., 1978. Trace element mobility during hydrothermal alteration of oceanic basalts. *Geochim. Cosmochim. Acta*, 42:127-587.

Date of initial receipt: 1 October 1990

Date of acceptance: 6 May 1991

Ms 125B-151