AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

TRACE ELEMENT CHARACTERISTICS OF LITHOSPHERIC AND ASTHENOSPHERIC MANTLE IN THE RIO GRANDE RIFT REGION

Frank V. Perry
Department of Geology
University of New Mexico

Trace element analyses of 10 mafic volcanic rocks from the Colorado Plateau transition zone, Colorado Plateau, Rio Grande rift, and Great Plains were obtained to characterize the trace element characteristics of asthenospheric and lithospheric mantle beneath these regions (Table 1). Characterization of these mantle reservoirs using the trace element contents of basalts allows one to track the response of the lithosphere to continental rifting and extension. Several of the samples (061WSB, 417WSB, 400WSB, 324WSB) have been previously analyzed for Sr and Nd isotopes (Perry et al., 1987) and have contributed to a model in which two distinct mantle reservoirs are involved in basalt petrogenesis: the asthenosphere beneath more extended terrains (transition zone and southern Rio Grande rift) and the lithospheric mantle beneath more stable terrains (Colorado Plateau, Great Plains, and northern Rio Grande rift.).

Plotting basalts of two endmember isotopic compositions (representing lithospheric and asthenospheric mantle) illustrates the trace element differences between lithospheric and asthenospheric mantle beneath the Rio Grande rift region (Fig. 1). Sample 061WSB (Fig 1, diamond symbol), derived from lithospheric mantle, is enriched in the light rare-earth elements (La, Ce, Nd) and Th and U, and depleted in Cs, Rb, Hf, and Zr, relative to sample 417WSB (Fig. 1, open circle symbol), a basalt derived predominantly from asthenospheric mantle. The light-rare earth enrichment is consistent with a mantle reservoir that has been isolated from the convecting, light-rare-earth element depleted asthenospheric mantle, and

enriched by asthenospheric melts and fluids, over long periods of time (hundreds of millions of years). Depletion in the high-field strength elements, Hf and Zr, is characteristic of island arc basalts, and suggests that the lithospheric mantle in this region has been infiltrated by a subduction-related component.

The nature of the lithospheric mantle can be explored by comparing the trace element compositions of lithosphere-derived volcanic rocks that represent widely different degrees of partial melting. On Figure 2 are plotted the trace element patterns of a tholeiite (324WSB, open circles), an alkali basalt (400WSB, filled circles), and a mafic minette (Z12161A, triangles), which represent large, moderate, and small degrees of partial melting of a lithospheric mantle source, respectively. Differences in trace element concentrations produced by different degrees of partial melting of a homogeneous source would produce similar patterns for different samples on such a plot. While there is a similarity in the shape of the patterns for many of the elements plotted on Figure 2, differences in the ratios of such elements as Ba and Th indicate that the lithospheric source is heterogeneous on a scale reflected by the source volume of different degrees of partial melt. The probable effects of crustal contamination can also be seen in Figure 2 in the relatively high abundances of Rb and Cs in the tholeiite (sample 324WSB).

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

TABLE 1. TRACE ELEMENT CONCENTRATIONS OF MAFIC VOLCANIC ROCKS
FROM THE RIO GRANDE RIFT REGION

Sample	Z12161A	AWL580	AWL282	AWL3583	AWL2583	SCR1-1	061WSB	417WSB	400WSB	324WSB
Age (Ma)	24.6	28.0	27.9	25.5	23.0	28.8	~2.5	4.3	~7.8	0.32
Type	Minette	BA	AOB	Katungite	Minette	AOB	AOB	AOB	AOB	THOL
Setting ¹	TZ	TZ	GP	CP	CP	TZ	NRGR	TZ	TZ	TZ
Sc	17.8	25.5	22.4	24.6	13.8	23.5	22.5	20.6	26.9	23.8
Cr	428	2	23	560	274	62	244	215	502	268
Rb	139	58	19	95	162	18	16	28	20	21
Sr	1580	460	930	2090	1640	610	1080	730	780	300
Zr	460	330	210	490	550	160	150	180	240	180
Cs	4.06	0.61	0.95	1.04	3.61	0.43	0.25	0.35	0.75	1.36
Ba	1990	760	1060	1960	3060	660	720	430	770	160
La	138.1	44.8	66.6	159.0	224.0	40.3	50.3	30.6	34.8	12.2
Ce	264.0	98.5	139.4	304.0	396.0	81.4	89.3	61.1	73.5	25.9
Nd	108	56	75	120	164	43	41	31	33	19
Sm	19.60	12.90	14.30	20.50	27.30	6.73	6.90	6.39	7.35	3.93
Eu	4.77	3.50	4.15	5.43	5.75	2.01	2.09	2.11	2.21	1.29
Tb	1.40	1.89	1.56	1.64	1.77	0.75	0.83	0.86	0.87	0.67
Yb	1.70	5.40	3.03	1.95	2.37	1.85	2.03	2.24	2.14	2.06
Lu	0.256	0.810	0.445	0.256	0.316	0.262	0.272	0.307	0.291	0.270
Hf	11.00	7.83	5.25	11.00	13.30	4.27	3.70	4.69	5.31	3.14
Th	30.60	7.14	4.12	19.70	99.30	1.98	7.23	3.16	4.24	1.66
U	7.70	2.10	1.40	5.50	22.20	0.49	1.50	0.78	1.15	0.61

¹TZ=Transition zone, CP=Colorado Plateau, GP=Great Plains, NRGR=Northern Rio Grande rift

FIG. 1

FIG. 2

**DATE
FILMED**

10/19/94

END