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Rb-Sr AGE OF SHOSHONITIC DIKES IN THE CRANDALL-SUNLIGHT REGION, ABSAROKA VOLCANIC FIELD, WYOMING

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We report Rb-Sr results for dikes in the Crandall-Sunlight region of the Absaroka Volcanic Field, Wyoming. Eight whole rock samples yield an isochron age of 93.4 ± 27.3 m.y. Three more samples plot above the isochron and are interpreted to have been contaminated by crustal sources. The isochron indicates that these rocks are older than previously inferred Eocene ages (Pierce and Nelson, 1971).

The area included in this study lies close to the Sunlight intrusive center, one of the most southerly eruptive centers in the eastern belt (figure 1). The area is a portion of the Beartooth Butte 15-minute quadrangle and includes the Reef Creek, Deadman Creek, and Russell Creek drainage systems, located between 44°47′ and 44°51′N latitude and 109°30′ and 109°37′W longitude. Primary access to the field area is by Shoshone National Forest road 114, leaving Wyoming 296 between Sunlight Creek and the Crandall Ranger Station, and continuing west up the Reef Creek drainage.

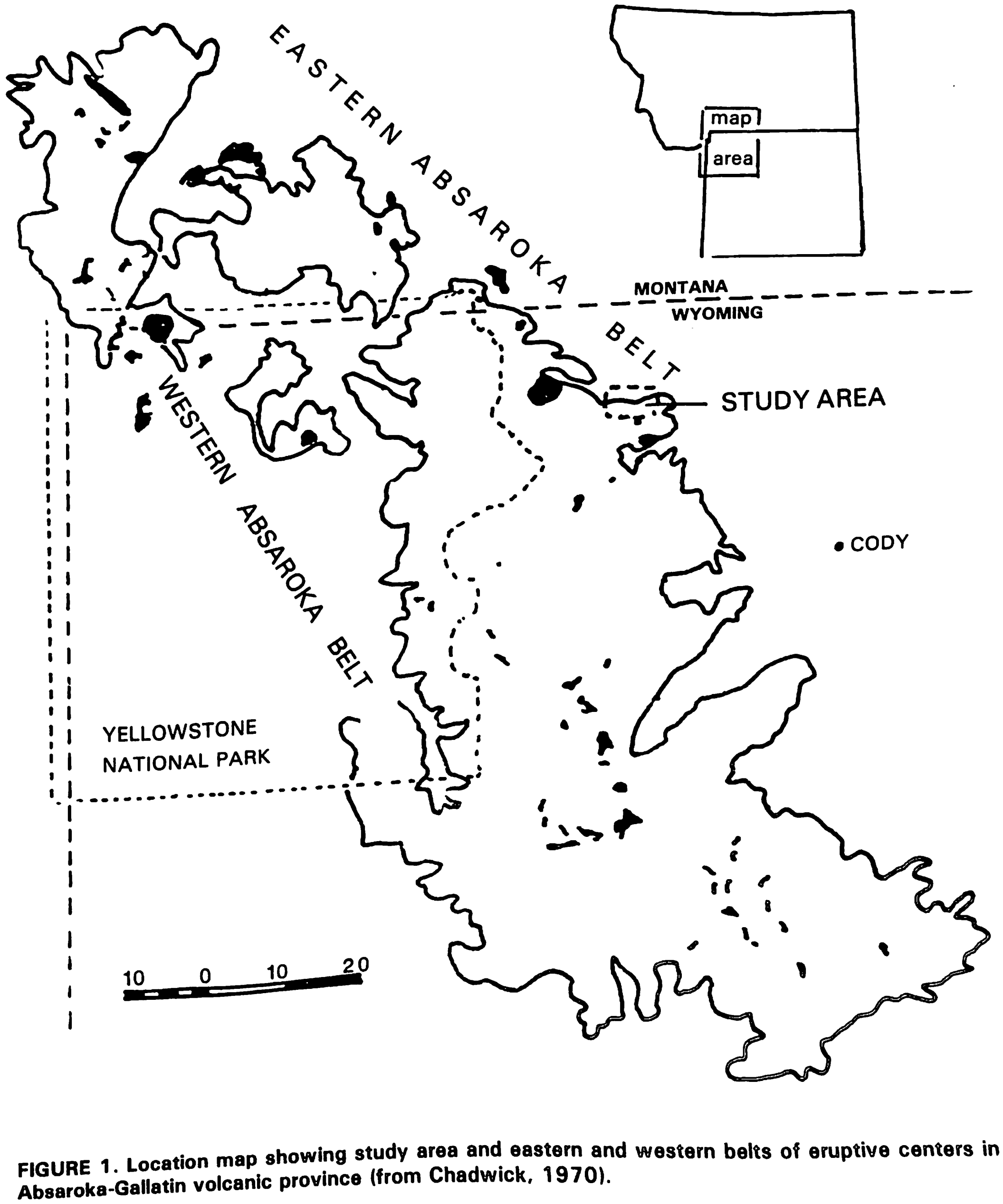

FIGURE 1. Location map showing study area and eastern and western belts of eruptive centers in the Absaroka-Gallatin volcanic province (from Chadwick, 1970).

GEOLOGY

The Absaroka Volcanic Province is made up of over 25,000 square km of volcanic rocks representing the eroded remnants of coalescing stratovolcanoes. The primary rock type is calc-alkaline andesite but compositions ranging from alkaline basalt to rhyolite are also represented. Individual volcanic centers are made up of a vent facies consisting of a chaotic mixture of lava flows, autoclastic flow breccias, tuffs and avalanche debris, and an alluvial facies which are epiclastic volcanic rocks that form a sedimentary apron around each volcanic cone, overlapping and interfingering with similar rocks derived from other cones. In the Crandall-Sunlight region various vent-facies breccias are by far the most abundant rock type.

Alluvial and vent facies rocks are intruded by widespread dikes which commonly occur in dense radiating or linear swarms, and erosion has exposed several shallow plutons that are thought to represent subvolcanic intrusions. Eruptive centers are generally identified by dike swarms that radiate from the locality of plutonic bodies or clusters of plutonic bodies (Antweiler and others, 1985). Chadwick (1970) suggested that eruptive centers in the Absaroka-Gallatin Province form two sub-parallel, northwest-trending belts that extend for over 240 km in southern Montana and northern Wyoming.

Volcanic rocks of the Absaroka-Gallatin region represent numerous separate volcanic centers; the stratigraphy defined by Smedes and Prostka (1972) is based on similarity of features including mineralogy, chemistry and color, and not on discrete laterally continuous horizons that can be traced from one area to the next. These features suggest a similarity of processes and evolutionary trends among volcanic centers of each group but they do not imply a strict age relationship, since ages of individual volcanoes in any given group can vary widely. Smedes and Prostka (1972) reported seven Eocene K-Ar dates from widely scattered locations and Love and others (1976) obtained three Eocene fission track ages from the western belt of eruptive centers. Lead and strontium isotope studies by Peterman and others (1970) yielded ambiguous results while an Rb/Sr study by Meen and Eggler (1987) has shown that Independence Volcano in the eastern belt is Cretaceous in age. Paleontologic studies (Jepson, 1939; Dorf, 1939, 1960, 1964; Hay, 1956; Hall, 1961) have generally given Eocene results.

ANALYTICAL PROCEDURES

Unweathered samples are not available in the study area so samples were cut to 1 inch chips with a lapidary saw and all visible weathering products were removed. Chips were then cleaned ultrasonically in distilled water to reduce the possibility of contamination from the saw and dried for one hour at 100°C. Chips were then crushed to pea size in a steel mortar and pestle and reduced to a fine powder in a 2.5 cm Plattner mortar and pestle. Samples were then sieved through a 100 mesh nylon screen; anything too coarse was processed in an Al_2O_3 mortar and pestle until the entire sample passed through the screen. Approximately 50 grams of each sample was prepared in this manner.

Twelve samples selected to represent the widest range in major- and trace-element composition were analyzed for Rb and Sr contents by isotope dilution. A 0.09 g split of each sample was spiked with isotopically enriched Rb and Sr solutions and digested using hydrofluoric and perchloric acid. Rb and Sr aliquots were separated using standard cation-exchange chromatography. Rb measurements were made using a Nuclide 1290 thermal ionization mass spec-

SAMPLE DESCRIPTIONS

Sample	N latitude W longitude	Sr (ppm)	Rb (ppm)	^{87}Sr/^{86}Sr	sigma	^{87}Rb/^{86}Sr	sigma	Descriptions
A53	44°48.9′ 109°30.3′	903	37	0.70431	0.000048	0.1206	0.00109	Abundant clinopyroxene phenocrysts with minor olivine in black, glassy groundmass containing plagioclase microlites
A54	44°49.6′ 109°34.3′	1055	50	0.70432	0.000048	0.1390	0.00125	Clinopyroxene phenocrysts in dark green, aphanitic matrix
A88	44°49.4′ 109°31.5′	797	7.5	0.70417	0.000048	0.0273	0.00025	Abundant olivine and clinopyroxene phenocrysts in black, glassy matrix
T41	44°48.9′ 109°35.2′	1094	75	0.70439	0.000048	0.1995	0.00180	Clinopyroxene and minor plagioclase phenocrysts in dark, grey-green aphanitic matrix
S36b	44°49.1′ 109°34.6′	1119	120	0.70453	0.000048	0.3101	0.00279	Plagioclase phenocrysts in light green, aphanitic matrix
S27	44°48.6′ 109°32.5′	1096	75	0.70445	0.000048	0.2000	0.00180	Plagioclase phenocrysts in somewhat vesicular, grey-green matrix
S32	44°48.1′ 109°32.9′	1085	107	0.70453	0.000048	0.2856	0.00257	Plagioclase phenocrysts in grey-green matrix
S45	44°49.8′ 109°34.3′	1399	111	0.70448	0.000048	0.2301	0.00207	Plagioclase and minor clinopyroxene in green, aphanitic matrix
S51b	44°49.5′ 109°34.6′	1143	96	0.70462	0.000048	0.2430	0.00218	Large plagioclase phenocrysts and traces of biotite in yellow-green, aphanitic matrix
G44a	44°45′ 109°33.2′	1435	118	0.70510	0.000048	0.2380	0.00214	Olivine, clinopyroxene, plagioclase gabbro from small stock
H39a	44°48.4′ 109°33.8′	901	73	0.70463	0.000048	0.2340	0.00211	Plagioclase and rare hornblende phenocrysts in green aphanitic matrix
H46	44°48.2′ 109°35.7′	1016	77	0.70465	0.000048	0.2223	0.00200	Hornblende and plagioclase phenocrysts in light-grey, aphanitic matrix

trometer, and Sr measurements were made on a VG 354 thermal ionization mass spectrometer. One-sigma error estimates for the ^{87}Rb/^{86}Sr ratios and the ^{87}Sr/^{86}Sr ratios are estimated at 0.90% and 0.0068% respectively.

DISCUSSION AND CONCLUSIONS

Strontium isotopic data were obtained for samples of dikes spanning the range from absarokite to shoshonite and including two hornblende-bearing rocks. A plot of ^{87}Sr/^{86}Sr versus ^{87}Rb/^{86}Sr (figure 2) reveals that eight of the samples form a linear array. The correlation coefficient of the line is 0.95 and the Y intercept and the presumed initial ratio for the magma is 0.70415 ± 0.000041. The slope of this line is 0.0013 which corresponds to an absolute age of 93.4 ± 27.3 m.y.

One shoshonite and both hornblende-bearing samples plot well off of trend defined by the other eight samples. All three of these rocks plot off the fractional crystallization trend in figure 3 and on the basis of that diagram are interpreted to have suffered some degree of crustal contamination. The relative enrichment of these rocks in radiogenic Sr is also consistent with interaction of the primary magma with crustal rocks.

Volcanic rocks of the Absaroka-Gallatin province have long been thought to be of Eocene age and to have been erupted in the waning stages of Laramide activity in the region. Volcanic rocks in the region show only minor deformation, so they indeed, must have been extruded after the bulk of Laramide deformation, but Rb-Sr results from this study, and a study of Meen and Eggler (1987) working at Independence Volcano 30 km to the north, suggest that Absaroka-Gallatin volcanism began in the Late Cretaceous and so may have been essentially coincident with Laramide orogenic activity.

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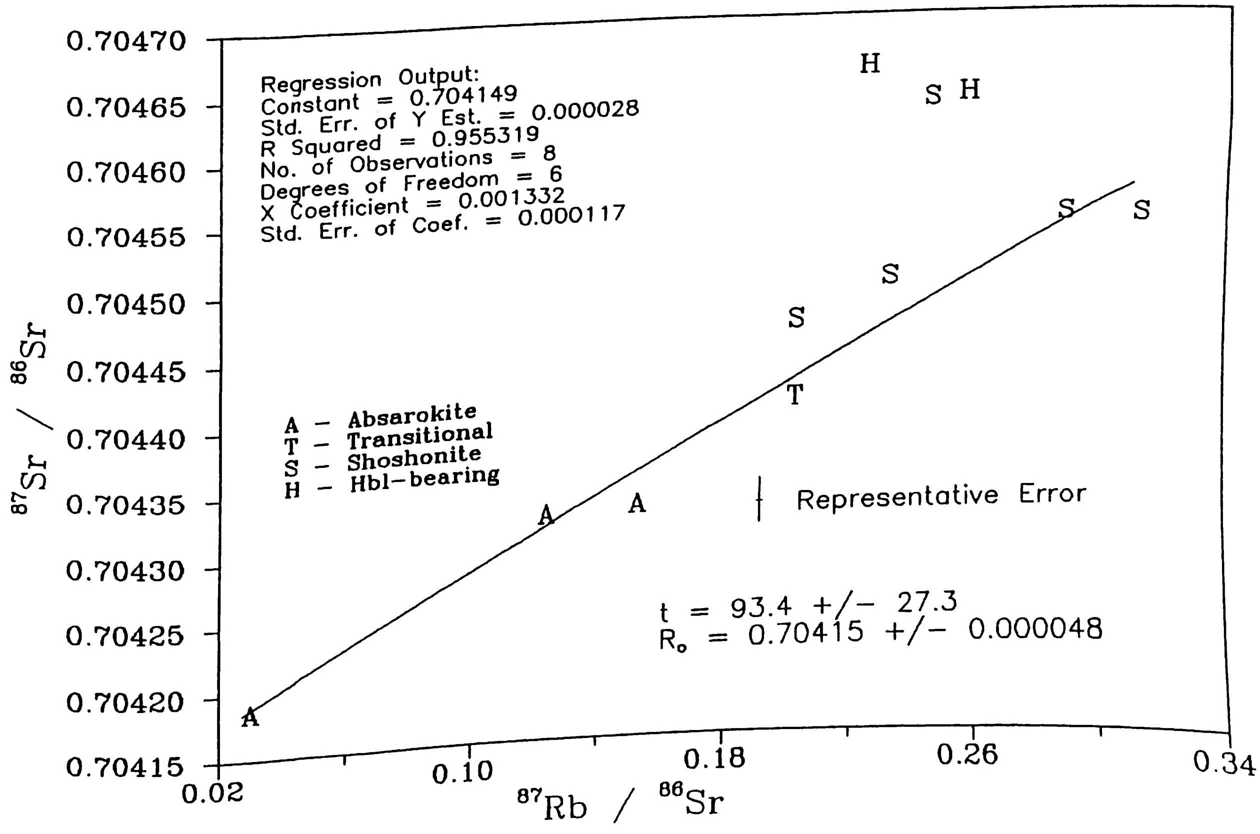

FIGURE 2. Plot of Rb-Sr isotopic compositions for 11 study area samples.

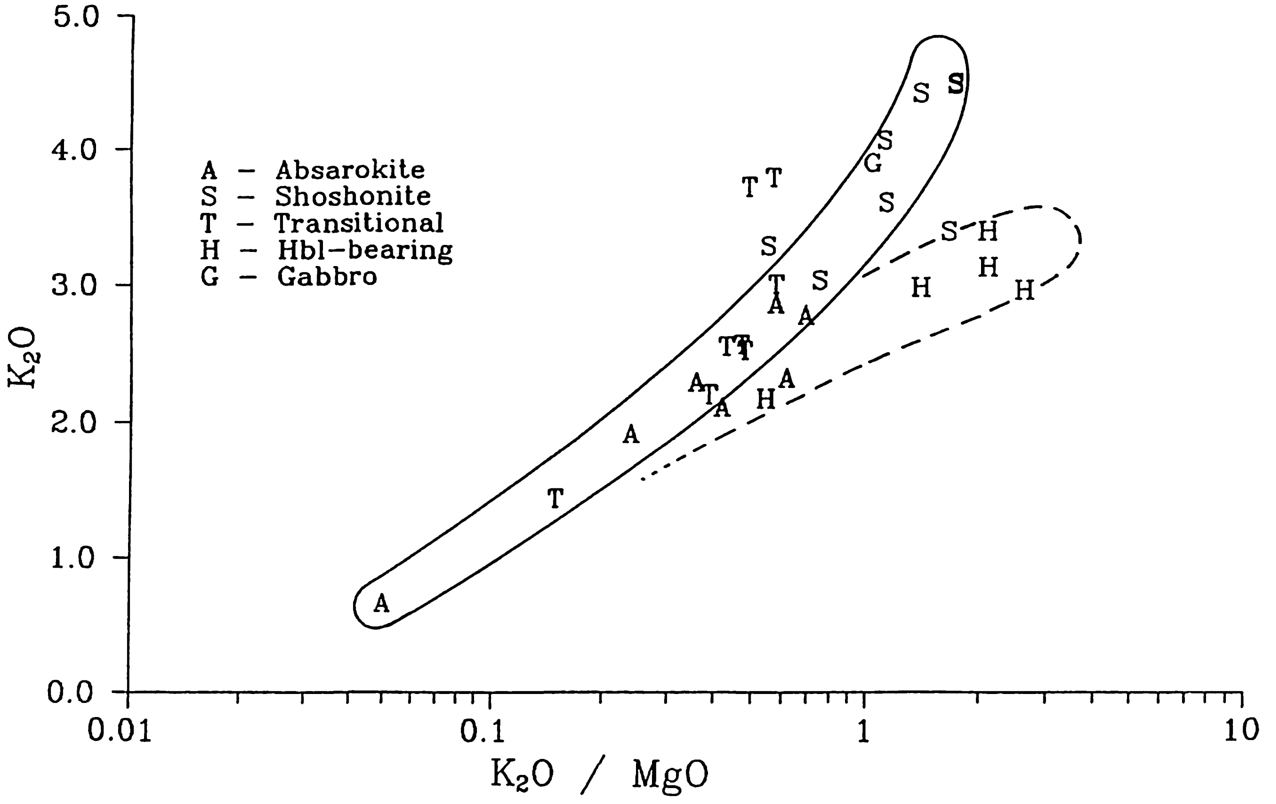

FIGURE 3. MgO tends to be low in partial melts of crustal rocks, even when derived from magnesium-rich rocks. K_2O, being much less refractory, tends to be high. As a consequence, crustal contamination produces higher values of K_2O/MgO relative to K_2O than does fractional crystallization (Meen, 1985). The solid line encloses the likely path of fractional crystallization of an uncontaminated mantle melt while the dashed line encloses samples interpreted to be the result of crustal contamination.

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