Rb-Sr MEASUREMENTS ON LUNAR IGNEOUS ROCKS AND BRECCIA CLASTS

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Igneous and microbreccia clasts from Fra Mauro breccias have been dated by Rb-Sr between 3.95 to 4.06×10^9 years (e.g.(1)(2)(3)). These ages are all within experimental error and the spread is reduced to 70 m.y. if inter-laboratory biases are corrected by adjusting dates to a common 14310 age. It has been suggested that these ages might be the result of metamorphism in the Imbrium ejecta blanket ((2)(3)). We have demonstrated that the Fra Mauro breccia 14321 had not been totally equilibrated in the ejecta blanket and that while the internal isochron ages of a basalt clast and a microbreccia clast were not distinguishable, their initial Sr ratios were distinct (3). This result did not preclude the possibility of short range ($\lesssim$1 mm) diffusion of Rb and Sr to reset internal ages (2). To test this hypothesis, we examined Rb-Sr systematics for a basalt clast and adjacent ($\lesssim$1 mm) microbreccia fragments from 14321,478. The data plotted in Fig. 1 show that neither equilibration nor detectable approach to equilibrium occurred at 4 b.y. on a scale of 1 mm. It is thus unlikely that the measured ages are the result of diffusion in the Imbrium ejecta blanket and more likely that the internal ages measured on the microbreccia clasts and intermediate iron-rich basalts (such as 14053) predate the Imbrium event. As the oldest basin-filling mare basalts postdate the Imbrium impact, it is possible to bracket the age of the impact between 3.8 and 4.0×10^9 years.

A five point isochron for KREEP-rich basalt 14310 yields an age of $3.94 \pm 0.03 \times 10^9$ years (2) and initial ratio of 0.70041 ± 5(Fig. 2). This basalt has now been dated by most of the laboratories measuring Rb-Sr ages of lunar samples and can be a useful tiepoint for interlaboratory comparisons. 14310 is probably the product of impact melting (e.g.(4)) and has an uncertain relationship to the Fra Mauro Formation.

62295 is a mesostasis-rich spinel troctolite, probably produced by shock melting (e.g.(5)). We have obtained a five point internal isochron of $4.00 \pm 0.06 \times 10^9$ years and initial ratio of 0.69956 ± 6 (Fig. 3). If fraction D, which requires a blank correction, is omitted, an isochron of $4.00 \pm 0.07 \times 10^9$ years and 0.69956 ± 8 results. Possible stratigraphic correlations (6) range from pre basin-forming events (7) to Imbrium ejecta (8).

A 0.5 g basalt clast from relatively friable breccia 15265 is significantly younger than the above samples. It has an age and initial Sr isotopic ratio consistent with Apollo 15 mare basalts. A similar age has been reported for a basalt clast in breccia 15459 (9).

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Table 1. Rb, Sr, K Concentrations and Sr Isotopic Composition

	Weight (mg)	K (PPM)	Rb (PPM)	^{86}Sr (PPM)	K/Rb (Weight)	$^{87}Rb/^{86}Sr$ (Atomic)	$^{87}Sr/^{86}Sr \pm (2\sigma)$	T_{BABI} (10^9 yrs.)
66295,35								
WR	29	562	4.02	12.74	140	0.0877	0.70452±24	4.39±0.26
Plagioclase	25	643	1.85	21.68	348	0.0237	0.70093±18	
"Olivine"	49	524	4.79	8.761	109	0.1522	0.70832±08	
H(ρ=2.8-2.96)	26	740	5.47	15.40	135	0.0989	0.70520±12	
D(ρ<2.59)**	2	-	3.49	16.80	-	0.0578	0.70287±10	
14310,132								
WR	62	3996	12.98	17.86	308	0.202	0.71166±14	4.37±0.18
Plagioclase	17	1534*	1.134	26.78	1353	0.0115	0.70107±12	
Pyroxene	49	790	2.48	2.448	319	0.282	0.71626±22	
D(ρ>3.3)	22	2406	8.63	3.651	279	0.658	0.73772±12	
I(ρ>3.3,magnetic)	11	3237	10.84	4.370	299	0.684	0.73998±14	
F(ρ<2.52)	1	11451	52.1	18.83	220	0.770	0.74404±16	
14321,478								
Basalt Clast	6	1225	2.93	9.29	418	0.0879	0.70433±10	4.24±0.24
Microbreccia Frag.	17	4546	11.68	16.78	389	0.194	0.71207±8	4.69±0.20
Microbreccia Frag.	5	4738	11.17	17.67	424	0.176	0.71046±12	4.54±0.22

* Measured on separate split
**~5.4% blank correction to $^{87}Rb/^{86}Sr$

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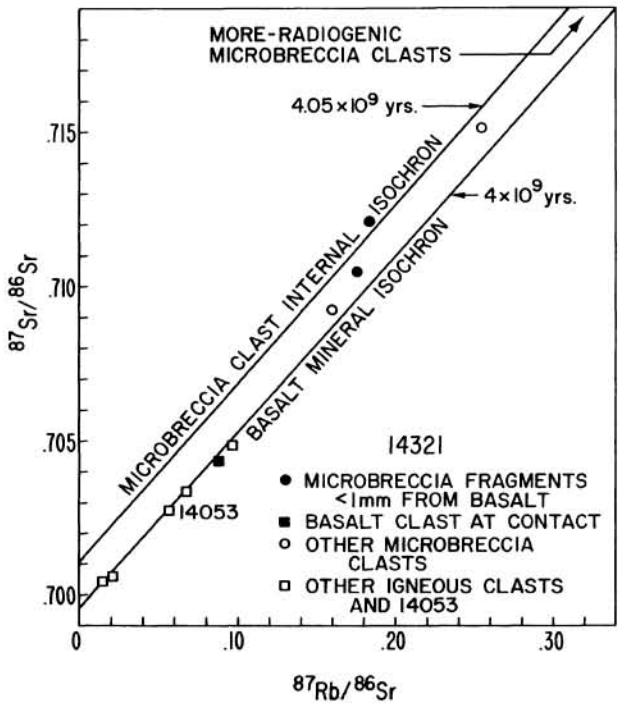

Fig. 1 The solid symbols represent a basalt clast and two adjacent (≲1 mm) microbreccia fragments from 14321,478. The isochrons (other clasts) are from (3). Other data from ((1)(2)(3)).

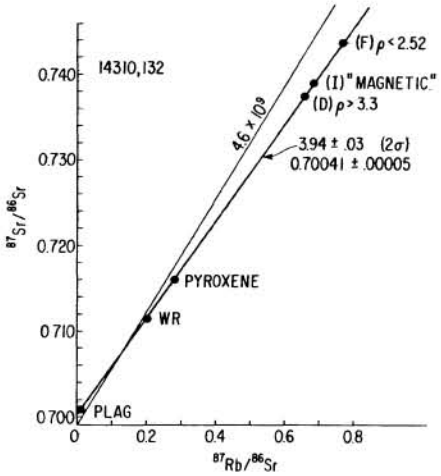

Fig. 2 14310 isochron.

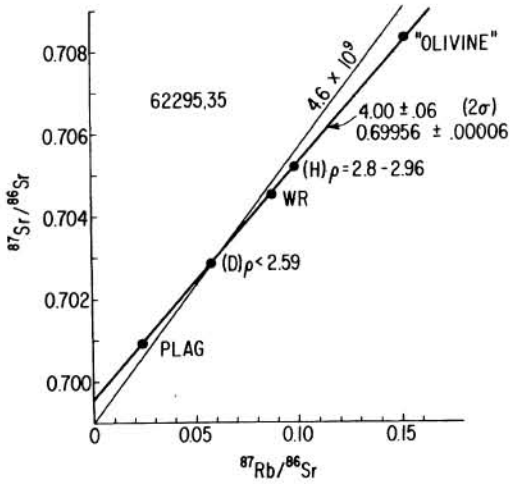

Fig. 3 62295 isochron.