LIQUID LINES OF DESCENT AND LIQUID IMMISCIBILITY IN HIGH Ti LUNAR BASALT; Malcolm J. Rutherford, Paul C. Hess, G.H. Daniel
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Experiments have been performed on rock 70017,29 to derive a series of cogenetic salic liquids that represent potential end products of lunar basalt fractionated at low pressure. Rock 70017 (29 and 127) is a medium grained (< 3mm) porphyritic basalt composed of 22% ilmenite, 2% olivine (Fo_{74-65}), 49% Ca-pyroxene (zoned $En_{48}Wo_{35}Fs_{17}$ to $En_{31}Wo_{23}Fs_{46}$), 23% plagioclase ($An_{88}Ab_{11}$ to $An_{76}Ab_{21}Or_{3}$) and minor pigeonite ($En_{63}Wo_{7}Fs_{30}$), cristobalite and mesostasis. Glass containing exsolved Fe-rich spherules is present in the cristobalite. The composition of these immiscible melts (Table 1) indicates that they are closer to the critical state than those in Apollo 11 basalts (1) possibly due to higher temperature, or some compositional effect. In the experiments, chips of 70017,29 were wrapped in Mo foil, sealed in evacuated SiO_2 glass tubes and either partially melted or significantly melted and then recrystallized. Rocks with the composition of the resulting glasses were synthesized and used in subsequent experiments.

Representative compositions of the fractionated liquids (Table 1) show that as MgO decreases, TiO_2 decreases uniformly (Fig. 1) and SiO_2, FeO,MnO and K_2O increase. A liquid line of descent constructed with similar data for Apollo 12 basalts (2) contrasts with this, but where the paths intersect, the liquids have similar major element concentrations. If the highly differentiated Apollo 12 liquids were to be fractionated at this point, presumably the liquid would then follow a path similar to 70017.

The significant results of the experiments on 70017 are that (1) only minor SiO_2 enrichment was achieved in the highly fractionated liquids although 95% of the basalt was crystallized, and (2) the immiscible liquid field has been approached and probably reached from the iron rich side. This is demonstrated in Fig. 2, where the compositions of the two most fractionated liquids obtained (1-4 and 1-9) plot within the central field of liquid immiscibility in the K_2O-Al_2O_3-SiO_2-Fe-O System even though other components are included. More importantly, the tie lines defined by the two immiscible liquids in 70017 pass close by both these compositions. A simple calculation shows that in terms of all nine elements considered, the composition of the fractionated liquids in experiments 1-4 and 1-9 lie on

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the join between the 70017,127 immiscible melts at approximately 80% of the Fe-rich end member.

The geological significance of these results is that (1) the field of liquid immiscibility was apparently reached with a randomly chosen fractionation path and major SiO_2 enrichment is not necessary to achieve it* (2) The amount of melt present at the onset of liquid immiscibility can be several times the amount of SiO_2 rich mesostasis, the Fe-rich fraction being camouflaged as additions to Fe rich minerals. (3) The amount of total immiscible melt in a lunar soil could be as much as 4 times the amount of granitic component if the latter were the result of liquid immiscibility, a fact which has a bearing on the trace element content of the soil (3).

REFERENCES

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* The presence of two immiscible liquids has not been confirmed, but submicroscopic exsolution may be present. Variations in SiO_2 counts on a similar glass produced in a somewhat longer experiment (3 days) indicate submicroscopic immiscibility.

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TABLE 1 Representative Liquid (Glass) Compositions

	70017 Imm. melts H.Si	70017 Imm. melts H.Fe	Rock[1]	70017, 29-3	70017, 29-1	70017, 29,5	Syn Expt.[2] 1-4	Syn Expt.[2] 1-9
SiO_2	71.3	42.2	41.02	45.77	46.07	47.66	49.61	49.14
TiO_2	1.9	4.1	11.04	9.35	7.08	4.85	3.51	2.71
Al_2O_3	14.0	7.6	11.68	10.19	9.41	9.15	9.46	8.95
FeO	5.6	29.9	16.35	15.83	21.70	22.66	24.81	27.18
MnO	0.0	.46	.16	.25	.28	.35	.49	.57
MgO	.51	1.5	9.05	7.27	4.68	2.59	1.35	.68
CaO	2.6	11.6	10.02	11.65	9.49	10.48	10.03	9.15
Na_2O	.47	.02	.37	.19	.37	.29	.39	.30
K_2O	3.2	.55	.13	.17	.24	.28	.66	1.15
Total	99.58	97.93	99.82	100.67	99.31	98.31	100.31	99.83
Temperature °C				1152	1100	1070	1030	1006
Percent Melt				65.8	15.4	7.4	38.5	22.4

1. Calculated from 29-3, mineral and glass compositions and mode.
2. Experiments on synthetic rock of 29-1 composition.

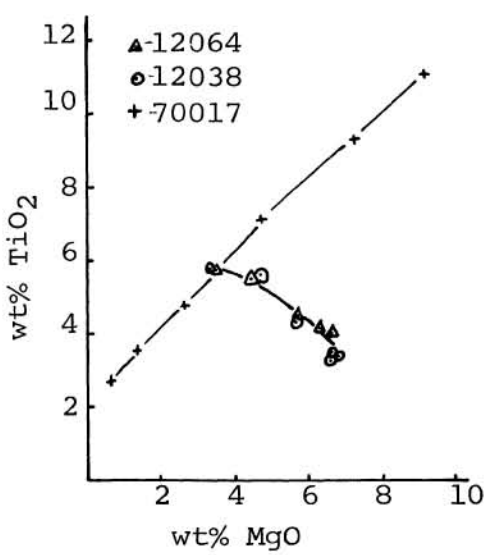

Fig. 1

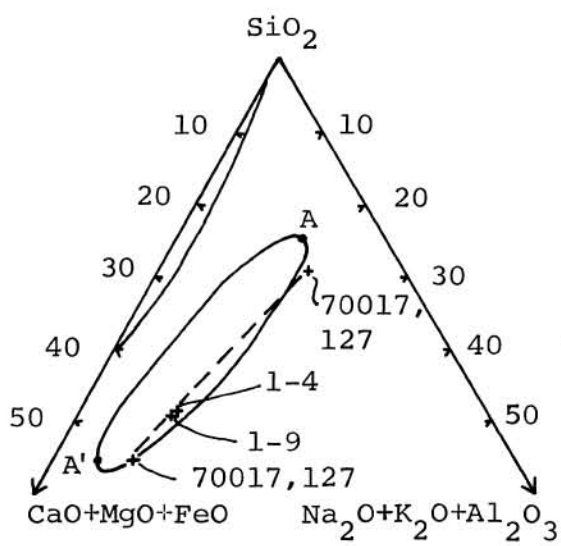

Fig. 2 (after (4))