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EXPERIMENTAL CRYSTALLIZATION OF APOLLO 11 AND 12 LAVAS - A RE-EXAMINATION, Biggar, G.M., O'Hara, M.J., Humphries, D.J., and Peckett, A., Grant Institute of Geology, Edinburgh University, Scotland.

Reexamination was aimed at resolving inter-laboratory discrepancies in data and interpretation of Apollo 12 basalts. Plagioclase remains in 12018, 12020, 12038 and 12040 at 1153°C in 3-day runs whether rock powder or glass is used as starting material. Reversal of plagioclase entry by holding 4-5 hours at upper temperature, then 5-16 hours at lower, has been accomplished on 8 samples (figure 1). Cotectic liquid compositions obtained from glass or rock powder were very similar in 12038, 12040. Temperatures are calibrated at m.p. of gold 1064°C and Li_2SiO_3 (1203°C).

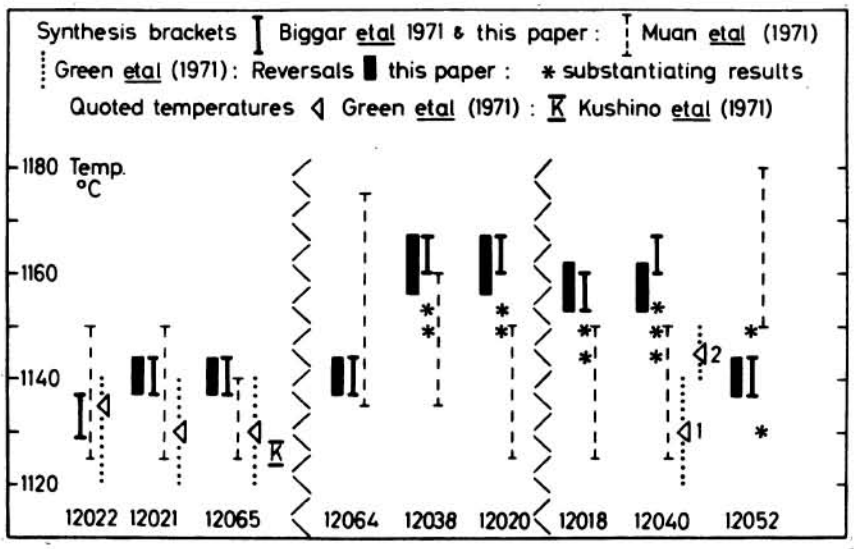

Fig. 1. Comparative results for plagioclase entry

Calculation, from analysed glass and crystal phase composition, of percentage crystals present at plagioclase entry yields values as low as one half of those quoted by other workers relying on visual estimation. Calculation of the putative residual cotectic liquids, by extracting the visually estimated amount of crystals, yields liquids which are enriched in potential plagioclase, and depleted in potential hypersthene relative to the analysed liquids (figure 2); substantial negative MgO, and some normative nepheline (in 'presence' of pigeonite crystals) appear in some of these calculations.

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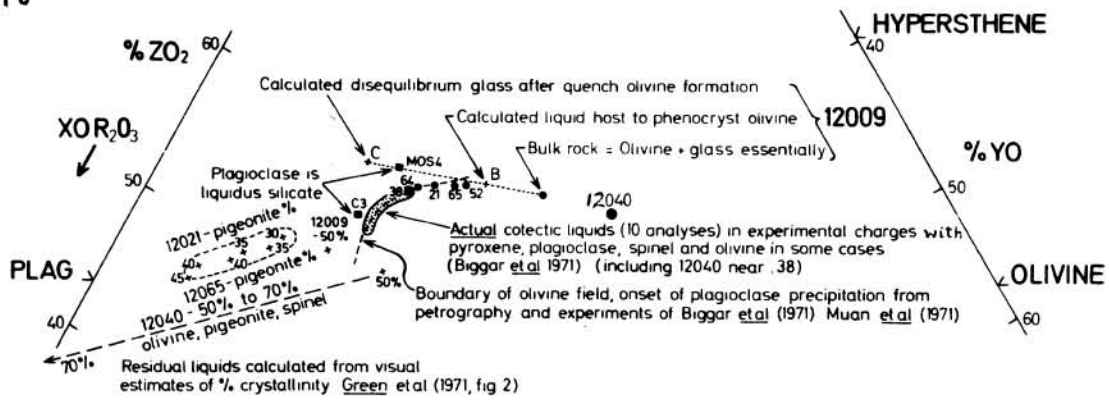

Fig. 2. Diopside projection contrasting analysed and calculated cotectic liquids

The composition of the basaltic magma supplied to the surface at the Apollo 12 site is best sampled by glass and lithic fragments in the soil, or by the bulk soil; or even by averaging the total weight of rocks distributed for chemical analysis (biased towards extremes? N.B. also that glass analyses will not include iron reduced by impact heating in vacuum). These compositions resemble the analysed cotectic liquids but differ from phenocryst-enriched mixtures like 12040 (figure 3). K9, K10 are impact produced glass fragments as rich in potential olivine as the phenocryst-enriched rocks. The glassy sample 12009 shares the thermal history (rapid chilling from > 1200°C) of the impact glasses, but differs from that of most other rock samples (slower cooling from c. 1170°C-1150°C). 12009 may represent a splash of impact remelted phenocryst-enriched lava.

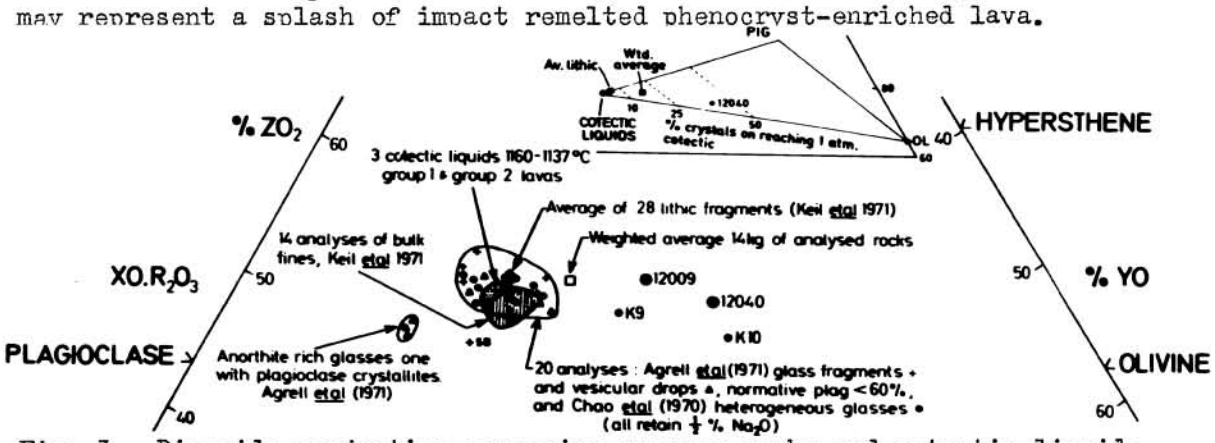

Fig. 3. Diopside projection comparing average rocks and cotectic liquids

The probability of the observed close approach of erupted lava compositions to low pressure cotectic liquid compositions being due to coincidence with a higher pressure primary magma composition is ~ 3 in 1000; in Apollo 11 ophitic group it is ~ 5 in 10,000, but reaches ~ 3 in 100 in the intersertal group. It is more probable that crystal-liquid fractionation at low pressures has controlled the observed lava compositions.

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CRYSTALLIZATION APOLLO 12

BIGGAR, G.M.

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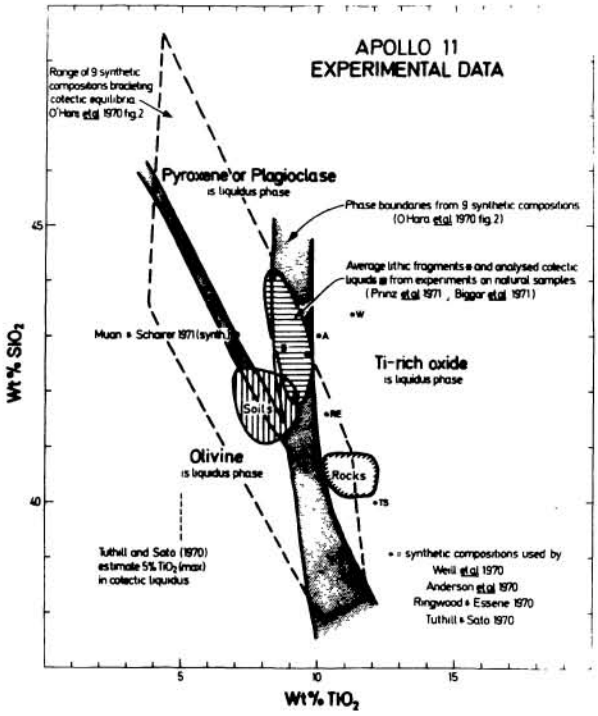
Prinz et al. (1971 Contrib. Mineral. Petrol. 32, 211-230) reported average composition for Apollo 11 basalts based on analyses of 21 low potassium and 18 high potassium lithic fragments in the soil. These are significantly lower in Ti, Fe, Mn and higher in Si, Al, than averages of analysed rock specimens, and accordingly much closer to the experimentally produced cotectic liquid compositions (cf. Apollo 12 lithic fragments, fig. 3). Selected figures for comparison are:-

	SiO_2	TiO_2	Al_2O_3	FeO	MgO	CaO
High K fragments	42.8	9.6	10.6	18.0	7.0	10.7
Low K fragments	42.9	8.7	11.8	17.0	7.2	11.4
Cotectic liquid (Biggar et al. 1970; average of 2)	43.0	8.8	10.3	17.7	6.5	11.3

The larger rock samples may have been selectively derived from the base of a flow into which ilmenite had accumulated. The average soil is yet more feldspathic than these averages and may reflect the overlying and complementary pole of the differentiation, now fragmented to form regolith.

Fig. 4

SiO_2-TiO_2 plot of phase data for synthetic and natural Apollo 11 compositions.



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