PROVENANCE OF THE CLAST POPULATION OF SOME FRA MAURO BRECCIAS

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We report results from continued textural and compositional studies of the clastic material of Fra Mauro breccias (14006, 14321, 14066 and 14063) with the aim of deducing its geological provenance and deformational history.

The grain size distribution of the clasts in 14066 and 14063 is consistent with the grain size characteristics reported for other breccias with crystalline matrices (14006, 14311, 14320, 14321) by (1). According to Fig. 1 all breccias have very similar size distributions. An important observation is that the clast population of breccias with crystalline matrices of variable texture (metamorphic grades 4 - 6 of (2)) have particle size properties which are almost identical in the measured size range of 0.0 - 4.75 Ø to those of breccia 14063 whose matrix is detrital. Compared to terrestrial single impact detritus the clastic material of the Fra Mauro breccias appears to be reworked by multiple impact but it is still far from reaching the steady state of the lunar regolith.

Previous data on the chemical composition of the plagioclase clast population in some Fra Mauro breccias (1) showed that the provenance of the mineral clast population might be determined successfully by particular major and minor element correlations which are indicative of the geological and chemical environment in which the minerals crystallized (3, 4, 5). The correlation of some oxides is plotted for pyroxene and olivine clasts of breccias 14006 and 14321, and for plagioclase clasts of breccias 14063 and 14066 (Fig. 2-7). In all plots the data are opposed to encircled fields which contain literature data points for the corresponding mineral phases from the three main groups of primary igneous rocks (mare basalts; KREEP and high alumina basalts; and anorthositic-noritic-troctolitic rocks indicated in Figs. 2 - 7 by solid, solid-crossed, and solid-dotted lines, respectively). It can be concluded from these data and from plagioclase data of 14006, 14311, 14320, and 14321 given by (1) that the mineral clast population of all analyzed breccias is dominated by high-alumina and/or KREEP basalts. It contains minor amounts of ANT-rocks, dunite, spinel troctolite, and possibly other types of mare basalts. The proportion of these minor constituents is rather variable from breccia to breccia: 14006, 14321 and 14063 contain ANT-mineral clasts (plagioclase, pyroxene), whereas 14311, 14320 and 14066 (dark matrix) are obviously lacking this component. In addition 14006 and 14321 (dark matrix) carry olivine clasts very probably derived from spinel troctolite and dunite, respectively

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(Figs. 6 and 7). Some of the mineral clasts in Figs. 2 - 5 fall outside of the encircled fields for common lunar igneous rocks. The reason is not well understood. One possible explanation is that part of the clasts originate from rocks which crystallized from impact melts of hybrid chemical composition and abnormal cooling history. In spite of this complexity in the presented provenance statistics the mineral clast population of the Fra Mauro breccias reveals the record of two important processes which belong to the pre-Imbrian time if we adopt the view that the breccias themselves are clasts in the Fra Mauro formation: a) mare-type volcanism (6, 7), and b) excavation of plutonic rock types such as dunites and troctolites by early large basin-forming events.

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Figure captions. Fig.1: cumulative volume-frequency size distribution of the clast population of Fra Mauro breccias and soil 14259; suevite from Otting,Ries; hatched area: range for the breccias 14006, 14055, 14311, 14320, 14321, Fig. 2 - 7: composition of randomly selected mineral clasts in Fra Mauro breccias; straight lines and crossed bars indicate regression

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lines, averages, and standard deviations (1σ) of data points; encircled fields: literature data for lunar igneous rocks (8-27, see text), 965, 1244, and 583 analyses of plagioclase, pyroxene and olivine, respectively.

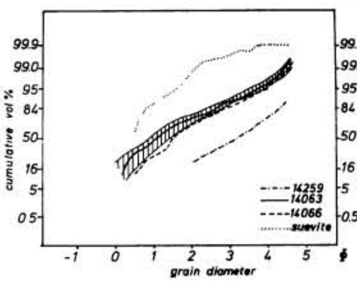


Fig. 1 ←

Fig. 2 →

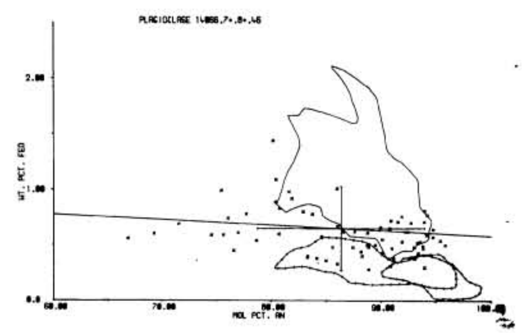


Fig. 3 ↓

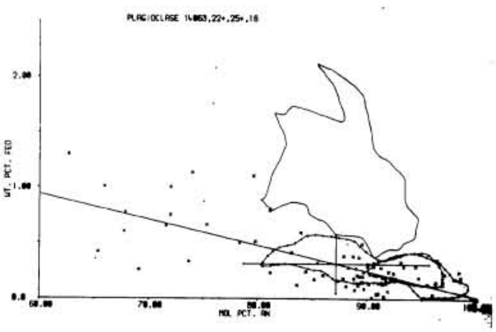
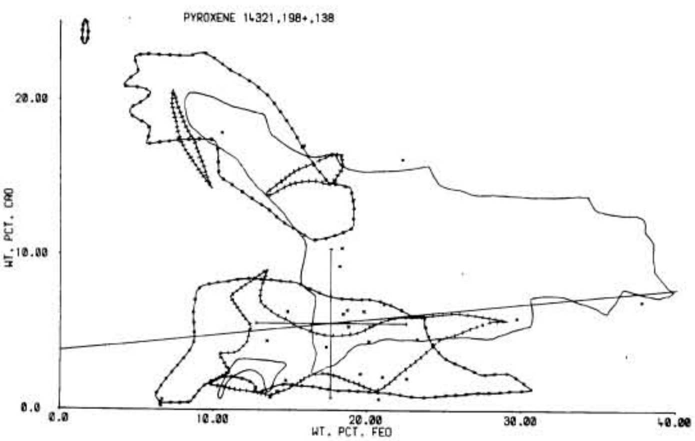


Fig. 6

Fig. 4 →



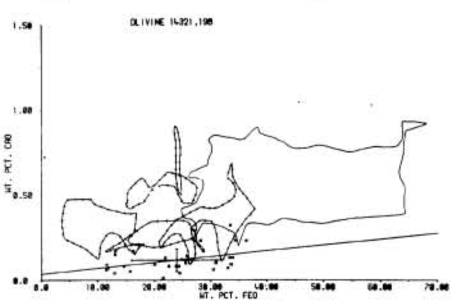


Fig. 7

Fig. 5 →