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## METAMORPHIC MATRIX BRECCIA 79215: CHEMICAL AND TEXTURAL EVIDENCE FOR A POST IMPACT METAMORPHISM

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Lunar breccia 79215 has been collected from a block field surrounding Van Serg crater at station 9 of the Apollo 17 mission. It has a granulitic matrix texture which is similar to the texture of terrestrial rocks with strong thermal metamorphism. Calculations of McGee *et al.* (1978) revealed that this

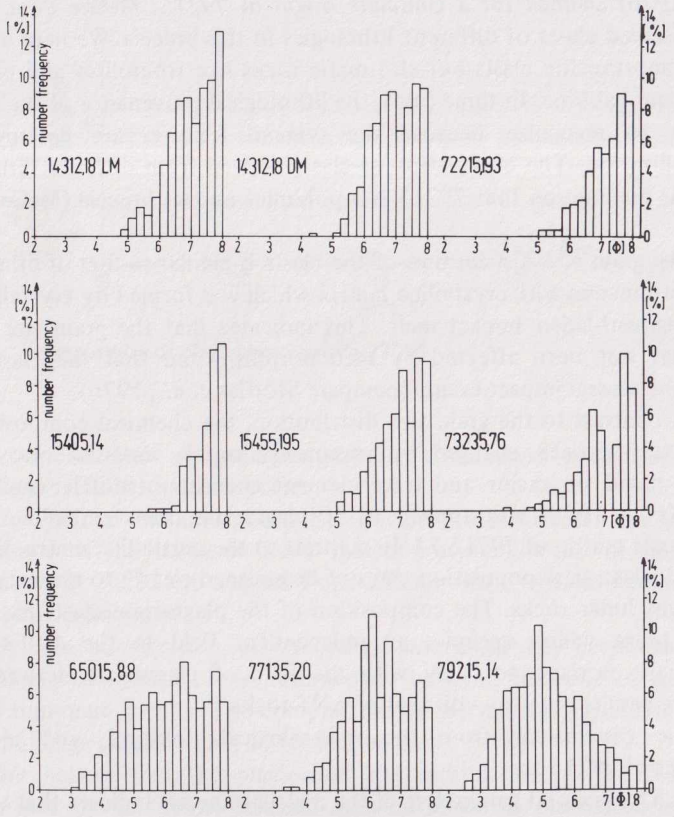


**Fig. 1** **Grain size distribution of matrix plagioclase in some lunar breccias.**

metamorphic event required temperatures of more than 800 °C for a time period of less than 10 million years.

A quantitative textural analysis has shown that the matrix texture of 79215 is distinctly different from that of other lunar breccias (Knöll and Stöffler, 1979). The mean grain size of the matrix minerals is larger and the grain size distribution has only one mode. In contrast, all lunar breccias investigated so far have at least a bimodal grain size distribution except for breccia 15405 which is extremely fine-grained (Fig. 1).

The transition matrix obtained from the textural analysis for the matrix minerals (Table 1) reveals that 98% of all grain contacts are those of plagioclase with pyroxene and olivine. This is due to the modal mineral content of 74.9% plagioclase and 24.9% pyroxene and olivine and to the fact that large plagioclase crystals (mean grain size: 37.6 μm) are surrounded by minor pyroxene and olivine crystals (mean grain size: 12.4 μm).

The chemical and petrographical investigations of Bickel *et al.* (1976) and McGee *et al.* (1978) resulted in different conclusions. Whereas Bickel *et al.* (1976) claimed for a cumulate origin of 79215, McGee *et al.* (1978) have observed clasts of different lithologies in this breccia. We have observed mainly anorthositic clasts but also mafic rocks like troctolites and probably norites and gabbros. In some cases, the lithological provenance of the clasts is difficult to recognize because the original textures are destroyed by recrystallization. The observation of clasts derived from different lithologies favor the assumption that 79215 is a polymict impact breccia (McGee *et al.*, 1978).

The grain size distribution of the clasts is similar to that of other lunar polymict breccias with crystalline matrix which was formed by crystallization of a fragment-laden impact melt. This indicates that the grain size of the clasts has not been affected by metamorphism and that the clasts have undergone several impact events (compare Stöffler *et al.*, 1976).

In contrast to the grain size distribution, the chemical composition of the clasts has been changed by metamorphism. A statistical provenance analysis based on major and trace element chemistry (Stöffler and Knöll, 1977; Knöll, 1978) was applied to 50 plagioclase clasts embedded in the granoblastic matrix of 79215,74. In contrast to the crystalline matrix breccias the plagioclase clast population can not be assigned clearly to the main types of igneous lunar rocks. The composition of the plagioclase clasts has a very narrow range which occupies an independent field in the An-FeO plot (Fig. 2). It overlaps not only with the field of plagioclase derived from non-mare basalts but also with that of ANT-rocks.

The conclusions from the mineralogical, textural, and chemical properties of 79215 are:

1. The textural parameters of the matrix minerals indicate that thermal metamorphism has caused a recrystallization of the matrix. Therefore the

**Table 1**
**Transition matrix of the matrix minerals in 79215.**
**plag = plagioclase, px + ol = pyroxene and olivine,**
**ilm = ilmenite, acc = accessory minerals**

| | plag | px + ol | ilm | acc |
|---|---|---|---|---|
| plag | 00.0 | 98.0 | 00.1 | 00.6 |
| px + ol | | 00.2 | 00.5 | 00.3 |
| ilm | | | 00.0 | 00.0 |
| acc | | | | 00.0 |

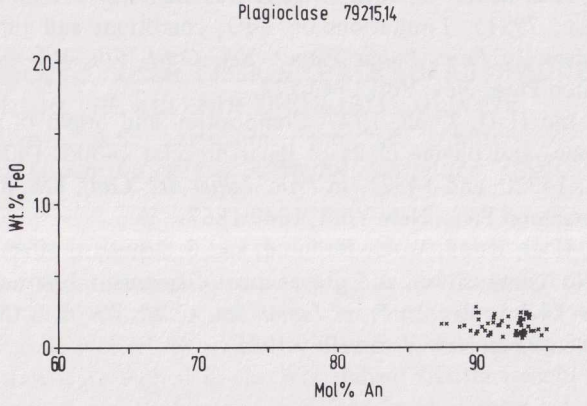


**Fig. 2 Composition of plagioclase clasts in 79215.**

matrix minerals have a larger mean grain size and a lower specific surface area than the crystalline matrix breccias.

2. Thermal metamorphism has obviously not affected the grain size distribution of the clasts. It is like that of a crystalline matrix breccia. The lithic clasts in 79215 are derived from different lithologies which means that this breccia is polymict.

3. The composition of the plagioclase clasts has been changed by thermal metamorphism. It is intermediate between that one of ANT-rocks and of non-mare basalts. The composition of the matrix plagioclase varies in the same range (Bickel *et al.*, 1976; McGee *et al.*, 1978).

We believe that the plagioclase clast population of 79215 has been equilibrated by an intense thermal metamorphism as postulated by McGee *et al.* (1978). The grain size distribution of the clasts indicates that the

precursor of 79215 was a crystalline matrix breccia which was formed by the crystallization of a fragment-laden impact melt.

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## LEAD ISOTOPES AND METAMORPHISM OF CHONDRITES

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Whole-rock lead-isotope ages of chondrites differ significantly from one another, and are generally somewhat lower than internal-isochron Pb-Pb ages of high-temperature phases in primitive chondrites and of achondrites.

We have determined uranium and thorium contents in several of the chondrites for which lead-isotope data were obtained by Huey and Kohman (1973), including the lead-rich Murchison (CM2), Mesö-Madaras (L3), and Abee (E4). Improved lead-isotope data have been obtained for Queen's Mercy (H6), for which Huey and Kohman obtained an anomalously high Pb-Pb age.

Examining only the lead-isotope data from our laboratory, there seems to be a trend towards younger single-stage-model ages with increasing metamorphic grade. This could be explained if post-accretional heating in the parent bodies caused not only the metamorphism but also a loss of some of the primordial and earliest-generated radiogenic lead. The Pb-Pb ages would