A PETROLOGIC COMPARISON OF THE KAPOETA PARENT PLANET WITH THE MOON.

INTRODUCTION: Numerous authors have contributed fundamental observations supporting the hypothesis that howardite meteorites evolved in an impact-derived regolith on their parent planets. These data include the presence of abundant rare gases, maskelynitized plagioclase, glass fragments and agglutinates, and solar flare tracks and microcraters in certain grains, and the recognition of the overall polymict-brecciated character of the howardites (cf. Rajan [1]).

Since the nature of rock fragments in lunar soils and soil breccias has proven useful in providing a petrologic characterization of selenologic units at each landing site, it seems logical to extend the approach developed in the study of these clastic lunar samples to howardites. We present here preliminary results of our study of rock and mineral fragments from the howardite Kapoeta, compare these to lunar samples, and discuss the consequences of our observations for the evolution of the Kapoeta parent planet, assuming that the source for this regolith is representative of that parent body.

ROCK FRAGMENTS: Two principal types of rock fragments (up to ~1 cm in size) occur in the Kapoeta meteorite: 24 consist predominately of pyroxene and plagioclase and can be termed "basaltic"; 6 consist predominately of pyroxene and can be termed "pyroxenitic". Plagioclase-rich anorthositic rocks, feldspathic basalts, and ilmenite-rich basalts, so characteristic of many lunar soils, are conspicuously absent.

The basaltic fragments display textures that include: 1) porphyritic-varioliutic, intergranular, and subophitic, suggestive of a volcanic and hypabyssal origin; and 2) recrystallized-granular, with a range in grain size, suggestive of a plutonic or metamorphic origin. All fragments contain pigeonite and rarely a small amount of primary ferroaugite. The pigeonite in recrystalized-granular fragments has undergone varied amounts of exsolution and inversion.

The basaltic fragments contain pyroxene with \((\text{Fe}/\text{Fe}+\text{Mg}) > 0.4\) (Fig. 1). The range in \((\text{Fe}/\text{Fe}+\text{Mg})_{\text{py}}\) in each fragment is small (~0.1), and the total range from fragment to fragment is only slightly larger. Pyroxene grains in some fragments are zoned, but the zoning is dominantly an outward increase in Ca-content, with only a slight variation in \((\text{Fe}/\text{Fe}+\text{Mg})\). This narrow range in \(\text{Fe}/\text{Mg}\) in the pyroxene must be related to primary crystallization, since it is a feature shared by all the basaltic fragments, irrespective of their inferred "origin".

The relatively iron-rich nature of the pyroxene suggests that the basaltic fragments are highly-evolved chemically, and are analogous to lunar mare basalts. This analogy is strengthened by the fact that two of the basaltic fragments yield \(\text{Rb}/\text{Sr}\) ages of 3.89 and 3.63 AE [2], similar to lunar mare basalts. However, the basalt fragments in Kapoeta are distinguished from lunar mare basalts by lack of extensive zoning in the pyroxene.

Plagioclase in the basaltic fragments has a total range in composition from \(\text{An}_{70-95}\), but the range is smaller (2-15 mole% An) in any given fragment. Some fragments contain zoned plagioclase, but most are relatively homogenous. The \(\text{K}_2\text{O}\)-content of the plagioclase is low, and similar to that in lunar mare basalts. Minor phases include ilmenite (<1 wt% MgO), chromite \((\text{Fe}/\text{Fe}+\text{Mg} > 0.8)\), \(\text{SiO}_2\), Ca-phosphates, troilite, and Fe-metal (<0.1 wt% Ni). Potassium-rich residual mesostasis is extremely rare.
The pyroxenite fragments include both coherent polycrystalline fragments and monomict breccia clasts. These consist of homogenous pyroxene with \((\text{Fe}/\text{Fe} + \text{Mg})Q.4\), but there is a considerable variation from fragment to fragment (Fig. 1). Rare grains of chromite, \(\text{SiO}_2\), Fe-metal (5-40 wt\% Ni), and troilite are also present, but plagioclase has not been identified.

The fact that the pyroxenitic fragments contain Mg-rich pyroxene and no plagioclase allows for the possibility that they represent early-formed cumulate rocks. They may be related to some of the basaltic fragments by fractional crystallization of pyroxene prior to the onset of plagioclase crystallization.

**MINERAL FRAGMENTS:** The Kapoeta meteorite contains fragments of olivine, pyroxene, plagioclase, ilmenite, chromite, \(\text{SiO}_2\), Ca-phosphates, Fe(Ni)-metal, and troilite whose compositions and relative abundances are consistent with derivation from material not unlike the observed rock fragments. However, the source of the olivine has not been identified. The range in composition of pyroxene clasts (Fig. 2) is similar to that in rock fragments, and matches well with pyroxene data from Kapoeta presented by Fredricksson and Keil [3].

Schmitt and Laul [4] have shown a remarkable linear correlation for FeO and MnO in lunar samples. The FeO/MnO value (~80) differs markedly from that of meteoritic or terrestrial silicate material. Fig. 3 illustrates a linear relationship for FeO and MnO in pyroxene utilizing our analyses of samples from all Apollo and Luna sites. The FeO/MnO value for lunar pyroxene is ~80, identical to the lunar rock value. The FeO and MnO contents of pyroxene in Kapoeta also show a linear correlation, with an FeO/MnO value identical to that of the total rock (~35), but quite different from lunar pyroxenes.

Several inferences may be drawn from these observations. Clearly, it points to coherent behaviour of Fe and Mn fractionation in the Kapoeta parent planet. The FeO-MnO correlation suggests that the pyroxene-bearing materials on the Kapoeta parent planet were derived from homogenous source regions related through pyroxene-melt equilibria. Since both lunar and Kapoeta rocks contain Fe-metal, they both formed under conditions of low ambient oxygen fugacity. Hence, the difference in the FeO/MnO value in Kapoeta and lunar pyroxenes cannot be attributed solely to differing oxidation states during crystallization of the rocks. The difference suggests that the Kapoeta parent planet evolved in a different physical-chemical environment from the moon, probably resulting in different initial oxide-metal proportions, as suggested by Wänke, et al. [5].

**SUMMARY AND CONCLUSIONS:**

1) Kapoeta basaltic rocks are relatively Fe-rich and K- and Ti-poor. Thus they are somewhat similar to Apollo 12 and 15 mare basalts, but different from Apollo 11 and 17 mare basalts. 2) Kapoeta basaltic rocks evolved in surface, near surface, and "deep-seated" environments, in contrast to the moon where similar rocks appear to have formed only as surface flows. 3) Kapoeta rock fragments contain native iron. This indicates that they, like lunar rocks, formed under reducing conditions. 4) In contradistinction to the moon, a source for pyroxenitic rocks, but none for anorthositic rocks, existed on the Kapoeta parent planet. Thus the petrologic evolution of the Kapoeta parent planet involved chiefly pyroxene (and olivine?), whereas plagioclase played an important role in lunar evolution. 5) The FeO-MnO relationship suggests that the sources for materials in the Kapoeta meteorite are fundamentally related, perhaps through a primary planetary differentiation, or perhaps a more localized fractional crystallization, and that they are chemically distinct from those on the moon.
KAPOETA PARENT PLANET
DYMEK, R.F. et al.