Accretionary lapilli and other sedimentary textures of the howardite Kapoeta.

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Introduction: Howardites and other meteoritic breccias are interpreted as lithified samples of asteroidal regoliths. Microscopic properties [the presence of solar flare tracks, solar noble gases and microcraters on surfaces of mineral grains and impact glass droplets (Brownlee and Rajan, 1973)] suggest an analogy between meteoritic and lunar breccias. For lunar breccias the textures and macroscopic sedimentary features are well described (Lindsay, 1976). Because the erosion by micrometeorites acts more efficiently along less cohesive strata, large boulders of the moon have a weathered appearence. Thus, on photographs taken during the Apollo missions, the layering of lunar breccias was clearly visible. On the other hand little is reported about this subject for meteoritic breccias. Meteoritic specimens are often small objects and a possibly "weathered" appearence of the meteoroid is erased during atmospheric entry. Sedimentary features are thus not so apparent as they are on the lunar surface. However, a sedimentological comparison of lunar and meteoritical breccias is of great importance in order to understand the evolution of regoliths on small objects. In fact, sedimentary features observed on 5-10 cm sized specimens during a recent noble gas study of Kapoeta (Pedroni, 1989; Pedroni, 1991) reveal remarkable analogies and some significant differences.

The layering: A layering cannot be observed directly for Kapoeta, however, several properties suggest a layering similar to that of lunar breccias: A) A weak **foliation** (by alignment of clasts) is present for some strata on the moon (Lindsay, 1976). A similar foliation was observed at the thin section level (Dymek et al., 1976) and is evident also in a centimeter sized fragment of Kapoeta. The foliation is present only in a single specimen, and suggests a sedimentary origin. B) Each layer of lunar breccias has a different **grain size composition.** In some fragments of Kapoeta clasts are nearly absent. Other fragments are highly enriched in centimeter sized pebbles, suggesting a clast-supported structure. C) The soil **maturity** is different in each layer of lunar breccias. A fragment of Kapoeta shows two matrix regions which are slightly different in darkness. The solar gas concentration for the two regions differ by a factor 2-3. A smooth transition band between these two regions is unusually rich in small preirradiated metal fragments and chondritic foreign inclusions. This suggests a boundary between two different strata.

Xenolithic breccia clasts: Many clasts of Kapoeta are xenolithic howardite-breccias by themselves. Some of them are very dark ("extra dark") and bear 2-3 times more C-chondritic foreign inclusions than the matrix. Other xenolithic breccia clasts are lighter and are nearly free of foreign inclusions. The xenolithic breccia clasts thus originate from more than one source, similarly as on the moon. The analogy with lunar breccias is, however, not complete: Solar gas concentrations for breccia clasts are always lower than that of the surrounding matrix of Kapoeta. Furthermore, multiple clast-within-clast relationships are nearly absent in Kapoeta. Thus, in contrast to the moon, materials which resided on the surface at some time have not been recycled frequently into the active regolith. The rarity of impact glass droplets and agglutinates confirms this conclusion. Therefore, blanketing by subsequent impact ejecta and/or loss to space must have been more efficient than on the moon.

Accretionary lapilli: Structures (Fig.1) strongly resembling the accretionary lapilli of lunar samples have been observed in a specimen of Kapoeta. Lindsay (1976) suggests that the lapilli accreted in a base surge generated by vaporization of soil during a great impact event. Impact generated vapors have, however, a further consequence: because of the surface/volume ratio, the fine-grained fraction of the soil is selectively accelerated by the hydrodynamic drag (Rehfuss et al., 1977). Thus, from the presence of accretionary lapilli I infer a selective loss to space of the fine grained fraction of the asteroidal regolith. In fact, grain size analyses of meteoritic breccias

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(if compared to lunar soils) reveal a remarkable underabundance of the fraction <100 μm (Bhattacharya et al., 1975). The finest fraction is also the most heavily irradiated one (Pedroni, 1989; Pedroni, 1991). This fact might have contributed to a systematic underestimation of residence times of soils on the surface of asteroids.

Conclusion: The regolith breccia Kapoeta shows remarkable textural similarities to regolith breccias found on the lunar surface. Excavation, deposition and compaction mechanisms which generate asteroidal soils and breccias are comparable to those acting on the moon. However, because of the lower gravity on the asteroidal parent body, the mass balance between excavation, deposition and loss to space is completely different. In particular, grain size-sorting effects might have played a much more important role on the Kapoeta parent body than on the moon.

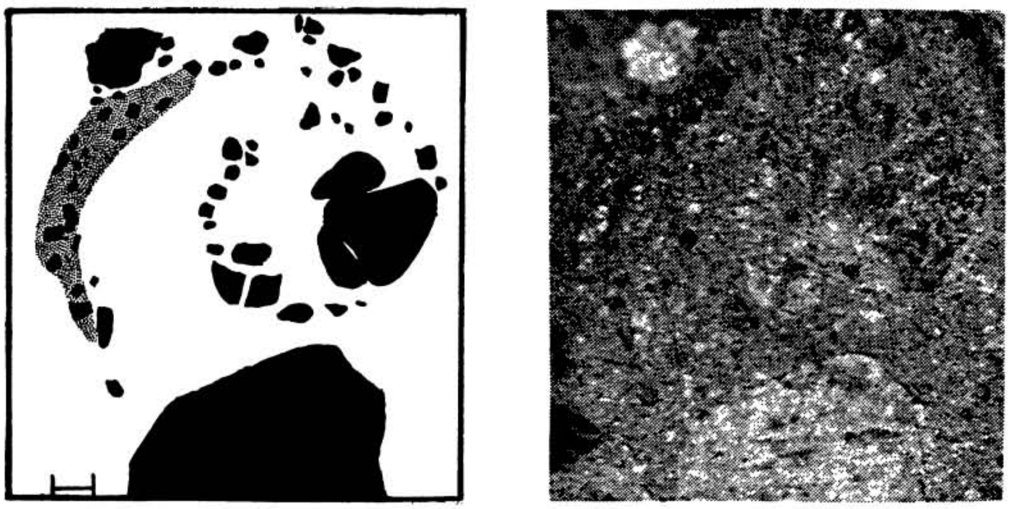

Fig.1: This structure, strongly resembling the accretionary lapilli found in lunar breccias (Lindsay, 1976), was observed in a clast rich fragment of Kapoeta (scale bar: 1 mm). The presence of these structures and of very thin glass coatings at the surface of some clast confirms the vaporization of soil during large impact events on the Kapoeta parent body.

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