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From the Editors

Is Kaidun really the Rosetta stone?

One of the dilemmas facing researchers in many fields, especially meteorite studies, is how much emphasis should be given to the "anomalies" relative to that given to the more commonplace. It might be said that we spend too much time discussing the anomalous meteorites before we have a good working hypothesis for the normal. However, if there ever was a Rosetta stone among the anomalous meteorites it is Kaidun. The Kaidun meteorite fell in Yemen on 1980 December 3 and a mass of ~850 g found its way to the Russian Academy of Sciences in Moscow. It has been the subject of an impressive series of papers and abstracts by A. V. Ivanov of the Vernadsky Institute, Moscow, and his collaborators. The large number of collaborators amassed by Ivanov reflects both the complexity and the importance of the meteorite.

Kaidun is arguably the meteorite specialist's ideal breccia. (See Ivanov, 1989, and Ivanov *et al.,* 1984 for an overview of the meteorite.) Its host material (Kaidun I), initially described as CV2 but now regarded as CR chondrite, encloses discrete clasts of CI or CM chondrite (Kaidun II; Zolensky *et al.*, 1991, 1996), EH5 chondrite (Kaidun III), EL3 chondrite (Kaidun IV; Ivanov and Ulyanov, 1985; Ivanov, 1989) and chondrule-like clast of material thought to be R3 chondrite (Brandstätter *et al.*, 1996). Most of these classifications are particularly well established, being based on inert gas content (Minh *et al.*, 1984) and O-isotopic analysis (Ivanov *et al.*, 1987; Fig. 1), as well as mineralogy, texture, and bulk composition. Each clast has a few properties that distinguish it from normal members of the class. The Fe/S ratio of the CI or CM clasts is higher than normal CI chondrites, and they tend to be somewhat coarser-grained (Zolensky *et al.*, 1991; 1996). The enstatite chondrite clasts are aqueously altered around the peripheries (Ivanov *et al.*, 1993). However, these differences generally reflect alterations caused by the impact mixing of such diverse materials and perhaps may also partly reflect limited data for small classes rather than major differences in origin. Ivanov and Ivanov (1989) have estimated that brecciation was caused by impact at velocities of 2-5 km/s and that much of the material was heated to 200–300 °C during the process.

The latest contribution from Ivanov and his colleagues concerns a third kind of enstatite chondrite clast that they describe as EH3-4. In particular, Ivanov *et al.* (1996) describe metal nodules in the clast and the wide variety of inclusions contained in them. They sort the metal nodules into three kinds: nodules that are accumulations of a number of welded globules, those with massive interiors surrounded by accumulations of globules, and nodules without internal structure. The mineral inclusions range from silica, albitic glass, enstatite, roedderite and a an inferred mixture of silica and sodium disulfide. Several studies of mineral inclusions in metal have previously appeared in the literature. They have usually been interpreted as the result of exsolution during metamorphism. But Ivanov *et al.* reject this idea for the present samples. They argue that the textures, and the similarity in composition between the metal and silicates enclosed in the metal and those in the matrix, suggest that the nodules are agglomerations of nebular materials and that the degree of melting accompanying agglomeration determined the textures. A series of gas-solid reactions subsequent to agglomeration are thought to have produced the extraordinary mineralogy of the inclusions.

It is clear that the Kaidun meteorite has plenty to teach us about brecciation. It might also have a bearing on the source regions of the various chondrite classes. In this sense, Kaidun might well be the meteorite researchers' Rosetta Stone. It is extraordinary that if EH, EL, CI/CM, CR and R chondrites formed in widely dispersed regions of the early solar system, as some researchers have argued, that fragments of all five classes should be found together in a rock smaller than a football. There might also be lessons here for understanding the genesis of the CR chondrite class. The CR chondrites are a relatively recently described class that was produced by collecting a number of meteorites with similar components but different bulk composition and redox states (Weisberg *et al.*, 1993). They have been related to the Bencubbin, Weatherford and Allan Hills 85085 meteorites that are probably best thought-of as metal-rich chondrites. Many authors have described ALH 85085 as having both enstatite and carbonaceous chondrite properties, and it is at least arguable that if the clasts of Kaidun had been more successfully comminuted during brecciation, the final result would have resembled ALH 85085 or even the CR chondrites. Certain "anomalous" meteorites clearly have an origin by mixing material that had already formed by the more familiar processes of chondrule formation, metal-silicate and lithophile element fractionations and O-isotopic exchange, fractionation or mixing. The idea should be explored that the CR class also owes its origin to mixing primary materials rather than the primary processes responsible for the nine major classes, whatever they were!

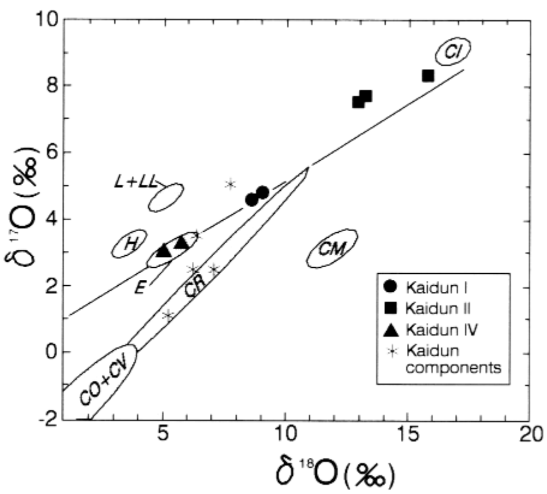

FIG. 1. Three oxygen isotope plot for clasts and host material from the Kaidun meteorite (after Ivanov *et al.*, 1987). Kaidun I is the host and plots on the terrestrial line with Renazzo and Al Rais, while clasts Kaidun II and IV plot in or near the fields of CI and enstatite chondrites, respectively. Data are not available for EH5 clast Kaidun III. The "components" are three chondrules, an olivine aggregate (right central data point) and a phyllosilicate inclusion (lowest data point). The CR chondrite field was taken from Weisberg *et al.* (1993).

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