PALLASITES: DOES DENSITY MATTER AFTER ALL?

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Introduction: Traditionally pallasite formation has been explained as the mixing of core-metal and mantle-silicate material at the core-mantle boundary of a differentiating body. However, there is a prevailing argument against the core-mantle boundary model that the density contrast between metal and silicates should lead to rapid separation and the inability to form pallasite-like samples [1]. As a result, many competing models have been proposed to explain the mixing mechanism [e.g. 2,3,4]. A review of the most prominent models can be found in [5].

While some authors have investigated the distribution of olivine and metal within pallasites (connectivity of phases, total volume) [6], no one has yet fully assessed the ability of CT-data to distinguish the 3D relationship between these phases.

Methodology: Pallasite specimens were scanned at the High-Resolution X-ray CT facility at the University of Texas at Austin. Most pallasites are cut into thin slices for display; however, CT-analysis requires more blocky samples to allow measurement of the 3D texture. The Monnig Collection at TCU contains suitable pieces of Pallasovka and Fukang, both of which were analyzed for this study. Each phase of interest (metal and olivine) was defined by hand for each slice of the CT-data in Aviso. The connectivity of the metal and olivine were measured using Blob 3D.

Discussion: The metal and olivine both yield connectivity values of 99% in Pallasovka and Fukang and a total olivine volume of 70.5% and 63.5% respectively. These results are very similar to those in a destructive tomographic study of Brenham [5], indicating that CT-scanning is a viable tool for analyzing the pallasites. The complete interconnectivity in the samples measured indiciates that both the metal and olivine are, in places, self-supporting networks, meaning that rapid separation would not be necessary even with the noted density contrast.

In addition to this, the samples measured in this study contain fragmental olivines, and are still approximated by the same random close packed (Fukang) or face centered cubic (Pallasovka) packing structure that is seen in those with rounded olivines, such as Brenham [6]. Mechanisms for fracturing, such as shock-waves from impacts [5], or impact disruption [4], would be expected to loosen the packing of the olivine crystals. Therefore, pallasitic olivines must have undergone some additional settling after the fragmentation process, to regain their closely packed, interconnected structure. This evidence for a later settling event can be used to constrain and test pallasite formation models.

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