RELATIONSHIP OF MAIN-GROUP PALLASITES AND IIIAB IRON METEORITES.

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Introduction: Pallasites are conventionally thought to come from core-mantle boundaries of differentiated asteroids. Based on the chemical elemental distribution pattern and oxygen isotopes, it was proposed that the main group (MG) pallasites come from the same parent body as the IIIAB irons [1]. However, this relationship has been challenged [2, 3]. Here we report new data on cloudy zone particle size and relative cooling rates of MG pallasites and IIIAB irons.

Results: We measured the sizes of high-Ni particles bordering the tetrataenite rim after careful polishing and etching of a selection of MG pallasites and IIIAB irons. The sizes of the high-Ni particles in 10 MG pallasites vary from 105 to 188 nm and in 8 IIIAB irons from 47 to 71 nm. The sizes of the high-Ni particles are not correlated with Ni content in the MG pallasites but correlate directly with Ni content in the IIIAB irons.

Discussion: Cooling rates. Using the proportionality between the high-Ni particle size and the metallographic cooling rate [4], the cloudy zone cooling rates in the IIIAB irons vary by a factor of ~2.7. They are also consistent with the variation of the measured metallographic cooling rates with Ni content [2]. For the MG pallasites, the inferred cooling rates vary by a factor of ~4. This range exceeds the 1σ uncertainty (10-20%) and indicates that MG pallasites did not cool at the same radius in the pallasite parent body.

Link between pallasites and irons. The measured particle sizes in MG pallasites suggest that these meteorites cooled ~2.5 to 25 times slower than the IIIAB irons. This precludes formation of MG pallasites at the core-mantle boundary of the IIIAB parent body. It also suggests that MG pallasites and IIIAB irons come from separate bodies. If the MG pallasites are from a single body, there must have been a significant thermal gradient across the pallasite zone. Pallasites could come from parent bodies that are not related to any iron meteorite parent body [3]. The formation of pallasites appears to require violent mixing of molten metal from a core with mantle olivine [3, 5], possibly due to a hit-and-run impact between differentiated protoplanets [6].