In the infrared, the spectra of CM chondrites Murray and Murchison are quite similar, with broad absorptions at 3 μm and from 8 to 12 μm, with a narrower feature centered on 6.2 μm. The Mg serpentine, amesite, has abundant spectral features beyond 13 μm that are not seen in the CM chondrite spectra. The Fe serpentine has absorptions that can contribute to those seen in the CM chondrites, but lacks the large absorptions beyond 13 μm, again providing a better spectral match than the Mg serpentine.

In the future we hope to compare the spectra of these Fe serpentine with a wider variety of CM chondrites. Additionally, a theoretical modeling study is planned that will attempt to match meteorite spectra using their mineralogy and grain size distribution as the initial input to the models.

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THERMAL HISTORIES OF PGE-RICH METAL PARTICLES IN A VIGARANO CAI. I. Casanova1,2 and L. Grossman3, 1Department of Geology, Field Museum of Natural History, Chicago IL 60605-2496, USA; 2Department of the Geophysical Sciences, University of Chicago, Chicago IL 60637, USA; 3Enrico Fermi Institute, The University of Chicago, Chicago IL 60637, USA.

Metal particles in Viganò 1623-8, a type B2 CAI [1], underwent virtually no sulfidation, as is typical of opaque assemblages from Ca-Al-rich inclusions in the reduced CV3 chondrites [2]. In this study, we have identified two large metal grains (M1 and M2) with chemical and mineralogical features that may indicate cooling under different conditions and are, therefore, difficult to understand in the environment of a single CAI’s thermal evolution. M1 is an almost spherical, kamacite/taenite bearing particle included in a fayalite grain of the CAI host; a 17.5 μm long (0.5 μm across) microprobe traverse along M1 shows that Ni and Ru contents in the taenite (31.5 wt% and 1.1 wt% respectively) are uniform, and differ from those in the adjacent kamacite (Ni = 4.5 wt%, Ru = 0.7 wt%).

M2 is a 20-μm, irregularly shaped taenite particle embedded in a fine-grained (spinel-rich) portion of 1623-8. It has a homogeneous composition with 10.5 wt% Ni, 0.4% Co, 0.7% Re, 0.6% Pt, and high concentrations of Ru (6.5 wt%), Os (4.3 wt%), and Ir (8.2 wt%), as previously recognized by [1]. The composition of M2 is such that it should have undergone exsolution at 800–900°C (according to experimental data by [3] to form at least two (kamacite-NiFe), or probably three (κ-RuFe) different phases. Lack of exsolution features in this large grain is therefore indicative of equilibration at relatively high temperatures (T ≳ 900°C) followed by rapid cooling. Other metal particles of similar bulk compositions in CAIs from the Leonid shower (also a reduced CV3) show extensive exsolution features that have been interpreted as the result of low-temperature equilibration of the CAIs and their constituents after incorporation into their parent body [4,5].

The relatively high-equilibration temperature of M2 is, however, inconsistent with the existence of kamacite in M1. From the phase relations in the Fe-Ni binary, a grain like M1, with 25 wt% bulk Ni, would barely start to exsolve kamacite at 550 ± 22°C (for a 25 ± 10 vol% kamacite fraction, assuming that the effect of 2.5 wt% Co and ~3 wt% total PGE is not substantial). Therefore, exsolution of kamacite in M1 must have occurred prior to its incorporation into 1623-8. Then, in order to preserve the sharply kamacite-kamacite boundary observed in M1, the cooling rate of the inclusion at T ≤ 1200°C must have been fast since diffusion of FeNi at 50°C/hr in the 1200–550°C range would result in appreciable reequilibration of kamacite and taenite after just ~1 hr. This is in conflict with previous experimental results that suggest that the reverse zoning observed in melilites from type B CAIs formed at cooling rates ≤ 50°C/hr [7]. Then, M1 could not have been incorporated into the CAI during the melting event that produced the primary melilites in 1623-8 (with reverse zoning [1]), but could have entered the inclusion during a secondary melting stage, such as proposed by [1], followed by very fast cooling (~50°C/hr).

After kamacite exsolution, the cooling history of M1 at T ≤ 550°C must have been slow. Calculations based on (Dp/DP) = 10−3 m2 s−1 [6] show that the homogenization of Ni in the taenite over distances of 5 μm (as observed in M1) would take about 8000 yr at 550°C (or require a cooling rate <0.1°C/yr). This should be considered an upper limit to the cooling timescale since the probable effect of the few percent levels of Co and PGEs in this grain will be to accelerate Fe-Ni interdiffusion, and taenite may homogenize substantially faster than in the pure binary system. But, if such slow cooling had taken place in the CAI, M2 (just a few hundred of micrometers apart from M1) would have undergone exsolution [3]. This means that not only kamacite exsolution but also production of homogenous taenite in M1 predate its incorporation into the CAI. The phase assemblages in M1 and M2 cannot be reconciled with a single thermal history and thus require separate environments for their early thermal evolution.


PRIMORDIAL MINERAL GROWTH IN A PLASMA. W. A. Cassidy and C. M. Kern. University of Pittsburgh, Pittsburgh PA 15260, USA.

Diamonds, SiC, TiC, and graphite have been found in primitive meteorites [1] as crystalline components existing with, but far removed from, equilibrium with lower-temperature minerals and, in some cases, hydrocarbons. From anomalous isotopic ratios there is a presumption that the grains, many of them submicron surface in size, had an extraterrestrial origin [1] and may have formed within stellar atmospheres. If that were true, their environment of formation was a plasma. A plasma is an electrically neutral gas containing a high proportion of its component molecules in the ionized state, with charge balance satisfied by the presence of free electrons; it has been described as a fourth state of matter. The exact