Possibly this nickel-iron is the remnant of a colliding particle on the newly formed crater.

These features of the Chainpur chondrules, especially their bowl-shaped craters lined by one or more glassy frills, fractured walls, breccias of different types, central mound in craters, glassy globules of different types and ejecta around craters convincingly demonstrate their high-speed motion resulting in a complex process of repeated collision prior to their accretion in the present form. This being a right-angle, grazing or head-on collision, had variable impact so as to result in fracturing, brecciation and even fusion and quenching of the melt.

Even in chondrules of smaller dimension (about 300 micron in diameter) impact processes have operated smoothly; the mechanism by which chondrules can be cratered by particles having low mass but super-high velocity must have been induced in the system. It is possible that these solid microscopic particles which were suspended in a gas medium behaved like giant molecules, and were propelled by collisions with the rapidly moving molecules of the suspension gas and their thermal energy.

MAJOR AND TRACE ELEMENT ABUNDANCES IN PENTLANDITE AND AWARUITE FROM THE ALLENDE METEORITE: A PRELIMINARY STUDY

Andrew M. Davis, Joel B. Fisher, John M. Allen and Lawrence Grossman, *Department of the Geophysical Sciences, University of Chicago, Chicago, IL 60637*

Metal and sulfide grains from the interior of a coarse-grained Ca-rich inclusion, sulfides from vugs within chondrules, sulfide from a rim around a chondrule and isolated sulfide from the matrix of the Allende meteorite were analyzed by electron microprobe and INAA. Pentlandite has nearly the same composition in chondrules and matrix and is slightly higher in Ni within the coarse-grained inclusion. All sulfides contain 5 to 10 ppm Ru, which is apparently not due to metal contamination, since these samples contain <25 to 270 ppb Ir and <8.6 to 43 ppb Au. The remaining siderophile trace elements measured, Os, Ir, Au, As and Sb, have no apparent chalcophile behavior in Allende. Zn is depleted in both metal and sulfide (<0.2 and <0.1 times their respective C1 levels). The two metal samples contain 69% Ni and have Ni/Fe ratios 42 times the C1 ratio. The other siderophiles are also enriched in the metal, but to a lesser extent. The enrichments show no systematic relationship with condensation temperature. The C1-normalized Os/Ir ratios of the two metal samples are 1.22 ± 0.15 and 4.63 ± 0.23, suggesting a relationship with refractory platinum metal nuggets seen by others. We infer that the metal now found in Allende formed by the following reaction below 400 °C: Troilite + Pentlandite [high Ni] + Taenite →Pentlandite [low Ni] + Awaruite. There is little change in the amount of metal in this reaction, so that Ni can be selectively enriched over other siderophiles in awaruite formed this way. Bulk chemical analysis of the Allende meteorite by Clarke *et al.* (1970) shows that the Ni/Fe ratio of the Allende metal-sulfide fraction is a factor of 9.2 higher than that of C1 chondrites. The origin of this Ni-rich fraction remains enigmatic because there is no evidence for *in situ* oxidation of metal and such a Ni-rich composition is not predicted by equilibrium condensation from a gas of solar composition. One possibility is that most of the metallic Fe was oxidized and incorporated into silicates during condensation before S condensed as iron sulfides. Since Fe is more easily oxidized than Ni, the remaining metal would have been Ni-rich. This metal would have reacted with S in the gas to form Ni-bearing Fe sulfides and metal even richer in Ni. Models of this type also provide an explanation for the four-fold depletion of the S/Si ratio in Allende relative to that in C1 chondrites, since complete condensation of S requires that half the total iron in the system be available as the metal. Further studies are needed to evaluate possible mechanisms for Ni enrichment in the metal-sulfide fraction of Allende and to determine the relationship between the sulfides we have studied and Fremdlinge.

Clarke, R.S., Jr., E. Jarosewich, E. Mason, J. Nelen, M. Gómez and J.R. Hyde, 1970. *Smithson. Contrib. Earth Sci.* **5**

ISOTOPE ABUNDANCE STUDIES IN METEORITES

J.R. De Laeter, K.J.R. Rosman, C.L. Smith and N. Mermelengas, *Department of Physics, Western Australian Institute of Technology, South Bentley, 6102, Western Australia*

The "cosmic" abundances of the elements have been largely based on the type 1 carbonaceous chondrites (C1), because it is thought that they closely approximate the condensable fraction of primordial solar system material. The concentration of a number of elements in the mass range $48 \leqslant Z \leqslant 56$ measured in the C1 meteorite Orgueil, have already been described (De Laeter and Hosie, 1978), and we now report the concentration of Pd in Orgueil to be 1.5 (with respect to S1 = 10^6 atoms). This is in good agreement with the presently accepted value of Cameron (1973), despite the variability on much of the published analyses for Pd in meteoritic material (Nichiporuk, 1971). Although based on only one C1 meteorite the analyses have been made by solid source mass spectrometry using stable isotope dilution, a technique which is admirably suited for trace element analysis requiring high accuracy and precision.