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"METAL-SILICATE RELATIONSHIPS IN DIFFERENTIATED METEORITES"

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Introduction A wide range of analytical and experimental techniques were used to determine the nature and origin of meteoritic material, and its significance in the early history of the solar system. The results on four major topics are summarized below. Lists of all published papers, abstracts and student theses are appended.

(1) Howardites The study of metal-silicate relationships in howardite breccias showed different compositions of indigenous and projectile metal, as in lunar rocks. Ni-poor metal occurs in clasts of primary igneous material but Ni-rich metal occurs in the impact glass and melt rock clasts present in some howardites. There are two classes of howardites; one, containing abundant Ni-rich metal, glass and melt rock clasts, particle tracks, rare gases and occasional fragments of carbonaceous chondrites, is regolith breccia, though less mature than the lunar equivalent; the other lacks the above features and is better regarded as crater ejecta, very little gardened.

(2) Mesosiderites The difficult question of how the metallic and silicate fractions of an asteroid (or two) were mixed was approached by attempting to define the thermal history recorded in the minerals of mesosiderites. Computer diffusion modelling of the exsolution of phosphide from metal failed to revise the very low cooling rates experienced in the low temperature range. Microprobe analyses of pyroxenes in both little recrystallized and highly recrystallized mesosiderites revealed a common experience of high temperatures: They both contain inverted pigeonite which was homogeneous above 1150°C. This suggests that the metamorphism experienced by mesosiderites was a result of different cooling rates in the high temperature range (all relatively high) after the heating-mixing event. Metal and silicate interaction after mixing was found to be controlled by a reduction reaction involving Ca in pyroxene and P in the metal. All models for silicate-metal mixing, both internal and collisional, were reviewed and the difficulties experienced by each were documented. Both the thermal histories required by the models and those recorded in mesosiderites must be better defined before the nature of the mixing event can be specified. This group was the first to recognize a mesosiderite among the Antarctic finds (Allan Hills A77019).

(3) Diogenites Microprobe work on diogenites was begun initially to provide comparisons for mesosiderite silicates. It was very soon clear that there is an equilibrium olivine-orthopyroxene assemblage in diogenites, but not in mesosiderites, where the olivine must be derived from dunites. It was also obvious from the variations in diogenites that they merited study in their own right. The textures differ: besides fragmental breccias, there are shocked cumulates (ALHA 77256), partly recrystallized cumulates (Tatahouine) and granoblastic rocks (Yamato 74013). The breccias are not all monomict: Ellemeet is monolithologic but displays composition variation equivalent to 1km in a terrestrial layered intrusion; three contain basaltic fragments. Basaltic fragments in Garland are magnesian, representing liquids possibly parental to diogenites; in Peckelsheim they are augite-rich. One diogenite, Garland is polymict in terms of pyroxenite components. Most other diogenites are similar to the more magnesian pyroxene in Garland, but Peckelsheim corresponds to ferroan Garland orthopyroxene.

Within each group Ca and incompatible minor elements increase with Fe. The reality of the subdivision has been demonstrated by multivariate statistical techniques and seems to represent two different fractionation sequences, the more ferroan one leading to Yamato 75032 and Binda, the more magnesian one possibly associated with magnesian norite and pigeonite clasts in Garland. The intrinsic oxygen fugacities of diogenites were measured and were found to be very similar to those of mesosiderite orthopyroxenites, indicating physical similarities of the parent bodies.

(4) Chondrules The textures of pyroxene excentroradial chondrules were simulated by cooling droplets of liquid suspended on wire loops from 1450°C at rates ranging from 50° to 3,000°C/hour. Unlike some other chondrules these were totally melted, were liquid for too short a time to lose volatiles, and were cooled at rapid but not instantaneous rates. Other chondrules were not completely melted. The cooling rates are consistent with the Wood model, with condrules formed from presolar grains (or aggregates) as they accreted to the solar nebula with heating due to friction in the nebula.

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14. R.H. Hewins and G.C. Ulmer. Intrinsic oxygen fugacities of diogenites and mesosiderite clasts. Geochimica et Cosmochimica Acta 48, 1984, 1555-1560.

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