Meteoritics & Planetary Science 37 (Supplement), A9–A156 (2002)
Available online at http://www.uark.edu/meteor

Abstracts

MICROSTRUCTURAL CHARACTERIZATION OF INCLUSIONS IN VIGARANO MATRIX OLIVINES.

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Introduction: The CV chondrites are an important group of carbonaceous chondrites that provide significant insights into a range of nebular and parental body processes. One key question concerns the differences between the oxidized and reduced sub-groups of CV chondrites. In this study, we have used transmission electron microscopy to characterize the matrix of the reduced type CV chondrite Vigarano, as part of a continued effort to differentiate primary nebular characteristics from secondary overprints.

Results: FeO-rich olivine is the dominant phase in both matrix and rims and has an average composition of approximately 56.4 mol% Fa. TEM studies show that inclusions are commonly present in many olivine grains in both rims and matrix, although a significant number of grains are inclusion-free. So far, we have identified five distinct types of inclusions in olivine grains [1,2]: (1) hercynitic spinel, (2) Fe-Ni metal; (3) carbon-rich; (4) voids, and (5) rare inclusions rich in Al and Ca. Here we focus on the spinel and Fe-Ni inclusions. The spinels are 5-50 nm in diameter with rounded shapes and are heterogeneously distributed from one grain to another. Compositionally, they are consistently higher in Fe than the host olivine grains. Due to their fine-grained nature, we cannot obtain clean analyses of the spinel phase. However, using a compositional extrapolation technique [3], we determined an approximate spinel composition of $Fe_{5.75}Mg_{1.18}Cr_{0.33}Ca_{0.11}Al_{11.3}O_{24}$, (Mg/(Mg+Fe)=0.17).

We also identified Fe-Ni metal grains included in several fine-grained rim olivine grains. These inclusions are texturally similar to the spinel inclusions and show sharp interfaces with the host grains. They are approximately 20 nm in diameter. Their compositions have not been established clearly, but they appear to be relatively Ni-rich.

Discussion: Several previously unrecognized inclusion phases occur in Vigarano matrix olivines that may provide useful constraints on the origin of the matrix materials. There is considerable heterogeneity in the abundance and nature of these inclusions, which suggests that there are several different sources for the matrix olivines. The inclusion population may therefore represent a primitive, nebular, signature. However, unlike the highly unequilibrated olivines in matrix of Kaba, olivines in Vigarano matrix have a narrow range of compositions that is probably due to equilibration during mild asteroidal metamorphism. This is supported by the composition of the spinel inclusions within olivine, which are always more Fe-rich than the host olivine (Mg/(Mg+Fe) = 0.17_{sp} cf. 0.56_{ol}), based on a comparison with coexisting hercynitic spinel and olivine in the metamorphosed CK4 chondrite, Maralinga [4]. In Maralinga, the spinel is also enriched in Fe (Mg/(Mg+Fe) = 0.43) relative to coexisting olivine (Mg/(Mg+Fe) = 0.66). Although these values are significantly different from Vigarano, probably due to a higher metamorphic temperature, the relative sense of Mg-Fe partitioning is the same and is consistent with solid state elemental partitioning. We therefore suggest that the hercynitic spinels may have originally been condensates of $MgAl_2O_4$ that could have served as seeds for olivine nucleation during condensation in the solar nebula.

Acknowledgements: Supported by NASA grant NAG5-9798 to A.J. Brearley (PI).

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MARTIAN ROCKS, MINERALS, AND MANTLES.

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The variable nature of Mars was first observed almost 400 years ago and modern observations began almost 40 years ago, culminating with the flotilla of spacecraft now at or heading for Mars. We now know that the atmosphere, which produced the visible variation of Mars, has also covered it with a mantle that makes difficult any detailed investigation of the rocks and minerals of Mars.

This mantle was produced by disaggregation of bedrock, by settling of wind-lofted dust and by aeolian drifting and sorting. The thickness varies greatly—in some areas simply softening the outlines of bedrock and geomorphic features and in others totally obscuring such evidence. Nevertheless, remote sensing has provided some insight into the petrology and mineralogy of Mars.

Thermal emission spectroscopy in the low albedo areas has shown the presence of two somewhat different, but basically basaltic, rock compositions whose distribution has been globally mapped. Basalt dominates the ancient southern highlands and andesitic basalt the younger northern lowlands. Elemental analyses by landers help to confirm this spectroscopic identification. Infrared spectra have demonstrated the abundant presence of plagioclase, calcic pyroxene, and glass, local abundant of olivine and hematite, and the low abundance or lack of quartz, micas, carbonates, and sulfates. The absence of a pervasively weathered surface, at least in the darker areas is strongly indicated.

High-resolution images show an incredible abundance of depositional aeolian landforms as well as the pervasive mantle. The nature of the surface soil, sand, and dust remain a problem. The soils are commonly interpreted as secondary weathering products of mafic igneous rocks, possibly resulting from palagonitization of basalt. However, a high abundance of weathering minerals has not been confirmed by remote sensing observations. The bright and dark albedo areas are well matched, respectively, by a fine and coarse aggregate of pyroxene and plagioclase. Thus the bright and the dark regions—and much of the soil and dust—may simply be basaltic material, broken up by impact processes or physical weathering and not involving extensive hydrolytic or sulfuric alteration at all.