

Modal mineralogy of differentiated achondrites

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A key parameter in describing any solar system (meteoritic or recovered) material is the proportions of its constituent materials, the "modal mineralogy". A major goal in planetary exploration efforts has been the determination of this for various planetary surfaces, where mineral proportions must be known for many purposes, including assessing mixing models in sediments, or modelling the petrogenesis of an igneous rock. Despite the importance of modal mineralogy, it is commonly not reported for meteorites, which represent our only samples of many solar system objects. Powder X-ray diffraction (XRD) has the capability to accurately assess the modal proportions in complex mineral mixtures. Further, powder XRD makes use of large samples, non-representative sampling is unlikely to affect the analysis of mineral modes. Previous quantitative XRD efforts have concentrated on chondritic meteorites, which are variably metamorphosed sedimentary rocks composed of various nebular components. In this study, we have applied Rietveld refinement of synchrotron XRD to quantify the modal mineralogy of a variety of achondritic meteorites that originated from differentiated asteroids –bodies that have undergone large-scale melting. We have investigated 1) Samples of "outer solar system basalt" NWA 4587 (paired with NWA 011); 2) Anomalous oxidized achondrite NWA 6704; 3) brachinites, Brachina and NWA 4872. We have also conducted a survey of the howardite, eucrite, and diogenite (HED) suite including howardites (NWA 942, NWA1943, NWA 5748, Dhofar 485), eucrites (Bereba, Tirhert, Millbillillie, Moama, NWA 1836, Talampaya, NWA 6744, NWA 7465, NWA 6711), glass-rich eucrite (JaH 626), diogenite (NWA 7831, Tatahouine), olivine-rich diogenites (NWA 6013, NWA 2968). The apparent pairing group of NWA 2968 and NWA 4587 show appreciable differences in both modal abundances and minerals present. Preliminary results also show small structural and compositional differences between the outer solar system basalt pyroxenes and eucrite pyroxene that may enable spectroscopic discrimination. The improved accuracy of the modal mineralogy of the HED meteorites will also improve the interpretation of existing spectral data for the surface of Vesta, and for the spectrally and dynamically related V-type asteroids.

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