IDENTIFICATION OF NANOPHASE IRON IN AN H-CHONDRITE IMPACT MELT.

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Introduction: One of the perplexing questions in planetary science is why there are so few asteroids that spectrally "match" meteorites. For example, many asteroids have interpreted mineralogies consistent with ordinary chondrites; however, the asteroids tend to have reflectance spectra with steeper spectral slopes (redder spectra) than measured meteorites in the visible and near-infrared. This slope difference is believed to be due to the production of nanophase iron in asteroidal regoliths. Nanophase iron particles are formed [1] by the reduction of FeO to metallic iron during impact heating and during implantation of hydrogen by the solar wind.

We have used transmission and analytical electron microscopy (TEM-AEM) to identify nanophase iron particles in an H-chondrite impact melt (Dar al Gani 896 or DaG 896). We have also obtained a reflectance and a Mössbauer spectrum of this meteorite. We believe this meteorite has important implications for petrologic and spectroscopic studies of asteroids.

Petrology: DaG 896 has a microporphyritic texture with abundant (~64 vol.%) olivine ($Fo_{82.5\pm2.5}$) crystals set in a groundmass consisting mainly of Si-rich glass plus quench microlites of pigeonite ($En_{59\pm5}Wo_{9\pm3}$). There are blebs of opaque phases disseminated within the glass. Chondritic relics (~10 vol.%) are spread throughout the igneous groundmass. DaG 896 is interpreted to have formed as the result of whole-rock melting of H-chondrite material, nearly complete loss of the metal plus sulfide component, and crystallization without significant igneous fractionation.

Opaque Phases: TEM-AEM investigations allow us to identify and characterize the submicron-sized opaque phases. These opaque phases consist mainly of metal (kamacite, 1.5% Ni) and troilite blebs. Metal blebs are typically found in contact with pyroxene microlites. The metal particles are 150 to 350 nm in size and have an occurrence frequency of ~1 per μm^2. Troilite particles typically free-float within the glass, are usually a few tens of microns in size, and have an occurrence frequency of ~10 per μm^2. The metal and sulfide blebs are interpreted as residues from the removal of FeNi-FeS melt from the silicate melt.

Spectroscopy: A reflectance spectrum (0.32-25 µm) for a sample of DaG 896 was obtained at the NASA/Keck RELAB facility. Its reflectance spectrum in the visible and near-infrared is significantly reddened compared to ordinary chondrites. The analysis of a room-temperature Mössbauer spectrum of the sample finds no detectable Fe^{3+}, arguing that its reddened reflectance spectrum is not due to terrestrial weathering.

Conclusions: Dar al Gani 896 appears to be evidence that the formation of impact melts on the surfaces of asteroids can produce nanophase iron particles that can redden the reflectance spectra of asteroids. Studies of impact melts may give us the best insight on the processes that are occurring in asteroidal regoliths.

References: [1] Hapke B. et al. (1975) *Moon, 13,* 339-353.