A SEARCH FOR SPECTRAL ALTERATION EFECTS IN CHONDRITIC GAS-RICH BRECCIAS.

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INTRODUCTION: The photons reflected by planetary surfaces do not penetrate the surface by more than a few millimeters, even in the most transparent minerals. Thus the large number of visual and IR reflection spectra of asteroids obtained with telescopes (and in the future by space-craft) sample only the very uppermost regolith. However these spectra are usually compared with lab spectra of solid meteorites derived from the asteroidal bedrock. Solid meteorite fragments are pulverized to simulate the scattering conditions in the upper regolith. This methodology implicitly assumes that the regolith-forming process on asteroids changes only the particle size and does not introduce spectral effects due to glass formation, solar wind implantation, etc. On the Moon, very strong weathering effects (mostly related to the formation of glassy agglutinates) exist in the uppermost regolith which largely conceal the absorption features of minerals, except in very fresh craters. While it is generally agreed that lunar-style glass formation is a very minor process in asteroidal regoliths due to the lower impact velocities, several workers have proposed alternate weathering effects to account for various mysteries connected with asteroid spectral interpretation (e.g. Pieters 1984; T.V.V. King et al. 1984; McFadden and A'Hearn 1986; Weatherill, personal communication, 1984). A small subset of meteorites, the solar-gas-rich breccias, apparently preserve portions of the uppermost regolith complete with alteration effects characteristic of long exposure to the space environment. Typically, areas of fine-grained matrix in these meteorites are rich in implanted solar wind gases, particle tracks left by galactic cosmic rays and solar flares, and small fragments of exotic meteorites classes, apparently projectile material which has survived low-velocity impacts. These effects indicate that this matrix material once resided on the optical surface of an asteroid, was turned over by regolith gardening, lithified by an impact, ejected, and transported to Earth. (A similar history is inferred for many lunar samples, including lunar meteorites). Large clasts in the same breccias usually are devoid of these effects in their interiors, which were protected from direct exposure to space. If any unknown weathering effect exists in the uppermost regolith of asteroids which significantly affects current interpretations of their composition, it should be evident in a spectral difference between gas-rich matrix and gas-poor clast interiors. We have carried out a systematic search for such effects to test the hypothesis that they could make ordinary-chondrite material resemble the common Class S asteroids.

MEASUREMENTS: Several samples of gas-rich breccias were selected, including slabs of the Kapoeta howardite, the ordinary chondrites Dubrovnik, Cangas de Onis, and Dimmit. Numerous 0.8-2.5 micron reflection spectra of selected areas on sawed or broken surfaces were measured with the Planetary Geosciences Division spectrogoniometer. While these spectra are not directly comparable to those of powdered samples (the continnua are systematically bluer), comparisons within the data set should reveal any spectral differences due to space weathering.

RESULTS: Kapoeta: Spectra of eucritic clasts resemble those of powdered eucrites. Spectra of dark gas-rich matrix are very similar except for slight reduction in band depths. Both lower albedo and reduced band depths are probably due to mild shock effects. Dubrovnik: All spectra very similar and resemble powdered ordinary chondrites, with pyroxene band depths reduced relative to eucrites due to presence of dispersed iron particles. Cangas de Onis: Spectra similar to Dubrovnik. A few highly shocked dark veins have anomalously shallow bands, but gas-rich and gas-poor regions are very similar. Dimmit: This meteorite contains a clast of impact melt rock in a chondritic matrix, representing the most extreme form of altered regolith. Spectra of this clast have very deep pyroxene bands. They closely resemble those of the eucritic clasts in Kapoeta, and earlier published eucrite spectra. This may be due to the lack of metal in the Dimmit clast; it appears to be a fragment of a large melt pool in which the metal component settled out.

IMPLICATIONS FOR ASTEROIDS: These results indicate that unknown regolith processes do not conver the ordinary-chondrite parent bodies with an altered layer exhibiting S-class spectral properties. This is consistent with recent interpretations of the new Q-class of asteroids as the ordinary-chondrite parent bodies. However, significant spectral effects do occur in asteroid regoliths: A) Darkening and suppression of absorption bands in highly shocked material, as seen previously in the so-called "black chondrites"; B) Segregation of metal in large impact melt pools on chondritic asteroids, which may have achondritic spectra. Neither of these effects is likely to be significant in interpreting current integral-disk spectra, but should be searched for in spectral maps returned by future spacecraft.

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