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Spectral changes with the direction of asteroid impact at Lonar crater, India: Findings from Mid-IR DRIFT analysis

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Meteoritic Impact Cratering is an important geologic process which is affecting all planetary bodies throughout the solar system including Earth and Mars. There are abundance of impact craters on the Earth and Mars. Identifying spectral signatures have important implications for understanding mineralogy and also geology of these craters. Fortuitously, Lonar Impact Crater in India is the only well-preserved terrestrial crater excavated completely on Deccan basalts and serves as an “excellent analogue” to craters on Mars and Moon [1]. Reported here are results of Mid-Infrared (1400–400 cm-1) spectroscopic studies on fine-grained (<45 μm) basaltic rock powers from this crater using Diffuse (Biconical) Reflectance Infrared Fourier Transform (DRIFT) technique.

Spectral data of the shock metamorphism of basaltic rock powders are examined. Infrared spectra of rock powders of relatively unshocked and shocked basalts are obtained to document the mineralogical and hence spectral variations with the direction of impact and thereby distribution of primary Tectosilicate, Inosilicate(e.g. Plagioclase Feldspar, Pyroxene etc) and secondary Phyllosilicate minerals (e.g. Illite, Smectite, Saponite, Serpentine etc). The results show relative loss of spectral features in western sector compared to eastern sector as a result of increased shock wave distribution and subsequent disordering of primary mineralogy. From east (direction of impact) to western sector, spectral features of all samples change systematically. The major changes are (i) line shifts, which are more pronounced in western sector than in eastern sector and (ii) all spectra show a systematic weakening in intensity and strength, and thus resulting in only few absorption bands in western sector. Also, all the samples display drastic decrease in strength and intensity of 590 cm-1 absorption band which has been considered very sensitive to the structural changes induced by shock pressure in feldspars dominant rocks[2]and thus serves as measure of the crystallinity and mineralogy of the rock. All these distinctive spectral changes are inferred as caused by pressure-induced structural distortions in bending and stretching motions of Si and Al tetrahedra dominantly within plagioclase feldspars rich basalts [2,3].The IR patterns in this relatively high pressure western sector are interpreted as a mixture of decreasing amounts of Tectosilicates, Ionosilicates and increasing amounts of Phyllosilicates. Thus, in shocked samples, crystalline and amorphous phases are likely coexist as intimate mixtures with the proportion of primary mineralogy decreases with increasing shock pressure resulting in the gradual disappearance of small absorption bands below 500 cm-1. Additionally, Omnic-present mineral distribution maps reveal abundance of primary and secondary minerals around the crater. These abundance maps are interpreted to reflect the effect of shock pressure distribution at Lonar. Future multi-technique spectroscopic studies (Emission, μ-FTIR, ATR, XRD and XRF) are targeted to reflect overall impact-, alteration- and weathering-processes occurring at Lonar crater and Mars.

References: [1] Fredriksson, K. et al (1973), Science, 180,862-864 [2] R.Ostertag (1983), JGR,88, B364-B376 [3] J.R.Johnson et al. (2007), American Mineralogist, 92,1148-1157.