CHARACTERIZATION OF BRECCIATED GRANITES AND SANDSTONE AT DHALA AND RAMGARH IMPACT CRATERS IN INDIA: IMPLICATIONS FOR FUTURE PLANETARY MISSIONS.

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Introduction: Imaging and non-imaging spectroscopy has immense potential to characterize any surface by utilizing the detailed spectral information obtained from hundreds of narrow and contiguous bands. This work utilizes the field samples and lab spectra for the Dhala crater (Shivpuri, Madhya Pradesh) and Ramgarh astrobleme (crater) (Baran, Rajasthan) in India to identify and characterize the surface geology and the changes that have undergone. The presence of sandstone, granites (brecciated), and quartz with impurities is noticed.

Geological history: The origin of the Ramgarh crater is widely discussed, and possible theories mentioned in previous research are a kimberlite pipe, diaper, meteorite impact, and a combination of volcanism and tectonism [1]. Ramgarh crater has mainly granulated quartzite and shows anomalous birefringence. This astrobleme is located in the Neoproterozoic sandstone and shale of the Vindhyan Supergroup. Ramgarh crater with a depressed interior surrounded by a raised rim having steep inner flanks and shallow outer flanks (Figure 1). Major minerals found here are Bhander sandstone Quartzite boulders, Spherules, Quartz grains[2-3].

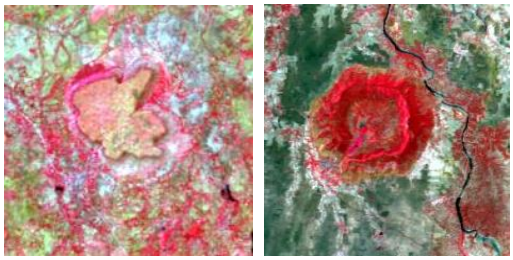

Figure 1: Dhala and Ramgarh Impact craters as seen from false-color composites (FCC) of DESIS Hyperspectral image

The Dhala impact crater results from the impact aged during Paleoproterozoic (Figure 1). Major litho-units reported from the Dhala crater include Granite, quartz reefs, brecciated granite with different sizes and shapes, impact melt rock, melt breccia with other felsic rock [4]. Melt breccia might have been weathered and mostly eroded, and hence the remnants are very sparse [5-6]. However, the lithological map shows the presence of sandstone only (Bhukosh, GSI).

Datasets: Rock samples were collected from both the impact crater sites (Figure 2 and Figure 3) and analyzed with SVC-HR 1024i Visible to Near Infrared (VNIR)- Shortwave Infrared (SWIR) spectroradiometer (340-2500 nm) and Bruker Fourier Transform Infrared Spectroradiometer (FTIR) (4000-600 cm^{-1}).

Figure 2: Inside the Dhala crater

Figure 3: Few outcrops in the Ramgarh astrobleme

Results and Discussions: The preliminary observation from the spectral analysis of both craters in the VNIR-SWIR range shows the presence of mostly quartz rocks with other impurities. Chromium and Manganese were seen around 300-400 nm. Iron is predominant between 600-1000 nm[7-8]. Also, iron, OH, and possibly carbonates are observed between 900-1000 nm (Figure 4 and Figure 6). Few other iron features were seen between 1000-1400 nm and 1700-1900 nm. OH, carbonates and Mg-OH were seen around 1900-2100 nm and 2200-2500 nm [9]. Features, including 673 nm, 1000 nm, and 1700 nm, are only visible for the Dhala crater (Figure 4). These major spectral features also resemble brecciated granite, sandstone, and iron-bearing rocks. The absence and presence of these can be due to weathering and degradation of the Ramgarh surface or brought by the impact (very rare possibility) from the space (extra-terrestrial surface).

The thermal range spectra (Figure 5 and Figure 7) typically show the spectral features for silicates, carbonates, and phosphates around 700-1100 cm^{-1}, with spectral features for granites at 2000-2400 cm^{-1} (for Ramgarh) [10], [11]. There is a noticeable

diversity of silicates minerals found at both craters, as shown in Figure 8. Being remnant, the spectral feature for granite breccias were still observed. Not much information other than silicates is obtained due to the heavy weathering.

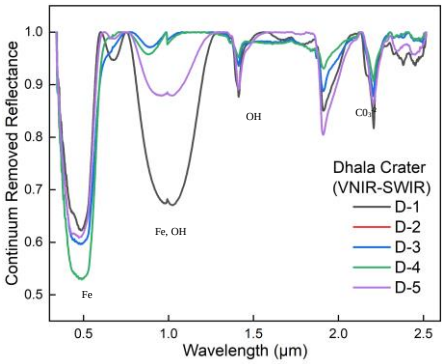

Figure 4: VNIR-SWIR spectra from the rock samples of Dhala impact crater

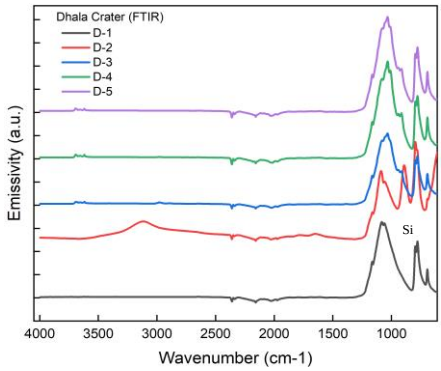

Figure 5: FTIR spectra from the rock samples of Dhala impact crater

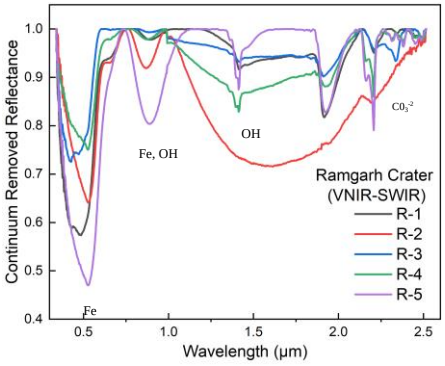

Figure 6: VNIR-SWIR spectra from the rock samples of Ramgarh impact crater

By comparing the spectral analysis and diversity results, a better understanding of the mineralogy of both cratering sites is obtained. From an extended spectral wavelength, spectral features for more than one mineral species, i.e., granite, sandstone, quartzite in this work, are observed. Previously, integrated studies were done for Earth and planetary surfaces, and implications were drawn for other terrestrial surfaces [12]. This work will be further extended to Raman and XRD analysis.

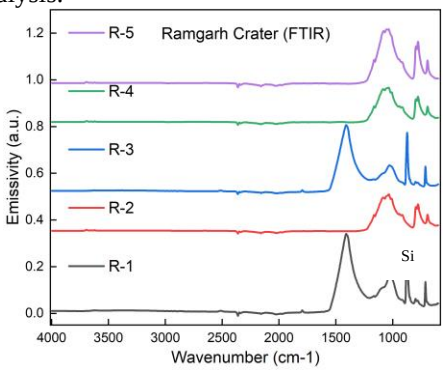

Figure 7: FTIR spectra from the rock samples of Ramgarh impact crater

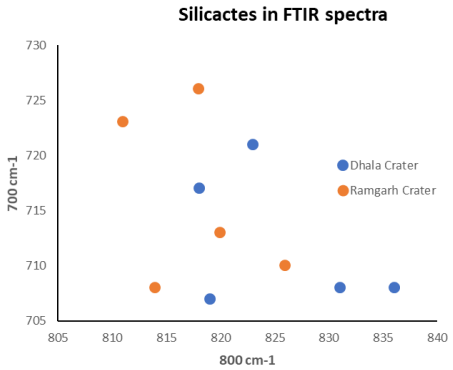

Figure 8: Diversity among silicates at both crater sites

Acknowledgments: Lithological information for impact crater sites was obtained from the Bhukosh portal of the Geological Survey of India (GSI). DESIS hyperspectral data was provided by the German Aerospace Center (DLR).

References:

[1] Crawford A. R. (1972) Nature, 237, 96. [2] Pandit M. K. and Master S. (2021) Geoheritage, 13. [3] Kenkmann T. et al. (2019) LPI Contributions, 2136, 5007 [4] Li S.-S. et al., (2018) Gondwana Research, 54, 81–101 [5] Keerthy S. et al. (2019) Planetary and Space Science, 177, 104691. [6] Pati J. K. et al. (2008) Meteoritics & Planetary Science, 43, 1383–1398. [7] Hunt G. R. (1982) Handbook of physical properties of rocks, 295–386. [8] Hunt G. R. (1970) Modern geology, 1, 283–300. [9] Hunt G. R. (1971) Modern Geology, 2, 195–205. [10] Christensen P. R. et al. Journal of Geophysical Research E: Planets, 105, 9735–9739. [11] Chukanov N. V. and Chervonnyi A. D. (2016) Springer Geology. [12] Tripathi P. and Garg R. D. (2021) Journal of Applied Remote Sensing, 15.