Spectral and chemical characterization of hydrous sulphate-phyllosilicate association and banded iron formation in India: Probable implications for Mars

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by

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ABSTRACT

Earth records the prevalent features generated by geological, chemical and biological processes of nature. These processes involve the natural agencies of Earth's atmosphere, particularly water, ice and wind. The geomorphology of planetary bodies is controlled mainly by the atmospheric agents prevailing on surface/subsurface condition; Mars' geomorphology today is the result of stormy winds. Geological features generated by direct involvement of water are well established on Mars' surface, like sedimentary structures: flow channels/gullies, cross bedding, mud cracks etc. Water related activities are involving the occurrence of life on Earth, hence speculations generated to search for the extinct life on Mars knowing the fact that today's atmosphere is not habitable for life-activity. Our understanding about Mars is based on the results obtained from orbital spectroscopy, visual imagery, laser altimetry and of-course meteorites hailed from Mars. Much is known about the habitable sedimentary settings on Earth, inferring this knowledge to analogous counterparts on Mars must be crucial.

Three potential terrestrial sedimentary settings considering their established nature of habitability for life, are selected for the research and have been investigated for mineralogy with sophisticated instrumentation. First, gypsum-phyllosilicate association of Karai Formation, Cauvery Basin, Tamil Nadu, India which is deposited through precipitation from low temperature fluids in fractures developed due to fluid overpressure in phyllosilicate rich ground mass. Second, banded iron formations (BIFs) of Odisha, Singhbhum craton, India, which are chemically precipitated units in marine conditions and possesses huge extent over the surface. Third, jarosite deposit of Warkalli Formation, India, which is found in association with kaolinite in coastal cliff

setting, is formed in locally existing acidic conditions. These mineral assemblages possess signatures of life which is a well established fact in terrestrial environments. VNIR reflectance spectroscopy, X-ray diffraction (XRD), laser Raman and Fourier Transform Infra-red (FTIR) techniques are used for the characterization of mineralogy after systematic sampling from the sites. Spectrally, Karai Formation samples are identified as gypsum and kaolinite, and similar results have been obtained from other analytical techniques. Banded iron formations are spectrally identified as hematite with characteristic absorption bands due to Fe; silica is not identifiable in the EMR range used for the study. Varkala samples show primarily the composition of jarosite and kaolinite with reflectance spectroscopy; but the XRD analysis detected natro-jarosite, jarosite, kaolinite, hematite, pyrite etc. in the samples. VNIR reflectance spectroscopic results are compared with the spectral responses of the same minerals from Mars. Based on the comparative mineralogical results, *Homestake* (Cape York), layered hematite deposit (Meridiani Planum) and jarosite (Mawrth Vallis) from Mars are proposed as mineralogical analogues to gypsum deposits of Karai Shale Formation, banded iron formations of Oidsha and jarosite deposit of Warkalli Formation respectively. *Homestake* is proposed to be analyzed in future Mars missions for palaeo-climate estimation as it may contain ancient waters in the form of fluid-inclusions with which water-chemistry and related palaeo-environment could be established, and for evidences of astrobiology in the form of remnants of microbial colonies which might have preserved within the gypsum (if life has ever existed on the planet).

Keywords:

Gypsum, banded iron formations, mineralogy, natro-jarosite, reflectance spectroscopy, X-ray diffraction, water-chemistry, Mars