The Mars Exploration Rover ‘Opportunity’ revealed the presence of mineral jarosite on the Meridiani Planum on Mars. The presence of jarosite, $K[Fe(SO_4)(OH)]_2$ signifies the existence of acidic, oxidizing aqueous conditions on the Martian surface, that are not common in natural terrestrial geological environments. The presence of jarosite indicates the presence of liquid water on the Martian surface at some time in the past. But how did the jarosite form?

3) Kachchh, Gujarat, India: a possible Martian analog?

The Bhuj Formation of late Cretaceous age is exposed near the village of Guneri in the study area. It is composed of sandstone and shale, with jarosite being commonly associated with the shale layers. The Bhuj Formation is succeeded by the late Eocene “Burns Formation”, which is exposed near the village of Ius, near Meridiani Planum on Mars. The presence of jarosite in the Bhuj Formation has been demonstrated by FTIR studies (Mitra et al., 2016, Gupta et al., 2016). The discovery of Martian jarosite has thus led to a search for comparable jarosite-bearing terrestrial localities that can serve as possible Martian analogs on earth.

In terrestrial sedimentary environments, jarosite has been reported within black shale horizons; the origin of the sulfate is generally attributed to oxidation of pyrites within the shale layers. The Bhuj Formation also contains hydrous sulfates, namely jarosite, anhydrite and gypsiferous, often associated with kaolinite clasts.

4) Spectroscopic & XRD results

For jarosite in the Bhuj Formation, jarosite also occurs within shale. At Site-2, jarosite occurs in association with layers of gysum. VNIR and FTIR spectra, supplemented with XRD results, confirm the co-existence.

5) Chemical Analyses

\begin{table}
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Formation & Matanumadh & Guneri & Harudi & Naredi \\
\hline
Jarosite & & & & \\
Shale & & & & \\
\hline
\end{tabular}
\end{table}

Conclusions:

According to Bhattacharyya et al. (2016), the Matanumadh Formation at Kachchh could be considered as a possible Martian analog site for investigating the formation of jarosite on Mars. In this study, we show that apart from Matanumadh, other formations in Kachchh also show striking resemblance to Martian jarosite localities. It can therefore be inferred that a major part of present-day Kachchh could be considered as a Martian analog site. Although jarosite-bearing assemblages appear in formations of different stratigraphic ages, it is very unlikely that all the different formations formed jarosite at different times. It is much more likely that jarosite in Kachchh formed during the final phase of marine regression, symbolizing the disappearance of a standing water body over the Kachchh region. In addition, the dry environment of Kachchh is suitable for the formation and preservation of jarosite. Similar to our area of study, Martian jarosite outcrops are detected on sparsely scattered areas on the planet. The presence of jarosite not only indicates the presence of acidic and oxidizing water on the surface, but also indicates its ephemeral nature. Jarosite therefore could constrain termination of surface water activity on Mars, and might be indicative of the final period of water-rock interaction on the Martian surface.

References:


