Mineralogical investigation of bole beds of Deccan Volcanic Province for Martian analogue

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This study investigates Fe-Mg-rich clay minerals within the green and red boles in Deccan trap basalt for understanding the physico-chemical processes responsible in their origin and extrapolates the same information for the origin of Martian clays. Although several studies provided chemical characteristics of bole beds, a detailed mineralogical and petrographical characterization is yet to be carried out. This investigation proposes clay minerals within bole beds in Deccan Basalts as analogue of those occurring in Martian conditions based on integrated field, petrographical and mineralogical investigation. Clay mineralogy of bole beds was characterized by X-ray diffractional (XRD) parameters and spectral bands in visible-near Infrared spectroscopy (400-2500 nm). The mineral chemistry of clay minerals was estimated using EPMA. The bole beds under investigation include outcrops of Deccan traps in Pune, Satara and Raigad Districts of Maharashtra and in Dhar District of Madhya Pradesh. Bole beds showing red, brown and green colours have variable thicknesses ranging from a few cm to few meters. While the red boles occur either as massive, laminated or brecciated beds, green boles are mostly laminated. Red boles consist of basaltic fragments and altered volcanic glasses as predominant constituents. Vesicular and non-vesicular glasses may appear orange, brown-yellow or black. Hematite, altered and fresh plagioclase, pyroxene (mainly augite) and iddingsite are moderately abundant, while olivine, brown amphibole, zircons, Fe-Ti opaque phases like ilmenite and magnetite occurs as accessory phase. The green boles consist primarily of celadonite, plagioclase (mainly labradorite and andesine), pyroxene, montmorillonite, Fe-Mg Smectites and altered volcanic glasses. Zeolite and chalcedony occur either as pore filling authigenic phases or as altered volcanic glasses in both red and green boles. VNIR absorption peak near 1.4 μm (overtone due to vibration of the OH group), 1.9 μm (combination bands of water fundamental vibration) and 2.2 μm (the wavelength of the metal-OH combination) and the (001) peak of 15Å (air dried), 17.6Å (glycolation) and 9.6-10Å (heating) in XRD (oriented sample) confirms montmorillonite. Celadonite is identified using characteristic d(060) peak less than 1.51Å in XRD and VNIR bands with metal-OH vibrations (2.25 μm, 2.30 μm and 2.35 μm), ionic transition of iron (7.50 μm, 9.22 μm and 1.11 μm), overtone

due to vibration of the OH group and combination bands of water fundamental vibration (~ 1.4 and ~ 1.9 μm).

Incipiently developed palaeosol horizon with root traces in places indicate the formation of red boles by the subaerial alteration of the basalt during a relatively long period of quiescence. The presence of fresh olivine and pyroxene in a few red boles indicate arid climatic condition for those bole beds. Zeolite (Ca-rich variety) form by the alteration of volcanic glasses, smectites etc. Iddingsite forms by alteration of ferromagnesian minerals (probably olivine) under oxidative weathering condition. A few red bole beds appear to be pyroclastic deposits, consisting of finer particles, accumulated at the end of a magmatic eruption. The presence of zircon within a few bole beds is intriguing but relates to an external source. The above study confirms the presence of Fe-Mg smectites and other phyllosilicates in red and green boles, which also occurs on Martian surface. While mineral assemblages of red boles correspond to a more oxic conditions, those belonging to green boles represent sub-oxic settings.