

## Water chemistry recorded in smectite from lacustrine sediment at Gale Crater, Mars

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There are lots of the evidences of the presence of the surface liquid water on early Mars [1,2]. Because aqueous solutions are unique transport media for the essential elements and metabolic energy sources required for the activities of life [3,4], the quantitative understanding of the water chemistry on the early Mars is crucial to access the habitability. There are number of attempts to estimate the water chemistry of early Mars by means of geochemical modeling [5,6,7,8]. The almost all previous attempts to reconstruct the ancient water chemistry on Mars are bottom-up approach to reproduce the observed mineral assemblages by assuming the initial solution compositions, reactants minerals, water-rock ratio and the series of chemical reactions. The water chemistries obtained from the bottom-up approaches must highly depend on the assumptions, which are always difficult to justify on early Mars.

The top-down approach for the quantitative reconstruction of the water chemistry of pore-water in terrestrial clay rocks was proposed by Gaucher et al [9]. This approach can reproduce the measured water chemistry in porewater in clay rocks without any estimated parameters [9,10,11]. Smectite is unique mineral that possesses the exchangeable cation ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$  and  $\text{Ca}^{2+}$ ) in the interlayer. The interlayer can record the major cationic composition of the surrounding solution. The geochemical modeling based on the cationic composition in smectite can provide the reasonable prediction of other solution parameters such as anion compositions including dissolved carbonate, pH and redox conditions [9,10,11].

The Mars Science Laboratory rover Curiosity has been analyzed the mineralogy and geochemistry of the fluvial-lacustrine sediment from long-lived lake in Gale Crater [1]. Two core samples of the lacustrine sediments were obtained at Yellowknife Bay formation. The matrices of the sediments are classified into mudstone containing secondary minerals such as smectite formed by early diagenetic process [1,6,12]. The light-toned calcium sulfate vein formed after the sedimentation and early diagenesis of the lacustrine sediments were observed in the formation [1,8,12,13]. The obtained X-ray diffraction patterns of smectite provides the information about the exchangeable cations in the interlayer [12,14]. The hydrologic activity in Gale Crater was considered to be occurred between 3.8 to 3.1 Ga [15]. The smectite in the Yellowknife Bay sediments possibly records the water chemistry in the pore-water at the last stage in the presence of liquid water. Present study quantitatively estimates the major components composition of pore water based on the exchangeable cation compositions in the smectite and the soluble salts mineralogy observed in Yellowknife Bay. The pH and redox condition in the pore-water are estimated based on the major composition.

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