Chemical models for formation of clay-rich layered rocks in the Mawrth Vallis region, Mars

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Clay minerals have been detected in ancient martian terrains with the near-infrared orbital spectroscopy [1,2]. In the Mawrth Vallis region, a prospective landing site for the MSL rover in 2012, minerals are observed within the following stratified sequence of layered rocks (from the top): silica and kaolinite, montmorillonite-like Al-rich clays, a Fe²⁺ phyllosilicate, Mg/Fe smectites, and sulfates [2-6]. We use three numerical models to explore a formation of these rocks through alteration of a fragmented basaltic material by a downward percolation of H2SO4-rich fluids. One model assumes a decrease in the solution to rock ratio with depth. In another model, the downward fluid migration is considered. In both models, fluids reach chemical equilibrium with rocks. In the third model, kinetics of mineral dissolution is considered along with fluid percolation. The modeling is performed for 0 °C and pressure from 0.006 to 1 bar. The system was either open or closed with respect to CO_2 and O_2 .

The modeling reproduces the observed silica-kaolinitemontmorillonite-smectite sequence of dominated minerals. In the models, the sequence reflects neutralization of fluids with depth. Open system models also lead to formation of goethite and/or hematite, and carbonates form in association with smectites (saponite). In closed systems, zeolites and Fe^{2+} chlorites occur with smectites, and Fe^{2+} -chlorite rich rocks form between layers rich in montmorillonite and smectites. The latter result is consistent with observations, though the upper part of the martian profile also agrees with an opensystem acid alteration. Modeled Ca sulfates coexist with clay minerals, and more soluble sulfates could form through evaporation of neutralized fluids accumulated in the lower part of the stratigraphic sequence.

Poulet et al. (2005) Nature 438, 623-627. [2] Mustard et al. (2008) Nature 454, 305-309. [3] Wray et al. (2008) Geophys. Res. Lett. 35, L12202. [4] Bishop et al. (2008) Science 321, 830-833. [5] McKeown et al. (2009) J. Geophys. Res. 114, E00D10. [6] Wray et al. (2010) Icarus 209, 416-421.

Study on the phase equilibrium of the quaternary system Cd²⁺, K⁺, Na⁺//SO₄²⁻-H₂O at 298 K

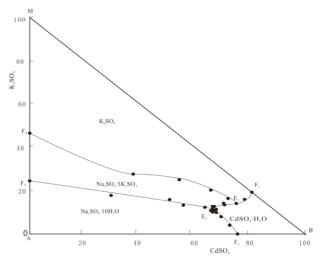
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Solid- Liquid Equilibrium of quaternary system Cd²⁺, K⁺, Na⁺// SO₄²⁻-H₂O at 298 K were studied by an isothermal solution saturation method. Experimental results indicate that there are five univariant curves E1F1, E1F4, E1E2, E2F2 and E_2F_3 , two invariant points E_1 , E_2 and four crystallization fields in the quaternary system. The system belongs to a quaternary system, and there is a double salt $(Na_2SO_4 \cdot 3K_2SO_4)$ existing. The crystallization zones of equilibrium solid phases are K_2SO_4 (E₁F₁MF₄ field), Na₂SO₄·3K₂SO₄ (E₁E₂F₃F₄ field), $Na_2SO_4 \cdot 10H_2O$ (E₂F₂AF₃ field), and CdSO₄ \cdot H₂O (E₂F₁BF₂ field), respectively. The composition of the invariant point E_1 is K_2SO_4 , Na_2SO_4 ·3 K_2SO_4 and $CdSO_4$ ·H₂O, respectively. The composition of the invariant point E_2 is $Na_2SO_4 \cdot 3K_2SO_4$, Na₂SO₄·10H₂O and CdSO₄·H₂O, respectively. The physicochemical properties of solution in the quaternary system show regular changes along with the increased cadmium concentration. CdSO₄ possessed the highest solubility among those three salts, which means a strong transfer of Cd ion and a high pollution risk of soil environment.



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