
Effects of Octahedral Mg²⁺ and Fe³⁺ Substitutions on Hydrothermal Illitization Reactions

Necip Güven and Wu-Liang Huang

Department of Geosciences, Texas Tech University, P.O. Box 4109 Lubbock, Texas 79409
Exxon Production Research Company, Houston, Texas 77001

Abstract: Three gels of illitic composition having different octahedral substitutions were hydrothermally treated in distilled water at 300°C and 500 bars for 7 to 90 days. The gel of the composition $K_{0.7}Al_{2.0}(Si_{3.3}Al_{0.7})O_{10}(OH)_2$, having no octahedral substitutions, yielded poorly crystalline and randomly interstratified illite/smectite (I/S) having possibly 30% or more expandability. These I/S particles occurred predominantly as foliated or compact lamellar aggregates having morphological features characteristic of common smectite. Laths having a morphology similar to that of diagenetic "fibrous illites" were also found in small amounts after the gel had been aged for 35 days. Their chemical composition was similar to that of the foliated aggregates of US in the same run.

Illitic gel having the composition $K_{0.7}(Al_{1.7}Fe^{3+}_{0.3})(Si_{3.3}Al_{0.7})O_{10}(OH)_2$ having octahedral Fe³⁺ substitutions yielded more and better crystalline I/S. The reaction products of the 7–35-day runs consisted mainly of randomly interstratified I/S having an expandability of 90 to 65%. The I/S particles occurred as foliated or compact lamellar aggregates having a smectite-like morphology, as described above. The Fe³⁺-bearing gel yielded, after 90 days of ageing, an R1-ordered I/S having 25% expandability and a morphology of ribbons and hexagonal platelets.

Illitic gel of composition $K_{0.8}(Al_{1.6}Mg_{0.4})(Si_{3.6}Al_{0.4})O_{10}(OH)_2$ having octahedral Mg²⁺ substitutions produced no illite even after 90 days of ageing, but a pure smectite in the form of foliated aggregates.

Key Words: Illite/smectite • Illitization • Interstratification • Octahedral substitution • Synthesis

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