Experimental Determination of the Rates of Precipitation of Authigenic Illite and Kaolinite in the Presence of Aqueous Oxalate and Comparison to the K/Ar Ages of Authigenic Illite in Reservoir Sandstones

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Abstract: The importance of precipitation rate as an effective control on illite and kaolanite formation during diagenesis has been examined by measuring precipitation rates, from Al fluid concentration, in a Dickson fluid-sampling vessel at 160 ° – 250 ° and 500 bars (50 MPa). These experiments are considered to be analogues of the precipitation of clays in sandstones from porewaters containing dissolved carboxylic acids, which have a transient stability and may influence aluminosilicate solubility. Precipitated illite had a lath-shaped morphology and its composition was consistent with authigenic illite in sandstones. Kaolinite formed tabular rather than vermicular shaped crystals. Kaolinite precipitation rate was two orders of magnitude faster than illite precipitation and was rate-limited by the decomposition of oxalate; kaolinite formation should be equilibrium-controlled at virtually all stages of burial. Extrapolation of illite precipitation rate to burial temperatures indicates that the first appearance of illite in a burial sequence may be kinetically controlled. A model of illite precipitation based on these experimental results has been used to predict the time required to precipitate illite during burial of a sandstone, taking into account temperature changes during burial. For northern North Sea examples, a predicted illitization threshold of −60 ° C occurring at 60 – 80 Ma corresponds to the observed initiation of authigenic illite precipitation. Times of around 2 – 5 Ma would be required to reach a 98% approach to equilibrium at this threshold. The main phase of illite precipitation in the northern North Sea basin is a later, hydrologically controlled event (30 – 50 Ma). Equilibrium would be approached in around 0.1 Ma during this phase, which is consistent with the narrow illite K/Ar age range (1 – 5 Ma) recorded for some sequences.

Key Words: Illite • Kaolinite • Precipitation rate • Oxalate • K/Ar • Sandstones • North Sea

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