Clay-Mineral Authigenesis in the Late Permian Coal Measures, Bowen Basin, Queensland, Australia

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Abstract: Mineralogical studies were performed on authigenic clay minerals of mudrocks, sandstones, and bentonites from 38 boreholes in the Late Permian coal measures of the Bowen Basin. Clay-mineral separations of samples from the northern Bowen Basin consist mainly of (Reichweite, R) R = 1 and R $\geqslant$ 3 interstratified illite-smectite (I-S), chlorite, and kaolinite. In the southern Bowen Basin, samples from higher stratigraphic sections are characterized by randomly ordered (R = 0) I-S mixed layers, and kaolinite and chlorite in smaller amounts. Samples from the lower sections consist of (R $\geqslant$ 3) I-S, chlorite, chlorite-rich chlorite-smectite (C-S), and laumontite.

Examination of the mineralogy and distribution of authigenic clay minerals from the Late Permian coal measures in the northern part of the Bowen Basin indicated that the presence of clay minerals is not systematically related to depth and clay occurrences do not occur regularly. These mineralogical variations of clay in volcaniclastic sediments are incompatible with thermal control. Variations in the rate of fluid flow and potassium supply owing to permeability exert major influences on clay-mineral paragenesis and the reaction of illitization. In more permeable zones (possibly faults or fracture zones), highly illitic clays with lath-shaped morphologies may have precipitated directly from potassium-rich fluids migrating from deeper parts of the basin. In addition, abundant chlorite precipitated contemporaneously with illitic clays, which may have resulted from sufficient magnesium and iron occurring in the fluids as a result of dissolution of intermediate or mafic-rock fragments. At the same time, clay paragenesis with less illitic I-S, kaolinite, and minor chlorite occurs outside the channelized zones of high fluid flow, where a diffusive-flow regime may have predominated with lower ratios of the activities of K^+ and H^+ (*i.e.*, $\alpha_{K^+}/\alpha_{H^+}$) in the solutions.

In the southern Bowen Basin, depth-related changes in the distribution of clay minerals are evident and may be indicative of thermal control on clay-mineral reactions. Zeolites are present locally in the Late Permian volcaniclastic rocks in the southern Bowen Basin, but not in the north. This is attributed to a low ratio of $\alpha_{CO_2}/\alpha_{H_2O}$ (where α = activity) and/or more saline and alkaline solutions.

Key Words: Chlorite • Clay-Mineral Distribution • Fluid Flow • Illite-Smectite • Kaolinite

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