

Basinal Variations In Mixed-Layer Illite/Smectite Diagenesis Of The Jeanne d'Arc Basin, Grand Banks Offshore Newfoundland

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ABSTRACT

Mixed-layer illite/smectite (I/S) clays were examined from 22 wells to investigate basin wide I/S diagenesis in the Jeanne d'Arc Basin (JAB). Results show that smectite and/or smectite-rich I/S clays were supplied to the JAB during Upper Jurassic to Tertiary times. However, smectite-rich I/S clays occur only in shallow samples irrespective of geologic age. The proportion of illite in I/S mixed-layers, as well as the degree of ordering, increases with depth and temperature, indicating that smectite-rich I/S clays have been progressively illitized in both rift and post-rift sediments of the JAB during burial. The transition from random to R1-ordered I/S occurs between subsurface depths of 1940 m to 3720 m and crosses major stratigraphic boundaries. The transition from R1- to R3-ordered I/S generally occurs below 4000 m depth.

Based on I/S-depth profiles, the basin can be subdivided into four regions with different illitization gradients. In the Southern JAB, advanced I/S diagenesis probably reflects uplift and denudation and/or higher paleogeothermal gradients. Rapid increase of %illite in I/S with depth in the Trans-Basinal Fault area is most likely controlled by upward flow of hot, K⁺-bearing fluids along faults. The migration of hydrocarbons probably followed the same pathways as the illitizing fluids. Delayed illitization in the Northern JAB and Central Ridge area reflects insufficient K⁺ supply due to lack of detrital K-feldspar in the host sediment, absence of faulting and the presence of thick shale intervals. These findings show that I/S-depth profiles may vary within the same sedimentary basin due to a variety of geological factors (temperature, fluid migration, lithology, faults and salt diapirism) and that single wells cannot generally be considered representative for the basin as a whole.