# Considerations and Applications of the Illite/Smectite Geothermometer in Hydrocarbon-Bearing Rocks of Miocene to Mississippian Age

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**Abstract:** Empirical relationships between clay mineral transformations and temperature provide a basis for the use of clay minerals as geothermometers. Clay-mineral geothermometry has been applied mainly to diagenetic, hydrothermal, and contact- and burial-metamorphic settings to better understand the thermal histories of migrating fluids, hydrocarbon source beds, and ore and mineral formation.

Quantitatively, the most important diagenetic clay mineral reaction in sedimentary rocks is the progressive transformation of smectite to illite via mixed-layer illite/smectite (I/S). Changes in both the illite/ smectite ratio and ordering of I/S, as determined from X-ray powder diffraction profiles, correlate with changes in temperature due to burial depth. Although the smectite-to-illite reaction may be influenced by several factors, reaction progress appears to be strongly controlled by temperature. Studies show that the model proposed by Hoffman and Hower in 1979 is applicable in burial diagenetic settings from about 5 to 330 Ma, and includes most rocks about Miocene to Mississippian in age. Reliability of the I/S geothermometer is, however, dependent upon a good understanding of the rock's original clay-mineral composition.

Changes in the ordering of I/S are particularly useful in the exploration for hydrocarbons because of the common coincidence between the temperatures for the conversion from random-to-ordered I/S and those for the onset of peak, or main phase, oil generation. Here, the utility of the I/S geothermometer is reviewed in hydrocarbon-bearing rocks of Miocene to Mississippian age. Using three common applications, the I/S geothermometer is compared to other mineral geothermometers, organic maturation indices, and grades of indigenous hydrocarbons. Good agreement between changes in ordering of I/S and calculated maximum burial temperatures or hydrocarbon maturity suggests that I/S is a reliable semiquantitative geothermometer and an excellent measures of thermal maturity.

**Key Words:** Geothermometer • Hydrocarbons • Illite/smectite • Illitization • Smectite diagenesis • Thermal maturity

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