

## **Exploring intra-crystalline B-isotope variations in mixed-layer illite-smectite**

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### **ABSTRACT**

The isotopic composition of boron in illite-smectite (I-S) can be important for monitoring fluid/rock interactions in sedimentary basins. Boron substitutes for Si during reaction of smectite to illite and can preserve information about paleofluid B-isotopic composition. Boron is enriched in oilfield brines, therefore the isotopic composition of those brines may be recorded during illitization and represent a monitor of hydrocarbon maturity and migration.

We re-examined previously published experimental results on B-isotope fractionation between I-S and water. By separating B from two crystallographic sites of I-S (tetrahedral and interlayer), we found differences in the  $\delta^{11}\text{B}$  that might be used as a single-mineral geothermometer. Boron incorporation in I-S follows a non-linear kinetic pathway. Maximum interlayer-B incorporation occurs during R1-ordering. R3-ordering approaches equilibrium with expulsion of interlayer-B leaving only tetrahedral layer-B. The important discovery is that tetrahedral layer  $\delta^{11}\text{B}$  does not change between R1 and R3 ordering. Boron substitutes in an equilibrium ratio early in the crystallographic reordering of I-S.

Natural I-S samples were tested from Gulf Coast mudstones, increasingly illitized with burial depth. Diagenetic reaction kinetics differ from hydrothermal experiments, but still reveal large  $\delta^{11}\text{B}$  differences (up to 40‰) between the interlayer and tetrahedral layer. Interlayer  $\delta^{11}\text{B}$  decreases with increasing temperature and illitization. We propose that interlayer  $\delta^{11}\text{B}$  values represent metastable equilibrium, whereas tetrahedral layer B represents a temperature-dependent equilibrium. If this is true, then the B-isotope geochemistry of I-S can be used to determine paleotemperatures and monitor the influence of hydrocarbons on pore fluids associated with diagenetic I-S.