AAPG Annual Meeting
March 10-13, 2002
Houston, Texas

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Post-Depositional Sm/Nd Fractionation in Sandstones: Implications for Neodymium-Isotope Stratigraphy

Neodymium-isotope composition has been widely used for provenance and stratigraphic correlation studies of Norwegian-continental-shelf sandstones. Variations in Nd composition track shifts in aggregate sediment provenance, which may have greater correlation significance than changes in depositional conditions (as reflected in GR-log patterns or whole-rock geochemical profiles).

A correlation parameter commonly used in previous Nd-isotope studies is "Sm-Nd model age", the validity of which depends on assuming that Sm-Nd systematics are not significantly altered diagenetically. However, Norwegian sandstone reservoirs commonly show widely varying post-depositional fractionation of Sm/Nd ratio, apparently due to preferential incorporation of Sm in diagenetic apatite. This fractionation appears to have occurred mainly during closed-system burial diagenesis, as phosphate deposited on the sea floor recrystallized to apatite and incorporated REE from the surrounding rock matrix.

Therefore, model age values in general contain two components of information: (A) the true crustal age of the sediment and (B) a secondary component of Sm/Nd fractionation, which can be either negligible or dominant. It is difficult to separate these components to correct for component B. Even in data showing no obvious signs of post-depositional fractionation, model ages may be variably disturbed by subordinate amounts of diagenetic alteration. However, the isotope ratio $^{143}Nd/^{144}Nd$ is expected to be relatively resistant to secondary Sm/Nd fractionation and should therefore be used rather than model age as the principal provenance indicator. In this way, Nd-isotope stratigraphy can still be used as a valuable and unique tool for provenance and correlation studies, even in strata showing strong Sm/Nd fractionation effects.

Strongly Sm/Nd-fractionated horizons (recognized by bulk-rock Sm/Nd ratios >0.23) may also be useful for stratigraphic correlation, but it is clear that their occurrence reflects special depositional conditions rather than shifts in sediment provenance.