which may not be accompanied by measurable earthquakes, also causes some failures. These tectonic factors appear to be important in triggering repeated failures in the thick sedimentary unit that is forming offshore of the Eel River.

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Mineralogic Analysis and Uranium Distribution of Sedimentary-Type Uranium Ores

Nine cores from a sedimentary-type uranium orebody of the upper Jackson Formation, Karnes County, Texas, were studied to determine the stratigraphy and the mineralogy in relation to the uranium distribution, and to provide guidelines for further exploration and/or exploitation. The uranium concentration ranges from 1.4 to 6,000 ppm in approximately 200 samples, as determined by delay neutron counting.

The orebody is generally a fine-grained, gray, well-sorted, arkosic sandstone that is enclosed in finer grained, poorly sorted lagoonal or paludal mudstone or lignite. The depositional environment of the orebody is presumably a beach-barrier-bar sequence with its northeastern end delineated by a downward-cutting fluvial system.

The bulk mineralogy of the ores consists primarily of quartz and feldspar with minor amounts of biotite, muscovite, augite, clinoptilolite, and very minor amounts of hematite, pyrite, and coffinite. The clay analysis of the less than 2 μm fractions reveals a preponderance of smectite with very minor amounts of kaolinite and illite.

The high concentration of uranium in the cores is generally associated with a high concentration of clays, zeolites, and/or carbonaceous material. Additionally, uranium concentration usually increases with a decrease in size fraction. Since smectite dominates the clay mineral assemblage in the ore, the expandable and absorptive smectite could be a significant factor in uranium mineralization.

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Athabasca Oil Sands—Facies Characteristics and Distribution

The Athabasca oil sands represent one of the world's great untapped energy resources, with in-place bitumen reserves estimated at 146 × 10^9 m^3 (922 × 10^9 bbl). About 10% of the reserves lie close enough to the surface to be mined in open-pit operations, but the vast majority (~90%) must be developed by as yet unproved in-situ means. A geologic understanding of the facies is crucial in applying in-situ techniques.

Most of the rich oil sand bodies are channel deposits in the Middle Member of the Lower Cretaceous McMurray Formation. This member, averaging 35 m in thickness, is dominated by upward-fining sequences interpreted as meandering river deposits. Earlier detailed work on epsilon cross-strata in outcrop confirms the interpretation of single channels 20 to 30 m deep. The channel sequence is dominated by trough cross-bedded sands at the base, grading upward into thinner bedded rippled sand units with increasingly abundant clay drapes toward the top. Burrowing is common in the upper parts but palynology indicates a basically freshwater setting. The channels are part of a complex fluvial-deltaic system associated with standing bodies of fresh to brackish water.

The fluvial Lower Member fills lows in the underlying Devonian limestone. The sands are commonly very argillaceous or water-bearing, but in places, form good reservoirs.

The Upper Member is a 20-m-thick sequence of shoreline deposits. This member is generally very argillaceous, but extensive upward-coarsening marine sands near the top commonly make good reservoirs.

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Induced Spectroscopy: A Mineralogy-Lithology Well Log

Nuclear spectroscopy logging, specifically with the induced gamma-ray tool (GST), measures the relative yields of gamma rays resulting from interactions of neutrons with different elements (isotopes) present in downhole formations.

The data are interpreted by associating the spectra of certain elements with sedimentary rocks which are typically dominated by the element (e.g., silicon = sandstone). The measured elemental yields are proportional to the volume fractions present in the rock formations. The yields are also proportional to some unknown values: effective neutron flux, concentration of selected elements in other sedimentary rocks, microscopic thermal neutron capture cross sections, and gamma-ray production and detection efficiencies. The effects of these unknowns can be minimized by laboratory calibration of yields in known formations or by comparison with whole or sidewall core data.

With the above and some additional information (SARABAND, NGT), the well-site analysis or a more sophisticated computerized presentation yield volume fractions of effective porosity, sandstone, limestone, feldspar, and the total clay ("shale") volume which may be further divided into volumes of clay porosity, illite, and chlorite. The resulting visual representation of these data becomes an invaluable aid to stratigraphic analysis.

In a field study of tight gas shaly sandstones in the Cotton Valley Group (Upper Jurassic) in east Texas, the analysis not only described the clay mineralogy and lithology but also highlighted several important geologic features which are important in designing an efficient hydraulic fracturing program: genetic units of sedimentation, laminated and thick-bedded shales, hydrated shale beds, and zones of well-developed intergranular pore-filling (quartz or calcite) cements—all of which may be fracture-containment boundaries.

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Surface Wall Texture and Evolutionary Classification of Cenozoic Planktonic Foraminifera

The classification most widely applied to Cenozoic planktonic Foraminifera employs relatively simple morphologic criteria, such as chamber shape and apertural position, to sort test forms into genera. Because the criteria are few and distinct, this traditional approach is easy to apply and has been generally accepted by stratigraphic paleontologists. Most morphologic features, however, evolved several times during the Cenozoic. Peripheral keels appeared independently at least eleven times. Form-genera based solely on such features are unavoidably polyphyletic.

Surface wall texture, in contrast, has been evolutionarily conservative during the Tertiary. Once developed, the few basic wall-textural types persisted within lineages. A classification based primarily on surface wall textures and secondarily on gross morphology most accurately reflects patterns of descent recognized from species-by-species evaluation of