mosaic of fault blocks that were differentially active through geologic time. The buildups are elongate northwest, and their distribution and overall shape appear to be controlled by northwest-trending paleostructures. Some larger buildups (i.e., Ismay) show local northeast-trending thicks within an overall northwest-trending buildup.

Examination of Landsat imagery revealed an extensive network of northwest-and northeast-trending lineaments that parallel linear patterns apparent from aeromagnetic, gravity, and subsurface isopach data. Additionally, outcrops along selected lineaments contain fractures that parallel these lineaments, suggesting that the lineaments are related to fundamental (i.e., basement) fracture zones along which algal buildups may have developed. Comparison of the fracture network to the distribution of algal thickening reveals these buildups occur predominantly along northwest-trending lineaments. Local disruptions within and apparent terminations of the buildups correspond to cross-cutting northeast-trending lineaments. This relationship provides guidance to locating prospective algal buildups. Integration of these data with detailed subsurface mapping can refine some leads into prospects. Several of these features have been successfully drilled.

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Application of Landsat Imagery to Hydrocarbon Exploration in Niobrara Formation, Denver Basin

The Niobrara Formation produces commercial quantities of oil from fractures in several places in the Denver basin. The Niobrara in this basin is an oil-prone, mature source rock having as much as 3.4% TOC, and has been in the generating window since early Eocene. This implies that hydrocarbon generation from the Niobrara is partly contemporaneous with the Laramide orogeny. The Laramide was a multiple-phase orogenic event that began with compression directed to the east-northeast during the Late Cretaceous to Paleocene and ended with compression directed to the northeast during the Eocene. We believe the Eocene phase activated northeast-trending extension fractures that may have acted as loci for storage and migration of hydrocarbons, locally generated in the Niobrara. The auto-fracing pressures related to hydrocarbon generation in the Niobrara theoretically would preferentially open and fill this northeast-trending fracture system.

Examination of Landsat imagery shows that zones of northeast-trending lineaments are present throughout the basin. Numerous northeast-trending faults are present in the basin, and many overlie older zones that were reactivated during the Laramide. This suggests that these lineaments are previously unrecognized fracture zones. We have defined an exploration fairway within the basin based on subsurface isopach and resistivity mapping. We believe that mapping of northeast-trending fractures can help identify leads (within this fairway) prospective for Niobrara production. Support of this concept is the location of several apparently productive Niobrara wells along a zone of northeast-trending lineaments.

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Sedimentation and Tectonic Implications of Cambrian-Ordovician Clastics, Renville County, North Dakota

Cambrian-Ordovician clastics of the Deadwood Formation were studied in detail from Newporte field in Renville County, North Dakota. This small Cambrian-Ordovician oil pool was extensively cored, often to the Precambrian basement, allowing close examination of clastic deposition influenced by local basement tectonics.

In Renville County, the basal unit consists of a well-rounded, fine to medium-grained glauconitic quartz sandstone. Paleohighs appear to have had a pronounced effect on Deadwood sedimentation. Sands, from quiet water settings, show poor to moderate sorting, are commonly finely laminated, and/or show traces of minor small-scale cross-bedding. In places, bedding planes are highly disrupted, suggesting intervals of intense bioturbation (Skolithos). Sands associated with paleohighs are clean, well sorted, and commonly friable. Their association with basement structure is suggestive of beach–barrier-bar sequences related to irregularly upthrown basement blocks. In one example, this clean basal sand is associated with an upthrown basement block and is sharply truncated by the pre-Winnipeg (early Ordovician) unconformity.

The first unit above the basal sandstone in structurally lower wells is an anomalous conglomerate unit. Large angular basement clasts up to cobble size were viewed in core. This unit grades upward into a fine sand sequence and distally grades into a marine sand. It terminates abruptly in upthrown wells and indicates rapid fault movement and offset during middle Deadwood deposition, with development of localized fanglomerate sequences associated with fault scarps.

Immediately capping this sequence is a dark-gray marine shale that thins depositionally toward paleohighs.

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Feldspar Diagenesis in Neogene Sediments, Northern Gulf of Mexico

Alteration of feldspars in the youngest of the Gulf Coast Cenozoic sands and sandstones is dominated by dissolution and albitization. Volumetrically significant amounts of alteration are only observed below burial depths of about 4.5 km in sands of Pliocene and Miocene age. Only trivial amounts of plagioclase dissolution were observed in Pleistocene units. In general, plagioclase exhibits minor amounts of secondary dissolution at all depths, and greater amounts in the deepest samples. Potassium feldspar is subject to very little dissolution to depths of about 3.5 km; by 4.5 km K-feldspar removal is virtually complete. Albitization affects only plagioclase and appears to be operative, in these sediments, over temperatures of 110°C-140°C.

Compared to older Cenozoic units elsewhere around the Gulf of Mexico feldspar dissolution and albitization in Neogene sands have advanced to a lesser degree, at least in the sense that they affect a smaller proportion of the total section. Comparison of pre-alteration feldspar composition, temperatures of alteration, and geothermal gradients for Gulf Coast sandstones of different ages suggests that the main controls on feldspar alteration are temperature, pre-alteration plagioclase composition, and possibly the amount of fluid flow. Time per se seems to be a factor of negligible importance, at least over time spans greater than 10^6 yr. Thus, the lesser volume of Neogene sand affected by feldspar dissolution and albitization can be attributed primarily to the lower geothermal gradients of the northern Gulf.

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Reservoir Description Applied to Iatan East Howard Field, Mitchell County, Texas

A reservoir description has been completed to help improve recovery over Mobil Producing Texas and New Mexico's leases in the Iatan East Howard field in Mitchell County, Texas. The following 5 phases of study have been used: core description, log analysis, stratigraphy, mapping, and follow-up.

Two 850-ft cores were used to study depositional environment and diagenetic history. Clear Fork (Permian Leonardian) pay is characterized by thin, discontinuous porosity zones cut by vertical fractures. Porosity development is controlled by facies zonation from a tidal flat similar to that on Andros Island today. Porosity developed in carbonate-sand accumulations along tidal channels that meander and bifurcate across the flat. Thickness and continuity increase northwestward toward the basin. Six major zones of transgressive channel belt sediments separated by regressive supratidal marsh sediments were identified in the upper Clear Fork.

Digitized logs were analyzed and log analysis was accepted where porosity matched whole-core porosity measurements. Histograms of log response were used to normalize uncored wells to cored wells for equivalent results.

Stratigraphy was studied by cross sections of each zone. Facies-biased contouring was used to map reservoir parameters. Pay thickness was mapped using 2 porosity cutoffs with the higher identifying the best reservoir. Maps were digitized and used to calculate the original oil in place. The fracture orientation was recognized as N60°E from injection-water breakthrough, water sampling, and water-oil ratio mapping. Injectors will be placed along this trend perpendicular to porosity trends. Follow-up with reservoir engineering will continue with comparisons of mapped