related to consequent rotation and/or tilting of the Shetland platform.

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Stratigraphy, Sedimentology, and Petrology of Upper Cretaceous Horsethief and St. Mary River Formations, Western Montana

The Horsethief and St. Mary River formations were deposited along the Late Cretaceous epicontinental seaway, which then covered much of the western interior. Where these formations presently crop out along the disturbed belt in western Montana, the sedimentary units form a volcaniclastic sequence deposited during the final regression of the Montana Group and contemporaneously with early stage development of the Laramide orogeny. The facies preserved within these volcaniclastic sequences represent barrier island, high-destructive wave-dominated delta, and fluvial plain environments of deposition.

The Horsethief, lower of the two formations, is divided into two facies sequences. Facies sequence A consists of coarsening-upward sequences of sandstones and interbedded shales. The predominant sedimentary structures include multidirectional planar and trough cross-bed sets, micro-cross-beds, and ripples. *Ostrea sp.* and *Ophiomorphia* are present and most abundant near the top of this sequence. These facies comprise a barrier island system consisting of shoreface, dune, tidal channel, and lagoonal environments. Facies sequence B, deposited along the depositional strike, consists of a coarsening-upward sequence of vertically stacked distributary channels that thicken and become more abundant upsection. Delta fringe and prodelta facies are absent; marine processes reworked the detritus into barrier island systems.

The St. Mary River Formation is divided into a lower and upper member. The lower member consists of shales, sandstones, limestones, and coals deposited in a lagoon landward of the barrier island system. The upper member contains trough cross-bedded, channel sandstones, overbank sandstones, shales, and carbonate-nodule horizons indicative of fluvial plain sedimentation. These genetically related sequences were deposited along a basin margin characterized by temperate-continental climates, moderate to high rainfalls, rugged relief, and marine processes characterized by microtidal to mesotidal ranges and dominated by longshore currents.

Petrographic analysis indicates the detritus of these formations was derived from a magmatic arc provenance. The texture and composition of these sediments are dependent on the relative distance of sediment transport. Statistically significant correlations document a decrease in grain size as the distance of sediment transport increases within the entire section and within distinct environments, including middle shoreface, upper shoreface, and dune facies. The high percentage of volcanic constituents decreases as the distance of sediment transport increases and the grain size decreases. Additionally, higher energy environments result in deposition of coarser grained detritus and higher percentages of volcanic components.

The interpretation of the depositional environments and petrographic characteristics as observed within these formations can be useful in analyzing facies sequences that have similar source lithologies and were deposited in basins with a similar evolution. The recognition of these facies is significant because of the potentially important application associated with hydrocarbon source and reservoir conditions, as well as heavy mineral assemblages.

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Prevention of Carbonate Cementation in Petroleum Reservoirs

By the time a carbonate unit has been buried to the depths of most petroleum reservoirs, the significant question is often not "how did the pores originate?" but rather, "why are they still there?" Preservation of porosity, regardless of its origin, is a consequence of one or more of the following mechanisms: (1) minimal burial; (2) reduced burial stress, generally due to overpressured pore fluids; (3) increased framework rigidity, which prevents compaction; (4) exclusion of pore waters by petroleum entry; (5) stable mineralogy; (6) permeability barriers, isolating porous intervals from diagenetic fluids; and (7) pore resurrection, a consequence of the temporary filling of pores with cement that is subsequently removed. Examples from the stratigraphic record demonstrate that each of these pore-preserving mechanisms may control reservoir quality.

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Significant Role of Structural Fractures in Ren-Qiu Buried-Block Oil Field, Eastern China

Ren-qiu oil field is in a buried block of Sinian (upper Proterozoic) rocks located in the Ji-zhong depression of the western Bohai Bay basin in eastern China. The main reservoir consists of Sinian dolomite rocks. It is a fault block with a large growth fault on the west side which trends north-northeast with throws of up to 1 km (0.6 mi) or more. The source rocks for the oil are Paleogene age and overlie the Sinian dolomite rocks.

The structural fractures are the main factor forming the reservoir of the buried-block oil field. Three structural lines, trending northeast, north-northeast, and northwest, form the regional netted fracture system. The structural fractures are best developed along the north-northeast fault zones and at the intersections of other structural lines. Since the regional stress field was changed during the late Mesozoic Era, the mechanical properties of the north-northeast fault zones were changed from compressive shear to extensive shear. Therefore, the expansion of the structural fractures provided a good pathway for the activity of karst water.

The north-northeast growth fault controlled the structural development of the buried block. The block was raised and eroded before the Tertiary sediments were deposited, so that the Sinian dolomite rocks were exposed to the surface and underwent weathering and leaching for a long period. In the Eocene Epoch, the Ji-zhong depression subsided, but the deposition, faulting, and related uplift of the block happened synchronously as the block was gradually submerged. At the same time, several horizontal and vertical karst zones were formed by the karst water along the netted structural fractures. The Eocene oil source rocks lapped onto the block and so the buried block, with many developed karst fractures, was surrounded by a great thickness of source rocks.

As the growth fault developed, the height of the block was increased from 400 m (1,300 ft) before the Oligocene to 1,300 m (4,250 ft) after. As the petroleum was generated, it migrated immediately into the karst fractures of the buried block along the growth fault. The karst-fractured block reservoir has an 800-m (2,600-ft) high oil-bearing closure and good connections developed between the karst fractures. This is the high-yield Ren-qiu buried block oil field.