(Amposta Marino), found by a consortium led by Shell, is scheduled to produce 40,000 BOPD by October 1972. Oil reserves are estimated at ½ billion bbl. Oil is 19° API with 5% sulfur and a pour point of 75°F. The field appears commercial and will help to reduce Spain's daily import of 410,000 bbl. Amposta Marino produces from porous, fractured dolomites of late Mesozoic age (Neocomian-Aptian) which are capped by the probable source beds of Miocene clays. The Miocene itself tested subcommercial(?) gas from several shallow sandstones and 37° API oil and gas from a basal carbonate which becomes biogenic on the flanks of tilted fault blocks. The field is on a relatively stable marine platform (not in a delta model) which accumulated thick (10,000 ft) Mesozoic carbonates. The early Tertiary was a period of emergence during which the easternmost fault blocks were stripped down to the Paleozoic rocks. In Miocene time, the area sank and marine clays, as well as evaporites of the Mio-Pliocene, were deposited in a basin between the mainland and the Balearic Islands. As exploration continues, the Tertiary and not the Mesozoic is postulated to become the main target. A drifting away of the Balearic Islands from the Spanish mainland is proposed by some to accommodate the geologic history.

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GRAND CANYON BIGHT—SIGNIFICANT TECTONIC FEATURE OF THE SOUTHWEST

A bight, by definition, is a curve in a coastline, or a bend, angle, or corner in any configuration. This seems to be descriptive of the dominant tectonic feature of southwestern Utah, northwestern Arizona, and a small adjacent tract of Nevada. The Grand Canyon is the best-known local geographic feature of the region, hence the name Grand Canyon bight.

The Grand Canyon bight is the somewhat drawn out and distorted southwest corner of the Colorado Plateau; more importantly, it is a region of relatively simple structure between the converging Wasatch line on the north and the Central Arizona uplift (Mogollon rim?) on the south. These great structural trends approach each other but, due chiefly to the change of direction of the Wasatch line from southerly to westerly and the dying out of the Central Arizona uplift, they do not merge and there is a space of relatively simple structure between them.

The bounding tectonic features came into topographic prominence when the Mesocordilleran highland was elevated in Middle Triassic time. Subsequent sedimentary deposits, especially the marine and fluvial formations, are strongly influenced by the bight. Cretaceous shorelines and isopachs show this influence particularly well. The river system which deposited the Salt Wash Sandstone Member of the Morrison Formation entered the region of the Colorado Plateau through the Grand Canyon bight; the present Colorado River leaves the bight in a reverse direction. Other geologic references also are simplified by recognition of the Grand Canyon bight as a tectonic entity.

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STRATIGRAPHY AND EXPLORATION OF LOWER CRETACEOUS MUDDY FORMATION, NORTHERN POWDER RIVER BASIN, WYOMING AND MONTANA

The Lower Cretaceous Muddy Formation in the northern Powder River basin of Wyoming and Montana was deposited during a marine transgression across a stream-dissected surface of the underlying Skull Creek Shale. The transgression occurred over most of the area, but was limited on the northeast by a prograding delta, which supplied most of the sand.

The Muddy Formation is divided into lower and upper units. The lower Muddy was restricted to a system of dendritic channels incised into the Skull Creek Shale during a period of emergence. The sands from the delta source were transported south by longshore currents. They were deposited principally in a transitional marine and estuarine environment, and are composed of fine-grained, moderately well-sorted, partially clay-filled quartzose grains.

By the time of deposition of the upper Muddy, the incised depressions in the Skull Creek topography had largely been filled. The upper Muddy sands were deposited in a complex marine shoreline environment, which resulted in offshore bars, barrier islands, beaches, and tidal deposits. Several shoreline trends are recognizable in the upper Muddy. They are progressively younger eastward and reflect the overall west to east transgression. These trends were controlled by the remnant Skull Creek topography and changing conditions of sediment supply.

Production from the Muddy Formation is principally from stratigraphic traps; however, structure has been important in localizing some of the oil and gas accumulations.

Lower Muddy pools are restricted to updip channel boundaries and are localized by structural noses and updip channel reentrants. Upper Muddy production is controlled chiefly by porosity development and lateral facies changes.

Exploration for Muddy sandstone reservoirs is aided by the use of an isopach map of the total Muddy Formation. This map shows the configuration of the Skull Creek channels and, therefore, the distribution of the lower Muddy sandstone. It also is helpful in predicting the orientation of the upper Muddy shoreline trends where they were related to remnant Skull Creek highs, and in showing an increased Muddy thickness due to sand buildups in nonchannel areas. Electric log maps, combined with zonal sandstone isopachs, provide a means of visualizing the rapid changes in sandstone geometry and also aid in the interpretation of depositional environments.

Exploration must be focused on the location of primary stratigraphic traps which have not been strongly altered by later structural movements. The widespread clay-filled porosity has resulted in large areas being nonproductive. It is believed that the clay fill is largely diagenetic and occurred subsequent to accumulation of primary oil. The lower percentage of clay fill in the oil-filled primary traps suggests that the presence of the oil inhibited clay diagenesis.

In the last 3 years, nearly 3,000 wells have been drilled in the study area in the search for Muddy oil. Every year new fields of significant size are discovered. Detailed stratigraphic work is called for as well as courage to use the drill as an exploration tool.

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LITHOLOGIC ASSOCIATIONS AND SANDSTONE PROVINCES

A limited number of clastic lithologic associations