Carbonate Mineral Reactions During Combustion Retorting of Oil Shale

Oil shale generally contains approximately 50% mineral carbonates by weight. During combustion retorting some or all of these carbonates decompose and/or react with other mineral species in the shale. Because the heat requirement for these reactions is large, they have a strong influence on the retorting process.

Data on the kinetics of decomposition of the major carbonates in oil shale have been obtained with heating rates and gas environments (N_2, CO_2 and H_2O) expected during typical combustion retorting.

Activation energies and preexponential factors characterizing the rate constants for these reactions have been expressed in a form amenable for use in mathematical models of the retorting process. X-ray data on the final-product mineral phases in fully burned oil shale indicate them to be mainly members of the akermanite-gehlenite series, merwinite, and diopside. These products are formed by reactions between carbonates in the solid state and/or their oxides and other minerals in the shale.

These results have implications for the processing and environmental aspects of oil shale retorting.

CAMPBELL, JOCK A., West Texas State Univ., Canyon, TX

Major Petroleum-Impregnated Rock Deposits of Western Colorado Plateau

Petroleum-impregnated rock deposits occur widely in rocks of Permian to Tertiary age in the western Colorado Plateau of Arizona and Utah. Although over 60 occurrences and deposits have been recognized to date, only six, all in Utah, are estimated to contain over one billion bbl of petroleum in place.

Two giant deposits occur in marine and marginal marine strata in the dissected plateau region of southeastern Utah. The largest of these, and the largest single known deposit in the United States, is the Tar Sand Triangle. It underlies approximately 225 sq mi (585 sq km), and is estimated to contain as much as 16 billion bbl of petroleum, principally in the White Rim Sandstone (Permian).

The Circle Cliffs deposit contains approximately 1.3 billion bbl of petroleum in siltstone and sandstone of the Moenkopi Formation (Triassic). The deposit underlies an area of approximately 28 sq mi (73 sq km) on both sides of a breached anticline. Several similar, but smaller deposits occur in the Moenkopi Formation to the north, in the Capitol Reef anticline, and in the San Rafael uplift.

The remaining giant deposits are located in the Uinta basin, and all contain petroleum which probably originated in the lacustrine Green River Formation (Eocene). These deposits include P. R. Spring, Hill Creek, Sunnyside, Asphalt Ridge, and Asphalt Ridge Northwest.

The total amount of petroleum contained in these deposits in the Tar Sand Triangle and Uinta basin approaches a resource base of 29 billion bbl. The deposits are variable, and each offers a variety of technologic and economic challenges.

CAMPBELL, JOHN A., U.S. Geol. Survey, Denver, CO

Lower Permian Depositional Systems, "Uncompahgre" Basin, Eastern Utah and Southwestern Colorado

Studies of depositional systems of the predominantly Wolfcampian Cutler Formation in the "Uncompahgre" (Paradox) basin have outlined five fluvial and two marine facies with associated eolian deposits. Outward from the source, the fluvial facies include (1) proximal braided, which consists of a fan-building sequence and a very coarse-grained fanhead sequence; (2) medial braided; (3) distal braided; and (4) 50 and (5) 100% meandering sequences. The braided facies outline three large (40 to 60-km radius) fluvial or wet fans: the Gateway fan in the northern part of the basin developed to the southwest of the Uncompahgre highland; the San Miguel fan in the central part of the basin formed to the south off the southern end of the Uncompahgre highland; and the Piedra fan in the southeastern part of the basin developed to the west off the San Luis highland.

The marine and eolian deposits occur only in the northern part of the basin around the Gateway fan. Transition of the streams from distal-braided to coarse-grained meandering occurred at the toe of the fan, which was near sea level. Westward of the toe, meandering became more common. A marine transgression occurred early during fan development, resulting in deposition of the limestones and shales of the Rico, or Elephant Canyon Formation of Baars. In a later marine invasion from the southwest, limestones, sandstones, and shales were deposited that are lateral equivalents of Cedar Mesa Member of the Cutler Formation. The eolian facies are closely related stratigraphically and geographically to the marine facies and are thus considered deposits of a coastal dune field.

The San Miguel and Piedra fluvial systems coalesced approximately along the present course of the Animas River. Transition of both systems from distal braided to coarse-grained meandering occurred along their southwest flanks and may also occur along their northeast flanks where reliable information is lacking.

CAMPBELL, S. E., Boston Univ., Boston, MA

Trapping and Accretion of Aeolian Sediment by Cyanophytes

The accretion of sediment by cyanophytes is usually associated with sediment trapping and precipitation of minerals by stromatolites in the marine intertidal and subtidal zones. Stromatolitic structures are also known to form in freshwater streams, lakes, and hot springs. All of these structures originate in aquatic environments. Current work suggests similar biogenic structures can form on dry land. Aeolian quartz sands as well as silt- and clay-size particles are trapped and held by filamentous cyanophytes which intertwine to form networks around the sand grains, and to whose sheaths the smaller particles adhere. Trapping and accretion occur whenever enough moisture is present to rehydrate dormant organisms and allow them to migrate by gliding motility to the surface of the mat. Such movements are accompanied by renewed production of polysaccharide sheath. The organo-sedimentary structures

which result cover otherwise barren soil and rock in arid and semiarid regions of the southwestern United States. The brittle, fragile mats cover hundreds of square miles in areas undisturbed by livestock and man, and represent an accretional phenomenon in an otherwise generally erosional setting.

CANFIELD, ROBERT W., Texaco Petroleum Co., Quito, Ecuador, GUIDO BONILLA, Corporación Estatal Petrolera Ecuatoriana, Quito, Ecuador, and RAYMOND K. ROBBINS, Texaco Petroleum Co., Quito, Ecuador

Sacha Field of Ecuadorian Oriente

The Sacha oil field was discovered in early 1969 about 112 mi (180 km) east-southeast of Quito, Ecuador. It lies in the present-day axial region of the sub-Andean basin which in Ecuador is filled with Upper Silurian to Holocene sediments.

Sacha field is on a low-relief, faulted anticline about 17.5 mi (28 km) long. At the principal reservoir there are approximately 41,000 acres (16,400 ha.) under a vertical closure of 200 ft (61 m).

Principal reservoirs are sandstones of the Lower Cretaceous Hollin formation and the middle to Upper Cretaceous Napp formation. The Hollin sands, the main reservoir, are marine-fluvial, whereas the Napo sandstones are largely continental deposits. The basal sandstone of the Upper Cretaceous-Paleocene Tena formation is a secondary reservoir.

Production from the field commenced in July 1972 and, at the end of September 1979, over 164,000,000 bbl of oil had been produced. Gross recoverable reserves in the field are estimated at 633,784,000 bbl. Through September 1979, 89 wells had been drilled in the field, two of which were dry holes.

CAROZZI, ALBERT V., Univ. Illinois at Urbana-Champaign, Urbana, IL, JOEL C. CASTRO, CARLOS V. BELTRAMI, et al, PETROBRAS, DEPEX, Rio de Janeiro, Brazil

Microfacies and Depositional-Diagenetic Model of Amapá Carbonate Rocks (Paleogene) of Foz do Amazonas Basin, Offshore NE Brazil

The extensive, thick Paleogene carbonate platform (Amapá Formation) of the Foz do Amazonas Basin developed next to the ancient shelf edge through four depositional cycles. This important stratigraphic-structural unit of the basin became the natural target of the search for potential hydrocarbon reservoirs.

The Amapá carbonate platform shows six environmental belts: slope, apron, coralgal platform, large foraminifer shoal, finger coral bank and restricted lagoon. These belts consist of zones of intense bioaccumulation by red algae and large foraminifers separated by transverse channels where the products of their mechanical reworking accumulated as calcarenites. At all times, a terrigenous environment consisting of fan deltas and lagoonal sediments existed immediately behind the carbonate platform. It was connected with the open ocean by transverse canyons cutting across the carbonate platform and filled with shales containing carbonate olistoliths.

Distinct reservoir conditions were generated by underground circulation systems during episodes of subaerial exposure at the end of each depositional cycle when high-stand sea level changed to low-stand conditions. Excellent porosity exists in all microfacies except for the facies of the apron and slope belts, and consists of mainly enlarged interparticle and moldic porosity with a minor contribution of intercrystalline porosity related to dolomitization by mixing of freshwater and marine waters.

The Amapá platform is unique in the geologic record and the only modern analog is the Belize shelf. However, similar conditions of underground circulation and dolomitization by mixing waters exist today at a comparable scale in Florida and Yucatan.

CASBY, SUSAN, Shell Oil Co., Houston, TX

Geologic and Geophysical Investigation of Part of Outer Continental Shelf and Upper Continental Slope, Northwest Gulf of Mexico

The continental slope in the northwest Gulf of Mexico ranges in width from 110 km (59 nmi) off the Rio Grande to 240 km (130 nmi) off Louisiana. Throughout its Cenozoic history, this continental margin has increased its limits through the progradation and aggradation of clastic sediments on a broadly downwarped and subsiding basement. Eustatic changes in sea level in response to Pleistocene climatic fluctuations have provided for the deposition of these transgressive and regressive deposits. Rapid Pleistocene sea-level changes are responsible for accelerated deposition and extension of the continental margin.

Lowering of sea level moved nearshore sedimentation to the outer edge of the continental shelf. Shelf outbuilding occurred as deltas prograded over the shelf-slope break. Growth faults cut the sediment column in response to this rapid sedimentation. Marine transgression resulted in a decreased sedimentation rate, depositing a transgressive sequence which capped the regressive clastics. The continental slope in the northwest gulf is further marked by diapiric salt uplifts of variable size.

Correlation of recent high-resolution seismic profiles with drill-core data in a selected location on the outer continental shelf and upper continental slope off the Texas Gulf coast, together with textural, micropaleontologic, and paleomagnetic information and sparker data, yield a history of the late Pleistocene to recent. Analysis of shelf-edge progradation and its relation to sedimentation and structural activity on the continental slope yield additional information with respect to the Pleistocene to recent depositional history.

CASEY, J. MICHAEL, Univ. Texas at Austin, Austin, TX

Paleogeographic Evolution of Late Paleozoic Taos Trough, Northern New Mexico

The Taos trough (or Rowe-Mora basin) of northern New Mexico was one of several tectonically active cratonic basins associated with the late Paleozoic Ancestral Rockies. As the basin and adjacent uplifts evolved, the depositional systems and paleogeography varied in conjunction with changing tectonic stability, fluctuating