exists between grain size and volume of quartz cement. These relationships indicate that silica was selectively dissolved via intergranular pressure solution in finer grained sandstones and that, at least locally, quartz cement was selectively precipitated as overgrowths on detrital grains in coarser grained sandstones. Little primary porosity is preserved in the pressolved, finer grained sandstones, whereas appreciable primary porosity may be retained in coarser grained sandstones that contain more quartz cement.

These relationships are also sensitive to thermal maturity, which increases eastward across the basin. This thermal trend is probably related to elevated temperatures associated with intrusions in as much as maximum burial depth of the Hartshorne decreases eastward. As thermal maturity increases, more intergranular pressure solution is evident for a given grain size whereas the volume of quartz cement does not change significantly. Thus, primary porosity tends to be preferentially preserved in areas of lower thermal maturity.

In areas of higher thermal maturity, the sandstones have lost more silica via intergranular pressure solution than has been precipitated as quartz cement whereas the opposite is true in areas of lower thermal maturity.

HOWARD, JAMES D., Skidaway Inst. Oceanography, Savannah, GA, and DIANE KAMOLA and ARMANDO SALAZAR, Univ. Georgia, Athens, GA

Depositional Facies of Cretaceous Spring Canyon Member, Blackhawk Formation, Book Cliffs, Utah

Facies study of the Spring Canyon Member indicates a shoreline characterized by beaches and river mouth bars. We envision the wave-affected river mouth bars building seaward and furnishing sediment to the downdrift, protected beaches. The beach sequences are characterized by a shoreface containing laminated-to-burrowed beds overlain by cross-bedded sands and a foreshore of parallel laminated sand. In contrast, the river mouth bar sands are hummocky bedded.

Associated transitional marine facies include channel-fill, splay, levee, swamp, and bays containing coal deposits. Three principal coal seams within this facies are related to the three Spring Canyon beaches. The lower two formed in a delta plane. The upper coal is associated with a marginal marine sheet sand. Low sulfur content, roots, plant remains, and continuity of coal seams suggests in-situ coal deposition in swamps flanking channels. Paleocurrent directions within most channels indicate a landward flow perhaps due to storm surges or flood tidal effects. The transitional facies contains abundant marine indicators including oyster shells, terrido borings, *Ophiomorpha,* and holes excavated by rays.

INGLE, JAMES C., Stanford Univ., Stanford, CA

Paleo-Oceanographic Significance of Cretaceous and Cenozoic Diatomites Along Eastern Pacific Margin

Diatomaceous mudstones and laminated diatomites punctuate the upper Mesozoic and Cenozoic marine sequence of California. These largely bathyal deposits provide a clear record of upwelling, primary productivity, and development of oxygen minima along the eastern margin of the North Pacific Ocean during the past 80 million years. Marine diatomites exposed in uplifted continental margin sequences in California include the uppermost Cretaceous Marca Shale Member of the Moreno Formation, the middle and upper Eocene Kreyenhagen Formation, and the middle to upper Miocene Monterey Shale. All three of these deposits contain pelletal or nodular phosphorite and represent fossil analogs of various Recent basin plain, slope, and outer shelf settings in which organic-rich diatomaceous sediments are currently accumulating beneath the well-developed oxygen minimum layer of the marginal eastern Pacific. Moreover, each of these units forms a known or potential source rocks for hydrocarbons in this region. The deposition and preservation of Cretaceous, Eocene, and Miocene diatomites along the California margin each demand: (1) a period of intensified upwelling, primary productivity, and associated development of oxygen minima via climatically induced accelerations of atmospheric and oceanic circulation; (2) coincident reductions in the flux of terrigenous clastic material to the continental margin through eustatic and/or tectonic adjustment of adjacent strandlines and pathways of sediment distribution; and (3) tectonic production of appropriate continental margin depocenters. Each diatomaceous unit can be correlated with a major climatic event or threshold associated with increased polar refrigeration, resultant increases in the pole-to-equator thermal gradient, compression of middle and low latitude surface circulation, and associated intensification of upwelling and siliceous productivity.

ISSLER, D. R., Petro-Canada, Calgary, Alberta, Canada

Predication of Organic Maturation Levels: Scotian Shelf

Recorded maximum bottom-hole temperatures may vary significantly from true formation temperatures. Circulation time and time since circulation are important variables in estimation of equilibrium bottom-hole temperatures. A theoretical temperature correction technique incorporating these factors was applied to well log-heading data to compute 191 static temperatures for 64 wells in the Scotian Shelf. A linear regression, performed on 140 computed temperatures produced an average geothermal gradient of 2.66°C/100 m; correlation coefficient 0.97. A geothermal gradient map constructed from the corrected data shows that areas of thicker sediment accumulation are marked by thermal highs (e.g., Abenaki, Sable subbasins), whereas areas of shallow basement coincide with thermal lows (e.g., LeHave Platform, Canso Ridge).

A technique for calculating maturation level of organic matter based on Lopatin's method and corrected bottom-hole temperatures was developed for the Scotian Shelf. A geologic model is constructed by superimposing a temperature grid on burial history curves. From this, TTI (Time-Temperature Index) values are derived which give the maturity level for specific sedimentary horizons. A comparison of 47 calculated TTI values with vitrinite reflectance measurements for 13 wells established a calibration of this technique for the Scotian Shelf. A correlation coefficient of 0.96 was obtained for the relation, $\log TTI = 6.7367 \log Ro + 2.7317$. This particular calibration of TTI is probably valid only for the Scotian Shelf since tectonic age and history play a role in the calibration. The procedure of calculating TTI values is readily adaptable to a computer since a standard approach is followed for every well.

JACKSON, M. P. A., S. J. SENI, and M. K. MCGOWEN, Bur. Econ. Geology, Univ. Texas at Austin, Austin, TX

Initiation of Salt Flow, East Texas Basin

Salt structures constitute five domains subparallel to the basin margin and the Louann Salt updip limit: (1) thin ($<$ 340-640 m) planar salt wedges at the margin; (2) low-amplitude periclinal salt pillows (mother salt 550-625 m thick); (3) intermediate-amplitude elongated salt anticlines separated by synclines evacuated of salt

(550– >760 m thick); (4) pre-Gilmer salt diapirs (Oakwood and, possibly, Grand Saline); and (5) post-Gilmer salt diapirs in the basin center. This inward increase in shape maturity results from increasing salt thickness and distribution of post-Louann sedimentary facies.

The Louann Salt (Middle Jurassic) was deposited in a broad continental basin on a post-rift unconformity surface. Domain 1 suggests that a critical salt thickness ($\sim$500 m) was necessary to initiate flow. In the Late Jurassic, an aggrading carbonate wedge uniformly loaded the underlying salt and formed the salt pillows of domain 2. Salt flow in the basin center had not begun by Gilmer time, probably due to a thinner overburden of basinal carbonate facies there. The Upper Jurassic–Lower Cretaceous Schuler-Hosston regressive terrigenous clastics prograded rapidly across the carbonate platform as coalescing fan deltas, filling the central basin. Salt anticlines of domain 3 grew by serial amplification of pre-Gilmer pillows to form ridges normal to dip direction fronting depocenters. Salt diapirs subsequently evolved from the distal anticlines.

Salt anticlines have trapped 80% of petroleum produced from the west-center of the basin. Marine pre-Gilmer source rocks, early initiation of folding, and the large size of the anticlines have all contributed to petroleum accumulation.

JAMES, DAVID P., Univ. Oxford, Oxford, England

Sedimentologic Aspects, Mannville Group, Southwestern Alberta

Due to the relative paucity of data, the Mannville sediments located at the western margin of the plains (T10-20, R27W4 to W5) have not been subjected to detailed study. However, recent exploration activity in this area has resulted in the acquisition of much core and drilling data. Using these data, together with those obtained from outcrop studies in the Foothills and from all the available core toward Range 20, a regional appreciation of the stratigraphy, sedimentology, and diagenesis of southern Alberta is now possible. Three major phases of sedimentation are recognized.

The first phase of Mannville sedimentation commenced with the deposition of coarse conglomerates in the Foothills (Cadomin) and chert-rich, often pebbly, sandstones in the plains (Basal Quartz, Cutbank, and Sunburst equivalents). These sediments were deposited as shallow braided or meandering stream deposits, often restricted to broad valleys on the Pre-Cretaceous unconformity. Fine-grained flood-plain deposits with well-developed pedogenic horizons are recognized within this interval.

The second, a transgressive phase of sedimentation, followed, with the deposition of bentonitic shales and fossiliferous limestones (Ostracod Member) and quartzose (Glauconitic) sandstones. The areally extensive sediments, which were primarily deposited in a complex of shallow restricted marine(?) environments, have a distinctive mineralogy compared to the underlying and overlying units. Changes in sediment provenance can account for this mineralogic diversity.

Thirdly, continental conditions returned to much of the area during post-Glauconitic time. This interval is represented by silts and shales intercalated with feldspathic and volcanic channel and crevasse sandstones. The textural and mineralogic immaturity of these sandstones is typical of the upper Mannville sediments of Alberta.

Complexities arise to the east of Range 22 where deep-channels originating during Ostracod, ?Glauconitic, and Upper Mannville times have cut through the underlying sediments. Recognition of the initiation point of these channels is important because reservoir quality is largely controlled by sediment composition. The most prospective reservoirs are quartz-rich sandstones which were not subjected to extensive silica cementation, a consequence of deep burial.

JANSA, LUBOMIR F., Geol. Survey of Canada, Darmouth, Nova Scotia, Canada

Development and Hydrocarbon Potential, Carbonate Platforms Offshore Northeastern America

The Jurassic-Lower Cretaceous carbonate platforms and banks form a discontinuous belt extending from the Grand Banks to the Bahamas (over 6,000 km). The thickness of the carbonate buildups progressively increases southward along the margin, attaining a thickness of more than 5 km on the Bahamas. The platforms also become younger southward, which has been interpreted as an indication of a northward motion of the North American plate. Six types of carbonate buildups recognized document variability of depositional, paleo-oceanographic, and tectonic processes along the margin. The composition of the buildups closely resembles the recent deposits of the western Great Bahama Bank, since oolitic shoals were present near the shelf edge and skeletal, peloid wackestones and biomicrites were deposited in the inner part of the platform. Coral-hydrozoan, sponge and algal stromatolite bioherms and reefs are important constituents of the Late Jurassic-Early Cretaceous shelf edge. The hydrocarbon prospectivity of the carbonate front differs for the individual carbonate platform types which prevents construction of a single model for evaluation of their hydrocarbon potential. Porosity has locally developed as a result of secondary dolomitization in a mixing zone. Hydrocarbons were at least locally generated and migrated through the porous carbonate rocks. The major critical factor is presence of a rich source rock. The latest deep sea drilling on the northwestern African and eastern North American margins, together with the interpretation of the Mesozoic paleogeography of the shelf, allows the elucidation of this important factor in a time and space framework of margin development.

JEFFERSON, C. W., D. B. KILBY, W. J. ROBERTS, and L. C. PIGAGE, Cyprus Anvil Mining Corp., Vancouver, British Columbia, Canada

Sedimentation Associated with Cirque Barite-Zinc-Lead Deposit

The barite-zinc-lead Cirque Deposit and other major showings in the Gataga district are part of an Upper Devonian to Mississippian sequence of basinal shales and submarine fan deposits of chert pebble conglomerate which were derived from the northwest. This sequence is preserved in the Akie, Pesika, and Gataga troughs, and unconformably overlies Ordovician to Silurian slope and basinal facies of the Kechika trough. The Akie trough is host to all known potentially economic barite-zinc-lead deposits in the district.

Both regional and detailed linear elements of the Cirque Deposit trend northwesterly and are asymmetric normal to the strike line. The background depositional unit is a soft gray aluminous shale which grades into black and carbonaceous shale to the southwest. An envelope consisting of diagenetically silicified fine carbonaceous clastic units was formed about the deposit. The outermost part of the diagenetic envelope consists of ribbon-bedded porcellanite with blebby and laminated massive barite on the northeast. Silicified platy poker chip shales with calcareous siltstone laminae are between the ribbon porcellanites and ore. The core of the cycle consists of up to 70 m of barite and sulfides on the axis of the deposit. Laterally, the ore section interfingers to the northeast with an equal thickness of flaggy to blocky bedded silicified black shale containing abundant finely laminated pyrite. Pb:Zn ratios increase northeasterly, and ore isopachs are asymmetric toward the northeast with the thickest zone being on the southwest edge of the deposit.