remarkable variety of calibration and depth scales. Visual analysis with well-to-well continuity is almost impossible with the logs in their original form. Fortunately, the hard-copy logs can be digitized and computer-processed to produce standardized logs that are amenable to accurate analysis for contained hydrocarbons and the spatial mapping of potential reservoirs.

The process does require the services of a petroleum geologist to determine the log response to clean formations within each well. However, once the individual curve parameters are determined, the computer can carry out the detailed computations for the display and isolation of all potential reservoirs. Examples of logs from New York state indicate that many gas-bearing reservoirs remain to be exploited.

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Geology and Organic Geochemistry of Dakla Shale, Egypt

The Dakla Formation is late Campanian to Paleocene in age and, in eastern Egypt, is overlain by the Nubian Sandstone and underlain by the phosphate-bearing Duwi Formation. Lithologically, samples of the Dakla shale member collected in the Red Sea area consist of marls to marly clays, range from brown to black in color, and are bounded at the top and bottom by phosphate-bearing strata. Organic carbon and extractable C_{15+} hydrocarbon concentrations for samples from Quseir, Hamrawein, and Safaga ranged from 3.8 to 5.9% C_{org} and 550 to 2,400 ppm HC, and may be petroleum source rocks in areas where burial and thermal conditions are adequate. Shale samples from the Quseir region yielded Fischer assay results of 40 gal/ton, and thus have considerable potential as oil shales.

Samples from the Sibaiya region in the Nile Valley are light to dark gray shale and average 0.2% C_{org}. In this area, the phosphate deposits associated with the Dakla Formation are presently being exploited.

The Dakla shale samples from the Abu Tartur region, in the Western Desert, contain organic carbon concentrations in excess of 4.0%. Such values are considered suitable for potential petroleum source rocks where other conditions are satisfied. Recent exploration activity in the Western Desert region may make petroleum source rock studies of the Dakla shales increasingly important.

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Coal Occurrence and Characteristics as Related to Environment of Deposition in Cerro Negro Area of Orinoco Tar Sands, Venezuela

Sedimentological analysis of cores taken in the Cerro Negro area of the Orinoco Tar Sands have provided lithological, textural, mineralogical, and paleontological data which have enabled facies identification. These facies have been interpreted as belonging from an upper delta plain to a semi-restricted shallow marine environment of deposition. Coal beds occur in all the wells analyzed. These occurrences are closely associated with specific facies, such as the back-barrier lagoonal facies of the semi-restricted environment of deposition and the backswamp facies of the delta plain. More importantly these coal beds present very distinguishable characteristics, such as variation in thickness from few inches in the back-barrier facies to 5 ft (1.5 m) in the delta plain facies. Their organic composition also ranges from micrite/atrinite to vitrinite and exinite in different proportions. Therefore, it is believed that variations in thickness and perhaps in organic composition are related to facies changes.

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Style Zonation in Fold-Thrust Belts

All orogens have thick-skinned and thin-skinned-style provinces. Thick-skinned belts form in a variety of crustal settings common in upper plates of Andean-type orogens and in both plates of aging collisional orogens. Thin-skinned belts specifically require transport at one transcrustal sole thrust. In collision belts, the sole thrust is the suture. In belts antithetic to Andean-type subduction, the sole thrust departs upward from the point of the asthenospheric wedge.

Arrays of strike belts with different styles signal the thin-skinned scenario and its distortion in thick-skinned settings. A proposed zonation includes the following. (1) Detached fold belt with 1 to 5 km (0.6 to 3 mi) deep sole sloping at 0 to 2°, without topographic slope, and with strain increasing coreward to 80%. (2) Imbricate belt with 3 to 10 km (1.8 to 6 mi) deep sole sloping at 1.5 to 3.5°, and with bulk strain increasing to 100% or more. (3) Allochthonous belt consisting of polyphase (typical: thick-skinned pre-transport strain) crust and cover rocks above a subthrust sediment complex showing 100 to 500% strain. Base of subthrust complex is 5 to 20 km (3 to 12 mi) deep and slopes at 3 to 15°. (4) Root zone with polyphase and progressive strain, steep dips, retrocharriage, and late shallow detachment. (5) Late stage thick-skinned structures including foreland upthrusts, massifs (Helvetic and Penninic), and core complexes (cordilleran) occur anywhere between root zone and foreland. Their detachment, rise, and transport distort the thin-skinned features but cause more thin-skinned detachment in the external belts.

Presence and width of strike belts and their style elements (e.g. folds, ramps, imbrications, back thrusts) can be explained as interplay between gravity spreading and thrust loading of an elastic foreland crust. Style-determining factors include (1) time spent within thrust wedge, (2) rigidity of foreland crust, (3) topographic slope, and (4) distribution of competent and incompetent rock units.

Polyphase kinematic sequences reflect the numerical divergence between the elastic foreland wedge and the transport requirement of "optimum taper;" we distinguish polyphase wedge thickening and fold-discordant wedge transport.

Seismic work and drilling in all five zones provide the data base for the zonation. Hydrocarbons are produced from all zones except zone 3. Conventional production comes from zones 1, 2, and 5. Most ongoing overthrust plays are made in zone 2. Zone 3 has potential where the allochthon is thin (such as ophiolites or detached shelf sediments), where the foreland sediment series is complete (as in collision belts), and where collision is too recent for thermal stabilization.

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Late Paleozoic Foraminifera as Depth Indicators

Many late Paleozoic foraminifera consistently occur in particular rock types for which depths of deposition may be inferred. A few genera appear randomly in many different rock types and were possibly pelagic.

Textulariina: In the Ammodiscacea, most genera of Hippocrepininae (Astrorhizidae) and Ammodiscidae are widespread and common in dark gray shales, siltstones, fine to very fine sandstones, and silty, calcareous mudstones deposited in basinal, slope, and deeper shelf setting below effective wave base. In the Lituolacea, the Hormosinidae, Lituolidae, Textulariidae, Trochamminidae, and Ataxophragmiidae include only a few late Paleozoic genera, which locally are abundant in dark to medium gray, silty shales, siltstones, silty sandstones, and carbonate wackestones and packstones; all deposited near wave base.

Miliolina: Late Paleozoic representatives are primitive (tubular, nonseptate) genera of Hemigordiopsidae, Fischerinidae, and Nubeculariidae. These occur mainly in shallow, warm water calcareous wackestones.

Fusulinina: These were the most taxonomically diverse of the late Paleozoic foraminifera and were adapted to a wide range of depth habitats. Parathuramminacea locally were very abundant in deeper water, dark gray calcareous wackestones formed in basins and slopes below wave base. Endothyracea (s.l.) included many genera and families that dominated most of the Early Carboniferous shallow water, calcareous depositional environments. Nodosinellidae preferred open shelf facies and may have extended to depths below wave base. Colaniellidae, Ptychocladiidae, Paleotextulariidae, Tetrataxidae, Tournayellidae, Endothyridae, Loeblichiidae, and Lasiodiscidae locally were common in shallow shelf, shoal, and lagoonal carbonate wackestones, packstones, and as displaced fossils in some grainstones, such as oolites. Bradyinidae were globose, had pseudoalveolar walls, and were widely scattered in a number of different lithologies suggesting a pelagic or planktonic habitat. Archaediscidae, which have recrystallized wall structure, were common in shallow water, carbonates and calcareous shales.

Fusulinacea, most of which probably had photosynthetic symbionts, were adapted to shallow carbonate depositional habitat at depths less than 15 to 20 m (49 to 66 ft). Carboniferous Fusulinidae and Ozawainellidae apparently occupied most of this depth range because of their adaptation to Middle Carboniferous cool surface waters. Permian Schubertellidae and Oazawainellidae became adapted to shallow, warm water lagoons and shelves. Verbeekinidae and Neoschwagerinidae were common in reef cores and upper flank deposits of Permian Tethyan reefs. Schwagerinidae also adapted to shallow to very shallow water carbonate environments, such as reef edges, shallow lagoons, tidal flat channels, margins of algal shoals and banks, and other shallow nearshore areas. For example, *Eoparafusulina* formed extensive skeletal grainstones in many cross-bedded, subtidal deposits.

Several globose lineages within the Fusulinacea possibly were pelagic, such as *Robustoschwagerina, Pseudoschwagerina, Verbeekina,* and many of the Permian Staffellidae.

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Regional Inventory of Peace River Oil Sands, Alberta, Canada

The Peace River oil sands of northwestern Alberta contain an estimated 92 billion bbl of bitumen trapped in an updip pinch-out of the Lower Cretaceous Bluesky and Gething Formations. The geologic reservoir characteristics of the Peace River oil sands are being mapped on a regional scale through the use of core and geophysical logs. Four wells per township are used wherever possible. A computerized data file on each well consists of basic well data, tops of the Bluesky and Gething Formations, and oil sand reservoir and the underlying pre-Cretaceous unconformity, and a coded lithology log. The lithology log is kept simple due to the limits of geophysical log interpretation but attempts to quantify sand, shale, interbedded sand and shale, oil, and water. Logs have been calibrated wherever possible with core control. Because the data are stored as a log of the well, a wide variety of useful maps can be generated by the computer. These include maps showing structure, sand/shale ratios, gross and net pay thicknesses, basal water, top water, lean zones, and uninterrupted pay.

Recognition of four major facies including continental, tidal flat, shoreline and shallow marine, and tidal channel deposits has led to the proposal of an estuarine model for sedimentation within the Gething Formation. Isopach maps from the top of the Bluesky and Gething Formations down to the pre-Cretaceous unconformity show a regional southeast to northwest drainage trend on the unconformity surface. Similar trends are seen in the main sand bodies. Coordination of computer-generated maps with the facies model highlights areas which satisfy specific criteria that may be critical in determining the applicability of a particular in-situ recovery method.

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Depositional and Exploration Models for Cretaceous Lower Mannville Fluvial Sandstones of South-Central Alberta

Production of hydrocarbons from fluvial strata of the lower Mannville Formation in the Taber–Milk River area of south-central Alberta occurs primarily from combination structural-stratigraphic traps situated on subtle north-northwest trending anticlinal features. Lower Mannville sediments were deposited in a north-trending valley that formed when sea level lowered and shorelines receded to the edge of the continent during the Late Jurassic and Early Cretaceous. The river that cut this valley shifted eastward in response to rising of the Cordilleran highlands, producing a west-facing escarpment. We regard this escarpment as a southward extension of the Fox Creek Escarpment of west-central Alberta. In latest Neocomian or earliest Aptian time, the river system began to aggrade as a result of southward transgression of the Boreal sea. The basal aggradational valley fill, the Sunburst Sandstone, is generally the coarsest, best sorted, and texturally most mature of the sandstones in the Mannville Group. Stratigraphic traps in the area are the result of: (1) updip pinch-out of the Sunburst Sandstone against the north-trending Fox Creek Escarpment (e.g., Horsefly Lake field); (2) general eastward-thinning of the Sunburst Sandstone within tributary valleys east of the Fox Creek Escarpment (e.g., Chin Coulee field); and (3) updip interruption of blanket fluvial sandstone units by clay-filled, abandoned reaches of the river system that deposited the lower Mannville sandstones (e.g., Taber field). A logical exploration strategy both in the Taber–Milk River area and in areas to the north and south would be to pursue the trends of the Fox Creek Escarpment and its tributary valleys.

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Sedimentology of Spearfish Formation

The Permo-Triassic Spearfish Formation of the southeastern Black Hills, South Dakota, consists of evaporite, clastic, and carbonate sediments which formed as the result of the complex depositional history.

The lithologies that occur as the result of primary deposition are (in decreasing order of abundance) gypsum, siltstone, shale, sandstone, conglomerate, limestone, dolomite, and a highly