attempts the direct detection of oil by virtue of its intrinsically high resistivity. Although success has been reported for several very shallow fields, strong theoretical arguments indicate that direct detection is untenable as a standard exploration technique. A second approach utilizes magnetotelluric or similar techniques to map deep, very large-scale structures, but high cost and poor resolution confine this work primarily to areas where seismic is unobtainable. A third approach is mapping electrochemical alteration patterns in the top 1,000 m (3,000 ft) of sedimentary overburden. These patterns are attributed to clay-mineral alteration or sulfide precipitation resulting from upward seepage of light hydrocarbons and brines from the traps below. Recent advances in instrumentation and data processing have made alteration mapping a promising supplement to ongoing seismic and geologic exploration programs, especially in the search for subtle stratigraphic traps, and in distinguishing productive from nonproductive structures.

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Depositional Environments of Devonian Cairn Formation, Rocky Mountain Foothills, Alberta, Canada

The Cairn Formation is a carbonate sequence of Frasnian (Late Devonian) age that is the stratigraphic equivalent of the major oil-producing Leduc Formation of southern Alberta. During the summers of 1982 and 1983, detailed stratigraphic sections were measured near Canmore where the Cairn Formation is a platform sequence of carbonates approximately 50 km (31 mi) from the nearest reef edge.

The entire sequence consists of sediments deposited in a subtidal environment. No evidence of intertidal or supratidal deposition was found. The formation consists of very fine to medium crystalline, buff to dark gray dolomite, in which original textures (usually mudstones, grainstones, and stromatoporoid floatstones) often can be identified. The sequence contains fair to good intercrystalline, biomoldic, and vuggy porosity. Some of the vuggy porosity has been infilled by very late, coarse crystalline dolomite and calcite.

Individual beds typically are composed of a consistent lithologic character throughout. These beds are usually 10 cm to 2 m (1 in. to 6 ft) thick, and are virtually always bounded by disconformities. Some individual beds can be seen to swell and pinch out.

The stromatoporoid floatstones are composed of 10–40% fossils consisting of *Amphipora, Euryamphipora,* bulbous stromatoporoids (5–20 cm, 2–8 in.), tabular stromatoporoids, horn corals, and colonial corals. All organisms are not in place but have only moved a short distance.

Some thin beds consist of a black bituminous dolomite and probably represent a restricted lagoon environment of deposition.

Although most beds are horizontal, some constructional bioherms up to 5 m (16 ft) in relief have been recognized in the sequence.

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Geology of Oscar Range (Devonian) Reef Complex, Canning Basin, Western Australia

The Oscar Range is a Late Devonian reef complex that formed at the margin between the Precambrian Kimberley craton and the Canning basin. The range covers an area of 80 × 10 km (50 × 6 mi), and resembles a large atoll in that Frasnian and Famennian reef, marginal-slope, and back-reef subfacies grew around an exposed Precambrian core.

Frasnian reefs are dominated by stromatoporoids and *Renalcis,* and the reefs show periods of upbuilding, drowning, backstepping, and basinward progradation. Fault-controlled reef growth is developed locally. Marginal-slope deposits contain stromatoporoid debris, sponge boundstone, and crinoids. Back-reef deposits are generally *Amphipora*-rich biostromes, although fenestral oolite-intraclast-peloid beds are widespread in the southern Oscar Range. Dolomite is best developed in Frasnian back reef and, to a lesser extent, in reef-margin and reef-flat subfacies. In the area of the Precambrian core, conglomerates of Precambrian debris are interbedded with Frasnian limestones that are in depositional contact with basement. Hills of Precambrian rocks rise tens of meters above these peritidal back-reef deposits, indicating perhaps several hundred meters relief during the Frasnian.

The exposed Frasnian-Famennian contact is a disconformity. Famennian reefs are dominated by *Renalcis* and associated algal stromatolites; the equivalent marginal-slope is characterized by allochthonous reef blocks, sponge bioherms, and crinoidal debris. Steeply dipping (40°) basinward-prograding reef and marginal-slope tongues make up the shelf margin. The Famennian back reef is composed of fenestral oolite-peloid lithologic units with common teepee structures, flat-pebble conglomerates, and cryptalgal fabrics.

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Early to Middle Pennsylvanian Changes in Paleoslope and Sediment Source Terranes in Northwest Illinois

The Abbott Formation (Atokan) conformably overlies the Caseyville Formation (Morrowan) which unconformably overlies Silurian and Mississippian units in the Rock Island area, Illinois. The two formations have a similar composition of $Qm_{95\text{-}100}$, $Ls_{0\text{-}5}$. More than 70% of quartz and heavy mineral grains (tourmaline and zircon; minor rutile and garnet) are rounded to well rounded. Their source is interpretated as a mature sediment on the craton, whereas equivalent sandstones in southern Illinois have an inferred metamorphic terrane component in the source.

Sediments of the Spoon Formation (Desmoinesian) conformably overlie the Abbott Formation, but their sandstones differ in composition. Spoon sandstones comprise $Qm_{45\text{-}60}$, $Qp_{7\text{-}20}$, $F_{5\text{-}10}$, $Lm_{5\text{-}18}$, $Ls_{1\text{-}8}$, and heavy minerals (tourmaline and zircon; minor sphere, garnet, hornblende). More than 55% of grains are angular to subrounded. The compositional change reflects a new sediment supply to the Rock Island area during the Desmoinesian. Grains from a metamorphic terrane are inferred to be mixed with those from a mature sediment.

Paleocurrent data indicate that a change in paleoslope near Rock Island coincided with the compositional change. The early Pennsylvanian fluvial system was probably locally controlled by the Mississippi River arch and flowed to the north. The arch could then have been submerged during the Desmoinesian, and flow was toward the southwest down cratonic paleoslope (which had influenced regional flow since the Morrowan.

Paleocurrent and petrologic data indicate that lower Pennsylvanian basin fill in western Illinois was derived from the northeast rather than the northwest (Transcontinental arch) as previously suggested.

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A Sedimentologic Model for a Microtidal Flood-Tidal Delta—San Luis Pass, Texas

San Luis Pass is a microtidal inlet located at the southwest end of Galveston Island, Texas. Continuous cores taken with a portable vibracoring rig, and surface grab samples provide data for developing a 3-dimensional sedimentologic model of the flood-tidal delta complex located landward of the tidal inlet. This model is based on the type, and vertical and lateral distribution of lithologic units, sedimentary structures, textures, and trace fossils.

A complete bayward vertical sequence in the flood-tidal delta complex consists (from base to top) of highly bioturbated bay clays and associated oyster reefs, highly bioturbated clayey sands/sandy clays of the delta margin, variably burrowed sand to shelly sand of the delta, and rooted or burrowed muds of the marsh or mud flat. Washover shell-hash deposits may occur at random intervals throughout this sequence. A more seaward sequence in the vicinity of San Luis Pass consists of a basal tidal inlet deposit of graded layers of sand and shell overlain by burrowed to shelly sand of the barrier spit.

This model for microtidal flood-tidal deltas differs significantly from models presented for mesotidal flood-tidal delta systems in the general lack of large-scale, high-angle sedimentary structures; the presence of intense bioturbation; the presence of washover deposits; and the general upward-coarsening nature of the vertical sequence. Mesotidal flood-tidal deltas with clean, coarse to medium-grained sands may make good petro-