The distribution of the various cement types within the reefs can be linked with the shallowing-upward nature of the limestone sequence as there is a predominance of early marine cement fabrics in the middle and upper parts of the reefs, particularly in the algal biofacies. The spatial and sequential nature of the various carbonate diagenetic fabrics show that the Hogklint reefs went through four main diagenetic events.

Microstalactitic cements, vadose crystal silts, grain-contact cements, and pseudofibrous isopachous cements are developed within cross-bedded peloidal grainstones at the top of the shallowing-upward sequence and indicate cementation within the freshwater vadose zone and intertidal and/or marine phreatic zone.

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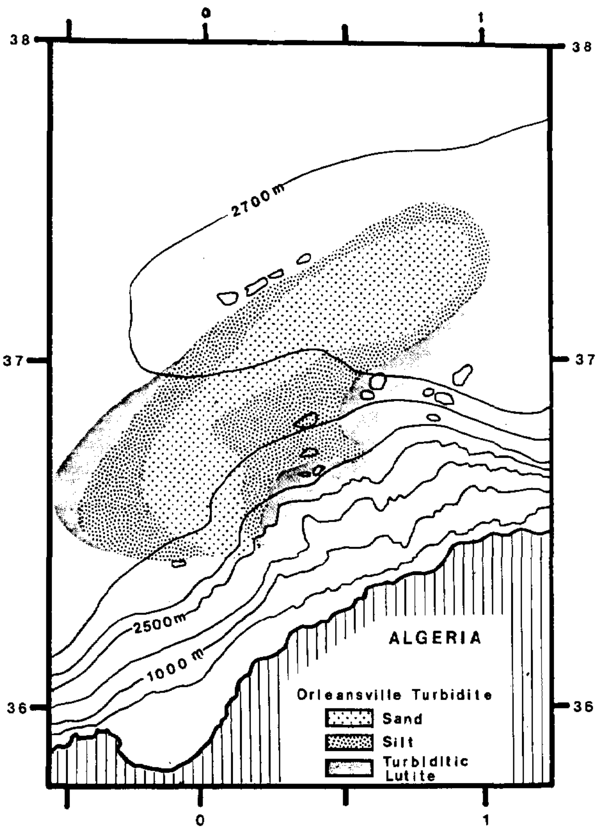
Orleansville Turbidite

The Orleansville earthquake in 1954 produced a turbidity current on the Algerian Mediterranean margin and adjacent South Balearic basin sea floor which broke five telephone cables. The report of this event represented a cornerstone in the evolution of turbidity current theory. The resulting turbidite has been mapped on the Balearic abyssal plain for the purpose of relating flow paths and turbidite size, and areal extent to cable break locations. This study is based on 50 gravity cores.



The Orleansville turbidity current actually consisted of two currents which arrived simultaneously on the basin plain via two canyon mouths separated by 30 km. The merged turbidity currents flowed 170 km out on the basin-plain floor and covered an area of 8,000 km^2. The turbidite is a tongue-shaped sediment body, 50 km wide, oriented northeast-southwest. It consists of a central band of 5-cm thick sand with a fringing 2 to 3-cm thick band of coarse to fine silt. Two of the cable breaks occurred on the abyssal plain at the extreme edge of the turbidite where the sediment is only 2 cm thick. An underlying turbidite of very similar dimensions to the Orleansville turbidite is separated from it by a 10 to 15-cm pelagic sequence. The consistent spacing between these two events indicates that although the Orleansville turbidity current broke telephone cables at its extreme margins, it caused no detectable erosion on the basin-plain floor.

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Analysis of Petroleum Source-Rocks of Bakken Formation (Lowermost Mississippian) in North Dakota

The Bakken Formation consists of upper and lower, black, organic-rich shales separated by a middle siltstone member. The sediments of the Bakken are marine in origin.

The middle member consists of very fine-grained sandstones, siltstones, silty limestones, and shale. The middle member generally has low porosity (1 to 5%) and permeability (<0.1 md), except where fracturing is present, as at Antelope field in McKenzie County. The lithologies, fossils, and sedimentary structures of the middle member are indicative of a nearshore marine depositional environment.

The black shales were deposited in quiet, poorly circulated, anaerobic waters. In thin section they exhibit a high degree of orientation of mineral particles and a high kerogen content. Thin-section and chemical analyses show the mineral matter of the shales to be predominantly quartz.

Pyrolysis, total organic carbon determinations, vitrinite reflectance, optical kerogen typing, and chromatography of extractable organic matter were used to determine the depth of onset of hydrocarbon generation, amount of generated hydrocarbons, thermal maturity, kerogen types present, and distribution of organic matter in the black shales of the Bakken Formation. These are extremely rich source rocks, because they contain high amounts of algal kerogen, a prolific source material of oil. Organic carbon values for the black shales average about 13 wt. % and extractable hydrocarbons are typically 4,000 to 5,000 ppm.

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Persimmon Creek Field—Anatomy of a Morrow Stratigraphic Trap

Persimmon Creek field in T20N, R22W, Woodward County, Oklahoma, on the northern shelf of the Anadarko basin, produces gas and condensate from upper lower Morrow sandstone. The field occurs above a prominent southward-plunging structural nose on the Chester limestone. This and similar noses nearby appear to be paleotopographic highs that strongly influenced subsequent Morrow deposition. A thicker Morrow section overlies Chester lows or paleovalleys and a thinner sequence occurs above the noses.

In this area, the Morrow contains an upper shale section and a lower sand-shale sequence containing four major sandstone units, each of which may contain one or more discrete sandstone beds with interbedded shale. The basal Morrow "Hamilton" sandstone strikes west-northwest, but filling of the subjacent Chester paleovalleys has caused local thicker sand accumulations with good porosity to trend north-south. The overlying "Yellow" sandstone has similar characteristics. In the "Brown" sandstone, this relationship is reversed, and the thickest sand accumulation and best porosity development occur above the plunging Chester noses. The uppermost "Fritzler" sandstone is more erratic in character, showing little relationship to Chester paleotopography.

Persimmon Creek field, with an area of about 2 mi^2, produces from north-south-trending "Brown" sand bars 8 to 20 ft (2.4 to 6 m) thick with 14 to 22% porosity. By analogy, in this part of the Anadarko basin, Morrow exploration should focus on locating porous upper lower Morrow sandstone above basinward-plunging Chester noses.

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Sea-Level Changes and Tectonic Control of Unconformities, Western Interior, U.S.A.

Unconformities are conspicuous stratigraphic features in the Phanerozoic strata of the Western Interior, U.S.A. Important unconformity traps for petroleum are found in strata of Ordovician, Mississippian, Permo-Pennsylvanian, and Cretaceous ages. The role of the unconformity in trapping petroleum is principally by truncation of porous zones and by providing a seal for the trap. Lenticular zones of porosity and permeability in sandstones immediately above the erosional surface are also important stratigraphic traps, both in marine and nonmarine strata.

An unconformity is defined as a sedimentary structure in which two sets of strata (or groups of rocks) are separated by an erosional surface where the erosion may be by subaerial or submarine processes. Factors to be considered in evaluating unconformities are structural discordance, nature of contact, hiatus, duration of erosion, areal distribution, and cause.

Principal causes for unconformities are sea-level changes, tectonics, or a combination of both. Two examples of unconformities controlling petroleum occurrences are as follows: (1) porosity beneath a paleokarst surface at the top of the Mississippian carbonates (Kevin-Sunburst field, Montana), and (2) the fluvial sandstones of Early Cretaceous age (Muddy Formation) that fill an incised drainage system resulting from a sea-level drop and subsequent rise approximately 97 m.y.B.P. (Recluse field, Powder River basin, and Third Creek field, Denver basin).

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Origin, Migration, and Entrapment of Natural Gas in Alberta Deep Basin: Part 1

The Alberta Deep basin, situated along the northeastern front of the Rocky Mountain belt, is the deepest part of the Alberta synclinal sedimentary basin. This trough-shaped deep basin, extending across northwestern Alberta and into northeastern British Columbia, covers an area of 65,000 km^2 (25,000 mi^2).

Enormous volumes of natural gas have been found in recent years within the thick, clastic Mesozoic sediments which partly fill the deep basin. These sediments exceed 3,100 m (10,200 ft) in total thickness.

Based on detailed geochemical analyses of more than 300 rock samples (mainly cutting samples) from several wells in the Elmworth gas field, information was obtained on the hydrocarbon source strata and the generation and redistribution of hydrocarbons.

The clastic Mesozoic rock section contains numerous shaly zones which are very rich in organic matter, and also a suite of coal strata. This section, containing mainly type III kerogen, is the ideal gas generator. Maturity ranges from about 0.5% vitrinite reflectance to about 2.0% in the deeper part of the section. Maturity has also been defined in terms of the "Methylphenanthrene Index" which is based on aromatic hydrocarbons. Apparently the mature section is still in an active phase of hydrocarbon generation. Due to the tightness of the rocks, hydrocarbon transport mechanisms seem to be dominated by diffusion processes. The light hydrocarbon distribution patterns observed throughout the wells suggest a dynamic trapping mechanism. Light hydrocarbons are lost at the top of the mature hydrocarbon generating zone and are replenished in the middle part of the section where rich source rocks are found.

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Oxygen Isotopes as Index for Paleosalinity During Deposition of Pennsylvanian Marble Falls Limestone of Central Texas

One major goal of a depositional model is to portray variations in salinity across an ancient facies tract. Qualitative determination of paleosalinity gradients with whole-rock, oxygen isotope analyses of limestones is usually hampered by the effects of cementation and reequilibration with formation water at depth. Numerous characteristics of the Marble Falls Limestone make it ideal for facies analysis using isotopes. Burial did not exceed 1 km and the low vitrinite reflectance, averaging 0.30%, indicates cool temperatures. A closed system during stabilization is manifested in high strontium levels in calcite (2,000 to 5,000 ppm).

The Marble Falls was deposited on the Llano platform which was bordered on the east by the Fort Worth basin. An east-west sediment profile consisted of black spiculite, algal boundstone, oolitic grainstone, spiculitic wackestone, and calcareous shale. Carbonate mud within spiculite and boundstone of the foreslope environment is isotopically "marine" ($\delta^{18}O = -2.52 + 0.55$ per mil PDB, $n = 12$). The whole-rock composition of grainstone ($\delta^{18}O = -4.00 \pm 0.56$, $n = 10$) is in accord with a two-component mixture consisting of marine ooids and meteoric cement, supporting the contention that the platform rim was exposed. The high standard deviation of the del values for spiculitic wackestone from the platform interior ($\delta^{18}O = -3.76 \pm 1.24$, $n = 20$) is due to changing amounts of runoff from the Concho arch. Calcite within the shale, a marsh deposit, is depleted ($\delta^{18}O = -5.10 \pm 2.26$, $n = 2$).

It is rare to find limestone sequences with facies-specific oxygen isotopes because most have undergone complex cementation histories or burial-related recrystallization. In limestones known to have escaped burial, oxygen isotopes should be of great utility for paleosalinity determinations, when combined with other types of data.

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Sedimentology and Stratigraphy of Upper Mannville in Parts of East-Central Alberta

Thick (15 to 35 m) sandstones occur in the upper Mannville (Colony, McLaren, and Waseca Members, collectively about 45 m thick) over a substantial area (T35 to 65, R1 to 20W4) of east-central Alberta. The sandstones can occur in belts flanked by zones dominated by siltstones and shales. The upper Mannville is a continental sequence in this area and the thick sandstones have previously been interpreted as (1) deposits of a network of vertically aggrading, laterally stable channels, and (2) valley-fill deposits. Investigation of a densely drilled area in the Wainwright field (T45, R6W4) shows that the absence of two 2-m thick shales that separate three correlatable sandstones, 9 m, 4 m, and 5 m thick, results in a 20-m thick sandstone in one location. This suggests that the "thick" sandstones may be the result of the amalgamation of several sandstone sequences.

Trace-fossil evidence and lateral continuity of the uppermost