Mountain Tuff (35 m.y.) was ejected from the southern Sawatch Range and flowed up to 30 km east of the Front Range. The Oligocene Castle Rock Conglomerate forms an elongate, northwest-southeast, discontinuous band across the southern Denver basin. Cross-beds dip east and southeast. Thick tabular cross-beds and large granite boulders derived from the Front Range indicate torrential flood deposition. North to northwesterly dipping bedding, and up to 1,000-m vertical offsets between Front Range Wall Mountain Tuff outcrops and those in the Denver basin suggest significant post-Castle Rock uplifting of the Front Range.

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Sedimentology and Tectonic Implications of Oligocene Castle Rock Conglomerate, Southern Denver Basin, Colorado

The Oligocene Castle Rock Conglomerate, 70 m thick, trends northwest-southeast in an elongate discontinuous band (80 km long) across the central Denver basin from near Castle Rock to Calhan, Colorado. The conglomerate was studied to determine the depositional environment and any implications on the tectonic history of the southern Front Range. The Castle Rock Conglomerate is a nonmarine formation with large-scale cross-bedding. It contains angular slump blocks of Wall Mountain Tuff, some exceeding 2 m in length, as well as rounded boulders and cobbles of Front Range basement rocks. It fills valleys, up to 90 m deep, carved into the underlying Oligocene Wall Mountain Tuff and the early Tertiary Dawson Formation. The Castle Rock Conglomerate is interpreted as a deposit of a braided stream, possibly an ancestral South Platte River, which flowed in a broad valley toward the east then southeast.

Several tectonic implications were determined from this study: (1) the Front Range, after being eroded to a low plain in the Eocene, was regenerated after the middle Oligocene, as shown by structural offset of the Castle Rock at the edge of the Front Range, and by its interpretation as a restricted fluvial deposit rather than a broad fanglomerate; (2) the fluvial interpretation supports other suggestions that this formation resulted from the eastward diversion of the Rio Grande headwaters by the Thirtynine Mile volcanic field across the area which is presently the Front Range; and (3) north to northwesterly dipping beds, opposite to paleocurrents, indicate post-Castle Rock rotation of the Denver basin.

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Storm-Surge Ebb Deposits of Early Cambrian Shelf: Andrews Mountain Member, Campito Formation, Eastern California

The Andrews Mountain Member of the Campito Formation consists of complexly interbedded fine sands, siltstones, and mudstones that accumulated in an offshore, shallow-shelf setting. Deposition of these units was punctuated by short duration, high-energy flows that deposited crudely graded, hummocky cross-stratified sand beds. These flows are inferred to be the product of the ebb of large storm surges. The sedimentology of these units indicates a five-stage scenario for their formation. (1) Initial erosion and suspension of muddy fairweather substrates occur in response to long-period storm waves. (2) As an intense low-pressure system moves onshore, a sediment-charged return bottom flow is generated by a storm-surge ebb. This flow moves across the shelf and further erodes and entrains material. (3) As the competence and capacity of the flow are exceeded, fine sand is deposited as parallel laminated and hummocky cross-stratified units. (4) Rapid attenuation of the flow then leads to low-flow regime deposition of climbing ripples and small-current ripples. Where deposition occurs within storm wave base, upper parts of the beds are reworked into complex wave-current ripples and flaser bedding. (5) Soft-bodied, benthic communities recolonize muddy substrates with the resumption of fairweather conditions.

Rather than depositing sand sheets over extensive areas, multiple storm-surge flows are inferred to have incrementally moved sand across the shelf. In addition, thinning/fining-upward and thickening/coarsening-upward stratigraphic sequences may reflect changes in both the intensity of the flows and the proximity of a local sand source.

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Sedimentologic Aspects of Bioturbation in Abyssal Atlantic Ocean

Relations between bioturbation features and sedimentologic aspects of abyssal pelagic ooze and clay were investigated in 26 box cores collected in 1,400 to 5,700 m of water in the central and southern Atlantic Ocean. Sediment composition, texture, and core stratigraphy were compared with the occurrences of biogenic structures and other aspects of bioturbation to determine the sedimentologic factors that most affect burrow preservation and biologic mixing of abyssal sediment.

Box core surfaces typically exhibited a heterogeneous microtopography of mounds, lumps, trails, agglutinated tubes, and open holes. Benthic protists (foraminifera and xenophyophorids) and fecal strings of larger organisms were common. Remnants of shallow infaunal tunnel systems sometimes were evident on slightly washed box core surfaces. For example, *Paleodictyon* occurred in carbonate-rich ooze; *Cosmorhaphe* occurred in deposits containing 20 to 30% coarse fraction; and *Spirorhaphe* appeared to be cosmopolitan with respect to sediment type.

Sediments of the mixed layer (upper 5 to 8 cm) and underlying Holocene transition layer were compared with respect to carbonate, organic carbon, and coarse fraction ($> 62\mu m$) percentages. Transition layer sediments, which contained the most visible burrows, were much more heterogeneous in terms of carbonate content than mixed layer deposits. However, the heterogeneity of organic carbon and coarse fraction concentrations were roughly equivalent in the two horizons.

Visibility of specific burrows was highest in cores with low carbonate contents ($< 30\%$ $CaCO_3$) and also in cores from the Sierra Leone Rise, where sedimentation patterns appear to have changed following the last glacial stage. Burrow visibility was poorest in cores with high carbonate contents ($> 70\%$ $CaCO_3$) throughout the entire core.

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Anatomy of Modern Open-Ocean Windward Carbonate Slope: Northern Little Bahama Bank

The modern carbonate slopes in the northern Bahamas are classified as windward or leeward types along open oceans, open seaways, or closed seaways.

Morphologically the open-ocean windward carbonate slope, north of Little Bahama Bank, can be divided into upper and lower slopes. The upper slope is relatively steep (2 to 4°) and heavily dissected by numerous, roughly evenly spaced submarine canyons or gullies that display 50 to 100 m of relief. The seismic facies of this upper slope consists of parallel to subparallel reflectors. Core data indicate that most sediments on this upper slope, including those immediately adjacent to shallow-water reefs, are fine-grained periplatform oozes. Core data combined with 3.5 kHz PDR profiles reveal a gradual downslope decrease in the amount of submarine cementation. Where cementation is not an important factor, submarine sliding begins, probably due to overloading.

In contrast, the lower slope is a broad, smooth, relatively gentle (~ 1°) region with few canyons. The seismic facies here consists of chaotic/discordant to wavy, subparallel reflectors. Core data indicate a dominance of coarse-grained debris flow and turbidity current deposits, interlayered with minor pelagic sediments. Most of the coarse detritus in these sediment gravity flows was derived from the upper slope. Pelagic sedimentation, incipient submarine cementation, and mass movements interact to produce very coarse-grained material on the lower slope from initially fine-grained upper slope sediments. Numerous unlithified deep-water coral mounds are also present on the lower slope.

The morphology and sedimentary/seismic facies relations of this carbonate slope indicate sedimentation from a line source rather than a point source. In contrast to submarine fan development from a point source, base of slope sedimentation along a line source produces a broad apron of coarse sediment, gravity flow deposits on the lower slope paralleling the shelf/slope break. In terms of hydrocarbon exploration the lower slope sediment gravity flow facies appears to have the greatest potential as a reservoir.

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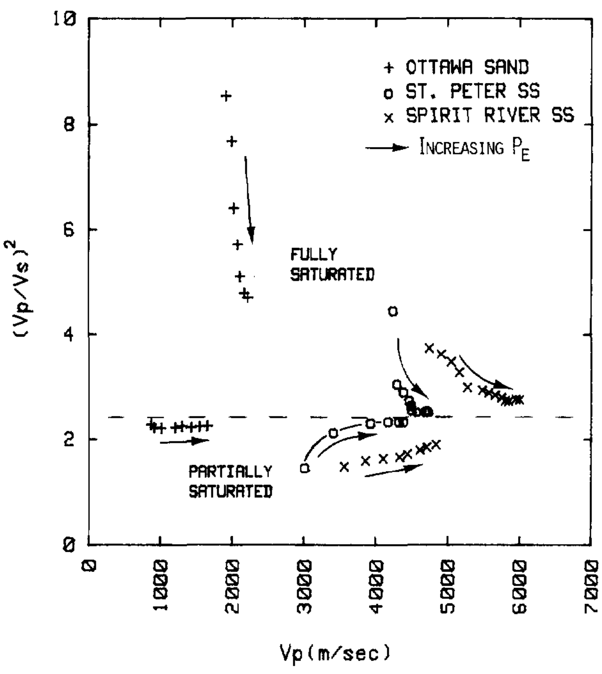
Diagenesis of Marine Sands to Tight Gas Sands: Effects on Acoustic and Hydraulic Properties



The primary stages of diagenesis of marine sands usually increase total grain contact area, increase the number of contacts, decrease porosity, and increase pore network tortuosity. These microstructural factors strongly affect the continuum acoustic and hydraulic properties of the sands. To better understand diagenetic effects on these properties, compressional and shear wave velocities, V_p and V_s, and their specific attenuation, $Q_p{}^{-1}$ and $Q_s{}^{-1}$, were measured in an unconsolidated quartz sand (Ottawa sand, porosity ≈ 35%), a quartzarenite sandstone (St. Peter sandstone, porosity ≈ 22%), and a lithic-quartz arenite (Spirit River tight gas sand, porosity ≈ 5%). Measurements were made under effective pressures, P_e, up to 350 bars as a continuous function of partial gas saturation, at frequencies from 10 to 15,000 Hz, and from 150 to 500 kHz. Experimental results are explained with relations derived from contact and packing theories. Results suggest that V_p/V_s and $Q_p{}^{-1}/Q_s{}^{-1}$ may be used to distinguish between gas and consolidation effects in reflection seismology and borehole sonic logs. Gas permeability was also measured in Spirit River tight gas sands from the Alberta Deep Basin as a function of effetive pressure and partial gas saturation. These values are compared with known values for quartz sands and sandstones, and the results are examined with simple pore network models. While porosity decreases by a factor 7 from Ottawa sand to Spirit River sandstone, gas permeability drops by as much as 8 orders of magnitude. Gas permeability in all granular sedimentary materials, especially the tight sands, is a strong function of clay content, partial gas saturation, and effective pressure.

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Relation of Calcite Cementation and Uranium Mineralization in South Texas

Host sandstones for uranium ore in the Miocene Oakville Formation commonly show strong calcite cementation. These hard, limy ledges are found in the area of the mineralization front and over the barren interior. They commonly occur at the top and the base of the host sandstone body, while the sand in between is only slightly calcareous and highly permeable. Outside the mineralization front, in chemically reduced zones, cementation is less pronounced or absent.

Precipitation of calcite cements occurred both before and after uranium mineralization, and has replaced some of the framework mineral grains. Uranium is usually found in the uncemented part of the sand; in only a few places is it in direct contact with calcite.

Carbon isotope values of the cements are interpreted to indicate that the carbon is the result of contribution from organic matter. Calcite in the highly cemented zone (>30% calcite) has δC^{13} values of − 11 to − 20 ppt whereas values in the slightly cemented sands of the proto-ore and altered interior range from 0 to −5 ppt. The light carbon in these cements associated with the uranium ores probably entered the sediments as light hydrocarbons associated with the H_2S which precipitated pyrite. Pyrite has been documented in other south Texas deposits as resulting from H_2S generation in the Edwards Limestone at depth with subsequent migration.

It appears that the occurrence of calcite cement is genetically related to the emplacement of uranium ore. The distribution of limy ledges, which can be mapped from electric logs, elucidates the geologic history of a uranium deposit and serves as an aid in exploration.