mineralogy. For example, the porous but smooth surface of an echinoid (magnesian calcite) dissolves much more slowly than aragonitic coral and gastropod grains, which have more complex microstructures.

The presence of dissolved magnesium enhances rates of dissolution, but does not strongly affect the relative reactivity between different grain types. The absolute dissolution rates show a strong progressive decrease in magnesium-depleted solutions.

Thus, assumption of mineralogic control over grain reactivity during early diagenesis is an oversimplification. Microstructure and solution chemistry emerge as important variables with predictive power for modeling both porosity development and diagenetic evolution within carbonate sequences.

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Diagenetic Fabric and Structures in Ordovician Slope Limestones

The very thin continuous bedding characteristic of the calcareous Ordovician slope sediments from western Newfoundland and Virginia is not a primary depositional fabric but a severe diagenetic modification caused by extensive physical compaction and pervasive pressure solution. The very thin-bedded (0.1 to 0.5 cm) units commonly are only 20 to 30% carbonate, but occur in a sequence with thicker (1 to 20 cm) limestone turbidite layers.

Some groups of very thin layers thicken laterally into elongate limestone lenses composed of quartzose, peloidal, and radiolarian-sponge spicule packstone to wackestone. Layers in the lenses have a primary depositional fabric. Each layer thins away from the lens by 50 to 80%, but is generally traceable for over tens of meters or from lens to lens where they are repetitive along bedding. As a layer thins away from a lens, fine carbonate is lost and peloids and most other carbonate grains are partly to completely pressure solved against more resistant grains or along fine solution seams. Radiolaria become crushed and spicules reoriented from essentially random to parallel with layering. Individual layers are commonly traceable from lens to lens with no change in amount of insoluble quartz, spicules, or other resistant grains.

The thickened layers associated with limestone lenses are interpreted to be remnants of once-continuous layers that have been dramatically thinned through pervasive pressure solution.

Further, there are numerous very thin layers that cannot be traced into a thicker limestone-rich zone. These layers are very similar to those which pass into thicker lenses. It is very probable that each of these layers is a remnant of a once much thicker carbonate-rich layer.

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Quaternary Mixing-Zone Dolomite, Eastern Yucatan Peninsula

Dolomite occurs in Pleistocene limestones a few meters below the water table on the eastern margin of the Yucatan Peninsula. It is present in five of seven cores (surface to depth of 11.5 m) which penetrate three stratigraphic units, the youngest of which is dated at 122,000 years B.P. Each unit consists of platform-margin reefs and back-reef facies, and there are no indications of evaporites or restricted conditions during deposition.

The most extensive dolomitization (up to 48 wt. %) is in the only reef-facies core from the middle unit. This core is calcite and dolomite in contrast to three cores in the back-reef facies which are calcite and aragonite. Dolomite occurs in a variety of forms including: (1) coarsely and finely crystalline pore-lining cement, (2) finely crystalline replacement of matrix and bioclasts, and (3) internal sediment in dissolution cavities. Most of the dolomite cement is precipitated in molds of aragonitic fossils. There are three types of dolospar cement: (1) limpid euhedral to subhedral crystals ($Ca_{57}\,Mg_{43}\,CO3_{100}$), (2) zoned crystals of dolomite and calcian dolomite ($Ca_{63}\,Mg_{37}\,CO3_{100}$), and (3) corrugated layers of alternating calcian dolomite and calcite. The calcian-dolomite layers in the zoned crystals and in the corrugated layers are partly dissolved. Typically, adjacent pores within the same sample contain different types of dolomite and dolomite-calcite intergrowths.

The complex mineralogy of the middle unit is evidence that this limestone was subjected to several changes in phreatic-water geochemistry. Concurrent work by Hanshaw and Back demonstrated the existence of a geochemically active and fluctuating phreatic environment in the zone of freshwater and seawater mixing immediately inland from the Yucatan coastline today. Similar mixing zones must have passed through the Pleistocene limestones during past sea-level changes. The geologic setting, textures, and mineralogy of these young limestones suggest that their complex variety and occurrence of dolomite is best explained by mixing-zone diagenesis.

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Hydrologic Setting, Occurrence, and Significance of Gypsum in Late Quaternary Salt Lakes, South Australia

Well-exposed, commonly laminated gypsum sequences occur in many Quaternary salt lakes in southern South Australia. The gypsum in the salt lakes is classified by increasing grain size into gypsite, gypsarenite, and selenite. The salt lakes are classified by age and hydrologic setting into (1) coastal salinas which are Holocene seawater-fed ground water lakes, and (2) continental playas which are late Pleistocene endorheic basins. A study of the relations between coastal salina hydrology and the associated gypsum deposition has shown that different types of gypsum form under distinct hydrologic regimes. As the hydrology above a coastal salina depositional surface changes through time, so does the type of gypsum deposited. Application of a gypsum depositional model derived from a study of the coastal salina gypsum to those parts of a continental-playa gypsum unit where deposition is no longer occurring confirms the applicability of the model to non-salina gypsum deposits.

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Early Carbonate Fabrics in Silurian Reefs of Gotland, Sweden

The Hogklint reefs of Gotland occur within a shallowing-upward sequence and are developed in the outer zones of a carbonate wedge adjacent to a shale belt. Shoal and peritidal sequences are the major carbonates which occur in the inner parts of the wedge and are preferentially associated with erosion surfaces.

The Hogklint reefs show carbonate fabrics that are inferred to indicate synsedimentary marine cementation of the reefs. These fabrics are: (1) pseudofibrous calcites that are believed to have replaced acicular/fibrous cements with original aragonite and/or Mg-calcite mineralogy, (2) pelmicsparite-pelmicrite areas, (3) stromatolite-like crusts, and (4) early micritic cements. The reefs also show evidence of subaerial exposure by the occurrence of erosion surfaces at the top of the reefs, dissolution cavities, and vadose crystal silt infills in cavities in the algal biofacies which cap the reefs.

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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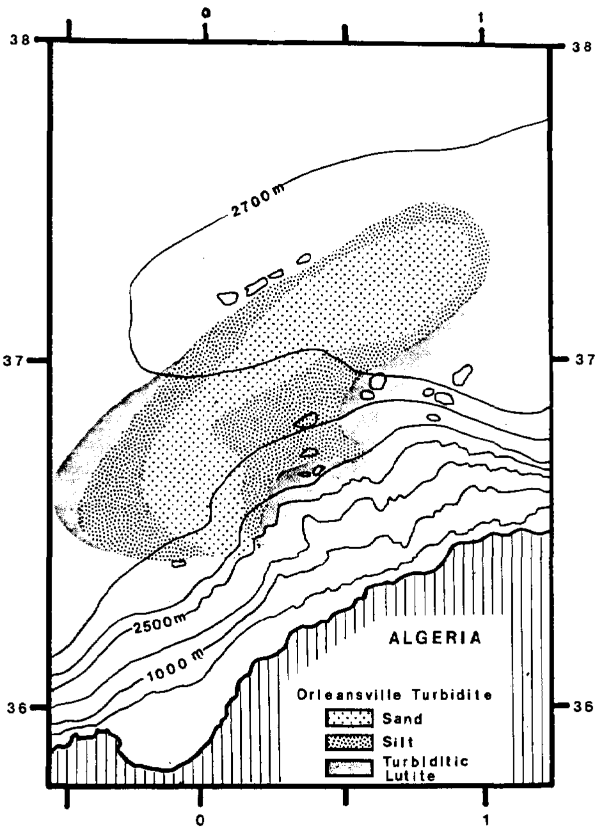
Orleansville Turbidite

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.