geologic settings. Case studies illustrate the type of information that can be extracted from seismic data on carbonate rocks, including North Sea chalk, fractured limestones in Venezuela, and porosity development in regional limestones of western Canada. In the North Sea, 2 adjacent structures that appear similar on conventional seismic sections display porosity development and fluid content changes within the chalk reservoir on the Seislog section. In a South American example, the Seislog display demonstrates the ability of seismic data to locate vertical fracture zones. In western Canada, secondary porosity development within Devonian carbonates was identified on Seislog displays, which led to the extension of a gas field. Examples from southeast Asia display a variety of depositional environments in Miocene sediments. Shallow-marine and shoreline sands can be identified in a Malaysian example. An example from the Natuna Sea displays a lower delta-plain setting, with regional shale markers and thick clastic packages. An upper delta-plain example (Gulf of Thailand) displays more faulting, expansion of clastic packages, and discontinuous channel sands.

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Recognition of Paleosilcretes: Example from North Texas

Recognition of fossil silcretes may be hampered by weathering, erosion, or subsequent burial. Silcretes develop during periods of exposure and nondeposition and can represent cumulative sedimentation for geologically important periods of time.

The basal Cretaceous conglomerate in north Texas (Antlers and Twin Mountains formations) was deposited and lithified on the Wichita paleoplain. The silcrete formed in a tropical climate without seasonal variation. Outcrops are sporadic yet widespread and topographically prominant. The rock is a quartz and chert-pebble conglomerate with a variety of silica cements. It is recognized as a silcrete by the following criteria. (1) Both the detrital and authigenic components are composed primarily of silica. (2) Vadose quartz overgrowths are found in association with phreatic chalcedonic cements. Vadose silt occurs with both cement types. Zonation within the cements suggests intermittant cementation. (3) Reworked cemented grains indicate syndepositional cementation, necessarily a surface phenomenon. (4) Petrified wood is abundant. Abraded petrified wood further suggests recurring silicification and transportation.

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Shelf Sedimentation Across Precambrian-Cambrian Boundary: Chapel Island Formation, Southeastern Newfoundland

The upper Precambrian–Lower Cambrian Chapel Island Formation consists of medium- and fine-grained siliciclastics and minor limestones that record the early evolution of shelly fossils and complex trace fossils. Deposition of these Avalonian sediments occurred in a variety of shelf environments. Temporal and spatial changes in the conditions of sedimentation during the deposition of this sequence resulted in a wide spectrum of sedimentary and biogenic structures.

Facies transitional with underlying terrestrial and shallow-marine red beds were deposited in foreshore and upper-shoreface settings under tidal influence and display tidal channels, shrinkage cracks (desiccation and synaersis), abundant current ripples (bimodal-bipolar current distribution), and phosphatic nodules.

Sandstones and siltstones deposited in shoreface to outer-shelf settings contain evidence of storm and wave reworking. Features present include: gutter casts, thin granule lag zones, phosphate nodules, slump-fold zones, hummocky cross-stratified beds, and thin to medium-grained sandstones with sharp bases and gradational tops, wave-rippled upper surfaces, climbing wave ripple laminations, and draping laminations. These features indicate deposition on a storm- and wave-dominated shelf with locally variable topography. Thick massive siltstone beds and pebbly mudstones are interpreted as debris flows formed on a gentle slope.

Red and green mudstones, nodular limestones, and medium to thick (up to 60 cm) limestones were deposited during periods of low siliciclastic input. The limestone beds—micrites to packed biomicrites—contain oncolitic and planar stromatolites, sheet-crack cavities (containing the oldest known coelobiontic fauna), iron-manganese encrusted surfaces, authigenic barite, mudcracks, intraformational and extraformational conglomerate layers, and small channels. These are interpreted as intertidal and supratidal deposits.

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Fission-Track Dating and Its Application to Thermal History of Sedimentary Basins

Fisson tracks are zones of intense damage formed when fission fragments of ^{238}U pass through a solid. Spontaneous fission of ^{238}U takes place at a constant rate. Therefore, the age of a mineral can be calculated by determining the number of tracks and the amount of uranium the mineral contains. Once formed, fission tracks are stable in most minerals at temperatures below about 80°C. However, if a mineral is heated to a high enough temperature, the tracks fade and disappear, resulting in an anomalously young fission-track age. The temperature at which this "annealing" occurs depends on the mineral and the duration of heating.

The two minerals most commonly used in fission-track annealing studies are apatite and zircon. Fission tracks in apatite are totally annealed at temperatures of about 150°C to 105°C over periods of 10^5 to 10^8 yr, respectively. Annealing temperatures of fission tracks in zircon are not as well known, but are probably in the range of 200°C ± 25°C for heating lasting longer than 10^6 yr. The annealing temperatures of apatite and zircon span the main temperature range of oil generation, and both minerals are present in the heavy-mineral suites of many sediments. Consequently, fission-track dating is a valuable method for studying the time-temperature history of sedimentary basins.

In the southern San Joaquin Valley, California, fission-track ages of apatite from drill-hole samples of Eocene to Miocene sandstones suggest that sediments in the rapidly subsiding basin northwest of the active White Wolf fault have been near their present temperature for about 10^6 yr, whereas those in the Tejon platform southeast of the fault have been near their present temperature for about 10^7 yr. These estimates agree with estimates based on other thermal history indicators in these rocks.

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In-Situ Rock/Water Geochemistry of Holocene Radial and Tangential Ooid Sediment, Baffin Bay, Texas

The crystal fabric in ooids from the shoreline of Kleberg Point (Baffin Bay) is predominantly tangentially oriented aragonite; however, multiple fabric elements (radial and tangential crystals) occur in ooids with mineralogies of both aragonite and 10.3-mole % magnesium calcite. Aragonite occurs as both radial and tangentially oriented crystals, whereas, high Mg-calcite exists only in a radial crystal orientation. High Mg-calcite occurs as an outermost coating surrounding aragonite, and also as an envelope about aragonite that encloses quartz nuclei.

Seasonal diurnal measurements were made in ambient bay water and water in the ooid sediment. Cyclic diurnal changes occurred in both the ambient and pore water, with the largest change occurring during the summer. Measured extremes for the summer ambient waters are: day = 32.7°C, pH of 8.22, Alk_C of 3.14 meq, and H_2CO_3* of $10^{-5.07}$; and night = 28.3°C, pH of 8.11, Alk_C of 2.54 meq, and H_2CO_3* of $10^{-4.88}$. Chlorinity (27.93 o/oo), $A_{Ca^{2+}}$ (2.7×10^{-3} moles/L), and $A_{Mg^{2+}}$ (2.8×10^{-2} moles/L) showed little diurnal variation. Aragonite saturation was greatest during the day with $\Omega_{ARAG\text{-}ambient} = 3.25\text{-}1.95$; and $\Omega_{ARAG\text{-}pore} = 4.07\text{-}2.52$. Both pH and Alk_C decrease with depth, whereas H_2CO_3* increases. The Ω_{ARAG} increases in the uppermost 10 cm of sediment and decreases with depth. Both ambient and pore waters are supersaturated with respect to a 10.3-mole % Mg-calcite.

Maximum ΣCO_2 in the ooid sediment occurs during the mid-afternoon, and increases with increasing sediment depth. A decrease in H_2CO_3*, produced through respirative processes with increasing sediment depth, indicates that precipitation is taking place in the sediment column, as the greater proportion of H_2CO_3* with increasing sediment depth is caused by precipitative processes. The differing mineralogy and ooid fabric is a product of changes in both water chemistry and energy.