through submarine canyons incised in the shelf margin, and (3) redeposited carbonate sediment derived from shelf-margin buildups.

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Sea Gullies and Development of Linear Conglomeratic Units

Sea gullies are localized dissections of California borderland upper basin slopes; the gullies form groups, covering distances of 10 to 16 km off points and narrow shelves. Gullies have youthful "V" cross-sectional profiles and relief of less than 100 m; they may extend to basin floors, creating small, coalescing submarine cones.

Gully development is attributed to subaerial stream erosion during eustatic sea-level lowering and outer-shelf exposure. Also, during rapid regional uplift, shelves become narrower and short, steep streams characteristic of immature drainage patterns prograde across shelves, depositing unstable coarse debris near the shelf break. Differential relief, overburden instability, and earthquakes trigger subaqueous mass flows, creating gullies by headward sapping; and at the base of slope, linear aprons of coarse conglomeratic debris accumulate.

Four stages of nearshore basin deposition are recognized in the lower Capistrano Formation (upper Miocene, Mohnian) at Dana Point, California. Basal deposits of fine siltstones, sandstones, and diatomite represent abyssal deposits. These are overlain abruptly by conglomerates interbedded with structureless coarse sandstones, superseded by graded sandstones and siltstones interpreted as mid-submarine-fan deposits.

Basin subsidence, tectonic activity, and increased erosion climaxed during the late Miocene. Conglomeratic debris flows are also associated with sinistral-coiled *Globigerina pachyderma,* indicating the late Miocene N-17 period of glaciation and possible sea-level lowering. Coarse debris accumulated near the shelf break, and gullied submarine slopes developed. Undermining through liquefaction caused debris flow down these gullies; the flows "froze" at the abrupt slope/basin junction, forming linear, composite conglomerate units. Overlying fan sequences reflect basin maturity dominated by canyon point sources.

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Shallow-Water Carbonate and Evaporite Sedimentation Patterns in Lower and Middle Jurassic Rocks of Southern Tunisia

The Lower and Middle Jurassic rocks in southern Tunisia can be divided on the basis of lithology into two distinct regions, the central and northern provinces.

Outcrops in the central province extend in a continuous escarpment south from the Wadi Tatahouine and display a variety of carbonate and sulfate rock types representing very shallow-water deposition. The Lower Jurassic and lower Middle Jurassic Mestaoua Formation is a largely gypsiferous sequence representing deposition in lagoons and on hypersaline shotts. The overlying Bathonian Krachoua Formation displays a range of carbonate lithologies, representing shoreline and tidal-flat environments, and sulfate units, again indicative of gypsiferous lagoons and shotts.

These formations pass northwestward into massive and laminated carbonate strata indicative of deposition on extensive wind-tidal flats. This is the northern province. The lower part of the sequence, the Semoumenia Breccias, is composed of breccias believed to have resulted from evaporite-solution processes. This sequence passes into clastic facies, the Sidi Stout Sandstones (an accumulation of wind-blown sand dunes), toward the Permian outlier of Djebel Tebaga.

Paleogeographic reconstructions show that the area preserves part of the carbonate shoreline sequence which acted as the sill separating a true marine area on the northeast, Tethys, and the Algerian-Tunisian salt basin on the southwest. Periodic marine incursions into the margin of this salt basin are suggested by the presence of extensive storm deposits.

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Devonian Organic-Rich Black Shales in Subsurface Pennsylvania—Stratigraphy and Natural Gas Production

The basal sediments of the Devonian clastic wedge in Pennsylvania consist of a series of black, radioactive, organic-rich shales interbedded with non-black shales and siltstones. Three major black shales are present in the subsurface as indicated by stratigraphic cross sections. These units are the Middle Devonian Marcellus shale facies, and the Upper Devonian Rhinestreet, and Dunkirk shale facies. Mapping of these facies indicates that they are distributed in three generally overlapping belts paralleling the regional strike. The Marcellus facies attains its maximum development in the eastern Appalachian Plateau. This unit, the oldest and deepest of the Devonian black shales, has had numerous shows of gas in wells drilled through it. However, gas has not been produced from it in commercial quantities. The Rhinestreet facies is best developed in the northwest. It is younger and shallower than the Marcellus and has produced commercially from wells in Beaver County. The Dunkirk facies is restricted to the northwestern part of the state where it reaches its greatest accumulation along the margin of Lake Erie. This youngest and shallowest of the major black shale facies has produced commercially since the early 1800s. All three facies have the potential to produce natural gas in commercial quantities. However, owing to drilling economics, the Dunkirk facies appears to have the most immediate potential because of its shallower depths and production history. The Rhinestreet facies is also considered to have immediate potential. The Marcellus facies does not appear to be an attractive primary target at this time because of its great depth, but it could be a good secondary drilling objective.

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Anatomy and Growth History of Holocene Ooid Shoal

Facies anatomy of the Joulters ooid shoal is strikingly