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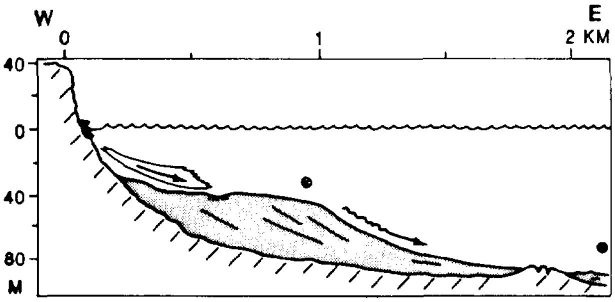
Downslope Transport on a High-Energy Shoreface: Evidence From Eastern Australia

Large shore-parallel sand bodies on the lower shoreface of the embayed and cliffed coast of central New South Wales, Australia, provide indirect evidence of downslope transport of sand. These sand bodies are 10 to 30 m (33 to 100 ft) thick, extend discontinuously for 40 km (25 mi) along the coast, and add a pronounced convexity to the shoreface profile.

Evidence from surface samples, deep borings, and side-scan sonar and high-resolution seismic reflection profiling from the sand bodies indicates that deposition occurred by downslope transport of sand from the upper shoreface and surf zone. The sand bodies consist entirely of locally derived quartz sand intermixed with marine mollusk fragments and microfauna. The internal acoustic structure of the sand bodies indicates growth by seaward progradation; the seaward face, or foreslope, locally attains a slope greater than 5°. Surface morphology indicates coalescing of individual sediment lobes and damming of bedload sediment against bed-rock ridges at the toe of the sand body in water depths of 70 to 80 m (230 to 262 ft). Channels and individual sediment lobes oriented normal to the shoreline also indicate seaward transport.

On this coast, the sea level reached its present position 6,000 years ago, and these sand bodies were produced by high-energy conditions on a steep shoreface during the stillstand period. Average waves here are 1 to 2 m (3 to 6.5 ft) and storm waves are much higher. Radiocarbon dates from analogous sand bodies elsewhere in New South Wales suggest continuous seaward progradation and upbuilding since the cessation of sea level rise. No direct observations or measurements of downslope transport are available, but we infer that sand derived from along the coast or the cliff face is gradually reworked seaward on the steep upper shoreface during fair-weather conditions. During storm periods, sand is flushed seaward by returning bottom flows onto and across the surface of the sand body.



In addition to downslope transport of sand to deeper watei, there is strong evidence of concurrent modification of the sand bodies by processes acting parallel to the shoreline. This evidence consists of textural trends, shore normal sand waves, and the overall alongshore continuity of the sand bodies.

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Sediment Failure on Continental Shelf: Response to 1980 Earthquake off Northern California

On November 8, 1980, a large magnitude earthquake (M ~ 7) occurred 60 km (37 mi) off the coast of northern California. Damage was minimal onshore, but extensive changes to the sea floor were reported from the area of the Klamath River delta. Data from three successive surveys conducted in the area at intervals of 1, 6, and 11 months after the shock demonstrate the extent and type of sea floor failure. Side-scan sonar and high-resolution seismic reflection profiles, together with sea floor photographs and video images, define a thin (< 15 m, 49 ft) failure zone that measures 1 × 20 km (0.6 × 12.5 mi) and trends parallel to the shoreline on the shallow (~60 m, 200 ft) and nearly flat (~0.25°) surface of the Klamath River delta. The failure zone is characterized by a very flat (~0.02°) terrace that is mantled by silty sand and is bounded to seaward by an irregular 1 to 2 m (3 to 6.5 ft) high scarp.

Sonographs and bottom photographs provide evidence that failure occurred by liquefaction, lateral spreading, and sediment flow, producing various sediment patterns and relief features on the sea floor. The modes of failure with their corresponding features are: (1) liquefaction—identified from side-scan sonographs showing sand boils 5 to 25 m (16 to 82 ft) in diameter; (2) lateral spreading—identified from photographs and sonographs showing a prominent, nearly continuous, blocky, chaotic scarp at the seaward terminus of the failure zone and belts of small (10 m long, 0.5 m high; 33 ft long, 20 in. high) pressure ridges seaward of the scarp; and (3) sediment flow—identified from sonographs showing both (a) overlapping rhythmic flow deposits that become more irregular in a seaward direction as flow became progressively less mobile, and (b) flow "windows," or voids, left by highly viscous, dewatered flows.

In addition to these large- and small-scale changes to the morphology of the sea floor on the Klamath River delta, the sediment failure resulted in several distinctive phenomena. These phenomena include a net seaward translation of sand, a reported temporary decrease in the abundance of Dungeness crabs, and plumes of gas venting into the water column that were still evident 11 months after the earthquake.

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Comparison of Depositional Systems and Reservoir Characteristics of Selected Blanket-Geometry Tight Gas Sandstones

Future development of gas in tight sandstones is highly dependent upon price and the state of technology, including detailed understanding of internal and external reservoir geometry. Part of the tight gas resource lies in blanket-geometry, siliciclastic sandstones; over 30 such sandstones in 16 sedimentary basins and at depths mostly less than 10,000 ft (3,000 m) were reviewed for the Gas Research Institute. Emphasis was placed on depositional systems and resulting lithogenetic facies as an important control on sand body geometry.

In contrast to lenticular sandstones, blanket-geometry tight gas sandstones were deposited as deltaic, barrier strand plain, and shelf systems. Overlap occurs between systems, as in the case of a strand plain developed marginal to a deltaic depocenter. Not all parts of all sandstones are tight (< 0.1 md permeability); tight areas vary from extensive ("J" Sandstone, Denver basin) to very limited (Hartselle Sandstone, Black Warrior basin). Five stratigraphic units were selected from which developments in reservoir characterization, fracture treatment, and other technologies can likely be extrapolated to a wider group of tight gas reservoirs.

The Travis Peak Formation (East Texas basin/North Louisiana salt basin) is a fan delta system. It ranges in depth from 3,000 to 11,000 ft (900 to 3,350 m), with net pay of 30 to 86 ft (9 to 26 m) and post-stimulation gas flows of 500 to 1,500 MCFGD. The Frontier Formation (Greater Green River basin) is a wave-