Chapter 6

Clastic Shore-Zone Systems

Introduction

The shore zone (Fig. 6-1), excluding deltas, comprises the narrow, high-energy transitional environment that extends from wave base at a highly variable depth averaging 35 ft (10 m) to the seaward edge of the alluvial coastal plain, raised terrace, or cliffs. Although restricted in area, migration of shorelines through time has resulted in widespread shore-zone deposits in the rock record, with considerable bearing on the distribution of hydrocarbon, coal, and uranium resources.

Beaches, barriers, lagoons, and tidal flats may be component facies of other depositional systems, such as deltas, or they may in combination constitute independent shore-zone systems. In either case, their prime characteristics stem from marine inundation or reworking, as distinct from direct fluvial influx. Shore-zone systems are supplied by longshore transport of river-derived sediments, onshore transport of shelf sediments, erosion of local headlands, residual concentration, and by small coastal streams. Sands are concentrated in barrier-island complexes and low-tidal and subtidal sandbodies with finer sediments to landward, or they may accrete directly on the mainland as strandplain beaches (Fig. 6-2).

The characteristics of depositional coasts, as opposed to elevated coastlands undergoing erosion, vary in response to two fundamental energy factors: waves and tidal currents. Both of these factors are directly related to tidal range (Hayes and Kana, 1976, p. 35–37). Wave effectiveness is inversely related to tidal range because, with increasing range, wave energy is dispersed over a greater width of shore zone during each tidal cycle. Distribution of coastal features associated with the three tidal range categories (Fig. 6-3) shows the greatest proportion of barrier islands and related environments along microtidal coasts of 0–2 m (0–7 ft) tidal range, which tend to be wave dominated (Hayes, 1975). Tide-dominated or macrotidal coasts (4–6 m; 13–20 ft) show flaring estuaries with linear sand ridges. Mixed-energy or mesotidal coasts (2–4 m; 7–13 ft) have intermediate characteristics with stunted barrier islands and extensive tidal flats or marshes (Fig. 6-4).

Shoreline configuration and nearshore bathymetry can impart considerable local variation in the relative effectiveness of waves and tides. The brunt of the wave energy is expended on headlands and open coast, decreasing in embayments, where tidal effects are enhanced (Price, 1958). Broad shelves and shallow nearshore profiles similarly dissipate wave energy while increasing tidal range (Redfield, 1958).

Along modern coasts there is a complete range in variation among wave-dominated deltas (Chapter 5), barrier islands, and strandplains. Systematic coastwise changes from active or inactive deltaic protuberances through strandplains and transgressive barriers to regressive barriers reflect the interaction between sediment supply and nearshore energy. Inactive deltaic headlands are flanked by transgressive barriers followed by regressive barriers formed in interdeltaic bights (Morton, 1977, 1979). Similar lateral relationships are documented in the rock record (Fig. 14–17, for example). In ancient deposits it is generally not possible to distinguish among the deposits of wave-dominated deltas, strandplains, and regressive barriers on the basis of vertical sequence alone (Fisher and Brown, 1972); isolith or cross-sectional delineation of sandbody geometry, or environmental interpretation of landward bounding facies, is necessary, in addition.

Shore-zone sands are characteristically, but not invariably, quartzose and may be practically monomineralic. Depending upon provenance, other lithologies, such as volcanic rock fragments, may be the predominant grain types. Nonquartz material, with the exception of resistant heavy minerals such as zircon, tourmaline, and rutile, tends to be removed by breakdown of the less stable minerals and winnowing of fines. Increase in compositional and textural maturity depends on prolonged recycling by waves and currents,
and continued grain abrasion during to-and-fro tidal transport can produce supermature rounding (Balazs and Klein, 1972). Interfingering of ancient marginal marine and coeval alluvial deposits is commonly accentuated by pronounced lithological contrasts between quartz arenites and the less mature sandstones updip (Ferm, 1974). Where fluvial systems supply quartzose sediment, this lithological distinction of ancient shore-zone is less clear (Vos, 1977). Some shore-zone deposits consist entirely of gravel-sized material, with fabric and bedding characteristics that distinguish it from alluvial gravel (Clifton, 1973).

Barrier-island and strandplain sand bodies are prime targets for petroleum exploration, with excellent primary porosity and high permeability. Landward and seaward interfingering with fine-