

SEQUENCE STRATIGRAPHY AND CARBONATE--SILICICLASTIC MIXING IN A TERMINAL PROTEROZOIC FORELAND BASIN, URUSIS FORMATION, NAMA GROUP, NAMIBIA

BEVERLY Z. SAYLOR

Department of Geological Sciences, A.W. Smith Rm. 112, Case Western Reserve University, Cleveland, Ohio 44106, U.S.A.

ABSTRACT: Superb three-dimensional exposures of mixed carbonate and siliciclastic strata of the terminal Proterozoic Urusis Formation in Namibia make it possible to reconstruct cross-basin facies relations and high-resolution sequence stratigraphic architecture in a tectonically active foreland basin. Six siliciclastic facies associations are represented: coastal plain; upper shoreface; middle shoreface; lower shoreface; storm-influenced shelf; and pebble conglomerate.

Siliciclastic shoreface facies pass seaward into and interfinger with facies of an open carbonate shelf. Four carbonate facies associations are present: mid-shelf; shelf crest; outer shelf; and slope. Facies are arranged hierarchically into three scales of unconformity-bounded sequences. Small-scale sequences are one to tens of meters thick and span a few thousand years. They consist of shelf carbonate with or without shoreface siliciclastic facies near the bottom. Medium-scale sequences are tens of meters thick and span a few hundred thousand years. They consist of shoreface siliciclastic facies in their lower parts, which grade upward and pass seaward into shelf carbonate. Large-scale sequences are tens to hundreds of meters thick and span 1 to 2 million years. They are identified by widespread surfaces of exposure, abrupt seaward shifts in shoreface sandstone, patterns of facies progradation and retrogradation, and shoreline onlap by medium-scale sequences.

Patterns of carbonate--siliciclastic mixing distinguish tectonic from eustatic controls on the evolution of large-scale sequences. Characteristics of eustatically controlled large-scale sequences include: (1) basal unconformities and shoreface sandstone that extend across the shelf to the seaward margin; (2) retrograde carbonate and siliciclastic facies belts that onlap the shoreline together, symmetrically, during transgression; and (3) upper shoreface sandstone that progrades seaward during highstand. In contrast, tectonically controlled sequences feature: (1) basal erosion surfaces and upper shoreface sandstone that are restricted to near the landward margin and pass seaward into zones of maximum flooding; and (2) asymmetric stratigraphic development characterized by landward progradation of carbonate from the seaward margin coincident with backstepping and onlap of the shoreline by siliciclastic facies. A two-phase tectonic model is proposed to account for the stratigraphic asymmetry of tectonically controlled sequences. Increased flexural bending during periods of active thrust loading caused submergence of the seaward margin and uplift of the landward margin. Rebound between thrusting episodes flattened the basin gradient and submerged the landward margin, causing expansion of carbonate facies from the seaward margin and simultaneous transgression of the landward margin. Although the two-phase model should apply to single-lithology successions deposited in active foreland basins, the mixing of carbonate and siliciclastic facies provides a particularly sensitive record of tectonic forcing. The sensitivity may be sufficient for medium- and small-scale sequences to record higher-frequency variations in flexural warping.