

PS Facies Stacking Patterns in a Late Jurassic Bahama-Type Platform Interior,
Dinaric Platform, Croatia*

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Abstract

The immense, several kilometers thick Bahama-type carbonate platform of the Dinarides was initiated in the Permo-Triassic as a portion of a land-attached Tethyan platform (Fig. 1). It developed into a Jurassic-Cretaceous isolated platform following breakup of the Adria microcontinent. Well exposed Mesozoic sections along the Dalmatian coast (S. Croatia) reveal the detailed stacking patterns of facies within the Late Jurassic (Tithonian) shallow platform interior (over 700 m thick). Subsidence rates (Fig. 2) during the Tithonian were relatively rapid (12-15 cm/k.y.) slowing to 6 cm/k.y. in the Early Cretaceous (Berriasian-Valanginian), and decreasing even further (1-3 cm/k.y.) from the Hauterivian to Aptian.



Fig. 1. Locality map of the study area. Northwest to southeast trending oval outline shows extent of Dinaric platform, superimposed on the geographic map of Croatia and environs (modified after Velic et al., 2002). Platform is approximately 700 kilometers long.

Facies of parasequences, 2 to 3 m thick (Fig. 3), include deeper lagoon dasyclad wackestone, oncoid wackestone, shoal-water skeletal or ooid packstone and grainstone, restricted lagoon lime mudstone, tidal flat microbial laminites and fenestral carbonates; transgressive, periodically emergent radial-ooid grainstone is common locally. Sections consist of 8-15 meter thick parasequence sets roughly 100 k.y. duration based on long-term accumulation rates (Fig. 4). Lower Tithonian sets are dominated by thick subtidal parasequences passing up into thin, more shallow water parasequences. Upper Tithonian sets also have thick subtidal parasequences in lower parts passing up into thin muddy peritidal parasequences with oolitic bases and microbial laminate caps. Estimation of water depths using the fenestral/microbial carbonate as a sea-level datum, show that the subtidal facies had overlapping depth ranges, implying mosaic-like facies patterns.

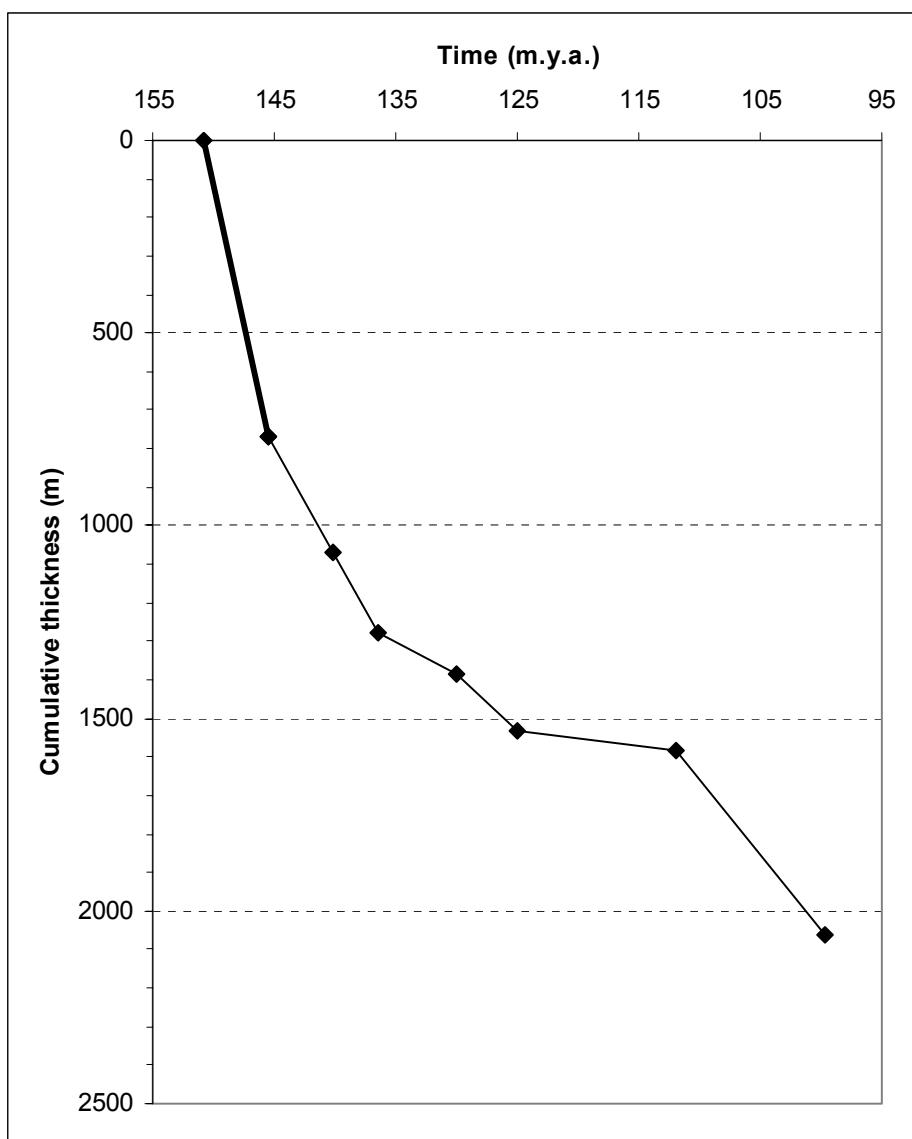


Fig. 2. Accumulation history plot for study area (Tithonian to Albian), southern part of the Dinaric platform. Tithonian portion of subsidence curve is shown by heavy line.

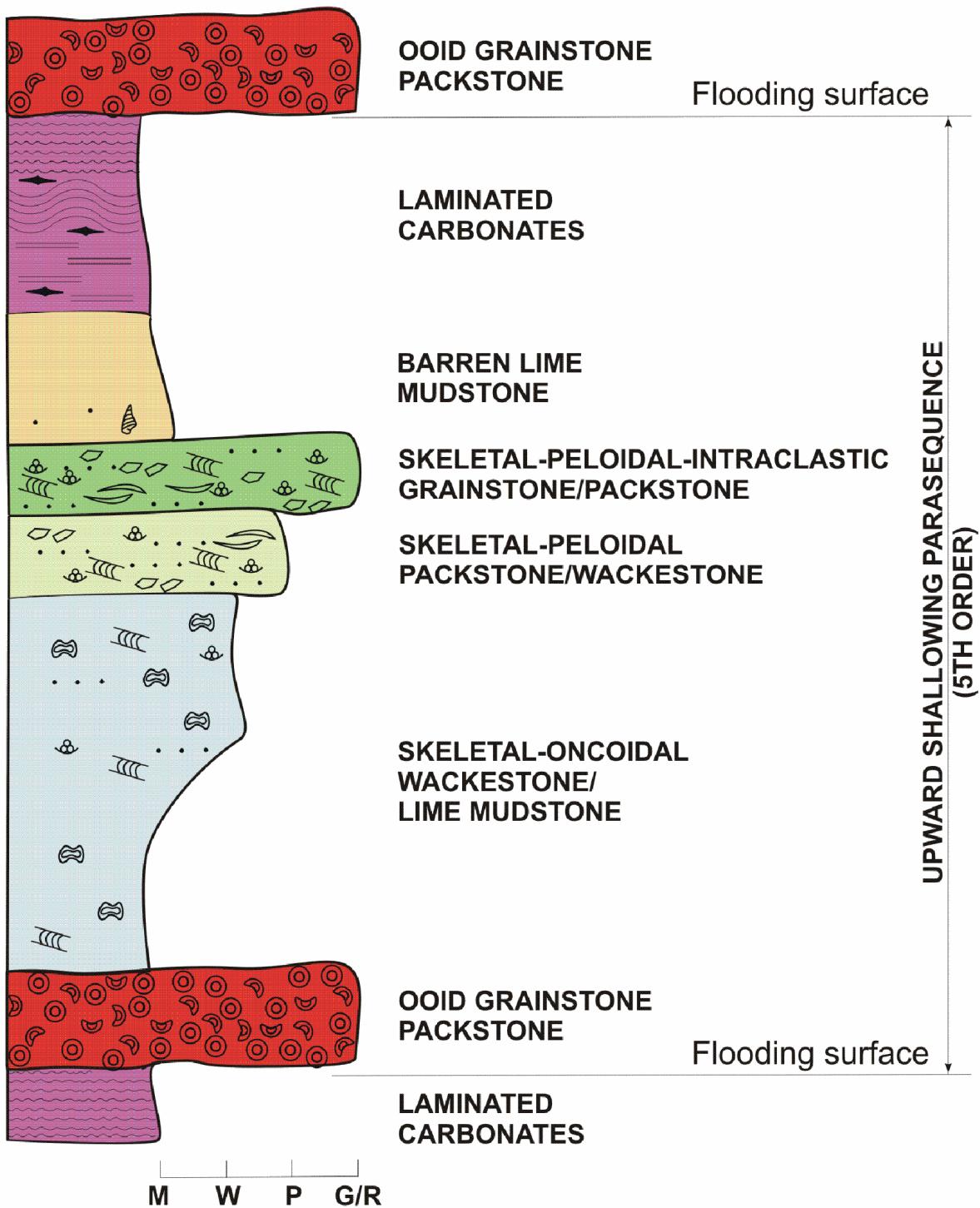


Fig. 3. Succession of facies within a typical Upper Tithonian parasequence, Dinaric platform.

Accommodation (Fischer) plots of the cyclic successions show four accommodation events approximately 1 to 2 m.y. duration equivalent to 3rd order sequences. These Tithonian 3rd order sequences evident on the Fischer plots may be partly equivalent to the four major sea-level cycles depicted on the Haq and Al-Qahtani (2005) chart, but it is not clear how they relate to Hardenbol et al. (1998) chart. Roughly 3-5 parasequences make up the 100 k.y. parasequence sets suggesting variably recorded eccentricity and precessional forcing. The presumed 100 k.y. bundles show up as smaller-scale rises and falls on the accommodation plots. The relatively high Tithonian subsidence rates likely favored relatively complete preservation of precessional cycles with few missing beats, in contrast to the more slowly subsiding parts of the Early Cretaceous where more missing beats are likely.

Radial ooid grainstones ranging from sand to granule size occur mainly at bases of parasequences and less commonly in upper parts of parasequences beneath barren mudstones or microbial laminites. Poor sorting and the irregular outlines suggest that these formed in ooid-precipitating settings that were not constantly high-energy as on shallow platform margin shoals. Instead they formed in low energy, periodically agitated shallow subtidal lagoon and intertidal hypersaline pond settings within the platform interior. Common broken and recoated ooids (vadoids) probably indicate periodic drying and wetting that cracked and broke the grains, followed by renewed precipitation of radial ooid coats. The transgressive oolitic units overlying tidal flat facies likely formed in hypersaline ponds as the tidal flats were being submerged by relative sea-level rise. Some of the thicker oolites (2-3.5 m) if not composite units, could have formed during transgression with the sediment surface overtaking sea-level rise in the lagoon. The radial calcite fabrics are compatible with Late Jurassic calcite seas in contrast to reported Middle Jurassic former aragonite ooids, but their fabrics also point to low energy.

The lack of subaerial surfaces in the Tithonian likely is due to the high accommodation rates which even during falling sea-level prevented prolonged emergence of the platform. As a result, 3rd order low sea-level stands were preserved as stacked cycles in the lagoon. However, there are numerous emergence surfaces above the Jurassic/Cretaceous boundary. These occur as extensive sequence-bounding subaerial clayey limestone breccia horizons interstratified with cyclic carbonates. These emergence horizons may reflect the almost 50% reduction in subsidence rates from the Tithonian to Berriasian.

The presence of 100 k.y. bundles in the Late Jurassic has also been observed in the Early Cretaceous elsewhere by others, and ascribed to presence of some polar ice. The abundant laminites capped, precessional cycles suggest greenhouse, low amplitude sea-level fluctuations, that generated water depths typically less than 5 m on the platform. This seems compatible with the Tithonian being the very warm phase in the overall Late Jurassic-Early Cretaceous cool mode of Frakes et al. (1992). The Jurassic-Cretaceous sections of the Dinaric platform in Croatia may provide important paleoclimatic data for this time interval during which some of the world's major petroleum reservoirs were generated.

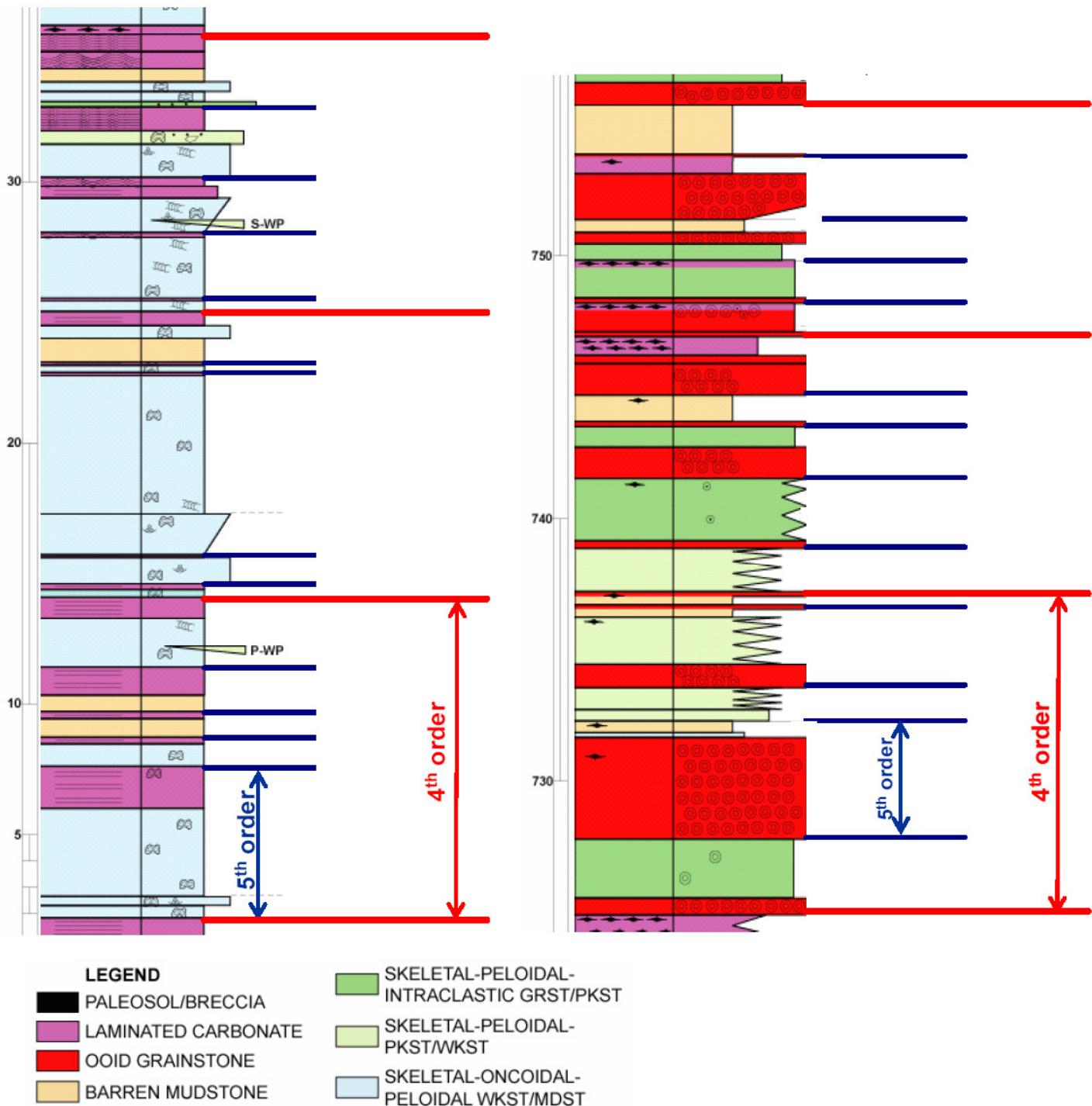


Fig. 4. Selected portions of measured sections showing (left-hand column) parasequences with thick subtidal units and (right-hand column) oolite-prone parasequences. The small horizontal lines show 5th order possible precessional cycles and the heavy lines to the right mark parasequence bundles that are possible short-term eccentricity cycles.