PALAIOS, 2009, v. 24, p. 697–716
Research Article
DOI: 10.2110/palo.2009.p09-018r

Variation in brachiopod preservation along a carbonate shelf-basin transect (Red Sea and Gulf of Aden): Environmental sensitivity of taphofacies

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Keywords: taphonomy, paleoecology, Brachiopoda, Red Sea, bioerosion

ABSTRACT

A bathymetric transect ranging from coral habitats down to a 1500-m-deep basin in the Red Sea and Gulf of Aden allows us to test the sensitivity of taphofacies to depth and sediment grain size in a tropical to subtropical carbonate basin, to partition variation in brachiopod preservation into extrinsic (environmental) and intrinsic (shell-specific) components and to quantify residual variation that remains unexplained by such components. Factoring out environmental effects, thin-shelled, organic-poor rhynchonellids are more affected by fragmentation and fine-scale surface alteration and degrade rapidly compared to the more frequently bioeroded, organic-rich terebratulids. The negative role of shell organic content is overridden by shell thickness, but preservation rates of organic-rich brachiopods are enhanced by syndepositional cement precipitation. Environmental trends in preservation are confounded by shell-specific factors that account for 16% of variation in preservation: the amounts of multivariate variation explained by environment increase from 29% using combined brachiopod preservation to 46% using terebratulid preservation. Environmental sensitivity of taphofacies is driven by present-day variation in environment but also by past Pleistocene conditions. First, reduction in fragmentation, encrustation, and bioerosion is consistent with a decrease in light penetration and primary productivity. Second, brachiopods are coated with aragonite cement in basinal sites with lithified oozes and microbial carbonates that originated during the last glacial maximum when syndepositional aragonite cementation was favored by high temperature and salinity, and thus can be affected by millennial-scale time averaging. Skeletal preservation rates are not in steady state over the duration of time averaging, and the bathymetric reduction in alteration is partly related to past conditions amenable to cement precipitation.