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Are the molluscs really missing? Modelling the spatial impacts of aragonite bias

Christopher Dean, Peter Allison, and Gary Hampson
Imperial College London, Earth Science and Engineering, United Kingdom (christopher.dean09@imperial.ac.uk)

Preferential dissolution of the biogenic carbonate polymorph aragonite promotes preservational bias in shelly marine faunas. Whilst multiple field studies have documented the impact of preferential aragonite dissolution on fossil molluscan diversity, the impact of shell dissolution on broader regional and global biodiversity metrics is debated. Epicontinental seas are especially prone to conditions which promote this preferential dissolution, which stems from water column stratification, seasonally anoxic/dysoxic conditions and the consequent generation of hydrogen sulphide by sulphur reducing bacteria. The ramp-like basin floor topography combined with temporal variation of oxycline position in the water column might result in spatially extensive zones with conditions predisposed for aragonite dissolution. Whilst previous studies have noted the importance of geographic scale, the potential effects of spatial organised aragonite dissolution on the distribution, preservation and our subsequent reading of the fossil record of aragonitic organisms remain to be examined. Here we present a multifaceted, model-based investigation of spatial aragonite dissolution within the intra-cratonic Western Interior Seaway of North America. Occurrence data of molluscs were gathered from museum collections, USGS databases and the Paleobiology Database, and plotted on new high-resolution palaeogeographic and palaeobathymetric reconstructions so as to map out aragonite distribution within the seaway. The distribution of occurrences, diversity estimates and sampling probabilities for calcitic and aragonitic fauna were compared in zones defined by depth and distance from the seaway margins within two time slices (the Cenomanian-Turonian boundary and the lower Campanian). Range sizes, which have the potential to be influenced by differential preservation potential of aragonite between separate localities, were also compared between the groups for all stages for which the seaway was present. We report evidence of preferential aragonite dissolution within specific zones across the seaway, with the odds of sampling calcitic fauna being seven times higher than for aragonitic taxa within the proximal offshore of the Cenomanian-Turonian strata. Additionally, aragonitic bivalves showed a statistically significant decrease in range size compared to calcitic fauna within carbonate-dominated Cenomanian-Turonian strata, potentially indicating that carbonate lithology exacerbates the effects of preferential dissolution. However, we are unable to conclusively show that aragonite dissolution had an impact on diversity estimates within the seaway. Therefore, whilst aragonite dissolution is likely to have affected the preservation of fauna in individual localities, time averaging effects and instantaneous preservation events allow for regional biodiversity to be captured elsewhere. Our results also highlight that biases in the fossil record can be both spatially expressed and scale dependent, and are an important consideration for palaeontologists working on palaeobiogeographical problems.