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Carbonates in skeleton-poor seas: New insights from Cambrian and Ordovician strata of Laurentia

Sara B. Pruss,[1]* Seth Finnegan,[2] Woodward W. Fischer,[3] and Andrew H. Knoll[4]

[1]Department of Geosciences, Smith College, Northampton, Massachusetts 01063, USA; [2]Department of Geological and Environmental Sciences, Stanford University, 450 Serra Mall, Stanford, California 94022, USA; [3]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125, USA; [4]Department of Organismic and Evolutionary Biology, Harvard University, Cambridge, Massachusetts 02138, USA
e-mail: spruss@smith.edu
**Corresponding author.*

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ABSTRACT

Calcareous skeletons evolved as part of the greater Ediacaran–Cambrian diversification of marine animals. Skeletons did not become permanent, globally important sources of carbonate sediment, however, until the Ordovician radiation. Representative carbonate facies in a Series 3 (510–501 Ma) Cambrian to Tremadocian succession from western Newfoundland, Canada, and Ordovician successions from the Ibex area, Utah, USA, show that, on average, Cambrian and Tremadocian carbonates contain much less skeletal material than do post-Tremadocian sediments. Petrographic point counts of skeletal abundance within facies and proportional facies abundance in measured sections suggest that later Cambrian successions contain on average <5% skeletal material by volume, whereas the skeletal content of post-Tremadocian Ordovician sections is closer to ~15%. A compilation of carbonate stratigraphic sections from across Laurentia confirms that post-Tremadocian increase in skeletal content is a general pattern and not unique to the two basins studied. The long interval (~40 myr) between the initial Cambrian appearance of carbonate skeletons and the subsequent Ordovician diversification of heavily skeletonized organisms provides an important perspective on the Ordovician radiation. Geochemical data increasingly support the hypothesis that later Cambrian oceans were warm and, in subsurface water masses, commonly dysoxic to anoxic. We suggest that surface waters in such oceans would have been characterized by relatively low saturation states for calcite and aragonite. Mid-Ordovician cooling would have raised oxygen concentrations in subsurface water masses, establishing more highly oversaturated surface waters. If correct, these links could provide a proximal trigger for the renewed radiation of heavily skeletonized invertebrates and algae.