PALEOECOLOGICAL, EVOLUTIONARY AND TAPHONOMIC EFFECTS OF SEAWATER CHEMISTRY IN PALEOZOIC AND MESOZOIC CALCITE SEAS

WILSON*, Mark A., Department of Geology, The College of Wooster, Wooster, OH 44691, U.S.A.; PALMER, Timothy J., Institute of Earth Studies, University of Wales, Aberystwyth, Dyfed SY23 3DB, Wales, U.K.

There were intervals in the Phanerozoic during which low-magnesium calcite was the primary inorganic carbonate precipitate in shallow warm seas. These "calcite seas" alternated with intervals of primarily high-magnesium calcite and aragonite precipitation ("aragonite seas"), which is the condition today. The geochemical reasons behind the precipitation of a particular calcium carbonate polymorph are still debated, but most geologists are confident that calcite seas are a function of high levels of atmospheric carbon dioxide and low magnesium levels in seawater, factors which are ultimately controlled by plate tectonic processes. The Ordovician and Jurassic Periods were characterized by calcite sea conditions and extensive limestone deposition, so they are particularly appropriate systems in which to study the effects of the phenomenon.

Field and petrographic evidence indicates that low magnesium calcite was precipitated rapidly as cement in seafloor sediments in calcite seas. The carbonate for this precipitation was in part derived from the early dissolution of aragonite shells on the seafloor. The calcite cementation formed extensive carbonate hardgrounds in basins with low to moderate siliciclastic influx. This early aragonite dissolution and rapid calcite precipitation had direct effects on benthic invertebrate communities.

Organisms with aragonitic shells, particularly mollusks, protected their shells from dissolution in calcite seas with periostraca or calcitic exterior shell layers. After death, though, these shells were quickly dissolved. The sediments surrounding or filling the shell were often immediately cemented with calcite. The resulting molds became substrates for contemporaneous encrusting and boring organisms, increasing seafloor habitat diversity. The aragonite dissolution process reveals the attachment faces of encrusters on the original shells, and hence occasional bioimmurations, and it often reveals casts of the borings in the shells. Early cementation of carbonate units also protects their included fossils from crushing by later sediment loading.

Hardgrounds in calcite seas were common. Many substrates which were assumed to have been soft carbonate mud or loose carbonate sand were actually cemented. The ubiquity of these hard seafloors has dramatically changed some autecological interpretations of organisms, such as strophomenid brachiopods and rugose corals, formerly thought adapted to soft substrates. Cemented substrates were also undermined by currents, producing caves and thus further increasing seafloor habitat diversity.

The widespread hardgrounds of the Early and Middle Ordovician were crucial environments for the radiation of attaching echinoderms, bryozoans and other organisms, and they support models of onshore-offshore community evolution. The hardgrounds of the Jurassic provided ecological space for the radiation of oysters and other attaching mollusks. Jurassic hardgrounds were also the primary substrates for the rapidly developing boring ichnofauna produced primarily by bivalves and sponges. Calcite seas thus increased, through geochemical phenomena, seafloor habitat diversity, facilitating rapid adaptive radiations and increased familial diversity in benthic communities.