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Cool-Water Carbonates: Depositional Systems and Palaeoenvironmental Controls: by Pedley, H. M. and Carannante, G., eds., 2006, Geological Society, London, Special Publication 255, 373 p., ISBN-13: 9781862391932, USD 180 (USD 108 member price).

Literature on the recognition and documentation of carbonates forming in settings other than tropical platforms continues to expand, as illustrated by this volume. There does not appear to be a clear consensus on what name to use for cool-water carbonates, despite or maybe because of all this literature. The term cool-water carbonates is probably as close to an agreement as possible, thus, its use for this volume, but temperate carbonates has also been used. Other researchers, including some in this volume, prefer to use such terms as heterozoan, foramol, rhodalgal, or bryomal, which reflect the association of key organisms making up the assemblage. The introduction by editors Pedley and Carannante contains a concise but inclusive review of previous works on cool-water carbonate ramps, including terminology that is quite informative. Of particular relevance is the distinction they draw between open ocean settings with deeper shelves and enclosed ocean basin regimes, in particular the Mediterranean, which is the focus of more than half the papers in the volume. The former are macrotidal and fully influenced by oceanic storms, whereas the latter are microtidal with minimal storm reworking—a critical distinction.

The first 11 papers of the volume cover cool-water carbonate examples all from the Mediterranean region,which range in age from Late Cretaceous to Holocene. Nalin et al. present a study on the formation of encrusting coralline algal buildups forming on a soft bottom medium (i.e., substrate) from the Pleistocene of southernmost Italy (Calabria) as a model for modern *coralligène de platea* or coralline banks currently forming in the Mediterranean basin. The Calabria examples were formed by the stabilization of a loose rhodolith pavement by the binding filaments of the algae in a quiet-water setting. High-energy bioclastic rudstones, grainstones, and packstones found adjacent to these buildups are interpreted as storm deposits that buried them and, thus, solve the puzzle of how low-energy and high-energy deposits are found adjacent to each other. Modern rhodalgal facies are the subject of the next paper by Basso et al. who worked with four cores taken in the Tyrrhenian Sea off the west coast of Italy. They describe a deepening sequence where bryozoans become abundant upward at the expense of the algae as the depth limit of the algae was passed. Rhodalgal assemblages of Miocene age from Sardinia, Italy, are reported on by Bassi et al. These authors have very nicely combined paleoenvironmental reconstruction and paleontological analysis with sedimentology and structural setting (a channel system developed in a graben) to explain the different assemblages of mollusks, bryozoans, and calcareous algae. A depositional history conundrum is presented by Kershaw and Guo regarding the origin of Pleistocene cyanobacterial mounds in central Greece. Cyanobacterial mounds formed during probable freshwater conditions over a faulted area. Subsequently, exposure, cave formation, and growth of euryhaline coralline algae took place. Due to tectonic activity, there were multiple episodes of water-level fluctuation during this history. The issue is whether the later stages involved marine or fresh water. The authors are not able to provide a definite answer, but favor a freshwater origin. Fornós and Ahr describe the Balearic Platform of the western Mediterranean as a low-energy, distally steepened, temperate carbonate ramp. Modern characteristic facies consist of rhodalgal-bryozoan gravels and sands that formed in place at depths down to 100 m due to the exceptional water clarity, which resulted from a the lack of terrigenous clastic input and low organic content. This setting is contrasted with both the modern isolated platform of the Bahamas and the low-energy tropical ramp of the Campeche Bank, which have different processes and products than the Balearic Platform. Toscano et al. present the results of their study in a short paper on the variation in modern rhodalgal facies in response to changes in bottom features and hydrodynamic conditions in and around the Bay of Naples. It is especially interesting that the authors note that these same active rhodalgal carbonates were also described by Johannes Walther in the mid-1880s. Massari and Chiocci present a fascinating study of 10–30-m-thick basinward-prograding heterozoan grainstone wedges from Pliocene exposures on Sicily and from submerged Upper Pleistocene to Holocene examples from the surrounding Tyrrhenian Sea. The authors also reference similar exposures in the literature for the Mediterranean basin. These grainstone wedges typically develop on submerged steep gradient margins subject to storm-dominated microtidal regimes. Evidence indicates that these wedges form at times of stillstand during falling, lowstand, and rising sea levels.

The scene shifts to the upper Miocene to lower Pliocene exposures in southeastern Spain with the paper by Braga et al. In several of the intermountain basins of the Betic Cordillera, cool-water limestones were deposited in a tectonically active area. The carbonates formed on shelves around basin margins where siliciclastic deposition was minimal or only sporadic in a variety of environments from shallow coastal belts to open platforms to deeper toe of slope and basinal settings. The response of cool-water carbonates in a microtidal setting to glacioeustatic change is explored by Pedley and Grasso. They looked at extensive exposures of Quaternary (Emilian) cool-water carbonates in southern Sicily. By establishing paleowater depths for each facies at each exposure, they determined the changes in depositional and diagenetic fabrics as related to eustatic changes. This, in turn, was used to build an overall model for glacioeustatic-driven ramp processes that is quite elegant and applicable to other similar settings. Reuter et al. discuss shallow-marine carbonates from the late Miocene of central Crete that contain features of both tropical and cool-water carbonate systems. In this example, extensive coralgal-bryozoan carbonates grade laterally into isolated colonial coral communities typical of warm-water settings. The authors note that this type of transition takes place over a wide latitude in open ocean settings but is compressed to a single long exposure in the Mediterranean. An example of older Mediterranean cool-water carbonates is presented by Ruberti et al., who studied Upper Cretaceous carbonates exposed in the Cilentro area just south of Naples, Italy. In these limestones the major contributors are rudists and rudist debris deposited in muddy sediments in low-energy, channel-like bodies on a shallow shelf.

The paper by Halfar et al. moves from the Mediterranean to the Gulf of California, Mexico, where they report on a modern bryomol assemblage usually associated with cooler temperature settings in warm (average 20° C) waters. The authors attribute eutrophic conditions with abundant nutrient supply and resulting low-water clarity that allow heterotrophic bryomol organisms to dominate over phototrophic organisms in this low-latitude setting.

The next four papers focus on studies of Neogene cool-water carbonates in Australia and New Zealand. Lukasik and James examine the role that climate played in producing different levels of stratigraphic completeness in lower to middle Miocene temperate-water carbonates in the Murray Basin of southern Australia. In this cautionary tale a transition from an incomplete stacking pattern to a more completely preserved record reflected a subtle change in climate rather than a significant eustatic change. A different example of documenting change in cool-water carbonates through time in response to changing conditions is presented by Anastas et al. In this study of the upper Eocene to lowermost Miocene Te Kuiti Group, North Island, New Zealand, evolution of sedimentation pattern from wave-dominated to current-dominated sedimentation and then back to wave dominated in response increasing water depth in a carbonate seaway is nicely demonstrated. The response of a temperate-water isolated carbonate platform to changes in sea level is the focus of Kindler et al. in their paper on the Neogene Southern Marion Platform off the coast of northeastern Australia. At times of early lowstand, maximum carbonate production took place, followed by submarine erosion and hardground development. With sea-level rise, drowning of the platform resulted only in the accumulation of pelagic sediments. Hendy et al. present an interesting study of cool-water taphofacies (shell beds) whose variations in sedimentology, taphonomy, and paleoecology can be linked to highstand and transgressive system tracks. The Matemateaonga Formation (late Miocene–early Pliocene) of the Wangenui Basin, New Zealand, was investigated in both outcrop and core for this study.

The last three papers in the volume focus on diagenetic aspects of cool-water carbonates. First, Mutti et al. demonstrate that the chemostratigraphy of Miocene cool-water carbonates can have potential given certain caveats since they appear to be better able to preserve an original marine stable isotope signature than similar warm-water carbonates. They compared samples from the Marion platform (offshore Australia) with Mediterranean outcrops in Sicily and the central Apennines. In the next paper, Knoerich and Mutti discuss the occurrence of epitaxial calcite cement on echinoid grains from the Oligocene–Miocene cool-water (heterozoan) carbonates of Sicily and Maltese Islands. They state that these carbonates preserve the only documented example of epitaxial cements that formed outside of the tropics, as well as during a time of aragonite seas where the cement source was early dissolution of aragonite components of the carbonates rather than pressure solution of echinoid grains themselves. Carun et al. developed a hypothetical diagenetic model for a thick sequence of Pliocene cool-water limestones deposited as part of a forearc basin-fill sequence on the North Island, New Zealand. What makes this model unique is their application of the terminology and concepts of sequence stratigraphy at the petrographic scale in an attempt to explain the cementation sequence and diagenetic environments through which the rocks had passed.

As with most theme volumes, the papers presented here are variable in scale and scope, but overall this volume is a very welcomed addition to the literature on cool-water carbonates. My knowledge of these carbonates grew as a result of reading the papers, as I assume it will for other readers as well.

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