THE FORMATION OF CELESTINE: A POSSIBLE MECHANISM FOR THE CREATION OF POROSITY IN PLATFORM DERIVED SEDIMENTS

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PROJECT OBJECTIVES

- To understand the importance of celestine formation on the occlusion and preservation of porosity.
- To understand the influence of celestine upon the pore water geochemistry during and subsequent to its formation.

PROJECT RATIONALE

Celestine (often referred to as celestite) is a common mineral formed during marine burial diagenesis as the Sr, which is more abundant in biogenic carbonates, is excluded during neomorphism and recrystallization. Celestine saturation is common in the deep-sea record and about 10% of all sediments cored by the Ocean Drilling Program-International Ocean Discovery Program (OPD-IODP) attain saturation with respect to this mineral (Hoareau et al., 2010). Celestine is also common throughout the geological record (Hanor, 2004) and in some instances forms large concretions, often replaced by calcite, up to one meter in diameter (Yan and Carlson, 2003). While celestine is also known in other depositional environments, such as coastal carbonates and evaporites (Hanor, 2004; Taberner et al., 2002), the origin of these occurrences is uncertain.

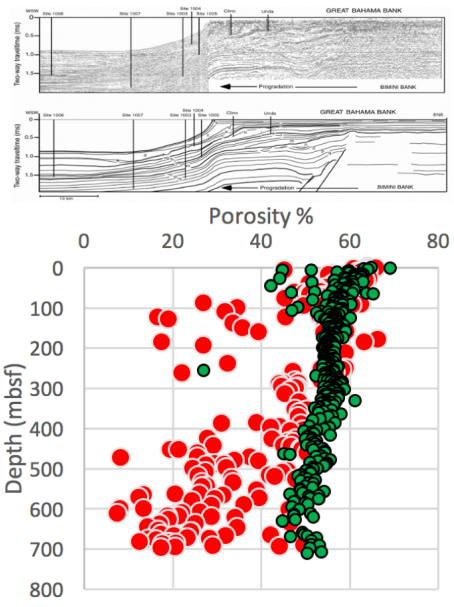

Fig. 1: Transect of sites off the western margin of Great Bahama Bank (upper panel). Changes in porosity from Sites 1006 (green) and 1005 (red) (lower panel).

The formation and occlusion of porosity in sediments deposited along the margins of carbonate platforms is an important process in controlling the hydrocarbon potential of a reservoir. However, the processes governing the development of porosity in carbonate reservoirs are poorly understood and frequently large variations occur without an obvious explanation. A particularly good example of this can be found in the changes in porosity that take place at two sites adjacent to the Great Bahama Bank (GBB) (Fig. 1). Site 1006, the

site furthest away from the margin of GBB, shows the decrease in porosity anticipated as a result of compaction, while Site 1005, located 20 km closer to the platform, shows large erratic variations in porosity normally ascribed to carbonate diagenesis (dissolution of primary carbonate components and their replacement by cement). In the proposed work we will investigate a new process we believe to be important in controlling porosity development in marginal sediments deposited adjacent to carbonate platforms.

SCOPE OF WORK

We will analyze samples collected during IODP Expedition 359 to the Maldives and from Site 1005 (ODP Leg 166). Expedition 359 drilled eight sites adjacent to atolls in the Maldives and penetrated up to 1000 m below the sea floor reaching sediments of late-Oligocene age. These sites were located close to Site 716 drilled during ODP Leg 115 where celestine was detected. During Exp 359, celestine was detected using X-ray diffraction at four of the sites cored; U1466, 1467, 1468, and 1471. The greatest abundance of celestine was measured at Site U1471, although since samples were only analyzed every ~9 m celestine may be more prevalent than recorded.

SIGNIFICANCE

The occurrence of celestine, while well known, has been mainly regarded as a curiosity. This study will be the first to recognize its potential as a major and important creator of porosity. We propose that this mineral forms early in the paragenetic sequence, filling porosity and thus preventing sediments from becoming compacted and filled with carbonate cement. Once the surrounding carbonate sediments become lithified and the sediment is buried below the zone of super saturated pore waters, the celestine dissolves and the porosity of the rock becomes available once more. Furthermore, this process occurs preferentially in sediments derived from aragonite precursors and therefore should be more prevalent in sediments that formed during aragonite seas.

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