APPENDIX A

A review of carbonate mud generation

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Carbonate settings have historically been subdivided into platform-slope-basin floor or ramp systems. Within these systems, carbonate mud has either a neritic or pelagic origin. In modern neritic tropical to sub-tropical environments, like the Great Bahama Bank and Florida Shelf, green codiacean algae, like *Penicillus*, are thought to be responsible for much of the shallow water mud generation since these algae break down into micron-sized aragonite needles (Stockman et al., 1967; Neumann and Land, 1975). Secondarily, biomicritization of grains by boring organisms, as well as fecal pellet production, play a role in shallow water micrite generation. There is a long standing debate over the organic versus inorganic origin of Bahamian mud (Shinn et al., 1989). Milky water column events consisting of suspended aragonite needles, termed whitings, are a common occurrence in both the Bahamas and Florida Shelf (Robbins et al., 1997). Whitings may be inorganic precipitation events or biologically induced and may be responsible for a significant volume of shallow water mud generation over time (Shinn et al., 1989; Robbins and Blackwelder, 1992; Purkis et al., 2017). Recent studies link precipitation events to ocean circulation patterns, specifically off-platform ocean currents that periodically reach the platform (Purkis et al., 2017).

Temperate carbonate seafloors host coarse-grained carbonates and generally lack mud producing organisms. The origin of carbonate mud in temperate, non-tropical settings is less common and more enigmatic. Studies of modern settings like South Australia suggest mud is composed of macerated shell fragments, rather than from aragonite precipitation in seawater documented from tropical to sub-tropical settings (O'Connell and James, 2015).

Pelagic biogenic production is an important source of carbonate mud. In Mesozoic and younger open water systems, pelagic biogenic production by calcareous organisms has resulted in the deposition of micro- and nannofossil tests and calcareous ooze deposition, preserved as pelagic limestones and chalks in the sedimentary record (Ekdale, 1984). Microfossils, like foraminifera, make up pelagic limestone units, like those found in the Cretaceous aged Eagle Ford, which are interbedded with organic and clay-rich shale beds (Denne et al., 2014; Hentz et al., 2014; Denne et al., 2016; Denne and Breyer, 2016; Fairbanks et al., 2016). Nannofossils, specifically coccololithophores, make up chalk deposits. Jurassic-age chalks preserved in the North Sea and across portions of Europe are among the most heavily cited geologic examples (Herrington et al., 1991). Chalks deposited in the Cretaceous Western Interior Seaway, like the Niobrara represent typical pelagic biogenic coccolithophore-rich mud deposition (Longman et al., 1998; Sonnenberg, 2011). Average calcareous ooze deposition rates from Cretaceous-aged chalks is 1.84 cm/ ky (Locklair et al., 2011). Where clay dilution was locally high, marls instead of chalks are preserved (Longman et al., 1998; Sonnenberg, 2011).

Large volumes of carbonate mud also occur in mud mounds. Mud mounds are carbonate buildups with depositional relief that are composed dominantly of carbonate mud, peloid mud, or micrite (Bosence and Bridges, 1995). Mud mounds may be microbial or biodetrital in nature (Bosence and Bridges, 1995). Microbial mounds are relatively in-situ features, constructed from the trapping and baffling of sediment by microbial mats (Bosence and Bridges, 1995; Lees and Miller, 1995; Monty, 1995), whereas biodetrital mud mounds are composed of broken and transported skeletal debris (Bosence, 1995; Bosence and Bridges, 1995; Bridges, 1995; Taberner and Bosence, 1995). In biodetrital mud mounds, mud may be generated locally or transported significant distances (Bosence and Bridges, 1995). These two types of mounds may or may not be mutually geographically exclusive. In some cases, microbial facies transition to biodetrital facies within one mound (Bosence and Bridges, 1995). Mud mounds can be found in a variety of settings ranging from deep basinal, to lower slope, to shelfal or lagoonal environments (Bosence and Bridges, 1995; Pratt, 1995).

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