EVIDENCE FROM CARBONATE PLATFORMS BEARING ON CLIMATE, SALINITY, DASYCLADALEAN DIVERSITY, AND MARINE ANOXIC EVENTS DURING THE LATE JURASSIC–EARLY CRETACEOUS GREENHOUSE

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Carbonate platforms are sensitive recorders of environmental change through geologic time. Climatically induced changes in sea level or changes in subsidence are expressed through migration of sediment belts that are recorded in the accumulating sedimentary succession. Changes in nutrient levels are recorded in shifts in the biotic community and, if eutrophic levels are reached, platforms may drown due to breakdown in carbonate production (Föllmi et al., 1994). Our group has been focusing on the ~60 Ma Late Jurassic–Early Cretaceous period, which was originally considered to have had uniform greenhouse conditions (Fischer, 1982). Available climate proxy data, however, such as oxygen isotope data ($^{18}$O) from deep sea cores, the paleontologic data (e.g., Frakes et al., 1992), and the $^{87}$Sr/$^{86}$Sr and carbon isotope data of Jurassic and Cretaceous carbonates (Jenkyns and Wilson, 1999), indicate that there were major cooling and warming events that likely affected global ice volume, sea level, and the accumulating sedimentary and microfossil record of carbonate platforms.

Numerous carbonate platforms were developed within the tropical–subtropical belt of the circumequatorial Late Jurassic–Early Cretaceous Tethys Ocean. Many of these platforms have comparable shapes, sizes, facies, subsidence rates, and geologic structure to the present-day Bahamas Banks, a commonly used modern-day analogue (e.g., Bosellini, 2002, and references therein). In addition, the outcropping Tethyan platforms provide important clues to the poorly known subsurface Mesozoic carbonates that underpin the modern Bahamas platform. The Tethyan platforms were characterized by high rates of sedimentation (from <30 up to >100 m/myr; D’Argenio et al., 1999) and exhibit meter-scale shallowing-upward cycles or parasequences generated during high frequency, small sea-level fluctuations within the Milankovitch band (Strasser, 1991; Schulz and Schäfer-Neth, 1997; Lehmann et al., 1999; Strasser et al., 1999; Immemhauser et al., 2004; Husinec and Read, 2007). The Late Jurassic–Early Cretaceous platforms contain important information about changes in fauna, depositional facies, diagenesis, and climatic events, as well as the history of platform growth and demise (Simo et al., 1993).

As such platform tops lie near sea level, they are sensitive to such small changes in sea level as those driven by the earth’s orbital forcing of global climate—Milankovitch forcing. There is abundant evidence of orbitally forced changes in climate and sea levels in Paleozoic and Mesozoic rocks from many carbonate platforms around the world (Read, 1995, and references therein). Namely, the cycles of precession (19–23 kyr, decreasing to slightly smaller values into the past), obliquity of the Earth’s rotational axis (41–54 kyr), and eccentricity of the earth’s orbit around the sun (98–123 kyr and 413 kyr) produce periodic variations in the insolation patterns (Berger, 1984; Berger and Loutre, 1994; Hinov, 2000), which in turn cause variations in oceanic and atmospheric systems.

During greenhouse times, precessional cycles (roughly 20 kyr and decreasing slightly with geologic age) appear to be dominant when the Earth is relatively ice free (Fischer, 1982; Read, 1995). Carbonate platforms during greenhouse periods—as in the Late Jurassic–Early Cretaceous—developed under relatively small sea-level fluctuations (typically a few meters) with roughly 10–20 kyr periodicities on which are superimposed small, ~100 and 400 kyr sea-level fluctuations (Koerschner and Read, 1989; Bond et al., 1991; Goldhammer et al., 1993; Lehrmann and Goldhammer, 1999). These platforms are consequently composed of markedly layer-cake, meter-scale, low-energy peritidal and or subtidal cycles (e.g., Osleger, 1991; Montañez and Read, 1992; Elrick, 1995; Read, 1998).

During icehouse times when the Earth had major ice sheets, Milankovitch-driven sea-level changes were large (many tens of meters) and typically, obliquity (40 kyr) or eccentricity (100–400 kyr) domi-