Preservation of Primary Lake Signatures in Carbonates of the Eocene Green River Wilkins Peak-Laney Member Transitional Zone

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Abstract

Important changes in carbonate mineralogy, texture, and stable isotope composition occur at the transition from the Wilkins Peak Member to the Laney Member in the Eocene Green River Formation, Wyoming, which reflect evolution of inflow waters, lake waters, and paleoenvironments.

Alternating organic-rich laminae and primary aragonite and calcite laminae were identified from the lower Laney Member in the Bridger Basin, Wyoming. Criteria for identifying primary lacustrine aragonite include its purity, preservation of well-sorted, prismatic crystals 5-10 μm in length, micro-lamination defined by crystal size variation, and poor cementation. Primary precipitated calcite also forms laminae that are monominerallic, unconsolidated, and lack diagenetic overprints. Calcite crystals are well-sorted equant blocky polyhedra, ~10 μm in size. Primary calcite and aragonite in the lower Laney Member have δ¹⁸O values that decrease upward by ~3‰ over 15 meters of stratigraphic section which suggests (1) source waters changed to high altitude foreland rivers or (2) lake waters underwent less evaporative concentration than in the underlying Wilkins Member.

The top of the Wilkins Peak Member contains heterogeneous laminae of calcite and dolomite. Evaporites associated with these layers suggest deposition in underfilled, evaporative lakes. Carbonate mineral textures include well-sorted euhedral primary-precipitated dolomite crystals <15 μm and interlocking diagenetic mosaics of calcite and dolomite 20-70 μm in size. Electron microprobe analyses indicate diagenetic overgrowths of Fe-rich dolomite on cloudy Fe-poor cores. δ¹⁸O values of carbonate laminae in the upper Wilkins Peak Member vary by ~6‰ with no covariance, suggesting diagenetic overprinting. The results from this study show that understanding the primary lacustrine versus diagenetic origin of Green River carbonate minerals is essential for paleoenvironmental and paleoclimate interpretations.
Floodplain Mudstone, over/illed lake. Previous work by Carroll et al. (2008) and Doebbert et al. (2010) states.

Alternating organic-rich laminae and primary aragonite and calcite laminae deposited in two large lakes: Lake Gosiute in the Bridger and Washakie Basins and Lake Owen in the Eocene Green River Formation, Wyoming (Figs. 1 & 2), which reflect euhedral primary-precipitated dolomite crystals <15μm (Fig. 5) and interlocking overgrowth crystals within pure-dolomite laminae. D) SEM image of a mixed calcite/dolomite layer showing diverse sizes in crystals. E) An isolated dolomite crystal from SEM.

1. Criteria for identifying primary lacustrine aragonite include its purity, unstable polymorph of a carbonate grain containing a calcite core with dolomite overgrowth. C) EMP line scan through transect A-A’ from through a carbonate grain showing the preservation of randomly oriented ~10μm needles. D) SEM image of pure unconsolidated aragonite needles. Aragonite shows sub-lamination defined by crystal size variation. E) SEM image of a large grain showing the preservation of randomly oriented ~10μm needles. Fossil Basin, Western Victoria; Warren, 1990 – Last et al., 2012; and Lake Balaton, Hungary (Kovacs, 1987); and Lake Balaton, Hungary (Kovacs, 1987); and Lake Balaton, Hungary (Kovacs, 1987).

Other minerals hydrodynamically deposited include primary aragonite (Fig. 6), low-relief margin setting - flooded basin (Fig. 7). Aragonite and calcite laminae deposited in a low-relief margin setting - flooded basin (Fig. 7). Aragonite and calcite laminae deposited in a low-relief margin setting - flooded basin (Fig. 7). Aragonite and calcite laminae deposited in a low-relief margin setting - flooded basin (Fig. 7). Aragonite and calcite laminae deposited in a low-relief margin setting - flooded basin (Fig. 7).

Table 2. Electron microprobe results from dolomite crystals which analyzed. A) Alternating light calcite-rich and darker, organic-rich laminae. E) Thin section image of core (Wilkins Peak Member, Late Eocene, Green River Formation, Wyoming). F) Diagenetic carbonate unit showing from core area (Fig. 6).

Conclusions

The petrographic study and stable isotope analysis at the lamina level resulted in a new isotopic shift for Laney Member deposits in the Bridger Basin and over the last 50 years. This reflects changing lake conditions from under/illed to balanced /f/ill over the last 50 years. This reflects changing lake conditions from under/illed to balanced /f/ill over the last 50 years. This reflects changing lake conditions from under/illed to balanced /f/ill over the last 50 years. This reflects changing lake conditions from under/illed to balanced /f/ill over the last 50 years.

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