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Lateral Variation in Microbial Carbonate Facies and Stable Isotope Geochemistry at Multiple Scales in the Oligo-Miocene Horse Spring Formation of Southern Nevada

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The Oligo-Miocene Horse Spring Formation (HSF), exposed north of Lake Mead in southern Nevada, comprises siliciclastic, carbonate and evaporite facies that formed in pre- and synextensional lake basins. Rift basins of this type usually are poorly exposed due to subsequent burial. However, incision by the Colorado River in this area leads to spectacular exposure and the ability to characterize the facies architecture of these basins in considerable detail. Numerous volcanic tuffs also provide excellent chronostratigraphic control. Carbonates within the HSF comprise thick (50-200 m), monolithologic sequences that can be traced, in some cases, over 25 km laterally and are dominated by sedimentary textures and structures that indicate a strong microbial influence in their deposition. Such a large concentration of thick lacustrine microbial carbonate sequences in both space and time appear to be unique to this area and may be associated with reorganization of aquifers and redirection of groundwater flow during extension of the eastern Basin and Range and uplift of the Colorado Plateau. Furthermore, in at least two HSF outcrops, it is possible to confidently trace microbial carbonate facies from very proximal marginal to distal basinal positions. This is one of a very small handful of ancient, preserved lacustrine carbonate sequences that allow for detailed examination of this important lithologic transition. As part of an on-going high resolution basin analysis study of the HSF, we have characterized the lithofacies, overall stratigraphic architecture, and stable isotope geochemistry of the microbial carbonates in this unique system.

We have documented systematic microfacies, macrofacies, and isotopic shifts from marginal to basinal positions in HSF lacustrine microbialites. First, we detect a greater degree of morphological diversity, both at the macro- and micro-scale, near paleolake margins compared to basinal positions. Margins are characterized by a wide range of domal stromatolite morphologies and, to a lesser degree, a range stratiform microbial carbonates. Stratiform stromatolites almost completely dominate basinal samples. Second, in marginal samples we see a greater range of micro-scale structures that appear to be microbially mitigated or influenced, whereas in basinal positions, samples show more evidence of simple trapping and binding of carbonate and siliciclastic (eolian) grains. Third, dessication features in marginal carbonates are restricted mainly to teepee structures that range in scale from 20-50 cm in height, whereas basin limestones show pervasive fenestral porosity development and some teepee structures. Finally, carbonates in marginal positions show distinct isotopic enrichment when compared to their laterally equivalent basinal counterparts (Figure 1).

We suggest that microbial carbonate morphology and isotope geochemistry can provide tools to discern relative up-dip versus down-dip position in lacustrine settings such as those of the HSF when sections can be reliably correlated. Our isotopic results, in particular, appear to hold even over relatively long lateral distances.

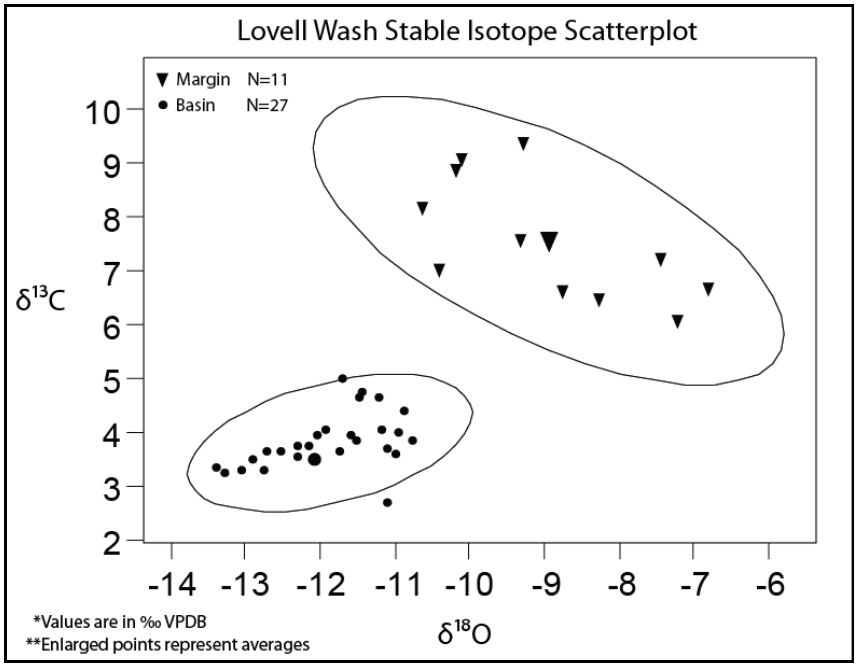

Figure 1. Lateral variation of oxygen and carbon isotopes from margin to basin in Horse Spring Formation microbial carbonates.

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