How Sediment Mixing and Transport Influences Recorded Carbon Isotopic Trends: Permian Reef Trail, Guadalupe Mountains National Park

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Abstract

At the time of deposition, a rock's carbon isotopic value represents the environment it lithified in. However, there are scenarios when this is not true. If a clast formed and was relocated to a different location, for instance, by a turbidity current, then the clast within that rock would not indicate the correct value for the environment. We aimed to explore how sediment mixing and transport of clasts influenced carbon isotopic trends by focusing on the Late Permian Yates Formation, Tansill Formation, and Mckittrick Limestone exposed along the Permian Reef Trail in the Guadalupe Mountains National Park. Along the slope, we extracted large slabs, from which multiple samples of different clasts, fossils, and calcite cement were taken. By comparing these values to values of an environment with less mixing, it is clear that transportation and mixing of clasts does impact the carbon isotopic trends recorded in the rock record.

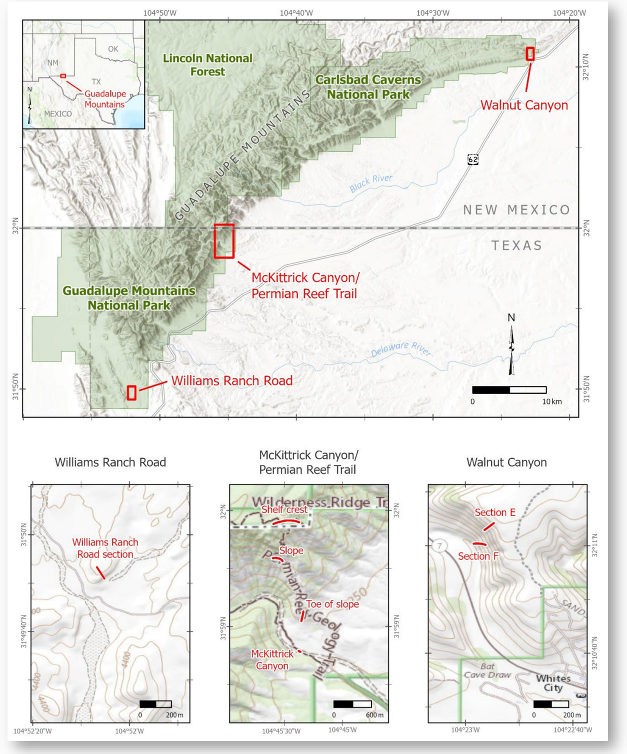

Figure 1: Map showing the study areas in Guadalupe Mountains National Park and Carlsbad Caverns National Park. The approximate extent of measured sections in this and related studies are shown as red lines on the detailed location maps. Note that this study focused on the "Slope" section along the Permian Reef Trail (detailed map at bottom center).

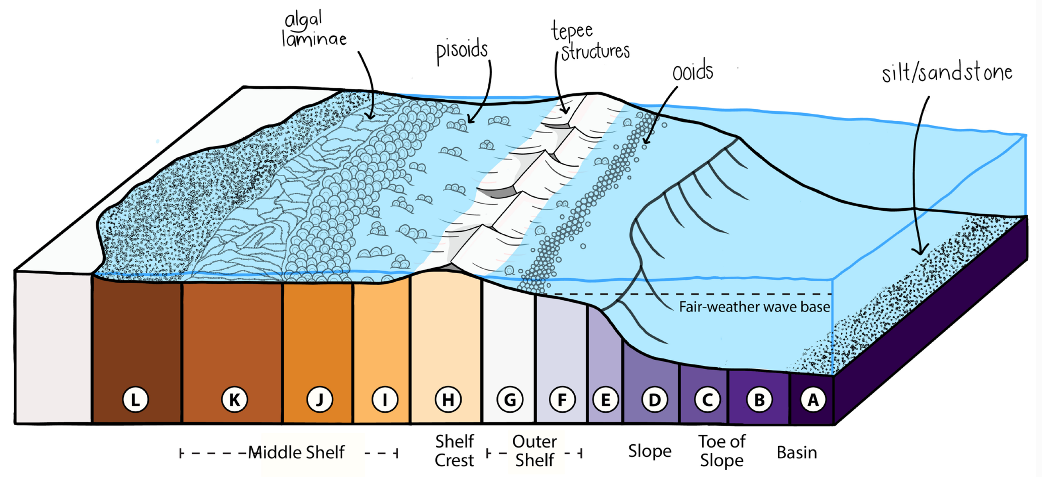

Figure 2: Depositional environment for the Delaware Basin modified from Tinker (1998) and Rush and Kerans (2010). Facies associations used in this study (identified by color and letter) are modified from those used in Rush and Kerans (2010) and Bebout and Kerans (1993)..

Period	Epoch	Age	Fusulinid Zones	Shelf Stratigraphy		Basin Stratigraphy	Sequence Stratigraphy
Permian	Late Guadalupian	Late Capitanian	PU-1	Tansill Formation	Capitan Limestone	Bell Canyon Formation: Reef Trail Member	HSF G29
			PG-6C			Lamar Limestone Member	HSF G28
			PG-6B				HSF G27
			PG-6A				
		Middle Capitanian	PG-5B	Yates Formation		McKittrick Limestone member	HSF G26
		Early Capitanian	PG-5A			McCombs Limestone Member	HSF G25

Figure 3: Lithostratigraphy, biostratigraphy, and sequence stratigraphy for the Delaware Basin modified from Rush and Kerans (2010), which builds upon Tyrrell (1969), Esteban and Pray (1977), Tinker (1998), Kerans and Tinker (1999), Wilde et al. (1999), and Lambert et al. (2002). Fusilinid zone abbreviations are: PG-5A - *Polydiexodina, Codonofusiella paradoxica, Leella bellula*; PG-5B - *Codonofusiella extensa*; PG-6A - *Yabeina texana*; PG-6B - *Paradoxiella pratti*; PG-6C - *Reichelina lamarensis*; PU-1 - *Paraboultonia-Lantschichites, Cordonofusiella, Reichelina.*

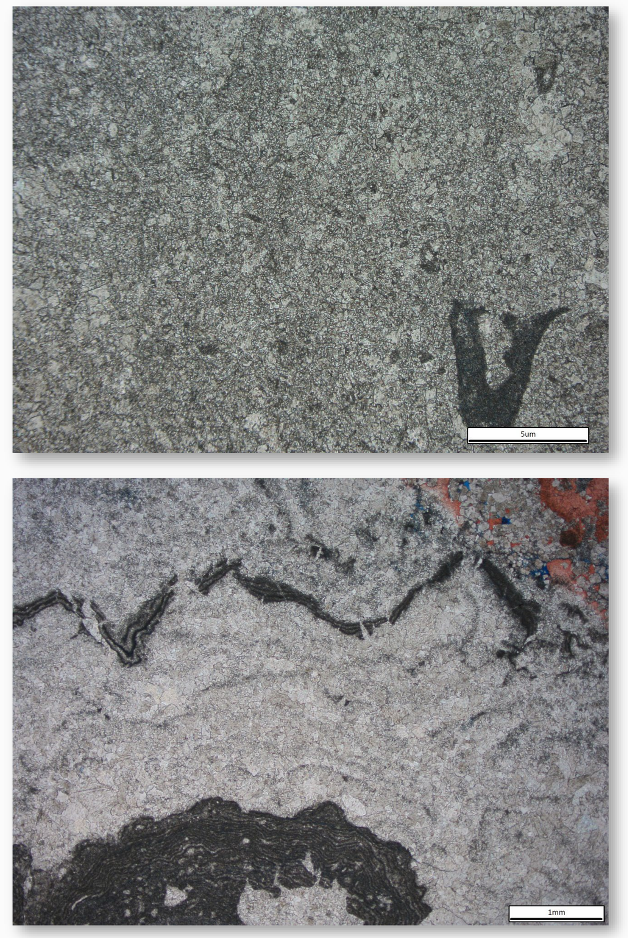

Figure 4: Petrographic analysis provides additional insight into the components that were drilled for isotopic analysis. The top image (14.3 m) shows that what appeared to be pristine micrite in hand sample was actually partially recrystallized and dolomitized. The bottom samples (5.6 m) shows that what appeared to be a pocket of pure spar was actually interlayered spar and *Archaeolithoporella* (a problematic fossil – possibly a type of red algae).

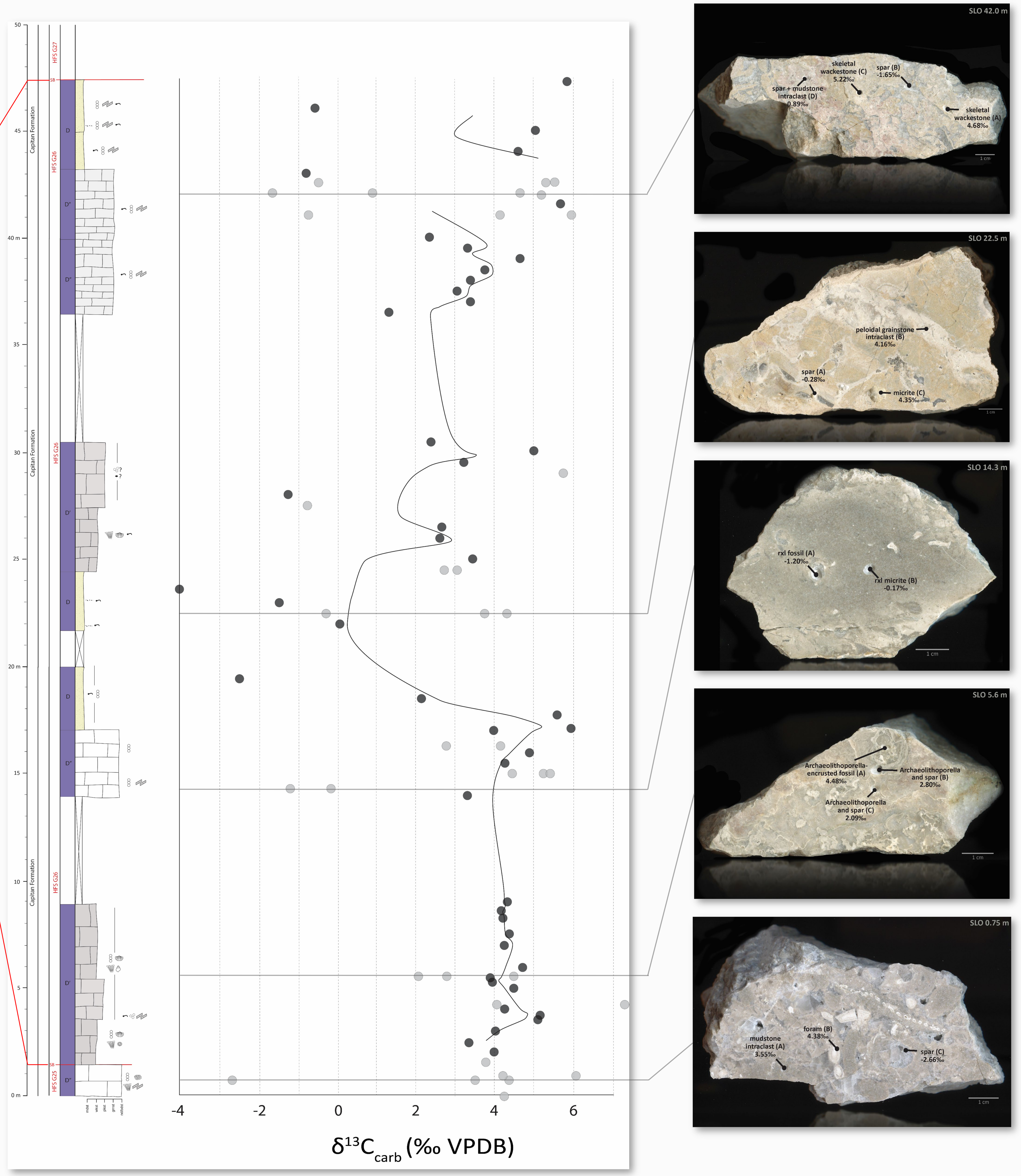

Figure 5: Summary graphic log and carbon isotopic record for the Permian Reef- Slope section. Light grey circles are for carbon isotopic values that come from slabbed hand samples. Dark grey circles are for carbon isotopic values from bulk rock. A selection of slabbed samples along show the range of clasts sampled and their carbon isotopic values.

Conclusions

Carbon isotopic sampling in slope deposits requires careful attention to what is being drilled because:

- Not all mud can be assumed to be primary, recrystallized mud displays carbon isotopic values lower than the surrounding rock.
- Calcite cements tend to have systematically lower carbon isotopic values than the surrounding rock.
- Fossils show a range of carbon isotopic values, but most of them had higher carbon isotopic values.
- Intraclasts record a range of carbon isotopic values, in some cases they were close to the surrounding rock but in others they showed a significant departure. This suggests that sediment transport is resulting in a range of carbon isotopic values in any given sample.

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Figure 6: Field team at the sand dunes in Guadalupe Mountains National Park.