Mid-Cretaceous Pacific carbonate platforms: Subaerial vs. submarine diagenesis

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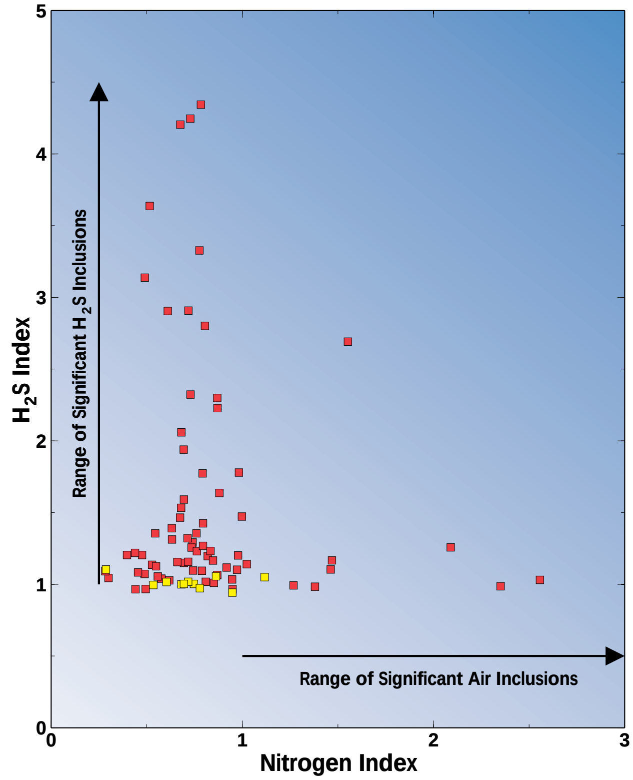
Submerged carbonate platforms in the oceans provide opportunities to study ancient oceanographic and tectonic events. Because the organisms that built these platforms thrived only in shallow water, their deposits can form a physical record of ancient seafloor depth, of fluctuations in relative sea level, and of important changes in water chemistry during and after their deposition. The distinction between subaerial and submarine diagenesis of carbonate platforms can impact our interpretation of paleoceanographic history.

Mid-Cretaceous carbonate platforms in the western Pacific show surface relief of 100-200 m. This relief suggests subaerial exposure for a significant period of time before final submergence of the platforms. A comparison of this topography to modern uplifted, subaerially eroded islands and atolls shows remarkable similarities [*van Waasbergen and Winterer,* 1993]. Subaerial exposure is documented by petrography and stable-isotope geochemistry of carbonate core samples recovered from the Mid-Pacific Mountains during ODP Leg 143 [*Winterer et al.,* 1995]. Subaerial exposure of the platforms requires either a global lowering of sea level, or a regional tectonic uplift of sea floor.

A final subaerial platform stage is not supported by petrography and geochemistry of platform limestones recovered during ODP Leg 144 from Takyuo-Daisan and MIT guyots, which also have 200 m deep depressions. If substantial exposure occurred, small microinclusions trapped in minerals formed in the upper part of the platform would include air and fresh water. The subaerial signatures of these inclusions should be recognized, even if only a small amount of cement formed. Of 77 samples analyzed (see figure), only three samples above 200 mbsf, and seven MIT samples between 410 and 703 mbsf contained air inclusions; 69 samples show a distinct presence of H_2S in the inclusions, which suggests a reducing environment for part of their diagenetic history. The various geochemical analyses of these limestones display primarily a seawater signature and evidence for reducing pore-water conditions; Takuyo-Daisan and MIT guyots do not exhibit geochemical evidence of extensive subaerial exposure. A different model for generation of the dissolution topography on these platforms must be invoked; possibly migration and oxidation of reduced sulfur-rich fluids contributed to this submarine diagenesis. Such fluids could have been generated during episodes of oceanic anoxia. The distinction between the two models is important because it affects the interpretation of post mid-Cretaceous oceanographic and tectonic events.



Cross plot of the nitrogen and hydrogen sulfide indexes, using data from Site 878 on MIT Guyot (red squares) and Site 879 on Takuyo-Daisan Guyot (yellow squares). Figure from Haggerty and van Waasbergen, [1995].

References:

Haggerty, J.A., and R.J. van Waasbergen, Geochemistry of MIT and Takuyo-Daisan carbonate platforms compared with other northwest Pacific guyots drilled during Leg 144: Implications for their diagenetic history, *In* Haggerty, J.A., I. Premoli Silva, F. Rack, and M.K. McNutt, (Eds.), *Proc. ODP, Sci. Results, 144,* 841-871, 1995.

Van Waasbergen, R.J., and E.L. Winterer, Summit geomorphology of Western Pacific guyots, *In* Pringle, M.S., W.W. Sager, W.V. Sliter, and S. Stein, (Eds.), The Mesozoic Pacific: Geology, Tectonics, and Volcanism, *AGU Geophys. Monogr., 77,* 335-366, 1993.

Winterer, E.L., R.J. van Waasbergen, J. Mammerix, and S. Stuart, Karst morphology and diagenesis of the top of Albian limestone platforms, Mid-Pacific Mountains. In E.L. Winterer, W.W. Sager, J.V. Firth, and J.M. Sinton, (Eds.), *Proc. ODP, Sci. Results, 143,* 433-470, 1995.