DECADAL PATTERNS IN MUD PRODUCTION ON GREAT BAHAMA BANK VIA WHITINGS

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PROJECT OBJECTIVES

- Deploy a deep-learning algorithm to identify whitings in daily MODIS ocean-color imagery over timescales of decades.
- Examine the whiting record for seasonal and multi-year trends and explore their controls.
- Develop an understanding of the variability of non-skeletal mud production through time and its influence on platform-top sedimentology.

PROJECT RATIONALE

The term "whiting" has been used to describe occurrences of lime mud precipitated directly from both marine and fresh waters. As a result of the potential of whitings to contribute to the Bahamas sedimentary record (e.g. Turpin et al., 2011; Purkis et al., 2017), considerable effort has been applied to understand the triggers and mechanisms of precipitation in this locality – a debate that has continued for more than eighty years.

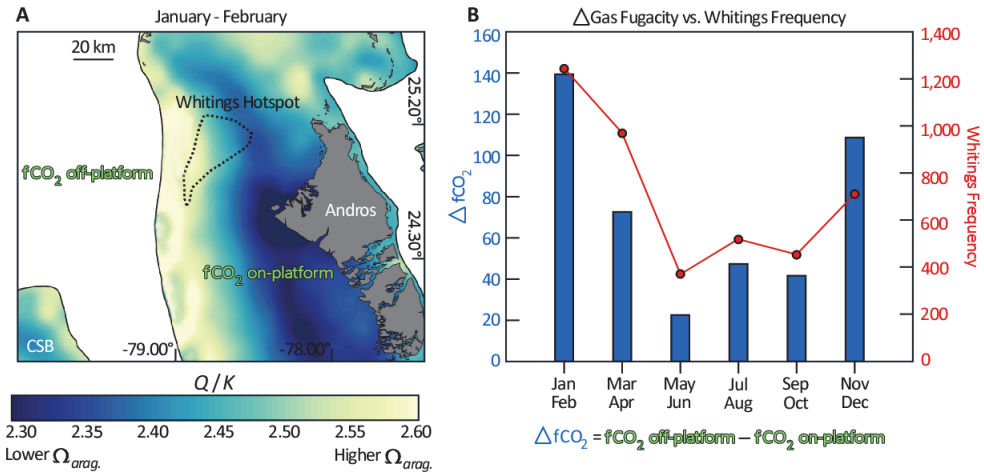

Figure 1: (A) Ωarag. atop GBB is lower in winter than summer, but more spatially heterogeneous because of the mixing of warm off-platform waters with waters chilled by winter storms on the platform top. (B) Cross-plot of bimonthly ΔfCO2 and whitings frequency suggests a possible link between water chemistry and aragonite precipitation.

Recent work by the group has implicated platform-top hydrodynamics as influencing the location and production rate of the whitings mud factory on GBB. Geochemical modeling has suggested platform-top Ωarag. to be higher in summer than winter, as would be predicted from basic thermodynamics, but

that this parameter is more spatially heterogeneous in winter. Furthermore, the whitings hotspot is situated in a zone of locally enhanced Ωarag. (Fig. 1A), induced by the inflow of off-platform waters across the western platform margin (likely facilitated by enhanced tidal exchange across the margin associated with the northerly-flowing Santaren Current), as well as inflow across the eastern margin from the Tongue of the Ocean to the north of Andros Island. To capture the seasonal disparity in platform-top water chemistry, the change in CO_2 gas fugacity (ΔfCO_2) between the off- and on-platform water bodies was computed as bi-monthly averages and cross-plotted against the seasonal whitings frequency (Fig. 1B). Correlation between the two parameters supports the hypothesis that the water chemistry induced by mixing in the whitings zone might serve as an important trigger for enhanced winter precipitation. Furthermore, the trigger appears to be sufficient to overcome the kinetic and thermodynamic forcings, which would otherwise be expected to promote summer whitings.

APPROACH

This study will call upon a newly developed deep-learning algorithm to automate the delineation of whitings from satellite imagery. Automating the counts will allow for more accurate examination of seasonality which, hitherto, have been inaccessible because of the laborious process of manual digitization. Seasonality must be determined over a long period because of the disruptive effect of cloudy days. Morphometric routines will be used to quantify the size, shape, and orientation of whitings through time, in order to more fully investigate the possibility that their trigger might vary seasonally.

SIGNIFICANCE

If sea-surface temperature differentials and hydrodynamics exert control on whitings, ocean acidification is expected to suppress their frequency in the coming decades. This observation has particular relevance to the production of carbonate muds in early Earth history – prior to the evolution of the myriad of carbonate-secreting organisms, abiotic precipitation might have been the only means of producing carbonates. Taking the GBB and its present-day water chemistry as an analog, whitings might have been more spatially localized in the rock record than previously assumed. However, integrated over geological time periods, whitings might still produce thick platform-wide sequences of lime mud as the locus of production migrates through time, but these deposits need not be contemporaneous and therefore may not correlatable.

REFERENCES

Turpin, M., Emmanuel, L., Reijmer, J.J. and Renard, M., 2011. Whiting-related sediment export along the Middle Miocene carbonate ramp of Great Bahama Bank. International Journal of Earth Sciences, 100(8), pp.1875-1893.

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