Lessons from the Past: Using micropaleontology & geochemistry to understand past & future climate changes

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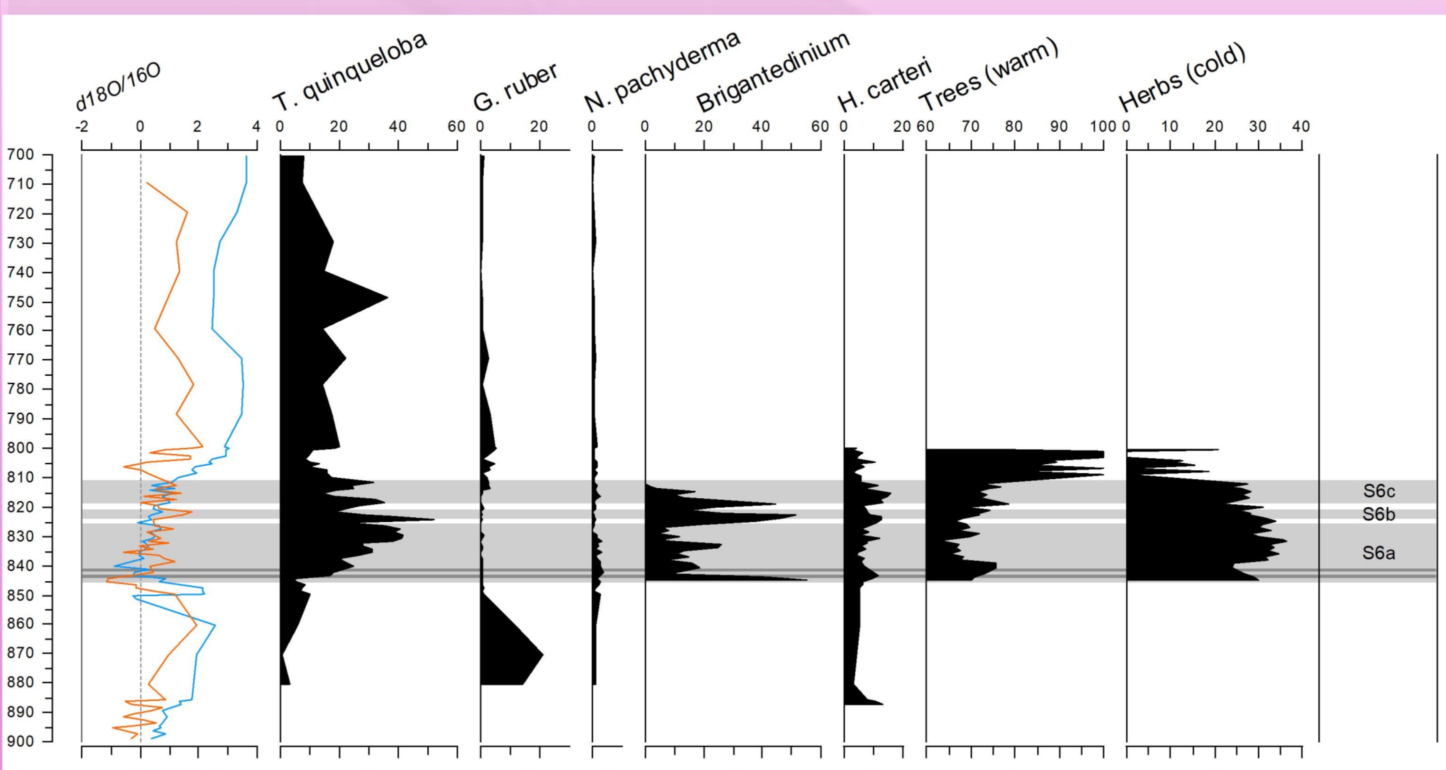
Introduction

Paleoclimatology is the study of Earth's climate before the time of instrumental measurements. With ongoing/rapid climate change that we are experiencing now, it is important to understand how our dynamic planet works and will work in the future. To do this, we must try to understand what happened in the past. Marine sapropels are dark-colored, organic-rich sediment layers that have been found basin-wide in sediments as old as ~14.2 Ma. Their formation is related to changes in climate, circulation, and biogeochemical cycles; and has been found to correspond with times of astronomically driven maximized summer insolation coinciding with precession (wobble of Earth's axis) minimum. These and the surrounding sediment layers hold many types of microfossils, like foraminifera, that can reflect the assemblage that once existed at the time of deposition. Changes in the distribution of the diff. species and the isotopic content of their anatomy are functions of the physical/chemical parameters of the environment where they once lived. This allows us to reconstruct the oceanographic/climatic conditions for the unascertained past of Earth's history. As we continue to increase greenhouse gas emissions leading to increased global temperatures and a future that is not yet fully understood, catastrophic climate driven impacts are expected. Included in these impacts could be events of anoxia in bottom waters leading to future sapropel deposition. All in all, my PhD research using micropaleontology and geochemistry to look in detail at the diff. mechanisms behind sapropel events of different times in the geologic past has promising potential to give us a glimpse of what we can expect for future oceans.

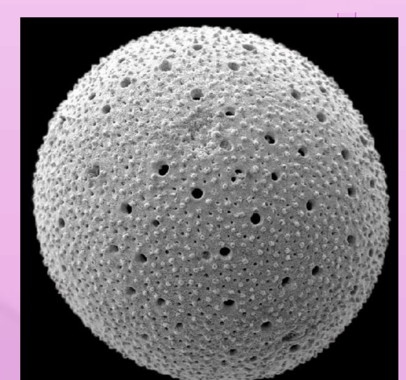
(1) Sapropel S6: ~176ka

This study investigated the "glacial" sapropel S6 layer found in the piston core M25/4-12 retrieved from the deep Ionian Sea (E Mediterranean). It used micropaleontology (foraminifera, nannofossils, pollen, dinocysts) and geochemistry ($\delta^{18}O$) to understand the climatic/oceanographic mechanisms behind the formation of sapropel S6. **Comparing our results with existing literature (Sierro et al, 2022, in press) on sapropel S6, we have proposed that this point in time was a mild/warmer glacial period, and that glacial meltwater was the initial trigger for sapropel S6 deposition by preconditioning the basin for a stratification episode.**

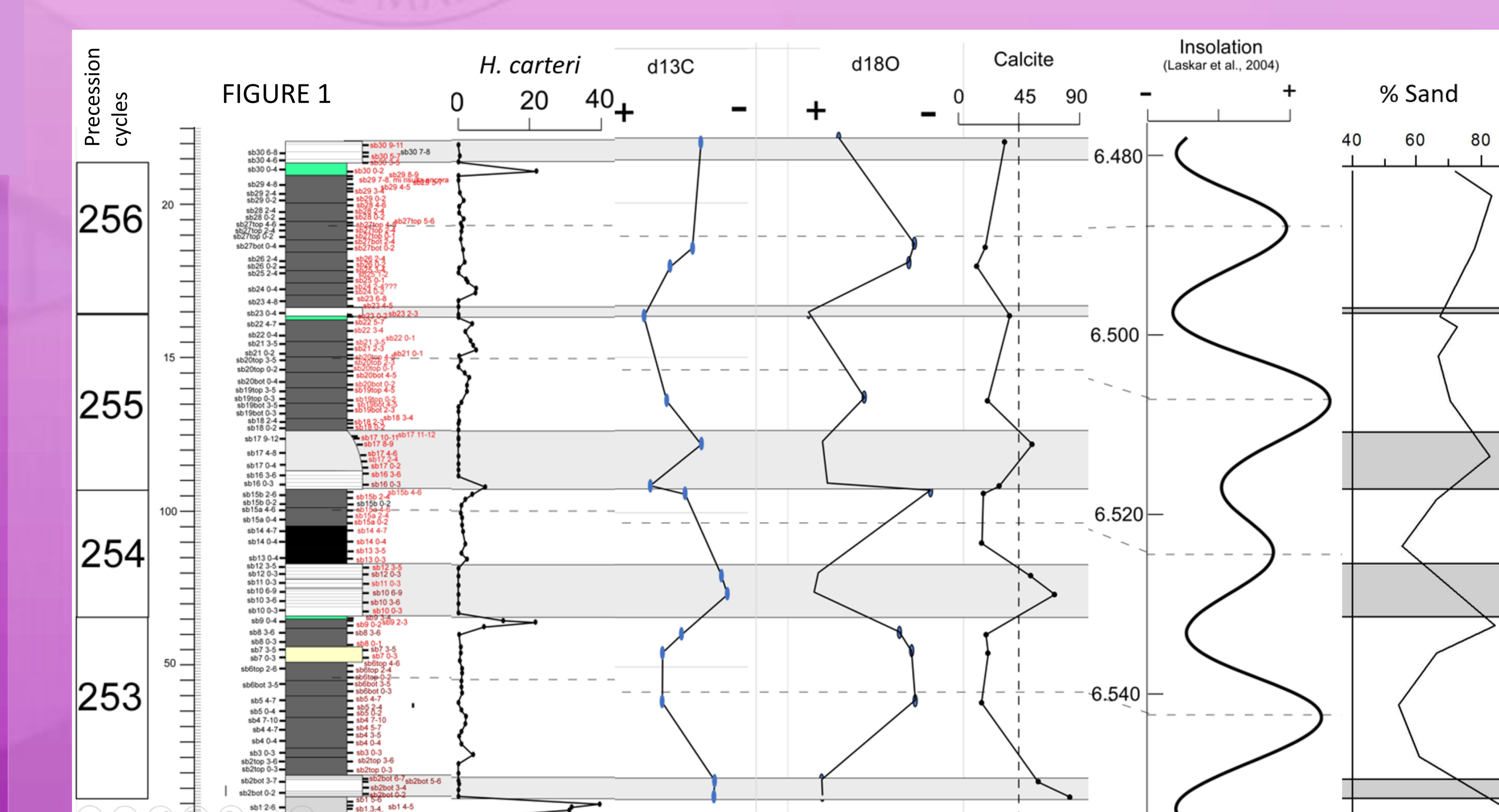


(2) Monte dei Corvi: Low- & high-resolution studies

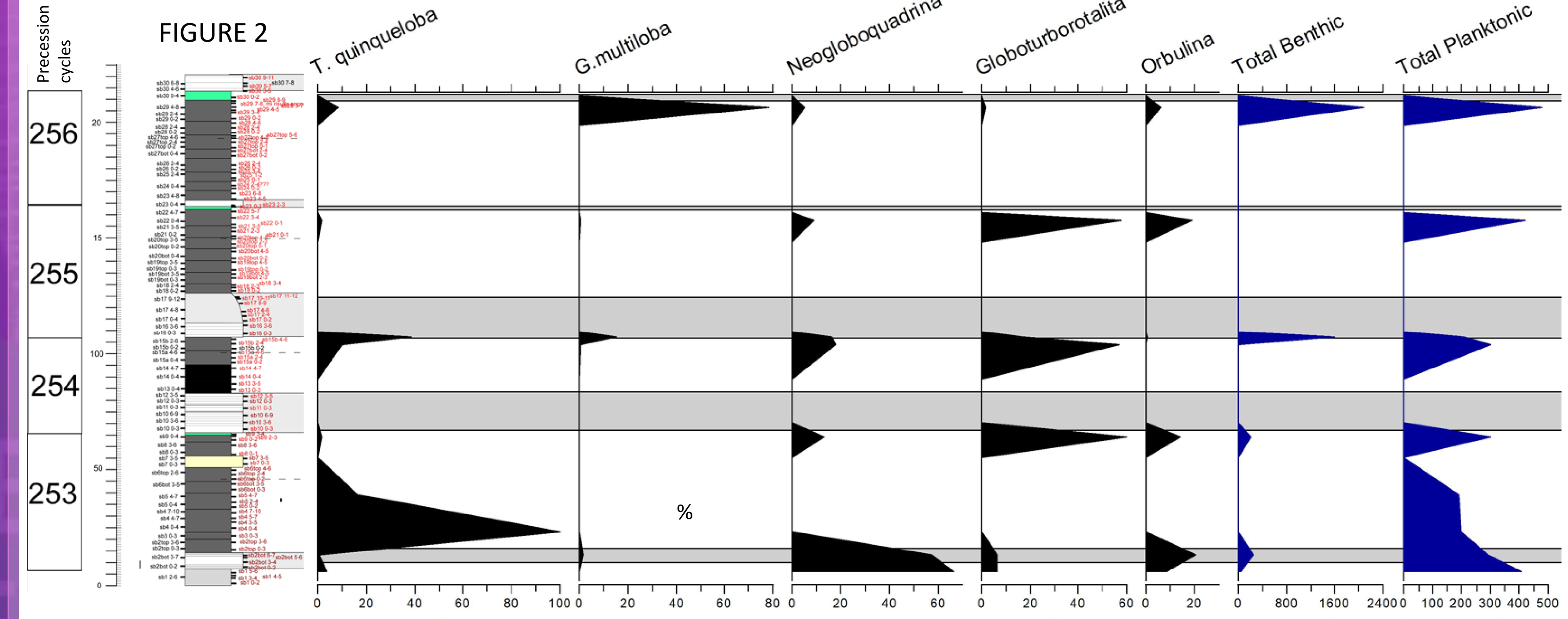
On the coastal cliffs of the Conero Riviera lies the Monte dei Corvi Section (MDC) which is an outcrop of a deposited sequence of uplifted pelagic sediments covering the Miocene Epoch → early Pliocene. Much of this section has been used for many integrated studies which have yielded results like magneto-, cyclo-, chemo-, and bio-stratigraphy, astronomical tuning of precession cycles (limestone→sapropel), and alkenone-derived SST's (Montanari et al., 1997, 2017; Cleaveland et al., 2002; Hilgen et al., 2003; Mader et al., 2004; Iaccarino et al., 2008; Hüsing et al., 2009, 2010; Wotzlaw et al., 2014; Tzanova et al., 2015). **The MDC Section offers a window into the Mediterranean that has not been available. These studies work to reconstruct the events characterizing the environmental history of the Miocene-Early Pliocene in this area.**



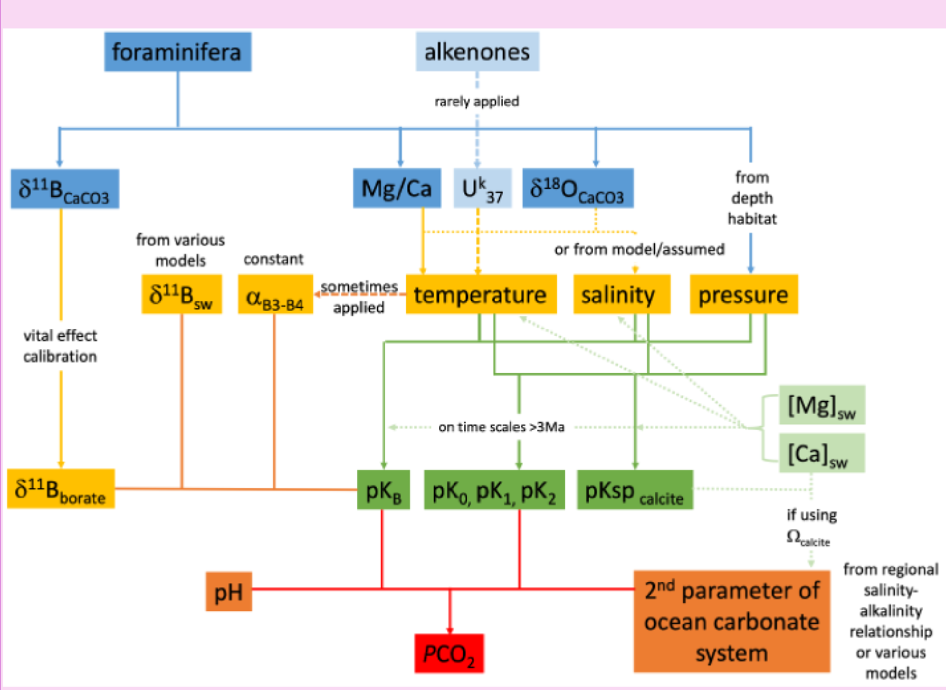
Orbulina universa – Planktic Foraminifera



Low- and high-resolution bulk-rock samples were collected systematically along the proposed precession cycles 249 – 260 (6.634 – 6.412 Ma) (Hüsing et al., 2009). Biostratigraphic (planktic & benthic forams; coccolithophores), grain size, mineral composition, and carbon & oxygen stable isotope analysis was applied on a portion of the samples. **The working results (Figs. 1 - 2) seem to indicate high levels of turbidity (shown by *H. carteri* and benthic forams) at the end of the sapropels and before the limestone layers.**



(3) Boron: paleo-pCO_2 proxy



Through erosion/weathering of Earth's crust, B makes its way into the oceans. As MDC has been studied in detail and resolution of paleo-CO2 proxy coverage is very sparse for the Miocene, we decided to test the feasibility of the location for B isotope reconstruction of pCO_2. After processing, the collected MDC samples were found to be abundant in the planktonic foraminifera, *Orbulina universa*, which happens to be B isotope calibrated. Therefore, if present, ~400 ind. were removed from each sample and sent to *The Foster Lab* (Soton) for analysis. Some of the samples were run for trace elements. The B/Ca and Mg/Ca results were not found to be in the expected range suggesting some diagenetic alteration and the forams were also found to be infilled with calcite. Therefore, we infer that samples collected from MDC are unsuitable for B isotope analysis.

Acknowledgements

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Citaions

Aiudi, L. (2020); de Groot, M. (2017); Hönisch et al., 2019; Rae, 2018; Marschall & Foster, 2018; Foster & Rae, 2016; Montanari et al., 1997, 2017; Cleaveland et al., 2002; Hilgen et al., 2003, 2005; Mader et al., 2004; Iaccarino et al., 2008; Hüsing et al., 2009, 2010; Wotzlaw et al., 2014; Tzanova et al., 2015; Rohling et al., 2015.