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Acevedo-Tirado T., Sánchez-González A.

Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Baja California Sur, Mexico. CP 23096. E-mail: tacevedot2300@alumno.ipn.mx, alsanchezg@ipn.mx

PRODUCTIVITY DYNAMICS IN THE TRANSITIONAL ZONE OF THE MEXICAN PACIFIC: INSIGHTS FROM GEOCHEMICAL TRACERS

Currently, the ocean absorbs approximately 30% of the anthropogenic CO_2 released into the atmosphere each year [1]. The concentration of this greenhouse gas has varied throughout the history of the planet. This change in CO2 concentration is modulated by the atmosphere-ocean, atmosphere-biosphere exchange, and by geological and biological processes. These processes are related to the biological carbon and carbonate pump [2, 3].

This is how the biological pump and its effect, the burying of organic carbon and calcium carbonate on the ocean floor, relates variations in atmospheric CO_2 to carbon fluxes on the seabed [1]. The factors and mechanisms that increase or decrease the burial of carbonates and organic carbon in sediments therefore represent important outputs that control the flow of carbon from the active or surface carbon cycle to the long-term geological cycle [4].

Global warming may cause the land surface to warm relatively faster than the ocean, which could lead to a greater land-ocean pressure gradient and intensify winds along the coast in regions of eastern boundary currents and drive more intense and frequent coastal upwellings [5, 6, 7].

The Mexican Pacific Transitional Zone is a complex region in its oceanographic conditions, which leads to changes in primary and exported productivity. Geochemical tracers: organic carbon (CO), biogenic opal, and calcium carbonate are used to assess primary and exported productivity in sedimentary records.

Organic carbon is commonly used as an indicator of carbon export from the photic zone. Over the past two millennia, there has been a global increase in organic carbon, indicating an overall increase in exported productivity [11]. However, organic carbon is subject to diagenesis and sudden depositional events that lead to misinterpretations about exported productivity [1]. To exclude these interpretations an independent indicator of exported productivity is needed, calcium carbonate is a productivity indicator that represents the production of biogenic carbonate (mainly foraminifera and coccolithophores). Both tracers of exported productivity will be coherent if the preservation of organic carbon has not been altered by diagenetic processes and sudden depositional events [8]. Biogenic opal (mainly produced by diatoms and silicoflagellates) is another major contributor to exported productivity, especially during coastal upwelling events [9].

Global warming may cause marine and export productivity to increase, as winds along the coast drive more intense and frequent coastal upwelling. In this sense, the climatic and oceanographic reconstruction, based on the use of biogeochemical tracers (organic carbon, carbonate and biogenic opal) in the warming episodes of the recent past, i.e. the Holocene Climate Optimum or Medieval Warming Period may be key to understanding the future interactions of marine plankton functional groups in future climate change scenarios in eastern boundary current systems, like the California Current.

The objective of the present study is to quantify the content of organic carbon, biogenic opal and calcium carbonate to infer changes in primary and exported productivity during warming episodes in the transition zone of the Mexican Pacific. The southwestern margin of Baja California Sur is located in the transition zone of the Mexican Pacific, where the current system in this transitional zone is characterized by the California Current flowing into the equatorial zone, the North Equatorial Current flowing west-northwest, and the California Countercurrent flowing toward the North Pole. The California Current carries cold, less saline, oxygenated, nutrient-rich water from the subarctic body of water. Meanwhile, the California Countercurrent, which carries properties of the equatorial subsurface mass, is characterized by being warmer, more saline and poor in oxygen.

The sediment core GC-2 was recovered at a depth of 680 m on the southwestern margin of Baja California Sur, during the October 2009 oceanographic campaign, aboard the RV New Horizon (Figure 1). The sediment core with a length of 144 cm was sectioned at intervals of 1 cm, representing a total of 144 sediment samples. [12]. A subsample of each interval was freeze-dried, macerated in an agate mortar and weighed for analysis. The Organic carbon analysis was performed on a COSTECH 4010 elemental analyzer with an estimated analytical accuracy of 0.2% of BBOT and Urea certified standards. The quantification of biogenic opal will be estimated from 500 mg of sediments and with the technique described by [10]. The extracted silica will be quantified by UV-vis spectrophotometry at 812 nm. A sodium silicofluoride solution with an analytical accuracy of 0.5% will be used as standard.

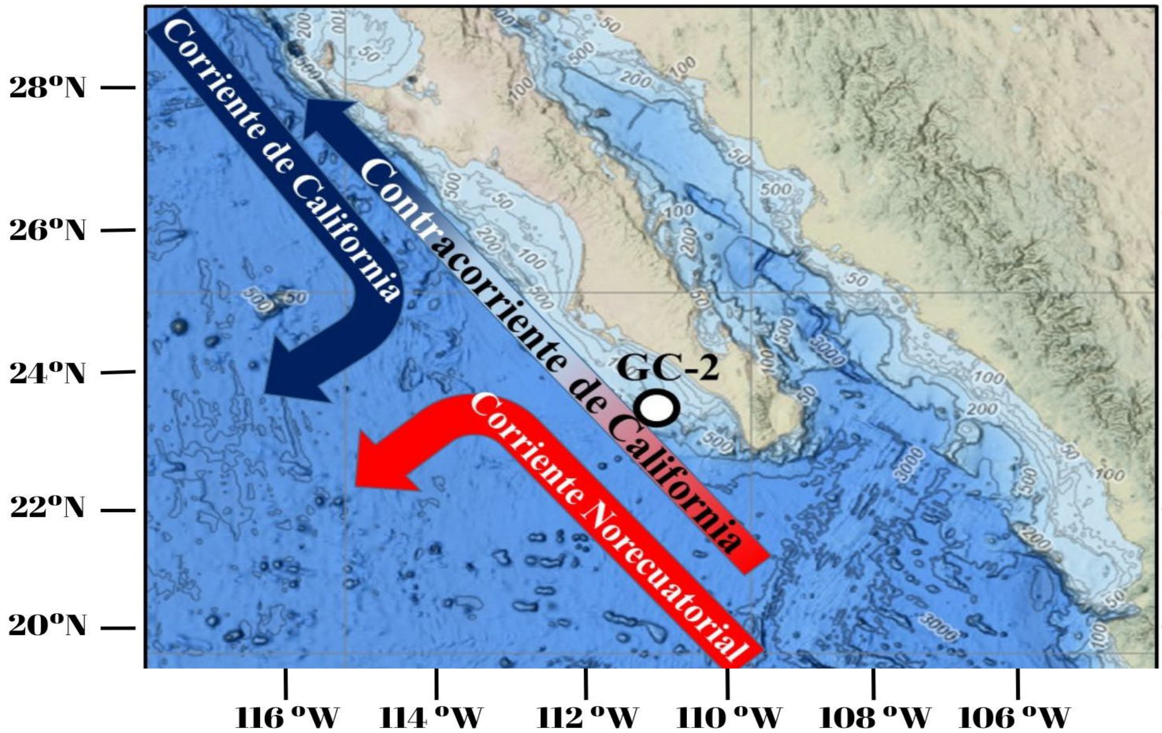

Fig. 1. Diagram of the California, Norequatorial, and California Countercurrent Currents in the Northeast Pacific Transitional Zone [13]. The dot indicates the location of the GC-2 gravity core collected

The organic carbon content ranged from 9% to 14%, with a minimum value of 9.54% and a maximum of 14.35%. Whereas, biogenic opal ranged from 0.2 to 19%, with a minimum value of 0.19% and a maximum of 19.33%. A spectral analysis was performed using the REDFIT procedure [14], which is included in the PAST 2.17b program. The organic carbon content showed periodicity of ~300, ~170 and ~100 years. Biogenic opal showed periodicity of ~310, ~270, and ~70 years. The values of organic carbon and biogenic opal showed a positive correlation with each other, showing an increase in warm periods such as the Roman Warm Period (1800 to 2200 years ago) and the Medieval Warming Period (700 to 1100 years ago). This suggests that primary and exported productivity responds to oceanographic conditions over various time scales.

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