DEPOSITIONAL AND ENVIRONMENTAL CONTROLS ON ORGANIC MATERIAL IN THE VACA MUERTA FORMATION

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PROJECT OBJECTIVES

- Produce a comprehensive depositional model identifying the position of organic rich source rocks within the prograding clinoforms in the Neuquén Basin.
- Identify environmental factors conducive to the development of high Total Organic Carbon (TOC) intervals.

PROJECT RATIONALE

The Vaca Muerta Formation gives access to Late Jurassic – Early Cretaceous strata and offers insights into organic-rich intervals within a prograding sedimentary system during a time interval that represents a major carbon sink in the geologic record. The repeated occurrence of TOC-rich intervals determined in outcrop and subsurface at certain sequence stratigraphic levels within the basin center indicates long-term or repeated optimal conditions for the accumulation of organic rich strata. Based on stratigraphic relationships it is our working hypothesis that the distribution of the organic-rich strata is related to the evolution of the prograding clinoforms and thus can be placed into the geometry of the clinoforms.

While sedimentary rocks high in TOC have been studied for decades, there

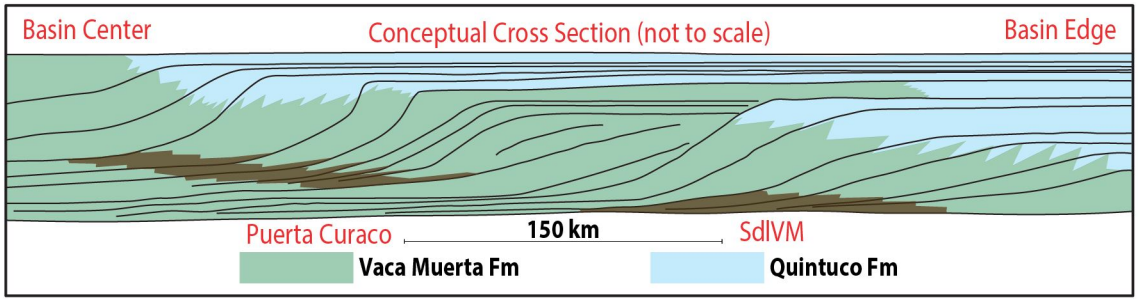

Figure 1. Depositional model of the progradation fill of the Vaca Muerta – Quintuco system. Organic material is concentrated at the extreme toe of slope of the clinoforms.

is still no consensus as to which factors control their deposition. There is, however, agreement in the literature to three main triggers for the presence of organic material in the sedimentary record. These include 1) Production: attributable to high rates of organic productivity, usually stimulated by a high nutrient flow. 2) Preservation; the presence of oxygen-poor bottom waters that limit reactions degrading organic matter. 3) Dilution; decreasing sedimentation rates that would otherwise dilute the concentration of organic matter. It is likely that within portions of the transgressive–regressive cyclicity, each of the three aforementioned primary factors plays a more prominent role.

SCOPE OF WORK

To produce a comprehensive depositional model, our existing TOC dataset will be integrated into the clinoform geometries using a regional seismic transect. To identify environmental factors conducive to high TOC intervals, geochemical proxies are used to identify the controls on organic material. A primary productivity driven model, as suggested by Pedersen and Calvert (1990) would mean that formation of organic-rich rocks is dependent upon elevated productivity - controlled by the availability of nutrients present in the water column. To examine this, samples from identified high TOC intervals will be measured for trace elements (e.g. Ba, P, S) as a proxy of nutrient input and elevated bio-productivity. The organic preservation is achieved by means of a well-stratified water column and anoxia. Such anoxic events manifest themselves in the geologic record in many ways. One, proposed by Gill et al. (2011), is a positive sulfur isotope excursion. These isotopic shifts can be measured in the $\delta^{34}S_{CAS}$ (Carbonate-Associated Sulfur) and $\delta^{34}S_{pyrite}$ and reflect increased organic burial under large scale anoxic and euxinic conditions.

Finally, a sedimentation rate or burial rate driven model has been used to assess dilution as the controlling factor. The "condensed section" model of Creaney and Passey (1993) assumes that as a response to rapid sea-level rise, a condensed section will form associated with the maximum flooding surface. The lack of detrital input will ultimately concentrate the organic matter in the sediment. The "condensed section" model aligns well with the stratigraphically aligned distribution of organic rich intervals observed in the data.

SIGNIFICANCE

This study will document the controls on laterally and vertically heterogeneous organic-rich sediments of the Vaca Muerta Formation. We will identify depositional trends and environmental factors that are conducive to the development of high TOC intervals. While most of this study will be done in outcrop, the inclusion of sub-surface samples from nearby wells will show the strength of using outcrop studies to understand the sub-surface and help improve the exploration efforts in the basin.

REFERENCES

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