

# ELEMENTAL SIGNATURES OF PRODUCTIVITY AND PRESERVATION IN THE VACA MUERTA FORMATION

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## PROJECT OBJECTIVES

- Conduct laboratory-based measurements of elements that were poorly resolved in XRF dataset, including Ba, U, and Mo using ICP-QQQ.
- Calculate enrichment factors, elemental ratios, and conduct rolling window regression analysis using integrated dataset.
- Refine interpretations for differences in the origin (enhanced productivity and/or preservation) of high %TOC intervals in Upper Tithonian and Lower-Middle Berriasian aged cores from the Vaca Muerta Formation.

## PROJECT RATIONALE

The Vaca Muerta Formation in the Neuquén Basin is one of the largest unconventional reservoirs in the world, yet consensus on the geological controls of intervals with high total organic carbon (TOC) content has yet to be established. Understanding the distribution of TOC within the basin has been a theme of major research and application of elemental proxies for paleoproductivity and preservation have provided new insight into potential controls on high TOC intervals. Prior work in the southern sub-basin has identified zones of both oxic and anoxic bottom waters in proximal depositional environments. In contrast, paleoenvironmental studies incorporating elemental signatures in the northern sub-basin are limited in spatial extent and support periodic transitions from anoxia to euxinia.

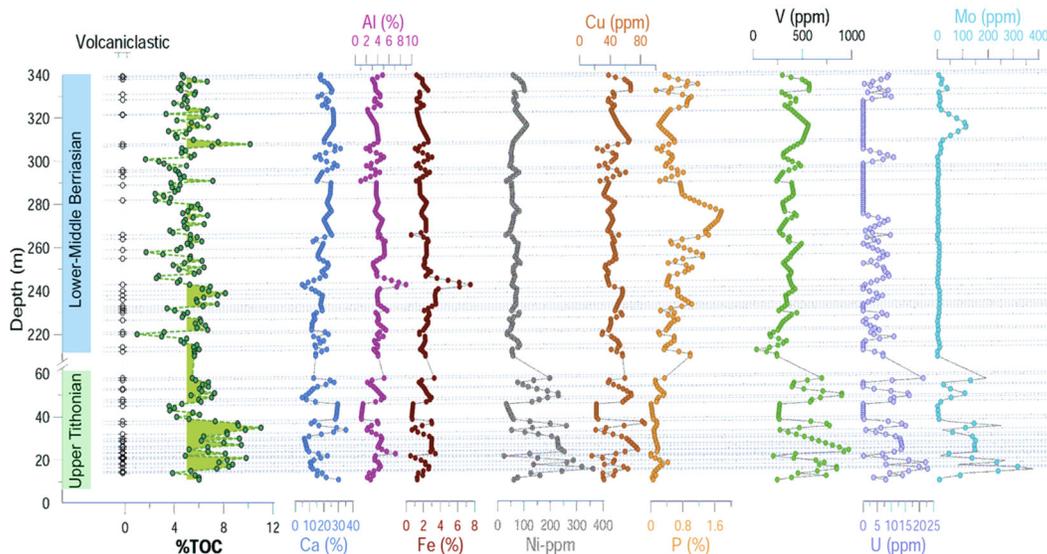


Figure 1: Variability in elemental concentrations of cored intervals from the Upper Tithonian measured by handheld Goldeneye XRF versus depth in meters above the base of the Vaca Muerta Formation. %TOC was previously measured and reported by Tenaglia et al., 2020. Occurrences of volcanoclastic materials are denoted as dashed grey lines across the plot.

In our recent analysis of elemental proxies for productivity and preservation in cores from the Upper Tithonian and Lower-Middle Berriasian intervals of the Vaca Muerta at El Trapijal, potentially important differences in geological controls on high TOC (>5%) intervals were observed. Based on XRF measurements of Ni, Cu, and P, the Upper Tithonian high TOC intervals were interpreted to have originated from enhanced productivity, possibly linked to volcanoclastic input of limiting nutrients. Analysis of redox proxies like V, Mo, and U suggested that the Upper Tithonian was also characterized by high preservation potential driven by anoxic-euxinic bottom waters (Fig. 1). The Lower-Middle Berriasian interval lacked elevated concentrations of productivity indicators Ni and Cu but contained elevated concentrations of P. Paleo-redox proxies like Mo, U, and V were limited by XRF detection limits, requiring further analysis using instrumentation with sub-ppm level detection limits. Here, we will report on new analyses of productivity and redox sensitive elements, such as Ba, Cr, Co, W, Cd, Mo, U, and V/Mo, using discrete samples of the Vaca Muerta Formation at El Trapijal.

## **APPROACH**

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We will accomplish these new measurements using ICP-QQQ technology, which will allow for characterization of these elemental concentrations at three orders of magnitude lower than XRF. Using this improved dataset, we will present calculations of enrichment factors (*sensu* Tribovillard et al., 2006) using the Post Archean Australian Shale values for normalization following previous studies in the basin at Puerta Curaco and Covunco. Finally, we will conduct rolling window regression analysis (Oehlert and Swart, 2019) of this dataset to investigate high-resolution changes in productivity and paleo-redox proxies in both intervals to refine our interpretation of paleoenvironmental conditions during the deposition of the Vaca Muerta Formation.

## **SIGNIFICANCE**

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Better understanding of the controls on high TOC intervals in the Vaca Muerta Formation will improve understanding of paleoenvironmental and paleo-redox controls in one of the largest unconventional reservoirs in the world.

## **REFERENCES**

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