SEARCHING FOR ELEMENTAL SIGNATURES OF SWEET SPOTS IN THE VACA MUERTA FORMATION

Amanda M. Oehlert, Ralf J. Weger, Gregor P. Eberli and Laura Rueda

PROJECT OBJECTIVES

- Conduct high resolution elemental analysis on ~400 samples collected from short cores drilled into outcrops of the Vaca Muerta Formation.
- Apply the increased analytical sensitivity (ppt to ppq) and elemental range of QQQ-ICP-MS to search for diagnostic elemental signatures of high TOC 'sweet spots'.
- Statistical analysis of elemental composition (rolling window regression, principal component analysis, pairwise correlations).
- Synthesize with previously collected data (Aavatech XRF Core Scanner and TerraSpec Halo Mineral Identifier) for integrated geochemical perspective on the Vaca Muerta Formation.

PROJECT RATIONALE

Detailed, multi-scale geomechanical, sedimentological, and diagenetic studies of the Tithonian to Valanginian Vaca Muerta Formation have demonstrated the spatial variability of this source rock, and the important role it plays in the Neuquén Basin petroleum system in Argentina (Eberli et al., 2017; Sánchez et al., 2018). Sweet spots, or intervals containing high total organic carbon (TOC), have been found to

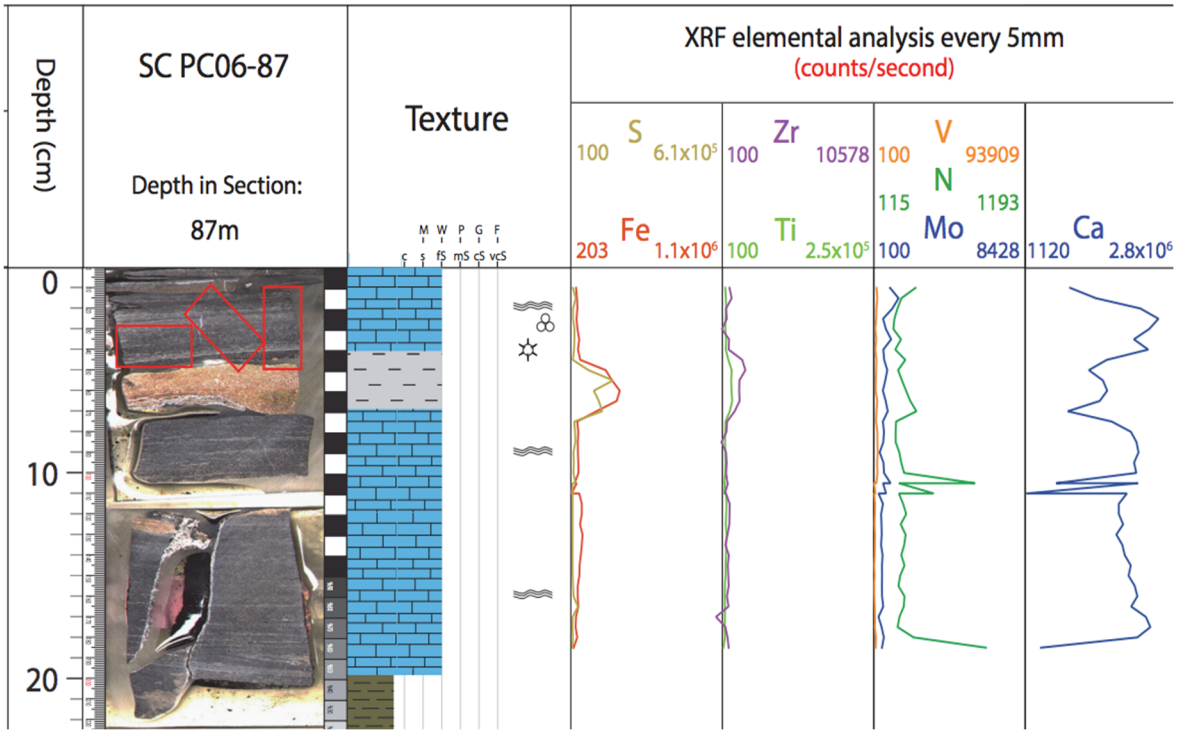

Figure 1. Example of a short core from Puerta Curaco, the lithological description, and results of XRF core scanning conducted by the Vaca Muerta Team at the CSL-Center for Carbonate Research (Eberli et al., 2017).

occur in not readily predictable patterns within the progradational system in both the subsurface and outcrop (Eberli et al., 2017). Recent geochemical analysis of the Vaca Muerta Formation and other globally distributed unconventional reservoirs documented heterogeneity within these depositional environments that is related to facies transitions, mineralogy, and redox state (Sánchez et al., 2018). The development of new analytical techniques like triple-quadrupole inductively coupled plasma mass spectrometry (QQQ-ICP-MS) expands the elemental analytes of interest from ~20 to more than 50 elements, and significantly enhances the analytical resolution of such analyses to the parts-per-trillion to quadrillion threshold. We will conduct discrete analyses of quantitative elemental concentration of ~70 elements using QQQ-ICP-MS to search for diagnostic elemental signatures of sweet spots in the Vaca Muerta Formation.

APPROACH

Approximately 400 discrete samples will be collected from the suite of short cores drilled in the Puerta Curaco outcrop area of the Vaca Muerta Formation. Quantitative elemental analysis will be conducted using a newly acquired Agilent 8900 QQQ-ICP-MS, which provides chemical resolution of isobaric interferences, the lowest detection limits for notoriously difficult to measure elements like sulfur, silicon, phosphorus and arsenic, and the possibility to measure isotopic composition of some elements. Statistical analyses (rolling window regression, principal component analysis, and pairwise correlations) will be conducted to quantitatively evaluate elemental signatures and their relationship to TOC data.

SIGNIFICANCE

Enhanced elemental characterization of samples of short cores from the Vaca Muerta Formation at the Puerta Curaco section are expected to provide new insight into geochemical indicators of high TOC intervals (sweet spots) and contribute to the understanding of the geological processes that produce spatial heterogeneity in elemental concentrations. Integration of QQQ-ICP-MS data and statistical analyses with previously collected elemental (XRF Core Scanner) and mineralogical data with a handheld Near-Infrared Spectrometer will provide a high-quality quantitative calibration of field-based measurements of the Vaca Muerta Formation.

REFERENCES

Eberli, G.P., Weger, R.J., Tenaglia, M., Rueda, L., Rodriguez, L., Zeller, M., McNeill, D., Murray, S, and Swart, P.K. (2017) The Unconventional Play in the Neuquén Basin, Argentina- Insights from Outcrop for the Subsurface. In: Unconventional Resources Technology Conference, Austin, Texas.

Sánchez, L.E.R., McNeill, D.F., Eberli, G.P., Tenaglia, M., Peterson, L.C., Swart, P.K., and Weger, R.J. (2018). High-resolution geochemical analysis of cycles of the Vaca Muerta Formation, Neuquén Basin". AAPG Annual Convention and Exhibition.