# ACOUSTIC AND ELECTRICAL CALIBRATION OF DIFFERENT VACA MUERTA FACIES (YEAR 3)

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## PROJECT OBJECTIVES

- Produce a comprehensive petrophysical data set (porosity, acoustic velocity, resistivity, permeability, and pore structure) of the facies in the Vaca Muerta Formation.
- Establish an acoustic and electrical data set for each of the Vaca Muerta facies in order to facilitate well log interpretation.
- Define the control of mineralogy and clay content on the petrophysical properties and, in particular, the acoustic anisotropy.
- Examine the relationship between clay content, acoustic velocity, and resistivity to find differences between ductile and brittle behavior of the mudstones of the Vaca Muerta Formation.

## PROJECT RATIONALE

Unconventional resource plays rely primarily on seismic data to recognize target intervals suitable for hydraulic fracturing. Successful exploitation of such plays requires reservoir zones to be brittle, porous, and rich in hydrocarbons. These properties are largely dependent on the composition of the background rock, and TOC and carbonate content. In addition, these properties have to be identifiable from the seismic signature. Some efforts have been made to calibrate different seismic and acoustic impedance facies in the Vaca Muerta with core data, but few laboratory calibrations have been published. Thus, this study aims to generate laboratory measurements of horizontal and vertical acoustic velocities as an aid to assess the mechanical properties of different facies within the Vaca Muerta Formation.

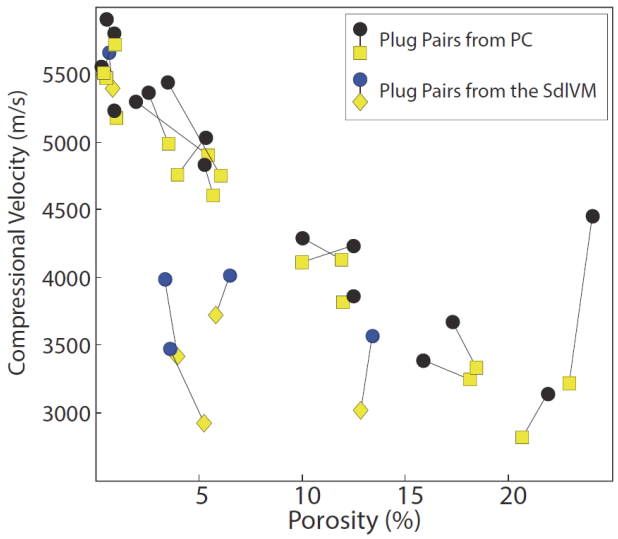


*Figure 1. Anisotropy measurements performed until early 2017. Large differences between horizontal and vertical velocities emphasizes the importance of accurate anisotropy determination in Vaca Muerta mudstones.*

## SCOPE OF WORK

Unaltered plug samples (little to no surface exposure) of representative facies and rock types within the Vaca Muerta Formation were retrieved from different outcrop locations by drilling over 100 m of short cores (3" diameter). Over 40 m of recovered core, strategically

distributed throughout the Puerta Curaco reference section, allowed all dominant facies of the Vaca Muerta Formation to be sampled.

We plan to measure acoustic velocity, porosity and resistivity of all samples and determine the mineralogy using XRD (X-ray diffraction). Chemical methods will be used to determine the carbonate content and the amount of Total Organic Carbon (TOC) will be measured on an Elemental Analyzer. Acoustic velocities will be measured on over 150 plug samples from both short core and sub-surface samples, while porosity will be measured for all plug samples under a variety of pressure conditions and saturation states. Furthermore, we will extract core plugs at three different angles to assess the anisotropy within the samples. The measured acoustic data is compared to data from mudstones of different ages and locations. Some of these measurements have already been completed and provide the first results (Figs 1 and 2).

## FIRST RESULTS

Porosity varies between 1-29%, while compressional velocities vary between 3 and 5.5 km/sec and their Poisson's-ratio ranges from 0.19 to 0.33. Carbonate content is between 1% and 89%, while TOC varies between 1-10%. The Vaca Muerta mudstones show substantially lower compressional and shear velocities than most other datasets. In addition, Vaca Muerta mudstones display a very high degree of anisotropy (VTI) with an average $\varepsilon$ of 0.06, ranging from 1-15%.

*Figure 2. Example of core plug extraction at several different angles at almost the same sampling location.*

## SIGNIFICANCE

Well documented acoustic properties of the different facies in the Vaca Muerta Formation will not only improve well log interpretation, but enhance understanding and the ability to interpret seismic data and its attributes. The study will produce a comprehensive data set of mineralogical and petrophysical properties currently unavailable for organic-rich fissile mudstones and will aid and improve seismic processing and result in better imaging.