**UP02**

**Pozo D-129 Formation, new shale play? A case study in an oil field on the fold belt of Golfo San Jorge Basin, Argentina**

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Introduction

Hydrocarbons associated with unconventional reservoirs have a continuous, regional-scale distribution and are independent from trap type. Shales are one of the Earth’s most common sedimentary rocks. It is a fine-grain rock composed mainly of clay flakes and tiny fragments of other minerals, especially quartz and calcite. Shale can be a gas/oil reservoir, but only formations with certain characteristics (source rock, seal and reservoir) are viable for development.

According to the US Energy Information Administration, Argentina holds the second largest recoverable shale gas reserves worldwide and the fourth largest recoverable shale oil reserves worldwide (Kuuskraa et al, 2013). In 2010, YPF started a complete evaluation and data acquisition from the different sources rock in Argentina, among them the shales of the Golfo San Jorge Basin.

This rift to sag basin is located in southern Argentina between the Somoncura and Deseadocratons in the north and south respectively. It trends roughly east-west between 45-47° south latitude (Fitzgerald et al, 1990). The study area is located in the western part of the basin (Figure 1). The main source rock in the basin is the Pozo D-129 Formation, responsible for most part of the oil production in the basin which to date has produced more than 600 x 10³ m³ (3800 x 10³ barrels) of oil and 70.3 x 10⁹ m³ of gas/oil. It is a lower Cretaceous lacustrine unit with high pyroclastic participation and the maximum thickness reaches up to 1500 m in the central area of the basin. Based on lithological and geochemical variations, three main sections have been recognized, where the upper section shows the highest TOC and HI values with a type I kerogen (Basile y Ugé, 2011).

The present work aims to introduce a complete geochemical characterization and analysis of the upper section of Pozo D-129 Formation as a shale play in an oil field on the San Bernardo fold belt of Golfo San Jorge Basin.

**Experimental and Workflows**

In order to evaluate this source rock as a shale reservoir, 3400 rock samples from 200 wells were analysed. Data gathered include Total Organic Carbon (%TOC) by acidization and LECO, Programmed Pyrolysis by Rock Eval and different organic petrography techniques (vitrinite reflectance (%Ro), visual kerogen, thermal alteration index and maceral analysis).

In order to predict the fluid type to be produced from the shales, mud gas from some conventional wells were interpreted and samples extracted from cores and cutting were analysed through GC thermal extract, High Resolution Gas Chromatography, MPLC (for saturates, aromatic, resins and asphaltenes), Saturate and Aromatic Biomarkers by GCMS and Stable Carbon Isotopes in Saturate and Aromatics Fraction.

Also, oil production samples were collected from conventional wells (oil sands reservoirs interbedded within the organic shales) and studied following the same analytical program than the extracted samples from rocks. Additionally, gas production and mud gas samples were analysed by GC Compositional Analysis and Carbon and Deuterium Isotope Analysis [13C/12C (δ13C) and 2H/1H (δD)] on the gas components.

Most of the analytical results were used to calibrate the basin modelling in 1 & 3 dimensions and finally, different geochemical maps were generated to determine sweet spots in shale (Figure 1).

**Results and Discussion**

In the study area, the upper section of Pozo D-129 formation has a variable thickness from 100 to 250 meters and an average depth of 1800 meters.

The organic richness ranged from 0.5 to 5.5% of actual TOC with averages close to 2.5-2.8%, representing a very good source rock (Figure 2). The S1 peak from pyrolysis showed the presence of free hydrocarbons (S1 values are higher than 1 mg HC/gr rock) and the S2 peaks reach values of 20-25 mg HC/gr rock, showing excellent petroleum potential. The S1/TOC parameter also shows the presence of producible hydrocarbons.

Maturity from vitrinite reflectance varies from top to base between 0.56% and 0.74%, the Tmax values from pyrolysis did not show changes in the entire analyzed interval and the hydrogen indexes (HI) decrease from top to base and the high values measured on the topsamples (up to 800 mg HC/gr TOC) are related to the maturity of the rock (immature to low mature).

No match could be observed between the compositional fractions and maturity parameter obtained from the extracted samples from rocks and production oil. Extracted samples correspond to medium and early mature oils, whereas the production samples show a very high saturated hydrocarbons phase and high maturity oils. Gas production samples showed a very rich gas composition and an equivalent maturity from isotopes around 1.2% VRE for C1 and a 0.9% VRE for C2. These different isotope behaviors for C1 and C2 gases were associated to different sources rocks, or the same source rock with different maturity degrees.

Figure 1. Location map, wells and maturity trend.
In conclusion, the Pozo D-129 Formation showed adequate shale play cutoff parameters (%TOC, thickness, depth, type of kerogen and rock mineralogy). However, the maturity, as a key parameter, did not reach the minimum value to be considered a shale reservoir. Due to this interpretation and the excellent production results obtained from conventional wells, Pozo D-129 formation was classified as a hybrid shale oil play.

As a follow-up of this research, one well was stimulated in unconventional way to evaluate the Pozo D-129 formation as a hybrid shale oil reservoir and the results showed a very good match between the geochemical studies and the type of production fluids.

Figure 2. Geochemical log and geochemical graphs from oil and extracted samples

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