

The application of AVO, seismic attributes, and velocity mapping in understanding the Doina discovery in offshore Romania, Black Sea Province

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The Doina and Ana gas fields in the Midia concession are Pliocene-age shallow-marine sandstone reservoirs located 100km offshore in Romanian waters of the Black Sea in water depth between 60 and 90m. Doina was discovered in 1995 by the Doina 1 well, which encountered dry gas within Dacian (Pliocene) and Pontian (Miocene) siltstones, and the Doina 2 appraisal well tested dry gas at rates up to 17 mmcf/gpd. Activity stepped up in 2007 when Midia Resources, a wholly owned subsidiary of Sterling Resources, started a re-evaluation of the concession. Ana was discovered in that year by the Doina Sister-1 (now Ana 1), flowing 18.6 MMcf/g of dry gas from Dacian sandstones and siltstones. The Ana 2 and Doina 4 wells have since been drilled as successful gas appraisals. These wells also applied new logging technologies (shear sonic and CMR logs) to unlock the reservoir characterisation issues and provide seismic calibration for prediction beyond the wellbore. In 2008, a 3000 line-km 2D seismic survey was acquired, then subsequently merged with existing 2D seismic to produce a final 2D seismic volume with dip lines spaced about 200m apart.

Both fields lie along a narrow, 40+km long fault terrace oriented NE-SW, which dips to the NW and plunges slowly SW from Doina towards the Ana field. Structural crests are relatively shallow, 1080 m tvdss at Doina and 1115 m tvdss at Ana. The reservoir is very fine grained, thinly bedded, muddy to silty, immature sands. Trap mechanism is faulted 3-way dip closure at Doina, and faulted 4-way roll-over at Ana. Top seal is by Dacian shales. Hydrocarbon is very dry biogenic gas (99% CH₄), self sourcing from within the Neogene.

The exploration model around the Midia concession is that seismic amplitude brights correlate to gas filled reservoir, and this is supported by detailed Rock Physics analysis & modelling based around . In 2009, the merged 2D seismic was inverted, and a short AVO assessment was carried out. Outcomes from these studies are that AVO alone is not sufficient to identify gas, but that certain inversion products clearly discriminate gas charged reservoir from the background. In addition, there is clear evidence from rock physics and elastic parameter crossplots to support a deeper GWC. Various seismic amplitude and inversion attribute maps show clear, mappable anomalies that conform to structural contours at Ana, but over Doina continue well downdip to the SW, going below the interpreted GWC. The challenge for Doina has been to integrate technology-led geophysics with sound geologic reasoning to arrive at robust, defensible volumetric estimates that do not require special pleading.

In the end, it has been old fashioned, detailed interpretation on vertical seismic sections that supplied the answer. An extensive system of cut and fill channels in the overburden that was not previously recognized has been identified and mapped using the modern, densely spaced 2D seismic. Nearby offset wells through similar features provide a geologic analogue to invoke variable (lower) velocity channel fill that would result in TWT pushdown sufficient to cause the non-conformance between depth maps and attribute maps. Mitigating for this kind of velocity anomaly produces depth contour maps where the attribute anomalies are consistent with structure.