Seismic interpretation has evolved during the last decades. Several workflows were developed and successfully implemented by the geoscience's specialists to reveal subsurface geology and improve seismic interpretation quality and cycle time. The advancement of technology allowed the use of more powerful algorithms, including visualization and combination of attributes, such as the RGB (Red, Green, Blue) blend of frequency volumes more efficiently.

Frequency decomposition is a technique that filters the seismic data into its frequency band pass components. The combination of three selected magnitude volumes for the low, mid, and high band frequencies into red, green and blue (RGB) respectively, allow seismic interpreters to maximize the use of wiggles, their amplitudes and frequencies, to better describe both the thickness and lithology variation of layers (Chopra et al, 2007).

The ability to validate the proposed geological concepts is crucial to close the loop and reduce uncertainties of identified opportunities to better assess the remaining potential of the area. This can be achieved by generating models with different geometries, rock properties, and/or pore fill to be tested. Synthetic volumes and their respective RGB blend volumes for a series of alternative possible scenarios were created based on the information of the sparse well information in the surroundings area and analogues for the study area. The synthetic results were then compared with the real RGB blend.

The Cerro Piedra study area is located at the western sector of the northern flank of the San Jorge mature Basin and is covered by 3D seismic recently acquired in 2016. The shallow Tertiary reservoirs, called the Rio Chico (fluvial), the Sarmiento (alluvial plain), and the Chenque (shallow marine) Formations, constitute the objective of interest of the present study (Foix et al, 2013). A total of 148 wells were drilled in the area, mainly focused in the development of deeper reservoirs, the Castillo and Bajo Barreal Formations from the Chubut Group. Consequently,
the Tertiary reservoirs remains underdeveloped, even though they are productive in nearby fields (Zabala Field) some 30 km away from the study area.

This work demonstrates the added value of applying seismic geomorphology using frequency decomposition along its validation to reduce uncertainties of identified potential opportunities for further development in a mature basin.

**Selected References**


Seismic interpretation has evolved during the last decades. Several workflows were developed and successfully implemented by the geoscience specialists to reveal subsurface geology and improve both seismic interpretation quality and cycle time. The advancement of technology allowed the use of more powerful algorithms, including visualization and combination of attributes, such as the RGB (Red, Green, Blue) blend of frequency volumes more efficiently.

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The ability to validate the proposed possible geological concepts is crucial to close the loop to reduce uncertainties of identified opportunities and better assess the remaining potential of the area. This can be achieved by generating a series of models where different geometries, rock properties and/or pore fill are tested. Synthetic volumes and their respective synthetic RGB blend volumes for a series of alternative scenarios are created based on the information of well information in the surroundings area and analogues. The synthetic results are then compared with the RGB blend from the actual seismic data.

The Cerro Piedra study area is located at the western flank of the San Jorge mature basin and is covered by 3D seismic recently acquired in 2016. The shallow Tertiary, called Rio Chico (fluvial), Sarmiento (alluvial plain) and Chonque (shallow marine) Formations, constitute the objective of interest of the present study. A total of 148 wells were drilled in the area, mainly focused on the development of deeper reservoirs, called Castillo and Bajo Barreal Formations in the Chubut Group. Consequently, the Tertiary reservoirs remains under developed, even though they are productive in nearby fields (e.g. the Zabala field) some 30 km away from the study area.

This work demonstrates the added value of applying seismic geomorphology by frequency decomposition along its validation to reduce uncertainties of identified potential opportunities for further development in mature basins.
3- CASE STUDY. CERRO PIEDRA. WESTERN SAN JORGE BASIN, ARGENTINA

LOCATION, GEOLOGICAL SETTING & DATA AVAILABILITY

The Golfo San Jorge basin is an intracratonic basin located in central Patagonia, linked to the Gondwana breakup, and associated with an extensional framework. Petroleum systems are associated with continental sequences (fluvial and lacustrine).

FIELD DESCRIPTION AND RESERVOIR OBJECTIVES (TERTIARY)

OIL PRODUCTIVE ZONE BAJO BARREAL FM.
RESERVOIRS

CERRO PIEDRA ASSET

148 DRILLED WELLS
611 km² SURFACE AREA

DATA CONDITIONING & SEISMIC INTERPRETATION

1 – VOLUME BASED STRUCTURAL SEMI-AUTOMATIC WORKFLOW

2 – SEISMIC INTERPRETATION: HORIZONS & FAULTS

THE WESTERN FLANK OF THE SAN JORGE BASIN HAS TWO STRUCTURAL STYLES: THRUST & EXTENSIONAL TECTONICS

AREA OF INTEREST


SCHEMATIC STRATIGRAPHIC COLUMN (MODIFIED FROM SYVORN ET AL. 2001)

WELL A

WELL B

DETECTED & INTERPRETED "GEOBODIES" – TERTIARY FM.

GOLFO SA JORGE BASIN

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DATA CONDITIONING & SEISMIC INTERPRETATION

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SCHEMATIC STRATIGRAPHIC COLUMN (MODIFIED FROM SYVORN ET AL. 2001)

WELL A

WELL B

DETECTED & INTERPRETED "GEOBODIES" – TERTIARY FM.
3- CASE STUDY. CERRO PIEDRA. WESTERN SAN JORGE BASIN, ARGENTINA (CONT.)

FREQUENCY DECOMPOSITION: METHODOLOGY TO CREATE THE “RGB BLEND” CUBE OF OPTIMUM FREQUENCIES

FREQUENCY ANALYSIS ALONG SEISMIC TRACE OF INTEREST

HIGH DEFINITION (HD) FREQUENCY DECOMPOSITION RGB BLEND ALONG WEST EAST SEISMIC SECTION

ON-THE-FLY REFINEMENT SELECTION TO OPTIMISE ANOMALIES & FREQUENCY BANDS

SELECTED FREQUENCIES: 25, 32, 42 Hz

MAGNITUDE SEISMIC CUBES FOR OPTIMAL FREQUENCIES

CLOSE THE LOOP: TESTING & VALIDATION OF ALTERNATIVE POSSIBLE GEOLOGICAL SCENARIOS
IN TERMS OF AMPLEITUDES, PHASE & FREQUENCY
UNTIL THE SYNTHETIC MODELED RESULTS HAVE A "HIGH CORRELATION" WITH THE SEISMIC & FREQUENCY DECOMPOSITION ACTUAL DATA

POSSIBLE GEOLOGICAL SCENARIOS & “VALIDATE” WORKFLOW

SEISMIC AMPLITUDES ORIGINAL DATA

SEISMIC AMPLITUDES ORIGINAL DATA WITH INTERPRETATION

PROPOSED POSSIBLE GEOLOGICAL SCENARIO 1

SEISMIC AMPLITUDES SYNTHETIC MODELED SCENARIO 1

SEISMIC AMPLITUDES & PHASE

SEISMIC INTERPRETATION

HORIZONS & FAULTS

ELASTIC PROPERTIES

RESERVOIR / NON RESERVOIRS

FLUIDS

POSSIBLE GEOLOGICAL SCENARIOS

SCENARIO 1

SCENARIO 2

HD FREQUENCY DECOMPOSITION 1

SCENARIO 3

HD FREQUENCY DECOMPOSITION 2

SCENARIO N

HD FREQUENCY DECOMPOSITION N

ORIGINAL DATA

HIGH DEFINITION (HD) FREQUENCY DECOMPOSITION RGB BLEND

SEISMIC AMPLITUDES & PHASE 1

SEISMIC AMPLITUDES & PHASE N
FREQUENCY DECOMPOSITION TO REVEAL AND VALIDATE GEOLOGICAL CONCEPTS FOR FURTHER DEVELOPMENT.
EXAMPLES FROM CERRO PIEDRA AREA, WESTERN SAN JORGE BASIN, ARGENTINA.

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3- CASE STUDY. CERRO PIEDRA. WESTERN SAN JORGE BASIN, ARGENTINA (CONT.)

POSSIBLE ALTERNATIVE SCENARIOS & VALIDATE WORKFLOW

REQUESTED INPUT FROM CALIBRATION WELLS AND/OR ANALOGUES: ELASTIC PROPERTIES RESERVOIR, NON RESERVOIRS

CALIBRATION IS CRUCIAL IN THE ABSENCE OF WELLS, ANALOGUES MAY BE USED. FOR CERRO PIEDRA TERTIARY RESERVOIRS, THE ZABAÑAL FIELD LOCATED 30KM AWAY COULD BE USED.

NEXT STEPS – FOLLOWING WORK

“GEOBODY” VOLUMETRIC CALCULATION FOR POTENTIAL FURTHER DEVELOPMENT OF GAS RESERVOIRS.
DETAILED MODELLING WITH EXTRA THINNER LAYERS TO VALIDATE GEOBODY’S INTERNAL AMPLITUDES & FREQUENCIES VARIATIONS.
FREQUENCY ANALYSIS WITHIN “GEOBODY” AS A POSSIBLE FLUID INDICATOR FOR BOTH THE COARSE AND DETAILED POSSIBLE SCENARIOS.
APPLICATION OF PROPOSED WORKFLOW TO ADDITIONAL IDENTIFIED ANOMALIES WITHIN THE ASSET & NEARBY ASSETS OF THE BASIN.

4- CONCLUSIONS & RECOMMENDATIONS

TECHNOLOGY ALLOWS A MORE EFFICIENT USE OF POWERFUL ALGORITHMS, SUCH AS VISUALIZATION & COMBINATIONS OF ATTRIBUTES.
FREQUENCY DECOMPOSITION FILTERS THE SEISMIC DATA INTO ITS FREQUENCY BANDPASS COMPONENTS.
- COMBINATION OF THREE MAGNITUDE VOLUMES (LOW, MID, HIGH INTO RED, GREEN, BLUE) TO MAXIMIZE THE USE OF WIGGLES, AMPLITUDES & FREQUENCIES TO BETTER DESCRIBE BOTH THE THICKNESS & LITHOLOGY VARIATION OF LAYERS.
- CLOSE THE LOOP TO VALIDATE THE PROPOSED POSSIBLE GEOLOGICAL SCENARIOS IS CRUCIAL TO REDUCE UNCERTAINTIES OF OPPORTUNITIES.
- SYNTHETIC MODELLED RESULTS ARE COMPARED WITH THE ACTUAL SEISMIC & FREQUENCY DECOMPOSITION RGB BLEND.
- THE PROPOSED WORKFLOW WAS APPLIED TO THE UNDER DEVELOPED TERTIARY RESERVOIRS WITHIN THE CERRO PIEDRA ASSET, WESTERN FLANK OF THE SAN JORGE BASIN, ARGENTINA AND WILL BE REPLICATED IN NEARBY ASSETS OF THE BASIN.
- THIS WORK DEMONSTRATES THE ADDED VALUE OF APPLYING SEISMIC GEOMORPHOLOGY BY FREQUENCY DECOMPOSITION WITH VALIDATION TO REDUCE UNCERTAINTIES IN IDENTIFIED POTENTIAL OPPORTUNITIES FOR FURTHER DEVELOPMENT IN A MATUORE BASIN.

5- ACKNOWLEDGEMENTS

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