**Abstract**

Spectral decomposition analyzes a given signal by the summation of simple, well defined basis functions. The spectral content of seismic data is influenced by the acoustic properties in the Earth, and therefore significant information can be gained from the analysis of the seismic at different frequencies through spectral decomposition during seismic interpretation (Partyka et al, 1999). The ability to examine and compare the response at different frequency bands is critical to obtain information that otherwise is difficult to visualize on the full bandwidth data (Chopra et al, 2007). Volumetric RGB (Red-Green-Blue) blend of the optimum frequency cubes (Hall and Trouillot, 2004) rapidly assess and highlight the presence of geological features present in the seismic data. Seismic geomorphology facilitates the study of the subsurface by the extraction of geomorphologic insights from 3D seismic data (Posamentier et al, 2005).

The Cuyo Group is an Early to Middle Jurassic siliciclastic sedimentary sequence in the Neuquén Basin western Argentina, bounded by two regional unconformities (Intra Liassic and Intra Callovian at base and top respectively) that reaches 2500 meters of thickness and includes several transgressive-regressive cycles associated to thermal subsidence, the paleo-Pacific Ocean connection and a continuous contribution of sediments (Dellapé et al, 1979).

3D seismic and chronostratigraphic regional interpretation (nine sedimentary cycles) for the Cuyo Group were conditioned for spectral decomposition, as seismic data quality and interpretation have significant impact in the results. Individual surveys (+20) were analyzed and regionally integrated.

Canyons filled with channels of different geometries and sizes are clearly identified in the slope, while fans are observed in the deep-water area. Seismic geomorphology using spectral decomposition volume-based interpretation allows the connection of channels in the platform, canyons in the slope, and fans in the deep-water area used to populate its sedimentary cycle facies maps.
This study demonstrates the added value of spectral decomposition volume interpretation to better delineate the depositional system for the Cuyo Group in Argentina as input to future explorations efforts in the basin.

References Cited


ABSTRACT
Spectral decomposition analyzes a given signal by the summation of simple, well defined basis functions. The spectral content of seismic data is influenced by the acoustic properties in the earth, and therefore significant information can be gained from the analysis of the seismic at different frequencies through spectral decomposition during seismic interpretation (Partyka g. et al, 1999). The ability to examine and compare the response at different frequency bands is critical to obtain information that otherwise is difficult to visualize on the full bandwidth data (chopra et al, 2007). Volumetric RGB (red-green-blue) blend of the optimum frequency cubes (Hall and Trouillot, 2004) rapidly assess and highlight the presence of geological features present in the seismic data. Seismic geomorphology facilitates the study of the subsurface by the extraction of geomorphic insights from 3D seismic data (Posamentier et al, 2005).

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3D seismic and the Cuyo group’s chronostratigraphic regional interpretation (nine sedimentary cycles) were conditioned for spectral decomposition, as seismic data quality and interpretation have significant impact in the results. Individual surveys (+20) were analyzed and regionally integrated. Canyons filled with channels of different geometries and sizes are clearly identified in the slope, while fans are observed in the deep water area. Seismic geomorphology using spectral decomposition volume based interpretation allows the connection of channels in the platform, canyons in the slope and fans in the deep water area used to populate its sedimentary cycle facies maps.

This study demonstrates the added value of spectral decomposition volume interpretation to better delineate the depositional system for the Cuyo group in Argentina as input to future explorations efforts in the basin.

1- OBJECTIVES

- MAXIMISE THE IMPACT OF SEISMIC TO HELP DELINEATE THE GEOLOGICAL MODEL AT A BASIN SCALE
- PROPOSE METHODOLOGY TO SEARCH, INTERPRET AND EXTRACT 3D VOLUME GEOBODIES USING SEISMIC SPECTRAL DECOMPOSITION
- DEMONSTRATE THE ADDED VALUE OF SPECTRAL DECOMPOSITION VOLUME INTERPRETATION TO BETTER DELINEATE THE DEPOSITIONAL SYSTEM FOR THE CUYO GROUP IN ARGENTINA

2- WORKFLOW & EXAMPLES

1- GEOLOGICAL FEATURES IDENTIFICATION IN SEISMIC AMPLITUDE

QUICKLY SCAN SEISMIC AMPLITUDES TO DETECT POTENTIAL AREAS OF INTEREST

3- GEOBODY DETECTION & EXTRACTION

ALLOW THE SUBSURFACE TEAM TO EFFICIENTLY INTEGRATE RESULTS

4- INTEGRATION INTO THE GEOLOGICAL MODEL FOR INTERPRETATION

VOLUME BASED SEMI-AUTOMATIC WORKFLOW

PROPOSED WORKFLOW

1- GEOLOGICAL FEATURES IDENTIFICATION (SEISMIC AMPLITUDE) SEISMIC SCANNING FOR ANOMALIES SEISMIC INTERPRETATION CONDITIONING SEISMIC FLATTENING

2- VOLUME BASED SPECTRAL DECOMPOSITION "ON-THE-FLY" PARAMETERS SELECTION BLEND RGB OPTIMUM FREQUENCIES

3- GEOBODY DETECTION & EXTRACTION "ON-THE-FLY" SEMI-Automated INTERPRETATION BY CLUSTERS GEOBODY CONVERSION TO HORIZONS

4- INTEGRATION INTO GEOLOGICAL MODEL FOR INTERPRETATION DE-FLATTENING INTEGRATION OF RESULTS

SPECTRAL CONTENT OF SEISMIC DATA IS INFLUENCED BY THE ACOUSTIC PROPERTIES IN THE EARTH
3- VOLUME BASED SPECTRAL DECOMPOSITION

METHODOLOGY TO CREATE “RGB BLEND” CUBE OF OPTIMUM FREQUENCIES

A- Selection of area of interest
B- Seismic flattening
C- “on-the-fly” frequency spectrum
D- Individual frequencies magnitude cubes
E- “on-the-fly” RGB Blend selection

Optimum Frequencies
Low (Red)
Medium (Green)
High (Blue)

GEObODY DETECTION, EXTRACTION & INTEGRATION INTO MODEL

A- Definition of “seeds”
B- Interactive geobody propagation
C- Semi-automated geobody interpretation
D- Quality Control - RGB Blend & Seismic Amplitudes

"RGB BLEND’’ AND SEISMIC AMPLITUDES SHOULD BE CAREFULLY QUALITY CONTROLLED BEFORE INSERTION OF GEOBODIES INTO THE GEOLOGICAL MODEL

Insertion of geobodies into geological model for interpretation
DE FLATTENING OF GEOBODIES
INTERPRETATION AND INTEGRATION OF RESULTS INTO THE GEOLOGICAL MODEL

CHANNEL MIGRATION INTERPRETATION (MEANDERING SYSTEMS)
OBJECTIVE RESERVOIRS: CUYO GROUP
EARLY TO MIDDLE JURASSIC SILICICLASTICS,
BOUNDED BY TWO REGIONAL UNCONFORMITIES
(INTRA LIASSIC & INTRA CALLOVIAN)

CASE STUDY. GRUPO CUYO, NEUQUÉN BASIN, ARGENTINA

EXAMPLES: SHELF CHANNELS, SLOPE CHANNELS & CANYONS, AND SUBMARINE FANS

EXAMPLE 1

CHANNELS FROM THE SHELF, WHICH CONTINUE INTO THE SLOPE ARE CLEARLY CONNECTED TO SUBMARINE FANS

EXAMPLE 2

SEVERAL INTERCONNECTED CHANNELS FROM SHELF TO SLOPE
SPECTRAL DECOMPOSITION FACILITATES A MORE DETAILED SEDIMENTARY ANALYSIS

EXAMPLE 3

TWO CHANNELS FROM SHELF TO BASIN FLOOR
SPECTRAL DECOMPOSITION ENABLES A MORE DETAILED CHANNEL MIGRATION ANALYSIS

EXAMPLE 4

SHELF CHANNELS BETTER DEFINE BY SPECTRAL DECOMPOSITION

DATA AVAILABILITY
✓ 3D SEISMIC DATA WITH DIFFERENT ACQUISITION & PROCESSING PARAMETERS
✓ REGIONAL SEISMIC INTERPRETATION

LOCATION, GEOLOGICAL SETTING & DATA AVAILABILITY

AAPG ACE, SALT LAKE CITY – MAY 2018
4- CASE STUDY. GRUPO CUYO, NEUQUÉN BASIN, ARGENTINA

EXAMPLES: SHELF CHANNELS, SLOPE CHANNELS & CANYONS, AND SUBMARINE FANS (CONT.)

SEISMIC GEOMORPHOLOGY BY SPECTRAL DECOMPOSITION VOLUME INTERPRETATION CLEARLY SHOWS THE CONNECTION BETWEEN PLATFORM & SLOPE CHANNELS AND BASIN FLOOR FANS

INTEGRATION OF RESULTS TO HELP DEFINE THE BASIN-SCALE GEOLOGICAL MODEL

EXAMPLE 5

SUBMARINE FANS ARE CLEARLY IDENTIFIED, VOLUME BASED INTERPRETED AND EXTRACTED IN THE DEEP WATER AREA

CONNECTION TO SLOPE CHANNELS IS OBSERVED

SPECTRAL DECOMPOSITION ACCELERATES THE INTEGRATION OF DETAILED SEDIMENTARY ANALYSIS INTO THE REGIONAL GEOLOGICAL MODEL

5- CONCLUSIONS

- Spectral decomposition using "Blend RGB" helps to identify subtle geological features not discernible with traditional seismic interpretation techniques, such as horizon slices in seismic amplitudes, RMS amplitudes, etc.
- A workflow to identify, interpret, and extract volume-based spectral decomposition geological features to help delineate the regional model is presented.
- More than 20 surveys with different acquisition and processing parameters were conditioned and analyzed following the proposed workflow for the Cuyo Group, Neuquén basin in Argentina, resulting in more than 200 interpreted geobodies (shelf channels, slope channels & canyons, submarine fans).
- Canyons filled with channels of different geometries and sizes are clearly identified in the slope. Fans are observed in the deep water area. Shelf channels are also interpreted. Examples from shelf & slope channels and submarine fans are presented.
- Seismic geomorphology using spectral decomposition volume based interpretation clearly show the connection between channels in the platform, canyons & channels in the slope and fans in the deep water area.
- This study demonstrates the added value of spectral decomposition volume interpretation to better delineate the depositional system for the Cuyo Group, Argentina as input to future explorations efforts in the basin.

6- ACKNOWLEDGEMENTS

We would like to thank YPF S. A. for the permission to present this work. Many thanks to our colleagues for their feedback, and my family for their support.