The Benefits of Employing Multi-Attribute Analysis to Mapping Seismic Facies

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ABSTRACT

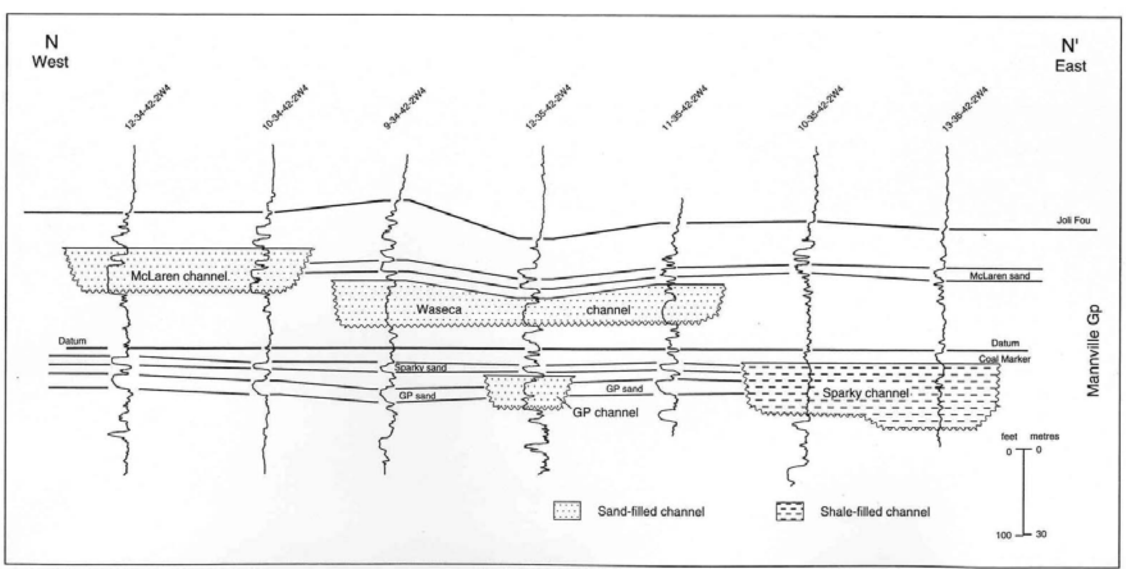
Summary

A 3D survey from Western Saskatchewan that is believed to cover at least three intersecting Mannville channel systems is evaluated. Although the channel systems are detectable in the seismic image, details of their extent and lithology are unclear using traditional interpretation techniques.

Seismic attributes, such as stack amplitude, instantaneous attributes, semblance and waveform correlation are simultaneously analyzed and compared geostatisically to well data in order to predict lithology and reservoir properties.

Introduction

The Upper Mannville sequence in this area is Albian in age and was deposited in a prograding deltaic environment in the foreland basin, from the sediment source in the Cordillera to the west. Mannville sediments have been locally re-worked by fluvial or tidal channels. The figure below from the CSPG atlas, illustrates the Mannville sequence in this area.



CSPG Atlas

Within the project area, gas is present in a Colony channel, at a depth of about 420 metres at the top of the Mannville section. Heavy oil (10 degrees API) is present in a Waseca Channel Sand up to 21 metres thick at a depth of about 450 metres. There is a thin oil leg over water in a thick GP sand at a depth of about 480 metres. There is no production from the GP in the project area.

The Waseca wells had initial production rates of 44 to 50 barrels per day and have had cumulative production of up to 20,000 barrels. Water has invaded the four producing wells and only one is currently producing. This well was only drilled to the top of the Waseca in order to stay away from the water. Two wells in the survey area have oil in a thin, regional Waseca sand. A McLaren aged channel has evidently cut down and eroded the Waseca in two wells on the project area.

The 4.6 square km 3D seismic survey was used to locate the wells. The survey was interpreted again using interpretive software which combined multi-attribute analysis with 3D visualization and volume rendering. The objectives of this interpretation were to use attributes to classify areas of best Waseca sand and to map the channel systems in as much detail as possible.

Method

A variety of pattern recognition methods are employed to extract and quantify multi-attribute patterns within the 3D survey. Attributes such instantaneous amplitude, phase, frequency and semblance are extracted from the data. A sub-cube or Strata-Cube, consisting of numerous layers, parallel to bounding horizons is then created for each attribute.

By evaluating multiple attributes simultaneously, subtle character differences, such as channel edges, are greatly enhanced. These differences, or similarities, are often overlooked using traditional methods.

Waveform analysis is also performed. Wavelets, from around the well locations on the 3D survey, are extracted from each of the attribute sub-volumes. They are then classified according to their similarity on a single map. Areas of the 3D with similar character to the extracted waveforms are easily identified.

Once the channel systems have been identified, Interval Analysis reduces the strata-cube volume to a more focused region. Additional statistical calculations are made and evaluated in an effort to generate a detailed understanding of the channel facies.

	Colony	**Waseca**	**GP**	
7-28	Channel, gas	Channel, oil	Channel, oil over water	Best Colony Waseca watered out
8-28		Channel, oil	NDE	Waseca producing well
9-28		Channel, oil	NDE	Shale at top of channel
10-28	Channel, gas	Channel, oil over water	Channel, wet	Water at base of Waseca, invaded other wells
3-28	Channel, low, dirty	Eroded, McLaren channel		
15-28	Channel, dirty	Eroded, McLaren channel		
13-21		Regional sand		

Results

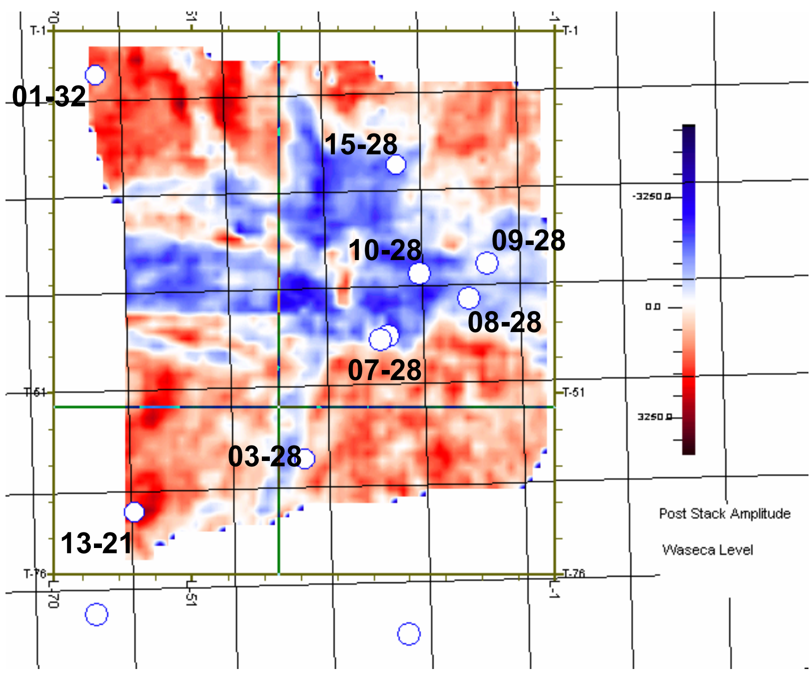


Fig. 1:Post Stack Amplitude, Waseca Level

The first example, *fig. 1*, is based on amplitude at the Waseca level. A strong east-west orientation is revealed, with a northeast to southwest feature probably a shadow of the Colony channel above the Waseca.

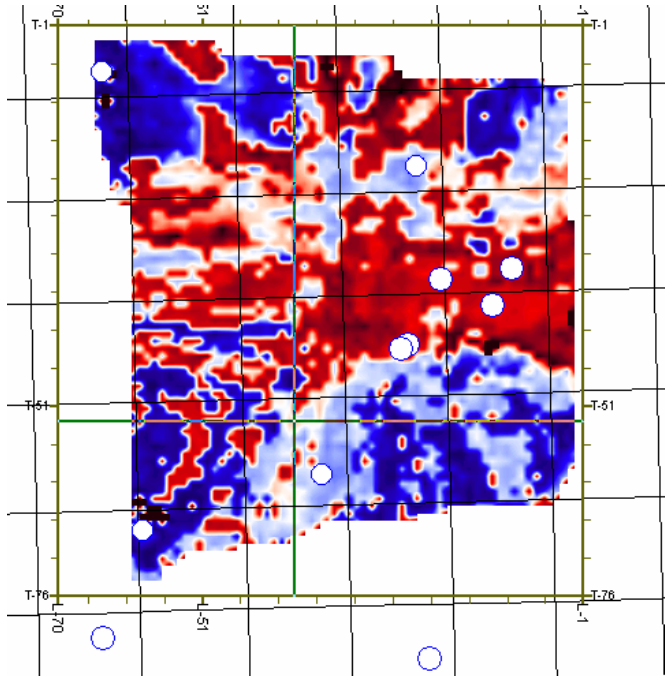


Fig. 2: Waveform Correlation using 8 wells

The next example, *fig. 2*, shows the east-west orientation associated with the Waseca. This figure is based on seismic amplitude classified against eight wells, grouped into three categories: Waseca Channel wells, regional wells and eroded Waseca wells. It is useful for looking at the Upper Mannville section as a whole but not for isolating individual channel trends.

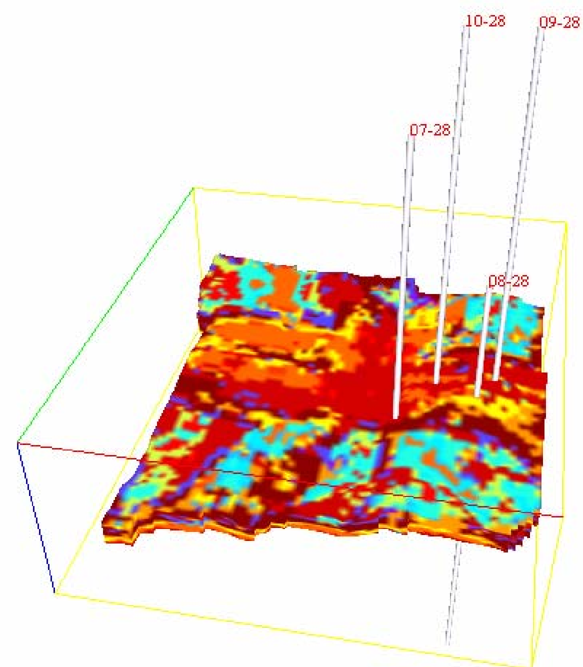


Fig. 3: Strata-Cube Classification: 5 Attributes, 20 Categories

The next example, *fig. 3*, is a Strata-Cube classification of the entire seismic section from the top of the Mannville to the Sparky, an interval of about 50 m in depth and 30 ms. in time. It shows more detail in the Waseca and reveals some of the other channel trends within the Mannville - a northeast- southwest Colony feature, a north-south GP feature and a northwest-southeast McLaren channel.

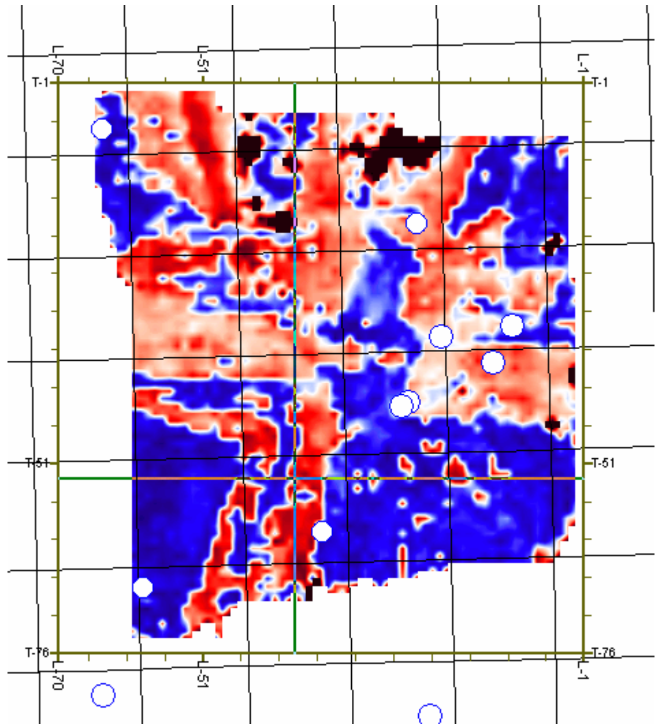


Fig. 4: Principle Component Analysis

In *fig. 4*, we have reduced the thickness of the cube to include only the Waseca interval, about 20 ms., and grouped the wells in the same three categories as above. We have mapped the principle component, incorporating 15 attributes. We now have some interesting detail in the Waseca channel. The Waseca in 7-28 and 10-28 has a thin shale over clean sand from 17 to 21 m thick. In 8-28, 15 m of clean sand was penetrated. At 9-28, 11 m of shale lies over 7 m of clean sand and 7 m of interbedded sand and shale. This well appears to have a distinctive character on this map.