Revealing Fault Control on Hydrocarbon Distribution in the Montney Play: a 3-D Exploratory Statistics Approach

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Abstract

Faults may influence sediment deposition, burial history, and create migration paths as well as pressure compartments in unconventional plays. These discontinuities generally induce sharp local disturbances in rock properties and in fluid composition. Thanks to the very high density of wells in the Regional Heritage area of the Montney Play, it is possible to track in 3-D these anomalies coming from multiple sources. Fault planes can then be extracted and their impact on hydrocarbon fluid distribution and well performance can be assessed.

A variety of observations along the well paths from surface to TD is assembled and analyzed within a three-dimensional volume in order to extract the various fault planes within the area of interest. Our analysis involves various data types including drilling problems (gas kicks, mud losses, etc.), gas composition or pressure anomalies and abnormal high porosity streaks, among others. Filtering the data is done using formation-dependent cut-off values, the resulting anomalies are then analyzed in 3-D, the projections of interest catalogued and fault planes extracted. Figures 1 and 2 illustrate a workflow adapted to high CO_2 occurrences and the expression of two extracted faults in map view (3-D projection in bottom insert of figure 1).

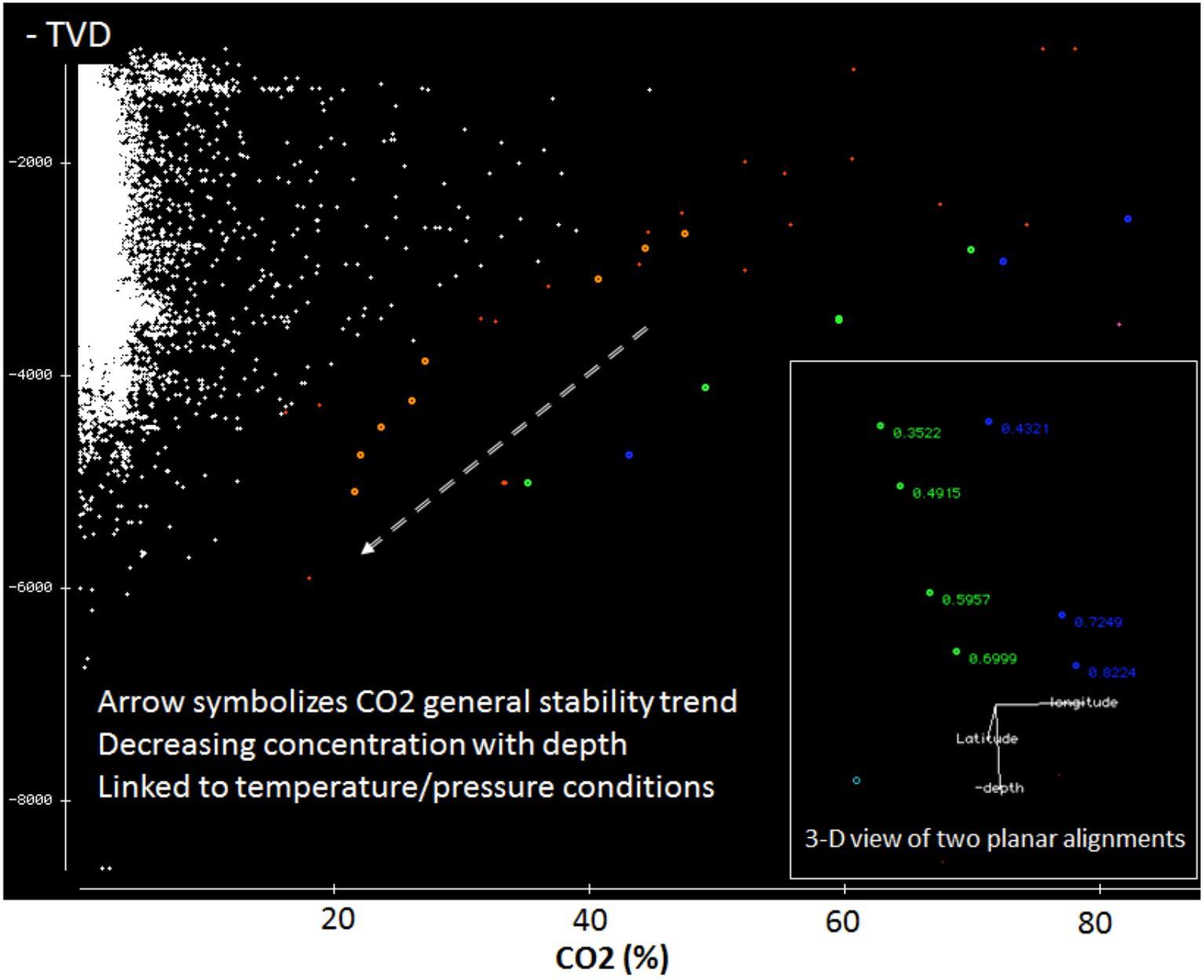
Examples will be given of individual fault planes extracted using a 3-D exploratory statistics approach. The intersection of these planes with stratigraphic surfaces such as the top of the Montney Formation allows for generating fault traces on a base map. The result can then be compared with structural elements derived from aeromagnetic data for instance, keeping in mind that the fault geometry may vary with depth and may be disrupted by other faults.

Additionally, using the formation tops available from the government database, a geometrical analysis of growth pattern based on delta D/D plots (Bischke, 1994) helps validating the interpretation or may reveal other faults that are not associated with abnormal pressures or unusual gas compositions. This additional step can also help indicate the timing of the fault activity and the delta D/D plots can be graphically incorporated into the maps to better identify compartments.

Whereas the 3-D definition of faults allows for a better understanding of facies and reservoir fluid variations in the Montney, it is also extremely useful in forecasting and preventing problems in wells, potentially reducing drilling and stimulation cost.

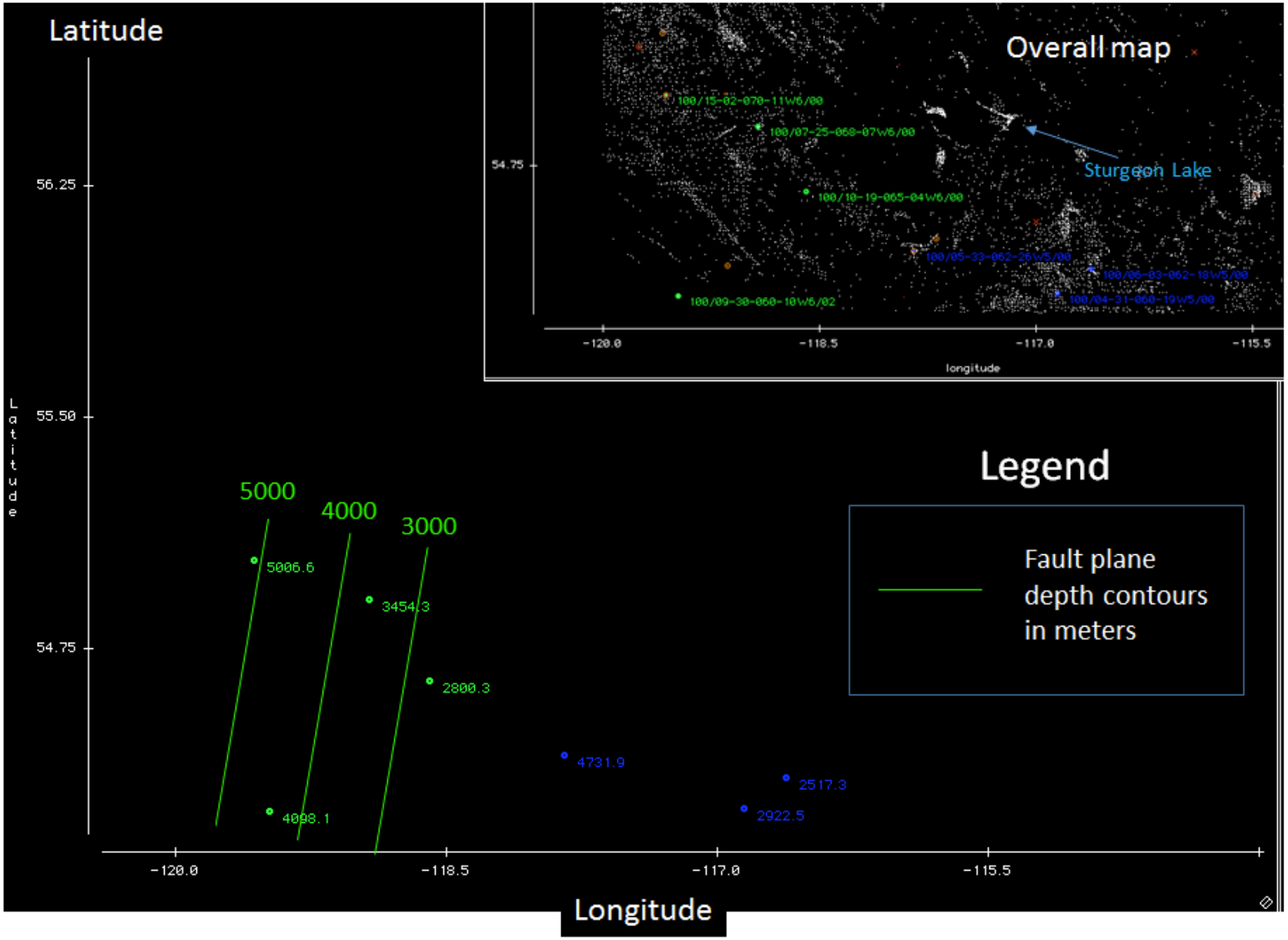
References

Bischke, R.E., 1994. Interpreting sedimentary growth structures from well log and seismic data (with examples). *AAPG bulletin*, *78*(6), pp.873-892.



Rotating the anomalies in a 3-D volume allowed to recognized two planar alignments of anomalies

Figure 1. CO_2 depth plot to identify faults associated with occurrences of abnormally high concentrations



The contours of the green fault have been created on the basis of TVD values; the final plane needs to be created on the basis of TVDss. Uncertainty linked to the sample depth estimates is acceptable considering the areal and depth spread of the data.

Figure 2. Location of two identified planar occurrences of high CO_2 concentrations interpreted as faults.