# Exploratory Statistics to Visualize, Quality Control and Refine 3-D Geological Interpretations at Basin and Field Scales*

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Search and Discovery Article #120159 (2014)
Posted November 30, 2014

*Adapted from an extended abstract given as an oral presentation at AAPG Hedberg Research Conference, Interpretation Visualization in the Petroleum Industry, Houston, Texas, June 1-4, 2014, AAPG©2014

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## Abstract

Exploratory statistics programs are interactive and easy to use but seemingly, the oil industry has yet to add them to the geoscientist tool kit. Direct applications of such programs will be demonstrated in three parts: one at a basin scale, one at field scale dealing with conventional reservoirs and one focusing on interpretation visualization of some resource plays.

These exploratory statistics programs allow interactive 3-D visualization (in reality n dimensions) with filtering, rotation and mathematical calculations to verify the reliability of the recognized feature. Tens of millions of data points are no problem but as speed is of the essence all of the "maps" are optimized for a best fit in window approach, meaning they are not honoring any GIS projection system. On the other hand, extraction and export into a proper mapping or geomodelling software is extremely easy.

## Introduction

Deep-seated fault systems can be outlined by linear patterns made by deep earthquakes in basins around the world; however, data may be sparse depending on the seismicity of the studied area. To obtain a more detailed picture, the structural grain of a basin can be easily extracted using 3-D exploratory statistics methods. Problems in wells such as high-pressure kicks or loss circulation can quickly establish a framework for faults and fault types (Figure 1a). Statistical analysis of core plugs petrophysics can reveal major subvertical open fracture trends (Figure 1b). In mature basins, similar structural trend extraction can be achieved via three-dimensional visualization of hydrocarbon occurrences using exploratory statistics programs.

## Discussion

For conventional hydrocarbon fields, structural features can be extracted easily using exploratory statistics. Through time, compositions and pressures are changing; this important information can easily be handled in depth plots with or without projection to a depth datum. The presentation will cover parameters such as API, RFT pressures, isotope compositions, thicknesses and porosity (the latter two not changing during the field lifetime) with the corresponding revealed structural features.

## Summary

When dealing with unconventional resource plays, location of faults and fractures swarms can be critical. In some cases, these sub-vertical structural features can be outlined by abnormal gas compositions such as high nitrogen content. Additionally, subtle fault displacements and compartmentalization can be revealed with numerous depth plots against production data such as reservoir pressures (Figure 2) or hydrocarbon compositions. Fractured zones and faults can be identified using geochemical data such as chromatography or Rock-Eval and integrated in a 3-D model for a refined interpretation.

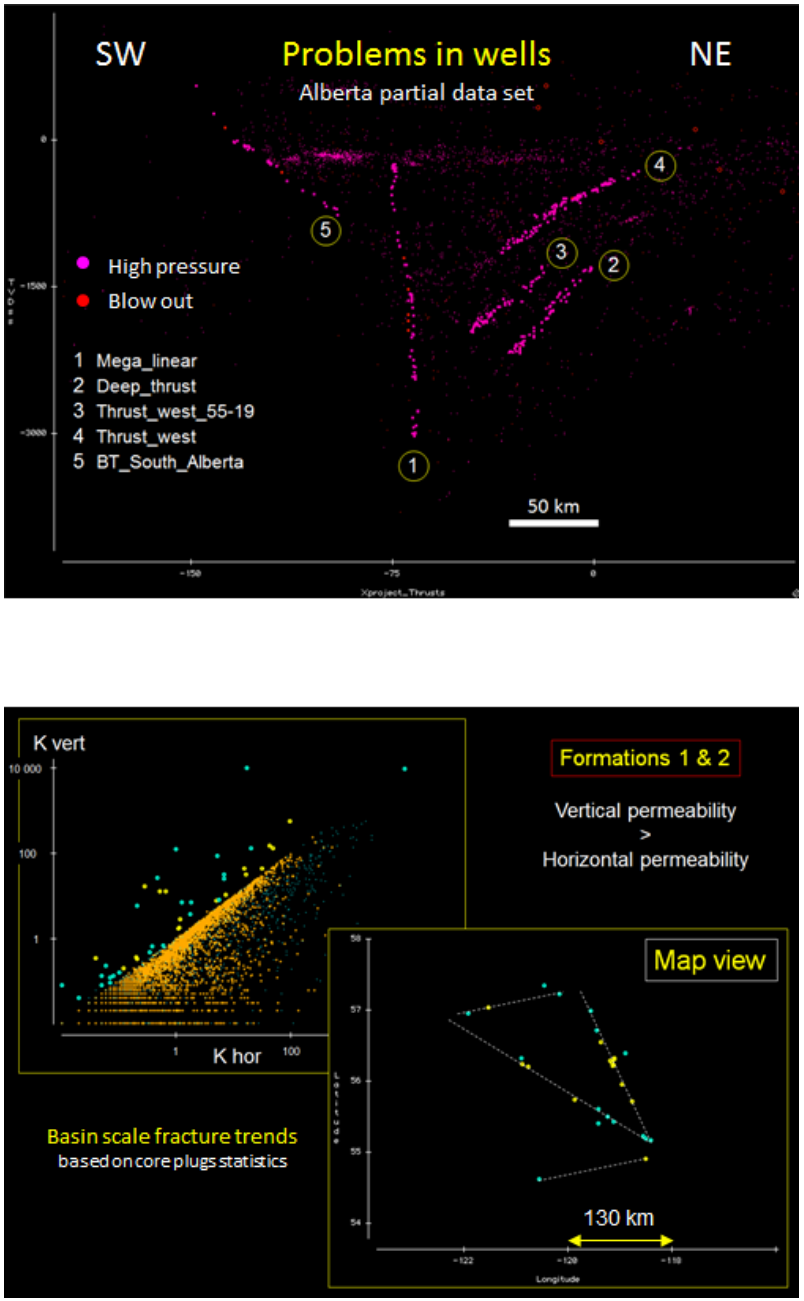


Figure 1. Examples of structural features revealed by drilling problems and core data.

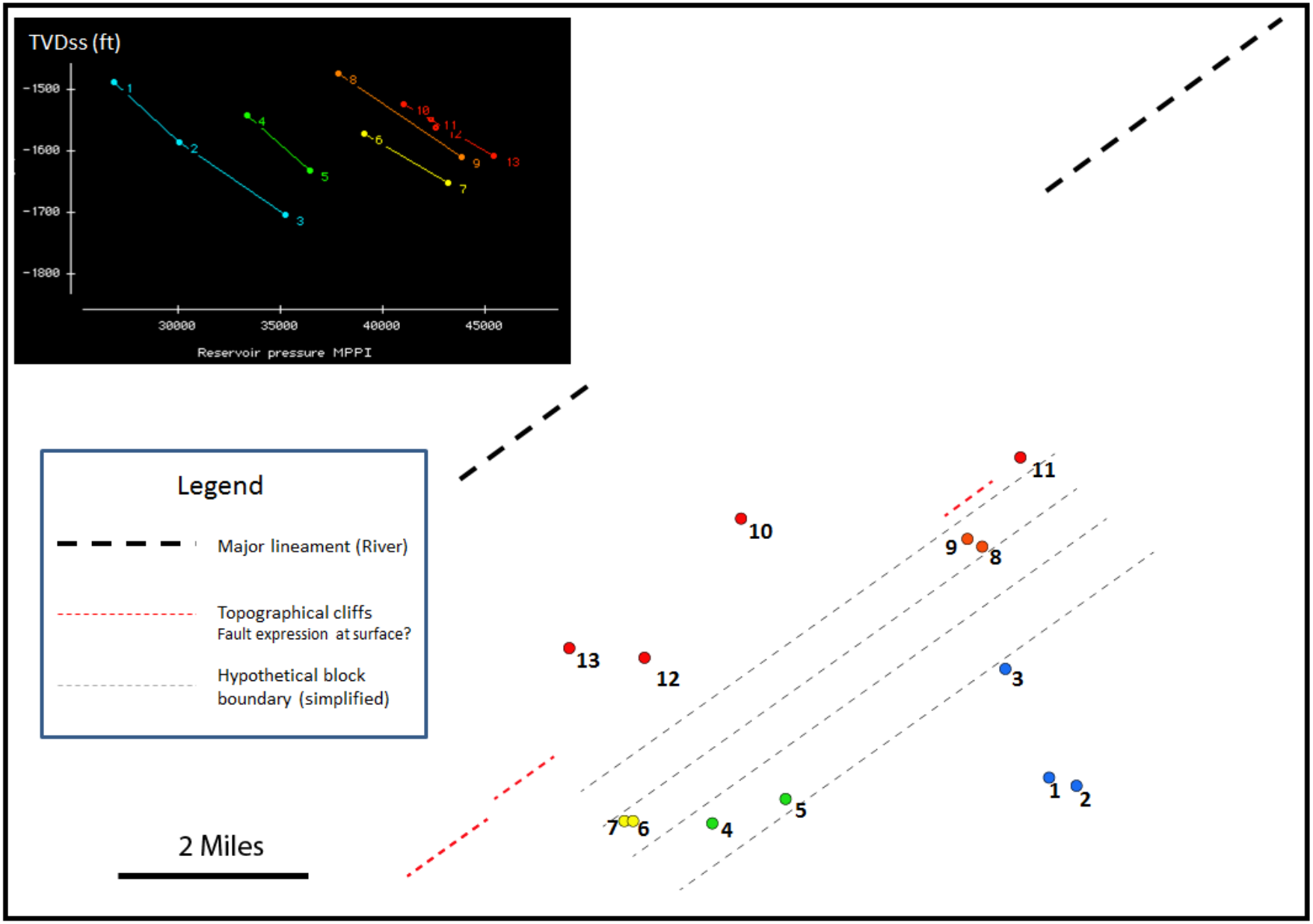


Figure 2. Depth trends of reservoir pressures indicating relative block motion post maximum burial with respect to the blue trend used as a reference.