Compilation of fault database for the NEBC and NW Alberta using publicly available data and open-source software

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Summary

We performed complex analysis of the fault structures in NE British Columbia and NW Alberta. Publicly available seismic data and open-source software were effectively used to develop structural fault interpretation workflow that uses trend surface analysis based on formation tops, with extensive quality control, combined with validation using available geophysical data. Seven formations are considered, from the Late Cretaceous Basal Fish Scale Zone (BFSZ) to the Wabamun Group. This method helped to resolve the problem of limited spatial extent of available seismic data and provided a broader spatial coverage, enabling the investigation of structural trends throughout the entirety of the Montney play. In total, we identified 22 structural corridors, which can be used as an input for other studies. Our study also outlines two buried regional foreland lobes of the Rocky Mountain TFB, both north and south of the DCGC. In this study, we present how open-source software can successfully be used to automate the process of seismic interpretation and geospatial analysis to improve the understanding regarding the fault structures distribution in this region.

Method & Workflow

Extensive research of the previously published fault compilations (e.g. Barclay et al., Fox & Watson, 2019) has revealed, that openly available fault databases are very often incomplete and/or indicate erroneous locations of the structures (Mei, 2009). Based on publicly available data, it is impractical to image and characterize such complex fault systems, yet it is inaccurate to reduce the description of structural elements to isolated faults. For these reasons, in this study we have adopted a different approach, through the identification and characterization of structural corridors rather than individual faults.

The first step of our analysis involved trend surface analysis applied to well log data to identify major structural corridors using the residual mapping obtained from the geostatistical analysis of the formation-top picks. The next step of the workflow was focused on the interpretation of the seismic data within the area of study. Detailed location coordinates were subsequently used to calculate the width of the structures and compared with the corridors' length identified on the residual maps. Empirical relationship between length and width of the structures intersected by the seismic profiles were then used as a proxy to estimate geometric parameters for the remaining corridors, where seismic data are not available. In the last step, spatially limited information about subsurface structures from the trend surface analysis was complemented by seismic interpretation results.

The analysis was performed primarily using the open-source seismic interpretation and geospatial software* (OpendTect, ArcGIS), and Python programming language. It consisted of the following steps:

1. Trend Surface Analysis
2. Seismic interpretation
3. Structural interpretation

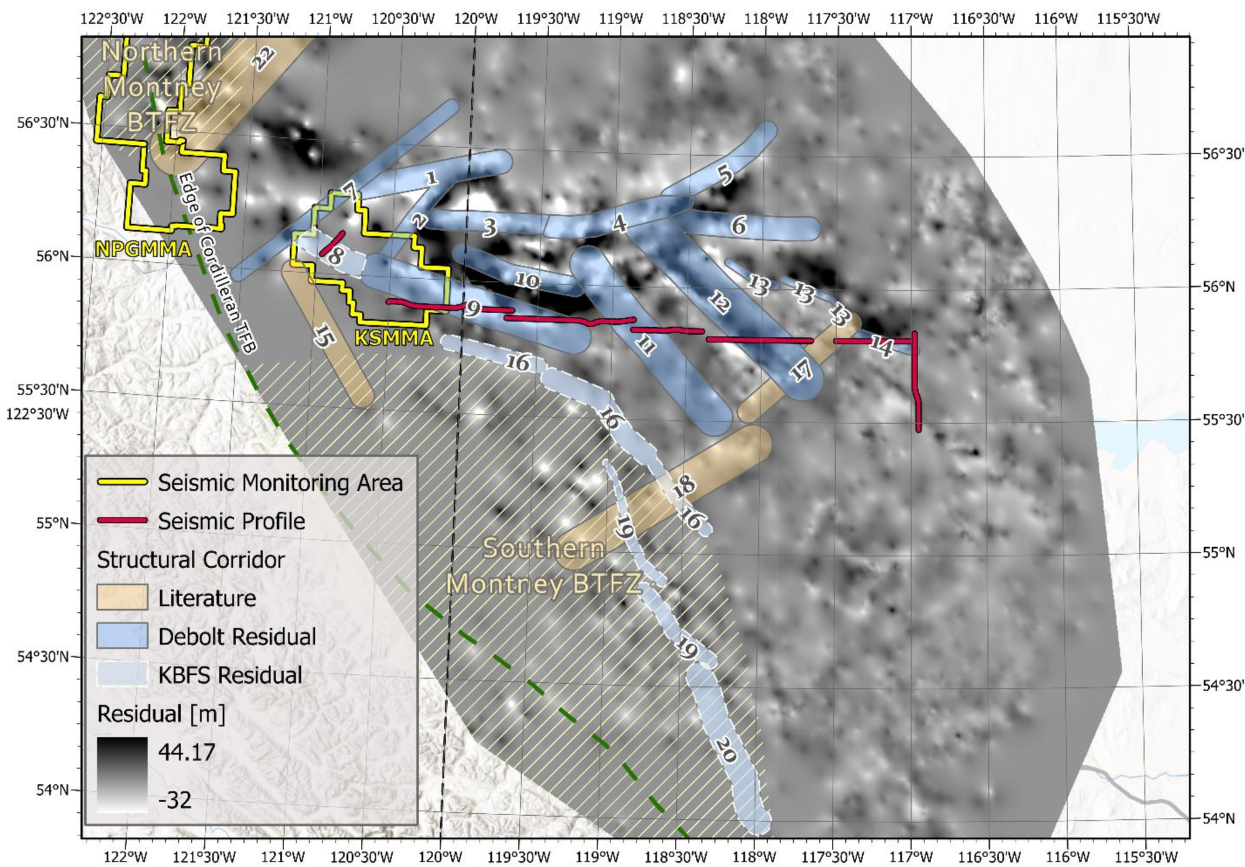

Fig 1. Map of Debolt Residual within Dawson Creek Graben Complex and southern Montney with overlayed structural corridors and main fault zones. Yellow and right lines indicate the seismic monitoring areas and reflection seismic lines, respectively. The eastern surface limit of the Late Cretaceous – Paleocene Cordilleran TFB is shown, for reference. Dashed line polygons indicate the extent of the Northern and Southern Montney buried thrust and fold zones (BTFZ). Colors of the structural corridors correspond to the source of information where the signature of the structural corridor was the strongest.

* Refined surface analysis was performed in the ArcGIS Pro software which requires the license. However, the analysis could be done using open-source tools which allow for the residual calculation and interpolation such as Python or R programming languages.

Results, Observations, Conclusions

Performed study allowed to analyze the tectonic development in the NEBC and NW Alberta based on the idea of structural corridors as opposed to commonly used single-fault based approach. We carried out comprehensive analysis using primarily openly available data and open-source software and adopted seismic interpretation workflow to identify major structural corridors within the area of study. Geometric relationships defined for the corridors intersected by the seismic lines were further used in combination with trend surface analysis to investigate the structures not intersected by the seismic lines. The compiled shapefile dataset will be published and publicly available as GSC Open File Report.

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