Unraveling Complexity: GIS Compilation of Faults in the Area of the Peace River Structural Anomaly

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Exploration for a wide range of mineral deposits is critically dependent on knowledge of the location and age of fractures, which may have acted as pathways for mineralizing fluids and kimberlite emplacement. Therefore, a state-of-the-art digital compilation of the known and interpreted subsurface and surface structural features in northern Alberta was conducted in order to aid government and industry in their efforts to better target possible occurrences of non-energy minerals in the province.

This compilation encompasses the roughly east-northeast striking zone of long-lasting structural disturbance in the western part of northern Alberta traditionally referred to as “the Peace River Arch” (PRA). This structural anomaly recorded the longest history of tectonic activity within the WCSB, with controlling basement faults active over an extended period of time or reactivated episodically through time. The Phanerozoic tectonic evolution of the region consists of three distinct phases. The pre-Late Devonian development of the topographically high PRA on the WCSB passive margin of proto–North America was followed by Early Carboniferous collapse and reversal of its topographic expression from a highland arch to an embayment. During the Early Carboniferous, an elongated zone of maximum subsidence formed along the northern margin of the Devonian PRA. In the Late Carboniferous, tectonic inversion of the Devonian PRA localized subsidence along the former axis of the arch within the Dawson Creek Graben Complex and was followed by more widespread subsidence during the Permian and Triassic. Enhanced Mesozoic subsidence within the PRE and was coeval with the initiation and evolution of thrust loading (Columbian and Laramide orogenies) in the Cordilleran orogen.

Lineaments from various literature sources (digital and non-digital) were compiled digitally into ArcView® layers (i.e., shapefiles), individually tagged and linked to a Microsoft Access® database.that includes attribute information for each line feature, such as reference, author’s criteria for inferring a fault’s existence, formation(s) affected, fault type, orientation of fault plane and AGS comments. The shapefiles containing the compiled and inferred faults/lineaments, respectively, and their attributes are distributed on a CD-ROM with the free ArcExplorer® software. In addition, the CD-ROM includes a comprehensive reference list arranged in chronological order from 1958 to 2000.

The digital format provides a flexible structure capable of incorporating additional information and allows various options for data selection based on such query criteria as location, timing, orientation and authorship. The product is envisioned as an open, flexible structure allowing for continuous updates and refinements. Time constraints required careful selection and prioritization of sources to be converted to GIS format. Consequently, the user should be aware that other structures have been described in the geological literature, but have not been yet included in the database. Nevertheless, at this stage the digital compilation includes more than 500 faults captured from published isopach and structural maps for various stratigraphic intervals in the subsurface of northern Alberta, a total of approximately 300 lineaments derived from facies and/or thickness changes depicted on maps in the *Geological Atlas of the Western Canada Sedimentary Basin* (Mossop and Shetson, 1994), tentatively interpreted by the authors to be structurally controlled.

Users should also keep in mind that ‘faults’, while represented as lines on a map, are frequently more zonal (or polygonal) in nature. A fault plotted on a map as a line may in fact be a shear zone and/or fault zone on the order of several kilometres wide. The lineaments captured in this compilation are positioned with an accuracy of about the same order of magnitude as that of the original source materials. An example of appropriate use of the Peace River Arch compilation data might be that, where a fault or an intersection of faults can be inferred to have economic potential, this should be regarded as a ‘zone of interest’ for further more focused investigation, not as an immediate drilling target.

The accompanying hard copy and digital (*.pdf format on CD-ROM) report provides an overview of the Late Proterozoic to Recent tectonostratigraphic evolution of northwestern Alberta, in order to facilitate understanding of the geological significance of the compiled structural features. Aspects that may be relevant for both energy and non-energy minerals are addressed, with particular emphasis on exploration for sediment-hosted mineral deposits within each tectonostratigraphic phase.

This work may inspire further comprehensive multidisciplinary studies of relationships between tectonics and mineral occurrences. The rewards can be expected to be more than just academic, because energy and non-energy minerals are still waiting to be discovered and produced in Alberta.