3D Regional geological modelling in structurally complex and data sparse environments: Benefits, challenges and strategies from the northern Labrador Trough, Kuujjuaq, Québec

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Characterization of deformation and visualization of regional geologic architecture are crucial to understanding a region's tectonic history. This is best accomplished by creating three-dimensional (3D) models of key regional features, such as faults and horizons, to visualize data in a 3D framework, test geological concepts, and highlight geological conflicts. Additionally, 3D models serve as expedient communication tools which can represent complex geology in a way that any lay-person, manager or investor will understand. The challenge to creating such a useful tool lies in representing real world surfaces and volumes using available data and technology. It is especially challenging in areas where geologic structures are complex and where data is sparse. This study focuses on developing an interpretive-constrained 3D regional model in the northern Labrador Trough near Kuujjuaq, Québec, with the aim of highlighting the challenges, strategies, and benefits of undertaking such a task. The northern Labrador Trough was selected because of the structural complexity of the faults and stratigraphic horizons in the region. Also, the Geological Survey of Canada (GSC) and Ministère de l'Energie et des Ressources Naturelles (MERN) are currently developing a publically available, extensive and mature regional dataset for the northern Labrador Trough, which includes geophysical studies and surface observations, providing the necessary tools for 3D visualization. These datasets however, provide few constraints at depth for modelling. The limitation of sparse data at depth is common in regional studies because drill core and seismic studies may not always be able to detect crustal-scale features, especially those that extend kilometres below the erosional surface. With minimal depth constraints, 3D modelling relies on the implicit knowledge from experience of geoscientists coupled with 3D technologies (using interpolation and extension algorithms) to interpret key geological features. As more studies are undertaken in these challenging terrains we see the interpretation and technology gaps highlighted. This is an essential but painful step in the process of better defining future workflow requirements, algorithm enhancements, and knowledge embeddings that will be needed to create a geologically reasonable modelling standard.

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