TOWARDS NATIONAL SCALE 3D GEOLOGICAL MODELLING USING AN IMPLICIT DEEP LEARNING METHOD

Michael Hillier (1), Florian Wellmann (2), Eric de Kemp (1), Boyan Brodaric (1), Ernst Schetselaar (1), Karine Bédard (3)
(1) Geological Survey of Canada, 601 Booth Street, Ottawa, ON K1A 0E8, Canada
(2) Computational Geoscience and Reservoir Engineering (CGRE) RWTH Aachen University, Mathieustr. 30 52074 Aachen, Germany
(3) Geological Survey of Canada, 490 rue de la Couronne, Quebec City, QC G1K 9A9, Canada

Geological survey organizations are becoming increasingly interested in building national scale 3D geological models to support a wide variety of geoscientific and societal purposes. Existing 3D geological modelling methods, however, are incapable of efficiently producing seamless 3D geological models at national scale using vast amounts of 3D geological datasets due to computational limitations. In addition, these existing methods have challenges in incorporating various forms of available geological knowledge, and as a result, can require significant amounts of time consuming post-processing to edit 3D geological models to respect this available knowledge. A deep learning-based method that performs implicit 3D geological modelling was developed to address these challenges. The developed method is flexible and scalable to support the efficient incorporation of large volumes of geological data and knowledge constraints that could provide a potential future framework for national scale modelling initiatives. A case study of the Western Canadian Sedimentary Basin in the province of Saskatchewan, Canada is presented to demonstrate the flexibility, scalability and modelling performance of the 3D modelling method. The dataset used to train the neural network consists of ~0.5M formation top markers and intraformational units derived from well data sampling 50 geological formations. In addition, knowledge constraints extracted from a stratigraphic column were integrated into the modelling process to ensure the generated 3D model respected known spatial relationships between geological features (formations, and unconformities). Furthermore, comparison metrics are given between two 3D geological models for the same case study area, one constructed using the developed method with the second constructed using SKUA-GOCAD™. Modelling results illustrate the method's capacity to fit a large volume of noisy data, represent unconformities, and the computational efficiency to implicit model large provincial scale 3D geological models.