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Three-Dimensional Property Modelling of the Montney Formation in Alberta

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Summary

The Lower Triassic Montney Formation extends over a large area of west-central Alberta and is a major drilling target for unconventional oil and gas, with a significant amount of natural gas liquids. A three-dimensional (3D) property model of the Montney Formation was created, the Alberta Montney 3D Property Model Version 1 (AB T_Mo 3D PM v1) (Lyster et al, 2018).

The model area covers approximately 88 000 km^2 and is bounded by the Alberta-British Columbia border in the west, the deformation edge associated with the Rocky Mountains to the southwest, and the erosional edge of the Montney Formation to the north and east. The volume of the model was defined by Montney Formation top and base surfaces that were interpolated from stratigraphic picks. Internal surfaces representing the top and base of the turbidite and coquina geobodies were interpolated. Figure 1 shows an isometric view of the Montney property model within the 3D Provincial Geological Framework Model of Alberta, Version 1 (3D PGF model v1) (Branscombe et al, 2018a and 2018b).

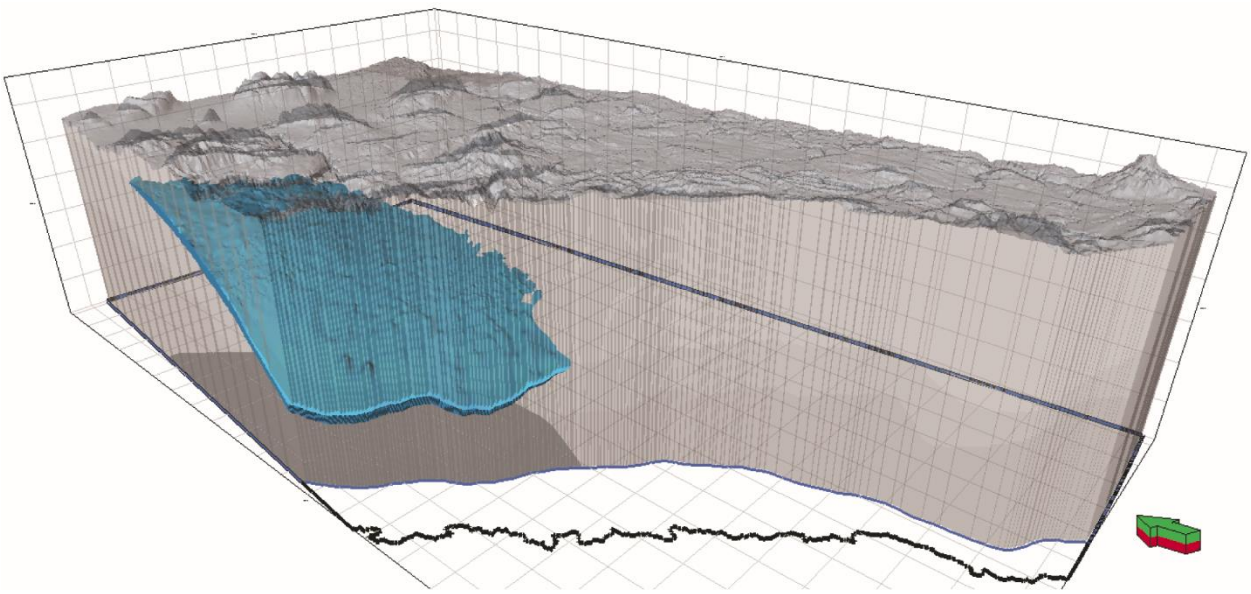

Figure 1: An isometric view of the AB 3D PM v1 (solid blue) within the 3D PGF model v1 (transparent grey) (Branscombe et al., 2018b). Vertical exaggeration is 50 times.

Method

We used a variety of data sources to create the Montney property model, including geological interpretations, well logs, well tests, well-production histories, and produced-gas tests. The geological interpretations and picks were used to develop the stratigraphic framework of the model. Well logs were used to model petrophysical properties in 3D. Figure 2 shows an isometric view of the 6513 gamma-ray logs used for modelling. Other data types are represented as discrete points and were used to model reservoir properties in 2D. The 2D model was upscaled to match the 3D geocellular grid. All properties were simulated using Gaussian Random Function Simulation (GRFS) to create 100 realizations that represent the range of uncertainty.

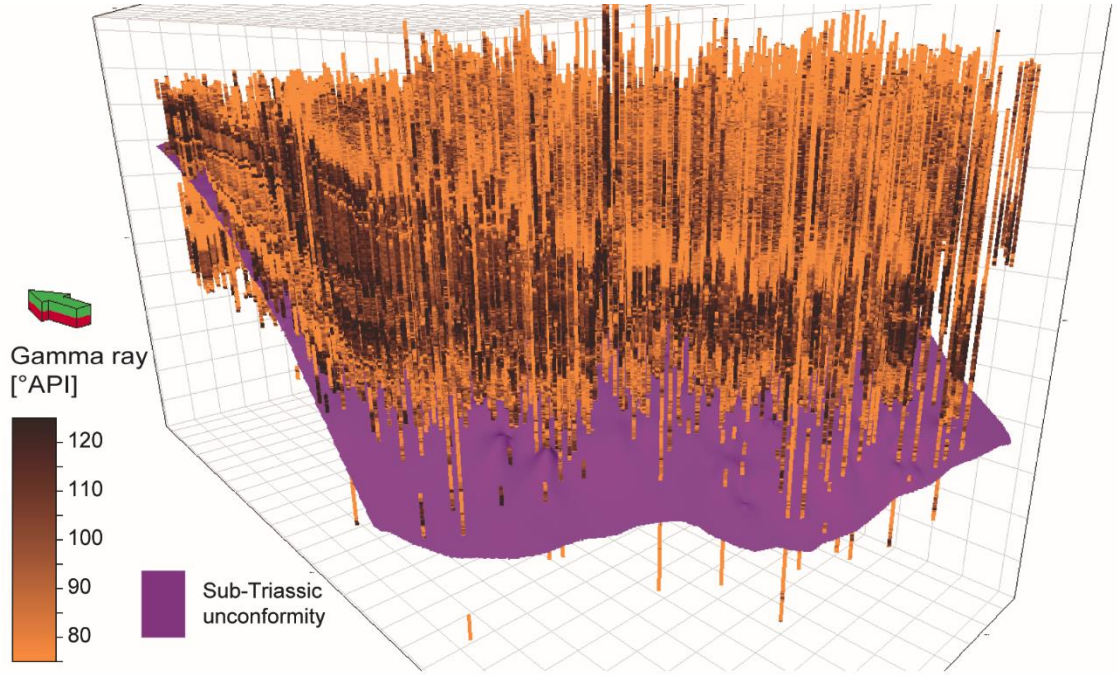

Figure 2: Isometric view of the 6513 gamma-ray logs used for modelling. The sub-Triassic unconformity surface (purple) is shown for spatial reference. Vertical exaggeration is 50 times.

Three properties were modelled in a 3D grid from petrophysical well-log analysis: gamma-ray response, total porosity, and total organic carbon. Four properties were modelled in two dimensions (2D) based on data that is more sparse and uncertain: pressure gradient, temperature gradient, gas-oil ratio, and condensate-gas ratio. The 2D properties were modelled to align with the 3D grid to allow for calculations using all of the properties.

All of the properties were simulated using the GRFS algorithm in Schlumberger Petrel 2015 (Petrel). In total, 100 realizations were simulated for each of the properties to represent the range of uncertainty in the model. Figure 3 shows an isometric view of the gamma-ray model, with two simulated realizations and the arithmetic mean of 100 realizations.

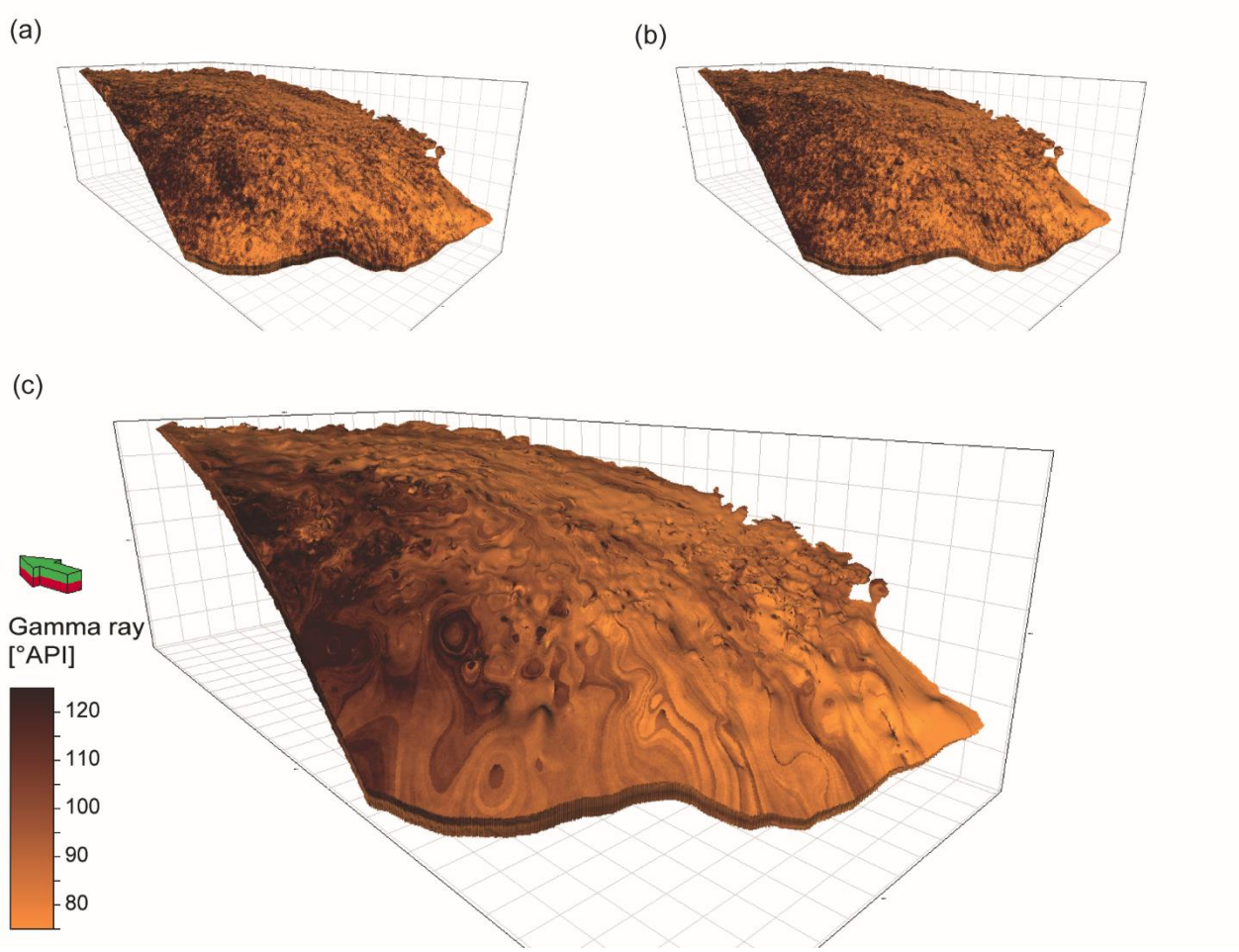

Figure 3: Isometric views of the gamma-ray model. a) and b) two simulated realizations; c) arithmetic mean of 100 realizations. Vertical exaggeration is 50 times.

Results

The AB T_Mo 3D PM v1 was created in Petrel and has been exported to non-proprietary formats for use in other software. A series of datasets from the 3D model is available for download in the form of deconstructed model products and digital data including;

- a deconstructed model dataset composed of discrete and continuous model horizons as Esri format grids, and zone model extent shapefiles,
- populated model properties as point data in ASCII format,
- an iMOD model dataset package, and
- a Petrel project file containing the model and properties

All of the standard format digital datasets can be viewed in iMOD, an open source software, and Petrel, enabling users to visualize, rotate, slice, explode, and toggle data on and off in 3D. The iMOD software provides users with an interactive geospatial environment where end users can manipulate 3D geological models and import their own geospatially referenced subsurface and surface data into it.

Acknowledgements

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