Introduction

Automatic methods, which are often purely data-driven such as ML/DL, have recently shown good performances for geoscience applications. Nevertheless, the consistency of the subsequent models can be limited when not enough good quality data is available and/or when the learning task is too complex. In such cases, domain experts still have an important role to mitigate uncertainties. To face the coming challenges, automated methods and domain expertise from different disciplines need to be combined into hybrid workflows to make the most of them.
In this paper, we show that such a hybrid workflow can easily embed interpreters' expertise to guide the automated processes and keep a full control on the interpretation quality when the subsurface geology is challenging.

Hybrid workflow designed for comprehensive seismic interpretation

The geoscientist keeps the full control onto a workflow that aims at converting signal discontinuities with vertical displacement into faults, seismic reflections into horizons, and every seismic sample into relative geological time (Pauget et al, 2009). The AFE phase is described in the Figure 1 and can be used to constrain the RGT modeling phase (Figure 2).

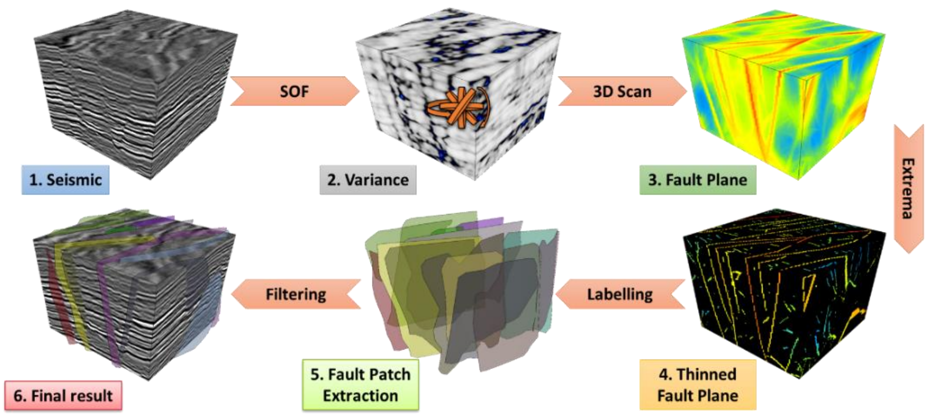

Figure 1 *Automated workflow for Fault Extraction (AFE); SOF = Structurally-Oriented Filtering*

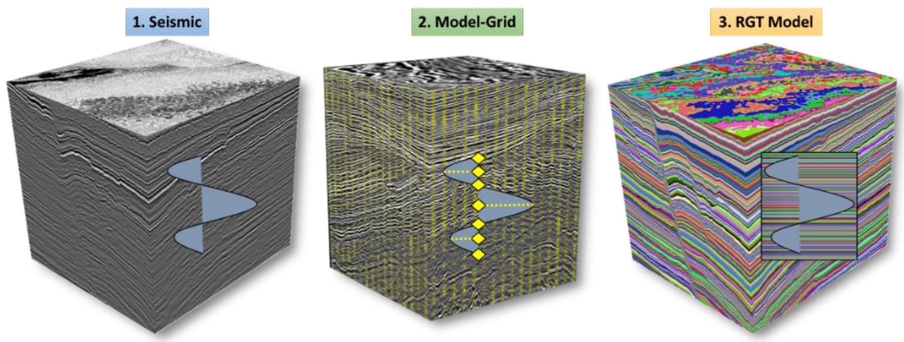

Figure 2 *Automated workflow for Relative Geological Time (RGT) modeling*

Every step of the AFE and RGT modeling remains under the supervision of the geoscientist. The fault network can be filtered – dip, azimuth, size – and completed (Figure 1, Step 6), and the RGT modeling can be refined by modifying the relationships between the auto-tracked horizons in the Model-Grid (Figure 2, Step 2).

Application of the method to the Exmouth sub-basin, North West shelf of Australia

This hybrid workflow – composed of automation and domain expert intervention – has been successfully applied to the most of sedimentary basin types, including the rifting context with faulted deposits of the Exmouth sub-basin, offshore Australia (Figure 3, 900 km²). An exclusive automation delivers a preliminary fault network composed of the major fractures and a RGT model which respects major large scale stratigraphic trends (Data Reconnaissance, 0.5 working day). The integration of domain expert knowledge allows an exhaustive extraction of classified fractures and enables to optimize the geological correlations – tilted blocks, key chronostratigraphic surfaces, seismic stacking patterns – toward delivering a high confidence RGT model (Detailed Stratal Analysis, 10 working days).

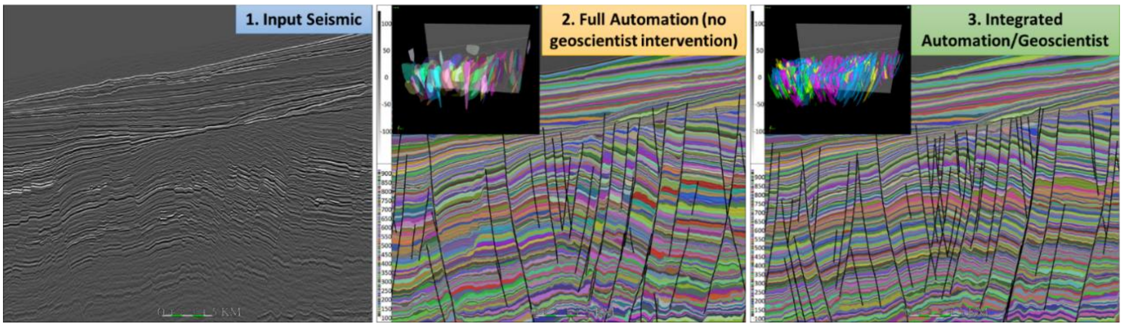

Figure 3 *Comprehensive hybrid Automation/Geoscientist workflow: 1) Input seismic data; 2) AFE and RGT results without domain expert intervention (0.5 working day); 3) AFE and RGT results with refinement by a domain expert (10 working days).*

The automation for RGT modeling operates while being fed by the interpreter's QC in real time: the more the major geological correlations are edited by the interpreter, the more the subtle ones are reliably managed by the automation. Nevertheless, the fault extraction remains a preliminary phase to be performed before the RGT modeling.

Conclusions

In a period of growing need for efficiency and accuracy, the proposed hybrid workflow relies on the synergy between automated processes and geoscientists' expertise. Since the routine work (fault extraction, horizon picking and propagation) is accurately performed by an automation, interpreters can focus on critical decisions and geological interpretation led by their knowledge. The efficiency of this hybrid workflow has been extensively proven in a broad range of challenging projects but can be improved by bringing additional structural constraints simultaneously to the RGT modeling phase.

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References

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