

## Overview of R&D on 3D Geological Modelling at BRGM

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BRGM has invested for long in the development of methods for geological modelling. These methods have progressively moved to industrialization through « homemade » software (GDM-Multilayer, 3DGeomodeller). Considering the wide range of applications and geological settings, the choice for own developments allows better flexibility and adaptive capabilities on tools and methods.

### Modelling geology in complex tectonic environment:

In the frame of Potential and Gradients Cokriging method (Lajaunie *et al.*, 1997), one of critical parameters when interpolating natural objects concerns the anisotropy which in current methods is at best considered as uniform within the domain. The introduction of spatially variable anisotropies will allow to model structures such as folds whose characteristics are variable in space, intrusive systems in orogenic domains, or even meandering alluvial systems (Fig.1). This will contribute to increase the realism of geological models.

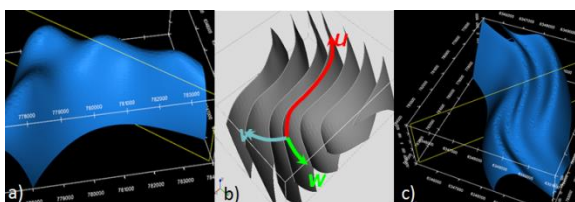


Fig. 1: a) Rather bubble shapes if not accounting for anisotropy b) Anisotropy tensor field varying in orientation and intensity c) Interpolation accounting for anisotropy field

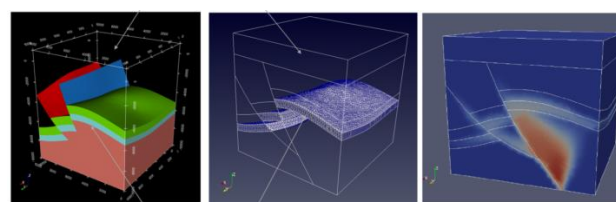


Fig. 2: 3D Geological model of a faulted aquifer and subsequent mesh for flow simulation

### Meshing problematic

Diversity of applications and physical domains lead to as many requirements for meshing type: (1) Obtain a conformable mesh to faults and layers boundaries described by implicit functions, (2) Respect of singularities and sharp angles, (3) size and shape criteria, (4) Respect of internal anisotropies. We recently used the Computational Geometry Algorithms Library (CGAL) to build conformal simplicial (tetrahedral) meshes that match any geological 3D object and its boundaries or internal 2D features such as fault surfaces (Fig.2).

### Geological architecture

This concerns the description of geological, topological, chronologic rules to combine sets of modelled surfaces so that they provide a partition of space corresponding to expected geology (Calcagno *et al.*, this volume).

### Storing and delivering geological models for every day Earth Sciences applications

Considering that no standard is currently yet accepted for 3D geological models, we started following an alternative approach based on a very simple concept. The idea is to try to escape from definition of standard formats, but rather try to define standard queries on models and standard services around models exploitation. In this scheme, models are stored in their native formats. For each type of format an API that provides an index-geology dictionary and implements simple geometric queries, called “oracles” has to be developed : (1) returns the geological formation for a given point p (2) returns an interface location in a segment [p1, p2]. With these two “oracles” and an index/geological unit we make the guess that it is possible to rebuild visualizations and extracts of any model.

The drawback is the necessity to implement readers and these two “oracles” for each native format. The advantage is to provide homogeneous services around models independent of native formats: predictive drill-holes, sections, Standard presentations, 3D views, meshing, maps, and delivery in interoperable exchange formats.

Lajaunie, C., Courrioux, G. and Manuel, L. (1997) Foliation fields and 3D cartography in geology; principles of a method based on potential interpolation. *Mathematical Geology*, **29**, 571-584.