Visualisation and interaction methods for 3D phenomena

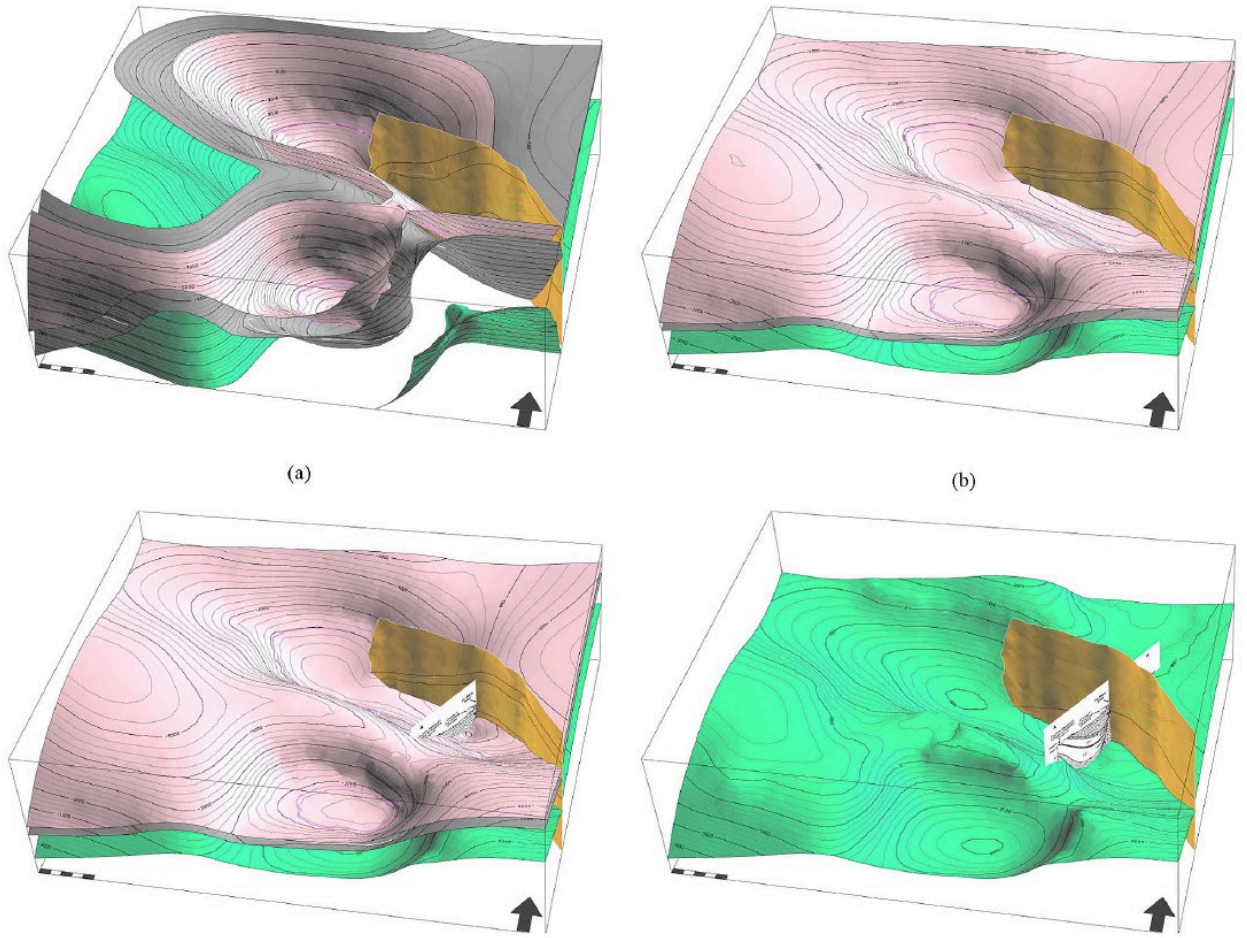
Mark Lindsay – CSIRO

3D modelling and Loop workshop

6th International Archean Symposium, Fremantle / Walyalup

Overview

- History
- Current techniques and difficulties
- Sharing
- Interaction
- Multiple models
- Other free / open source resources
- Concluding remarks



Modelling of La Popa Basin, NE Mexico

Caumon et al. 2013

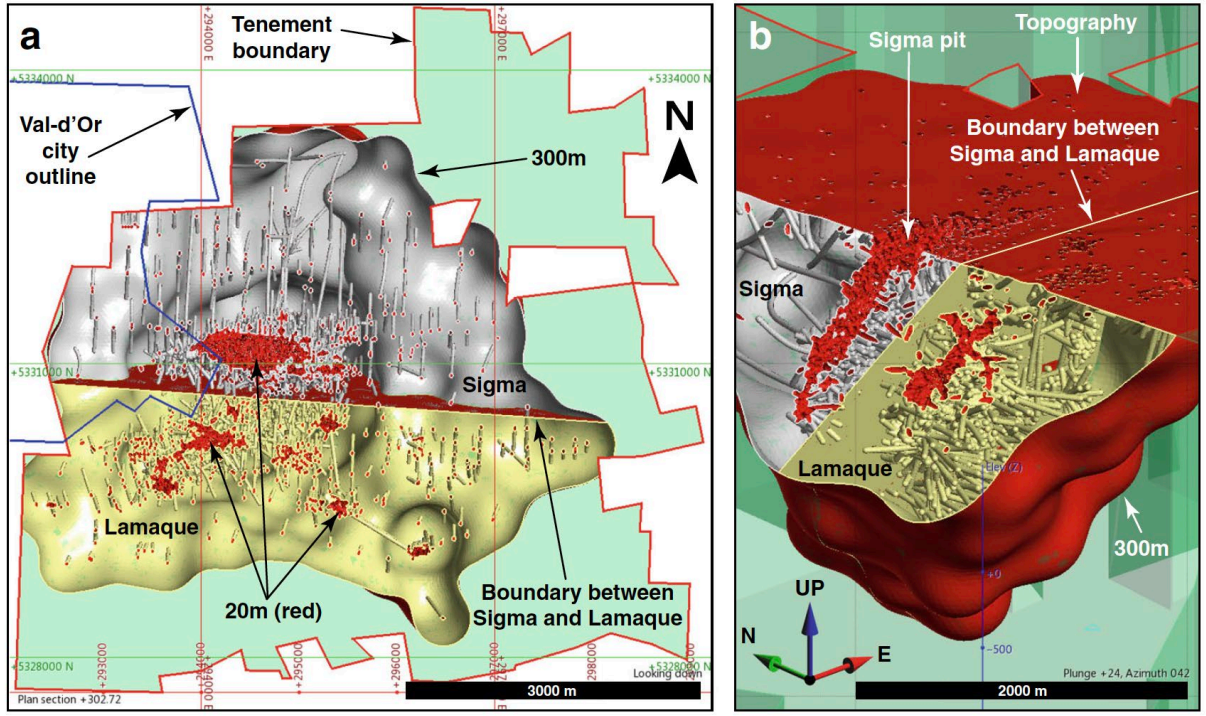
History

- Purpose
  - Practical
  - Scientific curisosity
- Communication
- Scaling
- Perfect representation of nature, or more to communicate ideas?

Saint-Belec slab - 2.2-metre by 1.53-metre stone
4000 year-old etchings of topography, western Brittany

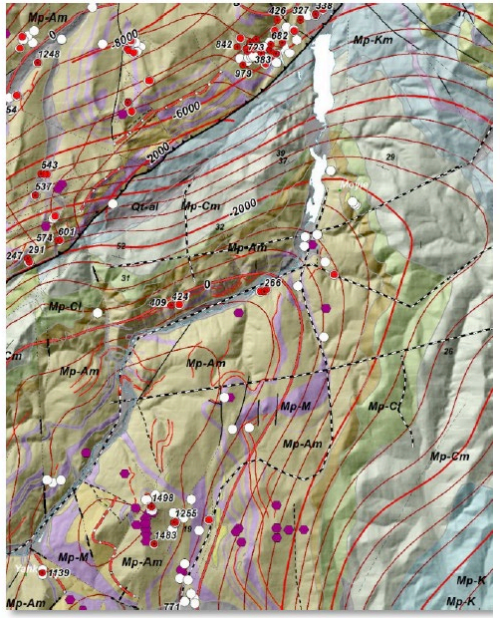
The Guardian, April 7, 2021
Photograph: Denis Gliksman

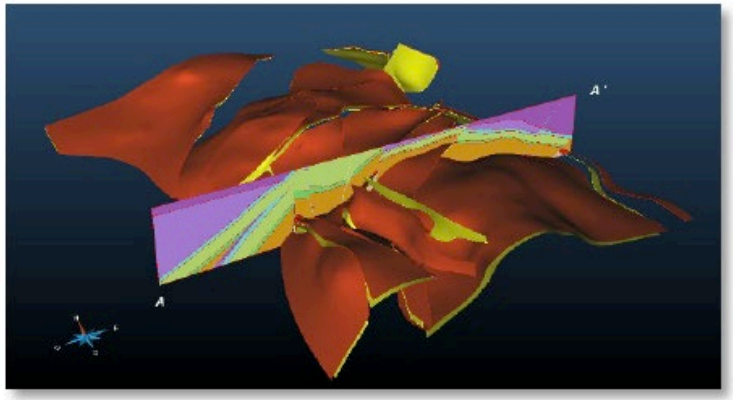
Visual summary

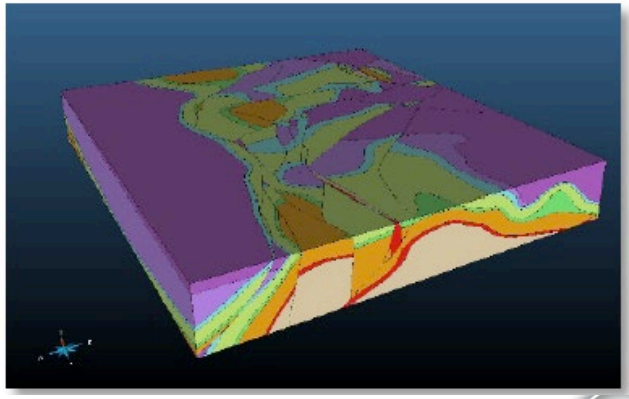


Cowan 2020
Sigma-Lamaque Au deposit, Canada

Simplify nature



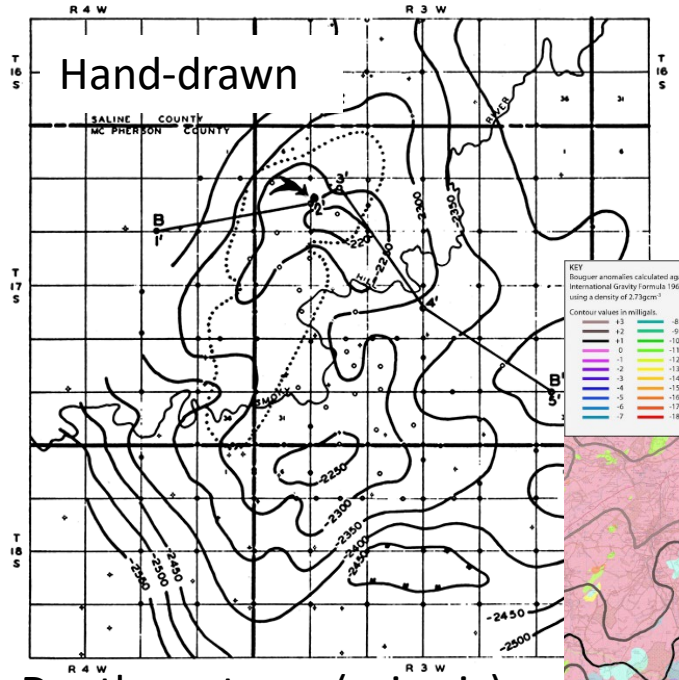




De Kemp et al 2017
Purcell Anticlinorium, Southeastern British Columbia

Centre for EXPLORATION TARGETING

Progression – geophysical grids (really models)

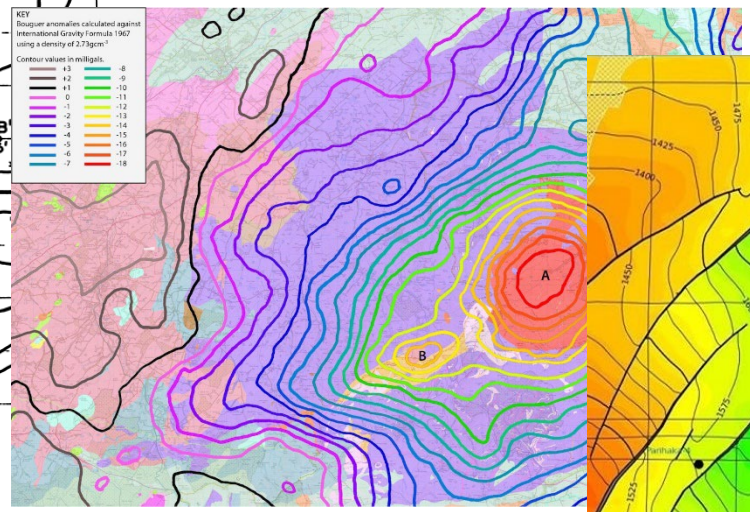


Hand-drawn

Depth contours (seismic)

www.kgs.ku.edu, Bulletin #137

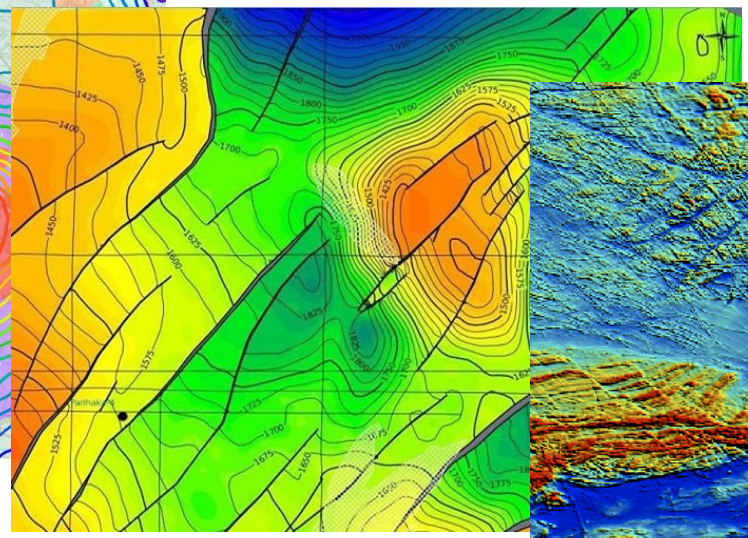
Auto-contour



Bouguer anomaly contours

www.geologynorth.uk

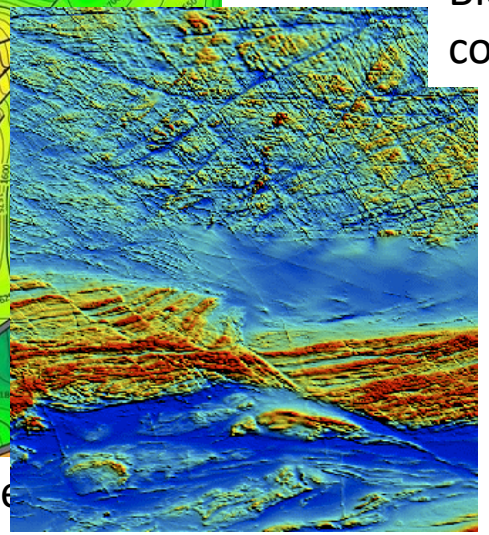
Grid interpolation



Depth grid and contours (se

www.pgdm.com “SeisEarth”

Blends, sun-shades, colour-mapping



Magnetic

c.f. GSWA

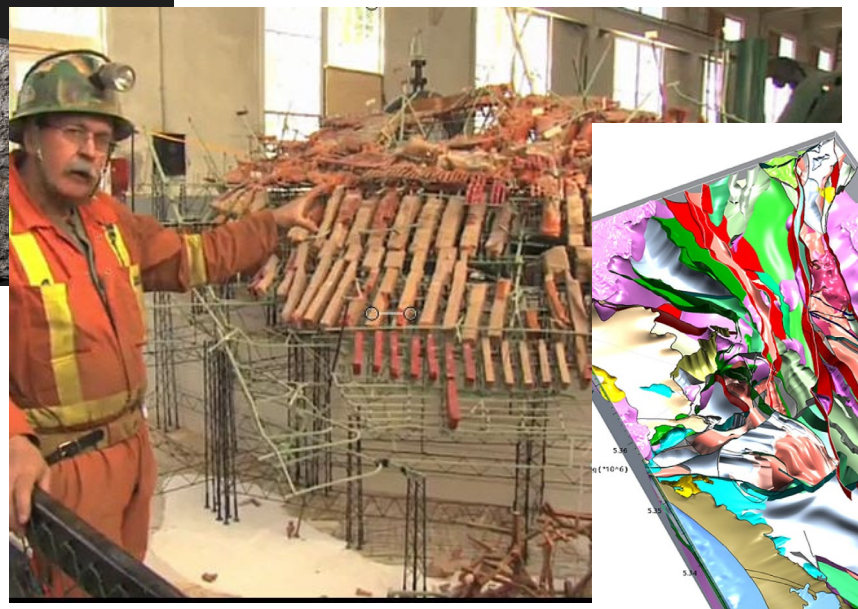
Grav and mag blend

Lindsay et al. 2020

Progression – 3D models

Saint-Belec slab

guardian.co.uk



Sullivan Mine Model

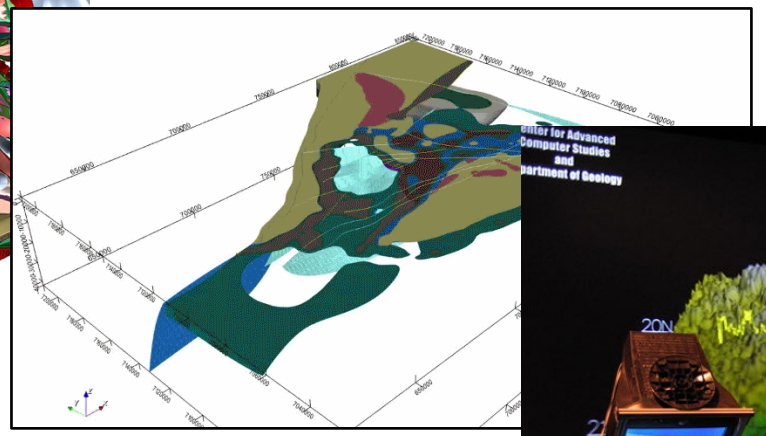
Thanks to E. De Kemp

Explicit

W. Tasmania

MRT

Implicit



Yerrida Basin, West. Aust.

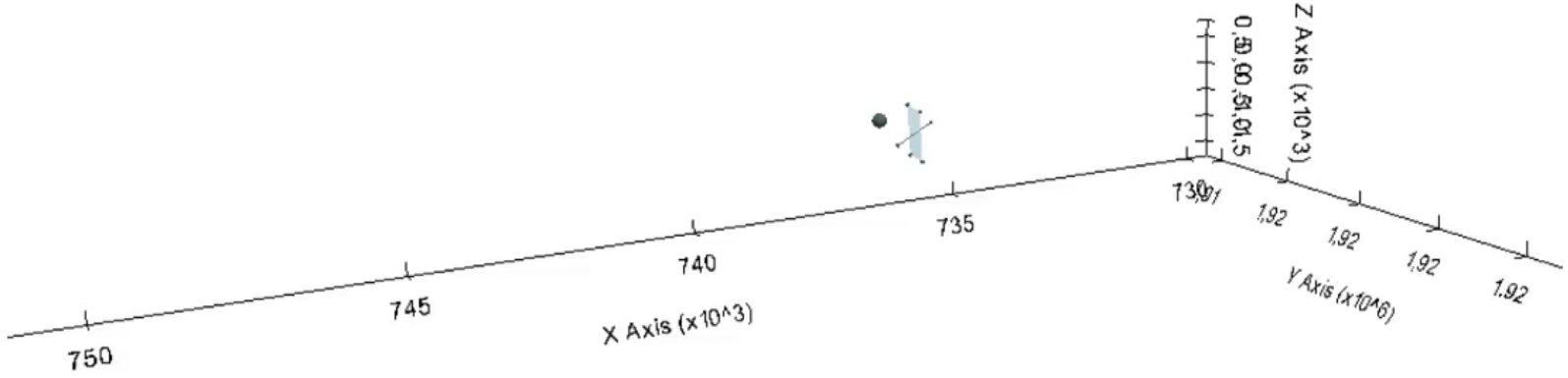
Lindsay et al 2020

Collaborative VR (‘*Kvasir-VR’*)

vrlab.cmix.louisiana.edu

Current practice

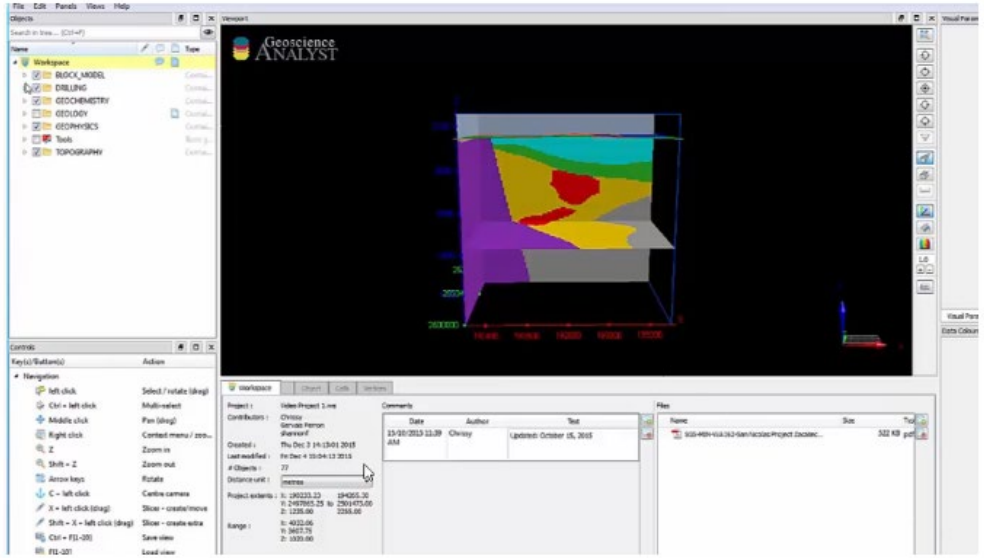
De la Varga
Terraniqma Solutions GMBH



- Points (0D)
- Curves (1D)
- Surfaces (2D)
- Volumes (3D)
- Time (+1D)

EarthSci (Geoscience Australia) ***Data discovery***

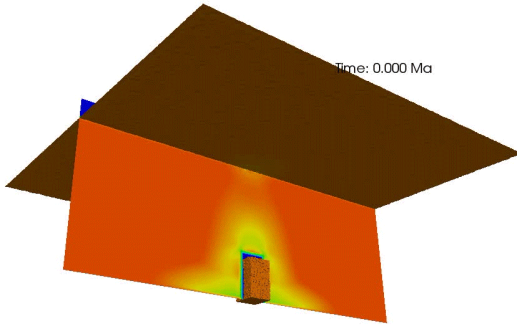
Geoscience Analyst (MIRA) ***Editing, modelling***



Current practice

Geodynamic models

Kohanpour et al. 2017
Examining tectonic scenarios using geodynamic numerical modelling: Halls Creek Orogen, Australia

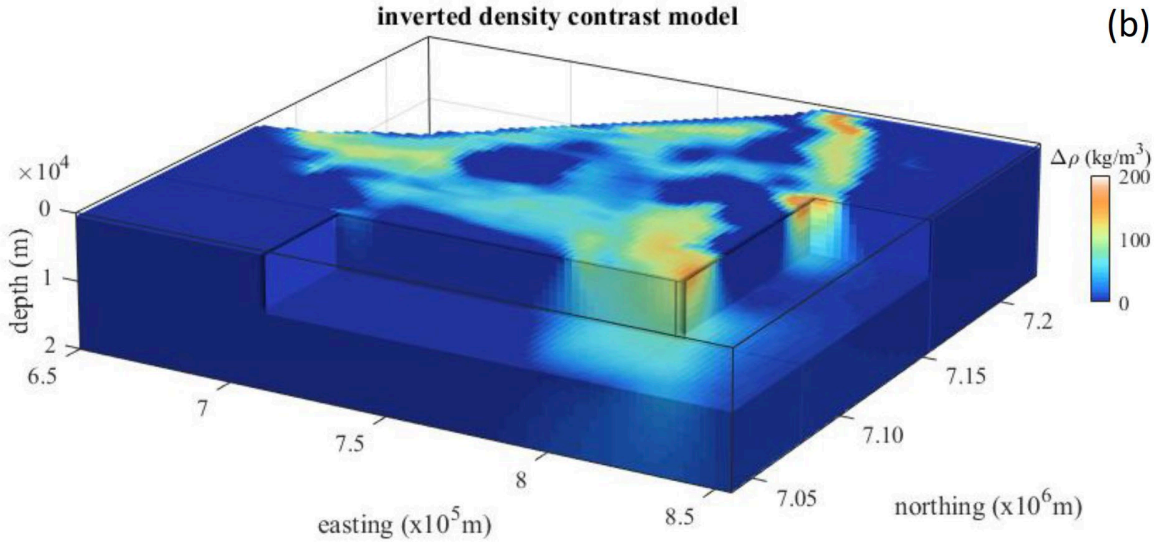


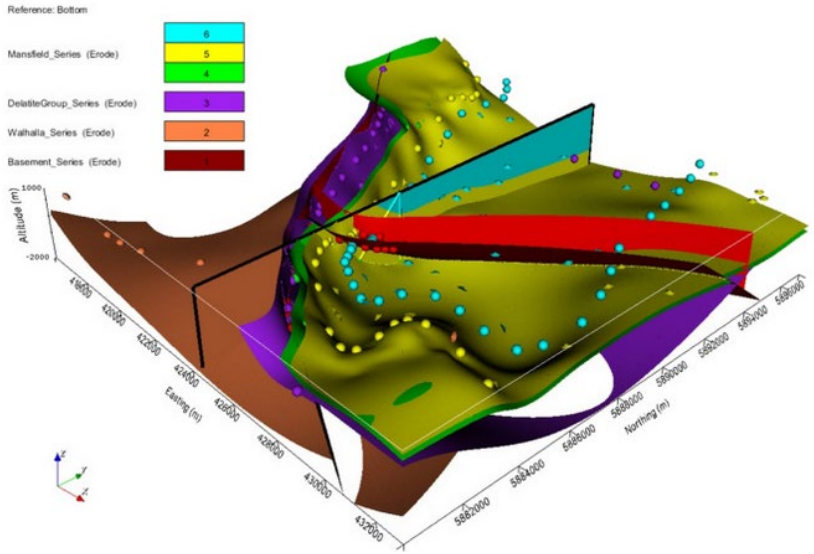
Gorczyk and et al. 2017
Intrusion of Magmatic Bodies Into the Continental Crust: 3-D Numerical Models

Current practice

- Difficulties of presenting 3D with a 2D medium

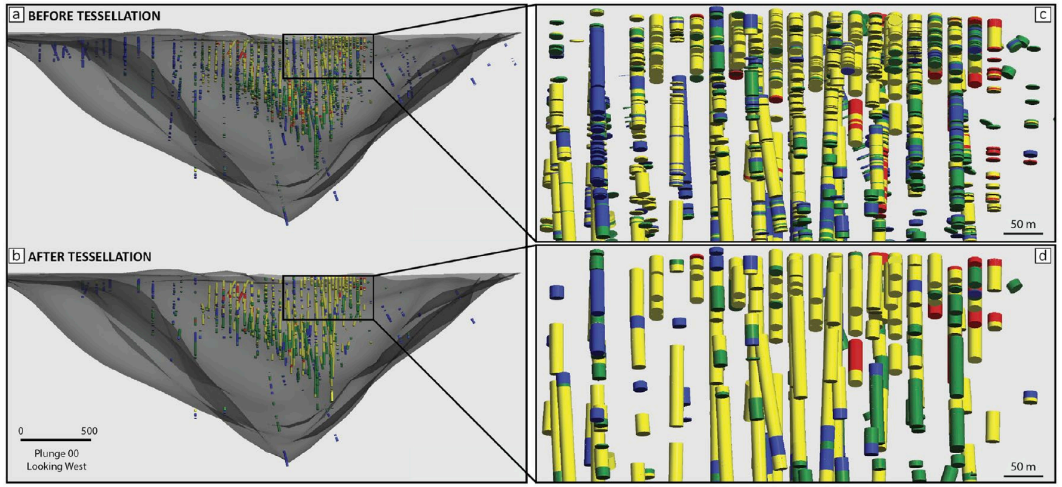
Giraud et al 2018
Yerrida Basin, WA, density model





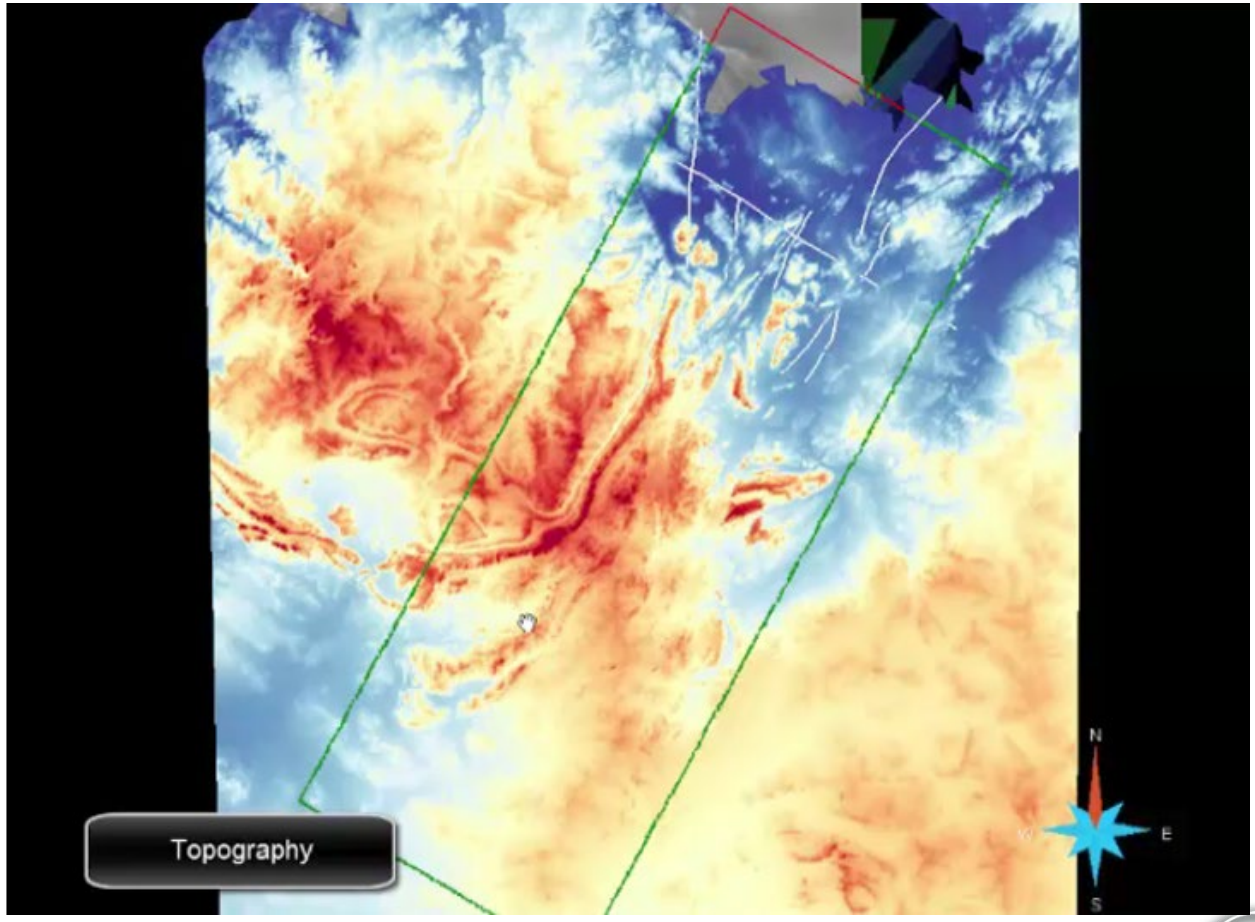
Pakyuz-Charrier et al 2018
Mansfield, Victoria

Le Vailant et al 2017
Kevitsa Mine, drill hole tessellation



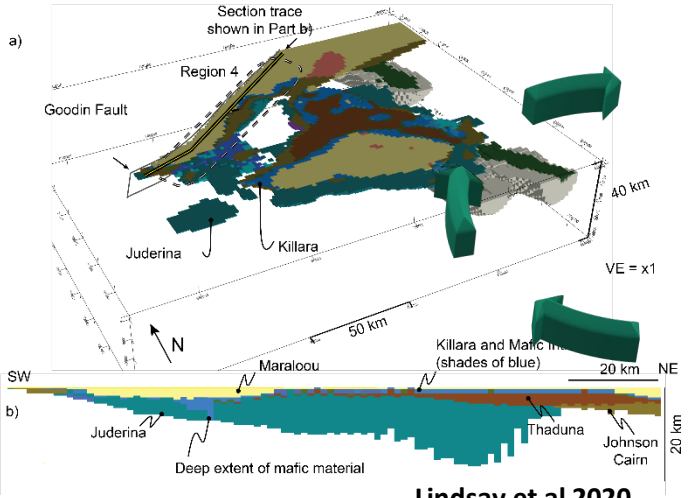
Current practice

- Difficulties of presenting multivariate model inputs with their results



Visualisation ~ Communication

- Models (inc. 3D) need to be predictive or generate inference
- Requires interaction and sharing between participants
- Collaboration



Lindsay et al 2020
Solid Earth

hsdinstitute.org

Scenarios for robust decisions

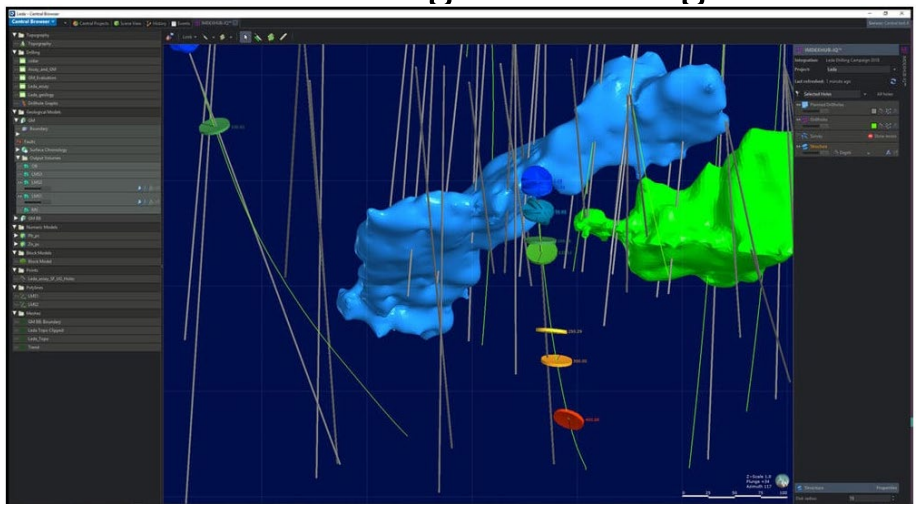
- help us investigate our assumptions;
- highlight important processes and decision points;
- engage different stakeholders;
- provide insight into what is possible
- provide visions of the future which motivate actions toward a desirable goal or away from an undesirable one;
- communicate complex information to non-scientific audiences

Bonnie McBain - https://i2insights.org/2019/07/02/designing-scenarios-for-decisions/

John Sykes – Greenfields Research/MinEx Consulting
Rhys-Davies et al. 2020a,b

Interaction and sharing

- Data and model management
  - Common repository
  - Version control (both data, model and predictions)
- Leapfrog (Seequent) Central
- IMDEXHUB-IQ
  - runtime drilling monitoring



Browser window

Avoiding uncertainty

- Linguistic uncertainty
  - Vague aims
  - Ambiguity and underspecified comms.
  - Stakeholder members / composition
- Value uncertainties
  - Agreement/disagreement on quantification, comparison and value of social goals, trade-offs, objectives

Ill-defined terms-of-reference and scope is a significant and difficult to mitigate source of uncertainty (Quigley et al. 2018)

Interaction and sharing

Virtual Reality Interface
Field Augmented Reality (FARMIN – EIT RawMaterials)

De la Varga
Terranigma Solutions GMBH

Interaction and sharing

- cloud-based
- visualize, edit and communicate geological data
- models in intuitive 3D
- real-time collaboration across multiple devices

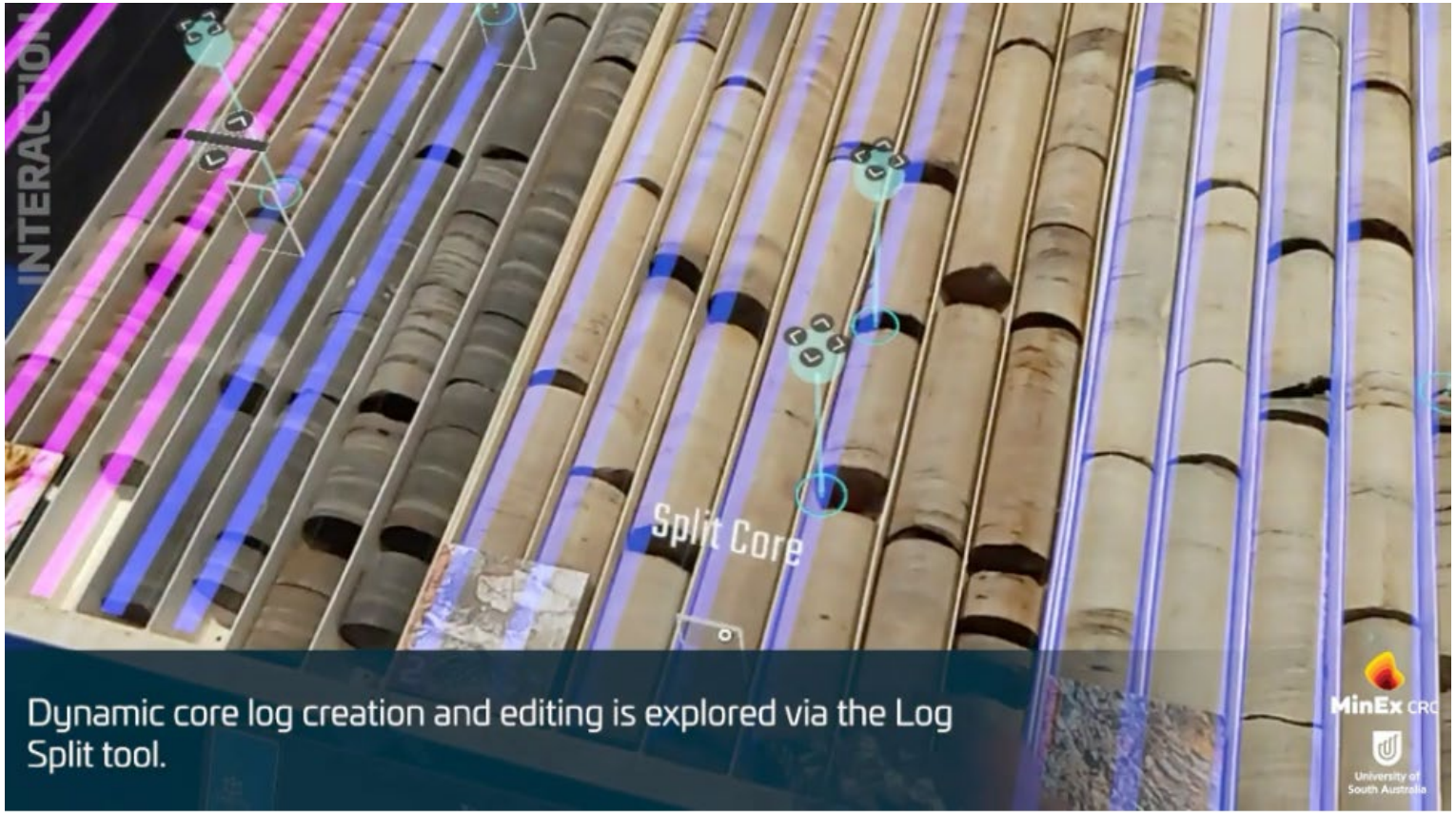
Liquid Earth – Terranigma Solutions

TERRANIGMA

https://www.terranigma-solutions.com/

Interaction and sharing

- Exploration Metaverse:
- augmented reality core logging (LogAR),
- virtual collaboration and visualisation of spatial datasets (OzMap),
- immersive analytics for geoscientific data (ImAxesGEO).



MinEx CRC

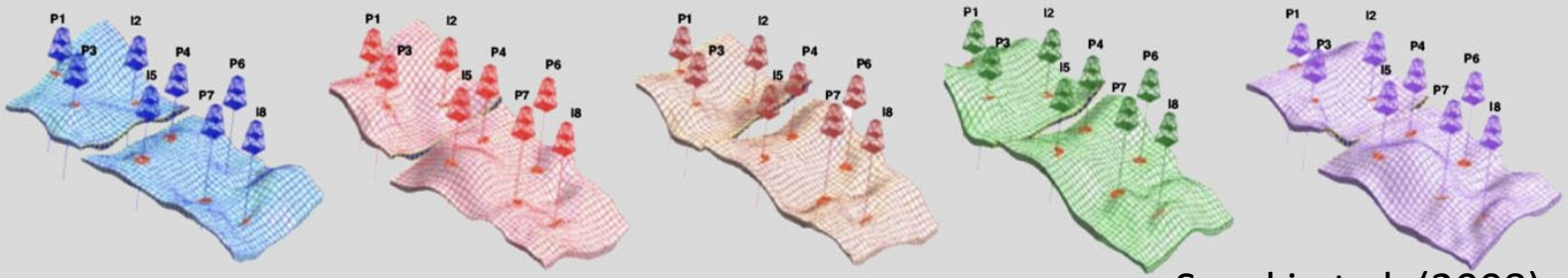
University of South Australia | Australian Research Centre for Interactive and Virtual Environments

Tom.Raimondo@unisa.edu.au

https://www.projectlive.org.au/exploration-metaverse

Interaction and sharing

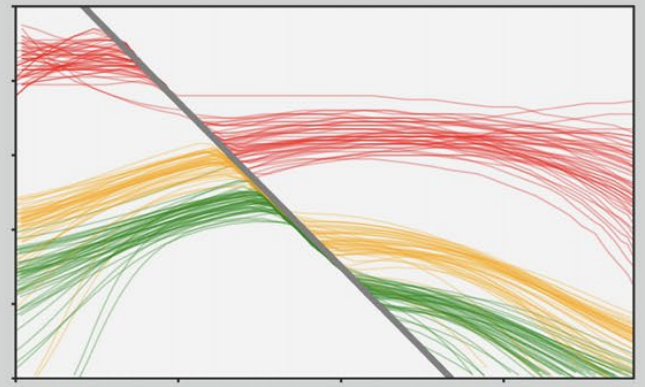
Multiple separate realisations



Suzuki et al. (2008)

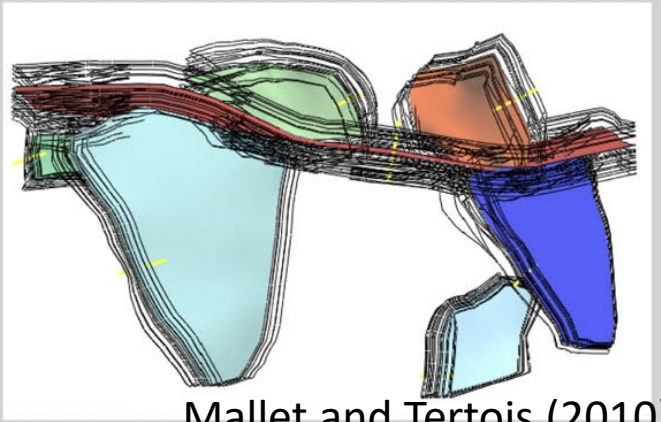
- Multiple models

Multiple separate interfaces (cross-section)



De La Varga (2018)

Multiple models (3D)

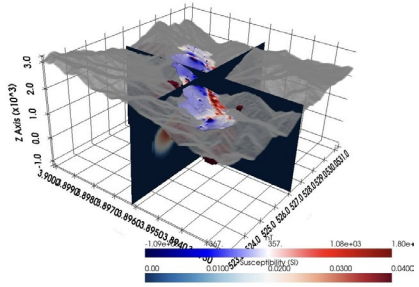


Mallet and Tertois (2010)

From Wellmann and Caumon (2019)

Other free or open source resources

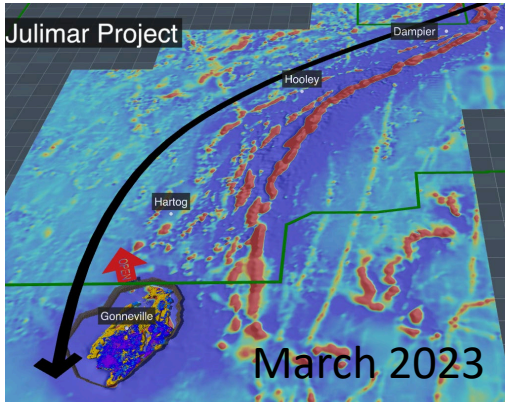
pyvista.org (with VTK)

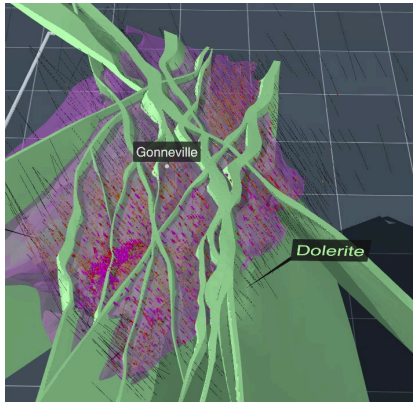


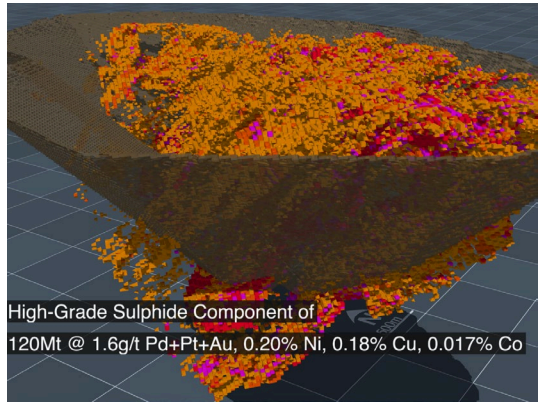
Receiver locations and geophysical data are mapped over a 3D model.

c/o Hakim

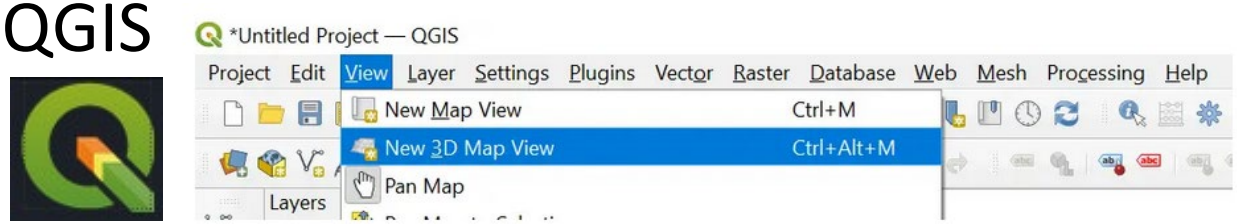
- Paraview, VisIt
- https://inventum3d.com/







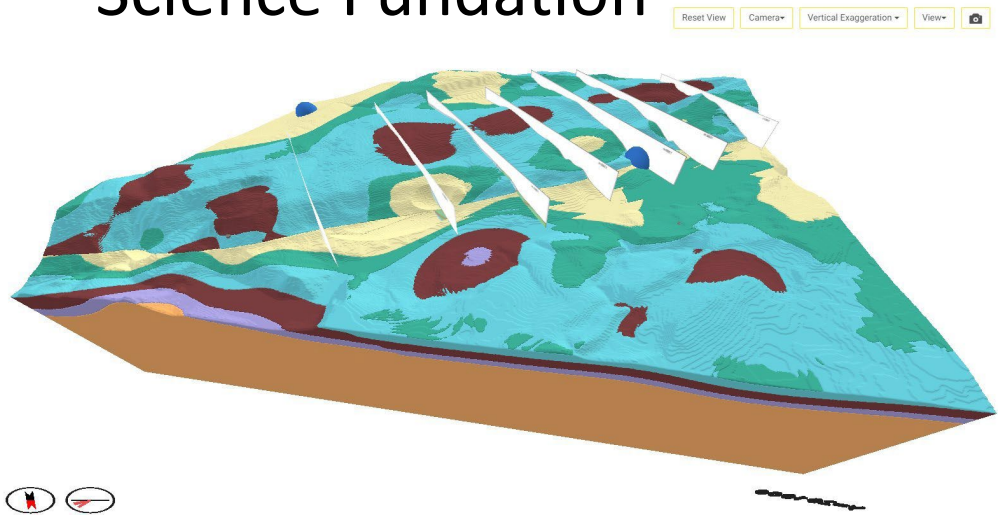
- Geoscience Analyst
- QGIS



Open a 3D Map View

https://www.visualkarsys.com/

- Visual Karsys
- Swisskarst project (2010-2014) Swiss National Science Fundation



Concluding remarks

- Visualisation is more than just a solo exercise
- Communicating with our collaborators and stakeholders
- Avoiding uncertainties and misunderstandings

Modelling

- Interactive
- Collaborative
- Joint visualization and construction