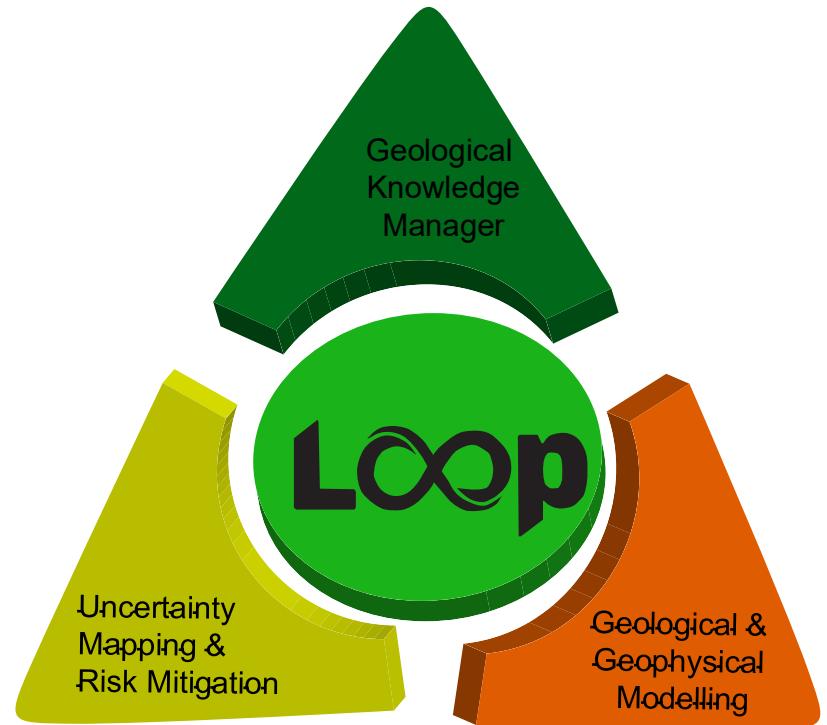


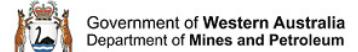
An integrated and interoperable platform enabling  
3D stochastic geological modelling

## The Loop Project - Overview

Presented by: Laurent Aillères, Lachlan Grose, Mark Jessell,  
Noelle Cheng, Guillaume Pirot, Angela Rodrigues, Rabii Chaarani, Vitaly Ogarko, Jeremie Giraud, Michel Nzikou  
for and on behalf of the entire Loop development team



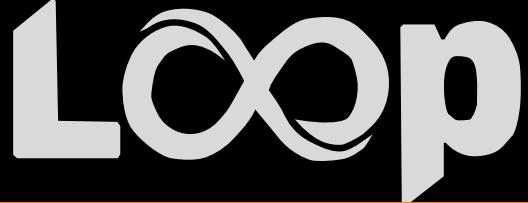
BHP



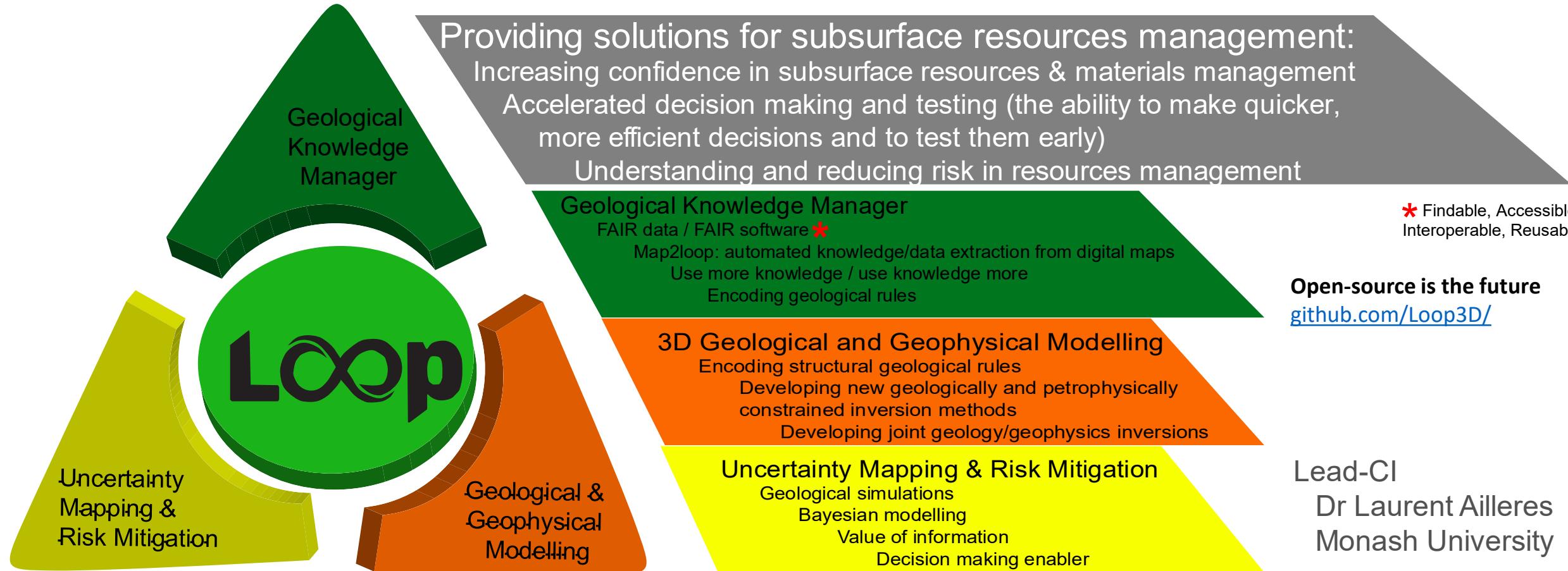
Government of Western Australia  
Department of Mines and Petroleum



Providing geoscience data globally



# An integrated and interoperable platform enabling 3D stochastic geological modelling



MONASH University

Australian Government  
Australian Research Council

Government of Western Australia  
Department of Mines and Petroleum

ONE

THE UNIVERSITY OF  
WESTERN AUSTRALIA  
Centre for EXPLORATION  
TARGETING

Australian Government  
Geoscience Australia

NORTHERN TERRITORY  
GOVERNMENT

Providing geoscience data globally

Tasmanian Government

Government of South Australia  
Department of State Development

ISTO

VICTORIA  
State Government

Queensland Government  
Business Queensland

SOUTH  
AUSTRALIA

NSW  
Regional NSW

AuScope

RWTH AACHEN  
UNIVERSITY

CSIRO

Université de Lorraine

DING  
Institut de Géologie  
de Lorraine

British Geological Survey

CANADA  
GEOSCIENCE  
COMMITTEE

Earth Science Institute of Ireland

MinEx CRC

AngloAmerican

100  
YEARS

BHP

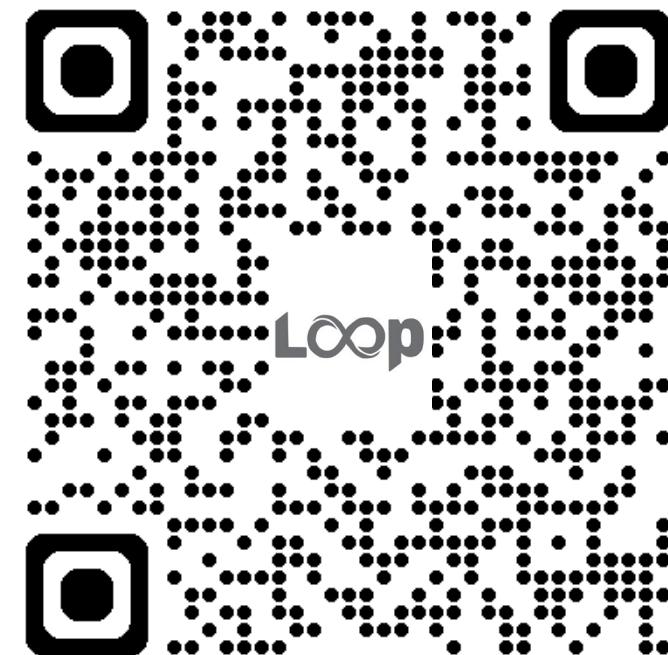
Government of Western Australia  
Department of Mines and Petroleum

# Loop – Why a new 3D geological modelling platform?

Providing solutions for subsurface resources management:  
Increasing confidence in subsurface resources & materials management  
Accelerated decision making and testing (the ability to make quicker,  
more efficient decisions and to test them early)  
Understanding and reducing risk in resources management

- Current commercial technologies do not allow for modelling of poly-deformed terranes in a reproducible sense  
-> structural geology based modelling algorithm
- Need for uncertainty characterisation
- Need for better geophysical integration
- Maximisation of 3D geology uncertainty reduction

This can only happen through automatisation of the modeling workflow



**Open-source is the future**  
[github.com/Loop3D/](https://github.com/Loop3D/)

# Loopers? Who are we?

## R & D providers

MONASH University



Centre for EXPLORATION  
TARGETING



Australian Government  
Geoscience Australia



## Partners



Government of Western Australia  
Department of Mines and Petroleum



BHP



Government of Western Australia  
Department of Mines and Petroleum

## Funding



Government of Western Australia  
Department of Mines and Petroleum

## Data / case studies



BHP

Loop

Since Nov 2018...



Providing geoscience data globally

MONASH University



Centre for EXPLORATION TARGETING

AuScope

\$150K



ARC Linkage

\$1,700K + \$1,550K



Loop Portal

\$200K



P6 & OP6

\$2,100K



VOI  
DECRA

\$1,000K



GSC Knowledge Manager

\$400K



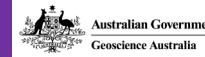
EGF 3D fault model

\$67K



Loop & Thin Geology modelling

\$200K



GeoMos

\$300K



DARE Data Analytics

\$600K



Loop embedded researcher

\$420K



\$50K



Australian Government  
Australian Research Council



British Geological Survey  
NATURAL ENVIRONMENT RESEARCH COUNCIL

USGS  
science for a changing world



Regional NSW



Government of South Australia  
Department of State Development



Government of Western Australia  
Department of Mines and Petroleum



AuScope



Australian Government  
Geoscience Australia



MinEx CRC



BHP



Government of Western Australia  
Department of Mines and Petroleum

RING  
UNIVERSITÉ DE LORRAINE

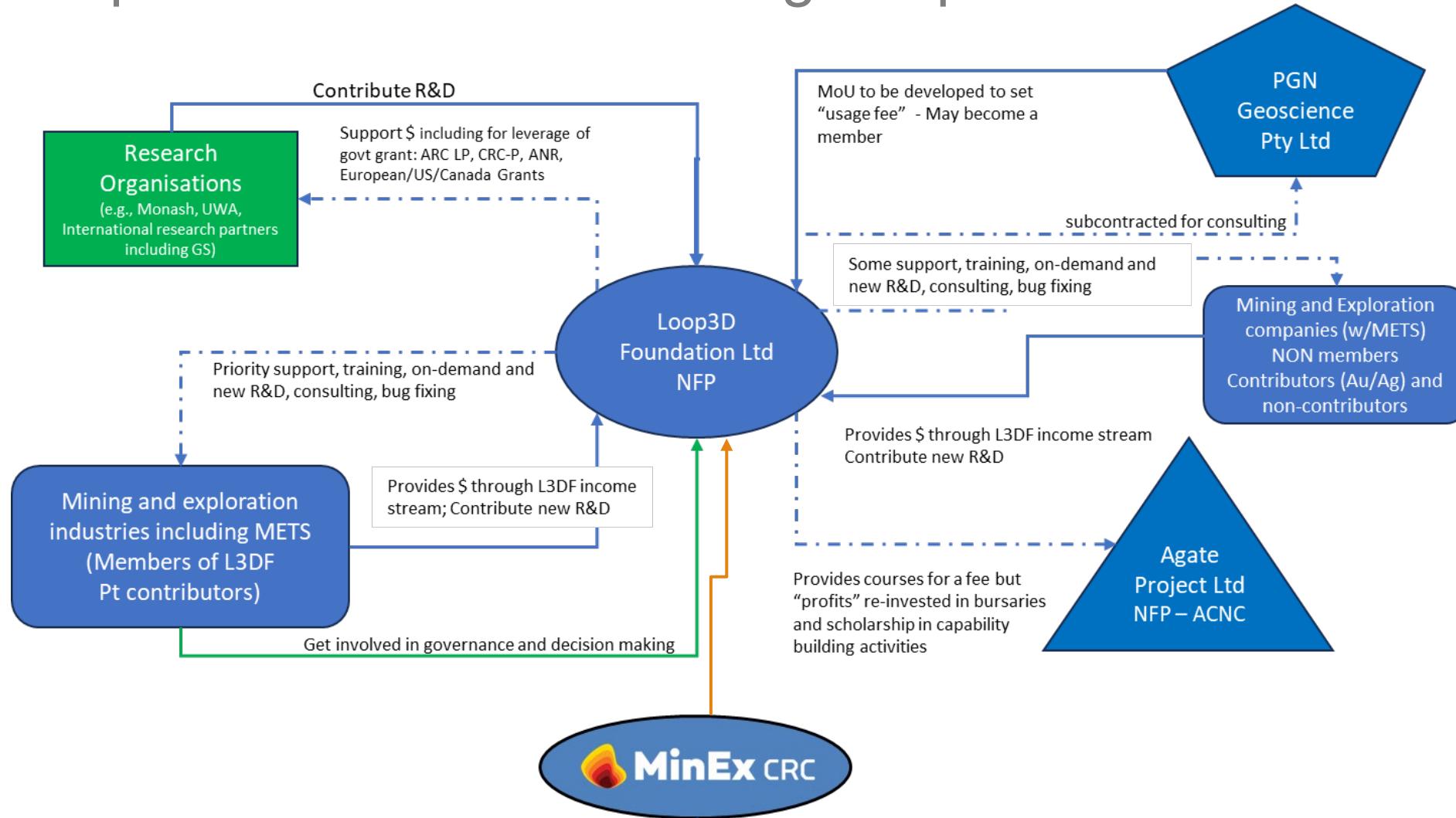


ISTO

RWTH AACHEN  
UNIVERSITY



# Loop3D Foundation – Making Loop R&D sustainable



a NFP public company

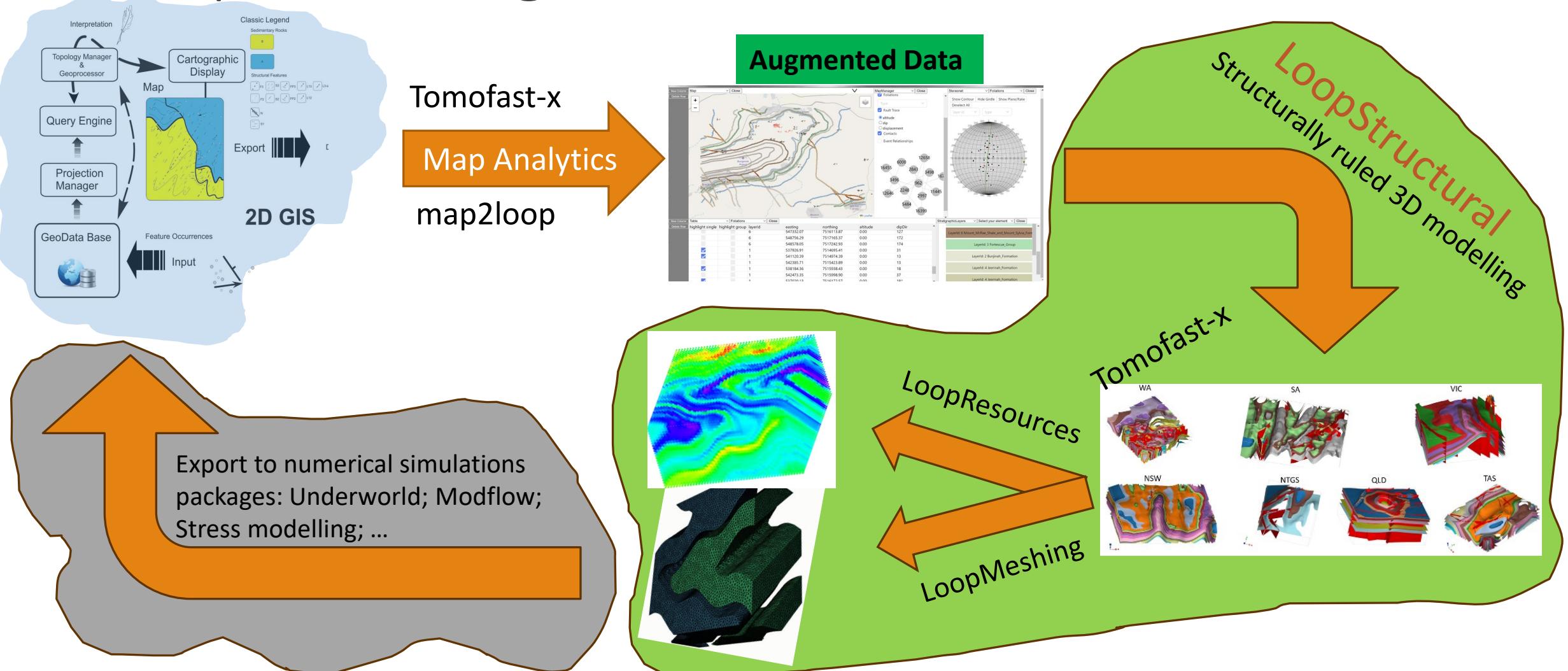
Loop

# Loop3D Foundation – purpose (constitution extract)

- The company's object is to pursue the following purpose(s) which may be charitable in nature:
  - (a) to **research, develop, maintain, and administer software** that concerns 3D geological (sub-surface) modelling (software);
  - (b) to make the **software freely and widely available** via a general use license or other appropriate means;
  - (c) to support and administer the software and/or its use as part of **a 3D probabilistic geological and geophysical modelling platform**;
  - (d) to **provide solutions for subsurface resources management** including via use of the software and/or associated platform;
  - (e) to advance the natural environment through educating and/or promoting the education of the community about geological resources and related issues;
  - (f) to research, maintain, develop, review, collaborate and contribute knowledge concerning any or all of these purposes;
  - (g) to **provide formal or informal training and supervision concerning the software** and/or the platform or the research and application thereof, and grant or facilitate prizes, scholarships and/or funding in respect of such training;
  - (h) to **provide services** (commercial or otherwise) concerning the software and/or the platform, including **training, consulting, and tailored application** requirements; and
  - (i) to support members in connection with any of the above purposes



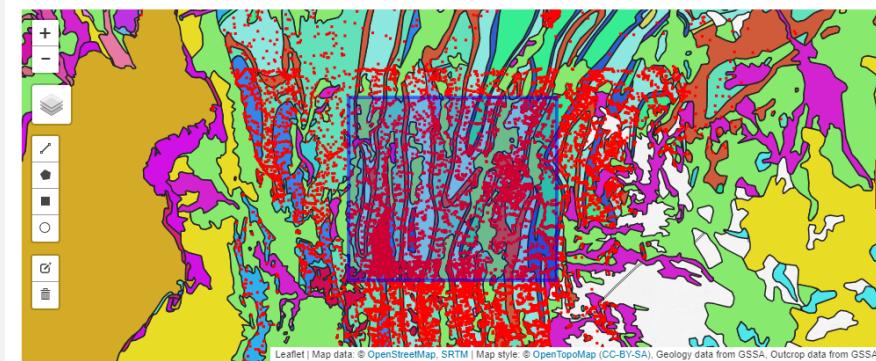
# Loop modelling workflow



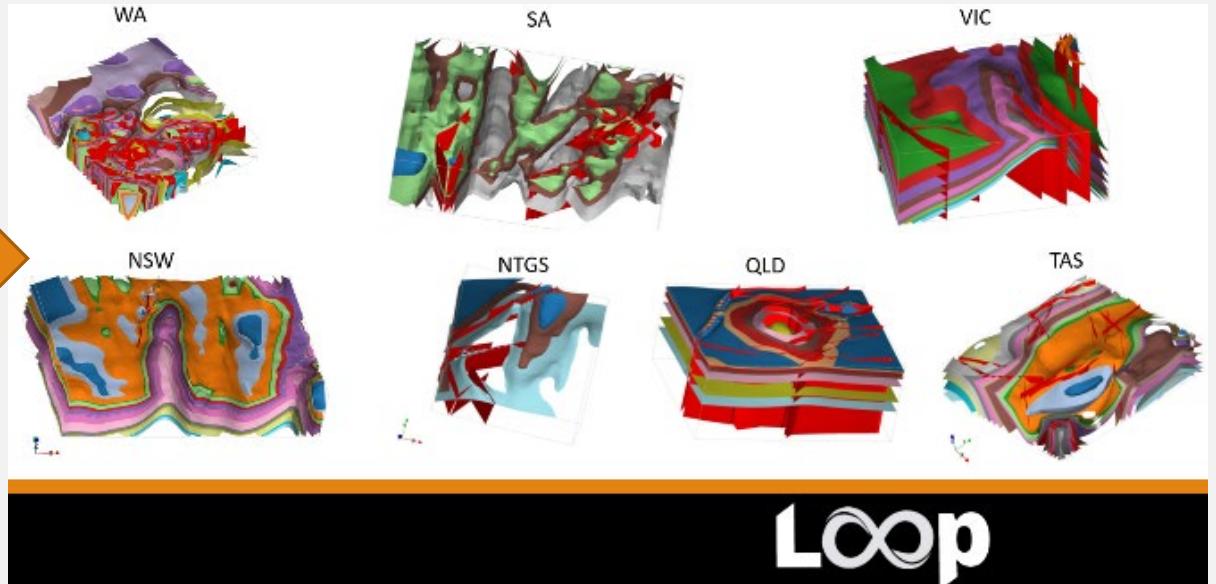
Loop

# Automation of Geological Digital Twin(s)

Automated 3D model creation with the link: map2loop -> LoopStructural



m2l analysis  
and data  
augmentation



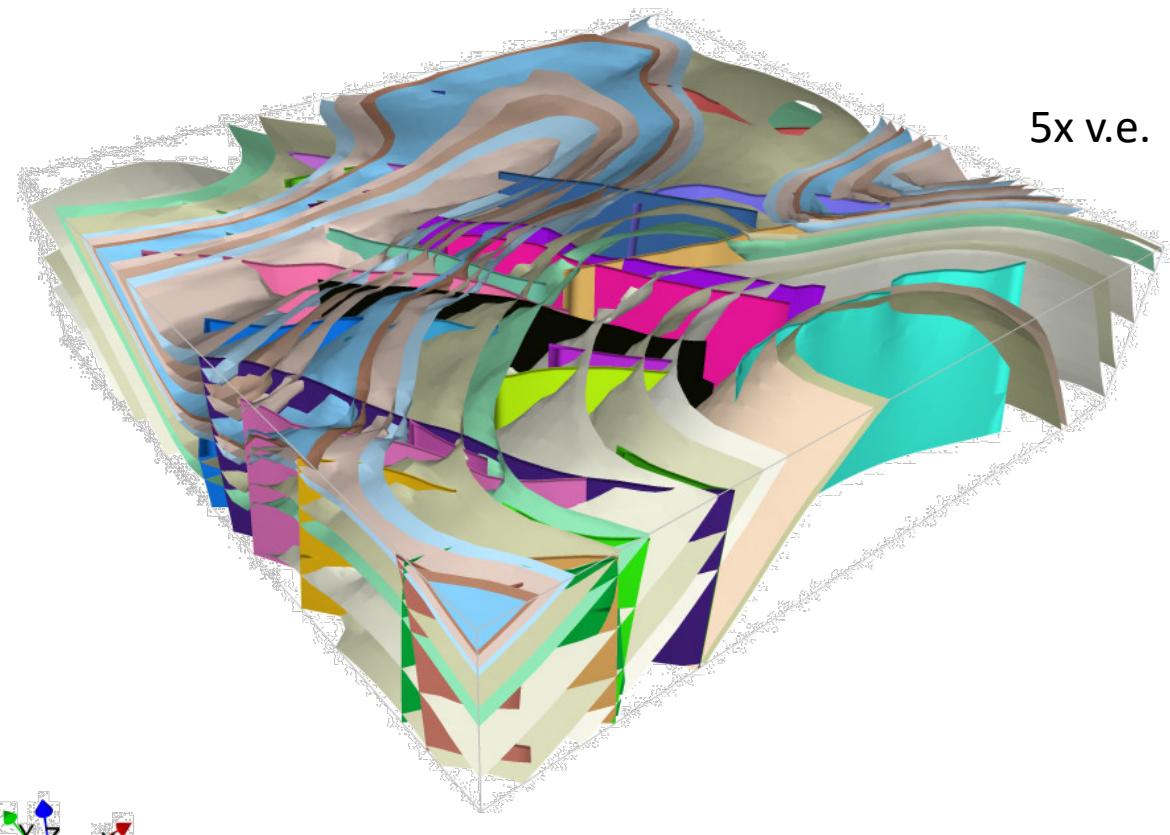
Data served by Geological Surveys in  
Australia

**EGU** European Geosciences Union  
Geoscientific Model Development  
Special issue  
The Loop 3D stochastic geological modelling  
platform – development and applications  
Editor(s): GMD topical editors | Coordinator: Laurent Allières

LoopStructural models calculated in a few minutes (inc. map2loop and loopstructural time) on a “normal” laptop  
E.g. Flinders ranges: 10K+ orientation data points; overall time ~11 minutes (Dell Inspiron 15).

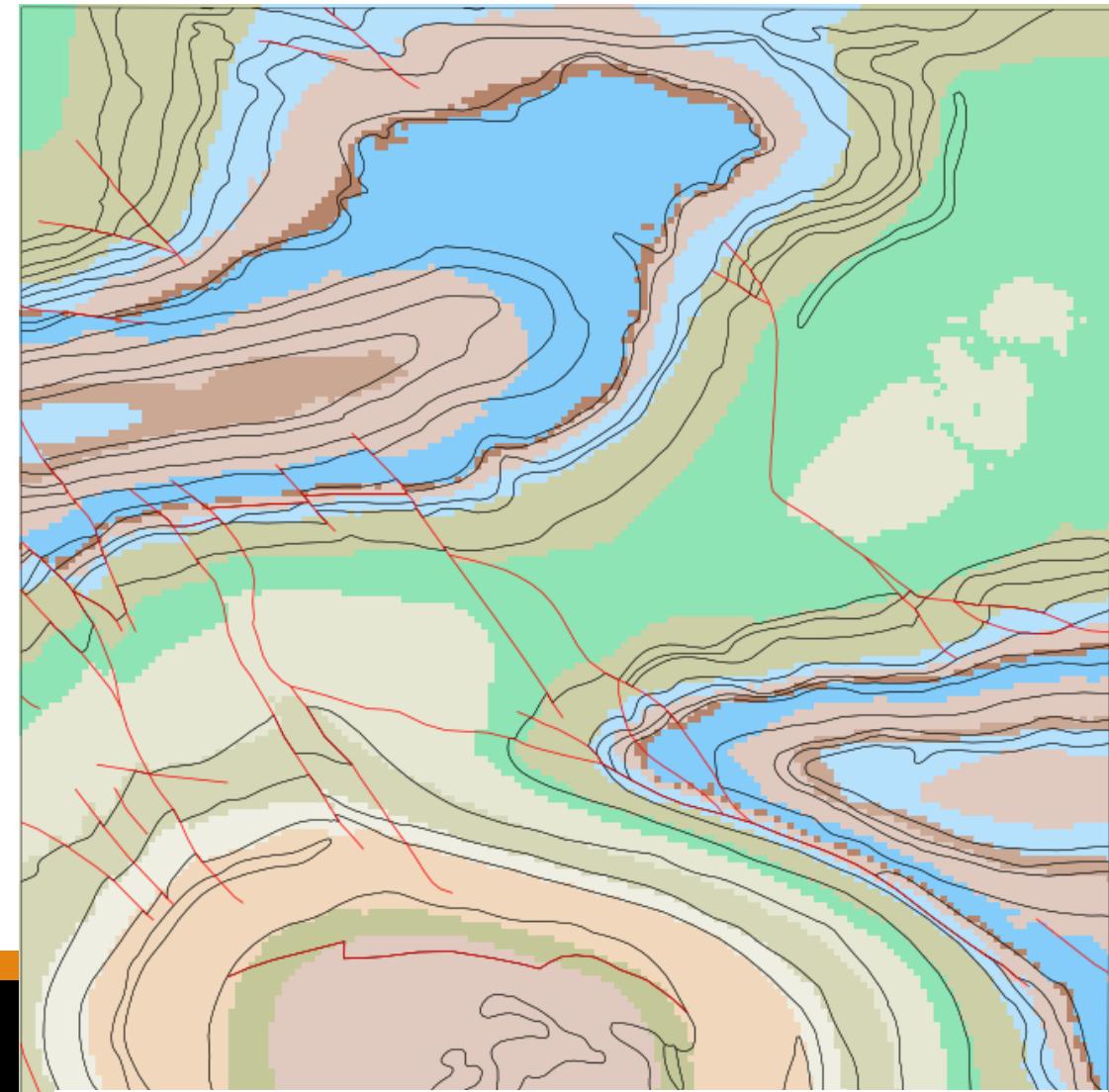
Loop

# 3D modelling LoopStructural

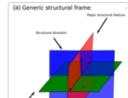


5x v.e.

~15 minutes from raw data  
(6 mins *map2loop*, 9 mins *LoopStructural*)



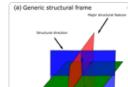
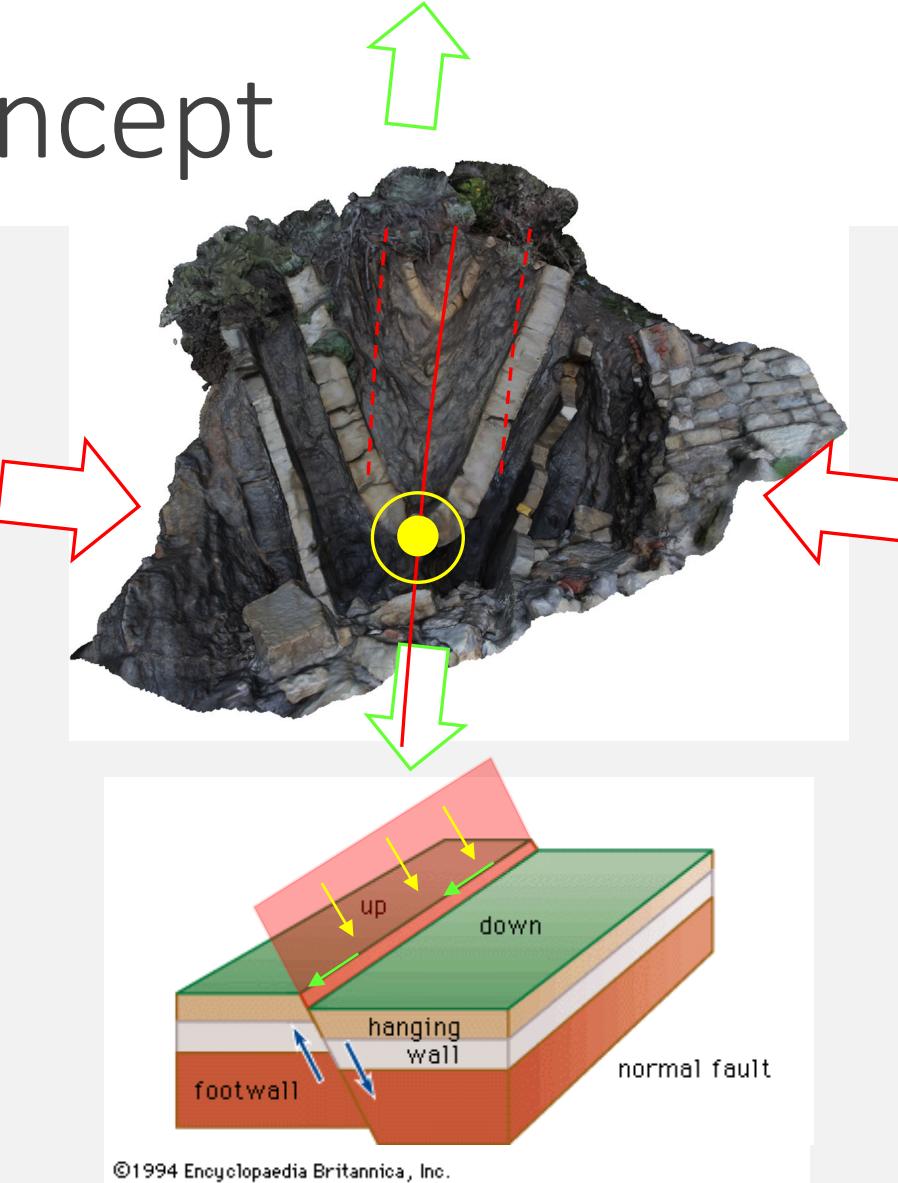
Comparison between top surface of model and map



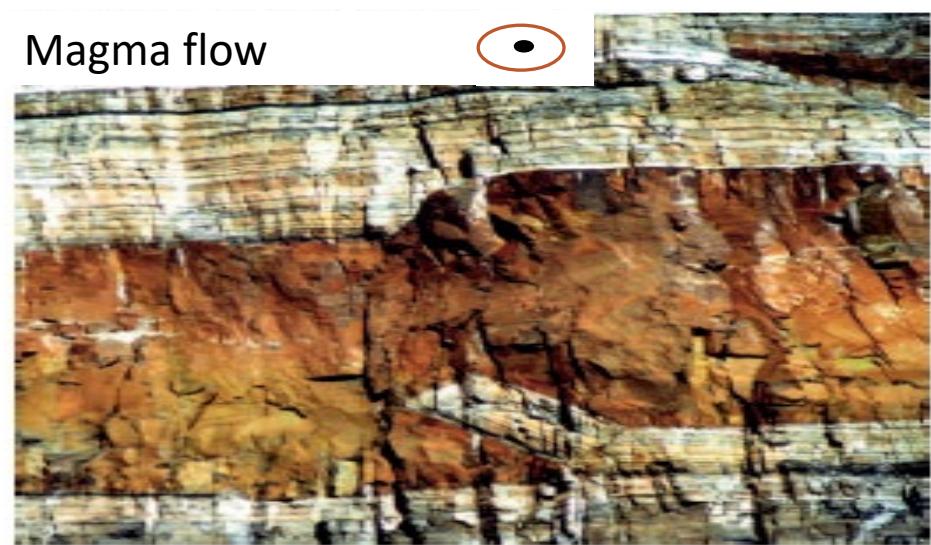
# The Structural Frame concept

Three coordinates – three scalar fields

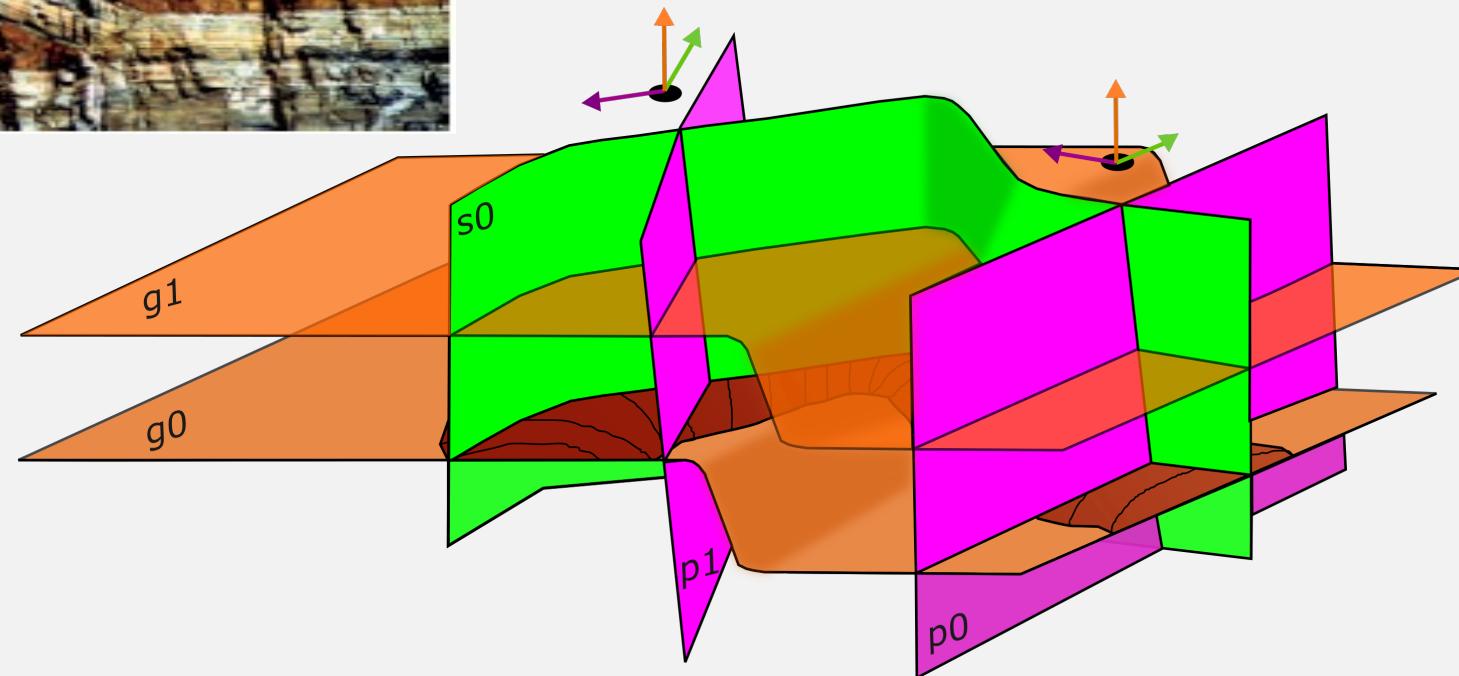
1. Major structural feature
  - fault surface
  - fold axial surface
  - intrusion major axis
2. Structural direction
  - fault slip direction
  - fold axis
  - intrusion flow direction
3. Additional direction (if required)
  - Fault , e.g. fault extent



Magma flow



Step geometry, sill  
(Hutton, 2009)



- Intrusion
- Structural frame isosurfaces
- Structural frame axes

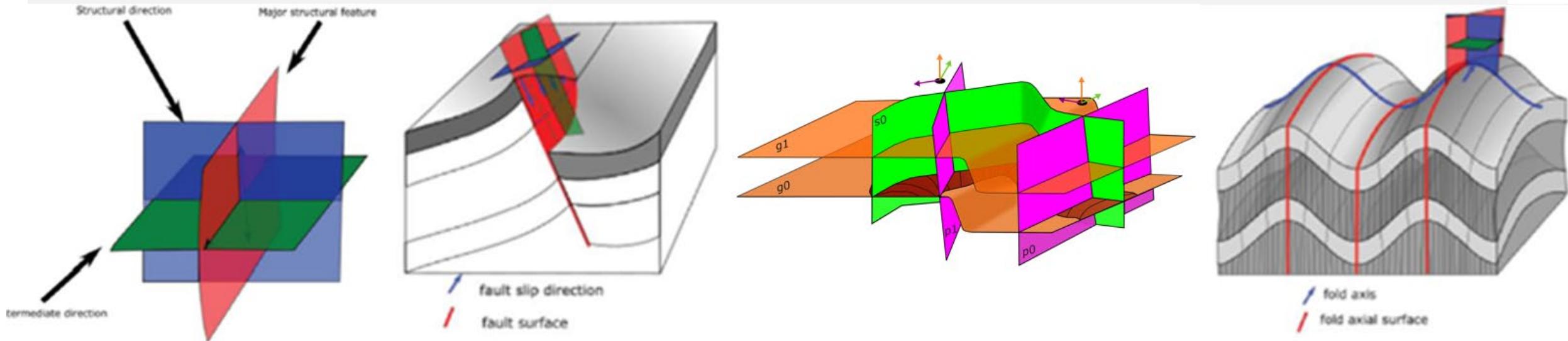
Fernanda Alvarado-  
Neves (PhD candidate,  
Monash University)

Loop

# **LoopResources** Reducing the Mining Footprint

- an automated, reproducible, update-able, workflow to model geology based on structural geological rules
- integration with geophysical modelling (early piecewise inversions or late level-set inversions)
- a characterisation of uncertainty that will guide further data acquisition (where and what)

AND a framework using **structural frames** to model ore body properties including:  
lithology, alteration, mineralogy, metallurgy, geotechnical parameters and grades

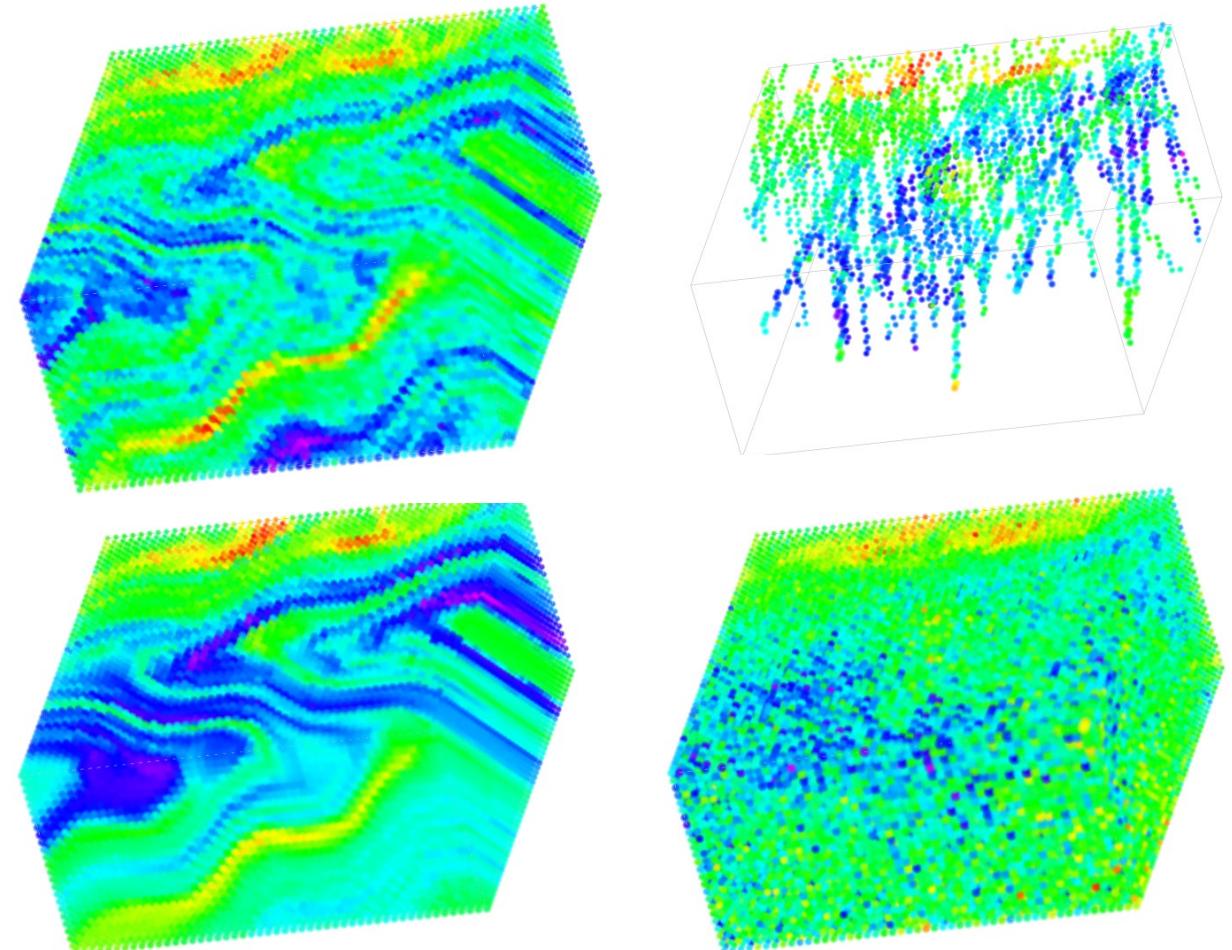


# **LoopResources** Reducing the Mining Footprint

## ■ The Loop Vision:

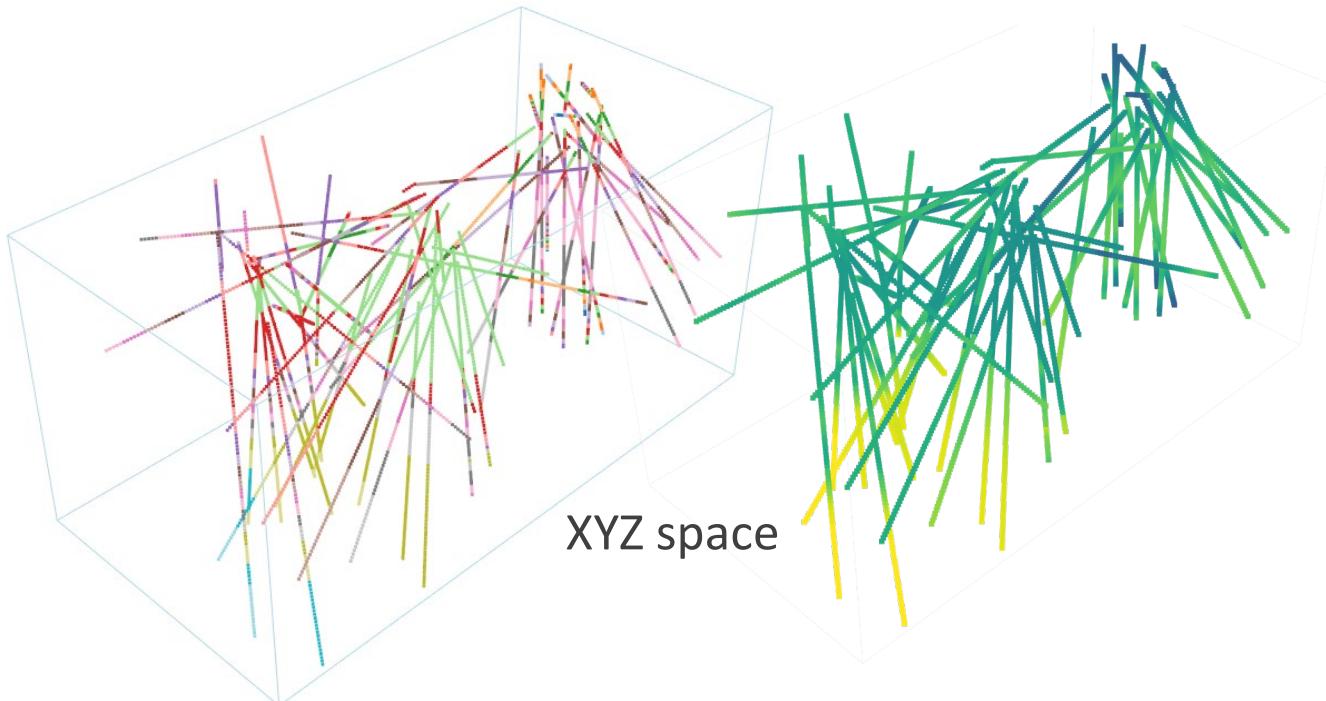
- Create more realistic digital-twin of the geology at all scales
- Help and optimise decision making related to managing our resources
- For example, at the mine scale:
  - Optimise drilling from 1<sup>st</sup> intersection
  - Propagate and consider uncertainty throughout the modelling process, including property modelling
  - Increase recovery rate
  - Decrease the amount of resources needed to extract (less energy for less drilling, optimised crushing and processing chain, less water...) with **enhanced 3D ore body modelling**

Optimising the extraction of resources  
for a greener tomorrow

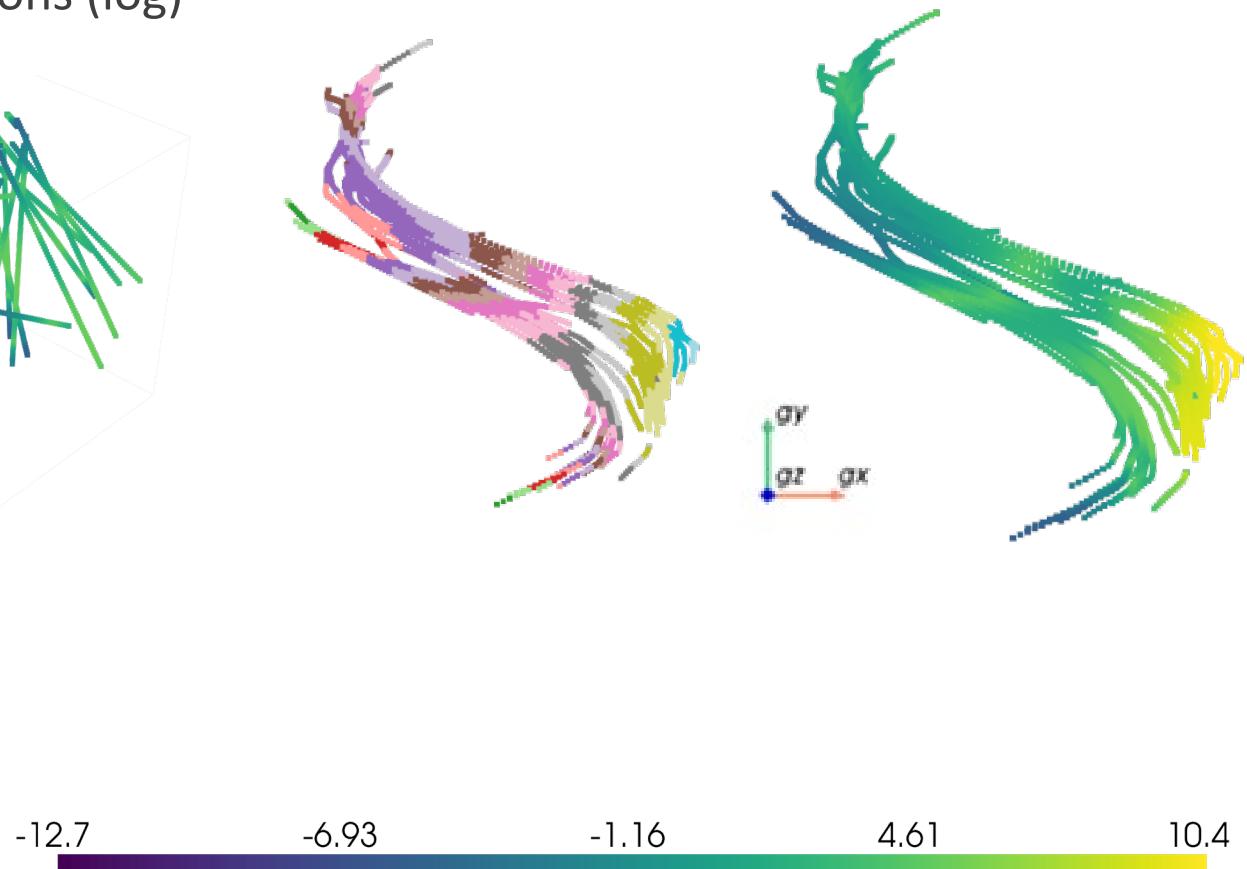


# LoopResources – structural frames clean geostatistics

A. Lithology

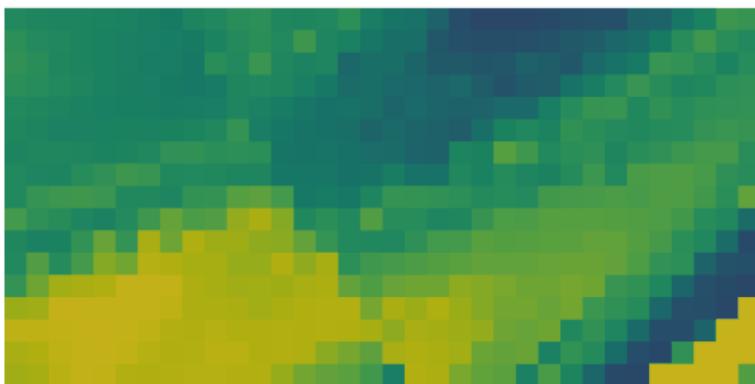


B. Property observations (log)

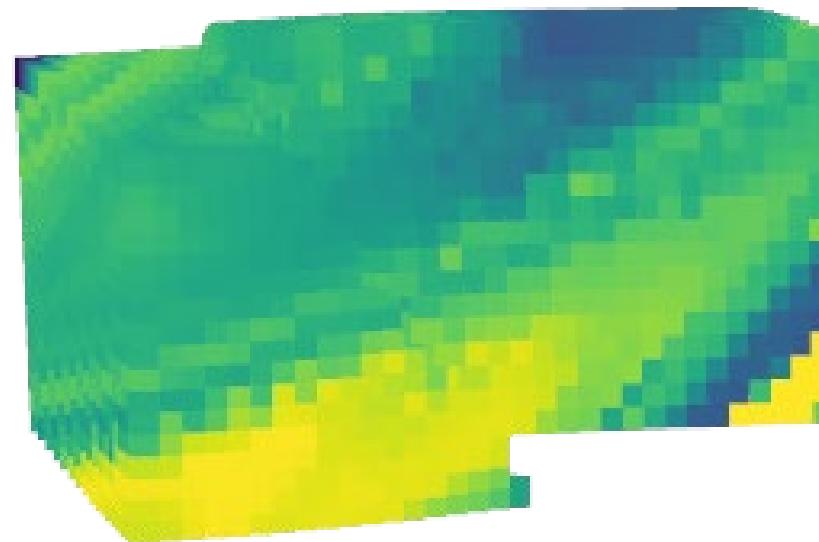


# Resulting property field

Property (logscale)



Property – restored space



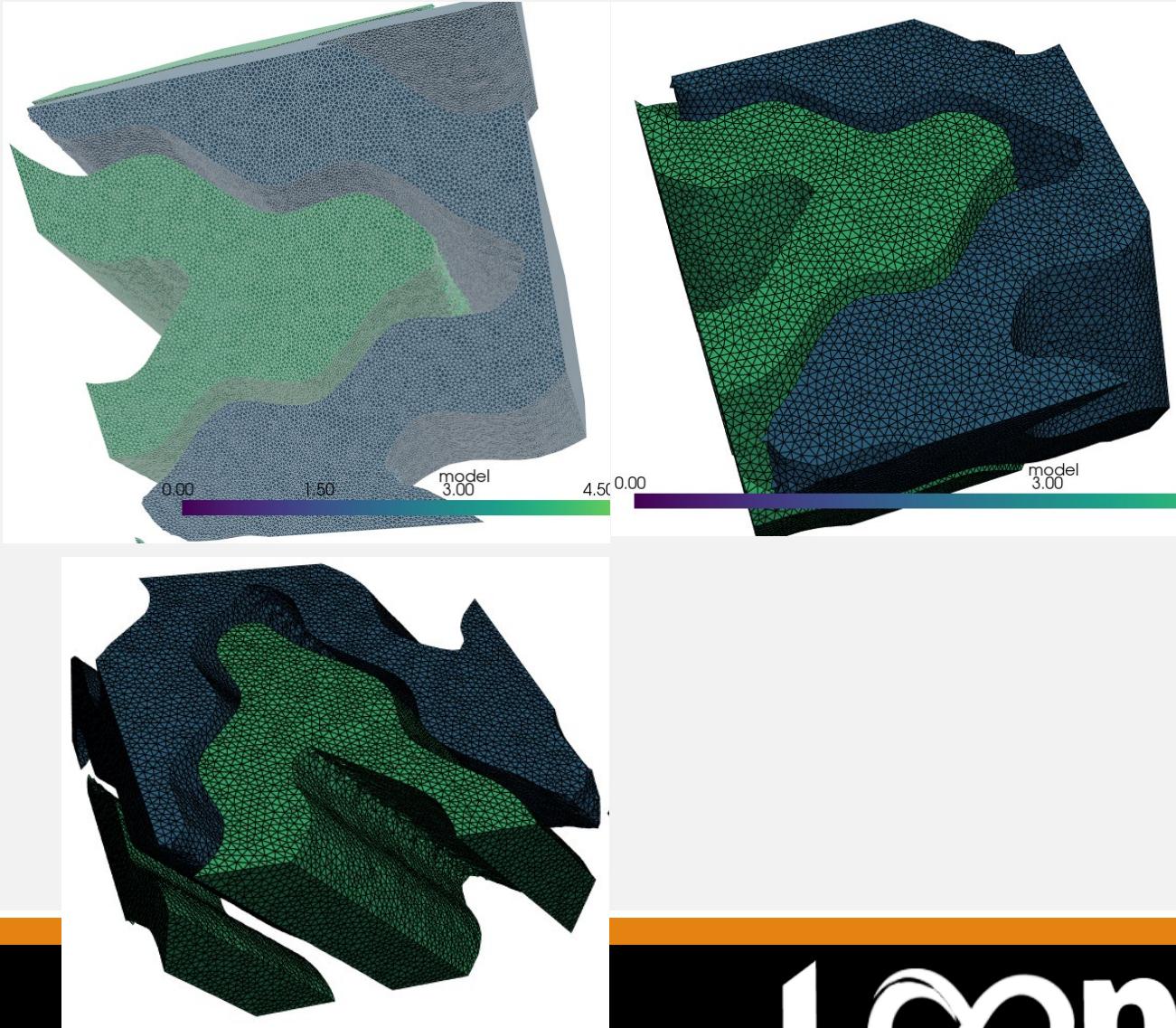
-12.7                  -6.93                  -1.16                  4.61                  10.4

# **LoopResources** Reducing the Mining Footprint

## ■ The Loop Vision:

- Create more realistic digital-twin of the geology at all scales
- Help and optimise decision making related to managing our resources
- For example, at the mine scale:
  - Optimise drilling from 1<sup>st</sup> intersection
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Optimising the extraction of resources  
for a greener tomorrow



**Loop**

# Map2loop augmented data visualisation

**Map**

New Column Delete Row

**MapManager**

Foliations

Type

Fault Trace

altitude

dip

displacement

Contacts

Event Relationships

**Stereonet**

Foliations

Show Contour Hide Girdle Show Plane/Rake

Deselect All

layer id type

**Table**

Foliations

New Column Delete Row

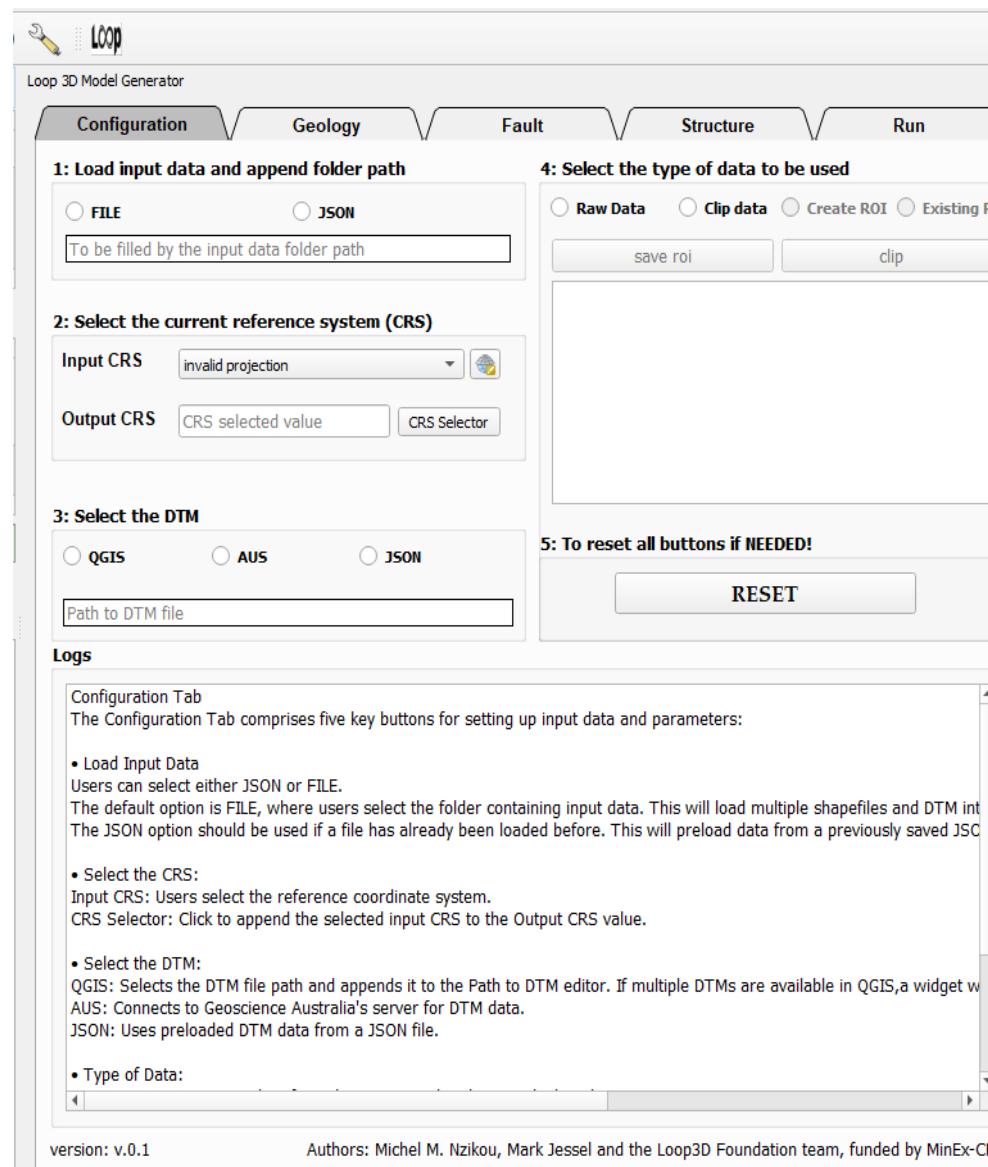
highlight single	highlight group	layerId	easting	northing	altitude	dipDir
		6	547332.07	7516113.87	0.00	127
		6	548756.29	7517165.37	0.00	172
		6	548578.05	7517242.93	0.00	174
<input checked="" type="checkbox"/>		1	537926.91	7514695.41	0.00	31
<input checked="" type="checkbox"/>		1	541120.39	7514974.39	0.00	13
		1	542385.71	7515423.89	0.00	13
<input checked="" type="checkbox"/>		1	538184.36	7515938.43	0.00	18
		1	542473.35	7515998.90	0.00	37
		1	537020.13	7516172.57	0.00	181

**StratigraphicLayers**

Select your element

- LayerId: 6 Mount\_McRae\_Shale\_and\_Mount\_Sylvia\_Forn
- LayerId: 3 Fortescue\_Group
- LayerId: 2 Bunjinah\_Formation
- LayerId: 4 Jeerinah\_Formation
- LayerId: 4 Jeerinah\_Formation

# Map2loop QGIS plugin



Loop

# LoopStructural WebApp

Chrome File Edit View History Bookmarks Profiles Tab Window Help

React App +

localhost:3000

New Chrome available :

All Bookmarks

Create New Model

Select model: final\_model

Bounding Box

final\_model's workflow

Add New Sequence

Seq: 2 fm

Seq: 1 flt2

Seq: 0 flt1

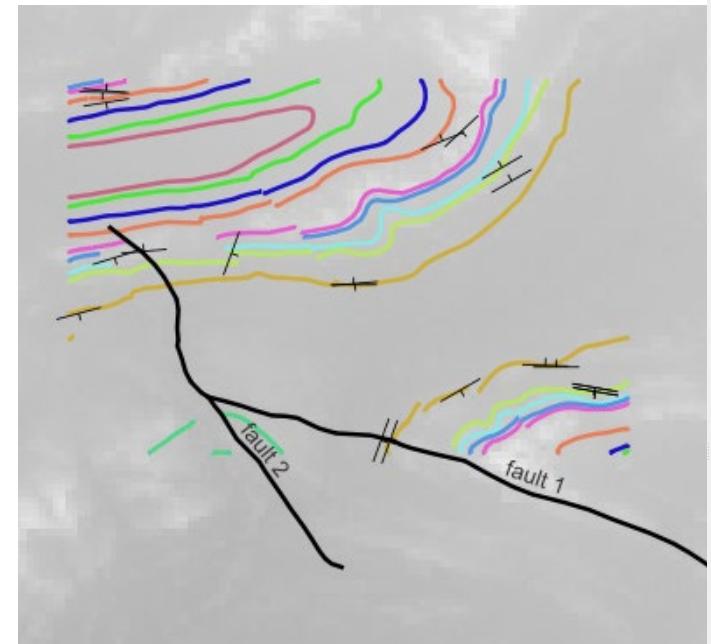
Visualise Model

Clear Model

Delete Model

Loop

# LoopStructural QGIS plugin



### Modelling

Load data Geological History Topology Model Setup Export Model About

#### Define Model

ROI  basal contacts  
Height 1000  
Depth -3000  
DTM  dtm\_rp  
Rotation 0.00  
CRS

#### Stratigraphy

Basal Contacts  basal contacts  
Unit Name 123 ID  
Structural Data  structural observations  
Format Dip Direction/Dip  
Dip Direction 123 fid  
Dip 123 fid  
Unit Name 123 fid

#### Faults

Fault Traces  fault traces  
Fault Name abc fname  
Dip 123 dip\_n  
Displacement 123 displac  
Pitch

### Modelling

Load data Geological History Topology Model Setup Export Model About

#### Stratigraphic Column

Turee_Creek_Group	10000.00	↑	↓	Pick Colour	Conformable
Boddington_Iron_Formation	513.35	↑	↓	Pick Colour	Conformable
Woongarra_Rhyolite	662.30	↑	↓	Pick Colour	Conformable
Weeli_Welli_Formation	488.06	↑	↓	Pick Colour	Conformable
Brockman_Iron_Formation	951.22	↑	↓	Pick Colour	Conformable
Mount_McRae_Shale_and_Greenstone	315.99	↑	↓	Pick Colour	Conformable
Wittenoom_Foreland_Basin	426.11	↑	↓	Pick Colour	Conformable
Marra_Mamba_Iron_Formation	286.70	↑	↓	Pick Colour	Conformable
Jeerinah_Foreland_Basin	791.03	↑	↓	Pick Colour	Conformable
Bunjinah_Foreland_Basin	5874.03	↑	↓	Pick Colour	Conformable

Save To Contacts

#### Fault Properties

fault 1  
Displacement 100.00  
Dip 90.00  
Pitch 0.00  
Center x 544334.19 y 7487595.88 z 0.00 Select on Map  
Major Axis 35787.87  
Minor Axis 11929.29  
Intermediate Axis 35787.87  
Active

Add Ellipse to Map

### Modelling

Load data Geological History Topology Model Setup Export Model About

#### Export Model

File Format geoh5  
Stratigraphic Surfaces   
Fault Surfaces   
Block Model   
Stratigraphy Data   
Fault Data   
Model Name test2  
Directory C:/Users/lach/OneDrive/Documents  
Save

#### Interrogate Model

Model contacts Add to Project  
Fault Displacements Add to Project  
Evaluate Model on layer Add to map  
Evaluate feature on layer group\_0 Add to map  
Gradient Add to map  
Mapped Lithologies Add to map  
Add fault traces Add to map  
Add scalar field group\_0 Add to Project

Loop

# 3D Geological Modelling Conference, Fremantle, WA, Australia. Apr 7-10, 2025

- 08:30-09:00 Introduction TALK [LA]  
Overview of the Loop project.
- 09:00-09:30 Introduction to 3D geological modelling using LoopStructural [LG]  
Introduction to implicit modelling, open source software and the Loop ecosystem.
- 09:30-10:00 Interactive 3D Modelling using Loop in QGIS HANDS ON [LG]  
Including the public release of the LoopStructural QGIS plugin allowing for modelling directly from a QGIS environment.
- 10:00-10:30 morning tea*
- 10:30-11:00 Loop web application and usability updates TALK [LA/NC]  
Overview of the Loop web applications and the future vision for building accessible and usable applications.
- 11:00-11:45 Preparing a Loop ready dataset TALK [RC]  
An overview of the processes required to make a public geological survey dataset model ready.
- 11:45-12:00 Automatic map deconstruction using QGIS TALK [MN]  
Overview of the map2loop QGIS plugin and an overview of using this for building 3D models.
- 12:00-13:00 lunch*
- 13:00-15:00 Map2loop qgis + web applications HANDS ON [LA/NC/LG/NC]  
Field application of null space navigation to investigate several geological scenarios.
- 15:00-15:30 afternoon tea*
- 15:30-16:30 Resource modelling and advanced Loop use using Loop TALK [LG]  
Introduction of the LoopResources framework and advanced use cases of Loop using Python. If time permits some examples
- 16:30-17:00 Wrap up discussion [ALL]

