Welcome to the renewed Quarterly Reports for the Loop project

It has been a long time since you received updates from the Loop Research team and I, on behalf of the entire team, would like to thank you for your patience. We have been quiet (and this is entirely my fault - apologies) but also very busy.

This report highlights what we have been doing since the end of the first and initial ARC LP which terminated in Nov 2020 and our last QR in May 2021. This time period includes one year between both ARC Linkages and the first year of the current ARC LP210301239.

During all that time, the MinEx CRC Project 6 continued R&D with specific developments regarding characterising and utilising geological uncertainties and optimisation of inversion algorithms in Tomofast-x.

In August 2022, we were informed that the ARC LP210301239 had been awarded. The research contract was signed in Apr 2023 and the 2nd ARC funded part of the project started on 20 Apr 2023 – a year ago. The focus of the R&D will be useability of the Loop platform

We have new and renewed partner organisations and once again, these organisations provide not only cash funding to support our R&D efforts but also research, data, case study and code contributions to accelerate the development of the Loop platform. The entire list of our partners is presented in the next two slides.
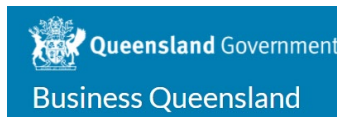
LOOP

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In the interim period between the two ARC Linkage grants, we managed to keep the Australian based research team intact thanks to extraordinary and generous contributions from:

- Geoscience Australia: Loop - Thin Geology Modelling (part of the EFTF program)

- Geological Survey of Western Australia: EGF 3D Fault model

- MinEx CRC: characterizing and utilizing geological uncertainties and optimization of inversion algorithms in Tomofast-x

In Australia, since the start of the second ARC LP, we were successful in attracting further funding from:

- AuScope (opportunity funding - $150k, one year) to support the employment of a software developer (Noelle Cheng) to build the Loop WebApp

- CSIRO – Internship funding, securing funding for a 3rd year student in computer science / geology to test map2loop and write documentation – This student (Aylah Edwards) will hopefully remain in the team to do Honours and a PhD in the Loop team.

- Northern Territory Geological Survey – NTGS provided full funding for an embedded research fellow for 3 years. Dr Rabii Chaarani (awarded his PhD in 2023 in the Loop research team) will be in charge of building a model of the Amadeus basin and work on making survey data digestible by Loop
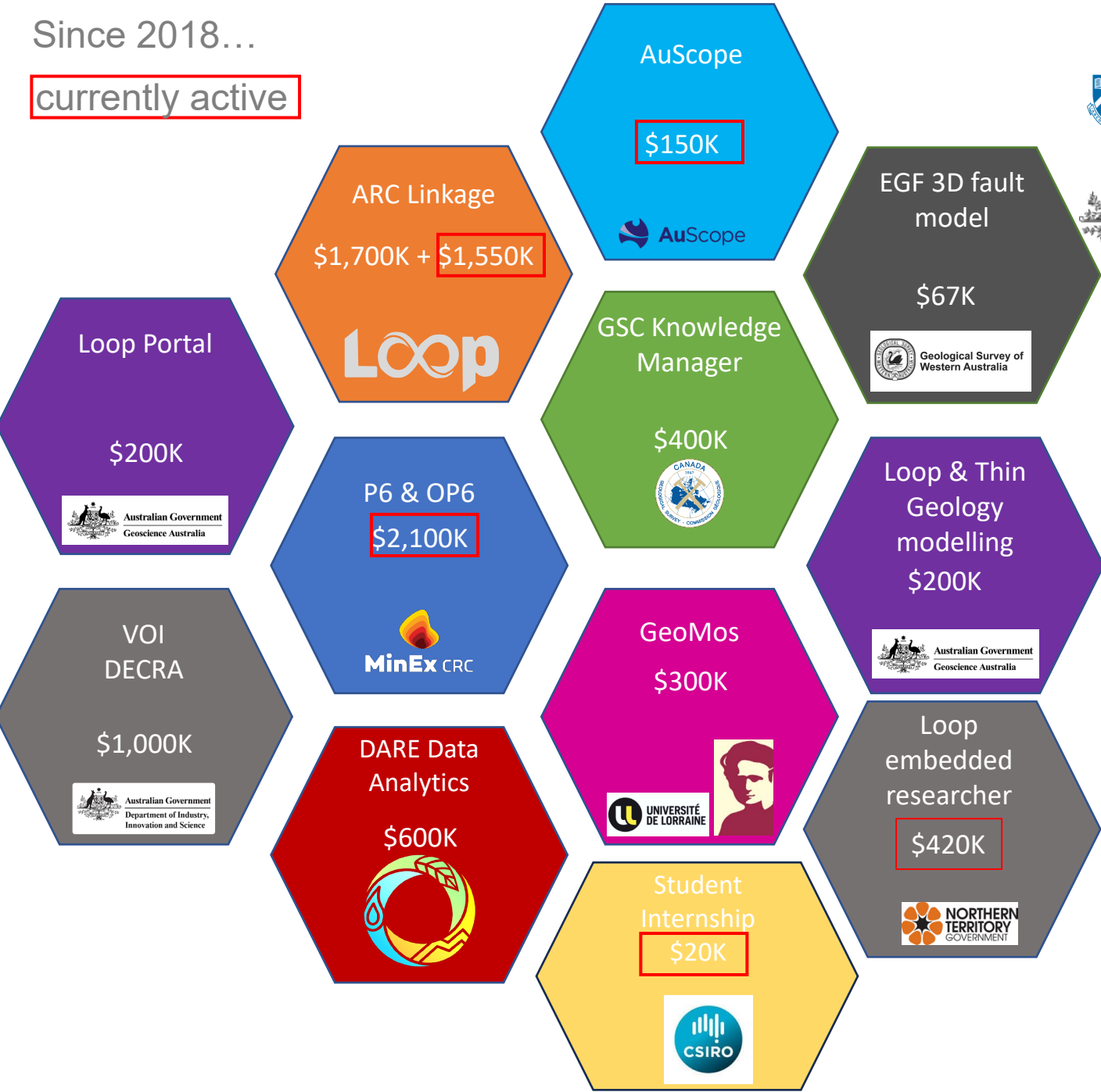
The next slide illustrates the level of funding of the project since its inception in Nov 2018 as well as funding for projects initiated within our partner organisations (in Australia, Canada and France), leveraging the Loop project.

Loopers? Who are we?

Project leader: Laurent Ailleres
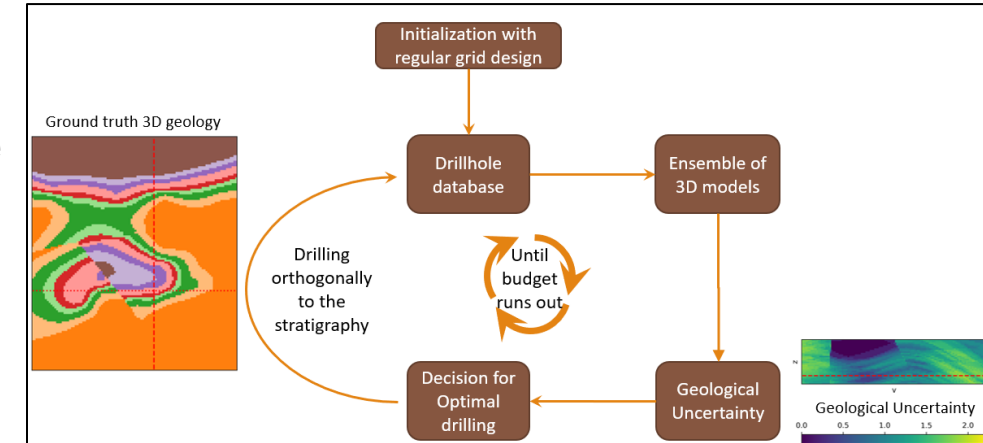
Research Leaders:

- Mark Jessell: MinEx CRC lead P6 and map2loop concept

- Lachlan Grose: LoopStructural, LoopResources – will take over software architecture

- Vitaliy Ogarky: Tomofast-x (code development and optimisation)

- Angela Rodrigues: map2loop (new capabilities)

- Guillaume Pirot: uncertainty characterisation, value of information

Reducing geological uncertainty with optimal drilling (G. Pirot)

Post-doctoral fellows:

- Rabii Chaarani: map2loop / loopstructural (NTGS applications and survey data ingestion)

- Michel Nzikou Mamboukou: QGIS plug-in for map2loop

- Thyagi Gollapalli: development of meshes from Loop implicit model to link with Underworld fluid flow modelling (funded by AuScope)

Development:

- Roy Thomson: overall software architecture, map2loop v3 (modular rewrite allowing external contributions and generic applications)

- Noelle Cheng: WebApp for map2loop outcome visualisation

Loop – in other news…

- Roy Thomson is unfortunately leaving but has generously offered to remain on a 0.2FTE position to ensure knowledge transfer to the team. Roy may also remain on a casual contract so that he can answer questions in the future.

- Lachlan Grose will take over software development and QA/QC. Under his guidance, the team has already implemented processes on github to ensure committed code is to standards.

- map2loop has been entirely re-written to work on generic cases and in a modular sense which allows simpler code contributions. Map2loop needs to be tested (my job) and new features implemented (including R&D).

- The Webapp and map2loop (v3) will be publicly released on github by the end of April 2024 – We will run demo session mid-May 2024, including the QGIS plug-in
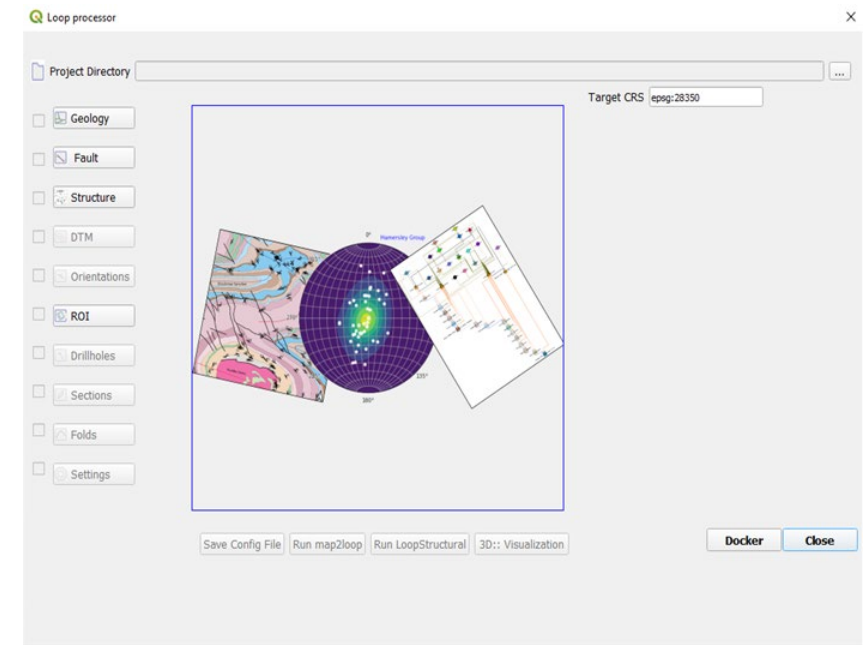

QGIS plugin launch window (Michel M. Nzikou)

- LoopResources: we have developed a conceptual property interpolator within LoopStructural frames allowing the interpolation and geostatistical characterisation of properties within complex geometries, using curvilinear coordinate system conformable to geology defined by the structural frames (see the last slide).

- LoopStructural: Lachlan implemented inequality constraints for the interpolators in collaboration with Vitaliy Ogarko. This allows to use off contact information.

- map2loop: Angela and Rabii are working on implementing multiple ways to calculate thicknesses from maps, on structural domaining and structural information extraction from maps (research) to be implemented in map2loop.

Loop – in other news…

- We are developing test case/benchmark with AngloAmerican for LoopResources;

- Loop3D Foundation has been incorporated as an NFP public company (see purpose from constitution on the next slide)

- We are organizing a 3D geological modelling conference for applications and methods development, to be held in Perth, Mar 3-7 2025. This will be open to everyone.

- It is near impossible to recruit PhD candidates - is it now also too late? Should we investigate cofounded PhD scholarship between Monash/UWA and partner organisations? (extra funding required). This may attract more candidates…?

- Visiting personnel:
  - Hong Li is an exchange PhD students from China University of Geosciences (Wuhan) and visiting the Monash node until Nov 2024 (one year overall). Hong is working on CNN to interpolate geology and testing methods developed by M. Hillier at the Geological Survey of Canada
  - Aylah Edwards – intern supported by CSIRO has been with the group over summer and worked on testing map2loop and developing documentation. We hope that Aylah will be able to return as an intern/research assistant during the second semester of 2024 and start Honours in 2025
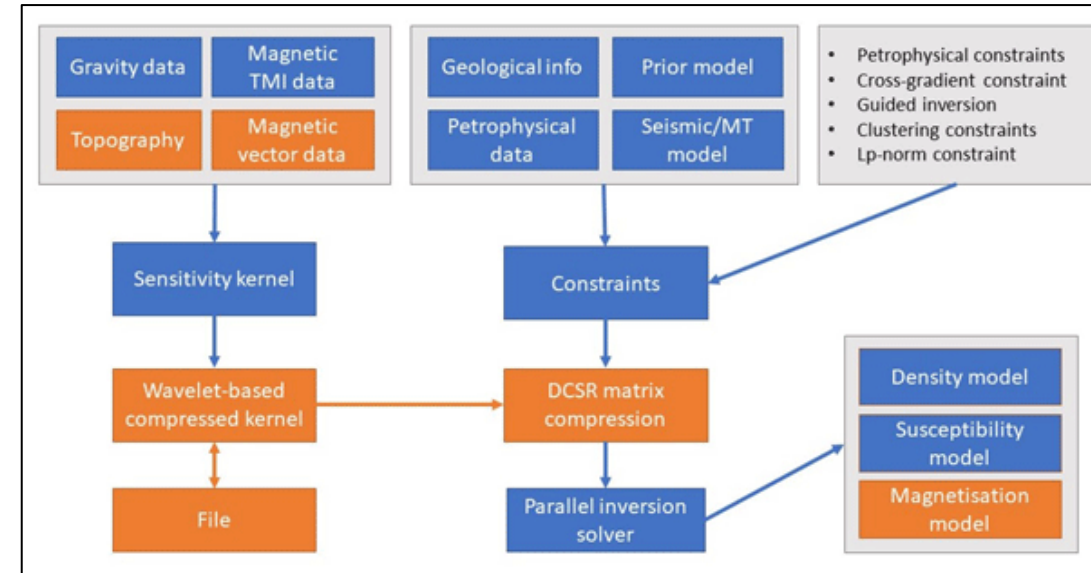

Tomofast-x 2.0 inversion workflow. New components are highlighted in orange. (Ogarko et al., 2024. GMD DOI: 10.5194/gmd-17-2325-2024

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 licence 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

Loop – progress illustrated
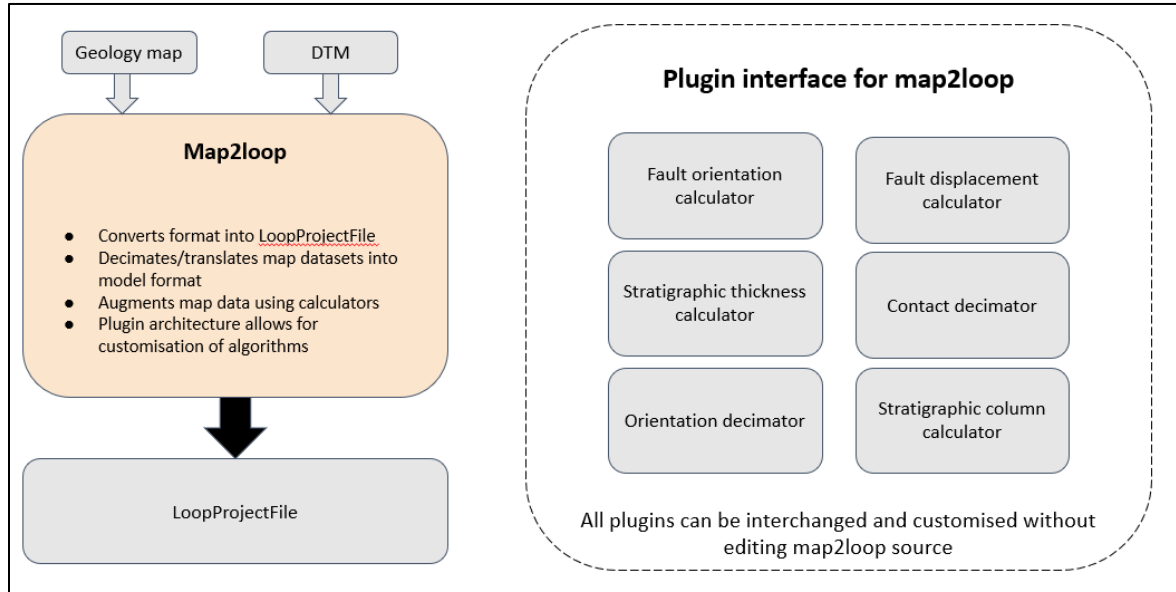
map2loop redesign (Lachlan Grose, Angela Rodrigues and Rabii Chaarani)
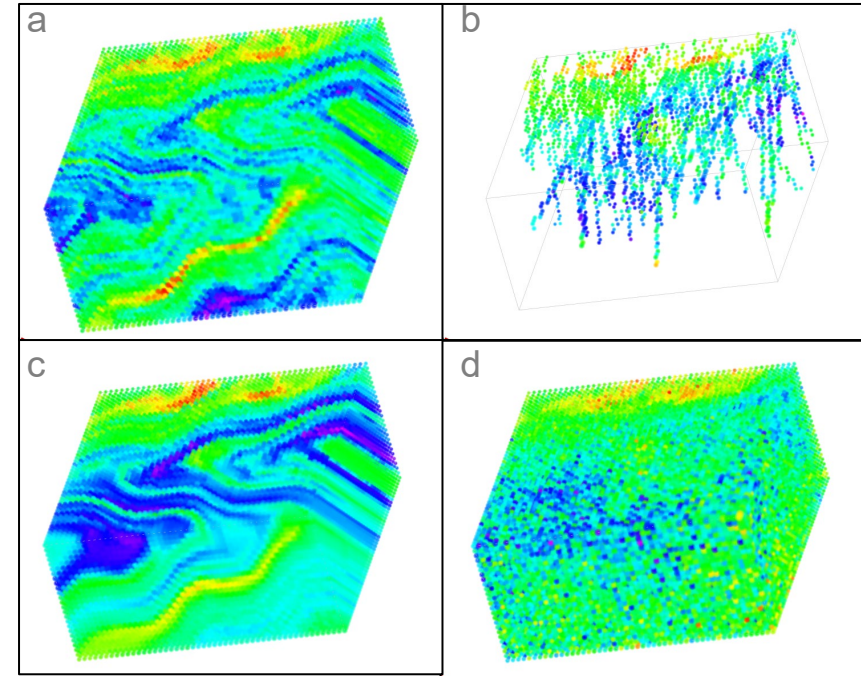
LoopResources: a) synthetic property model generated within the Laurent et al., 2016 refolded model. Each layer has its own randomly generated property model.
b) Sampling the synthetic model with random drill holes to generate the dataset to be interpolated. Drill holes are roughly perpendicular to the main structural trend (axial surface of early folds)
c) Using the lithological model (pre-built from Laurent et al., 2016) and fold structural frames to apply geostatistics to the sampled properties allows to recover a (too?) smooth model of the property
d) Cartesian interpolation fitting a semi-variogram in x, y, z without using the inherited lithological anisotropy