Advances in 3D geological modelling
Implications for the stone industry

Presenter: Consultant (Resource Geology)

Location: STONECHANGE 2016, Carrara
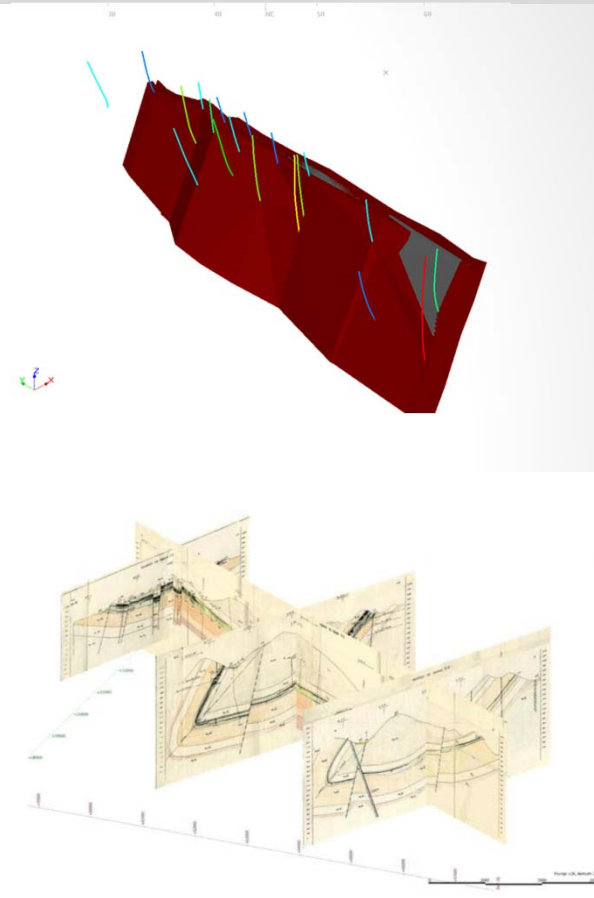16-17 June 2016

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- Traditional geological modelling based on manual definition by digitisation on 2D cross-sections.

- Interpretation is conducted by hand on paper sections, or on 2D sections in GIS software or general mining software packages (GMPs) based on CAD applications.

- 2D sectional interpretations are subsequently linked using tag lines between sections to form 3D triangulations.

- Until recently this traditional explicit modelling technique was the currently accepted industry standard, although there is a growing trend favouring models developed in true 3D and implicit modelling software packages.


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- Explicit modelling using 2D sections can be a very time consuming process.

- Difficult to update.

- Model is often adapted or simplified in order to deal with technical problems associated with the wireframing process.

- The geological interpretation is often inherited from the outset, due to time constraints.

- Often difficult to determine the geometry of a 3D deposit in a purely 2D environment.

- Difficult to deal with randomly distributed data that does not lie on regular sections.


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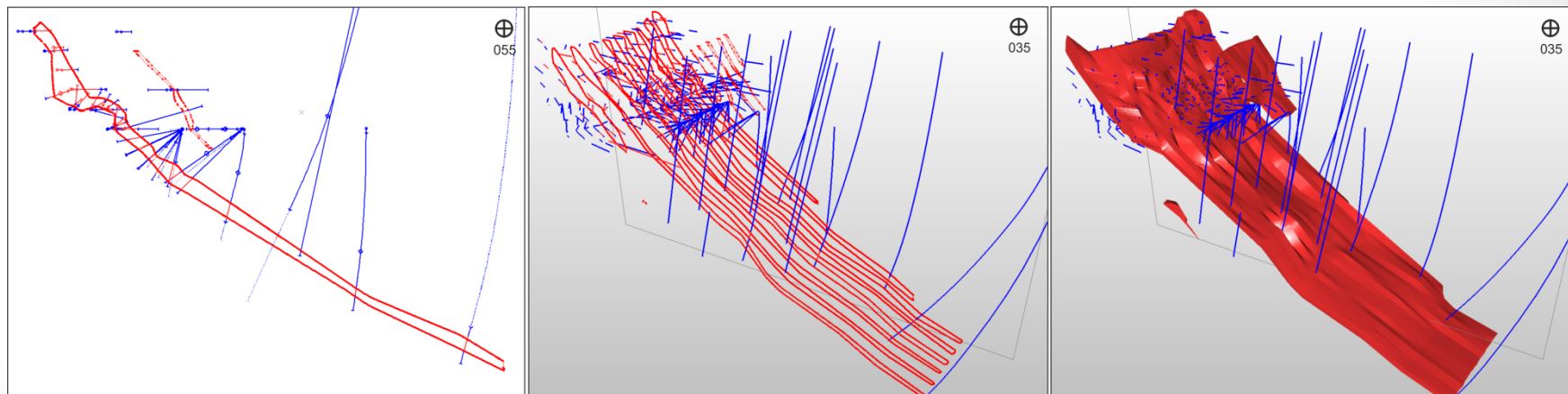
- In recent years, Geological modelling has moved into the 3D realm.

- Although 3D capabilities are now commonly included in many packages, many of these programs are still constrained to working on section and don't make best use of the 3D environment.

- Some of the most recent updates in software allow for models to be built in a truly 3D environment

- Working in open 3D allows many different data sources to be viewed simultaneously

- Complex geometries that may not have been immediately apparent in the 2D environment can be identified and modelled effectively

- New tools such as implicit modelling can provide greater insight into subtle geological features and streamline the wireframing process

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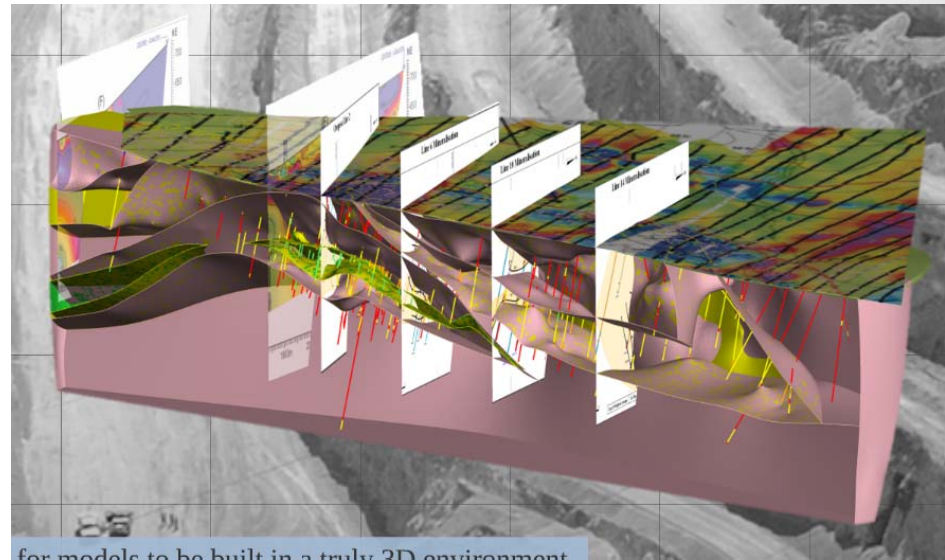
What is Implicit Modelling?

- Simply put, implicit modelling is a tool for generating surfaces, just like wireframe triangulations.

- Implicit modelling generates surfaces through software driven algorithms to produce a best fit surface between data points.

- These surfaces are guided by the geologists input through trends and geological rules and can easily be manually edited by the modeller.

- Originally introduced into the mining industry in the early 2000's by dedicated geological modelling packages including ARANZ Leapfrog and Intrepid Geomodeller, but now being incorporated into the larger GMPs including GEOVIA Gemcom and CAE Datamine.


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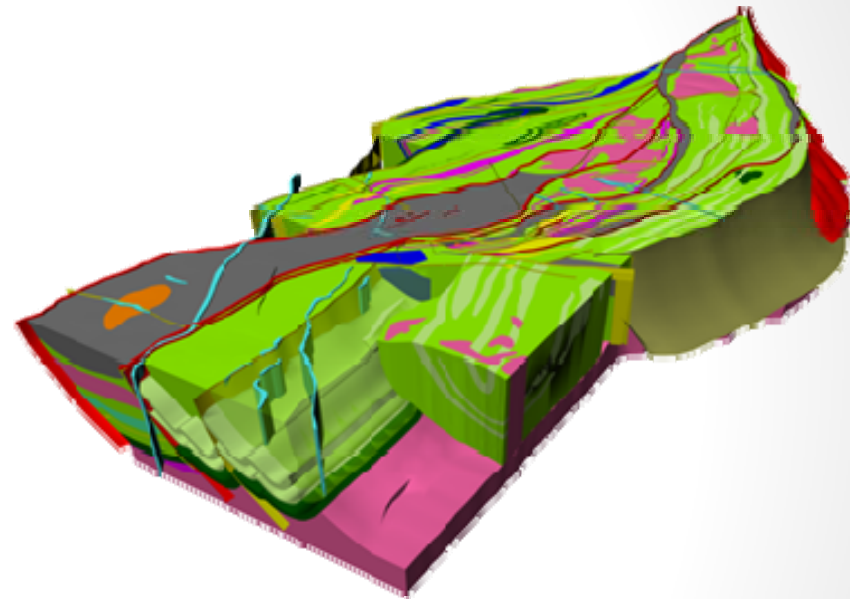
Advantages of 3D Implicit Modelling

- Footwall and hangingwall surfaces can be rapidly generated without manual digitisation – although can be edited with manual polyline / strings if required.

- Can use data from multiple sources to generate a single surface e.g. downhole contact data, digitised strings, mapping data, surface and downhole structural data etc,.

- Can use data in any spatial arrangement – sections are not necessary.

- Implicit modelling is very fast - thousands of contact points can be surfaced in a matter of seconds or minutes.

- Can incorporate larger data sets in much less time than would have previously been possible.

- Repeatable – models will rebuild automatically with the inclusion of new data or new geological rules.

- Produce multiple realisations of a deposit and show the level of risk inherent in a single model approach.

- Provide true 3D interpretations , particularly when interpreting complex three dimensional trends which may not be immediately apparent in the 2D environment.

- More cost effective.

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*Cut to demo video*

What is Implicit Modelling Used For?

- **Stratigraphic sequences** – Lithological contacts can be automatically generated from drillholes or created manually, using on or off section polylines. These points / polylines can then be rapidly interpolated to produce a series of contact surfaces and resulting lithological volumes.

- **Rapid modelling of spatial numeric data ("grade shells")** - Typically applied to model metal distribution based on assay data, but can also be applied to highlight the distribution of geotechnical parameters or any other numeric data set.

- **Indicator modelling** – Uses a similar approach to grade shell modelling, but applied to categorical data. This may be applied to model geological features such as plutonic intrusions, or categorical quality data.

- **Vein modelling** – A more manual approach whereby individual drillhole intercepts are grouped into selections which describe individual veins. These are then used to generate implicit vein wireframes which are automatically updated upon adjustments to the vein selections.

- **Complete geological models** - Current trends with implicit modelling software providers towards geological workflows. This allows geological rules including relative age relationships, fault offsets, unconformities and other key geological relationships to be hardwired into the geological modelling process.
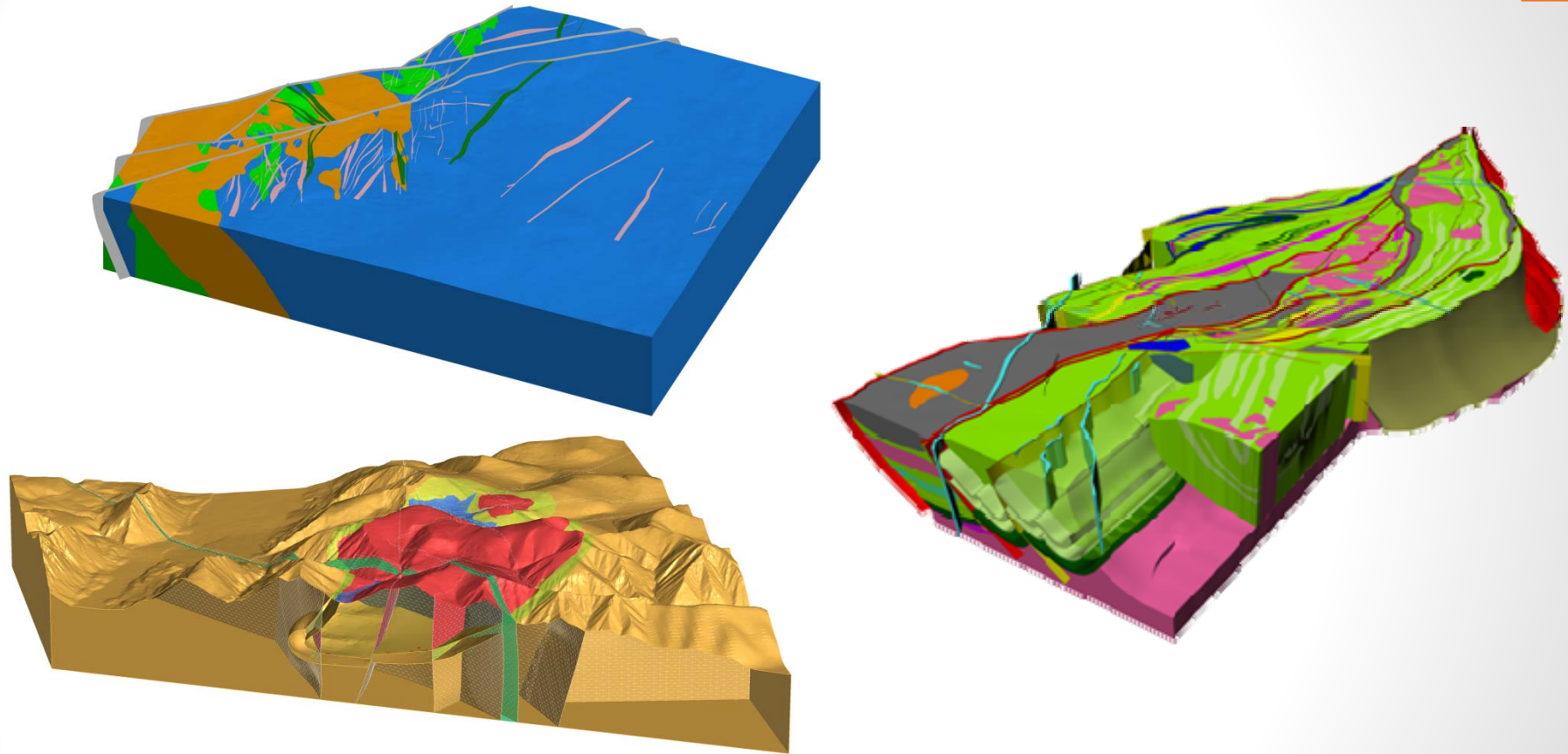
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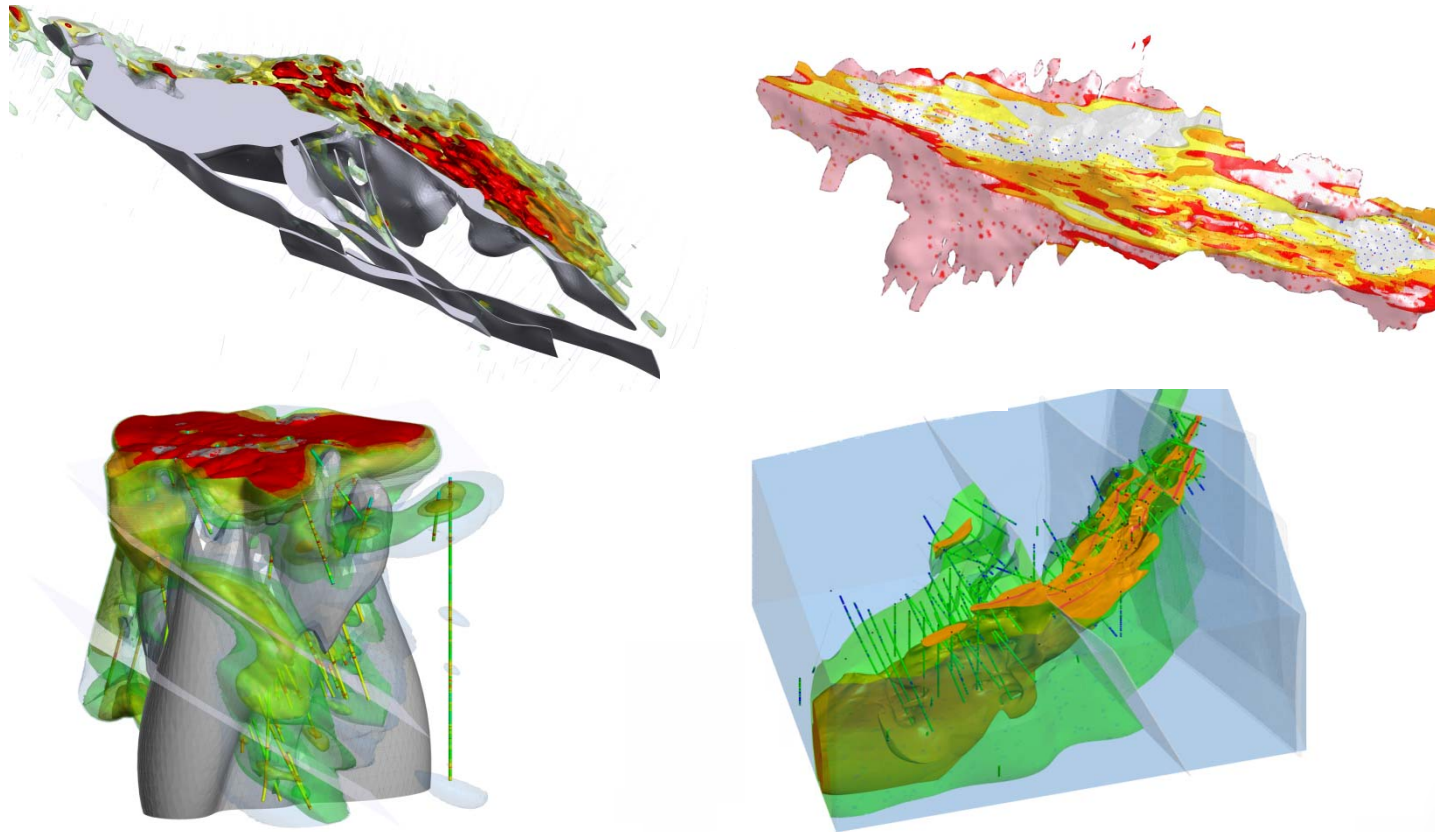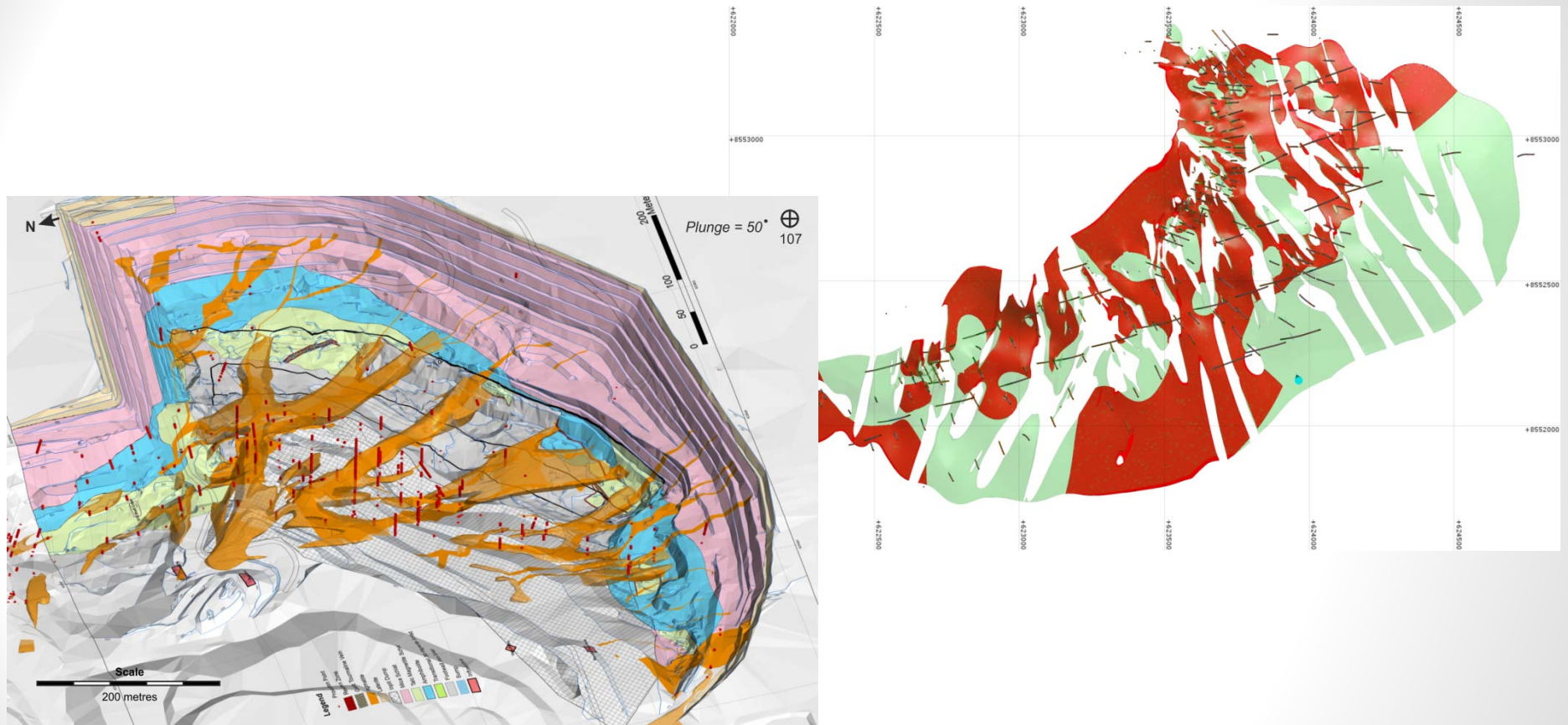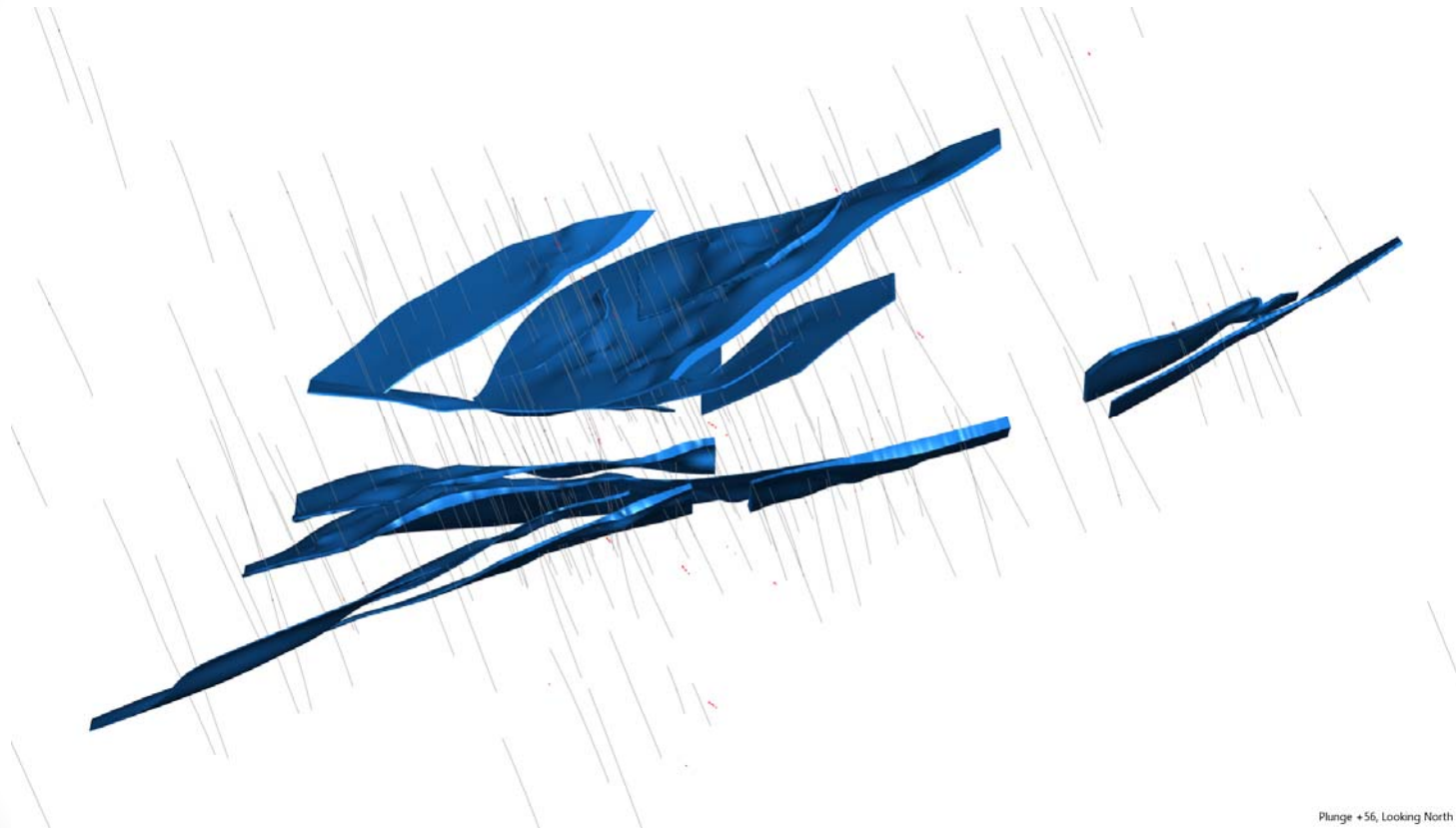
Plunge +56, Looking North

How can implicit 3D modelling be applied to Dimension Stone?

- **Stratigraphic modelling** is particularly useful for **marble** or **sedimentary** controlled dimension stone, which may exist in a sequence of multiple facies / members or be intercalated with waste rock types.

- **Fault offsets** or fault bounded domains may be incorporated into geological models.

- **Intrusional indicator modelling** may be more suitable for modelling **granite** or other **intrusive dimension stones.**

- **Weathering surfaces** can be **quickly and effectively** produced using offset mesh functions.

- **Any numeric factor can be rapidly interpolated** into models to view, assess and utilise volumes of favourable / un-favourable conditions including:

  - Joint-fissures opening fracture
  - Karstic factor
  - Block Volume

  - Joints per unit volume
  - Rock Quality Designation

How can implicit 3D modelling be applied to Dimension Stone?

- Categorical data including Quality Factors can be easily interpolated into the wider rock type domain.

- Individual aspects of quality including colour, texture and grain size can be rapidly interpolated and modelled independently.

- Easy to incorporate data from multiple sources (drillholes, geological mapping, face mapping etc.) into the modelling process.

- Models can be automatically updated as additional data becomes available from new drilling and mining information.

- Industry drive towards incorporation of block modelling routines into implicit modelling software. This means the whole process of modelling through to estimation can be conducted in one Project – any updates to the data or interpretation will result in automatic update to the resultant block model.

- Repeatable and auditable models.

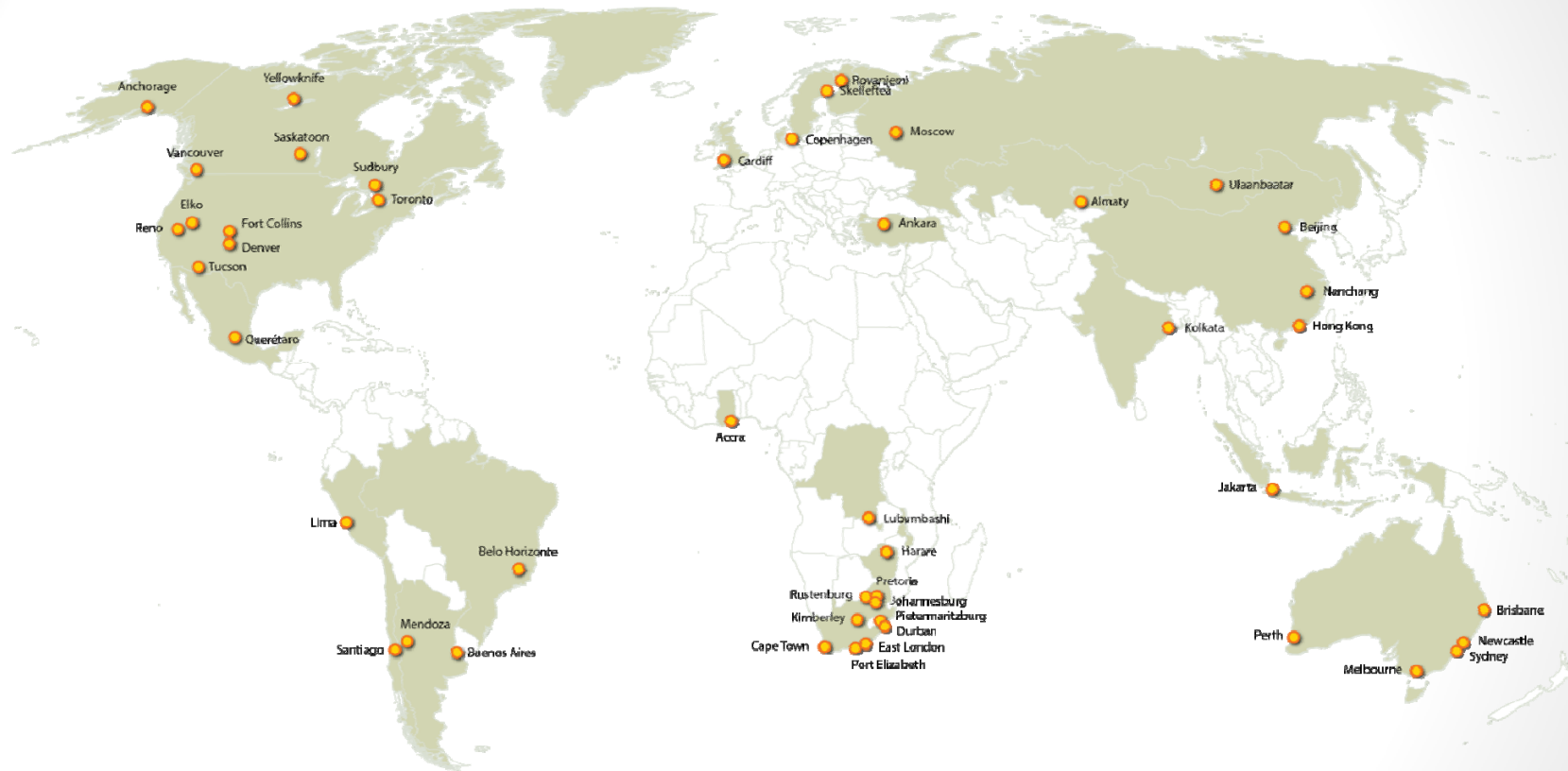**Thanks for listening**

Any questions?

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