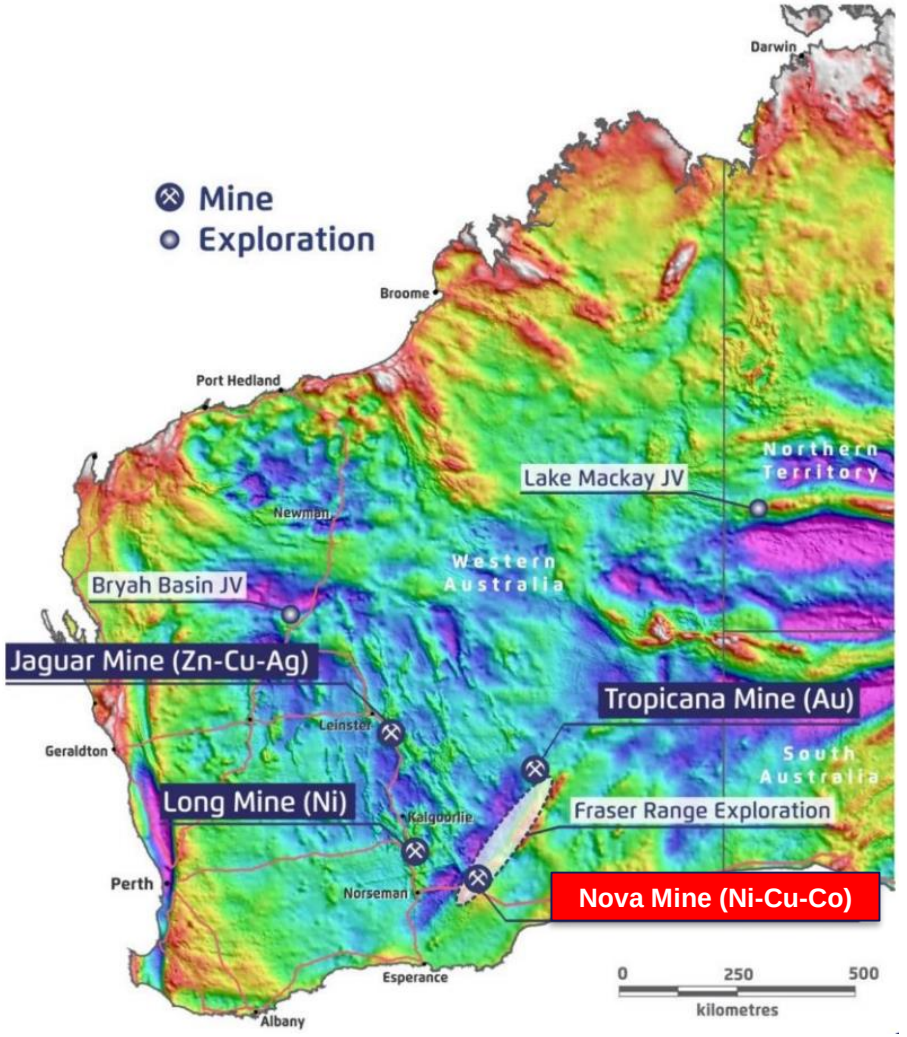
A Sirius/serious vision

"With the planned rates of development at Nova – Bollinger, the use of conventional face-mapping would always be extremely limited, and as such the requirement for a high speed scanning system was identified."

- Markus Staubmann, Sirius Resources 3D Laser Scanner Evaluation, January 2013

" The intent of this system is not to replace face mapping, but to take the mapping process from the underground environment to the surface. Apart from the obvious safety and time-saving benefits of this there will also be a significant increase in mapping accuracy that will ultimately feed directly into the production geological model."



3D LASER SCANNING OF UNDERGROUND MINE DEVELOPMENT AT NOVA

By Glenn Boyce & Ethan Barnes

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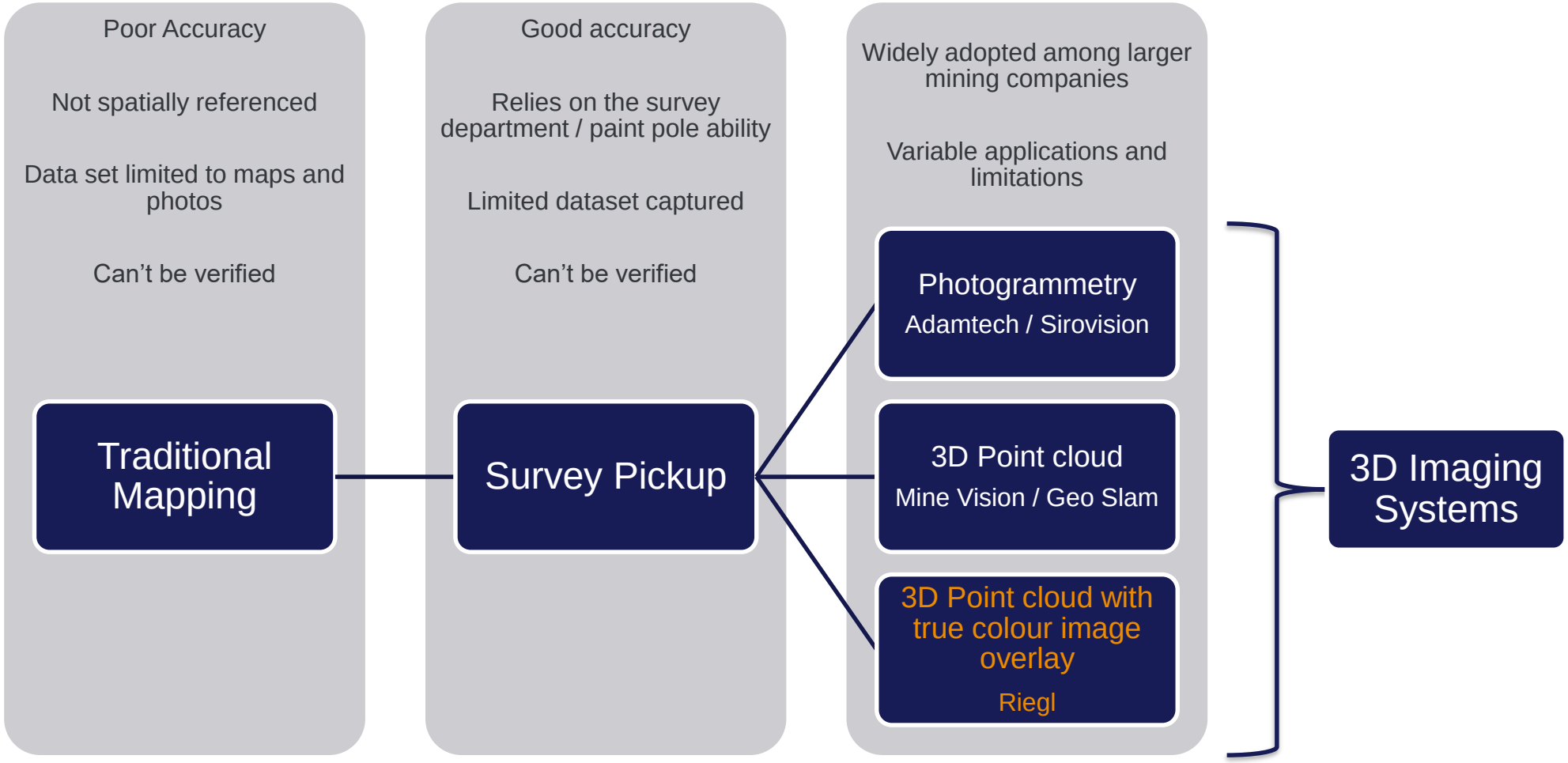
- Any references to Mineral Resource and Ore Reserve estimates for the Nova Project should be read in conjunction with Sirius Resources NL’s ASX announcement dated 14 July 2014.
- All currency amounts in **Australian Dollars** unless otherwise noted.
- Cash Costs are reported inclusive of Royalties and after by-product credits on per unit of payable metal basis, unless otherwise stated
- IGO reports All-in Sustaining Costs (AISC) per ounce of gold for its 30% interest in the Tropicana Gold Mine using the World Gold Council guidelines for AISC. The World Gold Council guidelines publication was released via press release on 27th June 2013 and is available from the World Gold Council’s website.

Overview

- Innovations in the underground mapping industry
- Riegl VZ-400 Features and Specs
- Nova method for digital mapping of underground geology
- Using reflectance to help build a better understanding
- Structural data capture & LisPro 3D trial
- Other applications
- Challenges & Benefits
- What’s next for us?

Innovations in the underground mapping industry

An emerging field – the incentive to innovate



VZ-400 Features and Specs

Geological mapping powered by survey precision

Scanner

- Scan rate 122 000 measurements per second
- Max range 600m / Minimum range 1.5m
- Scan angle range Vertical scan 100° (+60 ° /-40 °), Horizontal scan 360 °
- Weight 9.6kg
- IP rated IP64, dust-proof and splash proof
- Temperature range -20 °C to +40 °C
- Max Resolution 0.006 ° = 1mm spacing at 10m away
- Class 1 laser – completely

Features

Fully rendered high resolution digital meshing capability

Online Waveform analysis

Echo digitisation

Inbuilt GNSS

Integrated WLAN

Operation

- On board keypad and LCD display / touchscreen
- Laptop via ethernet cable or wifi
- Tablet /phone with android/iphone app

Camera

24MP Nikon D610 camera with AF Nikkor 14mm f/2.8D ED lens (fisheye)

Nikon Speedlight SB-910 flash providing photorealistic data

Software

RiSCAN PRO 2.5.2

Typical file size

~ 1 GB per scan

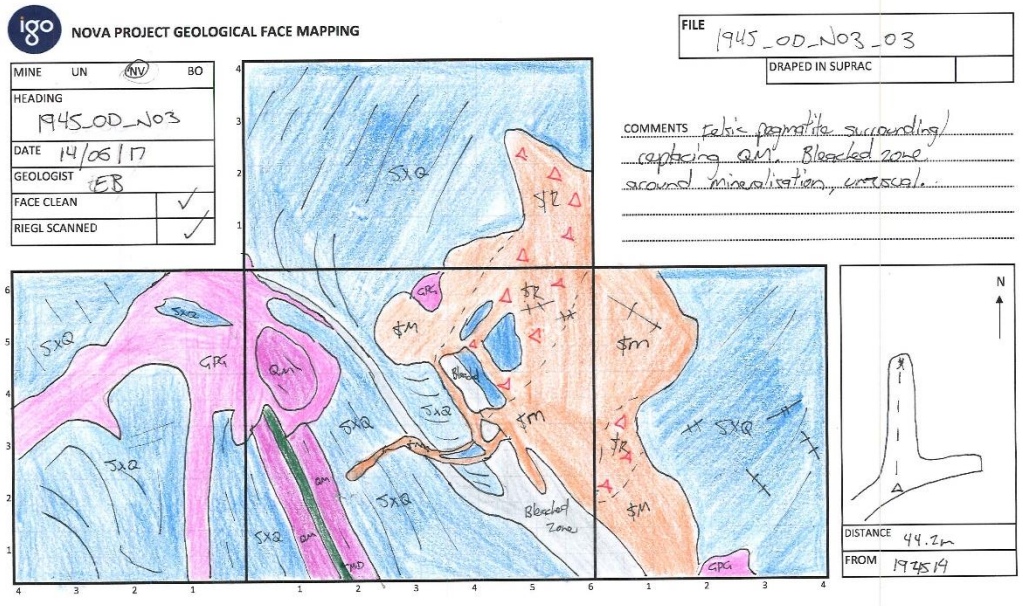
~ 22 511 501 points be scan at 0.40 ° point spacing

Other Australian users

Victorian Police for incident investigation

Rio Tinto for slope stability, volume calculations

Digital mapping is still coupled with traditional face mapping of development cuts

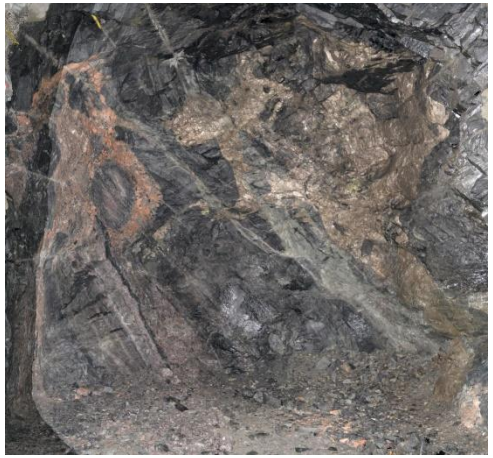

NOVA PROJECT GEOLOGICAL FACE MAPPING

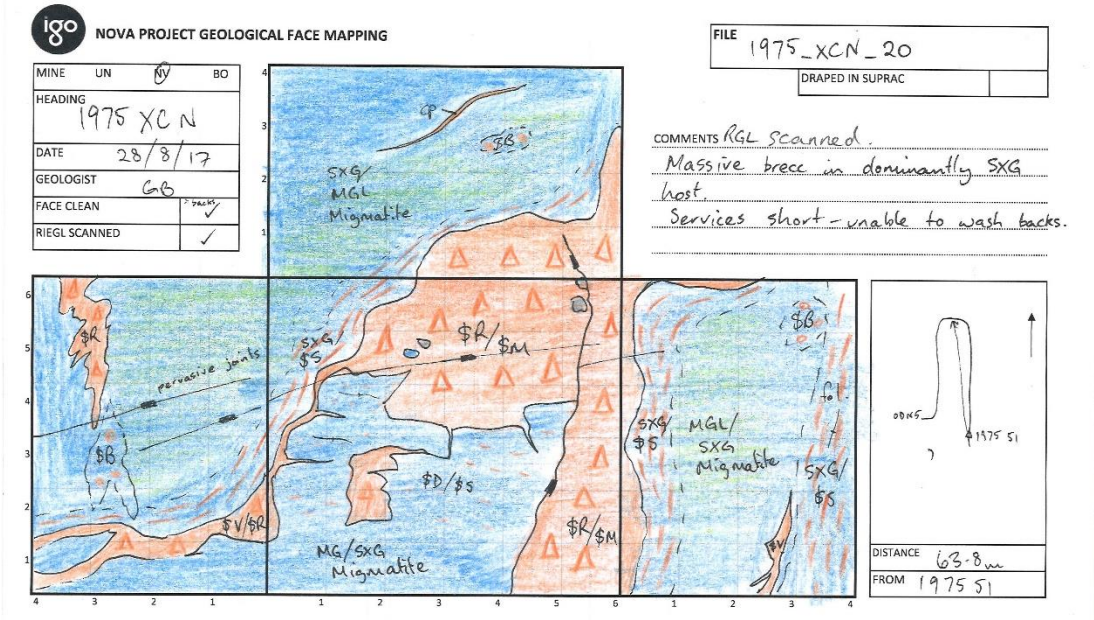
MINE UN NV BO
HEADING 1945_OD_N03
DATE 14/06/17
GEOLOGIST EB
FACE CLEAN ✓
RIEGL SCANNED ✓

FILE 1945_OD_N03_03
DRAPED IN SUPRAC

COMMENTS Felsic pegmatite surrounding/ capping QM. Bleached zone around mineralisation, unusual.

DISTANCE 44.2m
FROM 1945 19



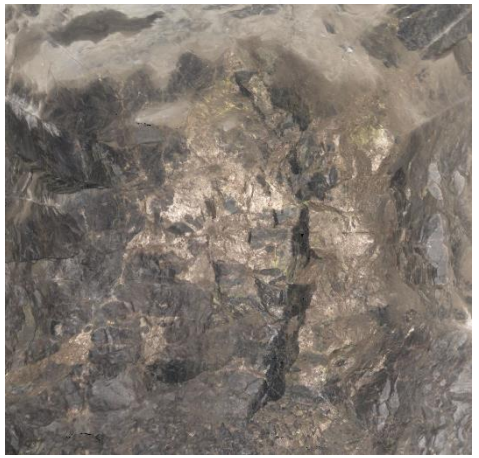

NOVA PROJECT GEOLOGICAL FACE MAPPING

MINE UN NV BO
HEADING 1975 XCN
DATE 28/8/17
GEOLOGIST GB
FACE CLEAN ✓ packs
RIEGL SCANNED ✓

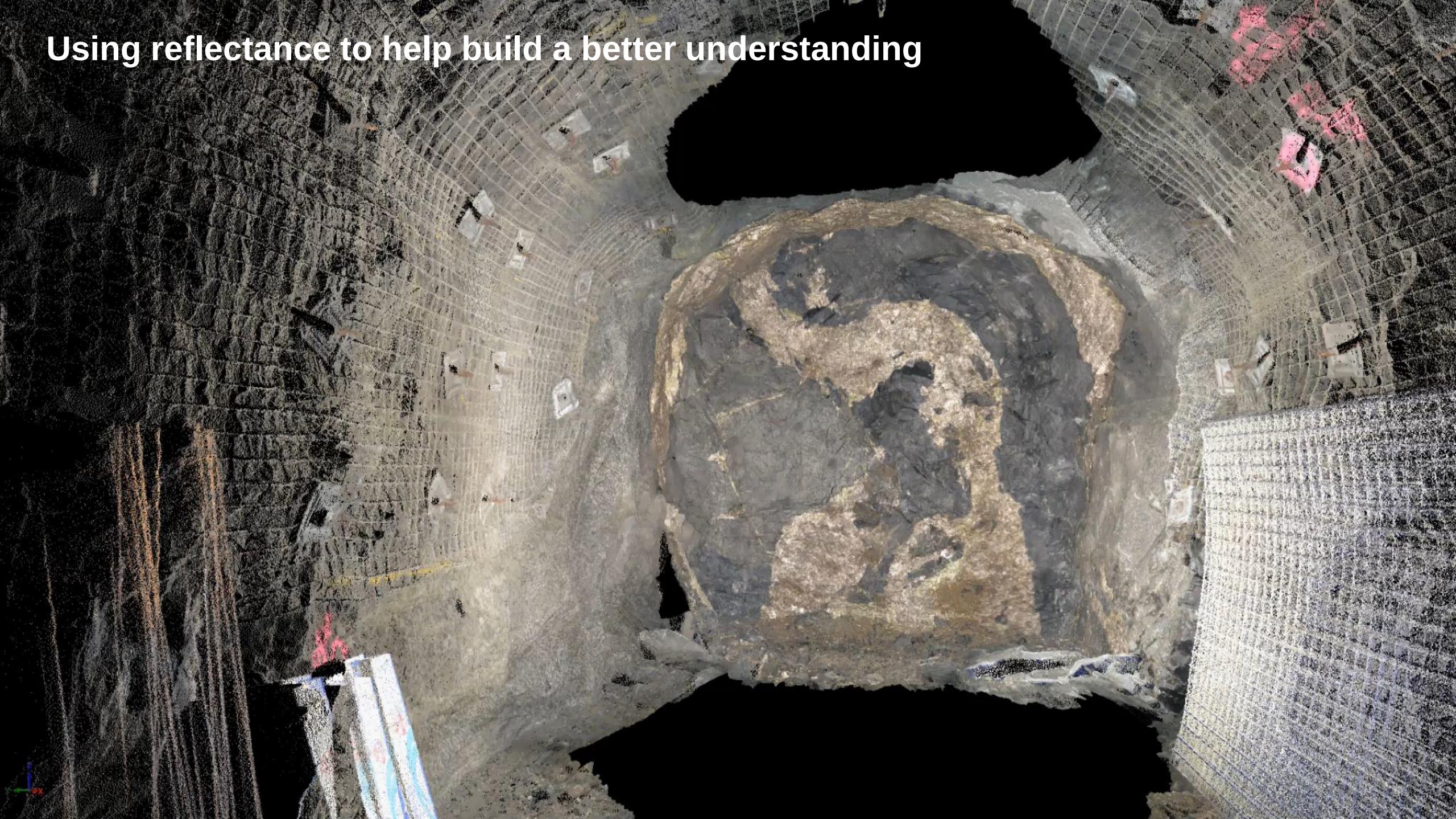
FILE 1975_XCN_20
DRAPED IN SUPRAC

COMMENTS RGL Scanned.
Massive breccia in dominantly SXG host.
Services short - unable to wash backs.

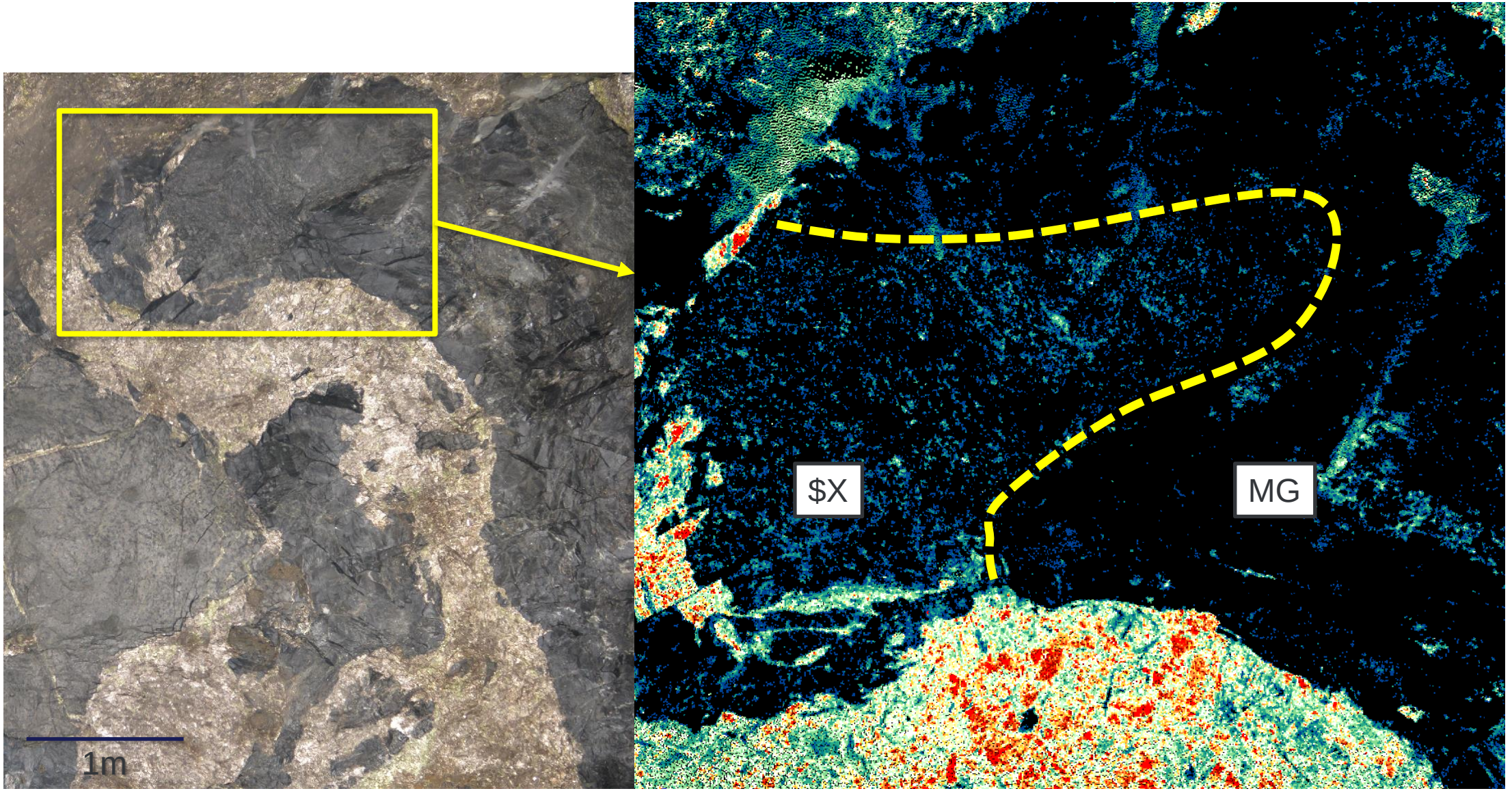
DISTANCE 63.8m
FROM 1975 51



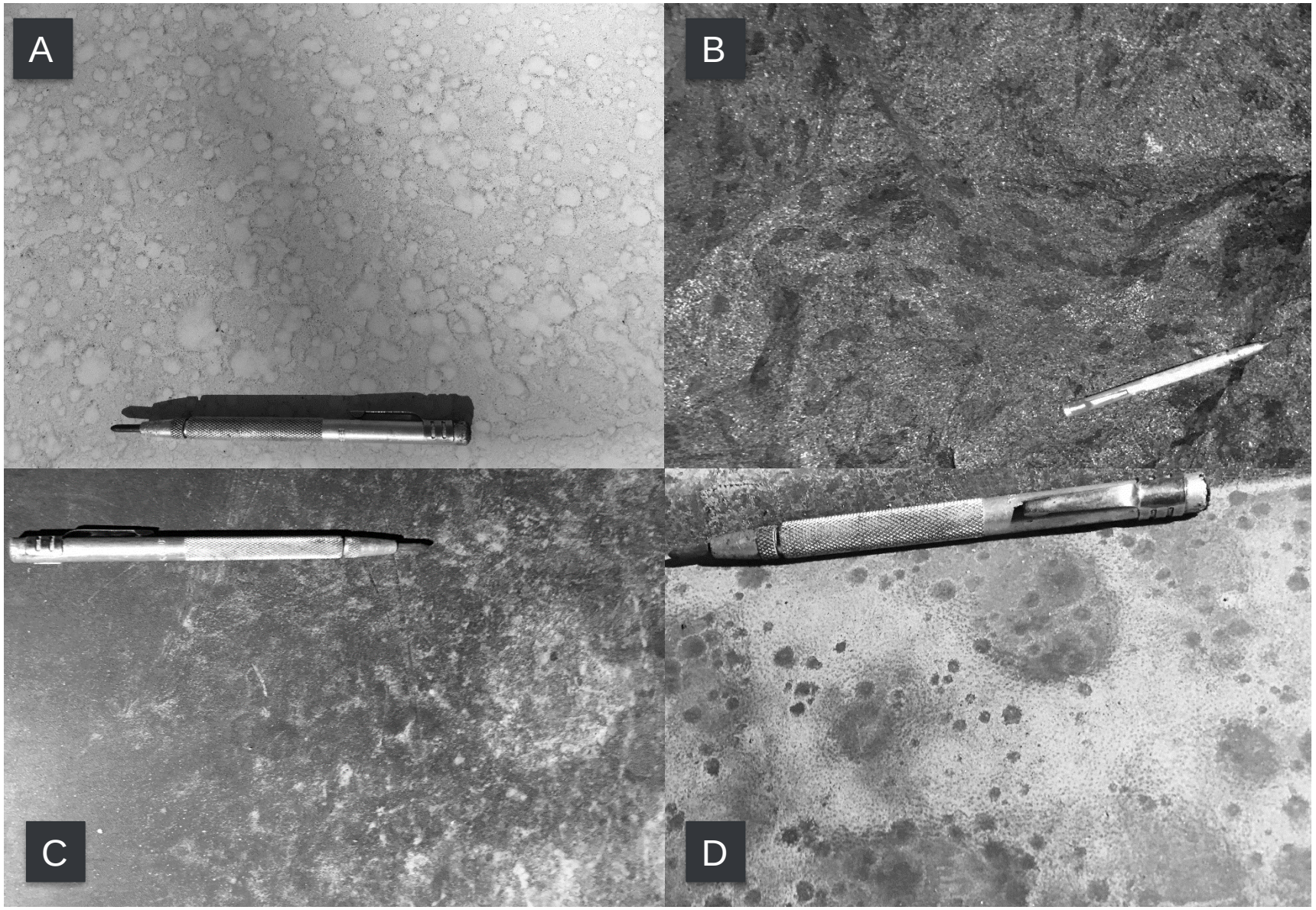
Using reflectance to help build a better understanding



Using reflectance to help build a better understanding



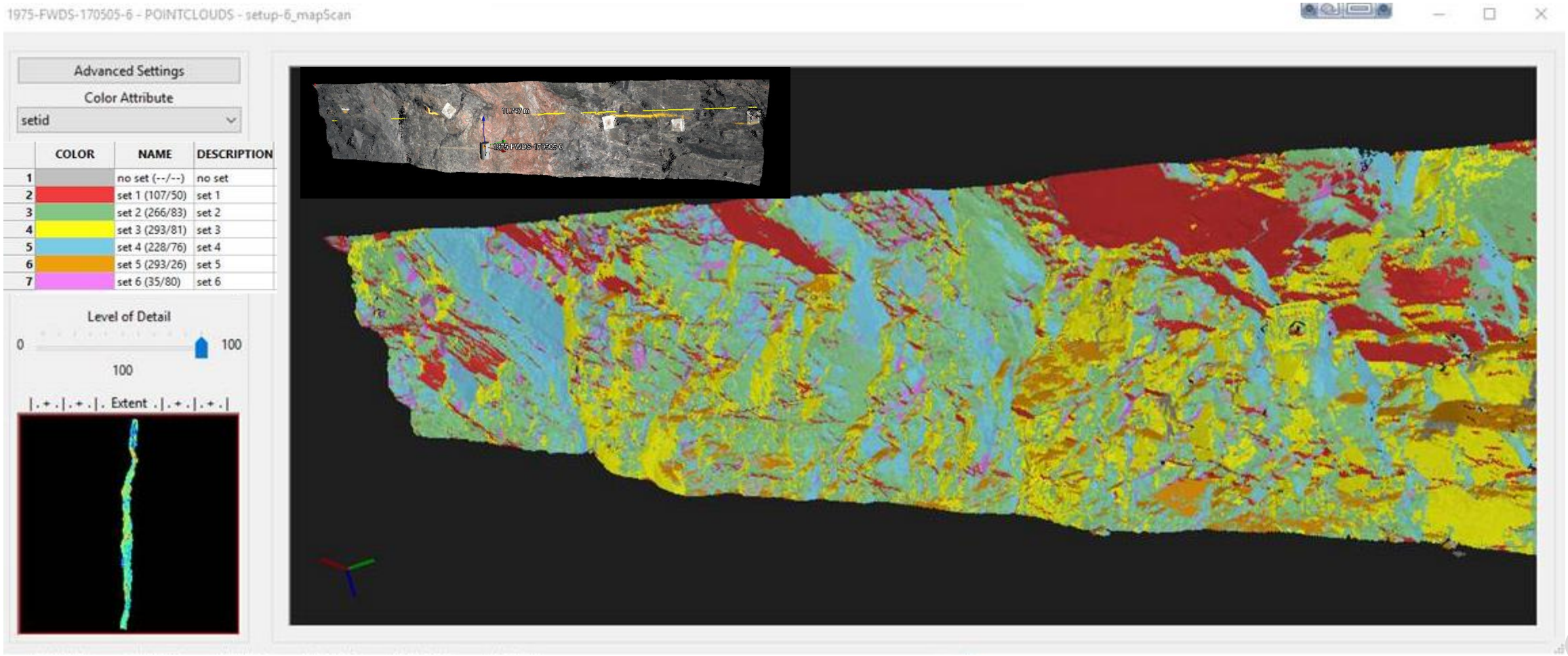
Power of photogrammetry



Using point cloud data with other software - LisPro 3D trial

Results

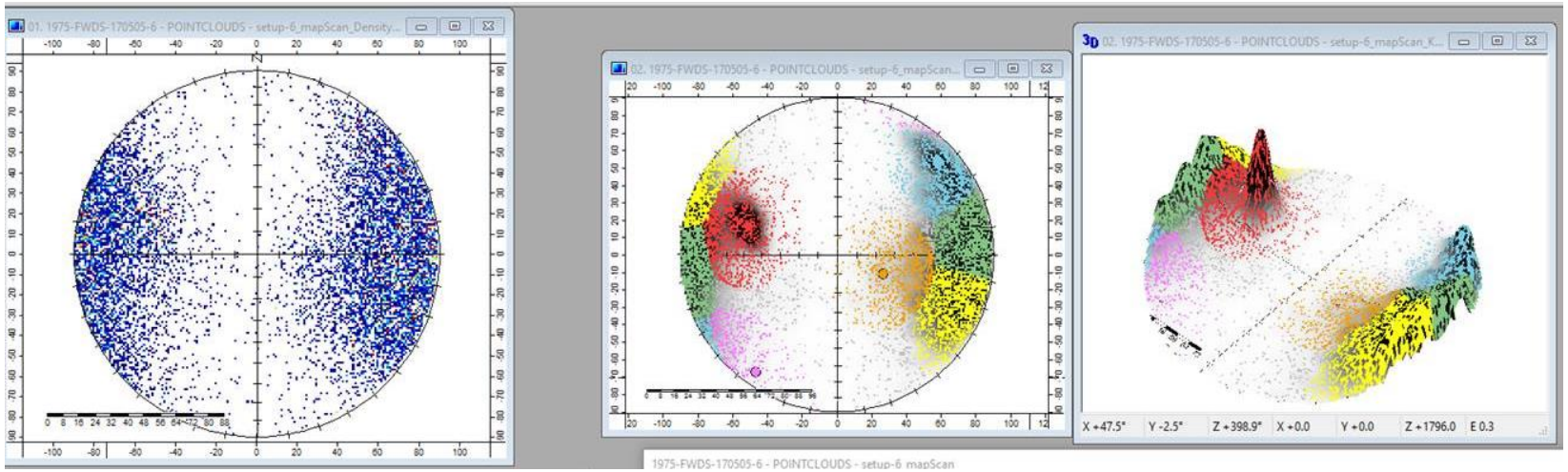
After data manipulation, the exported point cloud is divided into joint/plane sets, which are grouped together by the software based on their trend in dip direction



LisPro 3D trial

Results

Joint sets data can then be tabulated in text files (and visualised by stereonets) for use in mine plans (for Geotechs using Deswick or Surpac)



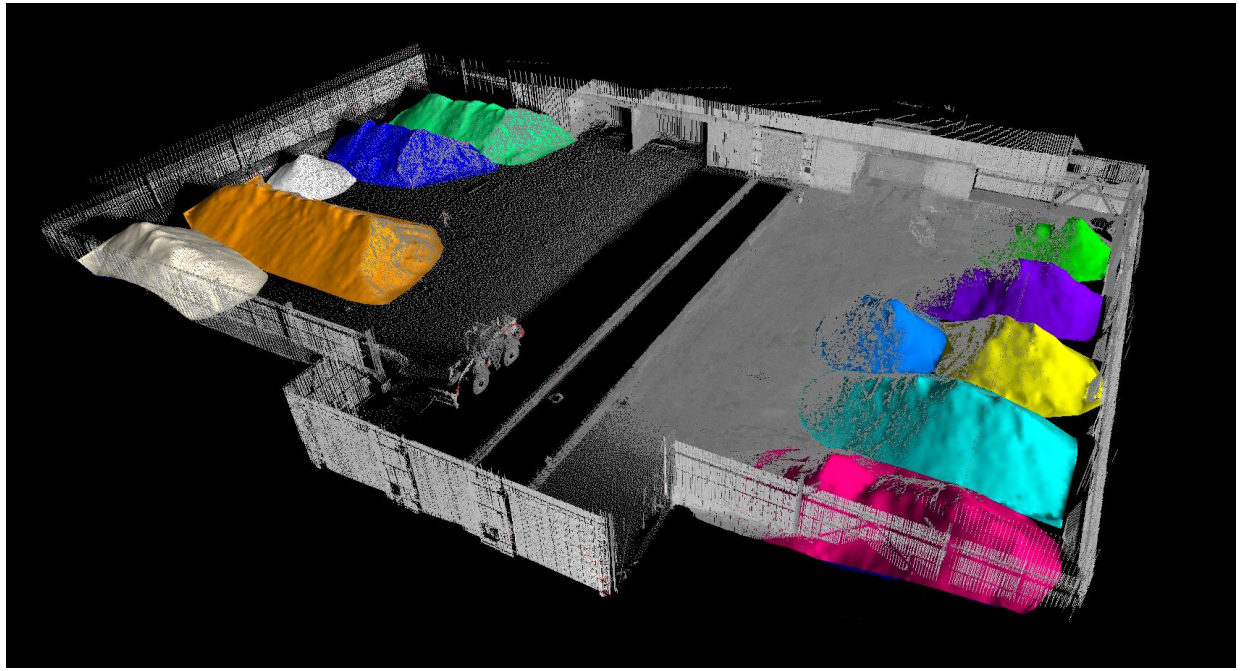
	set	dip_dir	dip	mean_spacing	ddev_spacing	nedian_spacin
1	1	107.41797	49.662865	0.146612	0.124647	0.120681
2	2	265.914383	82.851326	0.205689	0.177215	0.130311
3	3	292.833655	80.764439	0.209846	0.228445	0.13301
4	4	227.579148	76.237297	0.174903	0.134575	0.147198
5	5	292.932101	25.630162	0.155056	0.120042	0.122382
6	6	35.049374	80.032681	0.155065	0.119913	0.122404

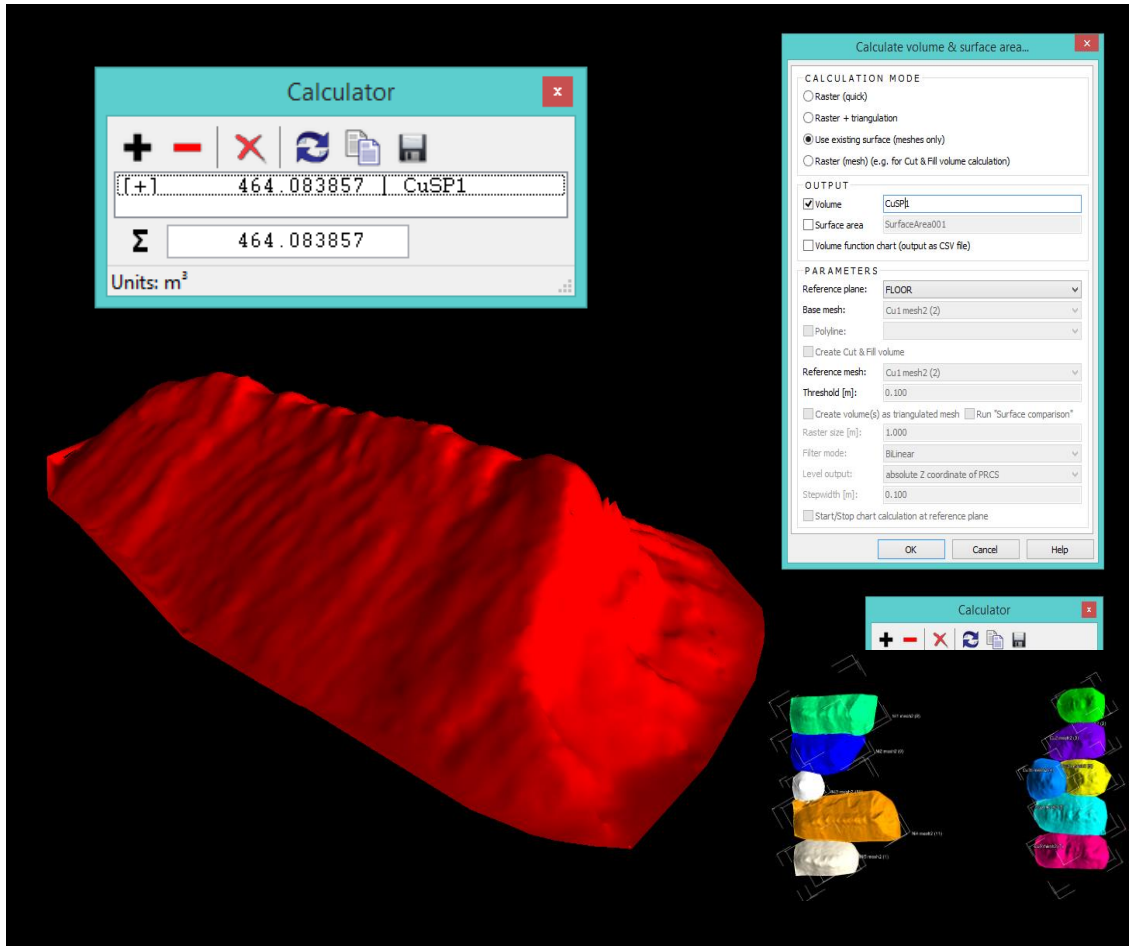
Preparation of point cloud data for compatibility with this software is very time consuming.

Other Applications

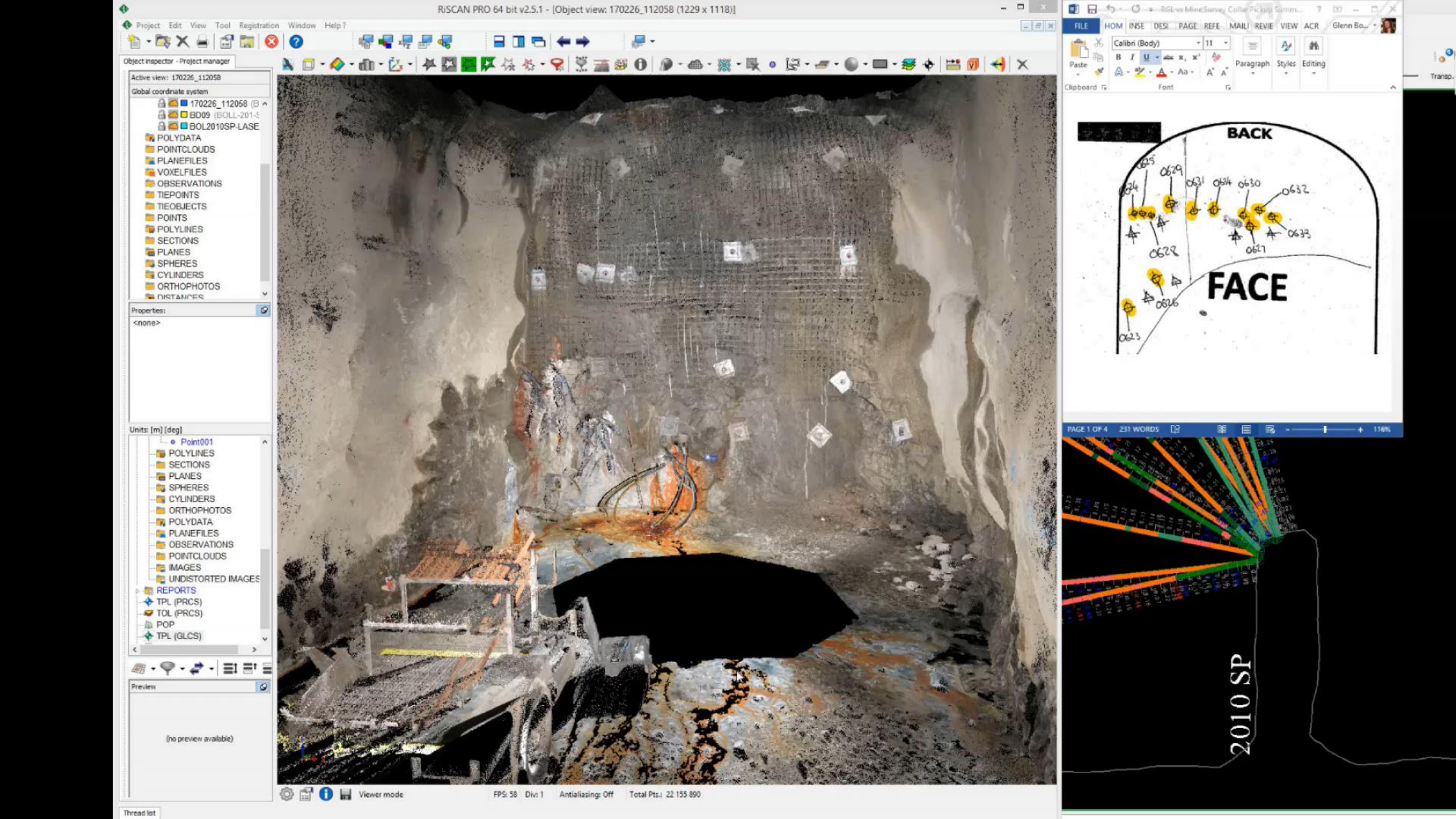
Not just for rocks

Other applications – Volume calculations of concentrate stockpiles





- Low resolution ~ 50 second scans
- Quicker and more detailed than a survey pickup
- RiScan inbuilt multi-stage adjust negotiates the need for control
- RiScan inbuilt meshing and volume calculating tools


RiSCAN PRO 64 bit v2.5.1 - [Object view: 170226_112058 (1229 x 1118)]
Project Edit View Tool Registration Window Help ?
Object inspector - Project manager
Active view: 170226_112058
Global coordinate system
170226_112058
BD09
BOL2010SP-LASE
POLYDATA
POINTCLOUDS
PLANEFILES
VOXELFILES
OBSERVATIONS
TIEPOINTS
TIEOBJECTS
POINTS
POLYLINES
SECTIONS
PLANES
SPHERES
CYLINDERS
ORTHOPHOTOS
Properties:
<none>
Units: [m] [deg]
Point001
POLYLINES
SECTIONS
PLANES
SPHERES
CYLINDERS
ORTHOPHOTOS
POLYDATA
PLANEFILES
OBSERVATIONS
POINTCLOUDS
IMAGES
UNDISTORTED IMAGES
REPORTS
TPL (PRCS)
TOL (PRCS)
POP
TPL (GLCS)
Preview
(no preview available)
Viewer mode
FPS: 58 Div: 1 Antialiasing: Off Total Pts.: 22 155 890
Thread list
BACK
FACE
0625
0629
0631
0634
0630
0632
0633
0627
0628
0626
0623
PAGE 1 OF 4 231 WORDS
2010 SP

Rig Inspections & Site setups

Engineering Applications

Challenges & Benefits

“There is no smooth road into the future” D.H. Lawrence

☒ Learn the ropes – new hardware, new software, new challenges

☑ It has not

☒ Heavily tool dependent

☑ Limitation is on interpretation rather than collection, mapping is still 2D

“The intent of this system is **not to replace face mapping**, *but to take the mapping process from the underground environment to the surface. Apart from the obvious* **safety** *and* **time-saving benefits** *of this there will also be a significant increase in* **mapping accuracy** *that will* **ultimately feed directly into the production geological model**.”

☒ Susceptible to humidity

☑ A geological as-built of a world class orebody – A complete dataset

☑ Less face time
☑ Incident capture

☒ Takes substantially longer than conventional mapping
☒ Process is still manual
☒ Result – falling behind on the backs mapping

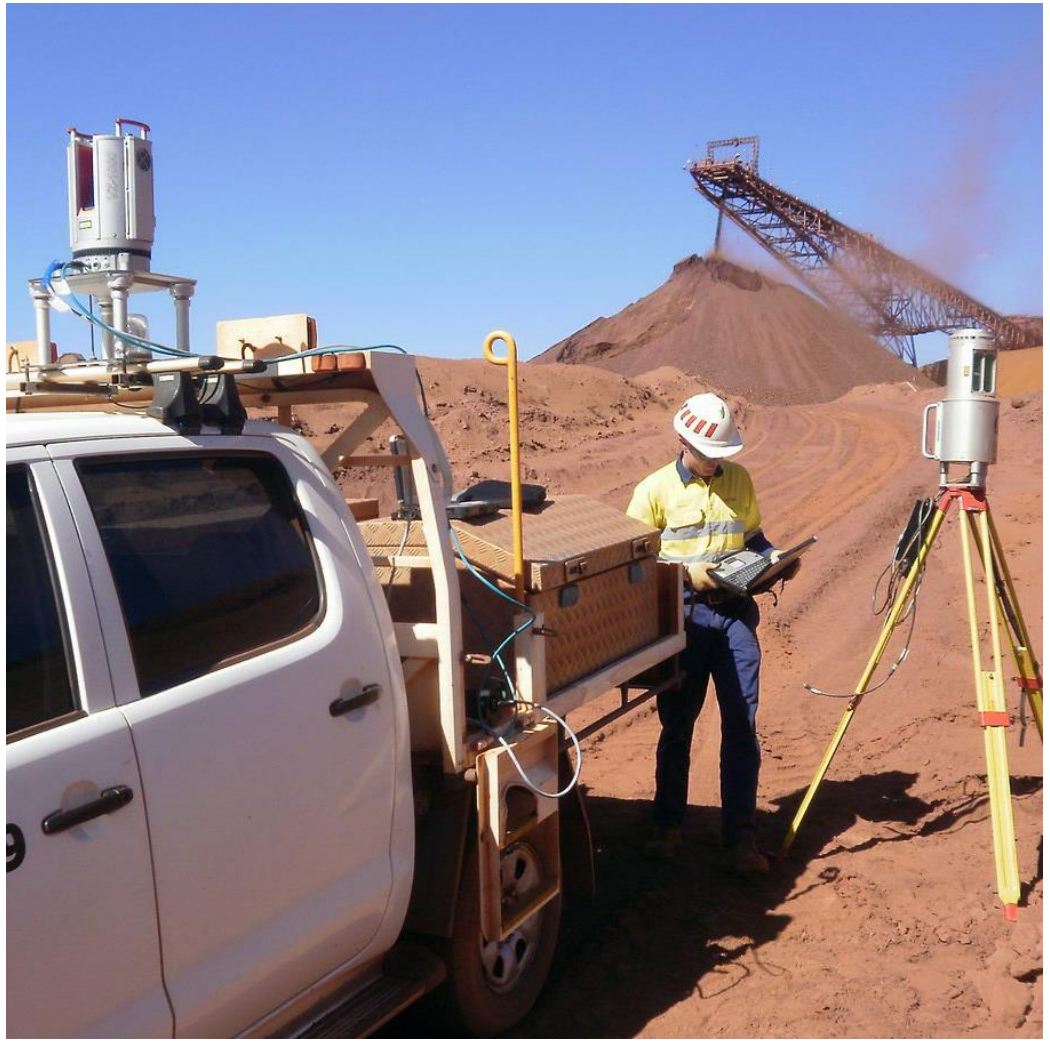
☑ Greater flexibility – better user experience

☑ Survey accuracy without the need for the survey dept.

What's next for us?

IGO aspires to be a leader in new mining and exploration technologies

- Routinely validate and tweak current wireframe model with captured contacts
- Point to point traversing of waste drives – LV vehicle mounted scanner
- Revisit LisPro structural analysis software



Rio Tinto – Vehicle mounted Riegl Scanner

1) http://survey.crkennedy.com.au/products/3d-laser-scanning/riegl-laser-scanners/riegl-vz-1000

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