

Modelling of Stability of High Westwall at Ok Tedi Copper-Gold Mine

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Risk Based Slope Design Optimisation Study

- **Stability analyses on many mine sections, deterministic and probabilistic**
- **Nonlinear stress analyses of high westwall to examine potential stress-related modes of failure:**
 - **progressive failure mechanism, via *FLAC***
 - **deep-seated toppling mechanism, via *UDEC***

Slope Stability at Ok Tedi Mine

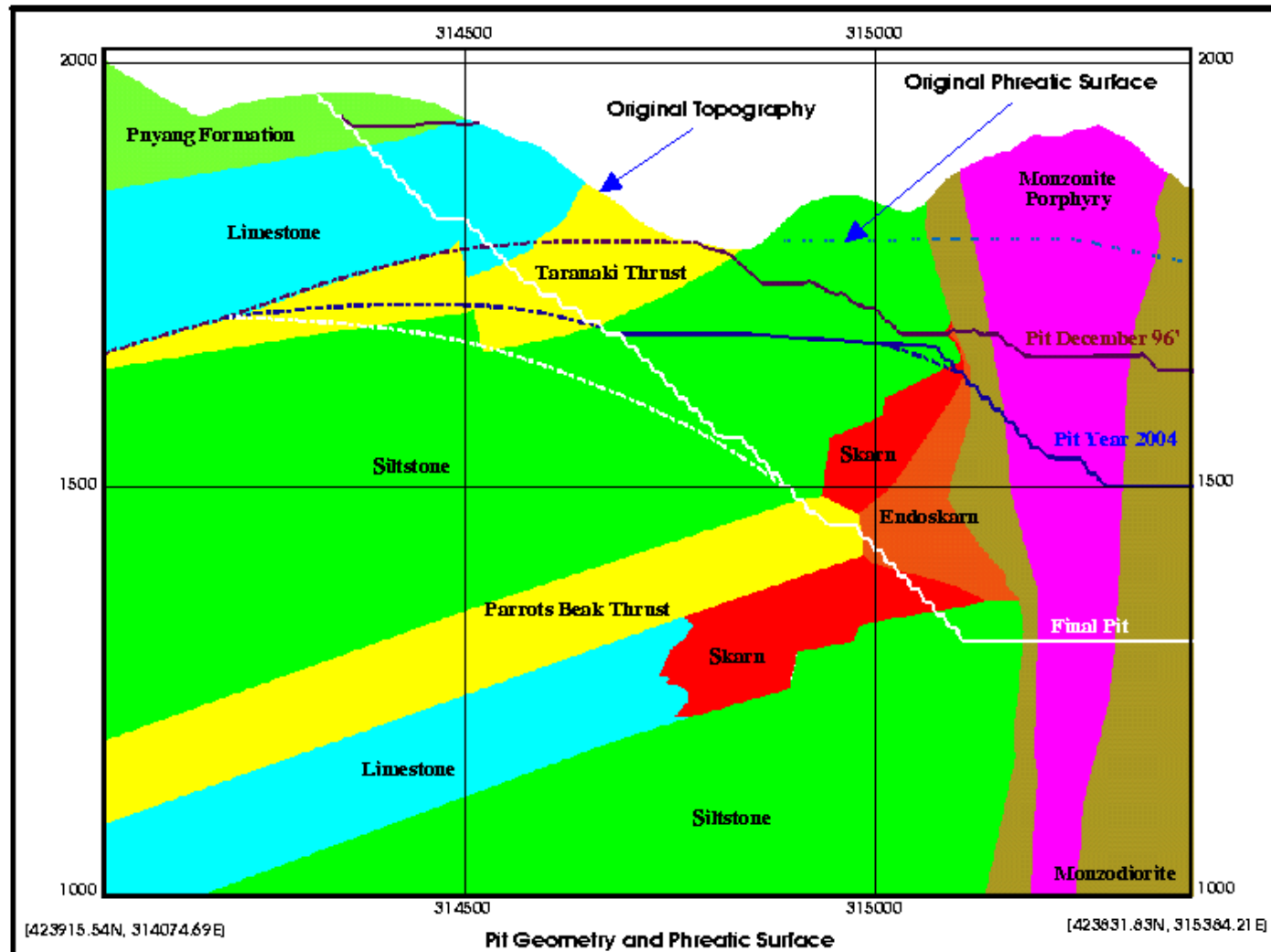
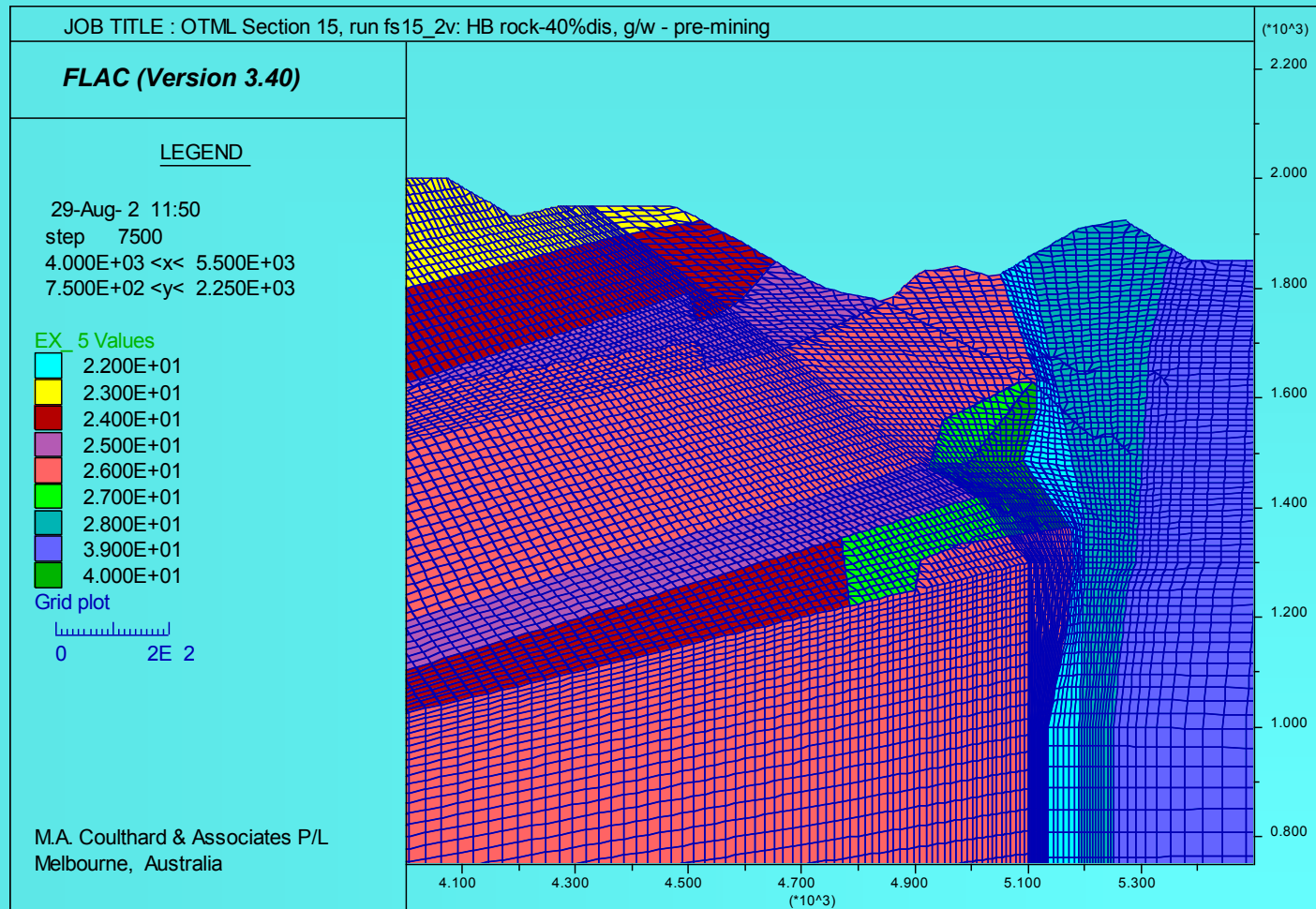


Figure 1: Geology and Groundwater for Cross Section 15 – Berlin Area

Mining Sequence in Models

- **Pre-mining conditions**
- **Dec. 1996 pit profile and phreatic surface**
- **Year 2004 pit**
- **Year 2010 pit**
- **Year 2010 pit with depressurisation**

Slope Stability at Ok Tedi Mine



Inner section of *FLAC* grid, showing rock domain numbers

Rock Mass Strength

- **Modified Hoek-Brown criterion:**

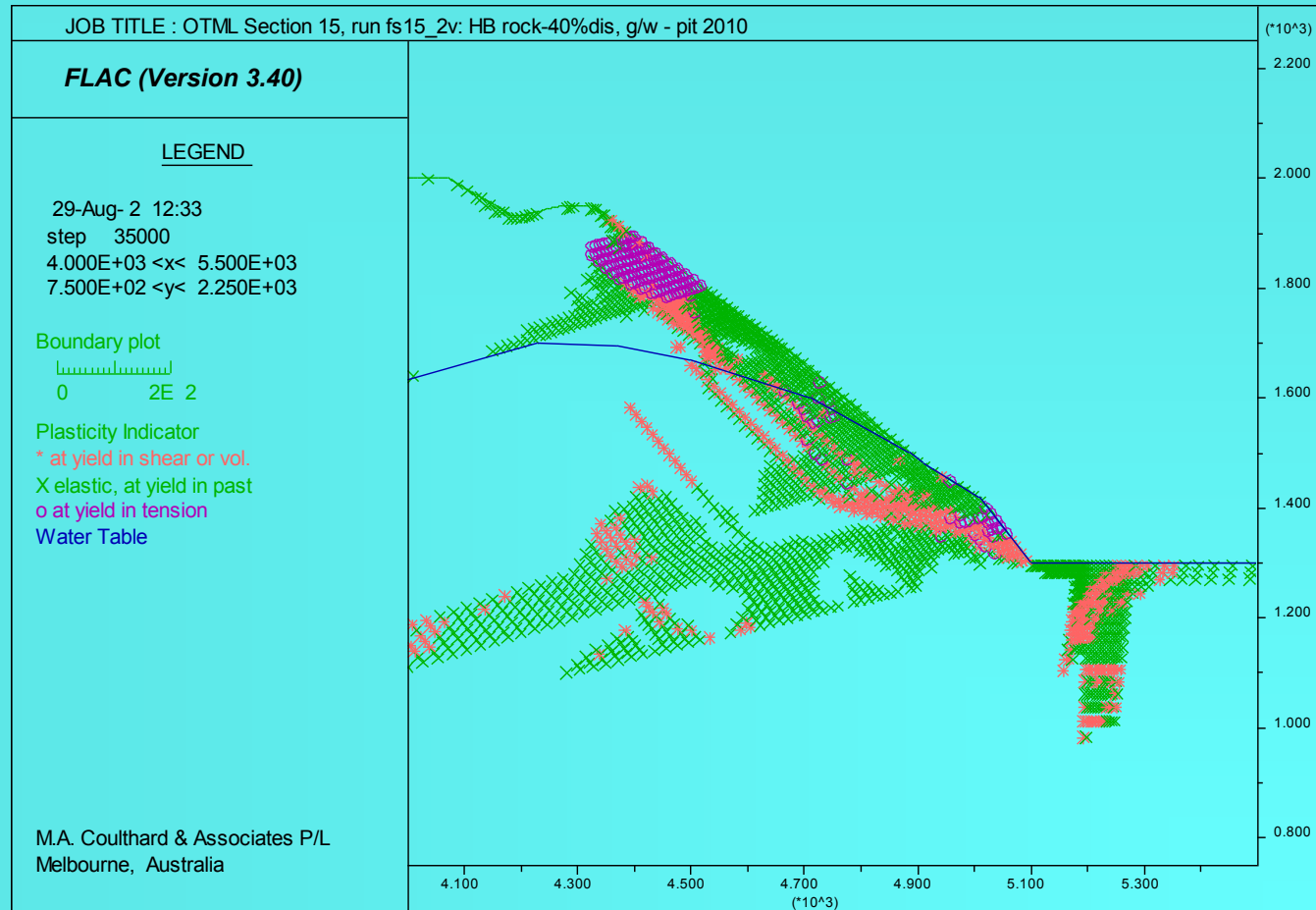
$$\sigma_1 = \sigma_3 + \sigma_c (m_b \sigma_3 / \sigma_c + s)^a$$

- **Generalisation of Itasca's HOEK.FIS to include:**
 - . multiple rock units
 - . effective stress
 - . $a \neq 0.5$
 - . tensile strength consistent with M-C in *FLAC*
 - . peak strength or brittle peak-residual transition

FLAC Modelling Results

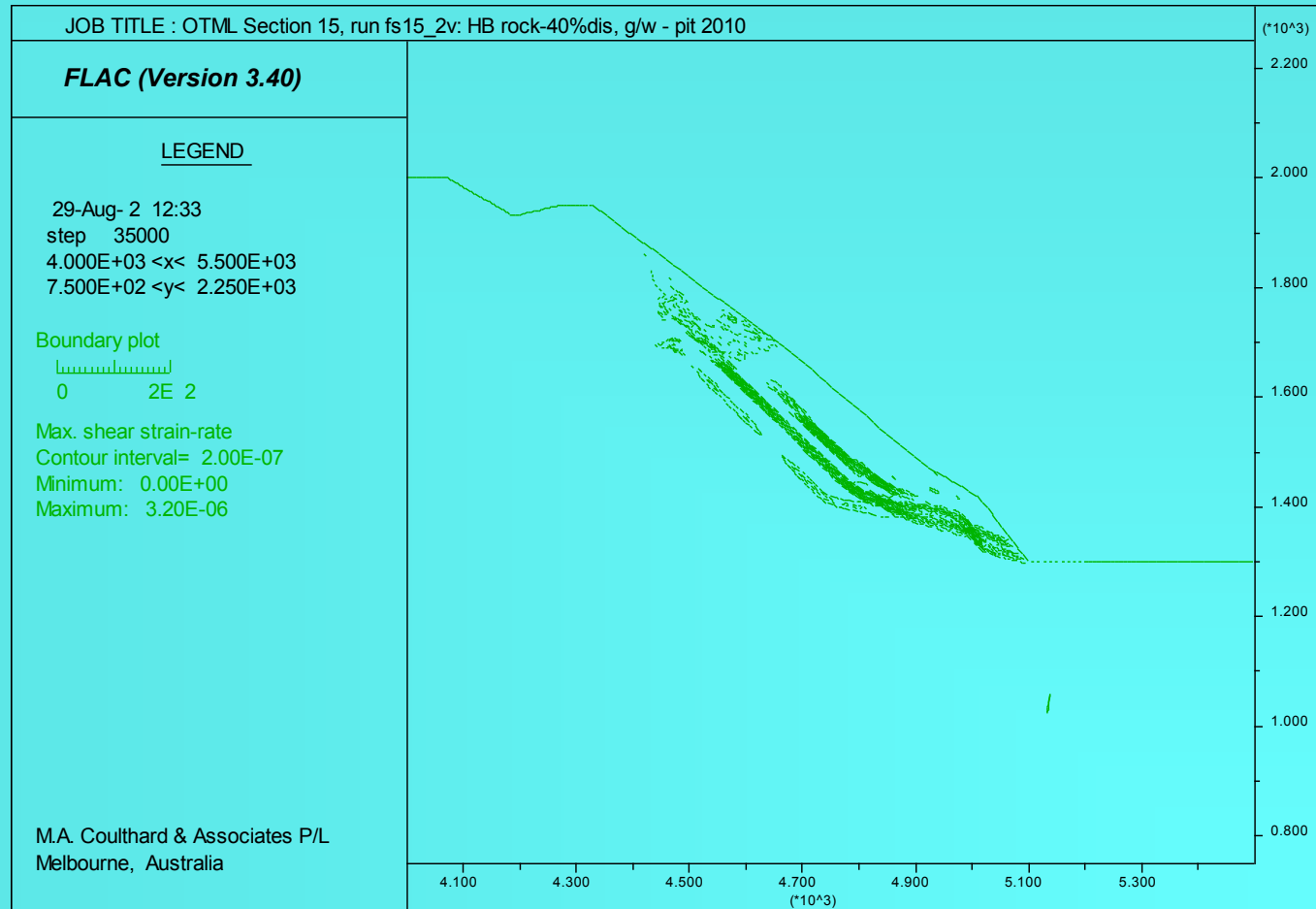
- **Mohr-Coulomb rock:** stable
- **Hoek-Brown undisturbed strength:**
stable, but more extensive yield
- **Hoek-Brown brittle yield:**
1996 stable, 2004 and 2010 unstable
2010 stable with / without depressurisation
if strength reduction $< 40 / 26\%$
- **Addition of major fault had little effect**

Slope Stability at Ok Tedi Mine



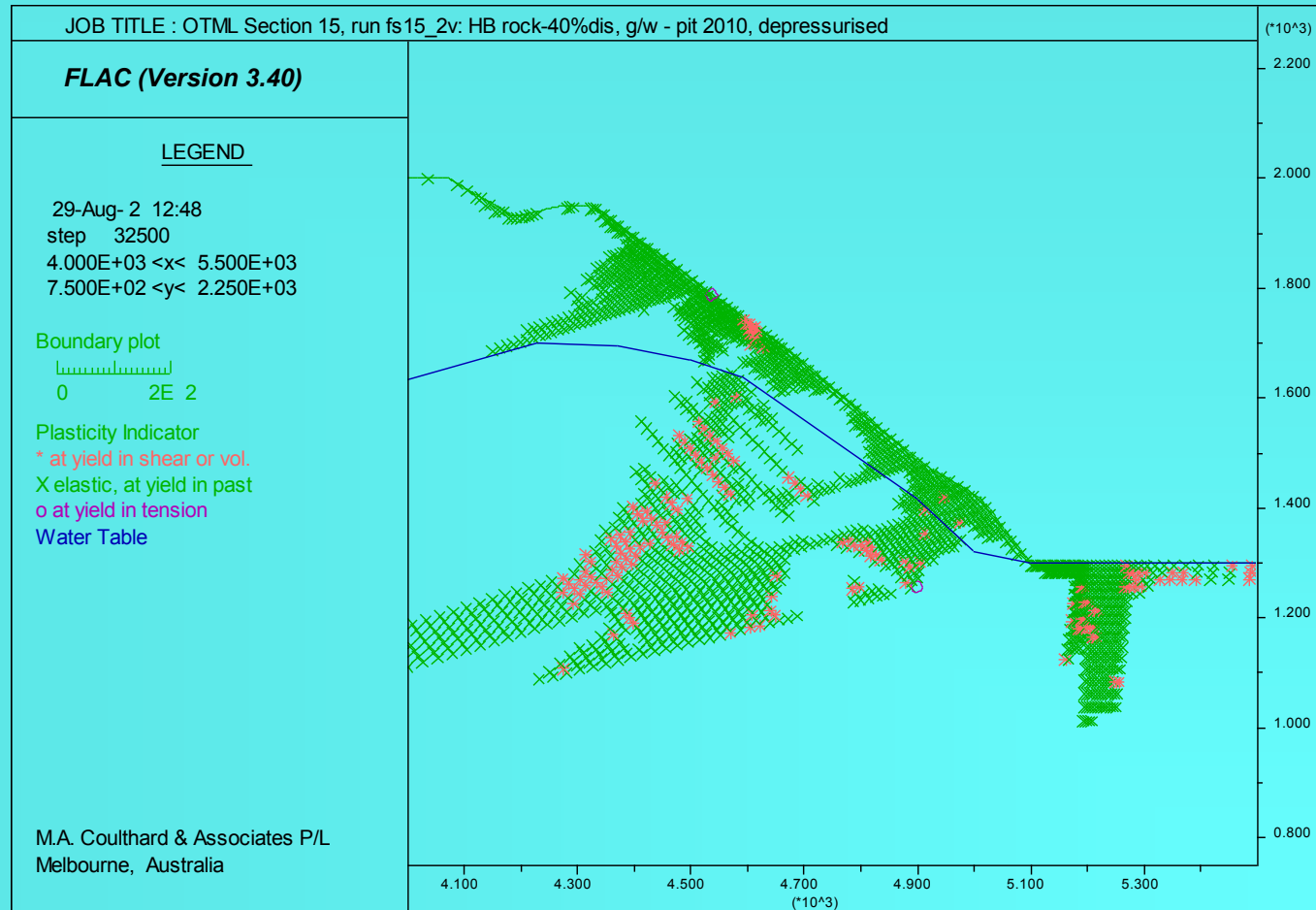
Plastic state and phreatic surface for Year 2010 pit without depressurisation: unstable

Slope Stability at Ok Tedi Mine



Shear strain rate contours for Year 2010 pit without depressurisation indicate failure surface

Slope Stability at Ok Tedi Mine



Plastic state and phreatic surface for Year 2010 pit after depressurisation: stable

Conclusions

- **Progressive (strain-weakening) slope failure may develop as pit is developed**
- **Magnitude of difference between undisturbed and disturbed rock strengths is critical; sharpness of transition may be also**
- **Depressurisation may limit failure**
- **On-going geotechnical studies and monitoring required as pit is deepened**