Discrete Element Modelling of the Isa Inlier

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Summary

Numerical modelling using the discrete element technique is employed here to examine the response of a fracture system in the Mt Isa Inlier, to an applied stress regime. Areas of low minimum principal stress and low mean stress indicate dilation and potential sites of fluid focusing, and areas of high differential stress indicate increased deformation. The models correspond to syn- to post- mineralisation for many deposits in the region. Areas that show a combination of 1) low values of mean stress (σm), minimum principal stress ($\sigma 3$) and fluid pressure required for failure (PFf), in conjunction with 2) increased differential stress ($\Delta\sigma$) predicting shear failure or low values predicting tensile failure, provide the best targeting solution for mineralisation. Many areas with these features correlate well with deposits and prospects in the region, as seen in the EFB models. These models may also predict areas that at present have no known deposits. The comparison of Eastern Fold Belt and Western Fold Belt results have highlighted the potential for an inlier wide stress regime that may be responsible for Cu mineralisation.

Aims

The main aims of the study are:

1) To compare local scale v's district scale v's regional scales (see Keys & Nortje)
2) Examine the influence of stress field rotation
3) To compare dilation versus contraction (dilational-compressional breccia styles)
4) Explore the effects of lithology and competency contrasts
5) To examine the influence of fluid pressure within fractures
6) To propose areas that are more likely to host Cu mineralisation

Study Area and Stress Values

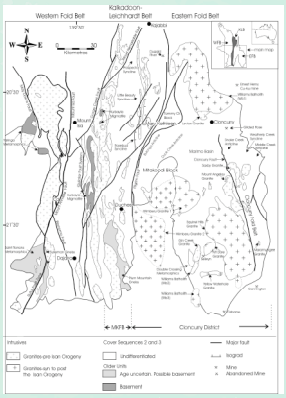

Figure. 1. Location (inset) and general geology of the Western, Kalkadoon-Leichhardt and Eastern Fold Belts showing the further division of the Eastern Fold Belt into the Mary Kathleen Fold Belt (MKFB) and Cloncurry District. The spatial distribution of Cover Sequences 1-3 and intrusive features pre- and syn- to post- Isan Orogeny are shown, (modified from Williams, 1998), as well as some of the major mineral deposits in the Eastern Succession.

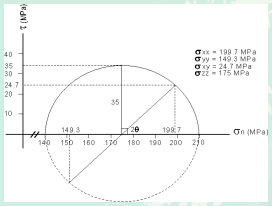

Figure. 2. Schematic diagram of Mohr-circle calculations for application of stress fields from 90 degrees (E-W) to 112.5 degrees (ESE-WNW). Calculated from a vertical stress applied to the plane at an equivalent lithostatic pressure of 7km depth (175 MPa).

Initial Regional Scale Results & Comparisons

WFB

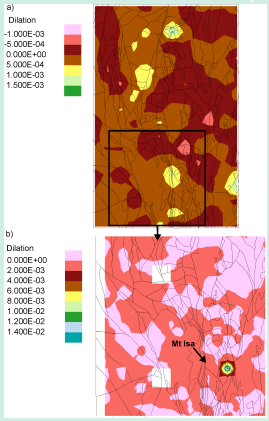

Figure. 3. UDEC output for the WFB with an applied stress field of 90 degrees (E-W) a) contours of dilation on a whole model regional scale and b) Sybella region, indicating areas that may indicate fluid focussing as a result of dilation. (+ve values indicate dilation, -ve values indicate contraction).

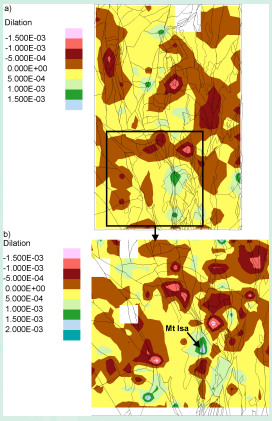

Figure. 4. UDEC output for the WFB with an applied stress field of 112.5 degrees (ESE-WNW) a) contours of dilation on a whole model regional scale and b) Sybella region, indicating areas that may indicate fluid focussing as a result of dilation. (+ve values indicate dilation, -ve values indicate contraction).

EFB

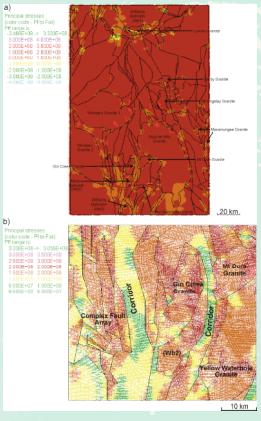

Figure. 5. Plots of fluid pressure required for failure at 112.5 degrees (ESE-WNW) stress field **a**) regional plot of the EFB displaying several areas in the northern region at yield, and strong trends in the Selwyn region anastomosing the granite bodies **b**) magnified plot of the Selwyn area displaying distinct north-south trends forming 'corridors'. Note: negative values indicate areas at yield.

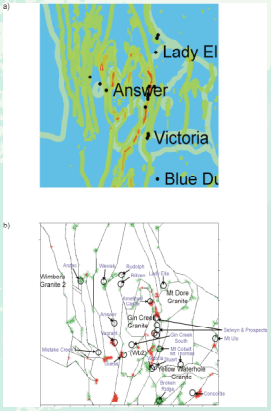

Figure. 6. Comparison of prospectivity analysis **a**) by Mustard *et al.* (2004), blue colours indicating no prospectivity and yellow to red indicating lower to higher prospectivity respectively **b**) plasticity indicators of the Selwyn region, indicating areas at yield. Known deposits and prospects of the Selwyn area are named and marked by circles.

Conclusions and further work

Initial results from the discrete element modelling of the WFB appear to indicate that a rotation of the stress field from 90 degrees (E-W) to 112.5 degrees (ESE-WNW) has a more favourable correlation with known Cu mineralisation. This is also seen at a similar regional scale in the EFB, which may indicate an inlier wide stress regime may have been responsible in part for Cu mineralisation throughout the Isa Inlier. Local scale models are also being tested (see D. Keys and G. Nortje this conference). Further testing of stress fields, fluid pressure, geometric considerations and field validation are required, however early results are encouraging.

predictive mineral discovery
Cooperative Research Centre

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