predictive mineral discovery
COOPERATIVE RESEARCH CENTRE

The pmd*CRC A1 (Architecture) Project

A Coherent Concept Aimed at Predicting the Mineral Potential of Major Fault Systems

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Major fault systems that penetrate deep into the crust are important, but poorly understood architectural elements of the Earth. Throughout space and time, these structures are of economic importance because they appear to play a major role in providing pathways for, and focusing mineralised fluids and magmatism into the upper crust. Despite the strong empirical relationship that exists between hypogene ore deposits and major, potentially trans-lithospheric structures and fault corridors, however, very little is known why some of these systems are metallogenically well-endowed, whereas other, seemingly identical faults are barren.

Tectonic Targets Data Base

Via the collection of empirical data, we are comparing and contrasting a large number of mineralised and barren fault systems (globally, independent of time and/or commodity). These data are used to identify geological, geophysical and geochemical parameters that are common to well-endowed fault systems. The XMML-based structure of the data base enables a broad range of users to create, retrieve and revise tectonic target information. Users can query the data base for individual - or combinations of – geological, geophysical and geochemical criteria, and obtain information on specific fault systems, mineral deposit types, and relevant references.

Key Area Studies

In order to validate results obtained from the interrogation of the tectonic target data base, multi-disciplinary investigations examine representative examples of both well-endowed and poorly-endowed major fault systems in Archaean-, Proterozoic- and Phanerozoic-aged terrains, namely the Yilgarn Craton (Bardoc-Boorara Fault Zone), the Mt Isa Inlier (Mt Isa Fault Zone) and the Hodgkinson-Broken River Province. Research includes the integration of spatial data sets, geological, structural and geophysical mapping of the major structures, chemical and geophysical modeling of associated fluid and alteration systems, geochronological and isotopic constraints, and a quantitative assessment of the geometry (fractal dimension) of 1st- and 2nd-order faults within each of the key areas.

Summary of Results to Date

Our results indicate that the majority of well-endowed major fault systems represent highly non-linear 'damage zones' that record a complex kinematic history, including 'switching' from compressional to transpressional convergence, and reversal of movement. Permeability contrasts, lithological and metamorphic heterogeneities, the presence of suitable seals and sinks, steep complexity gradients, and the overall geometry of the fault systems play key roles in determining their metallogenic endowment. Major metallogenically important faults are commonly steep and possibly transcrustal, as demonstrated by a close spatial association of mantle-derived magmas along many of these structures. Mantle-driven processes are probably important in the formation of world-class ore deposits. Where there is little direct evidence for a well-endowed fault to penetrate into the asthenosphere, late-stage decoupling of the fault might have occurred along a more ductile lower crustal layer. Via the synthesis of data sets, and linking between geological, geophysical and geochemical disciplines, the work reported herein is leading towards a significantly improved understanding of the fundamental geometrical and kinematic characteristics of metallogenically endowed fault systems that can be applied in predictive mineral discovery.

Acknowledgements

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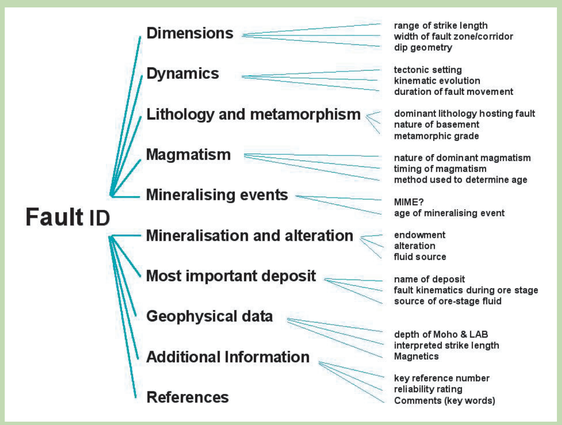
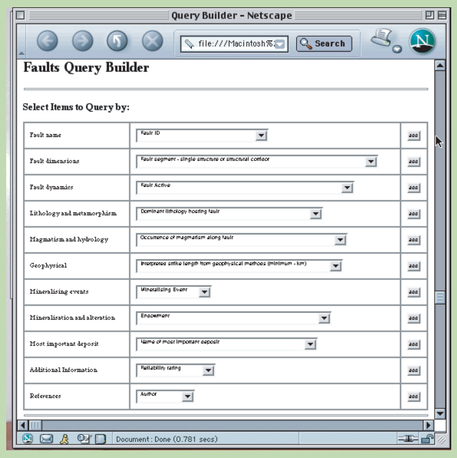
Tectonic Targets & Deposits Database

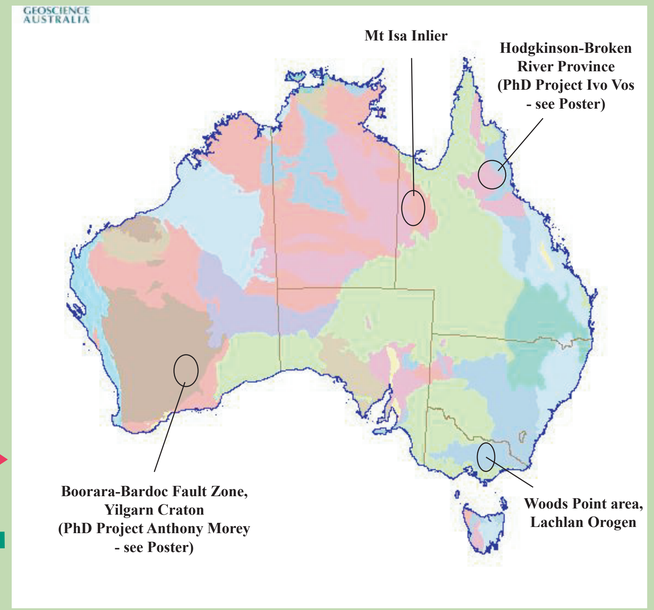
available on https://pmdsrv1.arrc.csiro.au/AOneWebApp/view/index.jsp





database criteria

Key Area Studies



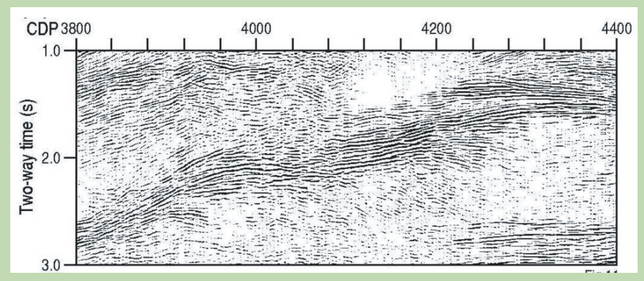
Deposits database (see A1-F4 Poster)

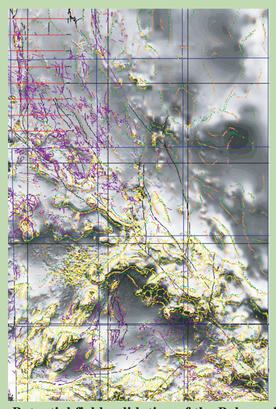
Input

Validation

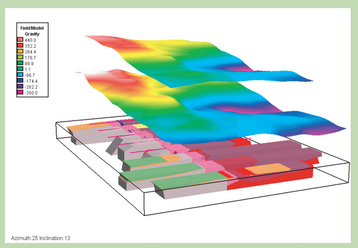
Enabling Methods

CO_2±CH_4-H_2O inclusion in quartz



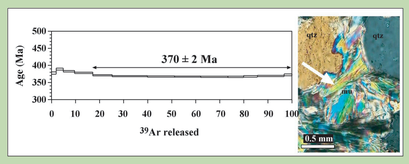


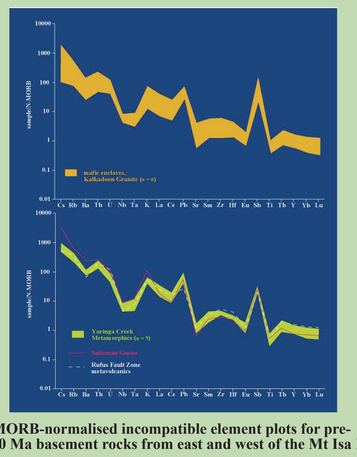
Potential field validation of the Palmerville Fault, N Queensland; green = 10km UC, orange = 5km UC, yellow = 1km UC; grid scale = 10 x 10km (M. Barlow)



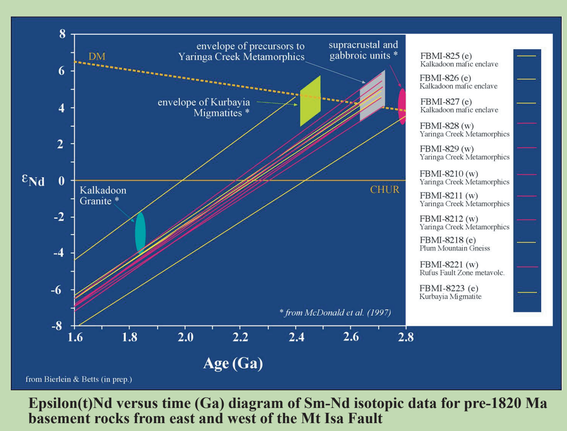
3D interpretation of dip and depth extent of Palmerville Fault based on gravimetric and magnetic gradients across fault plane (M. Barlow)

R. Weinberg examining a thrust plane in the Selkin deposit, Yilgarn Craton





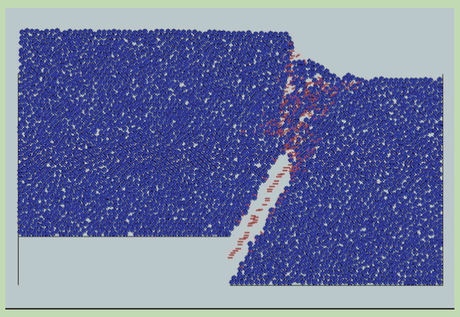
N-MORB-normalised incompatible element plots for pre-1820 Ma basement rocks from east and west of the Mt Isa Fault



Epsilon(t)Nd versus time (Ga) diagram of Sm-Nd isotopic data for pre-1820 Ma basement rocks from east and west of the Mt Isa Fault

Process Understanding
critical parameters

Modelling Scenarios



PFC model of fracture propagation during reactivation of basement fault (Chongbin Zhao; pmd*CRC M2 Project)

Application to Industry → *Predictive Mineral Discovery at a Significantly Reduced Risk*

Predictive Mineral Discovery

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