

# Cannington Discovery History – Making Sure We Have Learnt The Lessons



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Exploration masters, winners  
and the future, February 2020





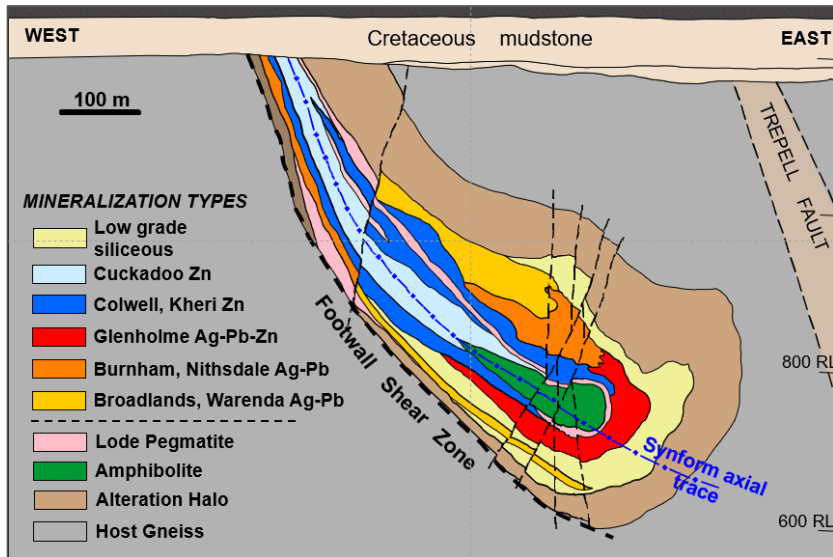
## CONTEXT

Cannington - concealed deposit found by BHP Minerals in 1990

Economic resource - 44 Mt at 538 g/t Ag, 11.6% Pb and 4.4% Zn

Example of the enigmatic 'Broken Hill-type' (BHT) deposit style

Result of a sustained exploration effort over several years



## DISCOVERY FACTORS

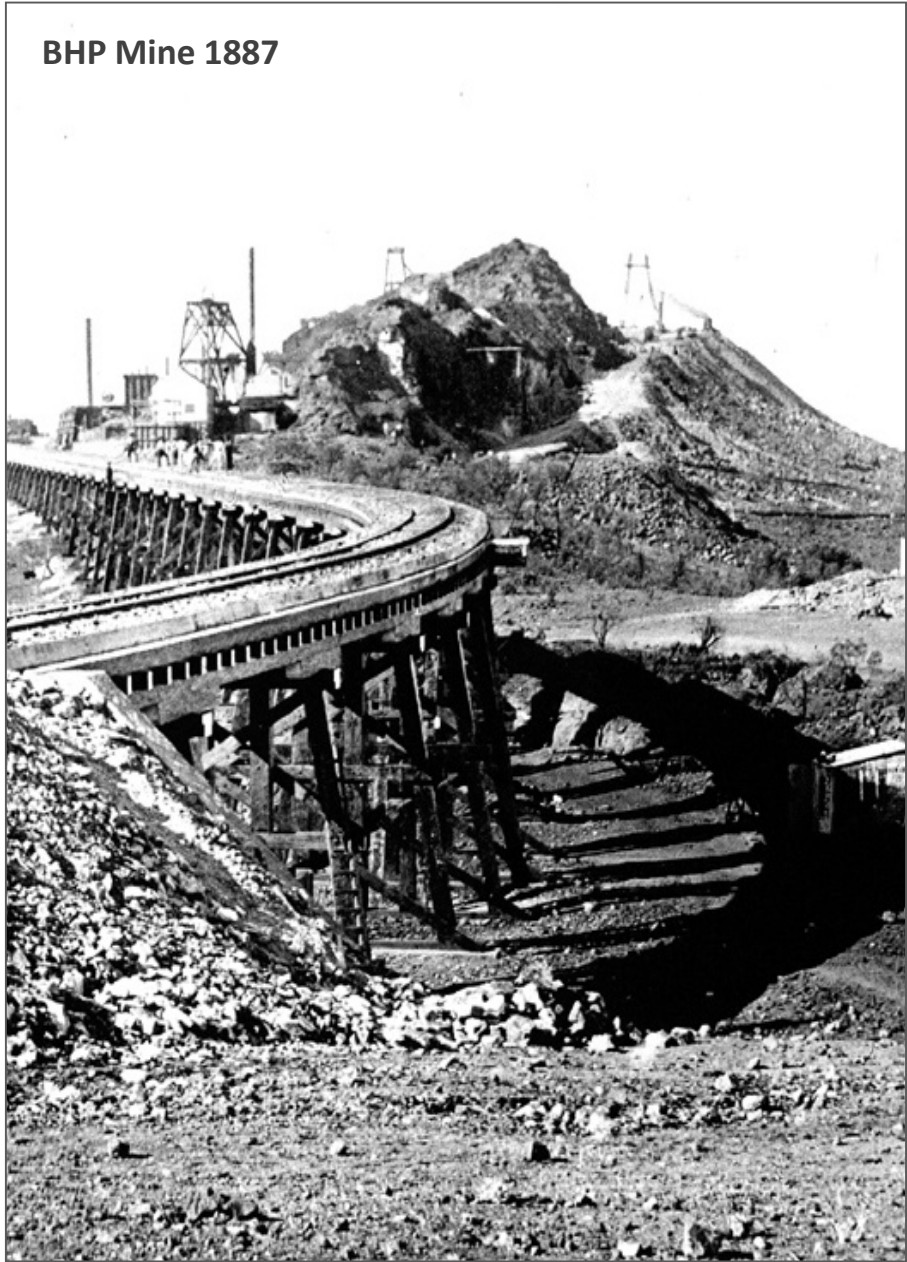
Used lithostratigraphic model developed by NSWGS at Broken Hill

Involved proprietary and novel exploration tools developed by BHP

Underground development lead to additional proprietary exploration tools

**Discovery was exactly what the exploration model was designed for**

BHP Mine 1887



## FORMATIVE ROLE OF BROKEN HILL

Broken Hill NSW –birthplace of the Broken Hill Proprietary (BHP)

One of the worlds greatest Pb-Zn-Ag orebodies

Centenary in early 1980's linked to some major NSWGS initiatives

Resulted in publication of detailed mapping and metallogenic studies

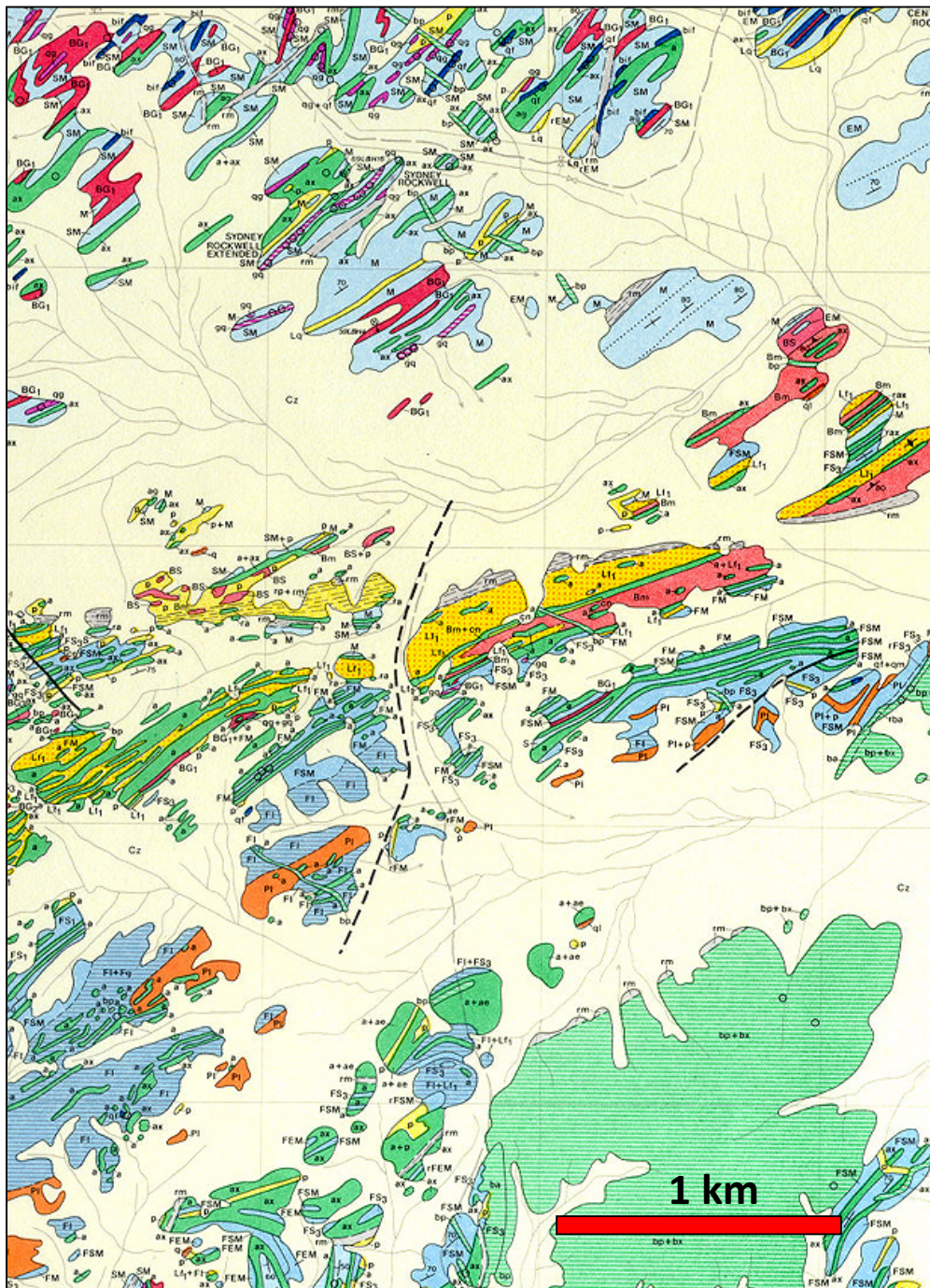
BHP left Broken Hill in 1939 – had no collective 'memory' or DNA

Decided to re-enter global Pb-Zn-Ag exploration in early 1980's

New information from Broken Hill crucial for developing a strategy

Lead to development of a novel BHT exploration model

Directly lead to Cannington discovery and has been applied globally



## KEY INGREDIENTS OF DATA RELEASES

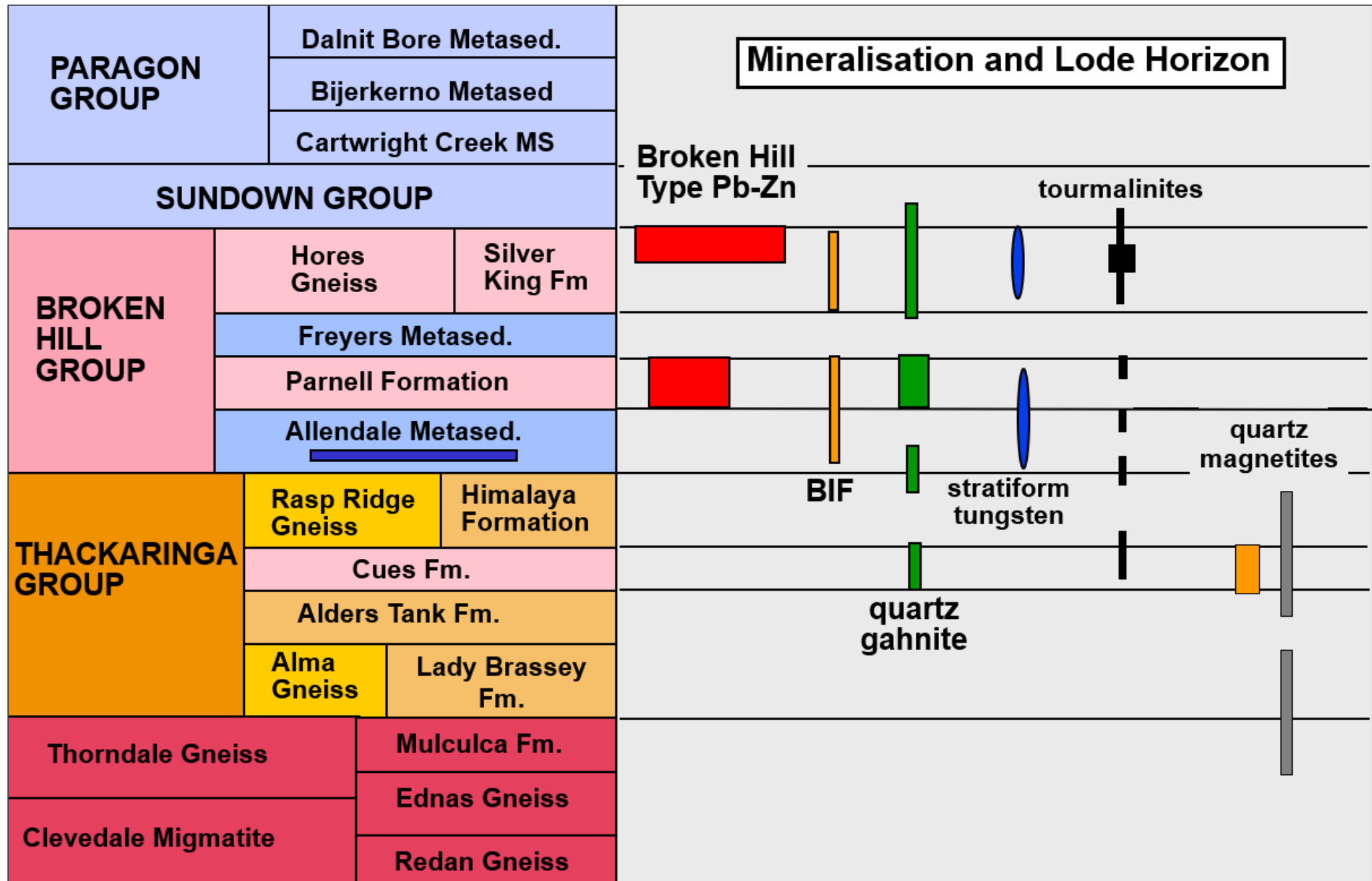
Full coverage of 1:25,000 'fact' mapping for Broken Hill Block

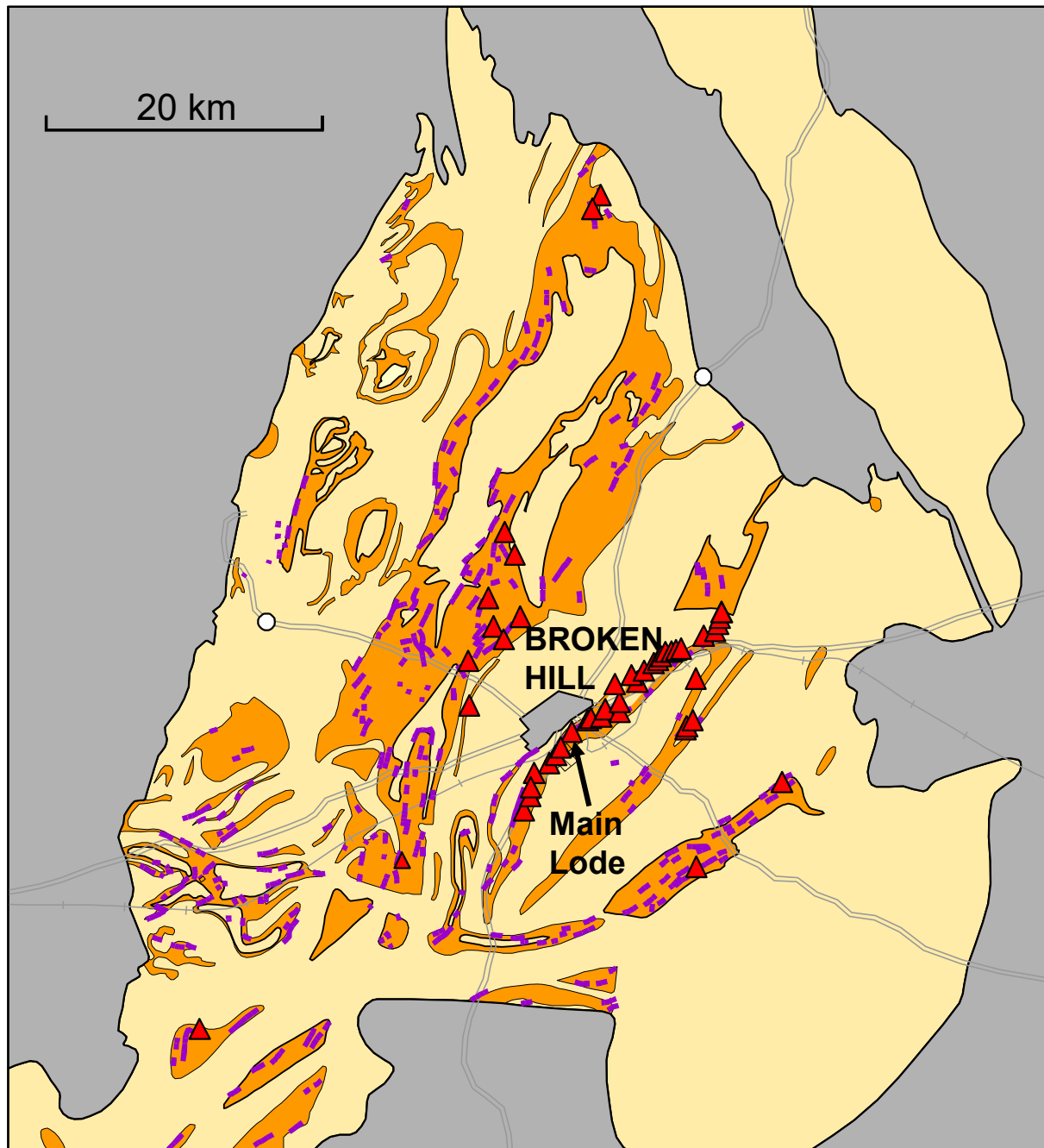
First definition of empirical but coherent regional framework

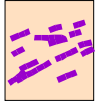


Allowed hundreds of mineral occurrences to be placed in context

Numerous field trips and conferences to disseminate learnings

Great way for BHP to become reacquainted and up to speed





-  Distribution of lode horizon quartz-gahnite and garnet-rich rocks
-  Broken Hill Group
-  Small BHT deposit
-  Outcrop of Broken Hill Block

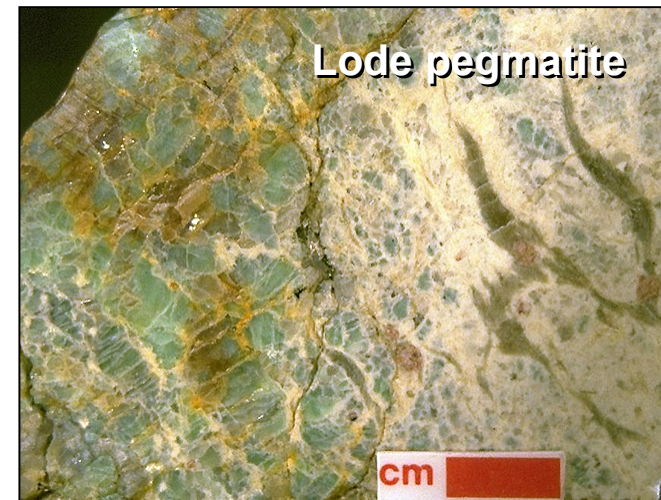
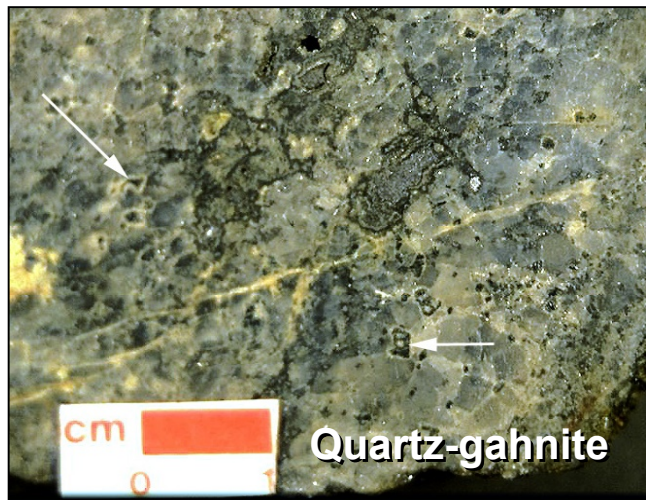
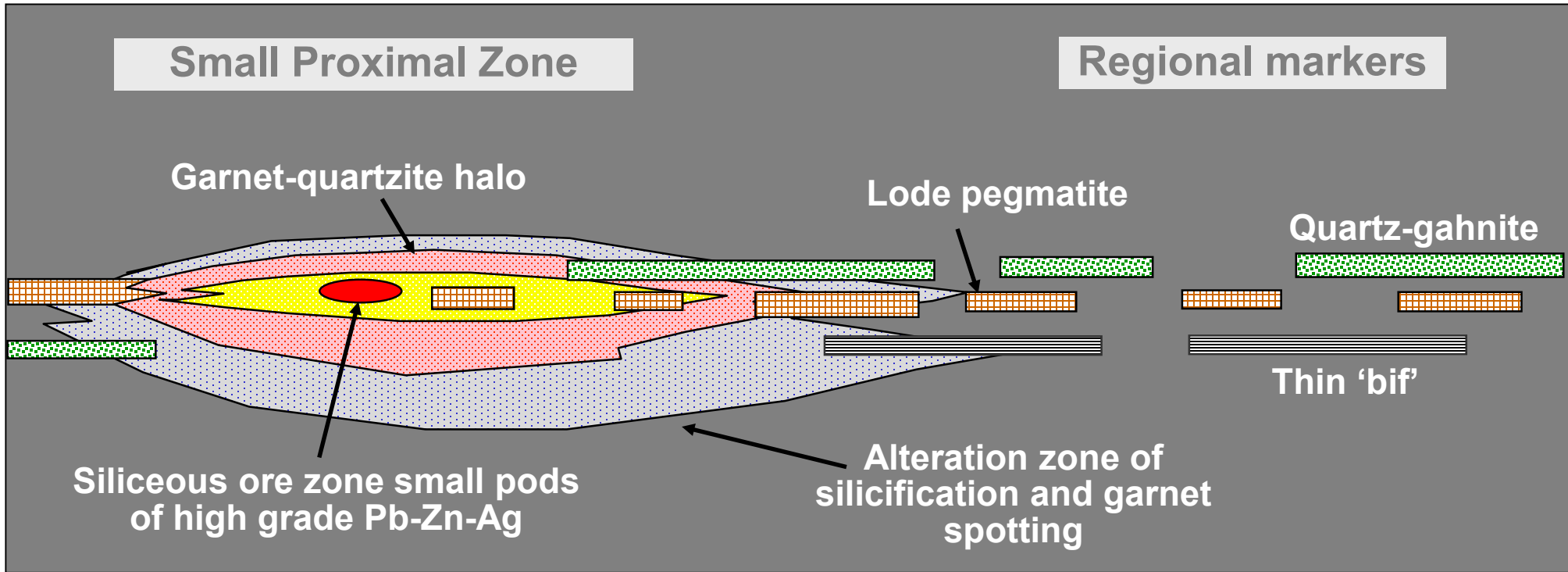
## LESSONS

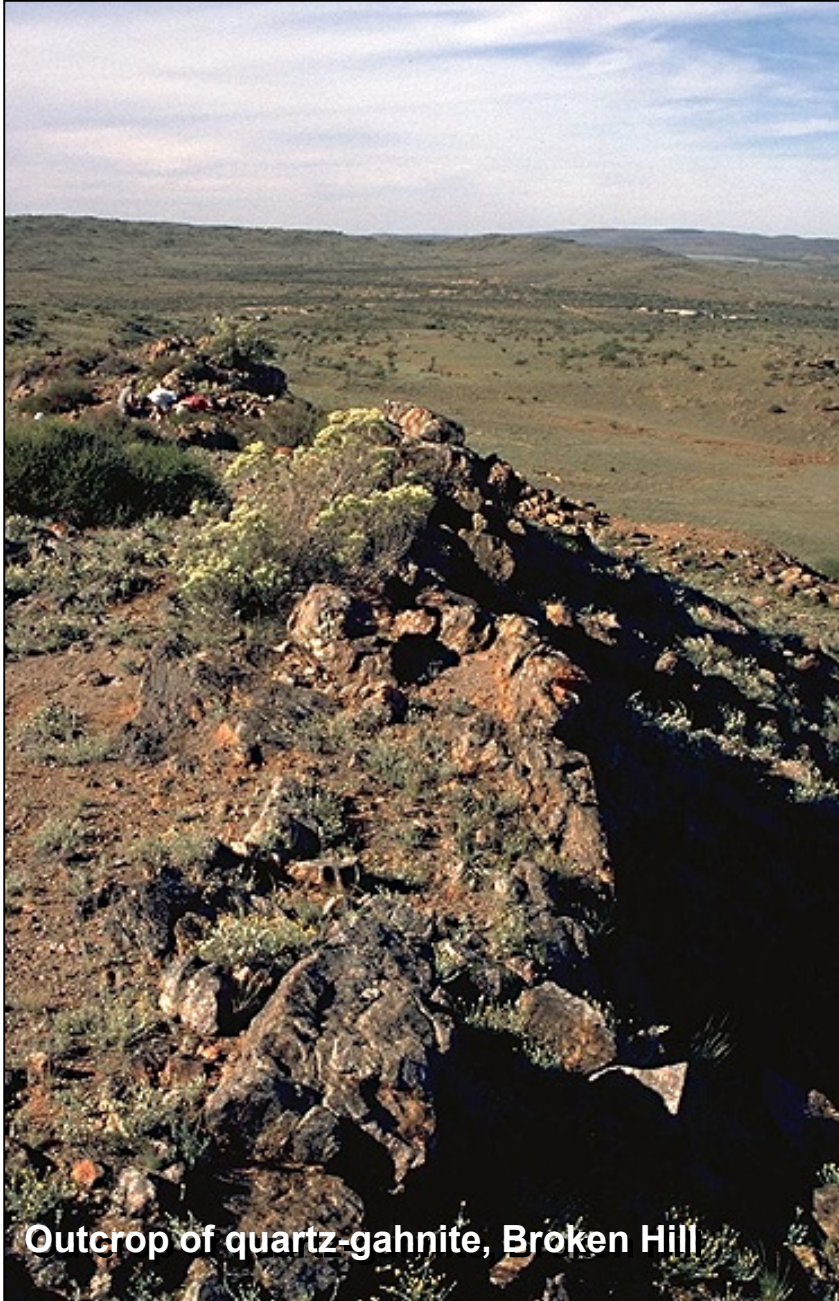
BHT districts can generate a lot of metallogenic 'smoke' which is often mis-interpreted

Mineralisation is strata-bound but has undergone amphibolite – granulite facies metamorphism

Results in complex and complicated relationships and endless genetic arguments (not helpful)

Effective exploration models need to be empirical





Outcrop of quartz-gahnite, Broken Hill

## CRUCIAL EXPLORATION ROLE OF LODE HORIZON

Regionally extensive Lode Horizon diagnostic feature of BHT terrains

Most Lode Horizon occurrences unrelated to significant mineralisation

Thin Lode Horizon with unusual mineralogy easily overlooked in field

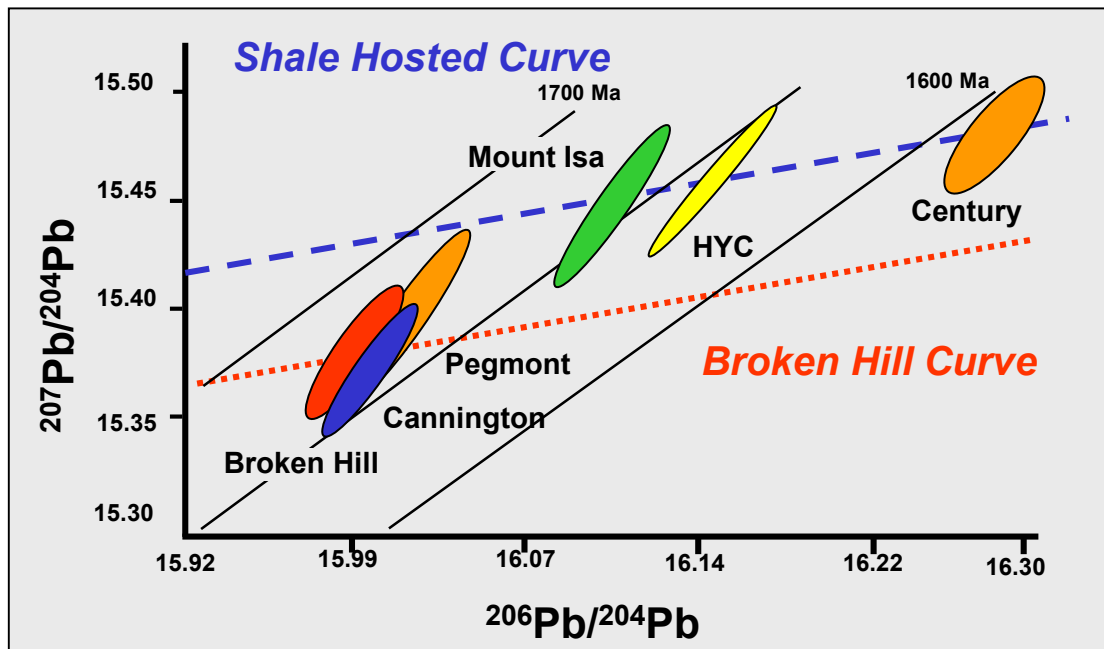
Generally not geophysically responsive and can be recessive

Not well documented - outcrops too small to show on regional maps

Once you detect and prioritize Lode Horizon it can define regionally prospective lithostratigraphic packages and point to 'hot spots'

**BHP developed suite of geochemical techniques to support this**



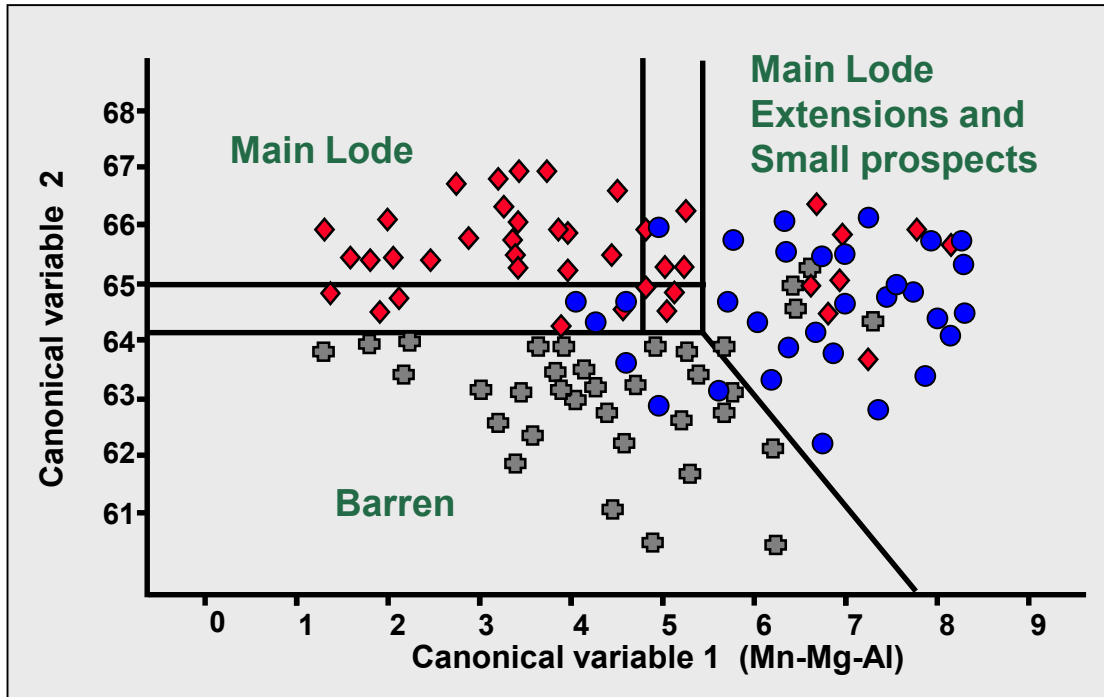


## FILTERING OCCURENCES USING Pb ISOTOPES

BHT deposits in Australia lie on distinctive Pb isotope curve

Can use this to filter the 'smoke' from poorly documented occurrences and showings

Most common (mis)-classification of these occurrences in metallogenic databases is as 'skarns'



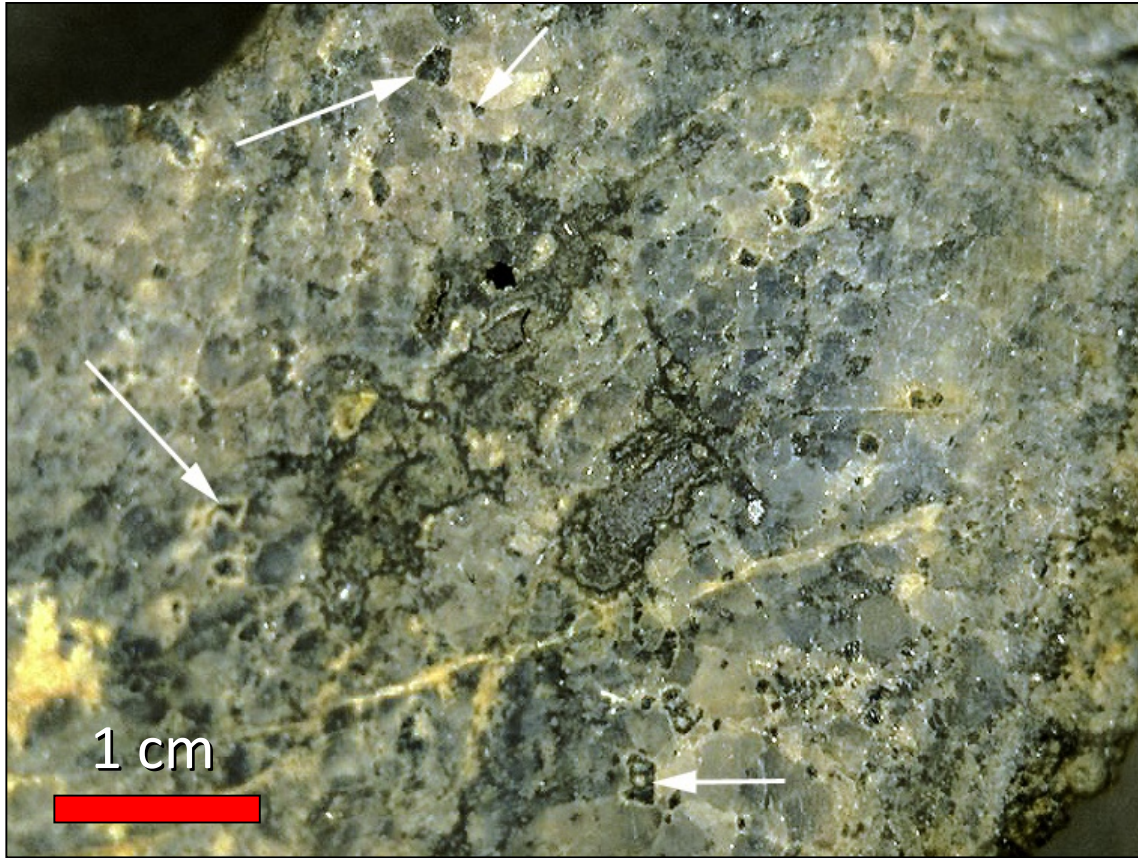
## DETECTION USING HEAVY MINERAL SAMPLING

Gahnite (Zn spinel) is an excellent resistate heavy mineral

Amenable to well-established sampling and processing methods used for diamond exploration indicator minerals

Following discovery of Argyle in 1979 had been a regional heavy mineral sampling 'rush' typically off-tenement

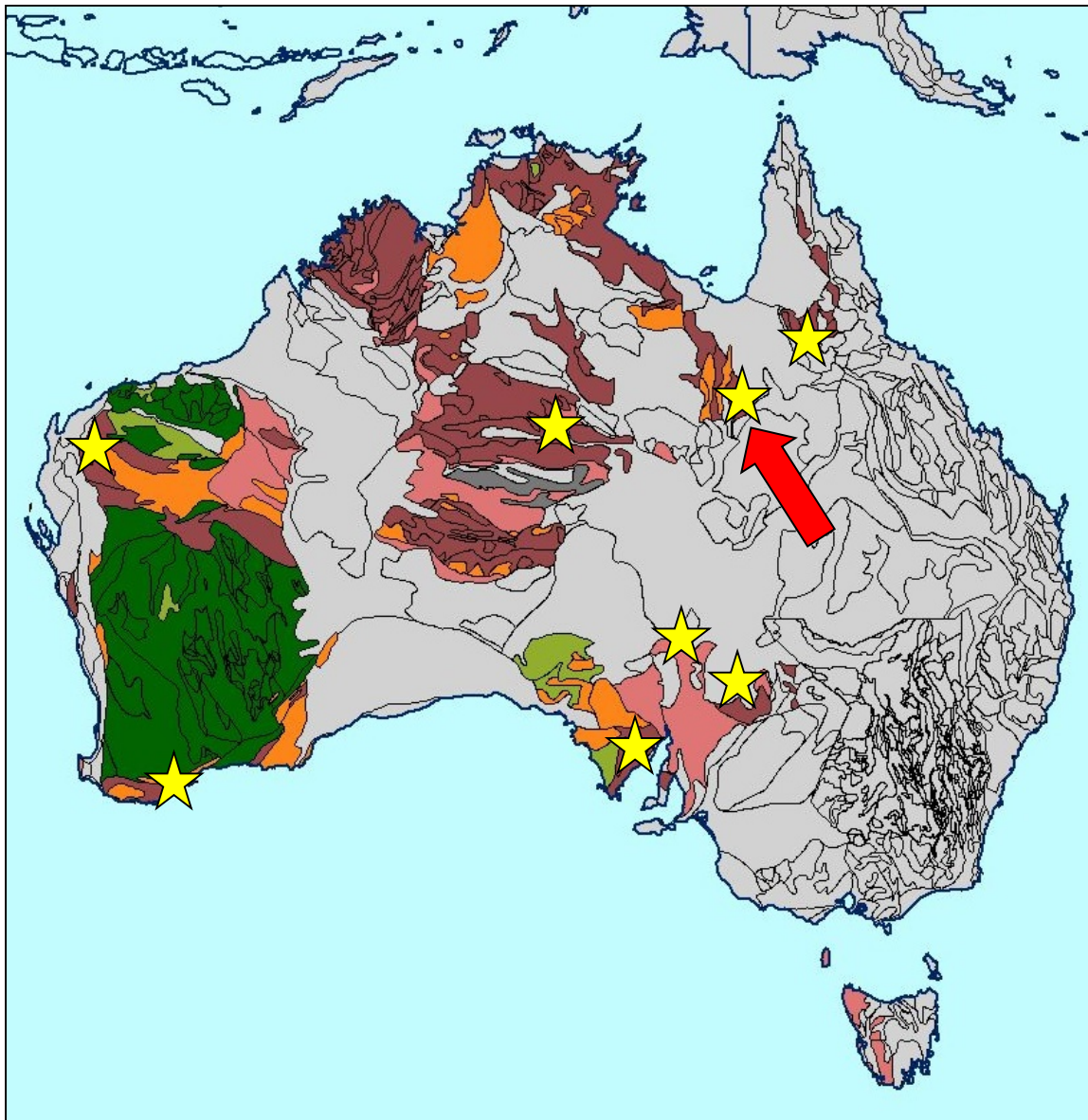
Able to re-use and extend extensive BHP sample archive and apply a proprietary assessment method



Gahnite in siliceous host rock – distinctive bottle green



Typical heavy mineral concentrate used for indicator picking



## SELECTION OF MOUNT ISA EASTERN SUCCESSION

Field inspection of mineral occurrences indicated BHT affinities and associations

Pb isotopes of occurrences gave BHT signatures

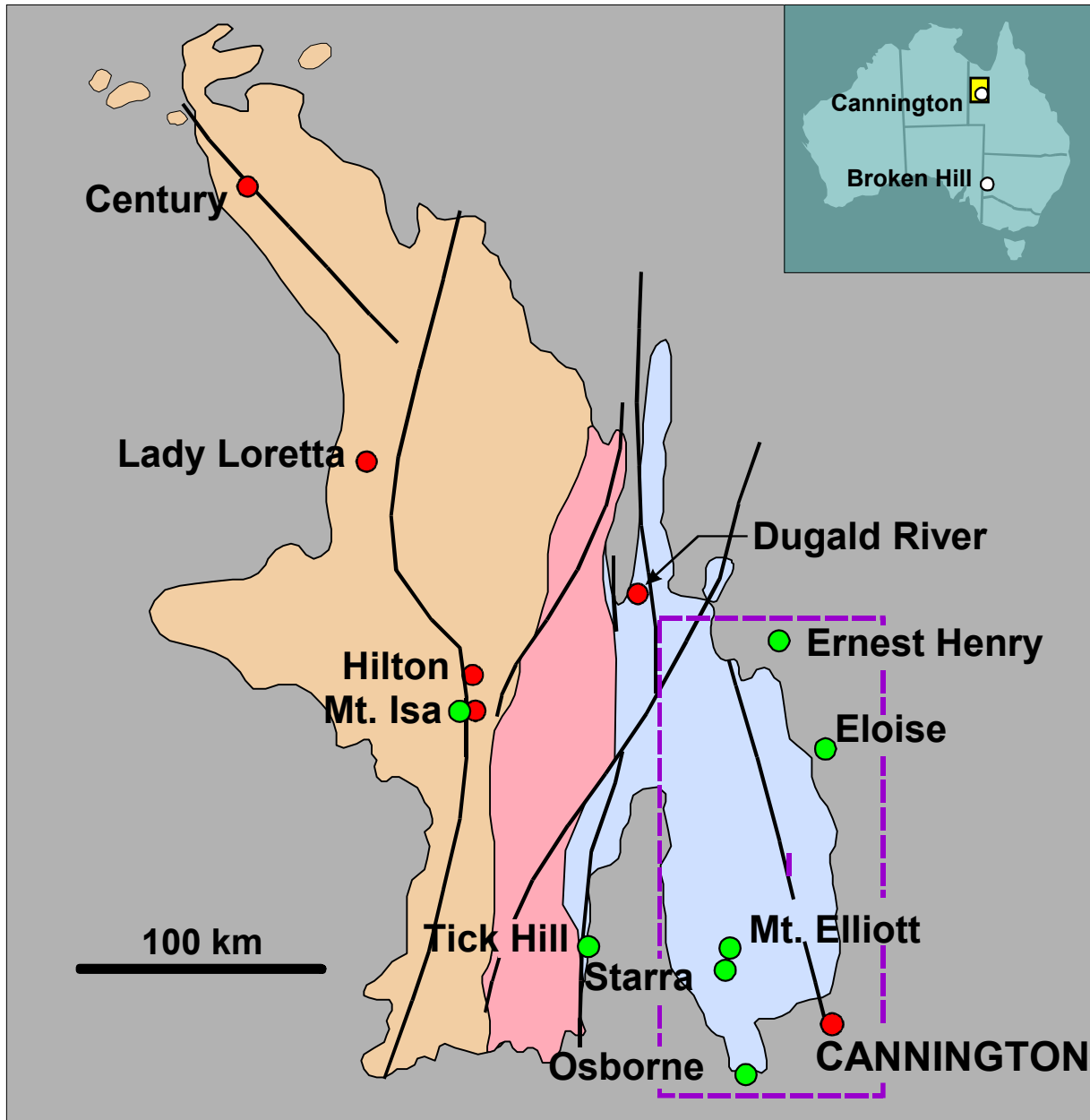
Application of regional HM discriminant highlighted prospective BHT gahnite populations

Lode Horizon defined regional lithostratigraphic packages

Regional geology poorly understood and under-explored

**Eastern Succession prioritised over other terranes**

Terranes assessed for BHT potential in early 1980's



Post-Proterozoic cover

Western Succession

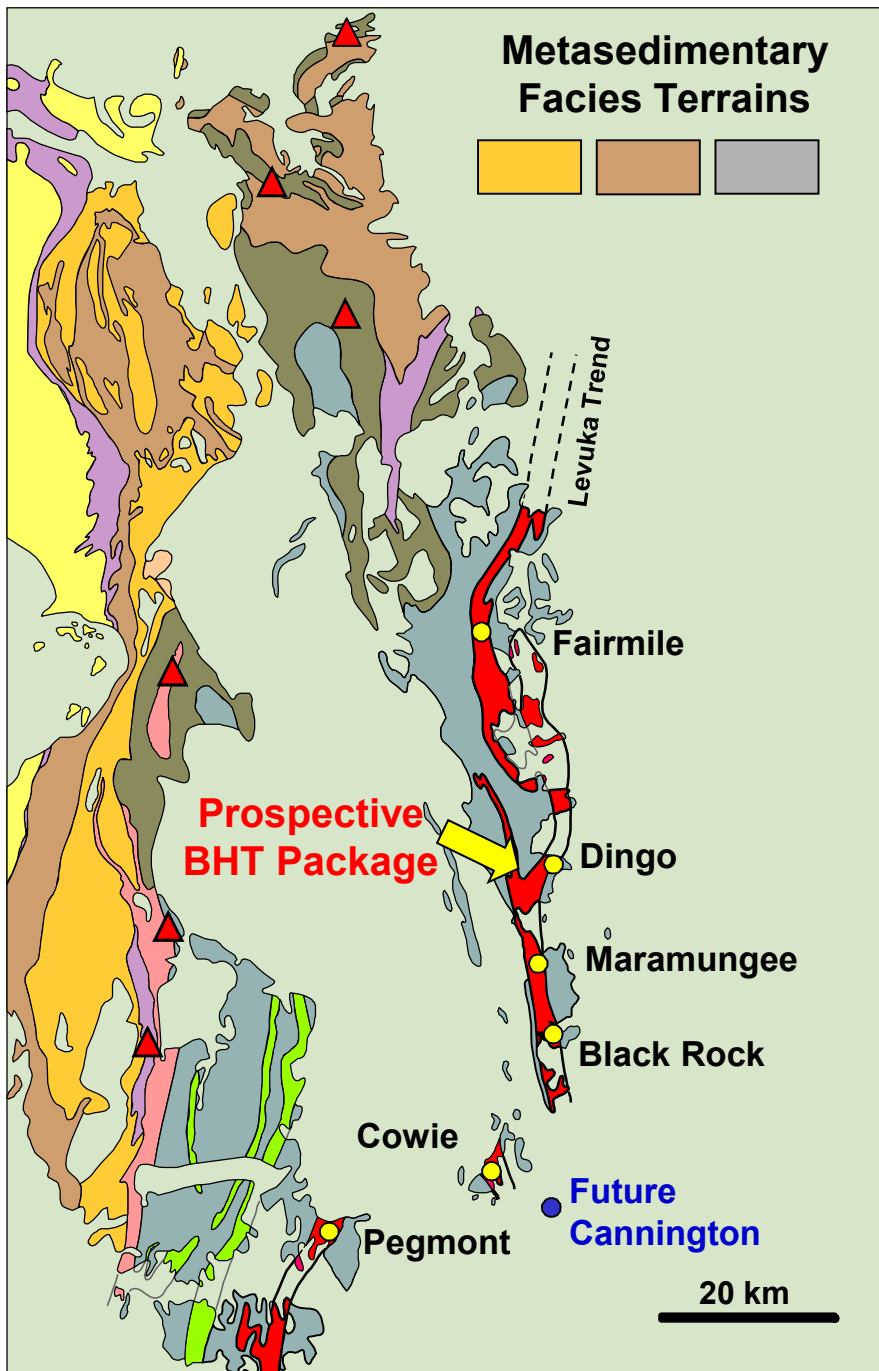
Central Belt

Eastern Succession

*Significant Deposits*

● Pb-Zn-Ag

● Cu, Cu-Au, Au



## IDENTIFICATION OF LODE HORIZON IN EASTERN SUCCESSION

Prior to BHP's involvement known endowment was only several small Pb-Zn-Ag prospects

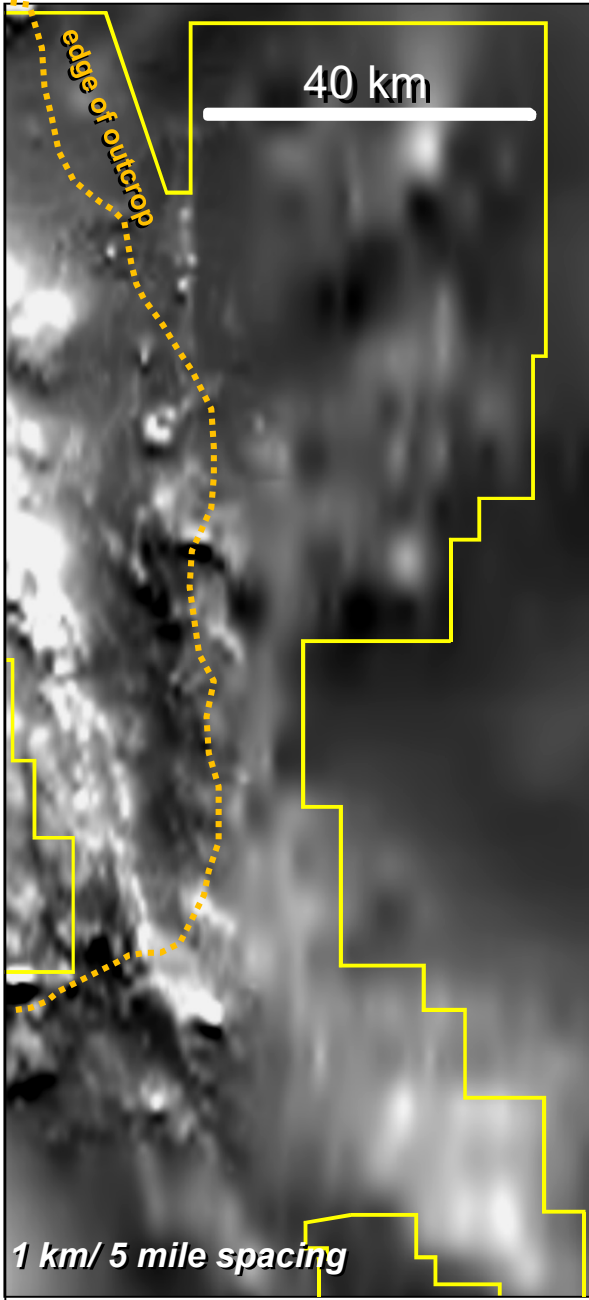
Regional sampling identified positive gahnite and Pb isotope signatures

Field mapping located typical regional Lode Horizon associations

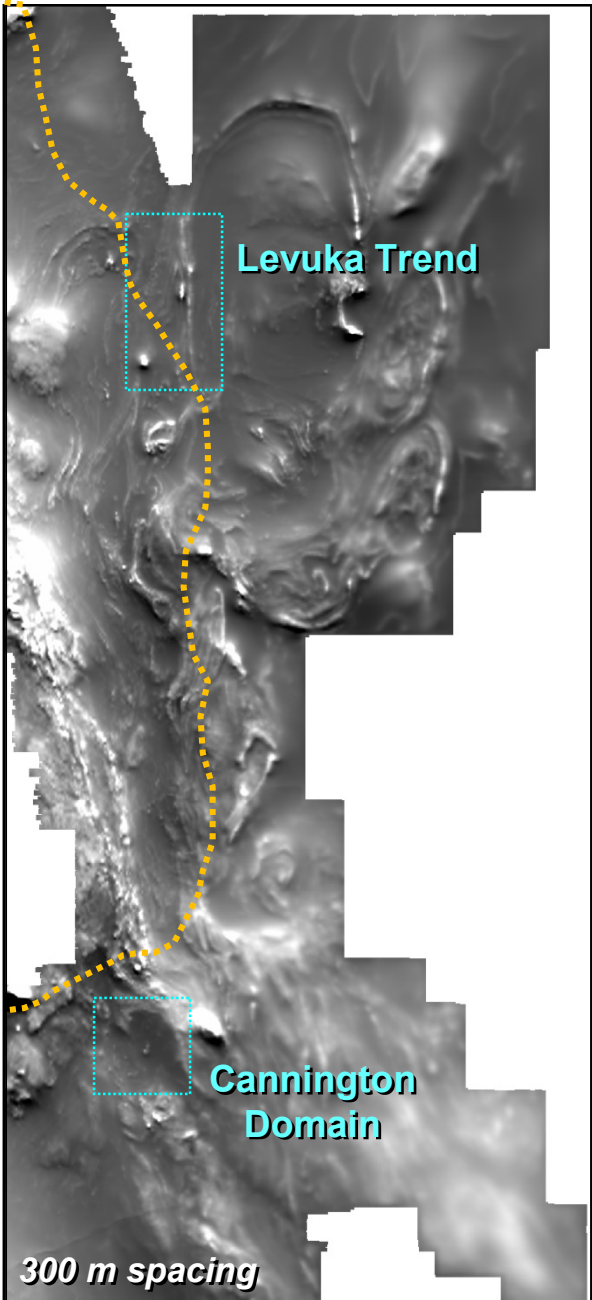
Crude lithostratigraphy was recognised with prospective packages identified in areas of outcrop

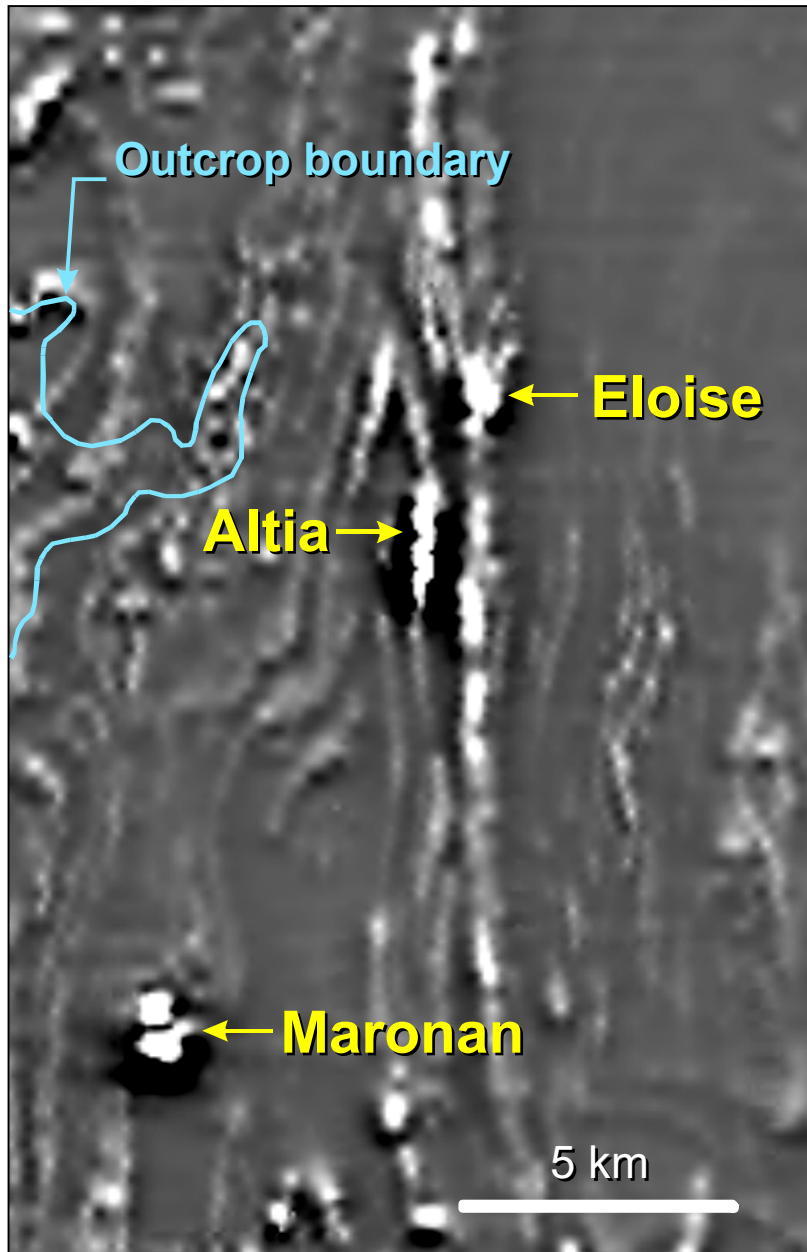
*Initial exploration coincided with use of digitally processed aeromagnetic surveys enabling a move under shallow cover*

Pre-1983  
government  
magnetics



1983-1990  
BHP surveys





## EARLY SUCCESS ALONG UNDERCOVER LEVUKA TREND

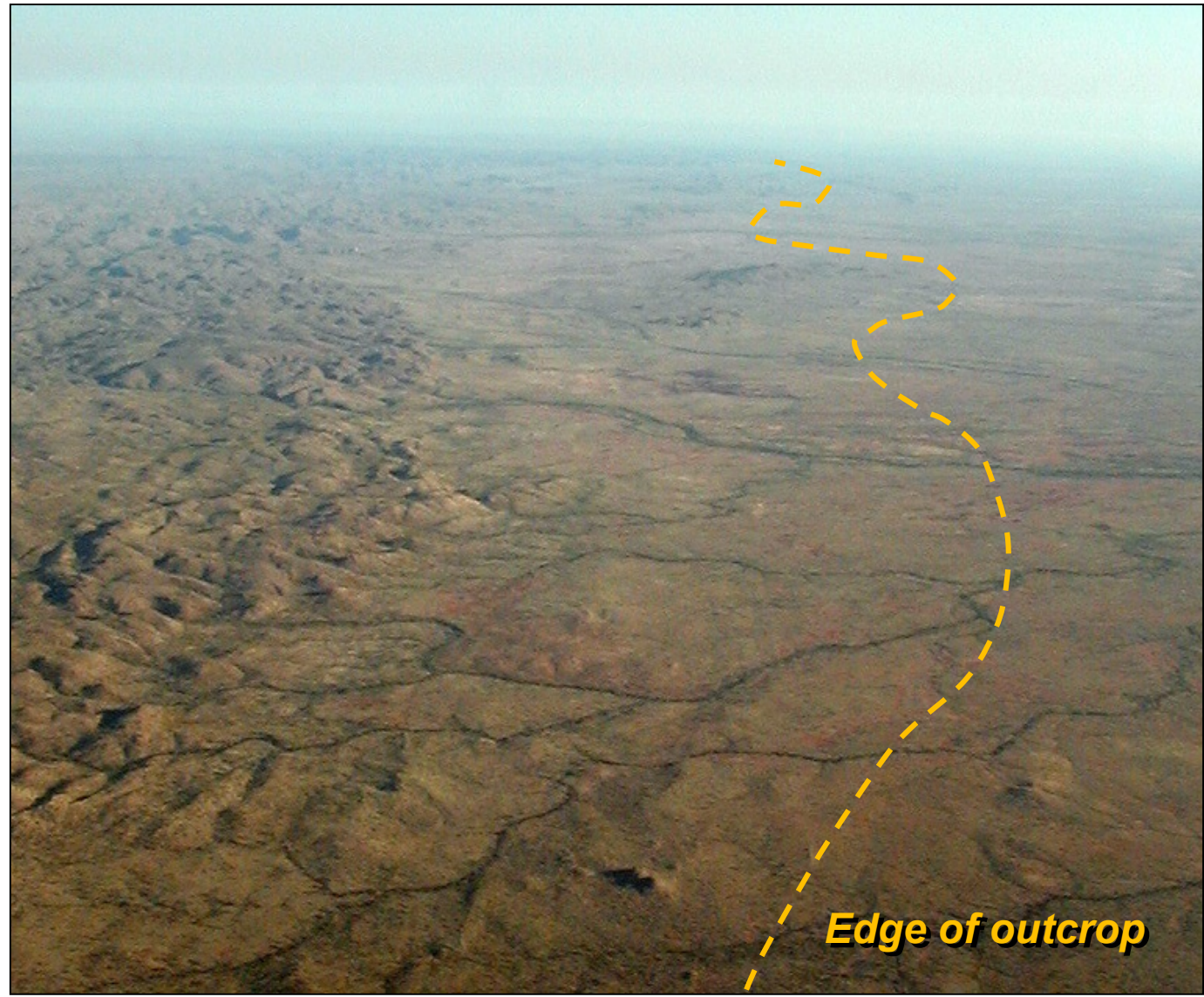
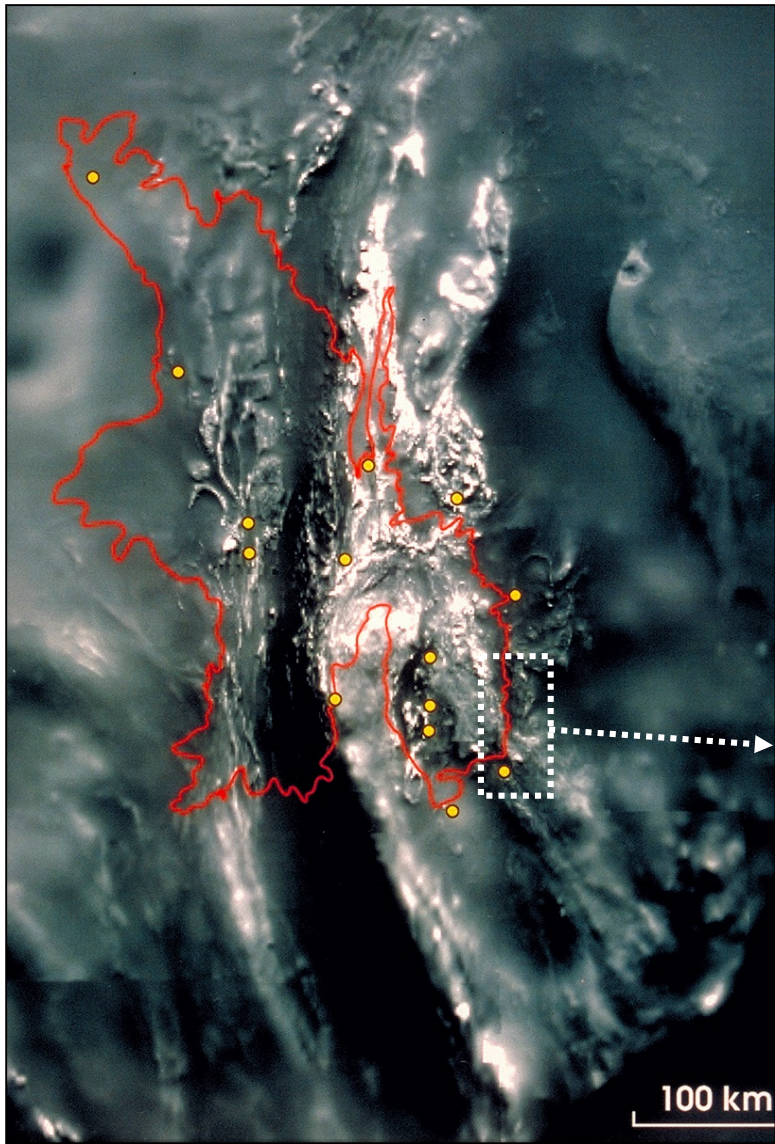
Levuka Trend continuation of prospective BHT package under cover

Included some distinctive, high-amplitude magnetic features that represented direct drill targets

Initial exploration by BHP in mid-1980's intersected large but sub-economic Broken Hill-type Pb-Zn-Ag system at Altia

Also discovered small high-grade Cu-Au deposit at Eloise

*Provided early encouragement and opportunity to refine exploration techniques under cover*



Eloise discovery provided confidence - magnetics provided the key undercover technique



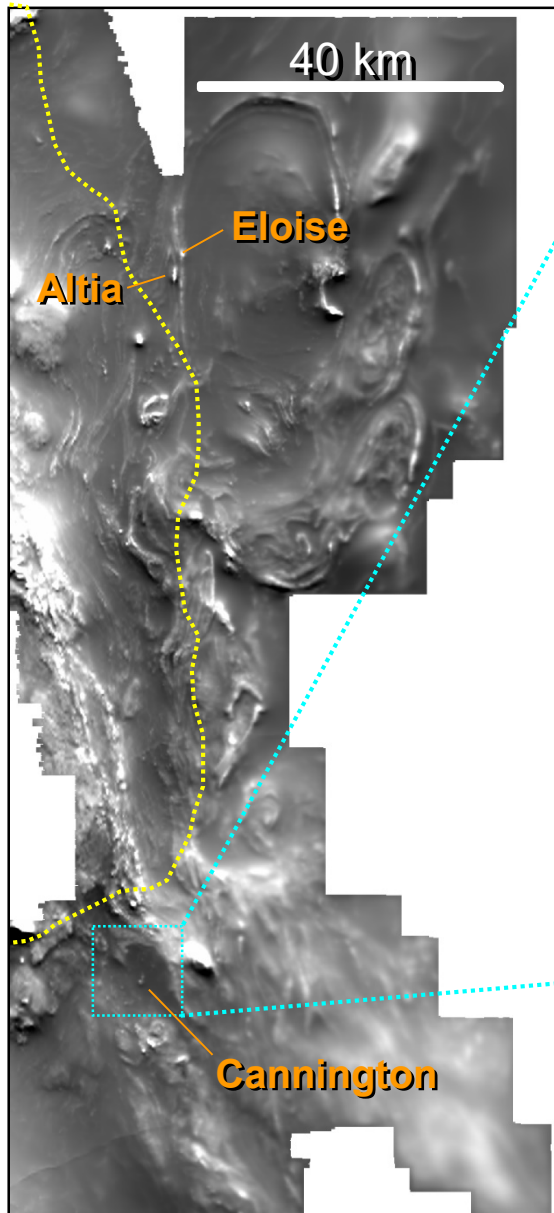
## CHALLENGES OF UNDERCOVER EXPLORATION



Cover sequences are Cretaceous black mudstones and oil-shales

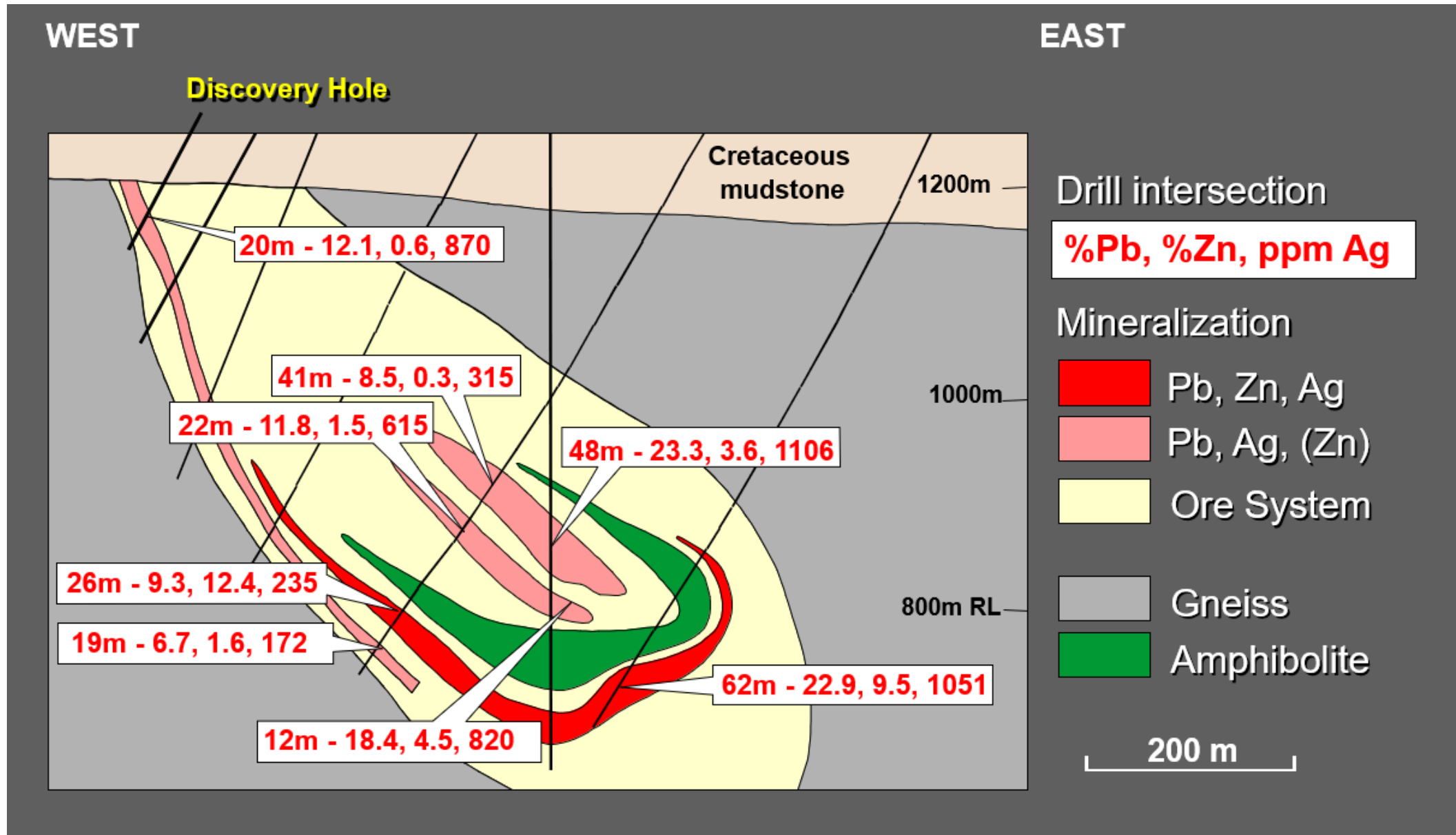
Mudstones are conductive and act as a geochemical 'wet blanket'

Magnetics is effective but hard to integrate with other techniques



First hole intersected 20 m at 870 g/t Ag, 12.1% Pb and 0.6% Zn  
Fresh sulphides at the Cretaceous unconformity – no gossan!

# ECONOMIC CREDENTIALS BECAME OBVIOUS VERY EARLY IN THE DRILL OUT





## MEMBER OF ENIGMATIC BROKEN HILL TYPE FAMILY

Typical complex and variable 'skarn-like' Broken Hill-type mineralogical assemblages

Hedenbergite, pyroxmangite, magnetite, Fe-Mn garnet, fluorite, grunerite, fayalite... Ca-Fe-F-Mn-P signatures

Dramatic Ag-Pb/Zn zonation, high levels of As, Sb, Cu

Striking contrast between galena-sphalerite dominant siliceous ore types and Fe-Mn-Ca 'mafic' ore types

Crudely stratabound ore lenses with extensive brittle-ductile overprints and extended paragenesis

*Many genetic theories and the usual controversies!*



## SOME DISCOVERY OBSERVATIONS AND LEARNINGS

1. BHT exploration model was based on integration of new data from government-funded initiatives at Broken Hill
2. Included some proprietary techniques and concepts that allowed a rapid terrain assessment strategy to be used (e.g. RIMs)
3. Comparative assessment and ranking generated management confidence
4. Initial exploration in Eastern Succession was highly integrated
5. Early success at Altia and Eloise generated sustained management buy-in
6. 'Step out' phase leading to discovery involved a dominance of magnetics as a single technique in first-pass exploration under technically challenging cover
7. Process took six years of sustained team-based effort to point of discovery

## SOME DISCOVERY FACTS AND FIGURES

(1983: BHP acquires Utah International Mining from General Electric)

1984: First high-resolution BHP aeromagnetic survey in Eastern Succession

1985: Start of drilling along Levuka Trend (discovery of Altia Pb-Zn-Ag prospect)

1988: First economic Cu-Au intersection at Eloise (EM targeting)

1988: Extension of aeromagnetic survey over covered areas to south

1990: Cannington discovery hole as a follow-up of survey

1993-1995: Completion of feasibility study

*280 surface core, 330 surface percussion, 73 underground core holes for a combined total of 107,000 m; exploration decline*

*Defined 43.8 Mt at 11.6 percent Pb, 4.4 percent Zn and 538 ppm Ag*

1996: Decision to proceed with development

1997: First shipment of concentrates



Bob Skrzeczynski

## FULL PAPER ON CANNINGTON DISCOVERY HISTORY

Walters, S., Skrzeczynski, B., Whiting, T., Bunting, F. and Arnold, G., 2002.

Discovery and geology of the Cannington Ag-Pb-Zn deposit, Mount Isa Eastern Succession, Australia: Development and application of an exploration model for Broken Hill-type deposits. Economic Geology Special Publication 9.

## CANNINGTON DISCOVERY AND DEVELOPMENT TEAM

See Acknowledgment section in paper for a full listing

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