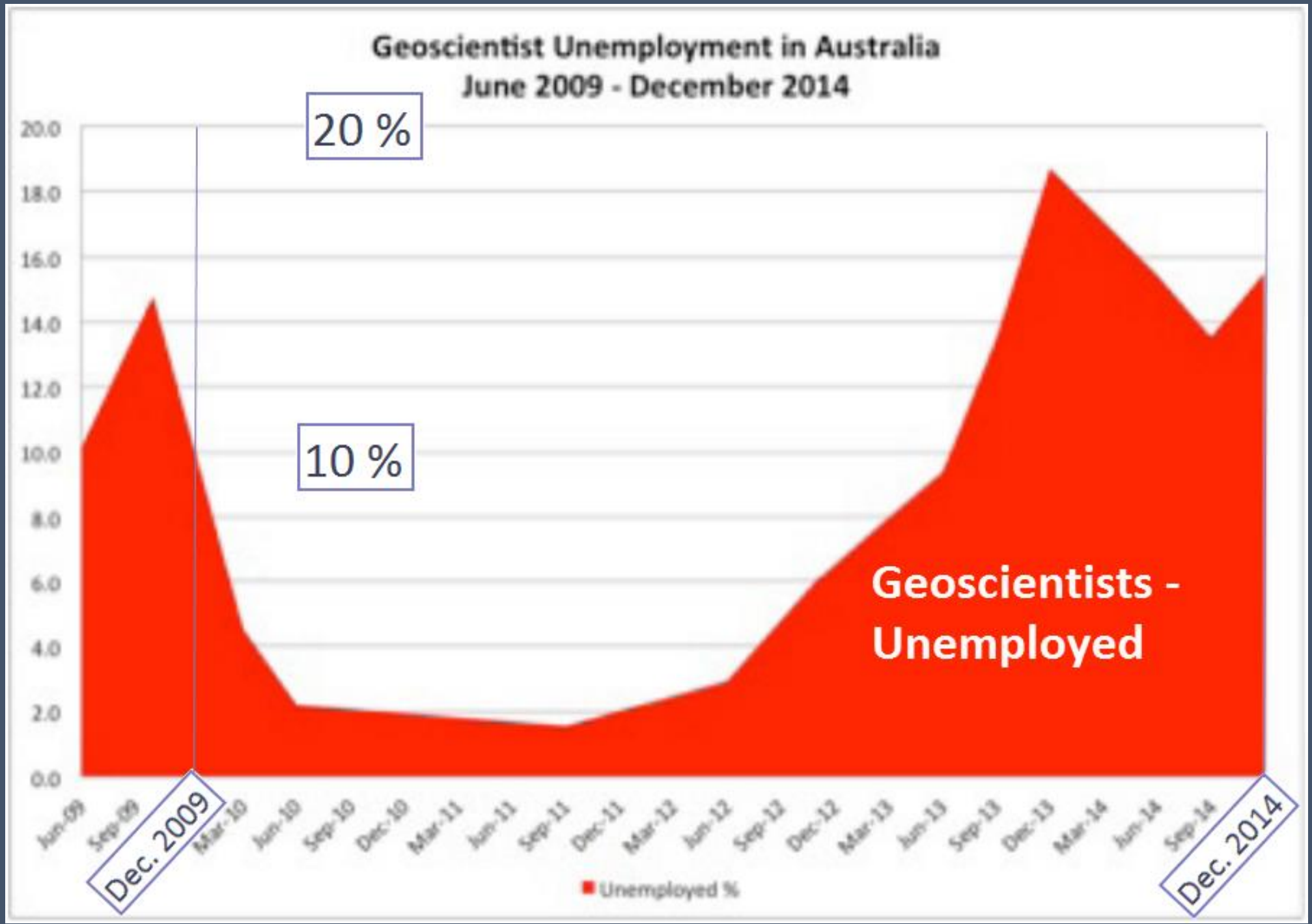
Employment in Mineral Exploration

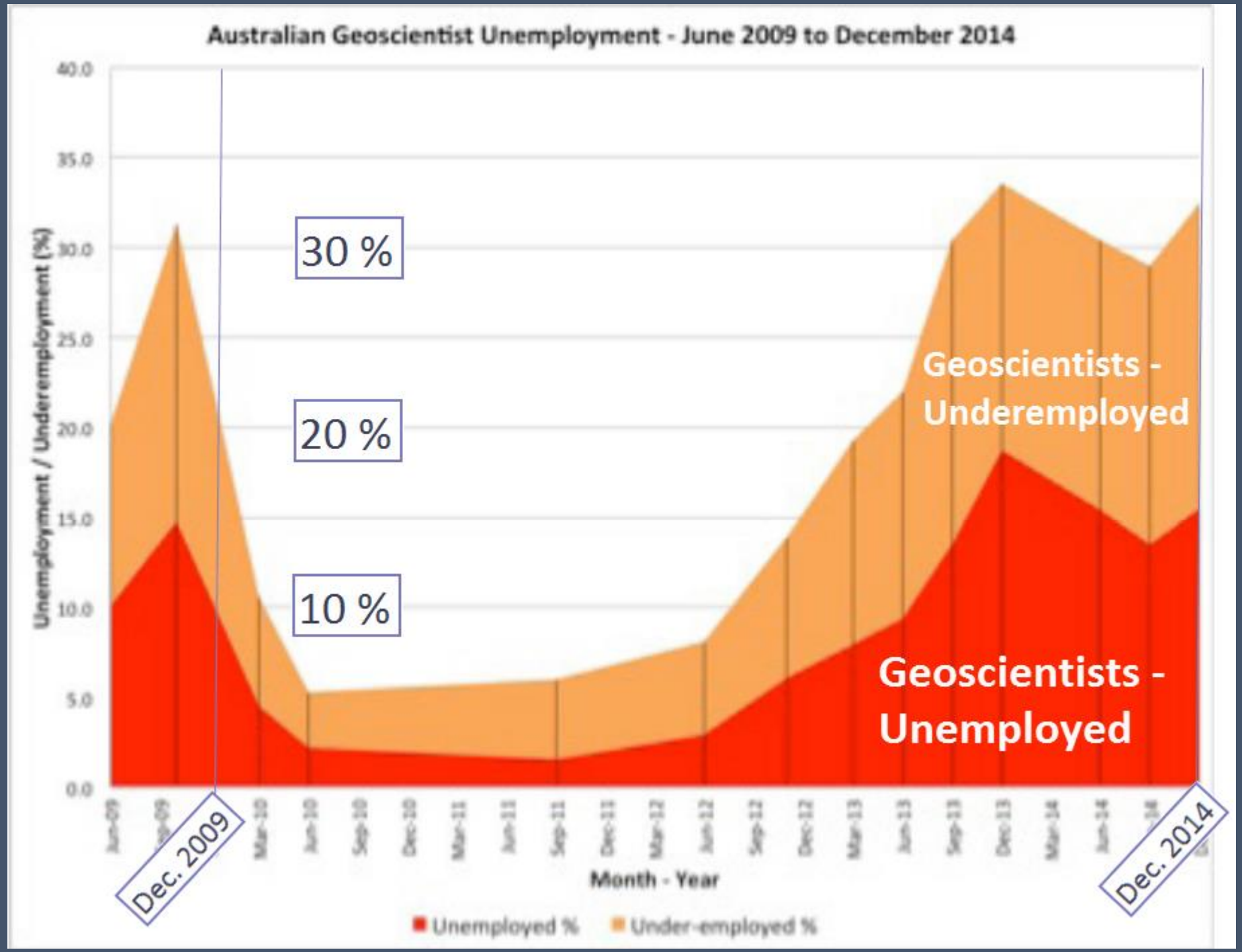
History, Present and Future Prospects

Rado Jacob Rebek - 2015



AIG Geoscientist Employment Survey (Dec. 2014)

Among geologists working in mineral exploration, unemployment is much higher than 15%



AIG Geoscientist Employment Survey (Dec. 2014)

Among geologists working in mineral exploration, unemployment + underemployment is much higher than 33%

AIG Geoscientist Employment Survey (Dec. 2014)

Only one half of geologists working in mineral exploration is still fully employed …but:

- Short of funds for drilling (drilling contractors going broke)
- Not commissioning new geophysical surveys (geophysical contractors going broke)
- Not starting any new projects

"New" ideas are needed to create new jobs in exploration
…but nothing is "new" except what was forgotten…

Where have companies committed to exploration gone?

Focus on NSW

Where are now the companies that have explored persistently in NSW **since 1960's**:

i. **BHP**
ii. **CRA** (Australian part of what after merger became **Rio Tinto**)
iii. **Broken Hill South Ltd.**
iv. **Electrolytic Zinc Ltd.**
v. **Geopeko**
vi. **North Broken Hill Ltd.**

These companies provided long term career employment and on-the-job training for mineral exploration geologists

(including overseas trips to see world class mines)

History of BHP Mineral Exploration

- **BHP** started at Broken Hill in 1885
- **BHP** used profits from Broken Hill to start iron ore & coal mining and smelting at Newcastle, Port Kembla and Whyalla
- From coal mining **BHP** expanded into oil & gas in Bass Strait
- In 1970's, **BHP** expanded into copper with the bid for Ok Tedi
- In 1980's, **BHP** explored for gold in NSW but concluded that projects are 'too small' for **BHP**
- In 1980's, **BHP** has undertaken expansion into many countries overseas from new San Francisco HQ for exploration
- In 1990's, **BHP** relied heavily on airborne geophysics and flew an airborne gravity survey in Broken Hill area, but did not follow up results
- In 2013 **BHP** declared that (except for 'near-mine' exploration on iron ore mines) – no further exploration will be done in Australia
- A large diversified company gave up on mineral exploration

History of CRA & Rio Tinto Mineral Exploration in NSW

- **Zinc Corp** started at Broken Hill in 1905, merged with neighbouring **NBHC** to form **Consolidated Zinc** and continued after merger with original Rio Tinto in 1963 under the name of Conzinc Riotinto Australia (= **CRA**)
- In period 1960 – 1995, CRA Exploration had exploration offices / bases with 2-6 geologists in:
  i. Broken Hill
  ii. Cobar
  iii. Orange
  iv. Armidale
  v. Sydney
- In 1996, **CRA** merged with **RTZ** to form new Rio Tinto
- Exploration expanded into South America, Africa and Asia so that NSW offices were closed
- Diamond exploration in Zimbabwe, Guinea, Canada, Brazil and India spent 40% of overall exploration budget in 1990's
- Iron ore in Guinea, copper in Peru and Mongolia, coal in Mozambique replaced diamonds as big spenders - $US 4 billion wasted on acquisition of a metallurgical coal deposit Mozambique…
- A large company with commitment to exploration has gone overseas

History of Broken Hill South Ltd. Exploration in NSW

- **Broken Hill South Ltd.** started at Broken Hill in 1880's
- In period 1960 – 1980, **Broken Hill South Ltd.** had exploration offices / bases with 3-6 geologists in:
  i. Broken Hill
  ii. Cobar (Cobar Mines Pty. Ltd. were owned by a JV with **Broken Hill South Ltd.** as the Manager - including exploration on the mining leases)
- In 1981, Peak gold discovery was made in southern extremity of mining leases
- By that time, **CRA** has become majority owner because **Broken Hill South Ltd.** has been taken over by **WMC** and **CRA**
- **Broken Hill South Ltd.** had undertaken successful exploration (Peak, Phosphate in Qld, Kanmantoo, etc.) by a very capable exploration department but after the takeover this exploration department has been closed down
- A middle-sized company with strong commitment to exploration in NSW and other parts of East Australia has disappeared due to take-over

History of Electrolytic Zinc Ltd. Exploration in NSW

- **Electrolytic Zinc Ltd.** made **Elura zinc** discovery in early 1970's (now called **Endeavour**)
- This discovery has major impact on exploration in Cobar District
- Many companies started flying magnetic surveys and drilling 'bull's eye' magnetic anomalies
- Recent examples are **Hera**, **Nymagee** and **Mallee Bull** discoveries
- **Electrolytic Zinc Ltd.** has been taken over by **North Broken Hill Ltd.**
- **Electrolytic Zinc Ltd.** had undertaken successful exploration (Elura, Ranger Uranium in JV with Geopeko, etc.) by a very capable exploration department but after the takeover this exploration department has been closed down
- A middle-sized company with strong commitment to exploration in NSW and other parts of East Australia has disappeared due to take-over

History of Geopeko (with a note on Northparkes)

- **Geopeko** made Northparkes copper-gold discovery in early 1980's
- Soon after that **Geopeko** also made Lake Cowal gold discovery
- These discoveries have provided major boost to exploration in NSW
- **Geopeko** also made Juno, Gecko and other discoveries in Tennant Creek District and Ranger Uranium in JV with EZ
- A series of discoveries means that **Geopeko** was a highly capable exploration group
- **Geopeko** was the exploration division of **Peko Wallsend Ltd.**
- **Peko Wallsend Ltd.** has been taken over by **North Broken Hill Ltd.**
- **North Broken Hill Ltd.** has subsequently been taken over by **Rio Tinto**
- A middle-sized company with strong commitment to exploration for new discoveries to start new mines has **disappeared due to take-over**
- **Rio Tinto** sold Northparkes copper-gold mine to **China Moly**
- **Northparkes team** continues with **successful 'near mine' exploration** in Northparkes area, but does not seem to be expanding into other parts of NSW

Commitment to Grass-root Exploration in new areas

Why have the companies listed below undertaken grass-root exploration in new areas, new regions, for a range of commodities:

i. **BHP**
ii. **CRA**
iii. **Broken Hill South Ltd.**
iv. **North Broken Hill Ltd.**
v. **Electrolytic Zinc Ltd.**

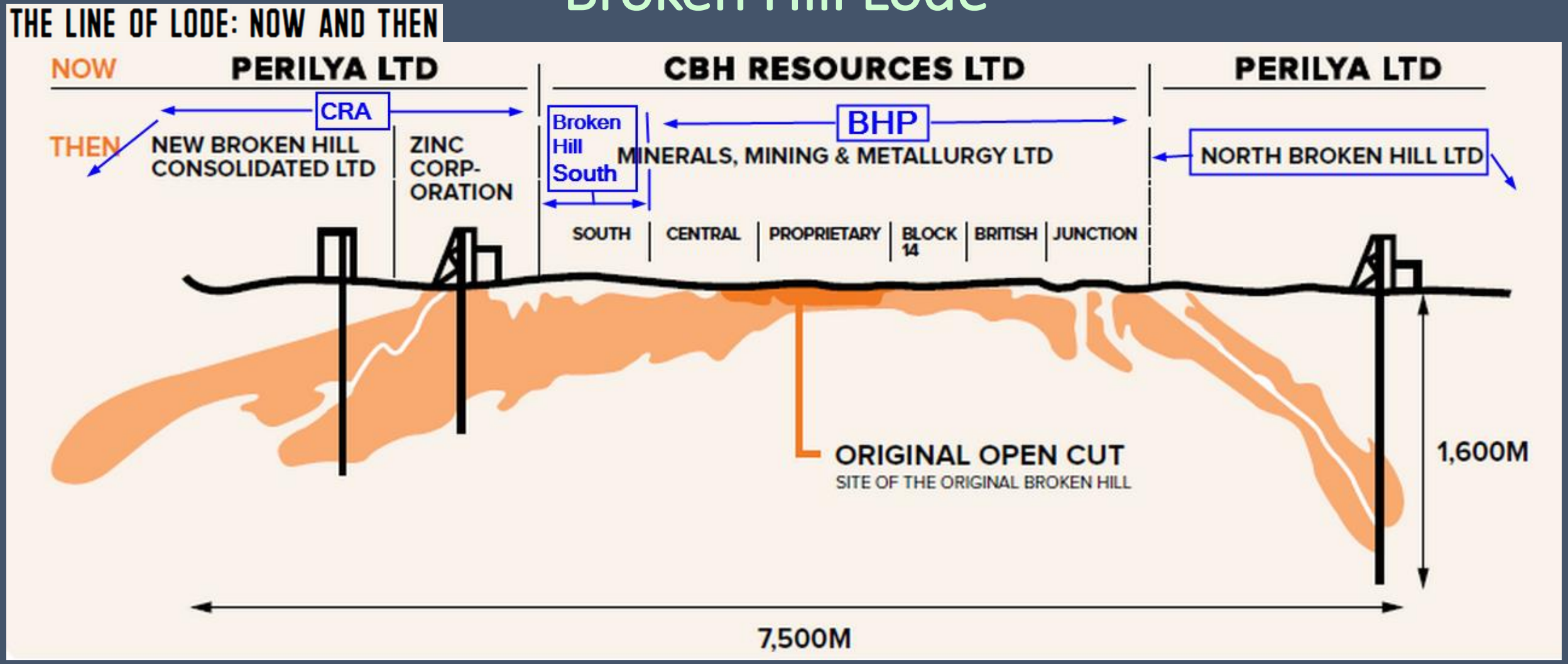
Answer:

- **In case of 'lode' mines like Broken Hill and Roseberry with long strike extent, there is limited scope for new 'near-mine' discoveries**

Additional examples of major companies that owned highly profitable underground 'lode' mines and were committed to grass root exploration in new areas:

Mt. Isa Mines, Cominco, Noranda, Inco, Falconbridge

Broken Hill Lode



Broken Hill South Ltd. was the most aggressive grass root explorer … because the ore reserves were rapidly running out…

Persistence with Exploration

History:

CRA

Broken Hill South Ltd.

North Broken Hill Ltd.

Electrolytic Zinc Ltd.

… persisted with **Grass-root exploration** and provided long term career employment for mineral exploration geologists because…

…cash flow from major ‘lode’ mines (Broken Hill and Roseberry) was available for persistent grass root exploration for decades…

NSW government imposed a special royalty on profit from Broken Hill mines, providing incentive to reduce the profit by spending more on exploration

A company with good cash flow and limited ore reserves is committed to exploration

1. Companies with cash flow that are depleting ore reserves are committed to exploration
2. A company that is facing **depletion of ore reserves in 1-2 years** can only save itself by making an **acquisition**
3. To make a discovery one has to undertake exploration for at least 4 years
4. To ensure the **exploration budget for 4 years**, the company providing the funds must have **a mine plan** that will be providing a **cash flow for at least 4 years**

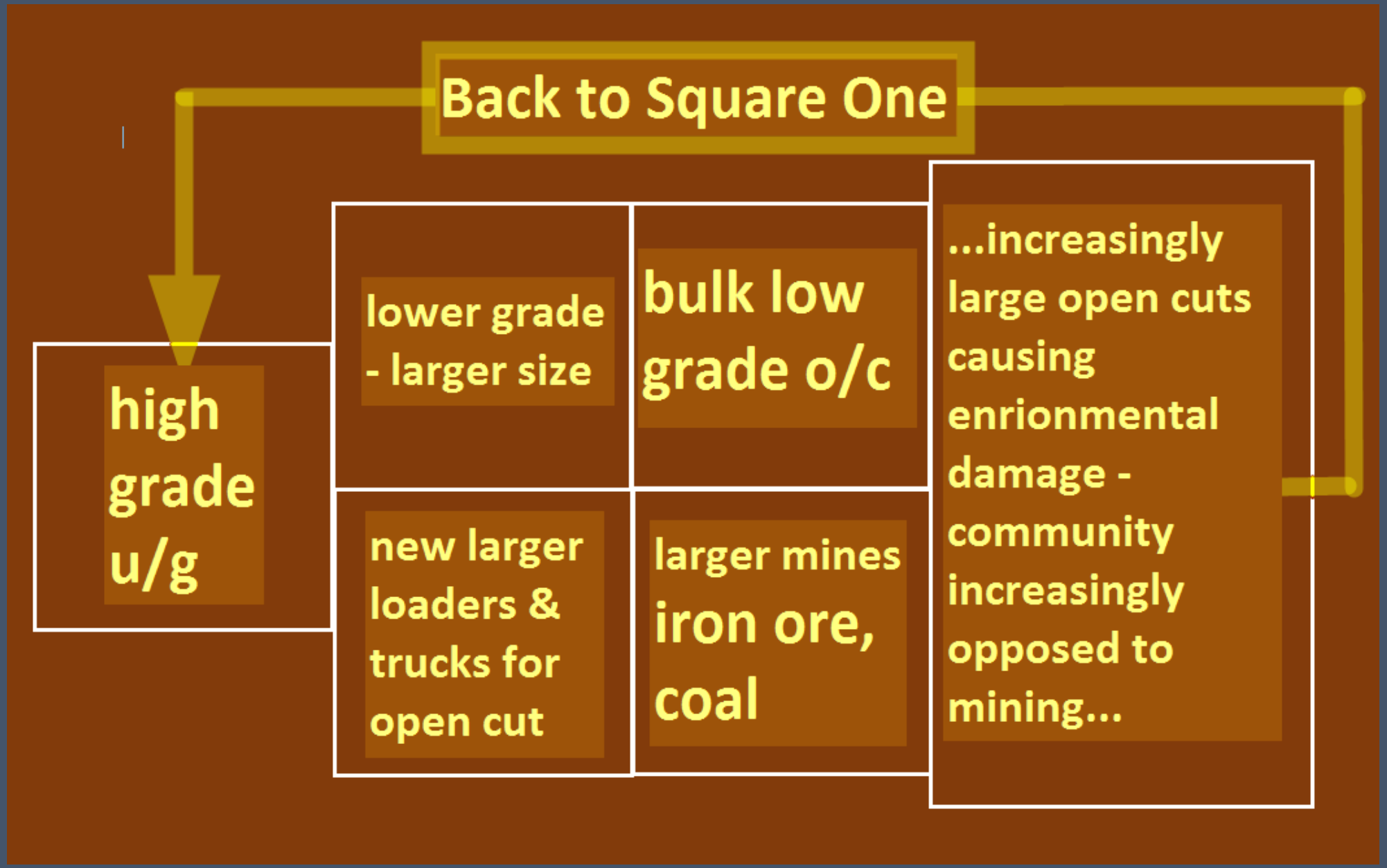
In-mine & Near-mine Exploration vs. Grass-root Exploration

“New” (= old, but partly forgotten) idea:

In-mine & near-mine exploration:

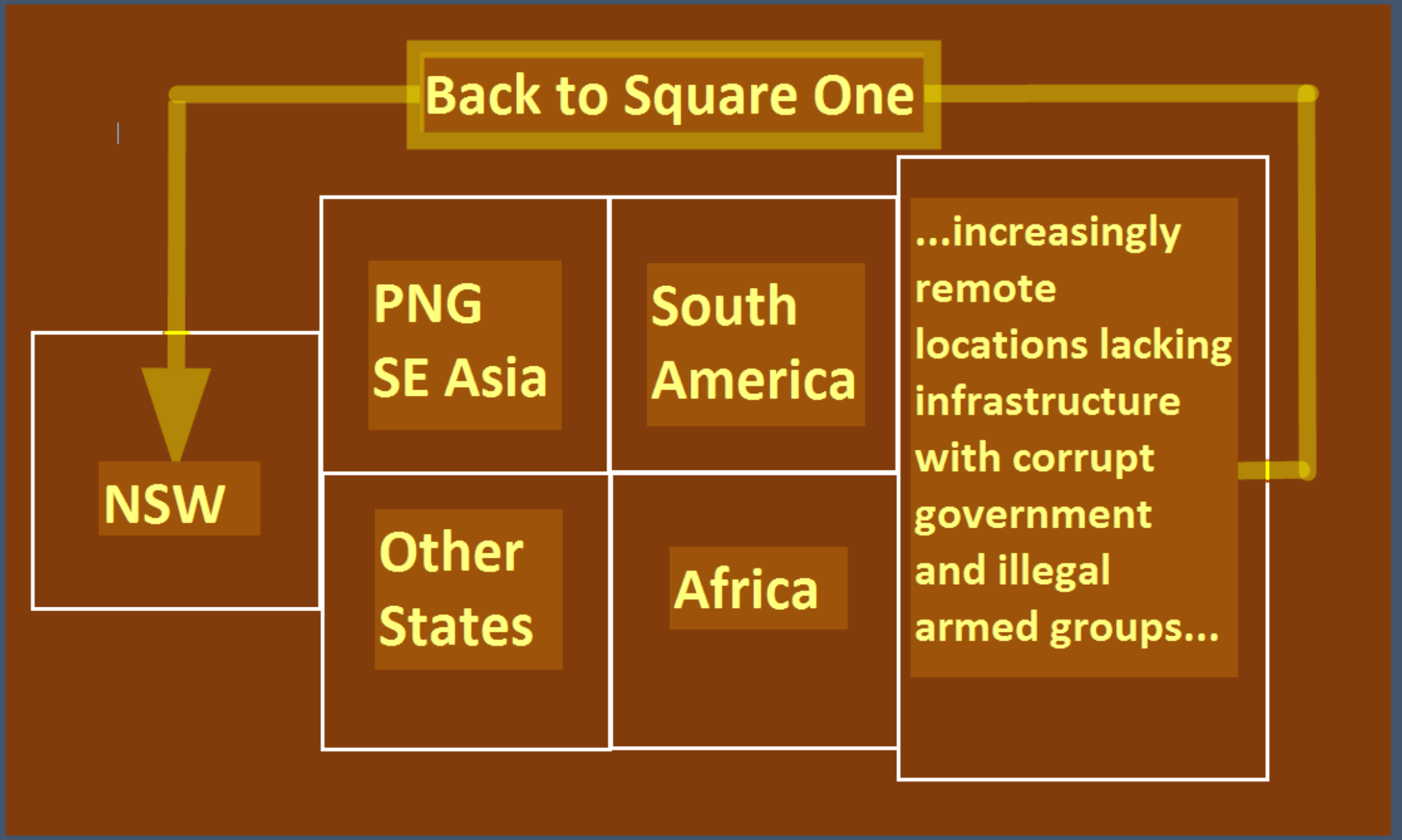
- Makes good returns on funds invested
- Provides employment for geologists and drillers living in nearby town
- Restores good relations between mining industry and communities
- Makes incremental additions to production so that supply does not end up larger that demand

In-Mine & Near Mine Exploration vs. Grass-root Exploration - 2



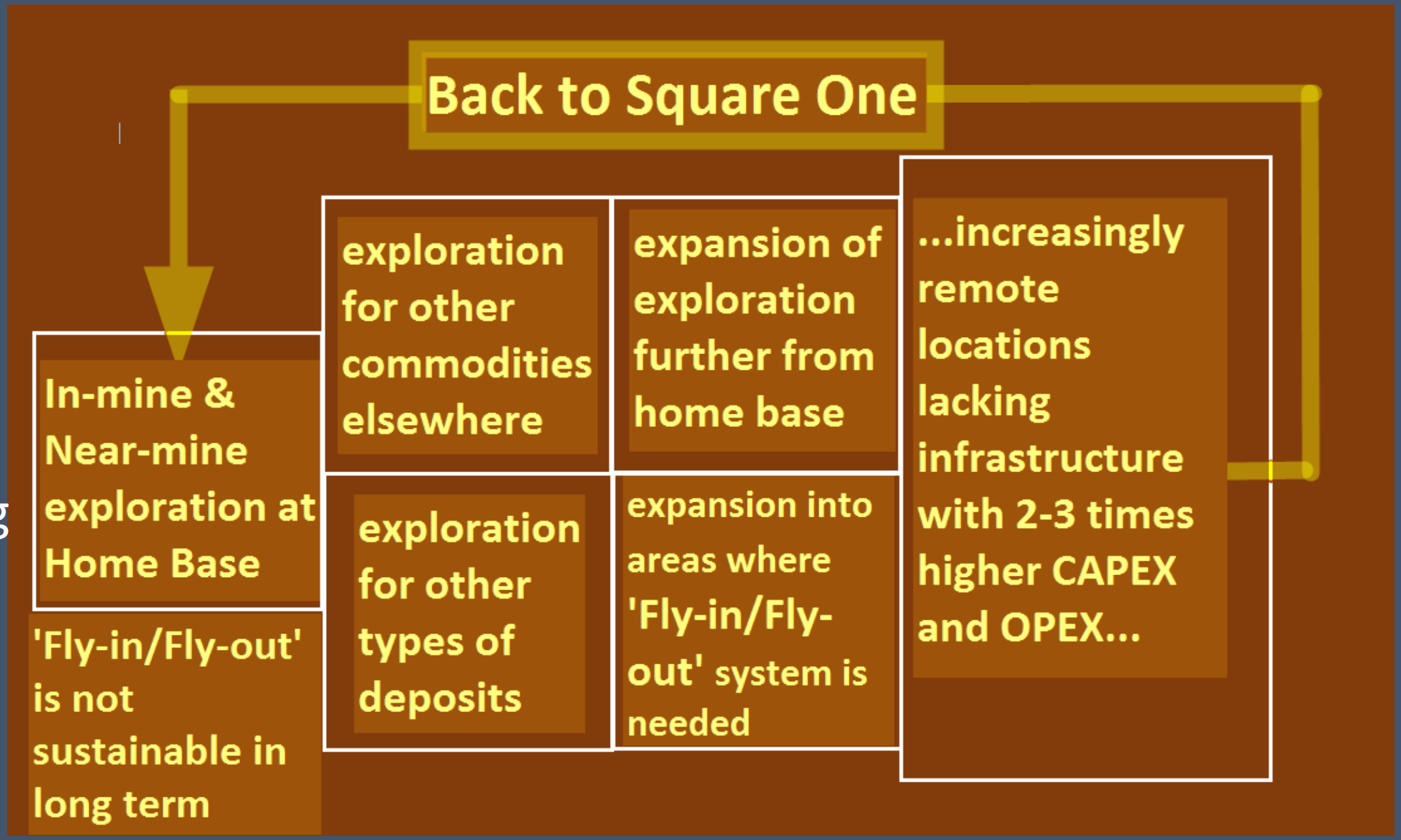
High grade mines progressing downward provide jobs, cause minimal damage to environment and are supported by local community

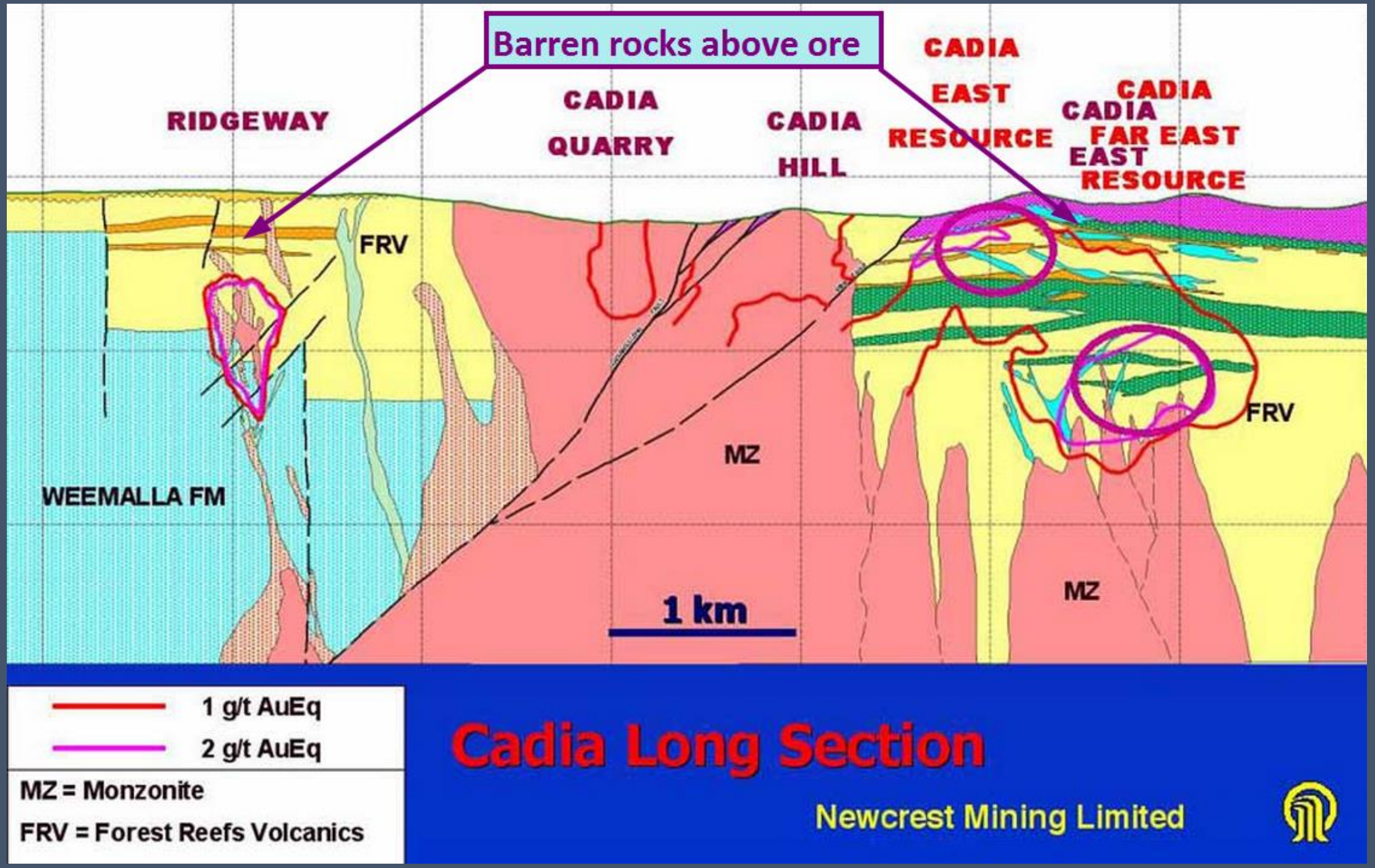
In-Mine & Near Mine Exploration vs. Grass-root Exploration - 3



In-mine & Near-mine Exploration vs. Grass-root Exploration - 4

Orange
Parkes
W.Wyalong
Cobar
Broken Hill





In-Mine & Near Mine Exploration continues at

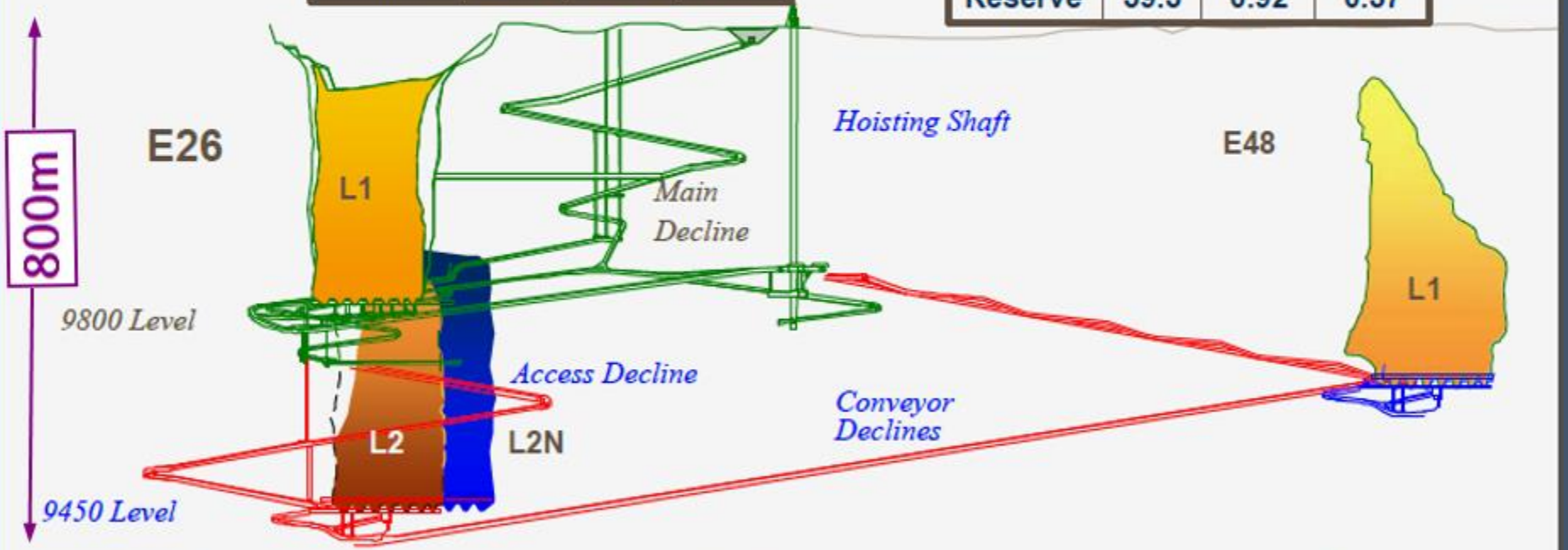
Cadia

RioTinto

Underground operations with 14+ year minelife ...

E26 L1	Mt	Cu %	Au g/t
Actual	25.5	1.40	0.43

E48 L1	Mt	Cu %	Au g/t
Actual	1.3	0.62	0.30
Reserve	**59.3**	**0.92**	**0.37**



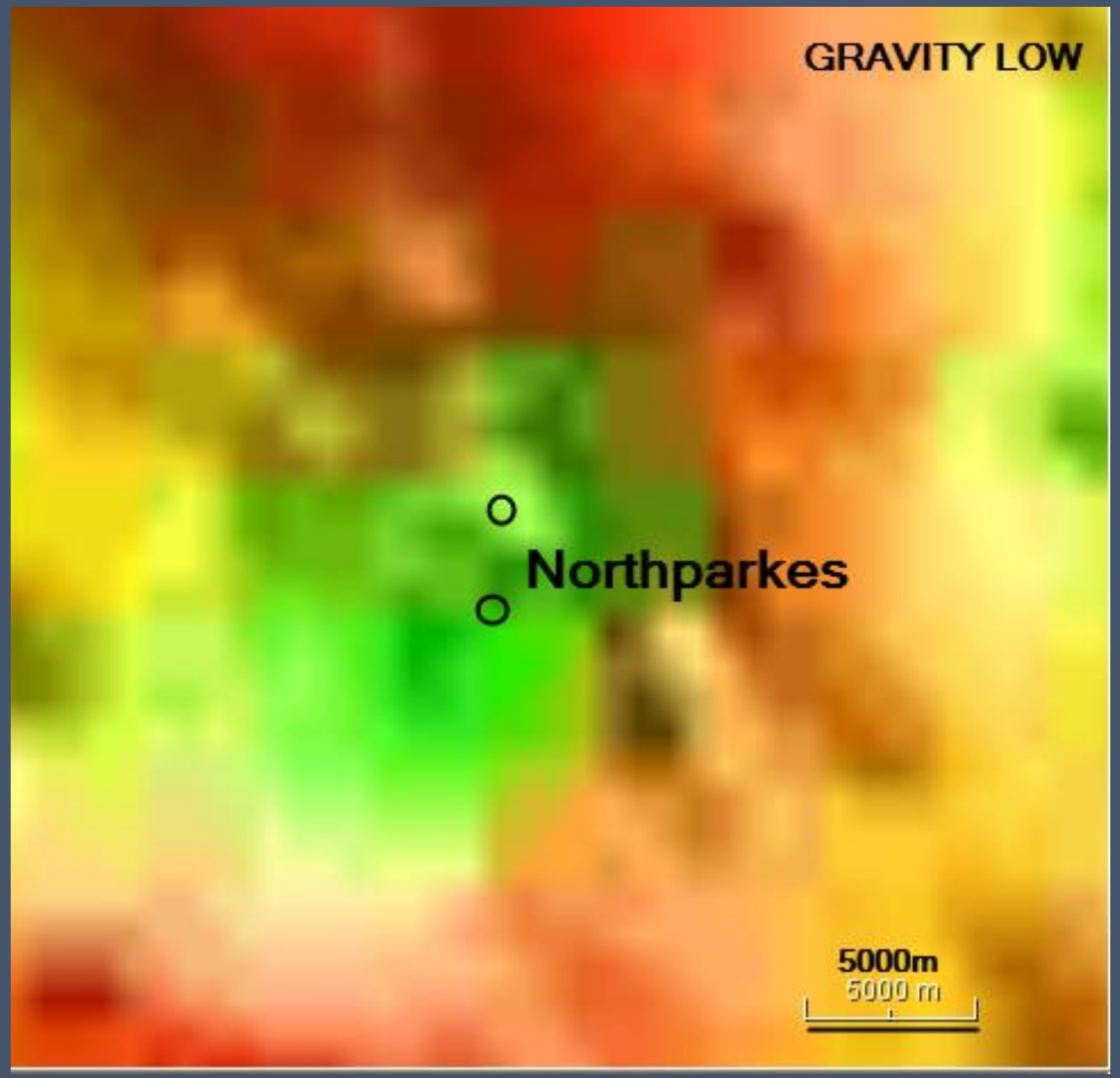
E26 L2	Mt	Cu %	Au g/t
Actual	13.3	1.36	0.58
Resource	**6.4**	**0.91**	**0.28**

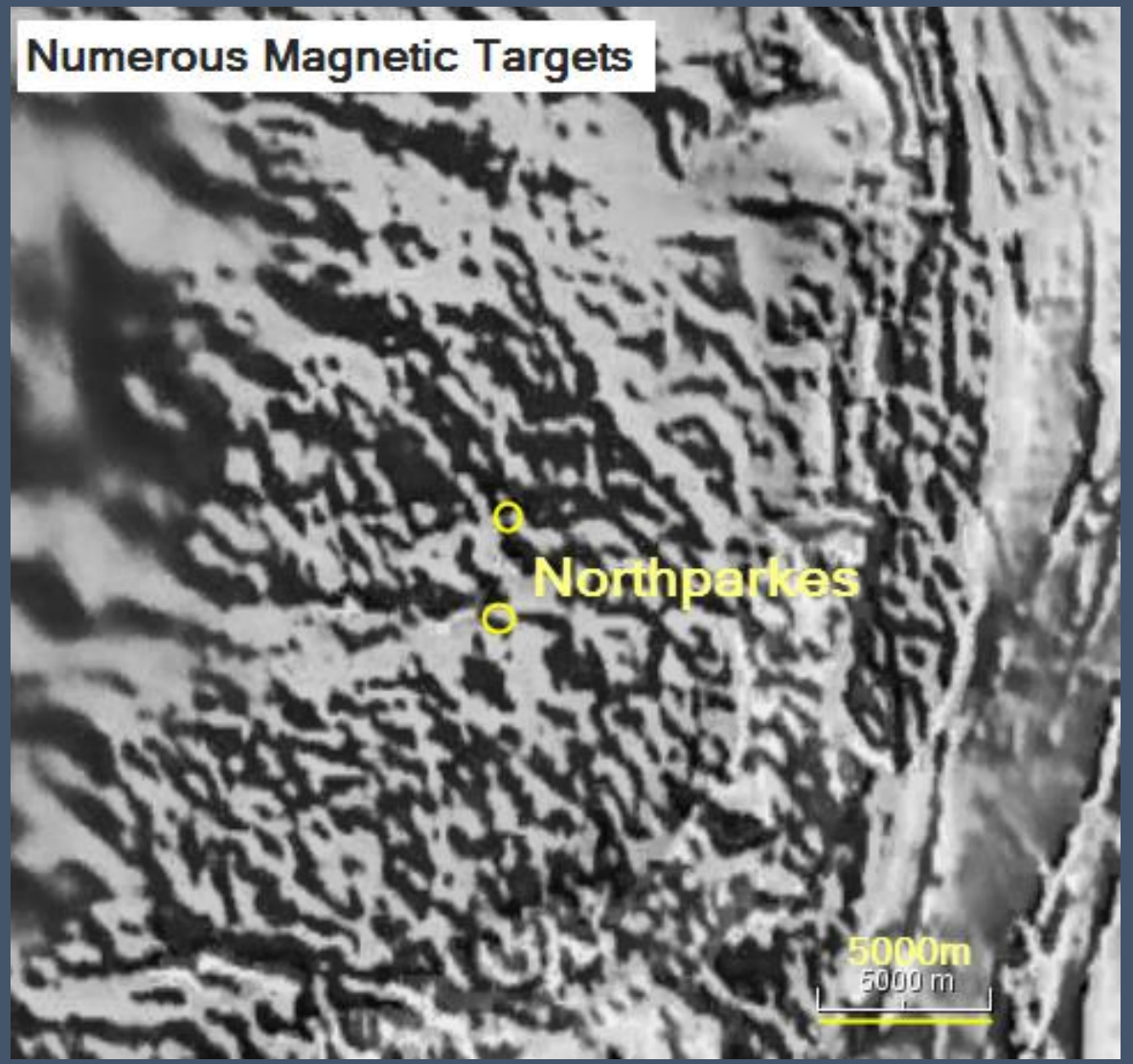
E26 L2N	Mt	Cu %	Au g/t
Actual	6.9	0.71	0.21
Reserve	**10.2**	**0.69**	**0.19**

NORTHPARKES

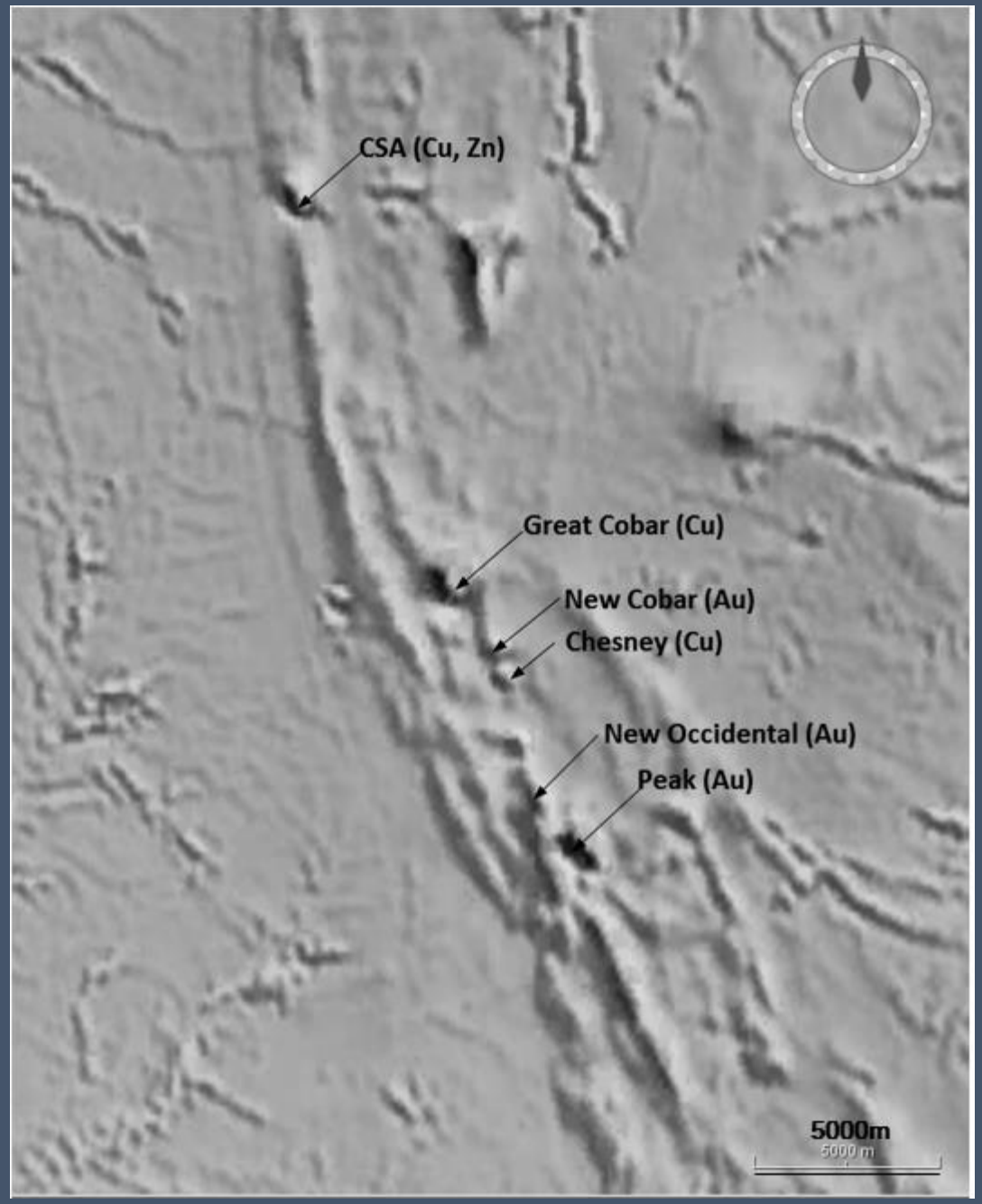
In-Mine & Near Mine
Exploration continues
at
Northparkes

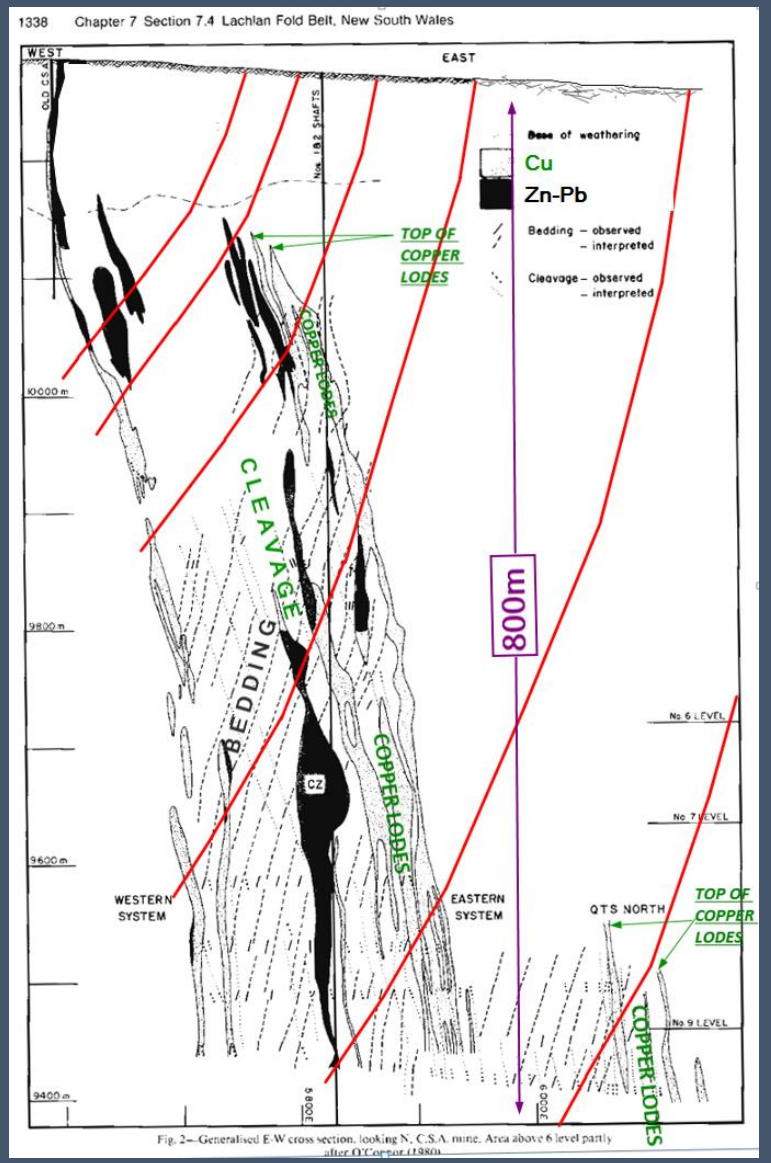
In-Mine & Near Mine Exploration continues at Northparkes

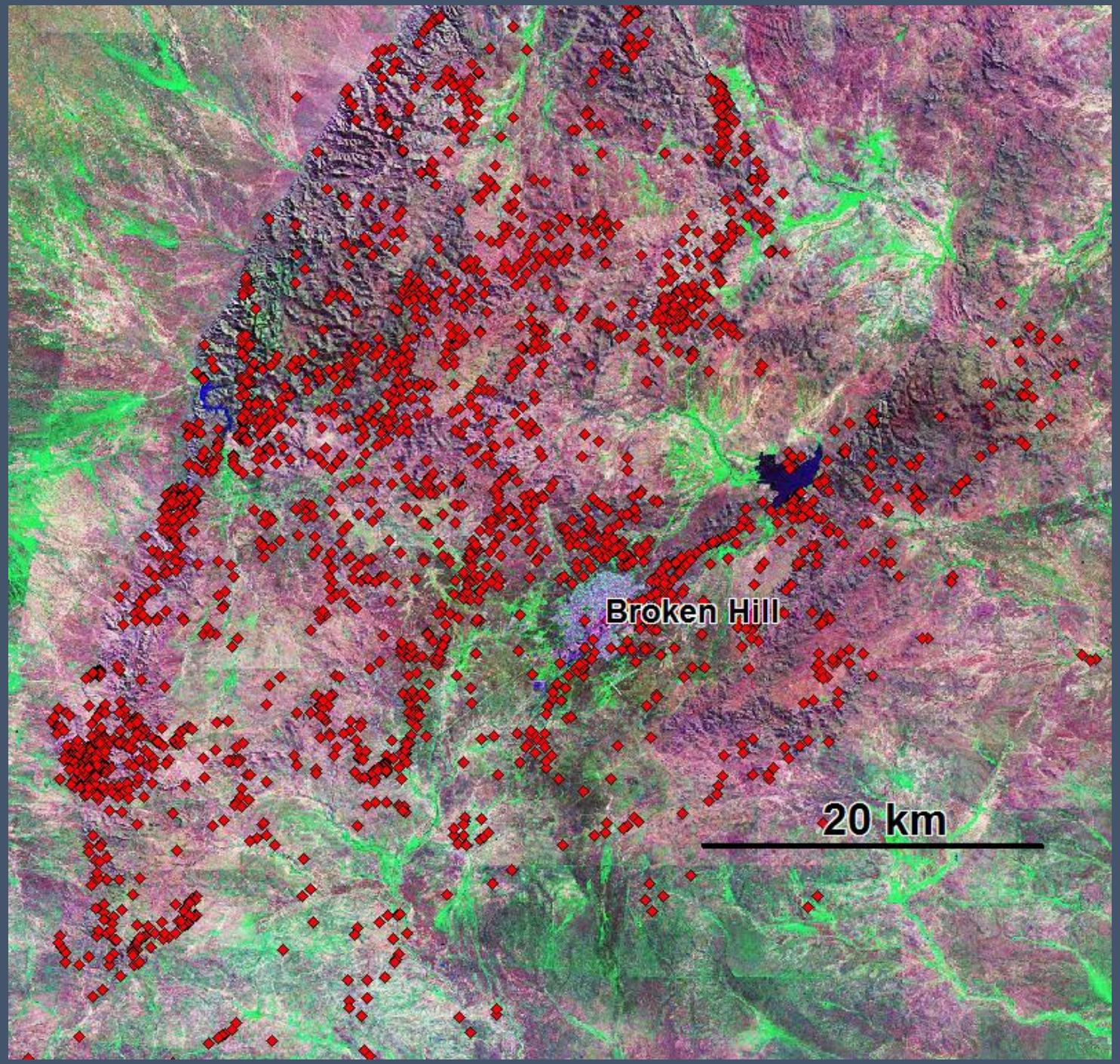




In-Mine & Near Mine Exploration continues in Cobar District







In-Mine & Near Mine Exploration continues in Broken Hill District

Red diamonds: Historic Mines

Persistence with In-mine & Near-mine Exploration

Current situation in NSW:

Cadia Mine
Northparkes Mine
Cowal Mine
Cobar District Mines
Broken Hill Mines

…will persist with **in-mine & near-mine exploration** and provide long term career employment for mineral exploration geologists because…

…many opportunities for new discoveries that can be developed at low cost – with **ore processed in existing mills** – remain…

Persistence with In-mine & Near-mine Exploration – Focus on Existing Mills

- Decision to persist with **in-mine & near-mine exploration** in preference to **grass-root exploration** in **greenfield** locations should be based on **economic analysis** with input from **geologists & engineers**
- **Local mine management** is keen to persist with **in-mine & near-mine exploration**
- **Existing mills** provide incentive to persist with exploration within trucking distance
- **in-mine & near-mine exploration** is LOW RISK and provides GOOD RETURNS ON FUNDS INVESTED

Ideal new project – high grade in low cost location:

‘High grade’ means a good combination of:
- High metal content
- Extraction of metal by simple methods at low cost

Low cost location means:
- Close to an existing mill
- Close to existing infrastructure
- Commuting distance to a town with contractors and employees
- Minimal environmental sensitivity (dry climate - no running water)

Consequences of Relentless Pursuit of Large New Projects

- In **major** companies with multiple mine sites **Boards of Directors** prefer to fund **grass root exploration** in **greenfield** locations to focus on larger discoveries because they are pursuing corporate objectives
- **Boards of Directors** of **majors** are obsessed with competition with other **majors** so that **growth** is the **overarching objective**
- **Increasing investments** were made in **increasingly large projects**
- **Consequences** were **disastrous: iron ore** and **coal prices collapsed** because **supply is now well in excess of demand**

Boards of Directors of Major Companies were focussed on very large new projects, but are now giving up on exploration

- **Major** companies focus on largest discoveries
- For example Rio Tinto spent billions in pursuit of large new projects, including $2.5B on Simandou iron ore project in Guinea and paid $4B for a coking coal discovery in Mozambique - only to find out that the problems are insurmountable
- Due to **billions of dollars written off** on very large new projects in remote high cost locations in new countries, **majors** have now **greatly reduced exploration**
- **BHP** has given up on mineral exploration and other **majors** are again **cutting exploration budgets**

Due to focus on very large new projects, Major Companies focussed on Iron Ore and Coal and caused collapse in price

- **Too many very large iron ore mines have been developed**
- **Supply of ion ore now greatly exceeds demand**
- **Price of iron ore collapsed**
- **Exploration for new iron ore deposits stopped**
- **Same in coal**

It will take 6-12 years for iron ore and coal price to recover

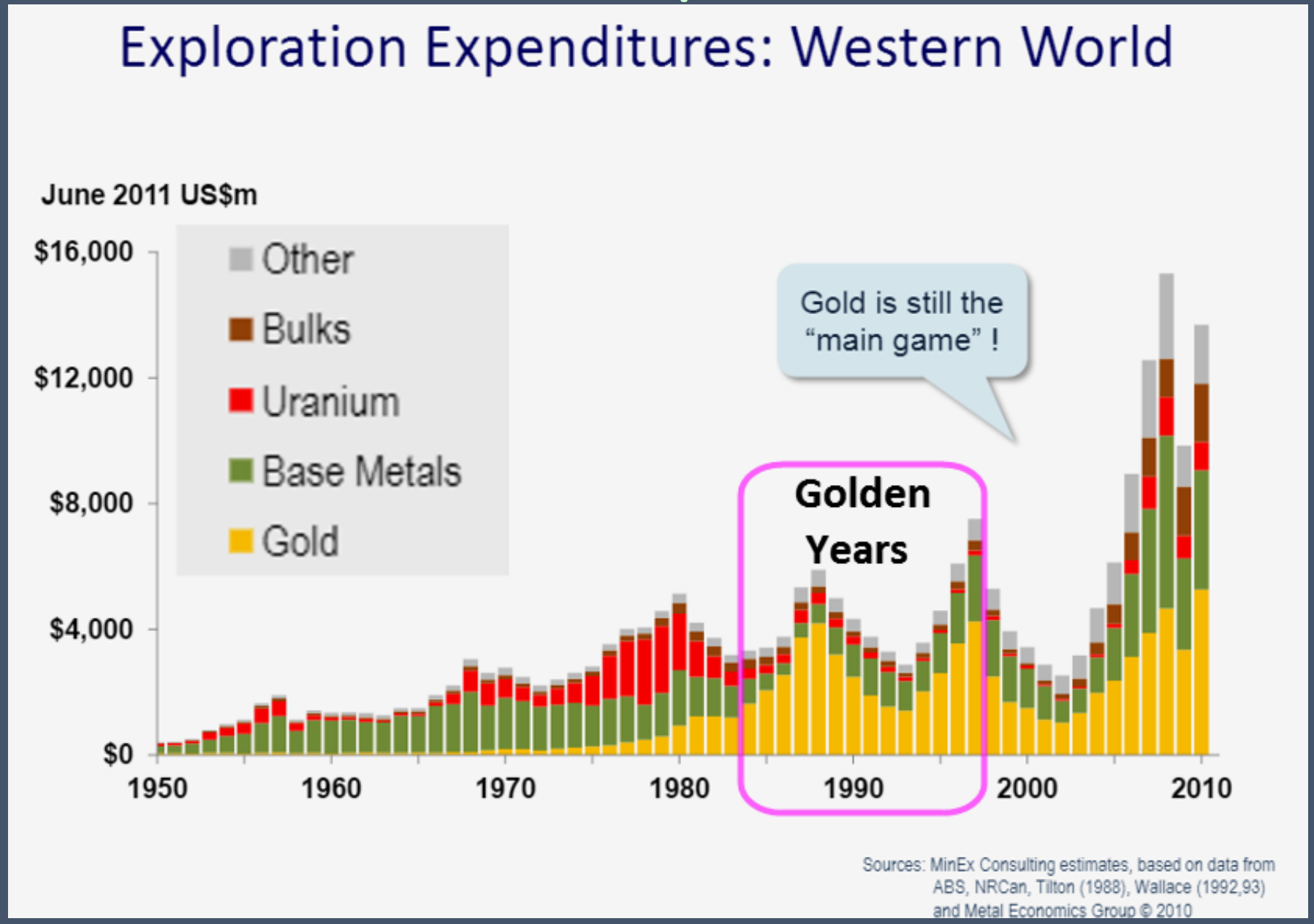
Competition between majors made iron ore and coal unattractive

In Gold Major Companies do not have a Dominant Role

- Gold mines are not able to increase production
- Main constraint is limited ore reserves
- Major new gold and copper-gold projects suffered setbacks:
  Pascua-Llama, El Moro, Tampakan, Frieda River, Namosi, Wafi
- Supply of gold is not likely to exceed demand
- Price of gold is not likely to fall because supply from mines is constrained
- Gold ore reserves and resources are being depleted
- Known gold in the ground will be depleted in 19 years according to USGS
- Good reason for exploration for new gold deposits to be increased

- Large numbers of geologists are employed in gold exploration
- Large number of drill holes is needed to define a resource

Gold Exploration Statistics



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Large number of drill holes is needed to define a resource

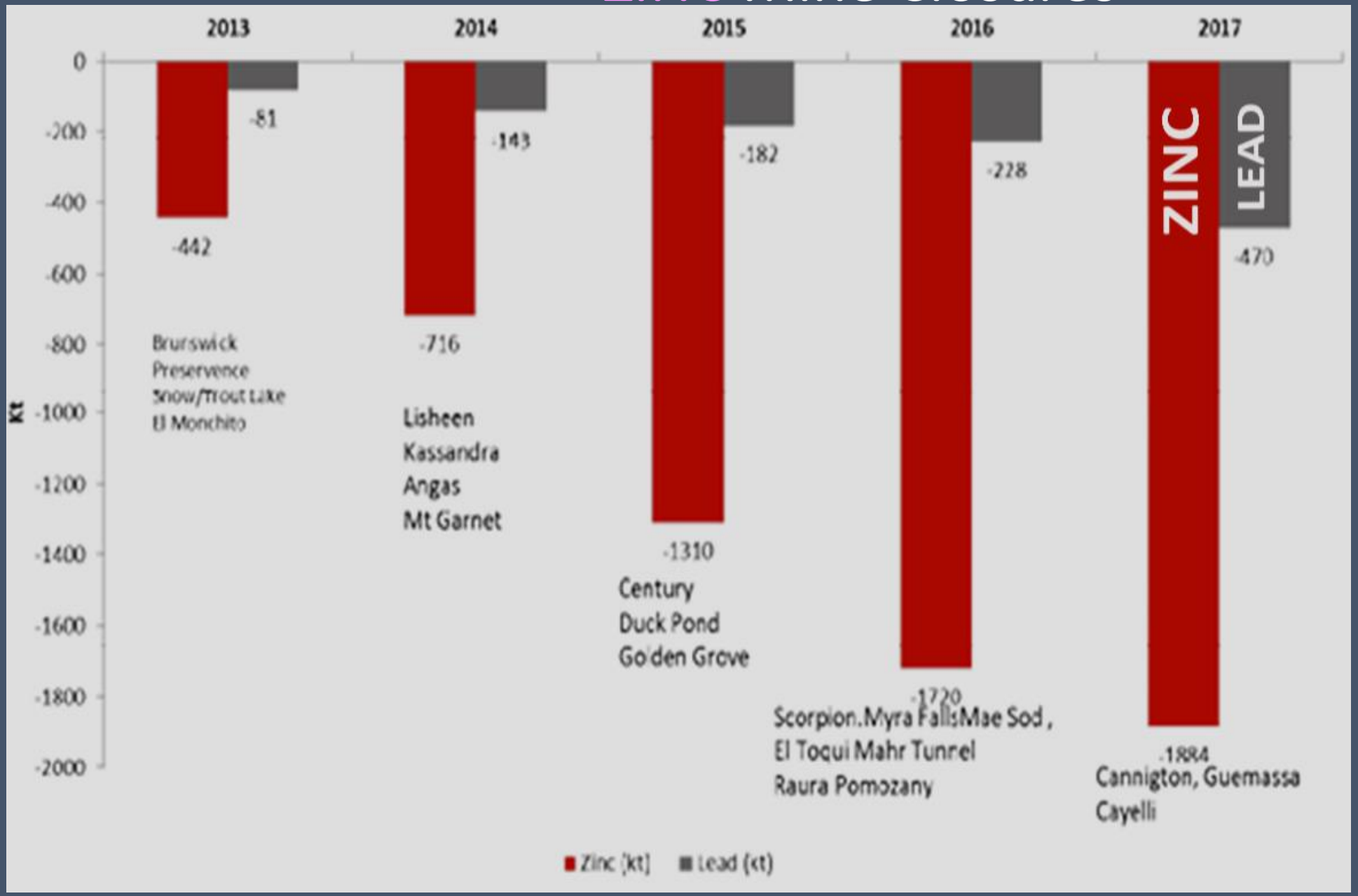
ZINC Discoveries

NSW: 1883 – Broken Hill (zinc production since 1905), 1880 – Captains Flat (zinc recovery since 1930's), 1965 - CSA, 1969 – Woodlawn, 1960's – Lewis Ponds, 1973 – Elura (=Endeavour) - no significant zinc discovery since 1973
Tasmania: 1914 – Hercules & Roseberry (zinc production since 1930's), 1974 – Que River, 1983 – Hellyer - no significant zinc discovery since 1983
Qld & NT: 1880's – Dugald River (drilling since 1948), 1923 – Mt. Isa (zinc production since 1931), 1955 – McArthur River, 1960's – Hilton, Lady Loretta, 1975 – Thalanga, 1990 – Century, 1990 – Cannington - no significant zinc discovery since 1990

Australia has largest zinc resources and is 2nd largest producer in the World

World-wide: - no significant zinc discovery since 1990

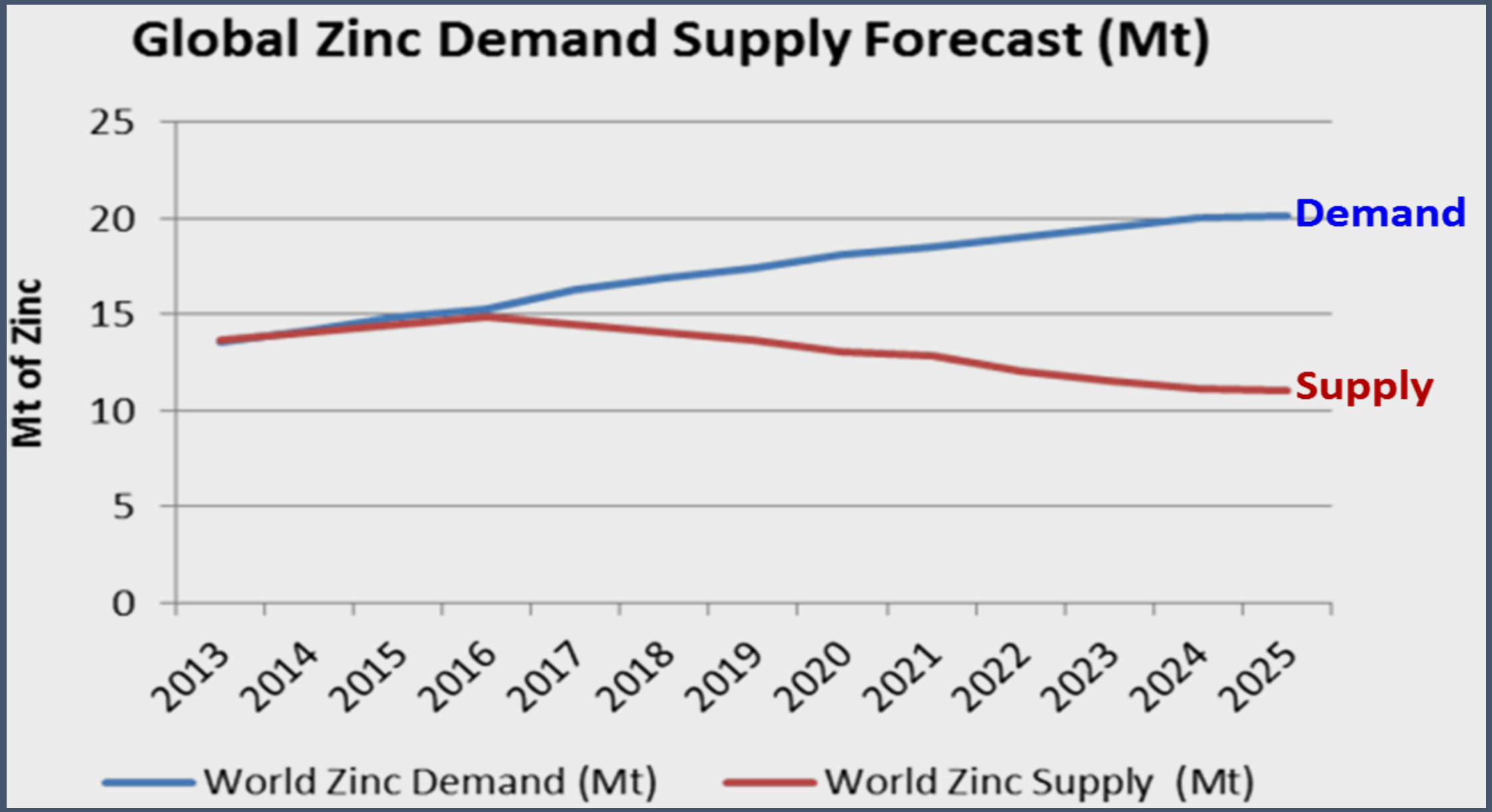
ZINC Mine Closures



Century – 2nd largest World zinc producer – is closing down in **2015**

World-wide mine closures will result in **higher zinc price**

ZINC Demand & Supply



Conclusions – Commodities & States / Countries

- **Gold** and **zinc** are the most attractive commodities
- Very good potential for gold and zinc discoveries in **NSW** (and Qld)
- **NSW** (and Qld) will provide better opportunities for employment in exploration than other States and other Countries
- **Sydney** remains a good home base for exploration geologists
- We need to make **exciting new drill intersections**
- **Exciting new discoveries** will restore confidence in **NSW** (and Qld)

Conclusions – Location

- Close to an **existing mill**
- Within **daily commuting** distance of a town with contractors and workforce
- **Safe distance** from a **running stream**
- Close to a **power line** and **water supply**
- In a favourable location even a modest discovery makes good return on funds invested
- New discoveries that **start production in 1-2 years** will restore confidence in **NSW** (and Qld)

Conclusions – Sources of Funds for Exploration

- Companies with cash flow from mines in **NSW** (and Qld) will be the main source of funds for exploration in **NSW** (and Qld)
- **In-mine** and **Near-mine** exploration is higher priority
- Only if a company is facing **depletion of ore reserves in 1-2 years** it may be willing to make an **acquisition** or enter a **Joint Venture**
- **Shortage of funds for exploration will continue until price of gold and zinc goes up**

Additional Advantage of NSW
Data Base made available by Geological Survey

After working in various under-developed countries where we did not even have a basic topographic map…
Coming back to work in NSW was a rewarding experience because of **very useful data base** provided by Geological Survey – easy to **access by internet…**

Here I will only make a few comments about magnetic and radiometric data…

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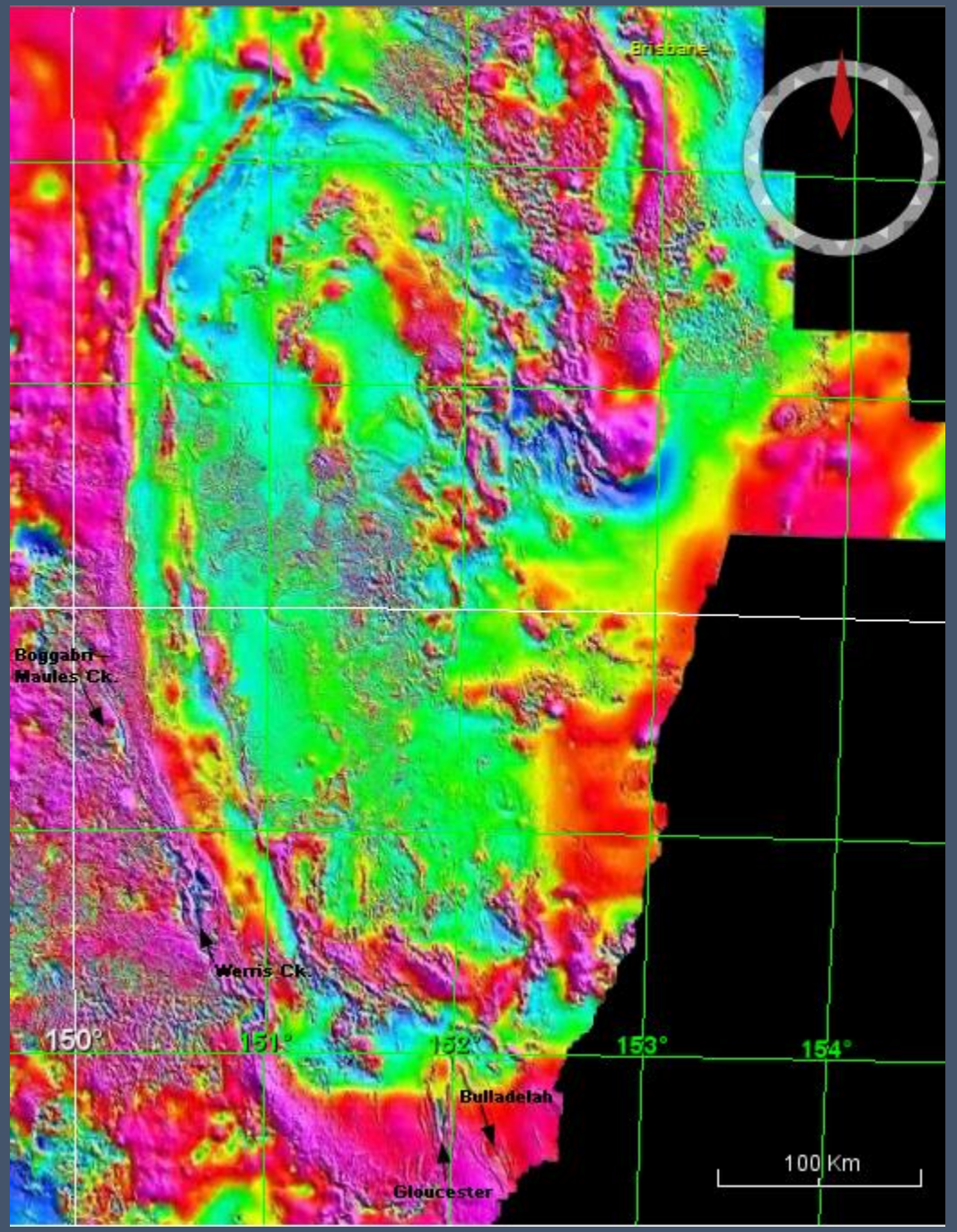
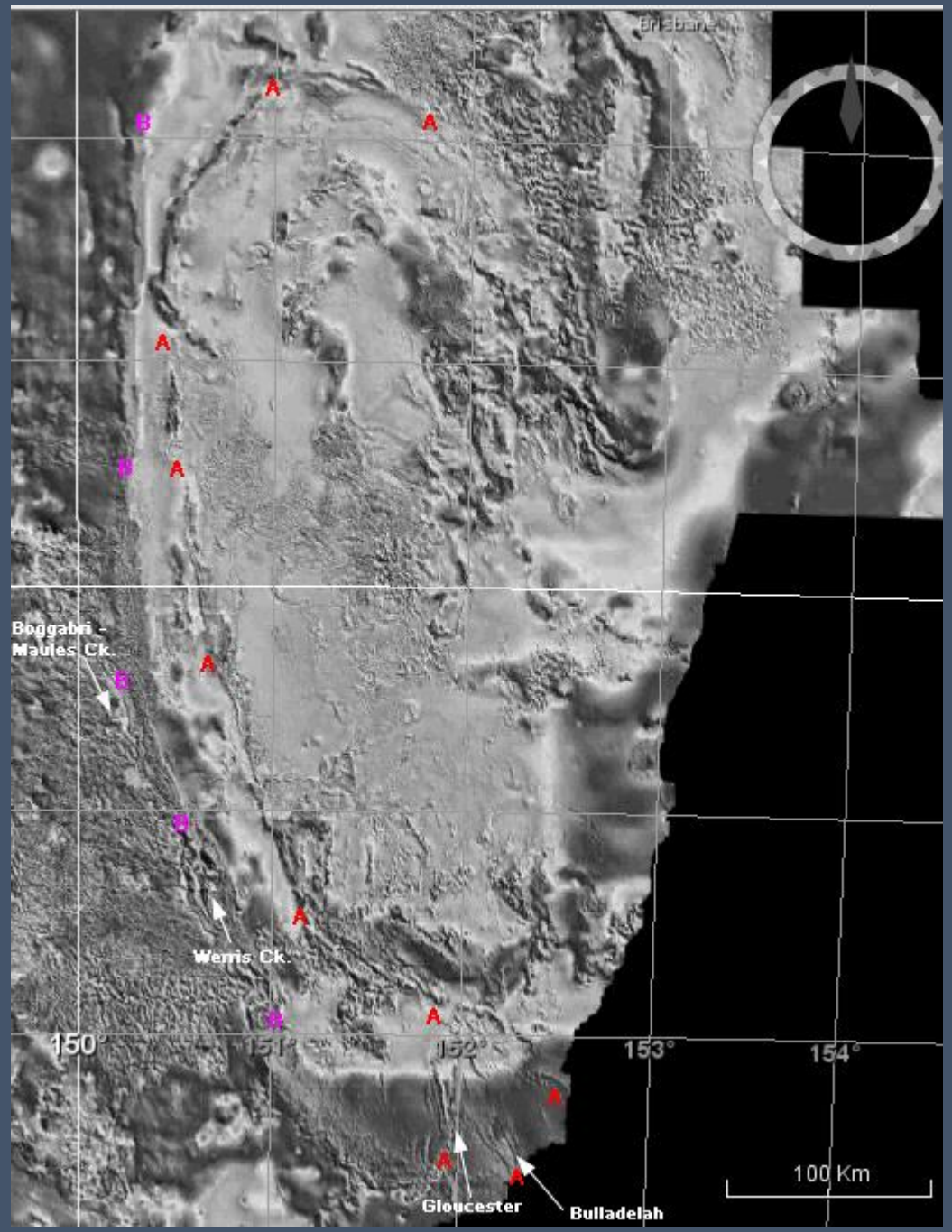
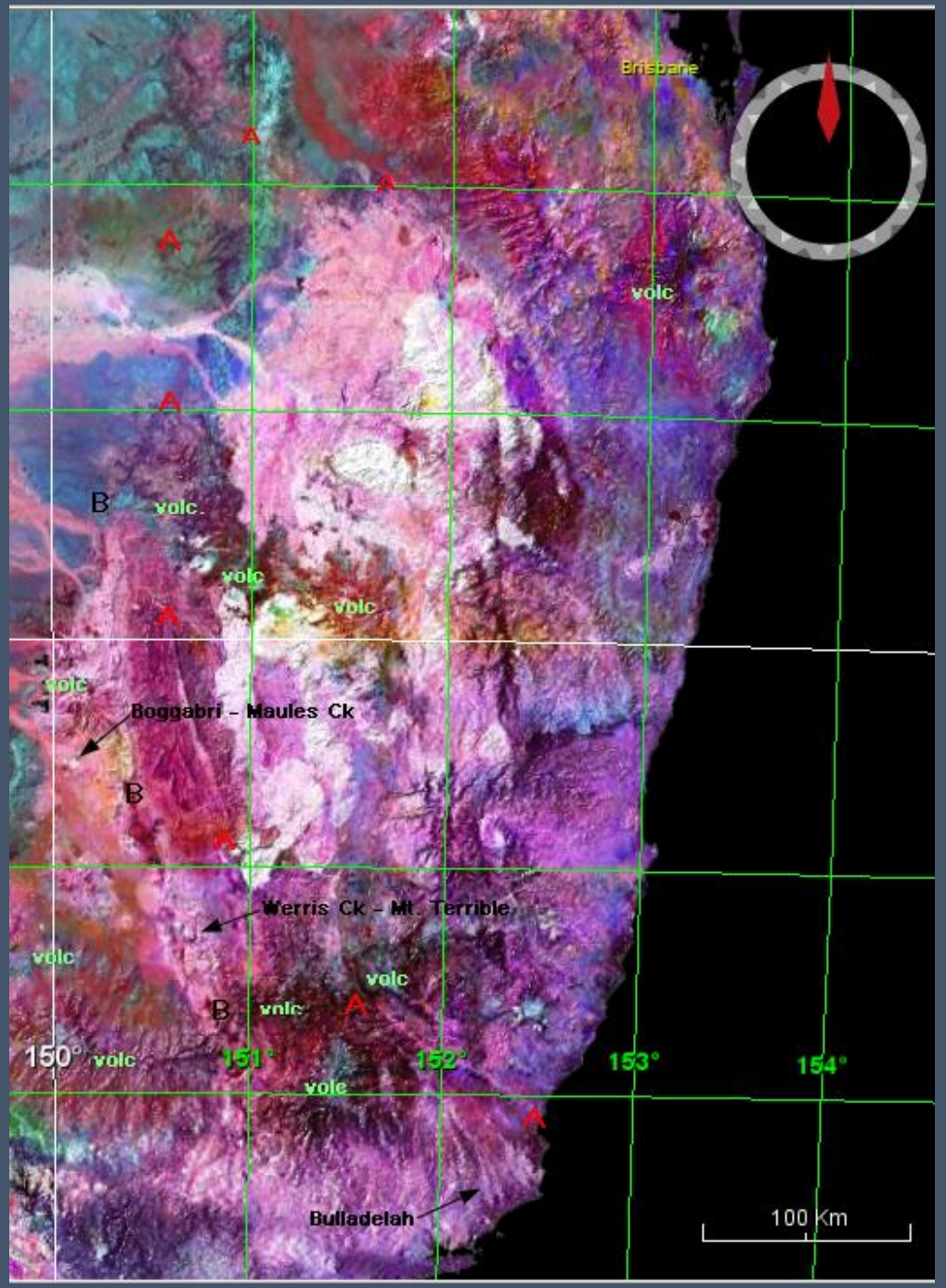


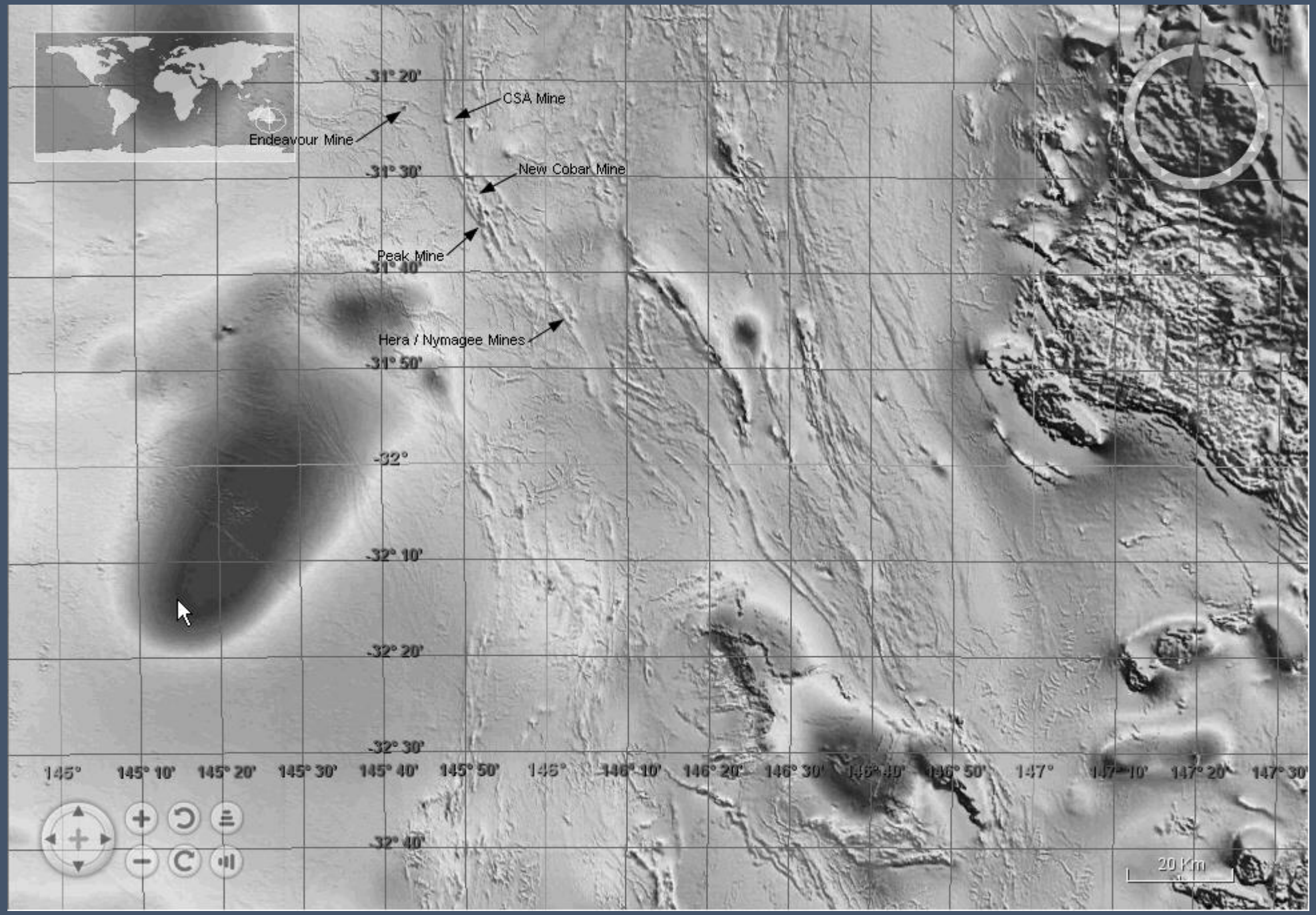
Additional Advantage of NSW **magnetic data colour**



Additional Advantage of NSW **magnetic data grey scale**



Additional Advantage of NSW **radiometric data ternary**



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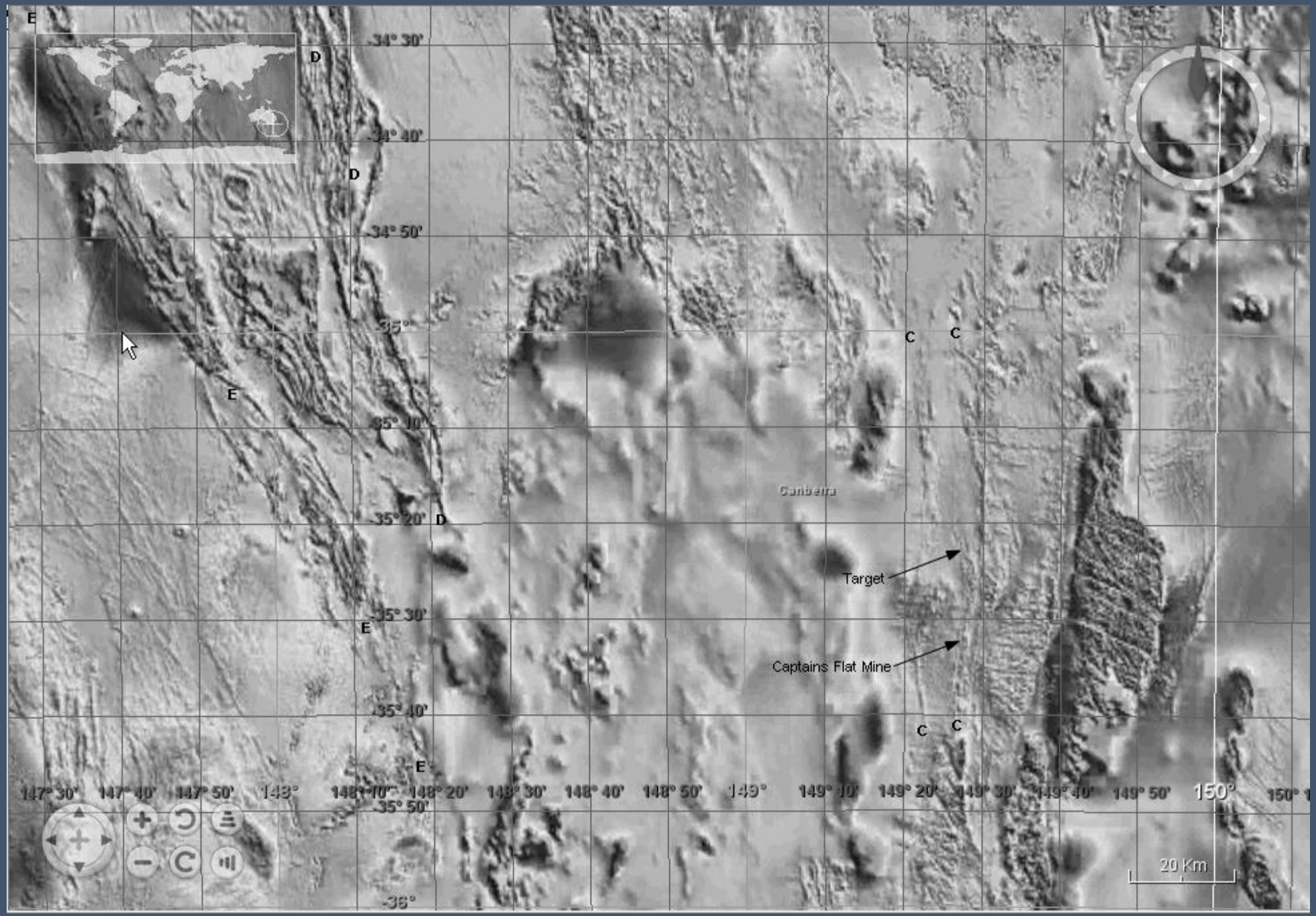

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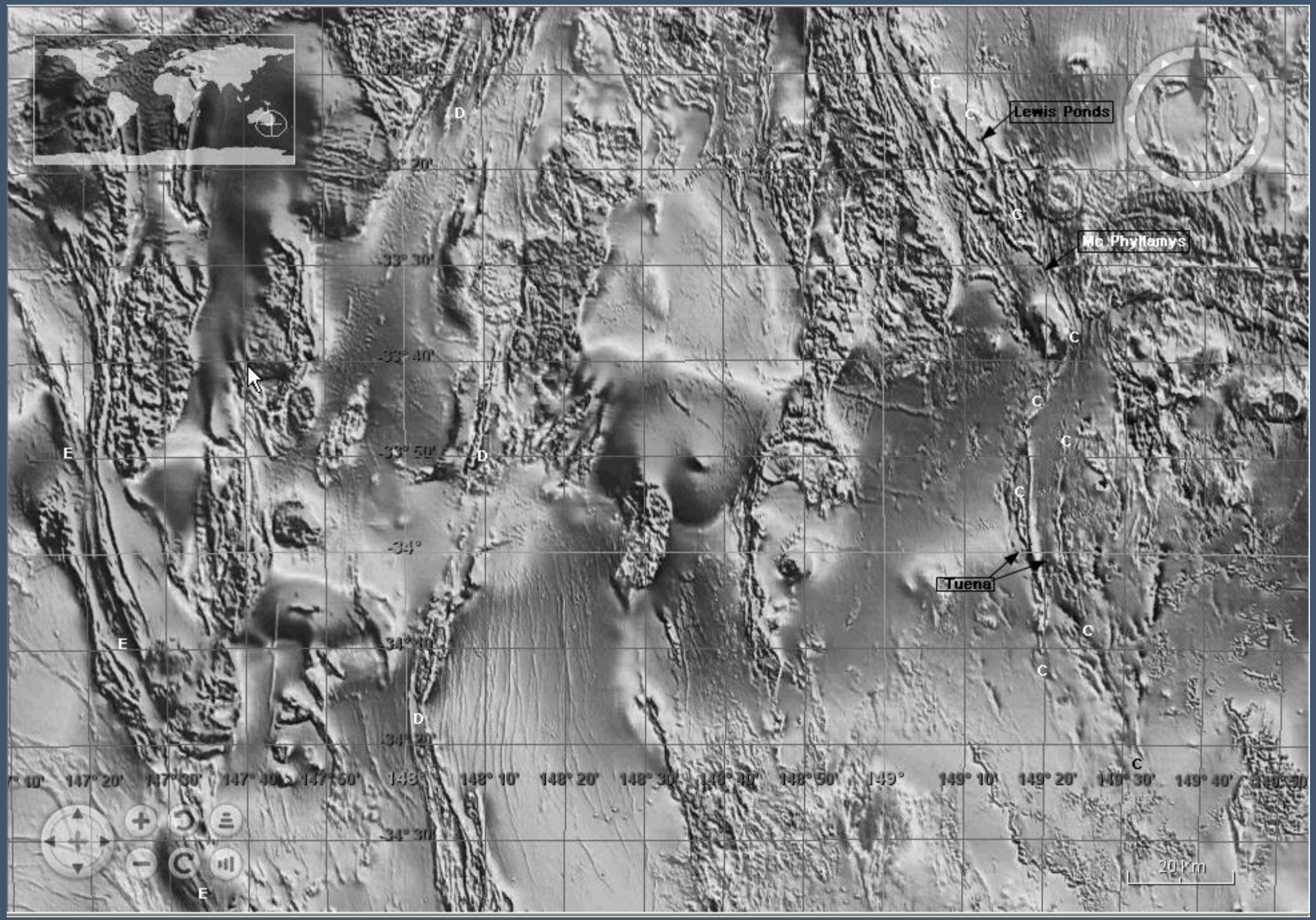

Additional Advantage of NSW **magnetic data grey scale**

Additional Advantage of NSW
Data Bases

Due to shortage of funds for drilling…

… this is the right time to study data bases and generate new projects…

End