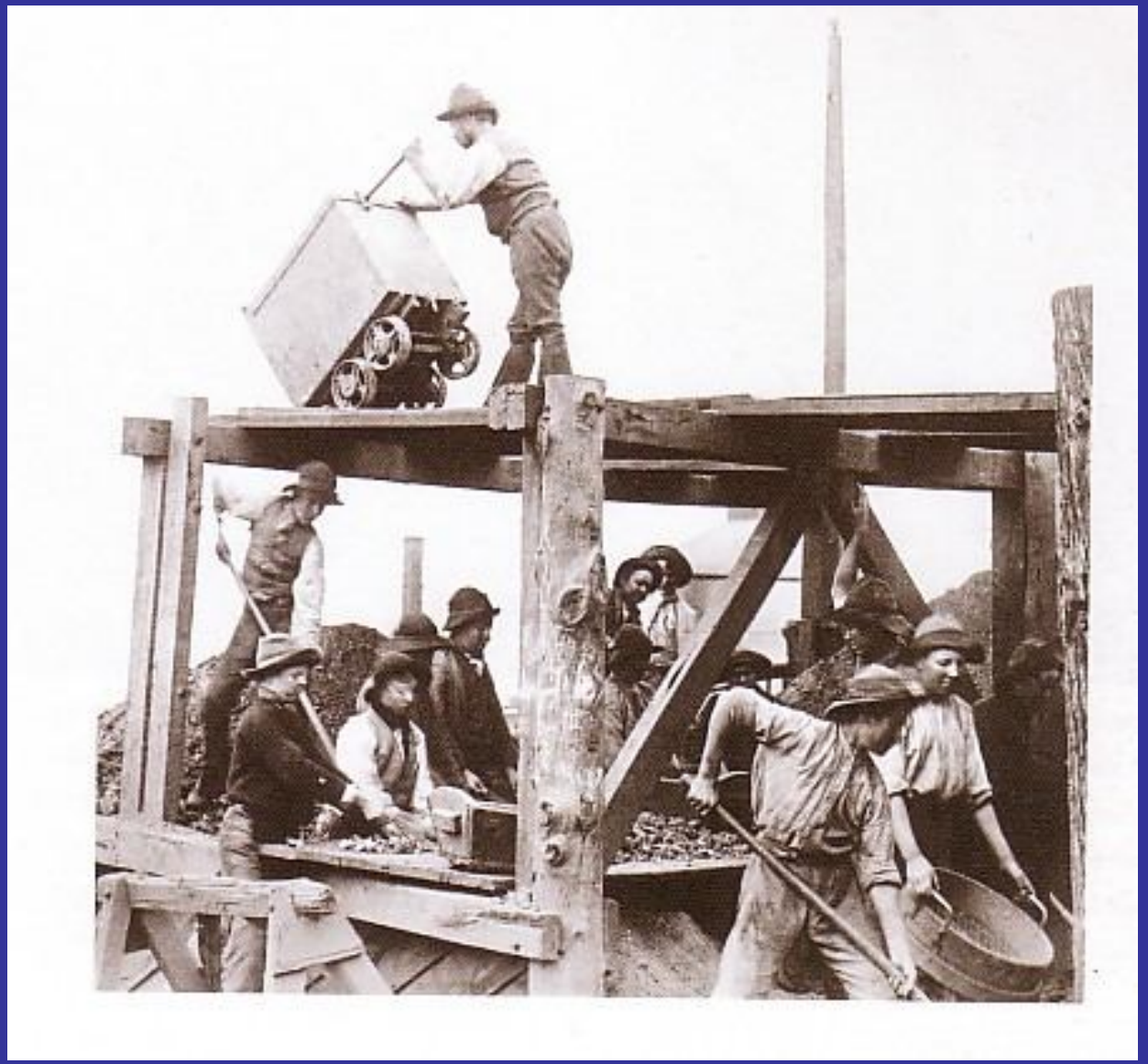
Geology of the Broken Hill Orebody

Compiled by Graham Ogle from “Minerals of Broken Hill”, edited W. Birch, 1999, + Laurie Lawrence

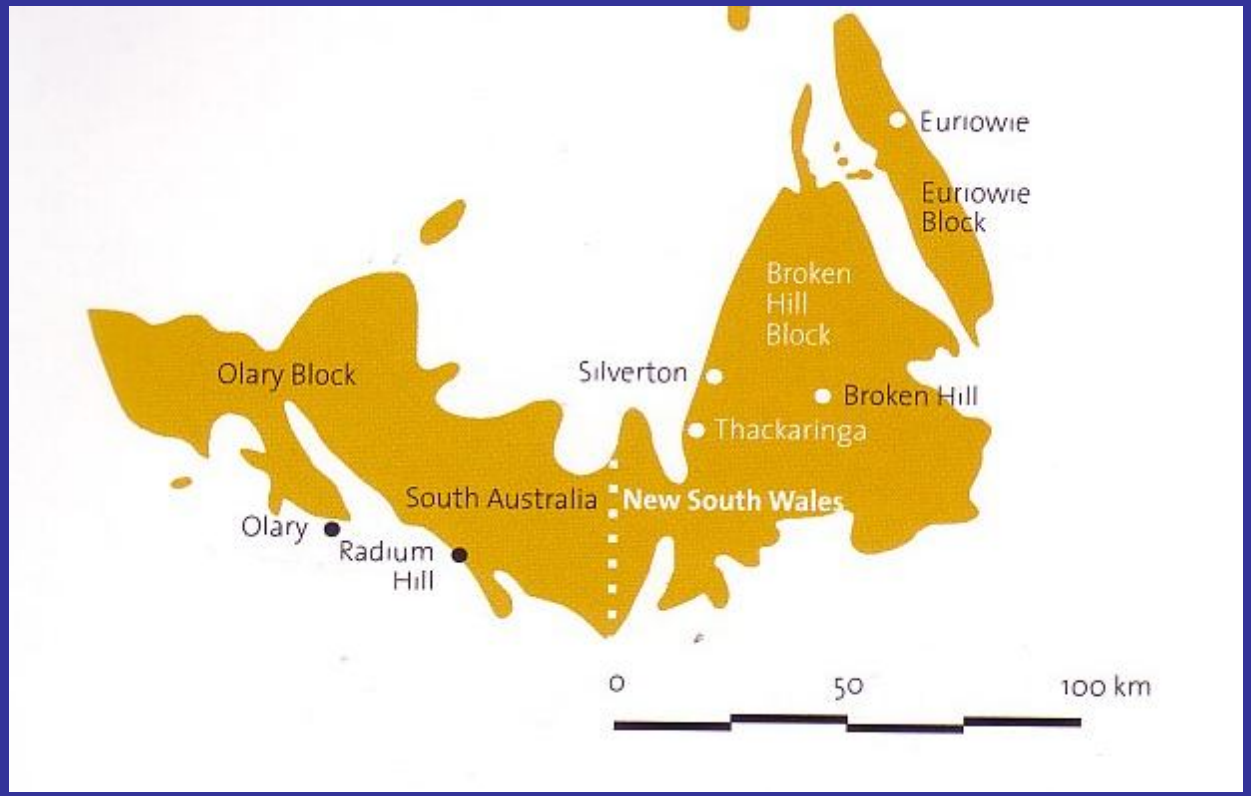
BHP Co.
Opencut, 1891



Boys sorting ore, McCulloch Shaft 1887

Willyama supergroup

- Series of Precambrian rocks extending from Broken Hill into South Australia



Summary

- Submarine Rift Valley
- Deposition of sediments
- Vulcanism
- Metamorphism
- Folding
- Erosion
- Weathering

Rift Valley

Kenya – Volcano in the Rift Valley – © P. Pillerault

Deposition of metasediments

- Originated as sandy, silty and clayey sediments, and volcanic or intrusive rocks, 1710-1640 million years ago

Broken Hill group

- Sandy to clayey sediments
- Comparatively small volume of acidic volcanic material was deposited, together with some chemically precipitated sediments or alteration products (the lode horizon).
- Amphibolite – doleritic sills intruding sediments soon after deposition

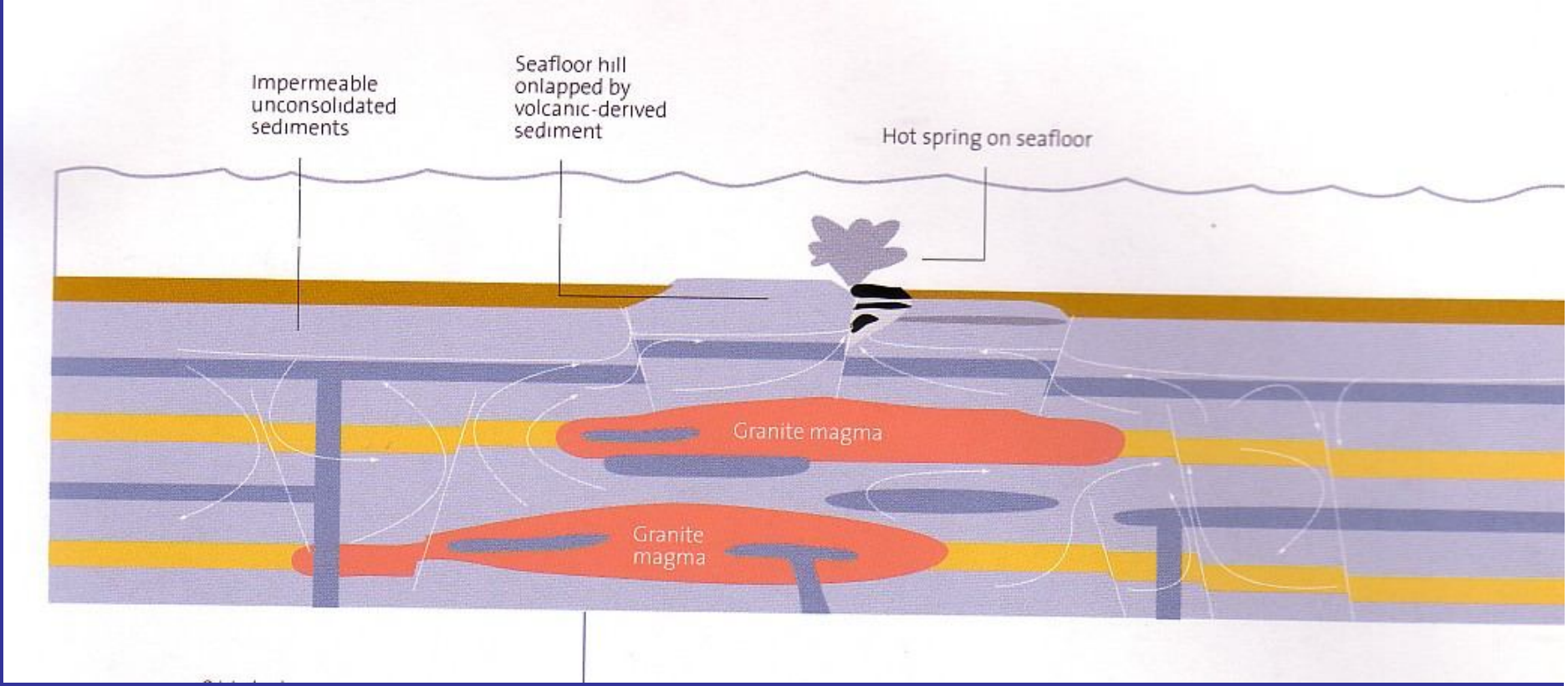
Origin of the Orebody

Syngenetic or exhalative theory

- Lead and zinc and other constituents of the orebody were chemically precipitated on the sea floor during deposition of the surrounding rocks, in the last stage of vulcanism
- Orebody constituents reached sea floor in dissolved form through hot springs, leached from surrounding rocks
- Hot brines and cooler water – precipitation of silicas in fractures – blocked. Eventual explosion, rapid precipitation of sulphides and other minerals, repeated to form the separate sulphide masses which make the orebody

Black smokers

Possible concept



Metamorphism

- Around 1,600 million years ago, local disruptions bent the rocks into tight folds and metamorphosed them.

- Temperatures to 750-800^0 C in the mine area, pressures to 1-6kbar, implying depths of burial 15-20km – led to coarse-grained metamorphic rocks –parallel growths of minerals such as micas and sillimanite – many rocks became schists and gneisses – the metasediments

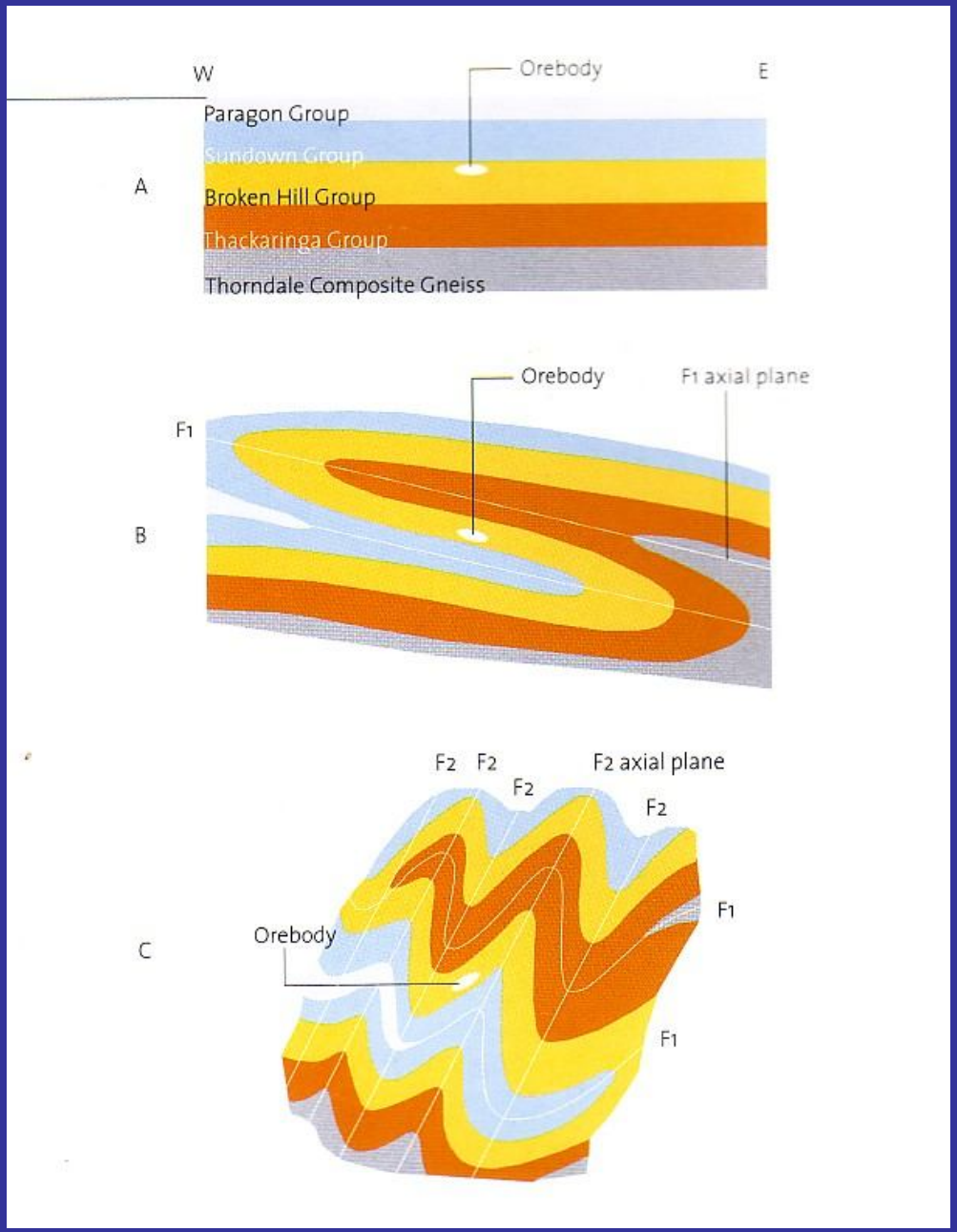
- Temperature and pressure - numerous thin patches of granitic and pegmatitic material, some composed mainly of quartz, feldspar and biotite +/- garnet – quartz-feldspathic gneisses

Folding – 4 periods folding and metamorphism

- F1 – folded and metamorphosed at hight temperature and pressure. Overturned beds!
- The F1 event developed an axial plane schistosity that was folded by F2 also at hight temperature and pressure, orebody increasingly involved in tectonic movements – fractured, brecciated, moved, ? partially melted – imposed on rocks that were already upside down

Folding – 4 periods folding and metamorphism

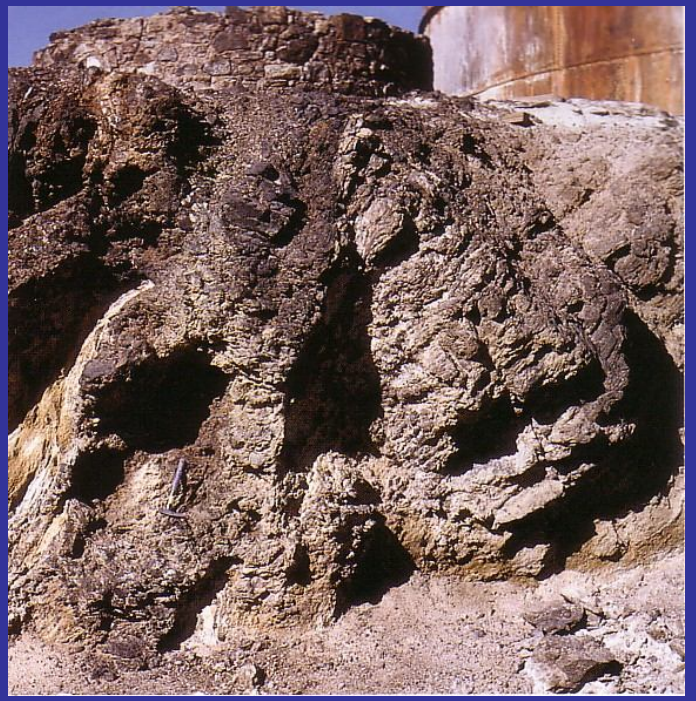
- F3 – lower-grade metamorphism – little faults and shears, crenulations – very tight folds right at the orebody
- F4 – little minor folds within the region of F3 folds


W
Orebody
E
Paragon Group
Sundown Group
A
Broken Hill Group
Thackaringa Group
Thorndale Composite Gneiss
Orebody
F1 axial plane
F1
B
F2 F2
F2
F2 axial plane
F2
F1
Orebody
C
F1

Refolded axial plane pegmatite in the Hore’s gneiss

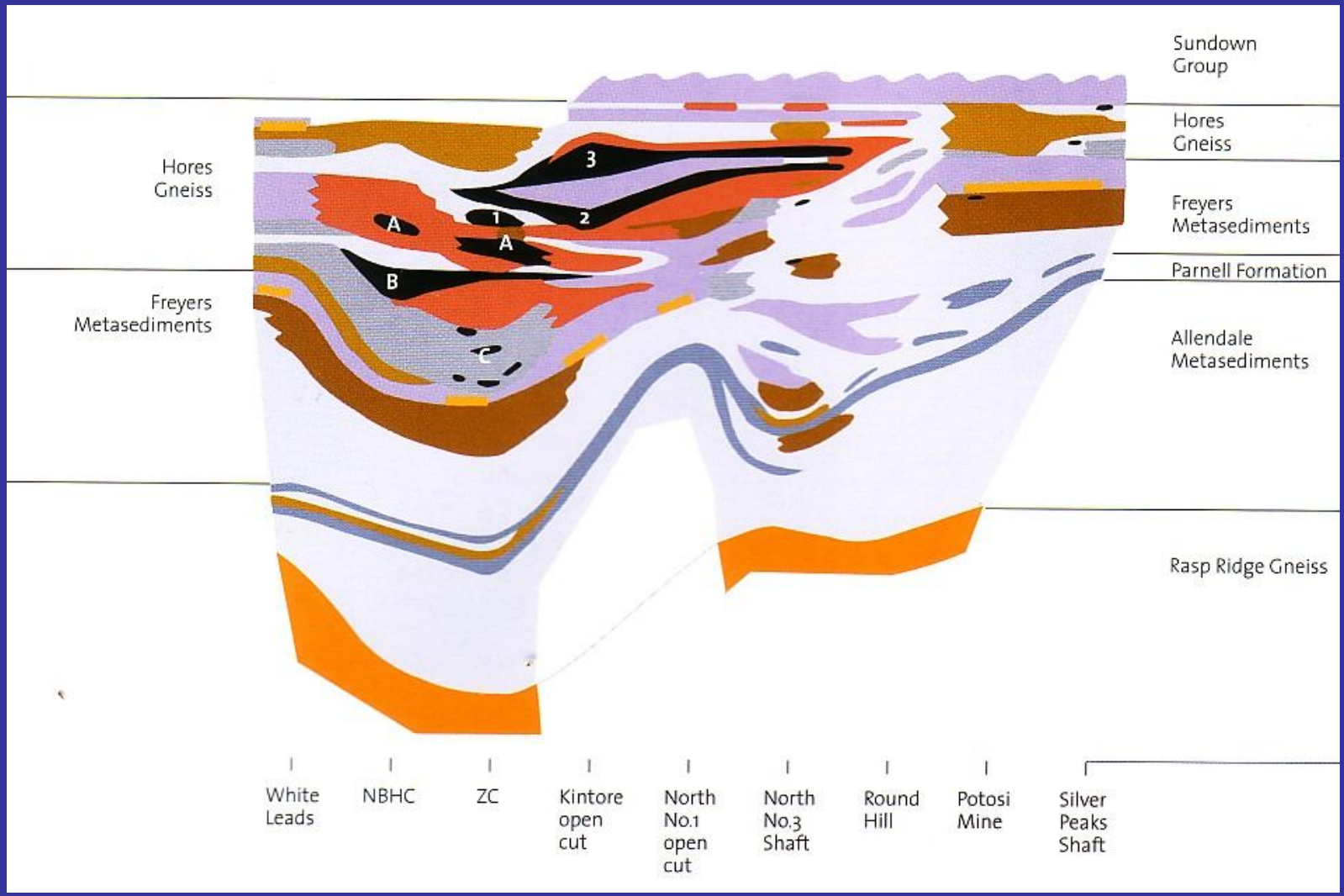
Later events

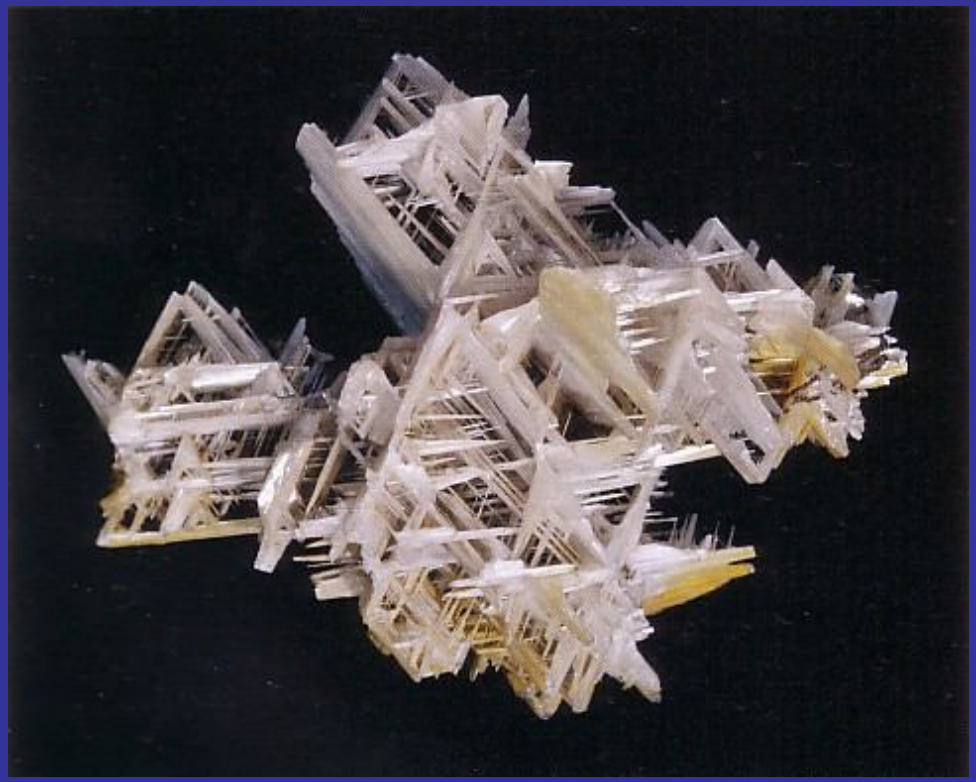
- Erosion (lots of it), including glaciation
- Pegmatite dykes (some with beryl etc) in Thackaringa/Triple Chance area
- Deep weathering that produced the oxidised zones of the orebody
- Uplift and tilting of parts

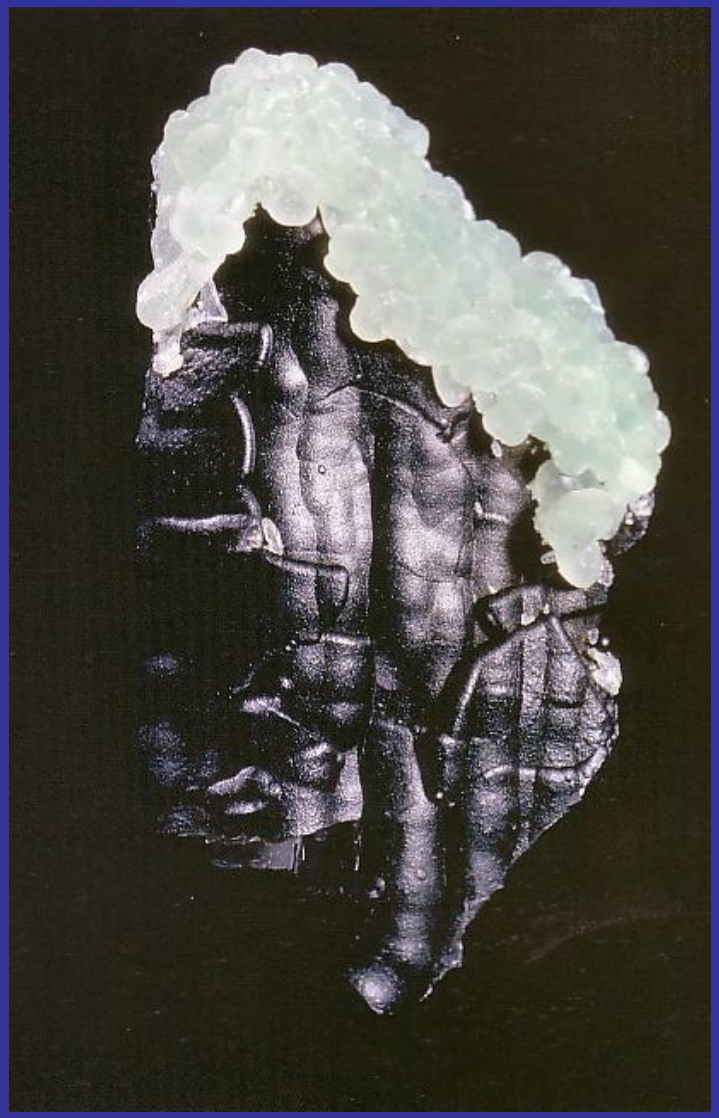


Orebody

- Stacked pile of sulphide-rich masses separated by metasediments, garnet- and quartz-rich rocks, pegmatite and metavolcanics. There are six major sulphide-rich horizons divided into lead lodes and zinc lodes
- Zinc lodes stacked above the lead loads (were deposited first then overturned)
- Resembles a boomerang about 8km long, up to 850m in vertical extent, and up to 250m in folded width
- Surfaces in centre, plunges downwards at both ends


Sundown Group
Hores Gneiss
Freyers Metasediments
Parnell Formation
Allendale Metasediments
Rasp Ridge Gneiss
Hores Gneiss
Freyers Metasediments
A
A
B
C
1
2
3
White Leads
NBHC
ZC
Kintore open cut
North No.1 open cut
North No.3 Shaft
Round Hill
Potosi Mine
Silver Peaks Shaft





Hoganite

Bernalite