Important World Deposits

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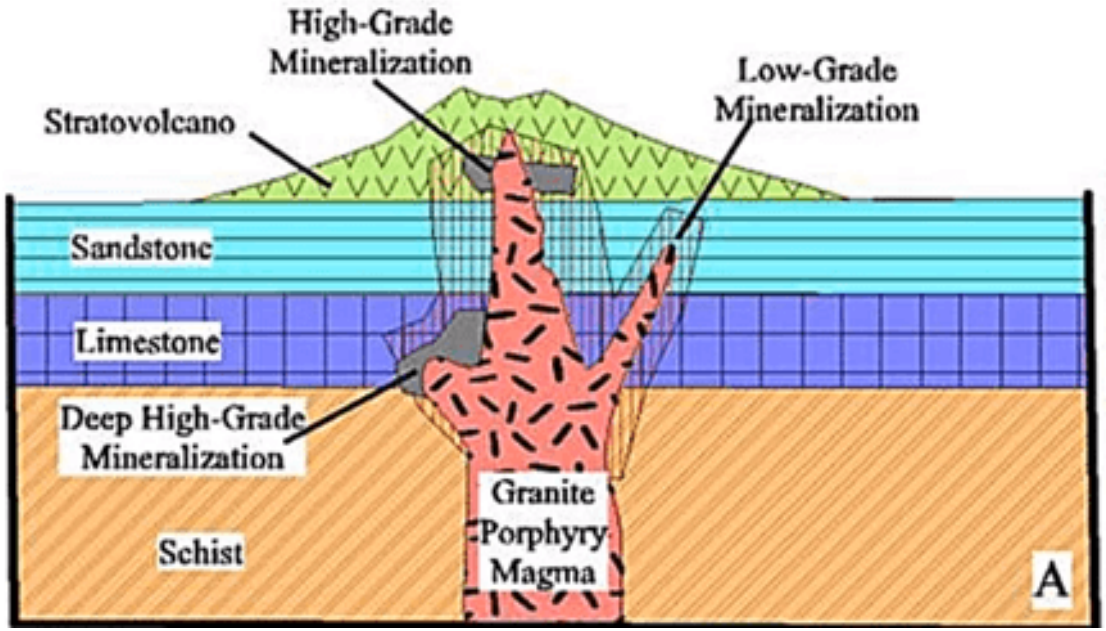
Porphyry Copper deposit

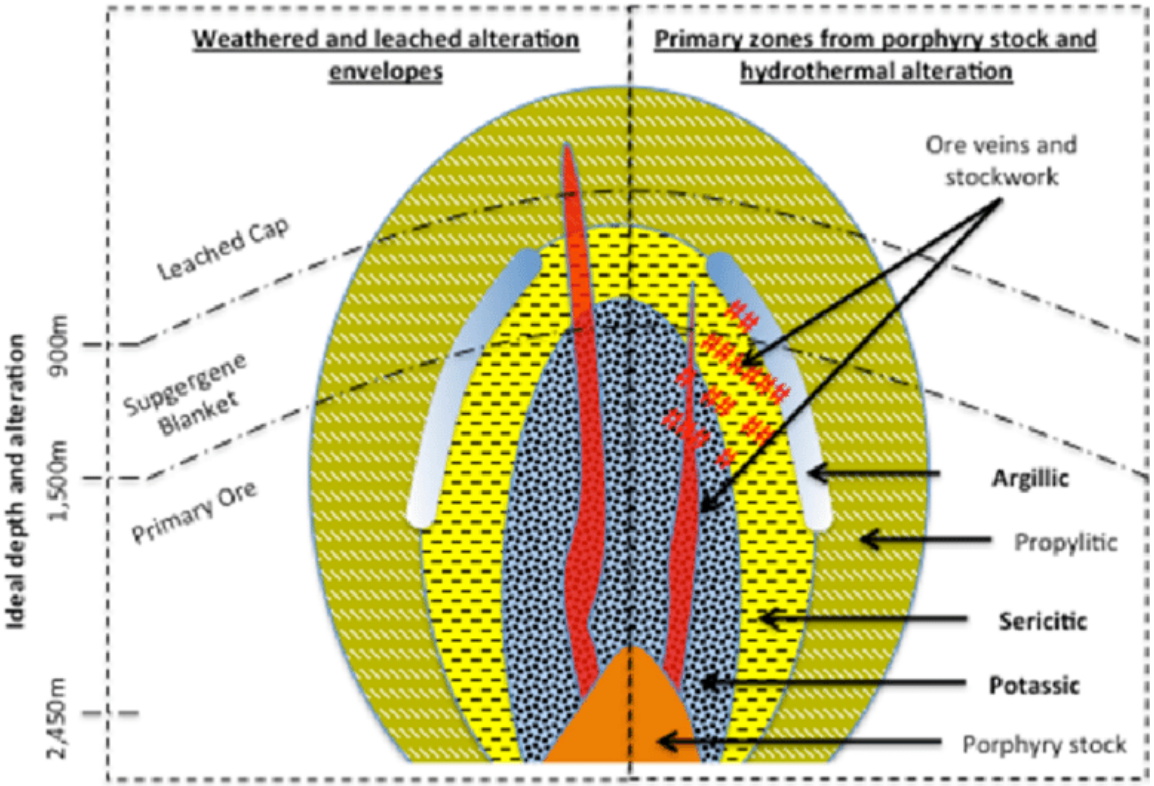
- The term "porphyry copper" is derived from the texture of the igneous rock that forms these intrusive bodies. Porphyritic texture is characterized by larger crystals of feldspar and quartz, known as phenocrysts, which are surrounded by a matrix of very fine-grained crystals.

- Host rock, typically a porphyry of granitic to dioritic composition, that has been fractured on a fine scale and through which chalcopyrite and other copper minerals are disseminated.

- Porphyry copper deposits commonly contain hundreds of millions of metric tons of ore that averages a fraction of 1 percent copper by weight; although they are low-grade, the deposits constitute important sources because they may be worked on a large scale at low cost.

- They have been formed by the dissemination of copper minerals in the crushed or fractured periphery of intrusive igneous bodies of such granitic rocks as quartz monzonite and diorite porphyry.





Initial formation of a porphyry copper deposit associated with a magma chamber beneath a stratovolcano. Hot water circulating near the magma forms low-grade copper mineralization next to the solidifying magma. High-grade mineralization forms over the top of the magma and in chemically reactive wall rocks, like limestone.

Porphyry Copper deposit

- Although copper has been mined from a number of different types of mineral deposits, porphyry copper deposits are the most important source for copper, accounting for more than 60 percent of the annual world copper production and approximately 65 percent of the known total copper resource.

- Porphyry copper deposits are also important sources for other metals, including molybdenum, gold and silver. Minor amounts of rhenium, tellurium, arsenic, zinc and platinum group elements are also present in elevated concentrations within these systems and are recovered at some mining operations.

Important World Deposits

- MVT deposits
- Broken Hill deposit of Australia
- Ni-Pt deposit of Ontario
- Stassfurt deposit of Germany
- Witwaters Sand deposit of South Africa
- Kuroko type deposit.

MVT Type Deposit

- Mississippi Valley-type (MVT) deposits are epigenetic stratabound carbonate-hosted sulphide bodies composed predominantly of sphalerite and galena.

- These deposits account for approximately 25 percent of the world's lead and zinc resources.

- They are so-named because several classic MVT districts are located in carbonate rocks within the drainage basin of the Mississippi River in the central United States (US).

- Important Canadian districts include Pine Point, Cornwallis, Nanisivik, Newfoundland Zinc, Gays River, Monarch-Kicking Horse, and Robb Lake

MVT Type Deposit

- MVT deposits are stratabound, carbonate-hosted sulphide bodies, composed predominantly of zinc and lead, bound in sphalerite and galena.

- The deposits occur mainly in dolostone as open-space fillings, collapse breccias and/or as replacement of the carbonate host rock.

- Less commonly, sulphide and gangue minerals occupy primary carbonate porosity. The deposits are epigenetic, having been emplaced after lithification of the host rock.

- MVT deposits originate from saline basinal metalliferous fluids at temperatures in the range of 75°-200°C.

- They are located in carbonate platform settings, typically in relatively undeformed orogenic foreland rocks, commonly in foreland thrust belts,

MVT Type Deposit

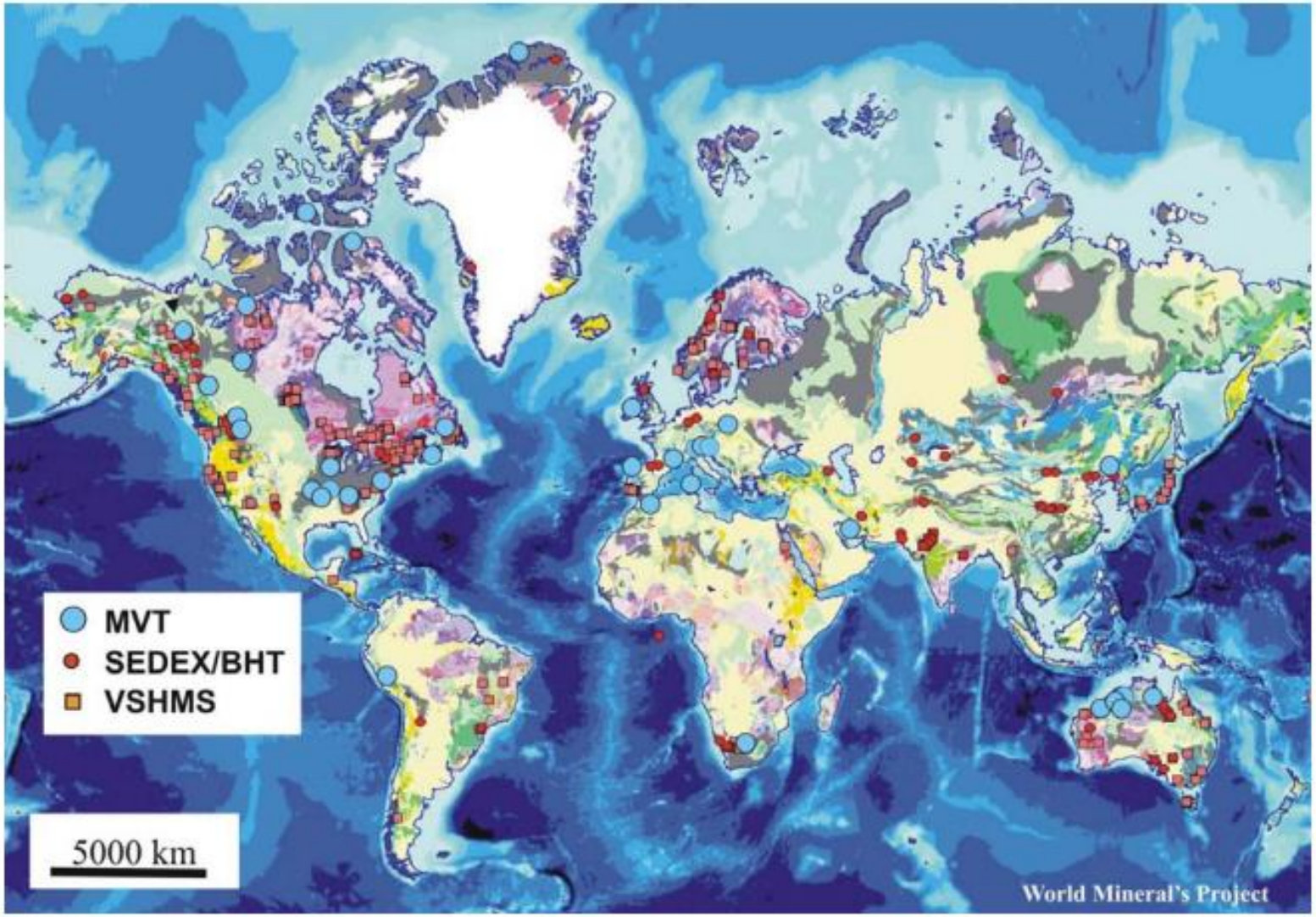


FIG. 1. Distribution of Mississippi Valley-type deposits and districts worldwide (from Sangster, 1990). Numbers on symbols are the deposit numbers of the World Mineral Deposits Database.

MVT Type Deposit

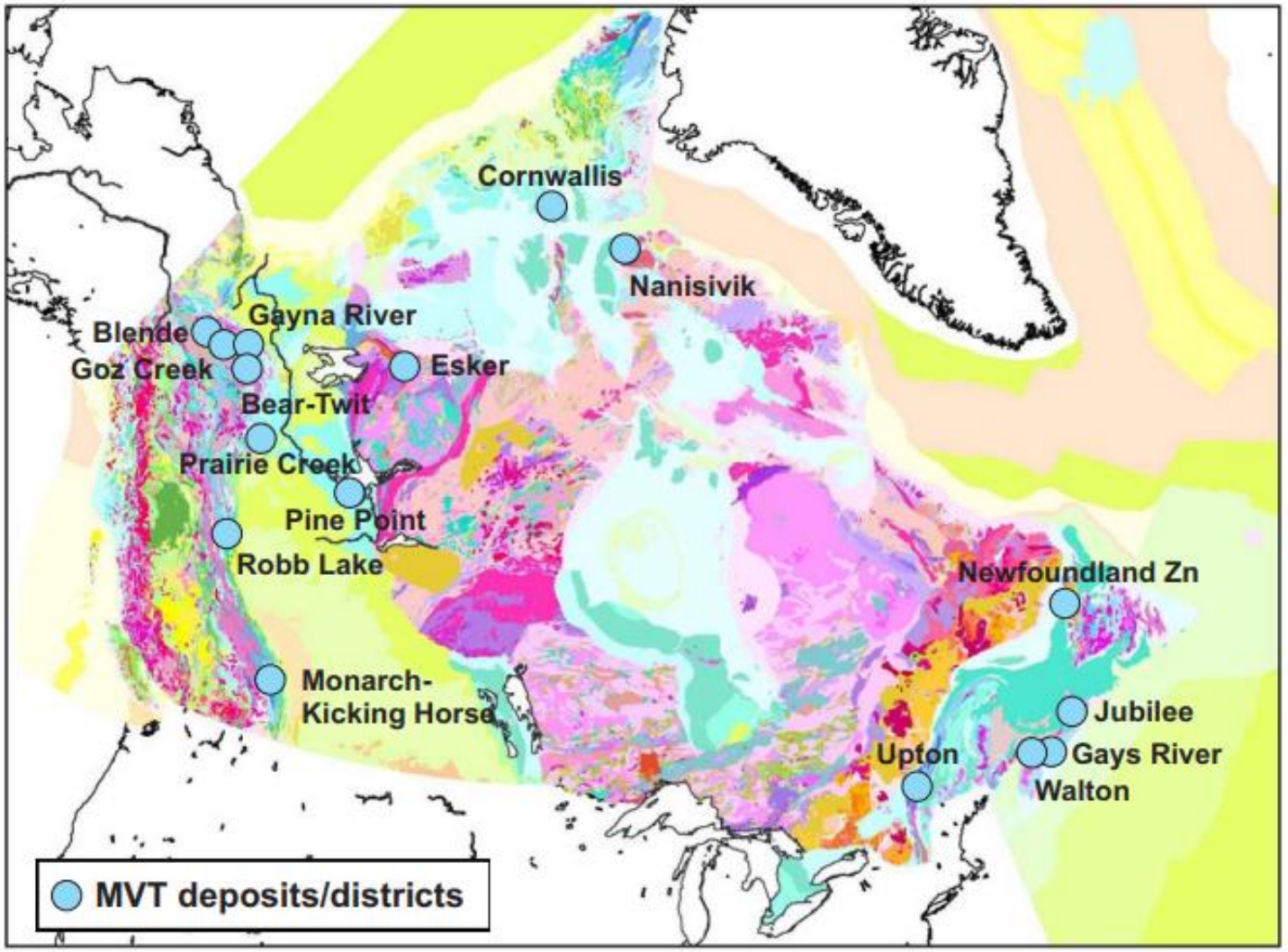
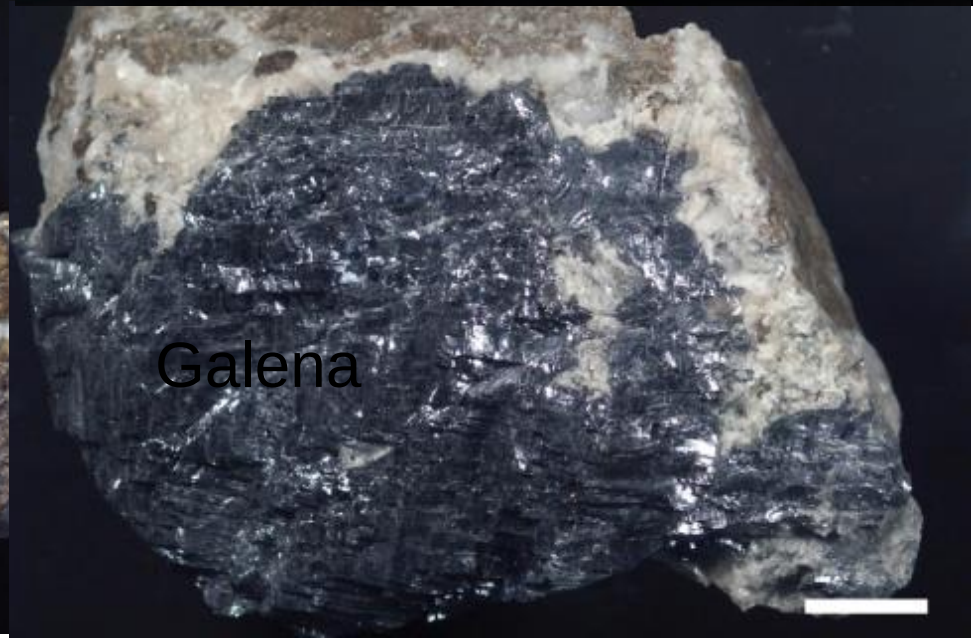


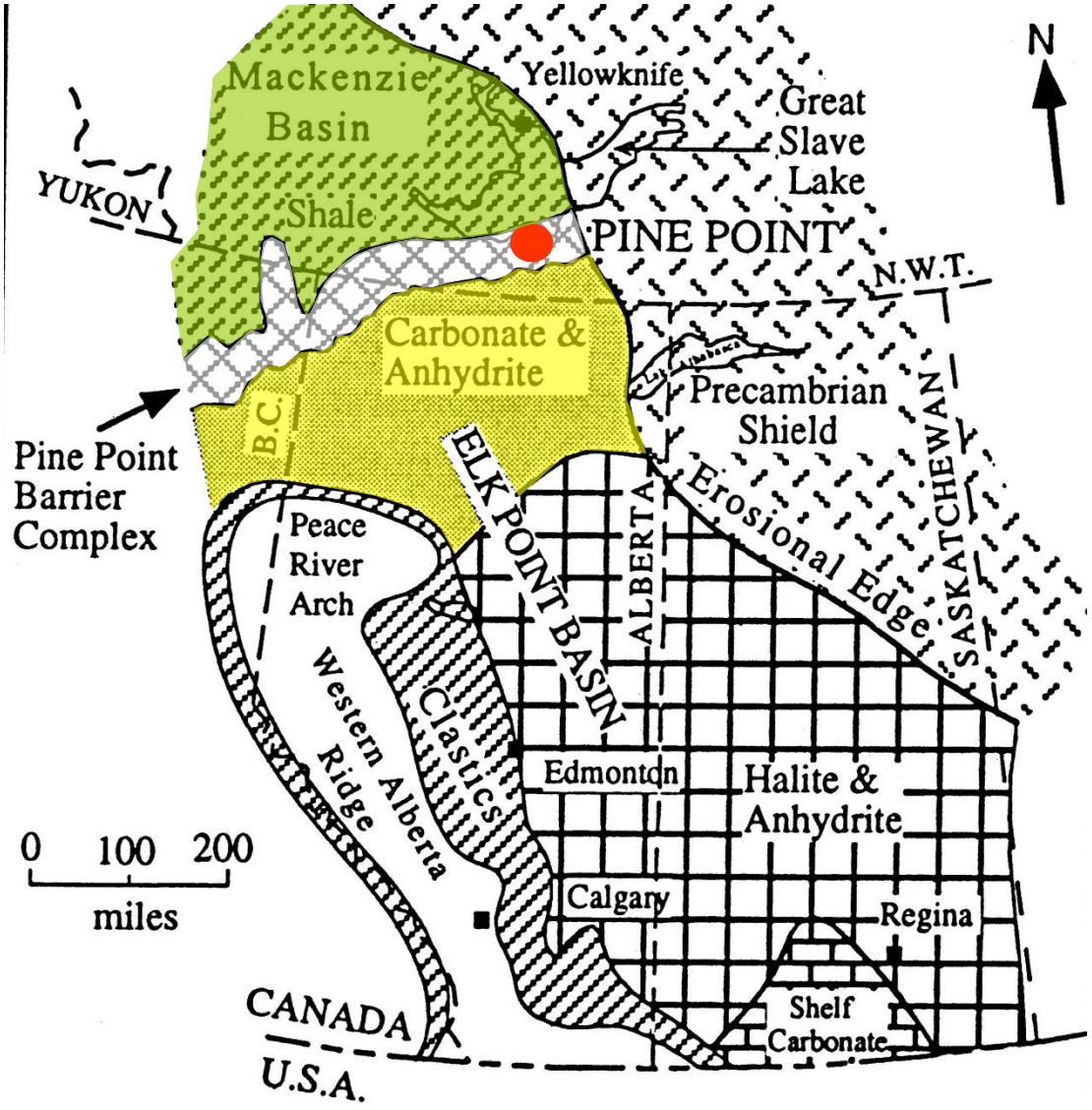
FIG. 2. Distribution of Mississippi Valley-type deposits/districts plotted on a simplified geological map of Canada (Map D1860A). Districts shown are, Cornwallis; Nanisivik, Pine Point, Prairie Creek, Robb Lake, Monarch-Kicking Horse, Blende, Bear-Twit, Gayna River, Goz Creek, Gays River, Jubilee, Walton, Newfoundland Zn, Upton, and Esker.

MVT Ores

Sphalerite and Galena in brecciated, dolomitized limestone



Geological Setting of Pine Point



Pine Point Ore and Host Textures

Broken Hill deposit of Australia

- The Broken Hill Ore Deposit is located underneath Broken Hill in western New South Wales, Australia
- Initially thought to be of Iron, later described as tin oxide and lastly Charles Rasp discovered the gossan or weathered sulfide outcrop of massive lead-zinc sulfides on a feature known as Broken Hill.
- It is arguably the world's richest and largest zinc-lead ore deposit.
- The Broken Hill ore body is hosted within the gneisses of the Willyama Supergroup, a mesoproterozoic sequence of sillimanite gneisses. The original sediments consisted of alternating clays, sandy clays, sands, granitic sills, gabbro sills, and pegmatite sheets.

Broken Hill deposit of Australia

- Deformation, folding, and metamorphism converted the sediments into gneiss, the granitic rocks in augen, and the gabbro into amphibolites and hornblende schists.

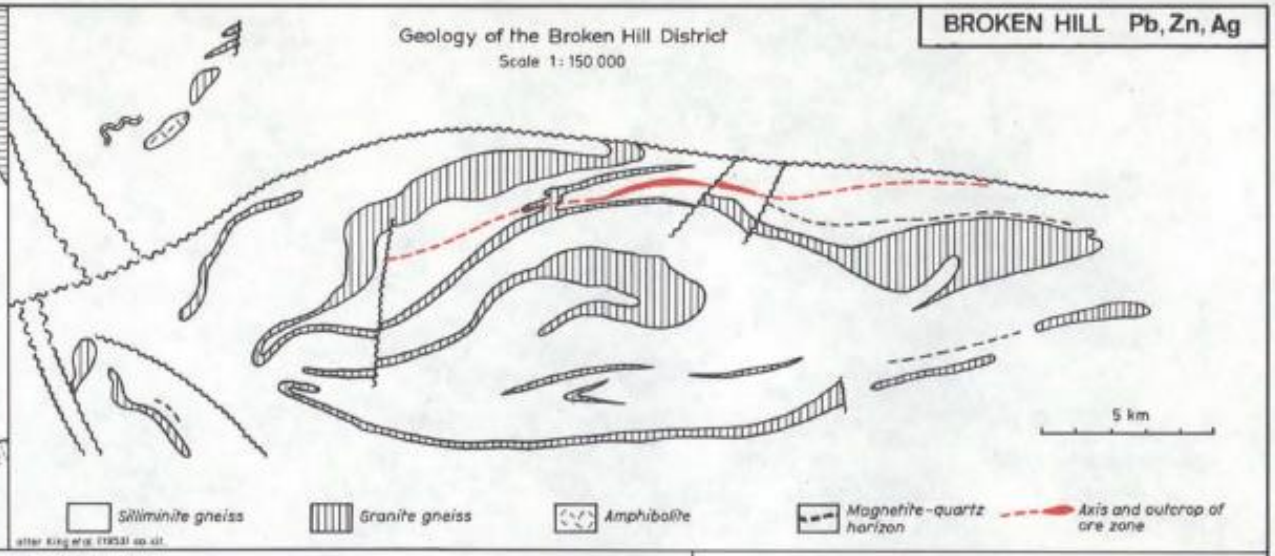
- The ore consists of massive, recrystallised sphalerite-rich, galena-sphalerite and galena-rich sulfide lenses in folded horizons, known as No. 2 Lens Formation and No.3 Lens Formation. Both have distinctive metal ratios and gangue minerals. The ore boundaries are parallel to the bedding planes.

- The footwall to the mineralization is a psammopelite gneiss, consisting of feldspar, quartz, garnet, biotite and amphibole, with a pelite gneiss on the hanging wall.

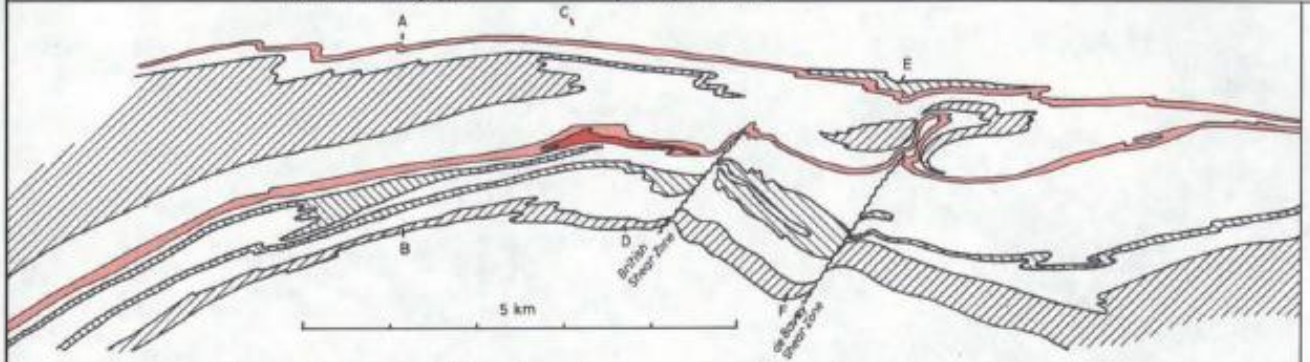
BROKEN HILL Pb, Zn, Ag

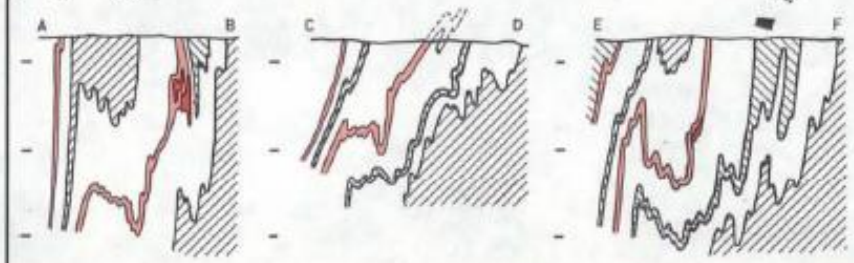
Superficial sediments
Torrowangee sediments
Mundi-Mundi Granite
Slate/schist, Gneiss (with structural form-lines) } Willyama complex

after Carruthers op. cit.



after King et al. (1953) op. cit.





Plan and sections of the Broken Hill Deposit
Scale 1: 60000

Mineralized horizon with ore bodies
Hangingwall gneiss
Potosi gneiss
Sillimanite gneiss with amphibolite

after Lewis et al. (1965) op. cit.

Vertical cross-section of the Broken Hill Ore bodies

Scale 1: 7500

Characteristics of the ore bodies

	Pb %	Zn %	Ag g/t	Gangue
B	5	20	34	Qz
A	4	16	34	Qz, Gnt, Rho, MnHd
1 Upper	8	20	34	Qz, Cal
1 Lower	8	20	34	Qz, Cal
2/3	17	16	257	Qz, Cal, Rho, Flu

Qz = quartz; Gnt = garnet; Rho = rhodonite; MnHd = mangan-hedenbergite; Cal = calcite; Flu = fluorite

after Carruthers (1966) op. cit.

Ni-Pt deposit of Ontario

- Also known as Sudbury Nickel Deposit, Canada
- This is the largest nickel-mining district in the world.

- In outline the geology seems simple; nickel and copper sulphides segregated from a basic magma; but there are some puzzling features that have led to great controversy.

- It has even been suggested that the whole complex was formed by a gigantic volcanic eruption triggered off by the impact of a large meterorite.

- The Sudbury lies on the boundary between a large area of Archean granite gneisses and somewhat younger Aphebian rocks of the Penokean Fold Belt, belonging to the Huronian Super-Group.

- In the centre of the Sudbury Basin is the Whitewater Group, beginning with a quartzite breccia (similar to the Sudbury Breccia) overlain by some spectacular ignimbrites, tuffs and pumicites, overlain in turn by calcareous argillites and slates and sandstones.

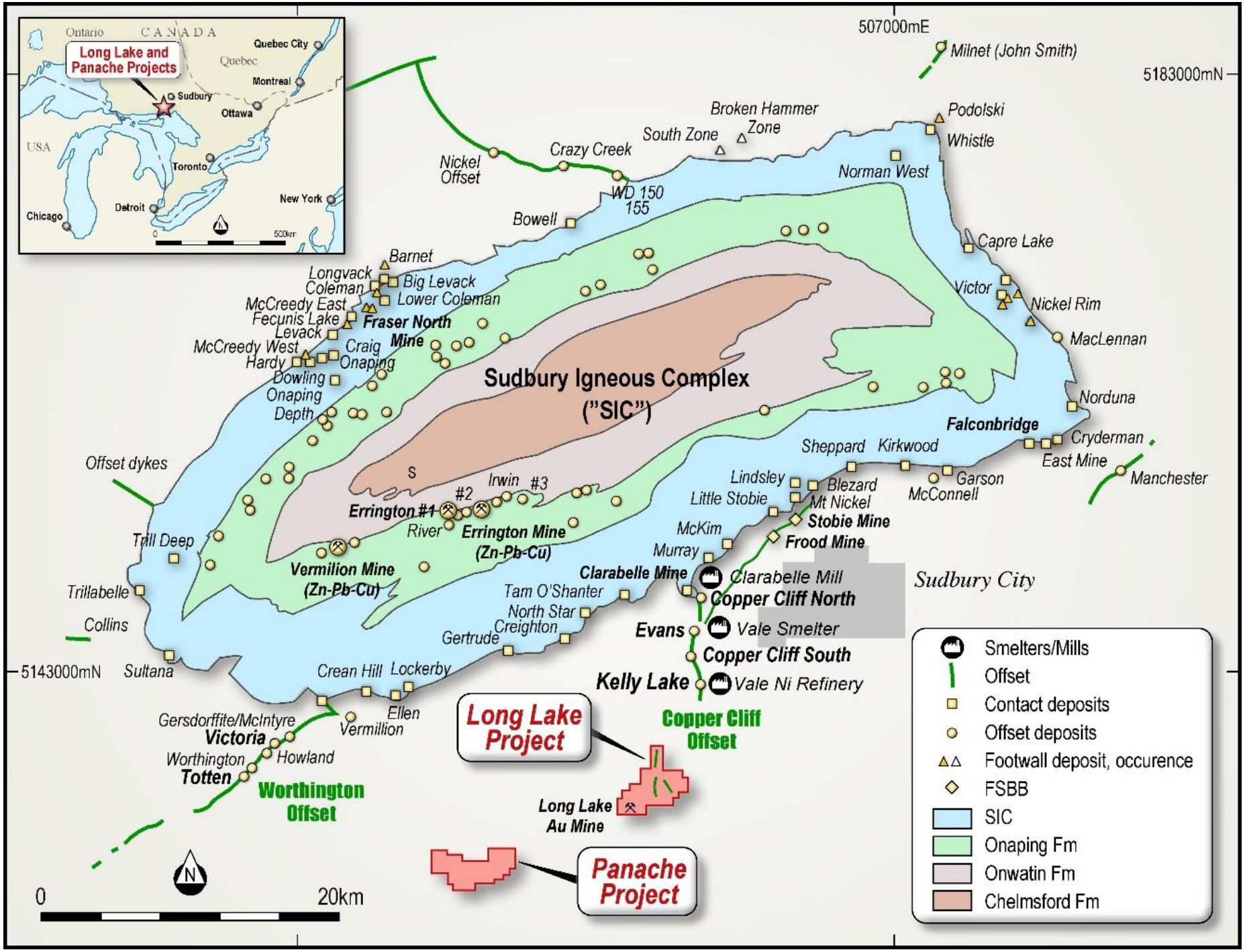
Ni-Pt deposit of Ontario

- Some fifty deposits are known round the edge of the complex.

- The deposits contain pyrrhotite intergrown with pentalandite, and chalcopyrite. In addition, small amounts of magnetite or ilmenite occur.

- Pyrite is present in some ore bodies and a large number of other minerals occur. The range of minor and trace-elements is large, including the platinum metals, gold, silver, cob alt, lead, zinc, bismuth, arsenic, antimony, selenium and tellurium.

- The form of the Sudbury igneous complex has given rise to much speculation. Originally, it was interpreted as a gently folded sheet or sill. The balance of opinion today favours a lopolith with a deep root, for which there is a little geophysical evidence. The idea that the complex started life as an astrobleme is supported by the occurrence of high energy shatter-cones in the surrounding rocks and the Sudbury Breccia; a stony meteorite 4 km in diameter would be required,


Ontario
CANADA
Quebec City
Long Lake and Panache Projects
Quebec
Montreal
Sudbury
Ottawa
USA
Toronto
Detroit
New York
Chicago
0
500km
507000mE
5183000mN
Milnet (John Smith)
Broken Hammer Zone
South Zone
Podolski
Whistle
Nickel Offset
Crazy Creek
Norman West
WD 150
155
Bowell
Capre Lake
Barnet
Longvack
Coleman
Big Levack
Lower Coleman
McCreedy East
Fecunis Lake
Fraser North Mine
Levack
McCreedy West
Craig
Hardy
Onaping
Bowling
Onaping Depth
Victor
Nickel Rim
MacLennan
Sudbury Igneous Complex ("SIC")
Norduna
Falconbridge
Cryderman
East Mine
Manchester
Sheppard
Kirkwood
Garson
McConnell
Offset dykes
S
Irwin
#3
#2
Errington #1
River
Errington Mine (Zn-Pb-Cu)
Lindsley
Blezard
Little Stobie
Mt Nickel
Stobie Mine
Frood Mine
McKim
Murray
Trill Deep
Vermilion Mine (Zn-Pb-Cu)
Clarabelle Mine
Clarabelle Mill
Sudbury City
Copper Cliff North
Trillabelle
Tam O'Shanter
North Star
Creighton
Collins
Gertrude
Evans
Vale Smelter
Copper Cliff South
5143000mN
Sultana
Crean Hill
Lockerby
Kelly Lake
Vale Ni Refinery
Ellen
Vermillion
Long Lake Project
Copper Cliff Offset
Gersdorffite/McIntyre
Victoria
Worthington
Howland
Totten
Worthington Offset
Long Lake Au Mine
Panache Project
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20km
Smelters/Mills
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Contact deposits
Offset deposits
Footwall deposit, occurence
FSBB
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Chelmsford Fm

Stassfurt deposit of Germany

- Staßfurt (Stassfurt) is a town in Saxony-Anhalt, Germany. It is situated on both sides of the river Bode.
- The first potash deposits in the world were discovered in 1856
- The commencement of raw potash salt extraction in Staßfurtfive years later marked the birth of potash mining.
- The nutrient potassium, which until then could only be obtained from wood ashes (the origin of the word "potash"), was now available in large quantities for use in agriculture.
- Potash is a general term referring to any potassium fertilisersused in agriculture.
- Potassium is a naturally occurring element which cannot be manufactured synthetically.
- As one of the most important plant nutrients (besides nitrogen and phosphate), it is indispensable for productive and healthy plant growth.
- Potassium fertilisers therefore make a decisive contribution to better providing the growing world population with food, in terms of both quantity and quality.

Stassfurt deposit of Germany

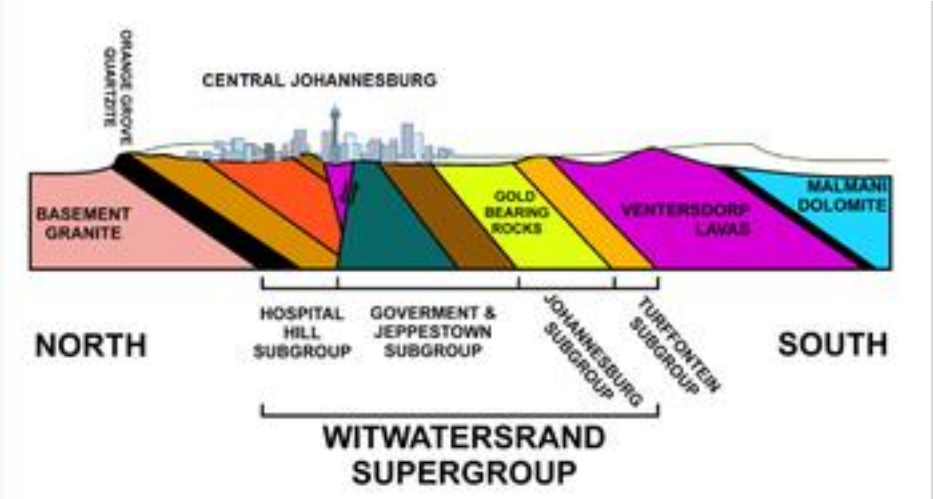
- Potassium is the seventh most common element occurring in the Earth's crust, accounting for 2.4% of its mass.
- K present in most rocks and soils.
- Sedimentary salt beds remaining from ancient inland seas (evaporitedeposits)
- Salt lakes and natural brines
- Potash refers to a variety of K-bearing minerals
- Potash deposits, i.e. natural concentrations of raw potash, consist of potassium salt rock, predominantly made up of the potassium minerals:
  - Sylvite(KCl),
  - Carnallite(KMgCl3*6H2O),
  - Kainite (4KCl.4MgSO4.11H2O) and
  - Langbeinite(K2Mg2(SO4)3)

Witwatersrand deposit of South Africa

- The Witwatersrand (locally the Rand or, less commonly, the Reef) is a 56-kilometre-long (35 mi), north-facing scarp in South Africa.

- It consists of a hard, erosion-resistant quartzite metamorphic rock, over which several north-flowing rivers form waterfalls, which account for the name Witwatersrand, meaning "ridge of white waters" in Afrikaans

- The Witwatersrand Basin is a largely underground geological formation which surfaces in the Witwatersrand, South Africa. It holds the world's largest known gold reserves and has produced over 1.5 billion ounces (over 40,000 metric tons), which represents about 50% of all the gold ever mined on earth.



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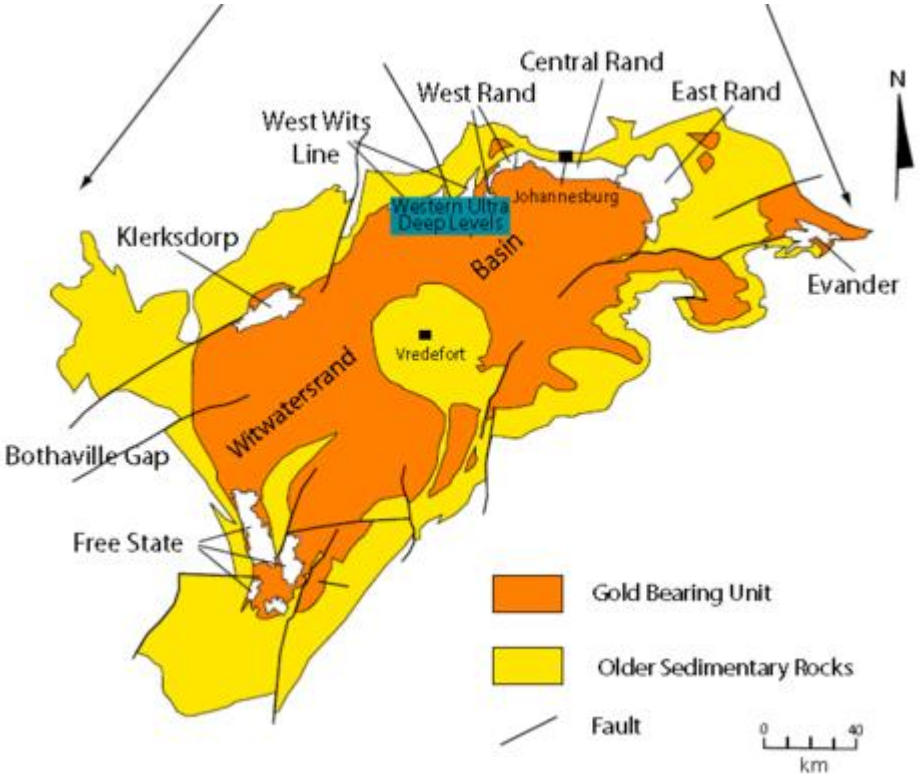


Witwatersrand deposit of South Africa

• Workable gold and/or uranium occurs at specific stratigraphic levels in the sequence and are locally termed 'reefs'.
In general they are of two types: conglomerate or 'banket' reefs, and carbon-seam reefs.

The first type consists of clean conglomerate of well-rounded pebbles usually of quartz, but sometimes including chert, quartzite and other hard materials. The matrix usually contains a lot of pyrite, itself sometimes in the form of small pebbles or pebble-like fragments and with fine micaceous minerals and fine-grained quartz. Uranium is generally present as fine, rounded grains of uraninite.

The second type are semi-continuous bands of a carbonaceous material often only a few millimetres thick known as 'carbon leaders'. The 'carbon' is a fibrous, high~carbon, hydrocarbon complex which contains uranium and sub-microscopic gold.

Kuroko type deposit

- VMS deposits constitute some of the richest deposits of copper, lead, and zinc known.

- The most famous is in Japan and called kuroko deposits, yield ores that contain as much as 20 percent combined copper, lead, and zinc by weight, plus important amounts of gold and silver.

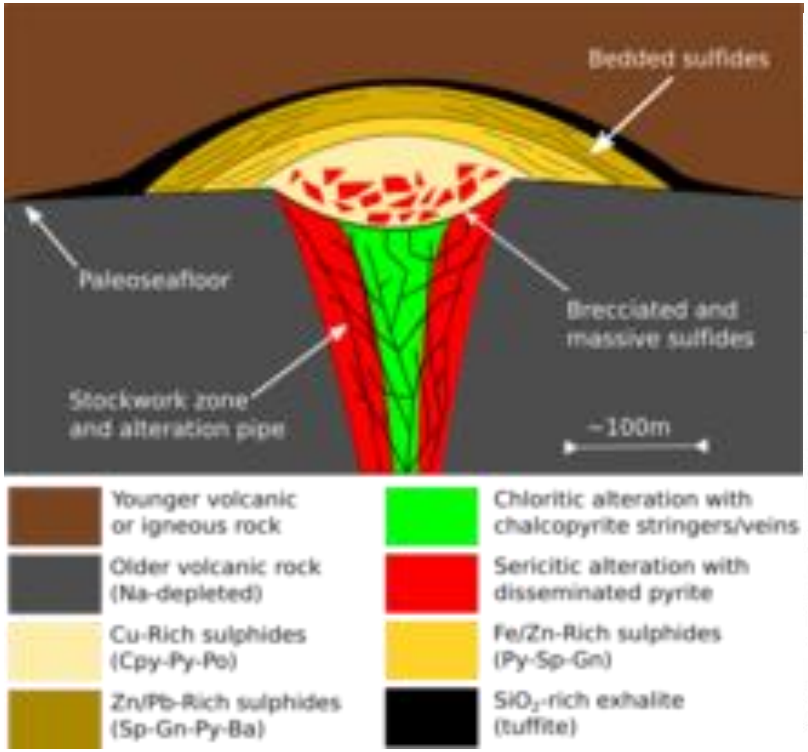
- Six clusters of sulphide ore bodies have been discovered in the district, which have the form of irregular lenses varying from 100-200 m in length and in thickness, from a few metres to 50 m. Some mineralization occurs in the upper, altered, parts of the lava domes, but most is in, or just above, the volcanic breccias.

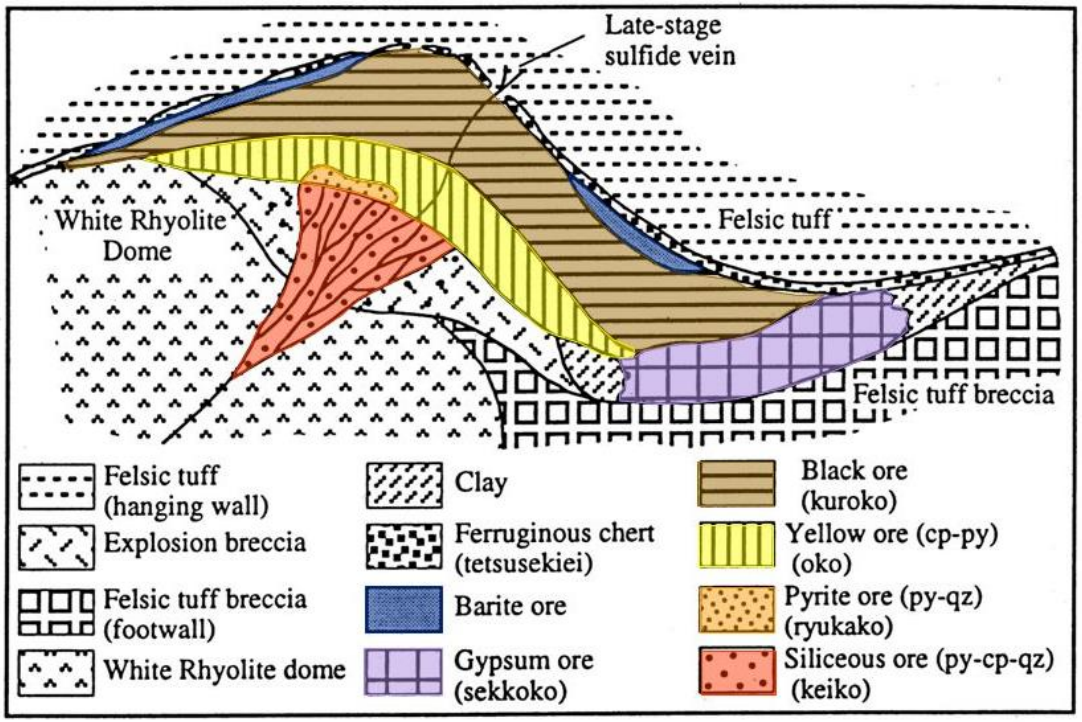
- The ore bodies are strikingly zoned In texture and mineralogy. The most complete sequence is displayed by Uchinotai-nishi ore body, which has been divided into four zones. The lowermost zone is of veinlet ore in volcanic breccia, which, though altered, still retains its original texture.

Kuroko type deposit

- The veinlets contain pyrite and chalcopyrite, the quantity of which increases upwards and eventually changes to a zone of massive pyrite and chalcopyrite.

- The third zone is the true kuroko (black ore) consisting of banded (and probably bedded) sulphides including pyrite, silver-rich galena, sphalerite, tetrahedrite and some barite.





Any
Questions??

Thank You !!!