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Earth Resources

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Terminology

- Ore mineral
- Gangue minerals
- Ore
- Ore grade
- Deposit
- Resource

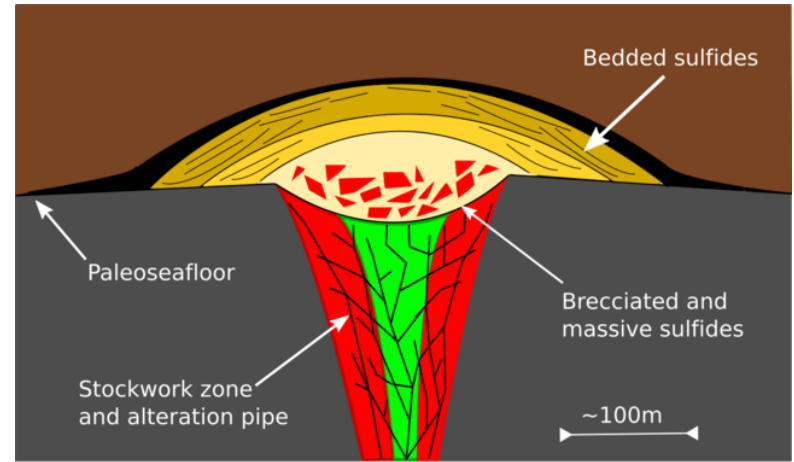


Gossan of nickel-sulphide ore Otter Shoot, Kambalda, WA by R Hill. CSIRO Science Image



Ore Formation

- Igneous
 - Intrusive
 - Exhalative
- Hydrothermal
- Weathering = leaching
- Complex combinations



Younger volcanic or igneous rock	Chloritic alteration with chalcopyrite stringers/veins
Older volcanic rock (Na-depleted)	Sericitic alteration with disseminated pyrite
Cu-Rich sulphides (Cpy-Py-Po)	Fe/Zn-Rich sulphides (Py-Sp-Gn)
Zn/Pb-Rich sulphides (Sp-Gn-Py-Ba)	SiO ₂ -rich exhalite (tuffite)

Cross-section of a typical volcanogenic massive sulphide ore deposit. (RockingGeo 2019 Wikimedia Creative Commons)



Exploration Techniques

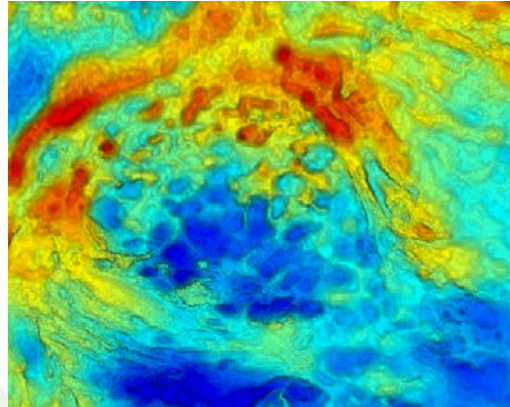
- Gathering information



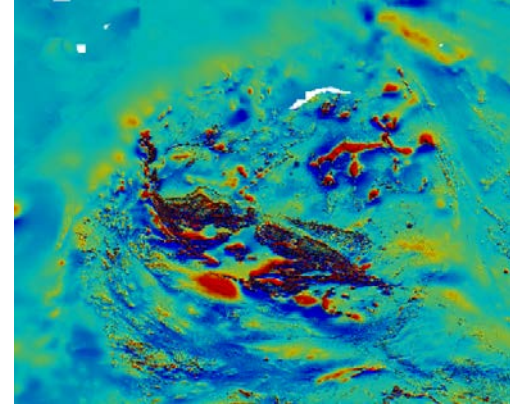
Exploration Techniques

- Gathering information
- Geophysical surveys
 - Magnetic
 - Gravity
 - Radiometric

Gravity Map



Magnetic Anomaly Map



From Geoview

<https://geoview.dmp.wa.gov.au/geoview/?Viewer=GeoView>

accessed 15 April 2020



Exploration Techniques

- Gathering information
- Geophysical surveys
 - Magnetic
 - Gravity
 - Radiometric
- Field work
 - Chip samples
 - Stream sediment sampling
 - Soil sampling
 - Drilling (reverse circulation, diamond)



A core sample for the Woodlawn mine near Goulburn, NSW (CSIRO Science Image)



Mining

- Open cut
 - Ore deposit relatively close to surface
 - Dug downwards in intervals (= benches)



Open cut mining at Paddington Gold Mine near Kalgoorlie (1998, CSIRO Science Image)



Mining

- Open cut
 - Ore deposit relatively close to surface
 - Dug downwards in intervals (= benches)
- Underground
 - Ore deep underground (often in pockets)
 - Accessed through tunnels and shafts



Entry to Wiluna Underground Gold Mine, Wiluna WA (2009, Wikimedia Creative Commons)



Processing

- Crushing and grinding



Ball mill at Cadia mine, NSW (2012, S Filan)



Processing

- Crushing and grinding
- Magnetic/Gravity separation



Multi Gravity Separator manufactured by Gravity Mining Ltd, England (2008, Wikimedia Creative Commons)



Processing

- Crushing and grinding
- Magnetic/Gravity separation
- Froth flotation



Flotation mill at Woodlawn mine, NSW (CSIRO Science Image)



Processing

- Crushing and grinding
- Magnetic/Gravity separation
- Froth flotation
- Carbon in leach (pulp)



*Sunrise Dam Gold Mine (WA) carbon in leach tanks
(2009, Wikimedia Creative Commons)*



Processing

- Crushing and grinding
- Magnetic/Gravity separation
- Froth flotation
- Carbon in leach (pulp)
- Elution
- Electrowinning



Copper cathodes at the Inspiration Consolidated Copper Company's electrowinning refining plant (Arizona, USA) (CM Keyes 1972, National Archives and Records Administration public domain)



Processing

- Crushing and grinding
- Magnetic/Gravity separation
- Froth flotation
- Carbon in leach (pulp)
- Elution
- Electrowinning
- Smelting



Liquid gold that has been smelted in an arc furnace is removed to pour (demonstration in South Africa) (D Brown 2006, Wikimedia Creative Commons)



Rehabilitation

- Backfilling and contouring



The former Jackpile-Paguate uranium Mine in New Mexico USA has been backfilled and contoured. (M Gant, National Institute of Environmental Health Sciences 2013, Public Domain)



Rehabilitation

- Backfilling and contouring
- Ripping
- Top soil return



The Polkemmet coal mine in North Lanarkshire Great Britain is being landscaped. (R Webb 2009, Wikimedia Creative Commons)



Rehabilitation

- Backfilling and contouring
- Ripping
- Top soil return
- Seeding
- Weeding
- Monitoring



Megathyrsus maximus (Petrie Green Panic) is pasture grass sown in mine rehabilitation sites in the Hunter region of NSW (H Rose 2016, Wikimedia Creative Commons)



Environmental Hazards

- Noise
- Dust
- Chemical Contaminants
- Others

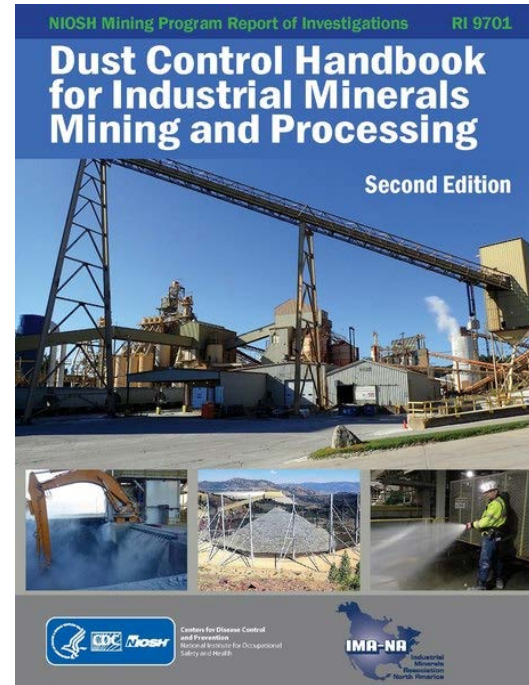


Soil pollution at the Brukunga Pyrites Mine in the Mt Lofty Ranges, SA. (J Coppi 1992, CSIRO Science Image)



Reducing Environmental Impacts

- Environmental approvals at all stages
- Securing drill sites
- Backfilling trenches
- Dust suppression



Dust control handbook from the National Institute for Occupational Safety and Health (USA). (NIOSH 2019, Public Domain)

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Reducing Environmental Impacts

- Environmental approvals at all stages
- Securing drill sites
- Backfilling trenches
- Dust suppression
- Lining tailings ponds
- Pollution control methods
- Ongoing monitoring



Black Cloud Mine tailings pond in Colorado USA. (J Holm 2008, Wikimedia Creative Commons)



Social and Heritage Issues

- Social issues may include
 - Health impacts
 - Supporting family life
 - Land use competition
- Heritage issues may include
 - Sites of cultural significance
 - Native title
 - Land use competition



Old head frame of underground workings at Whim Creek Mine, WA (2008, Public Domain)





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