Arsenic mineralogy and mobility at two historic gold mines, New Zealand

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Introduction

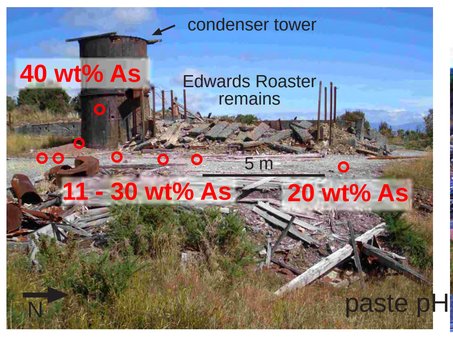
Arsenic (As) is a trace metalloid element that is commonly associated with metallic mineral deposits. The mining and beneficiation of gold, which is commonly intergrown with the sulphide phases, produces arsenic rich mine wastes, thereby accelerating the natural processes of arsenic mobilization. Arsenic is considered to be toxic in the environment at relatively low (ppb) levels.

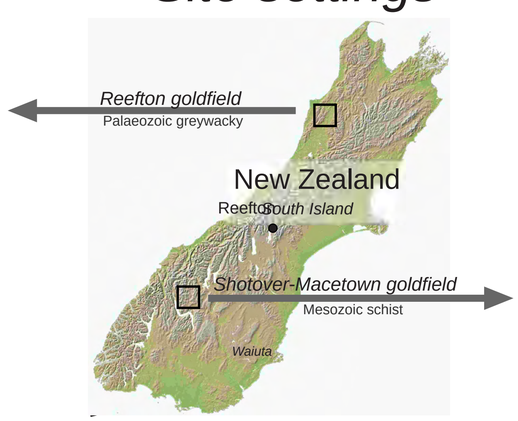
Focus

1.) Assess the influence of ore processing techniques on arsenic mineralogy of residues.
2.) Establish the distribution and morphology of arsenic minerals.
3.) Characterise arsenic mobility, on site and in the downstream environment with respect to secondary arsenic minerals.

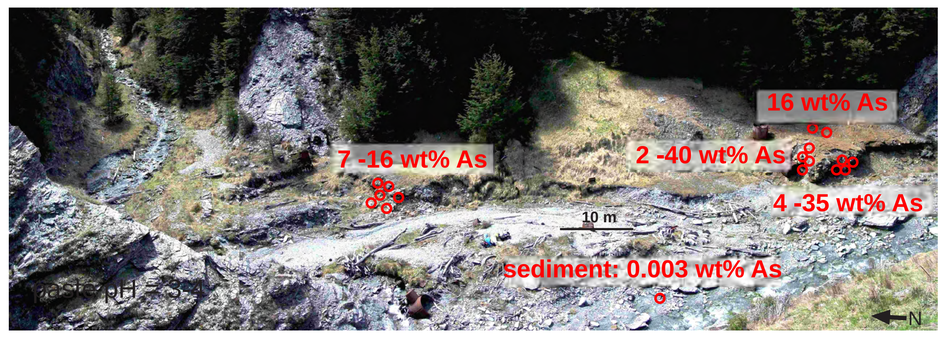
Site settings

Blackwater gold mine
1938 - 1951





Phoenix gold mine
1864 - 1907

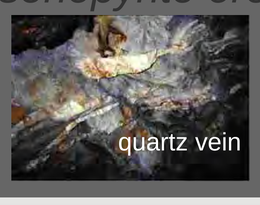


1

Originally all arsenic was present as arsenopyrite in the mineralised zones hosted by the Greenland Group rocks (Blackwater Mine) and the Aspiring lithilogical association (Phoenix Mine).

Blackwater mine

arsenopyrite ore



FeAsS
arsenopyrite

Phoenix mine

crushing + roasting
$2\ FeAsS + 5\ O_2 \rightarrow Fe_2O_3 + As_2O_3 + 2\ SO_2$

Edwards Roaster

hematite + As_2O_3 gas + SO_2 gas

atmosphere

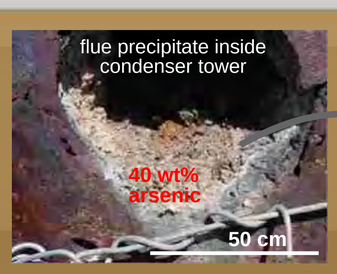
soil

As_2O_3 condenses

condenser (40 wt% As)

As_2O_3 precipitate
(arsenolite)

70 mg As = fatal [1]
→ 0.2 g of precipitate could be fatal



crushing + cyanidation

tailings

FeAsS
arsenopyrite

principal source of environmental arsenic

dissolution + oxidation + precipitation

dissolution + oxidation + precipitation (up to 12 g/L[2]) $As^{III} \rightarrow As^{V}$

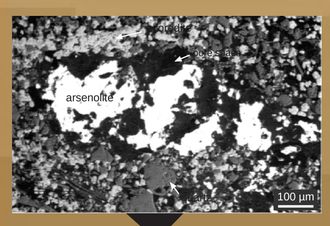
transportation + spillage

ore processing

2

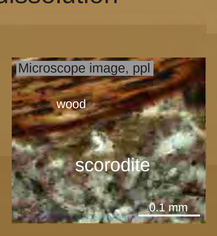
ground around condenser (up to 30 wt% As)

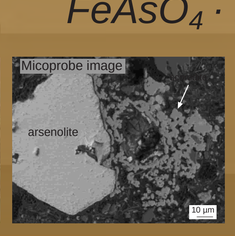
detrital As_2O_3

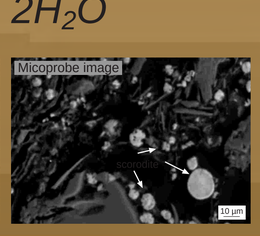


encapsulated by scorodite and unavailable for dissolution

scorodite cement
$FeAsO_4 \cdot 2H_2O$



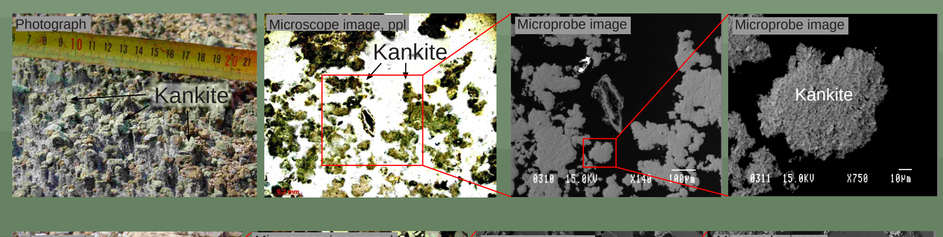


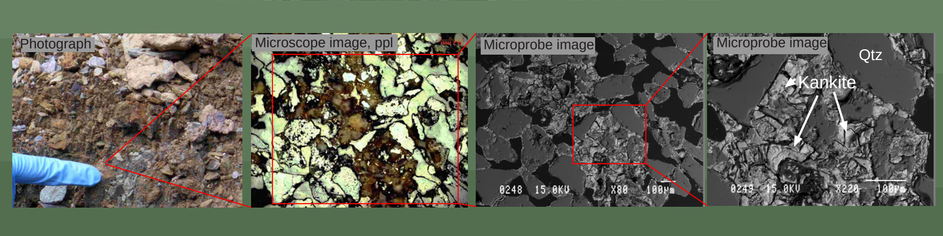


The cementing nature of hydrated secondary arsenic minerals encapsulates arsenic rich material

tailings and surrounding ground (up to 30 wt% As)

FeAsS
arsenopyrite
+
kankite cement
$FeAsO_4 \cdot 3.5\ H_2O$





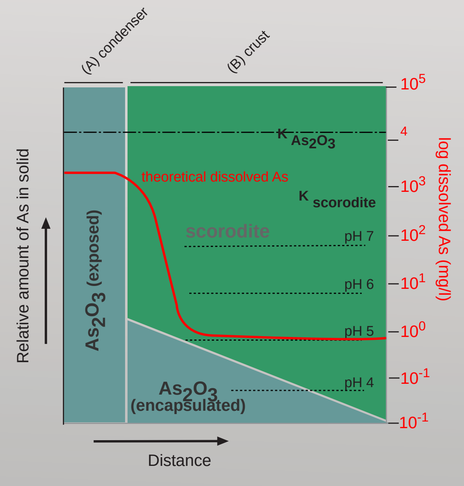
dissolved arsenic in residues

3

dissolution

dissolution

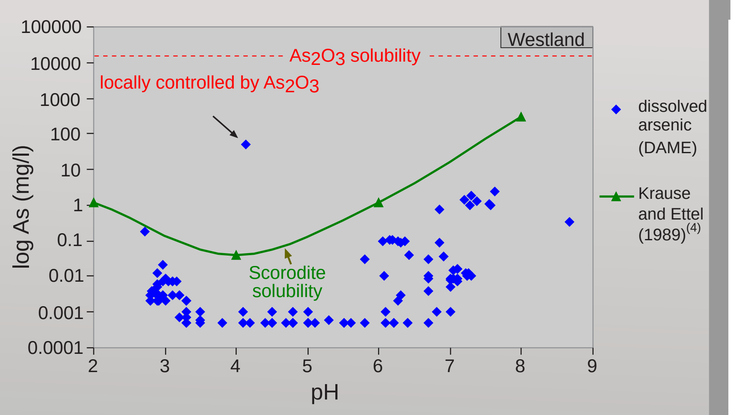
LOCAL downstream environment



Dissolved arsenic is controlled by $FeAsO_4 \cdot nH_2O$ in the local and regional downstream environment.

regional catchment

REGIONAL downstream environment



References:
(1) Abernathy, C., 1993. Draft drinking water criteria document on arsenic. US-EPA Sci Adv Board Rep.
(2) Krause, E. and Ettel, V.A., 1989. Solubilities and Stabilities of Ferric Arsenate Compounds. Hydrometallurgy, 22: 311-337.

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