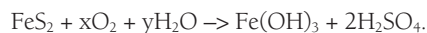


Acid Drainage

Acid drainage occurs when sulphides (usually iron sulphides) are oxidised according to the following, highly simplified, equation:



The process is bacterially mediated and temperature and moisture all affect the rate and expression of the problem. However, the neutralising capacity of the gangue is probably the most significant factor in reducing or preventing the formation of acid drainage. The geochemical reactions and indicators of sulphide oxidation and acid generation are shown in Figure FS 7.1.

In addition to the generation of acid, the low pH of these waters can mobilise trace and heavy metals, resulting in the potential for widespread contamination.

There are many techniques available to foresee if acid drainage is likely to be a problem, including:

- chemical prediction/materials characterisation (NAPP, ANC, NAG, solution indicators);
- models (eg. for location of acid generating material in a model of the orebody and waste, rates of acid generation, timing of appearance in mining schedule, predictions and schedule of cost of treatment); and
- predictions of ecological impacts.

Once acid drainage is present, opportunities to manage it are limited to:

- prevention of the generation of acid:
 - separate the acid producers (for sale or entombing);
 - cut off oxygen (wet or dry covers);
 - pacify the mineral surface;
 - solidify the waste rock or waste rock mass; and
 - minimise water movement (generation and transport of acid); and/or

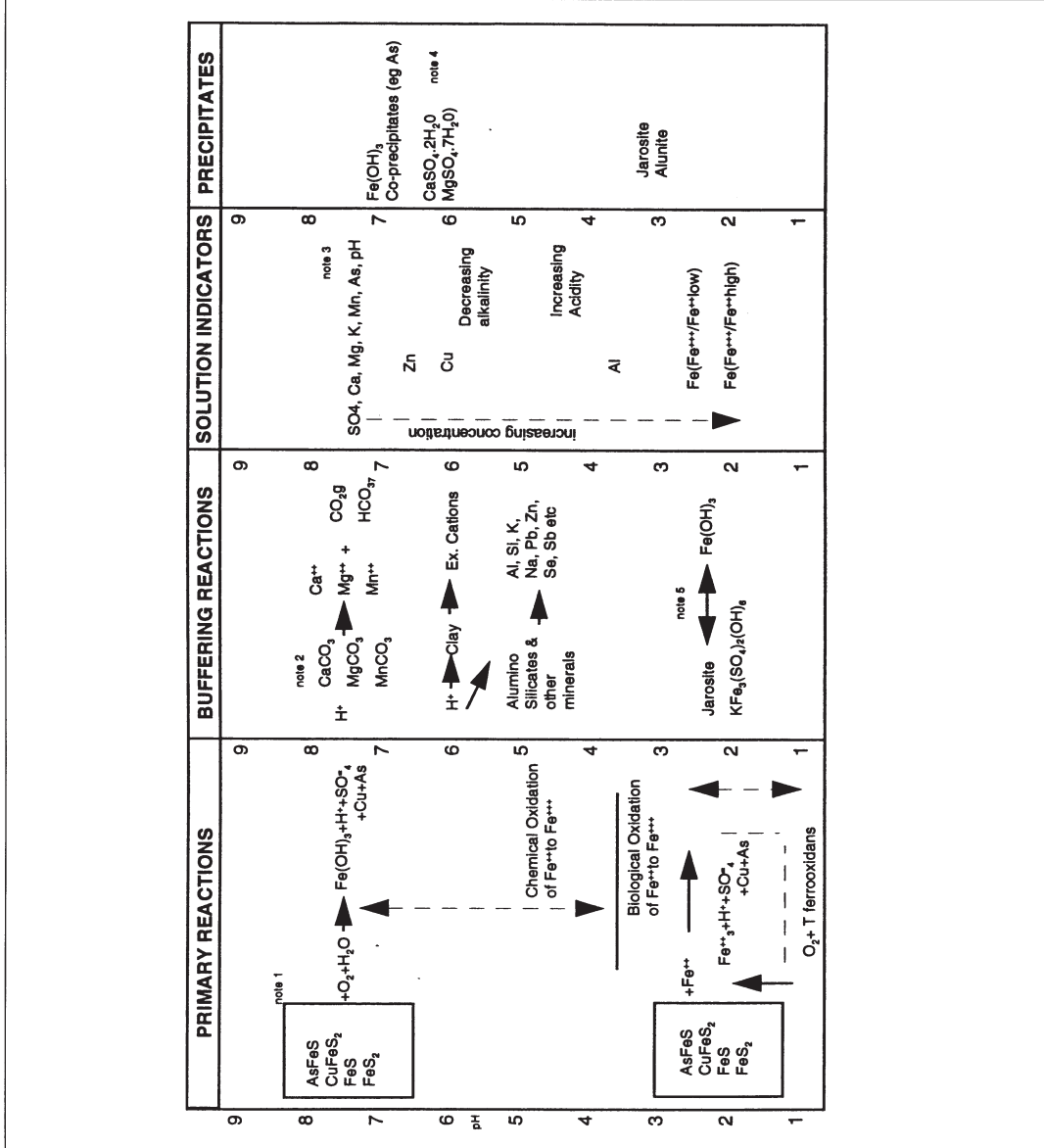
- treatment of acid drainage:
 - lime or alkali treatment of the drainage; blend solids with alkaline material eg. limestone;
 - use bacteria for sulphide precipitation;
 - use plants to uptake and store metals, eg. wetlands; and
 - use concentration/recovery process, eg. cementation.

Considerable work has been undertaken around the world and the status and outlook for key control technologies are summarised in Table FS 7.1.

In high rainfall environments, the volumes of contaminated water that are generated can be extremely difficult and costly to contain and/or treat. This potentially ongoing, long-term cost should be factored in to any development decision.

Acid Drainage

FIGURE FS 7.1: Geochemical Reactions and Indicators of Sulphide Oxidation and Acid Generation



Note 1: Non ferrous metal sulphides such as CuS, PbS, NiS, ZnS are acid neutral. Sulphides such as Cu₂S are acid consuming.

Note 2: Siderite (FeCO₃) is not included since it has nil net neutralising capacity in an oxidising environment.

Note 3: pH of site drainage may initially increase in response to sulphide oxidation and acid neutralization reactions.

Note 4: Other precipitates such as CuCO₃, MnO₂, CuSO₄ can also be observed over a wide pH range.

Note 5: Jarosite iron oxide/hydroxide equilibria is a strong pH buffer and can maintain the pH as 3 even after all pyrite has been oxidised. Jarosite and iron oxides coat soil mineral surfaces and dominate the mineral solution chemistry.

Acid Drainage

TABLE FS 7.1: Status and Outlook for Key Control Technologies

Technology	Applicable	Current status	Research outlook	Major limits
Chemical prediction	All	Inexact	Good	Costly
Prediction models	All	Incomplete	Good	Complex
Pre-treatment	Some	Beginning	Good	Site specific
Dry covers	Many	Field demonstration	Very good	Cost
Wet covers	Many	Laboratory/Field	Very good	Site specific
Fixation	Selected	Laboratory	Fair	Cost
Lime neutralisation	All	In practice	Excellent	Perpetual
Sludge disposal	All	Emerging	Good	Volume/ Containment
Bio-treatment	Partial	Laboratory/Pilot	Fair	Capability/ Efficiency
Metal recovery	Selected	Laboratory/Pilot	Poor	Economics