Factors that control mine water quality from bituminous coal deposits in New Zealand

Pope, J.[1], Trumm, D. [1], Weber, P. [2], Partridge, T. [3] & Craw, D.[3]
[1]*CRL Energy Ltd, 97 Nazareth Ave, Christchurch, New Zealand.*
[2]*O'Kane Consultants NZ Ltd, Darfield New Zealand*
[3]*University of Otago, Dunedin, New Zealand*
email: j.pope@crl.co.nz

In New Zealand, bituminous coal is mined in mountainous areas with temperate climate and with high rainfall (2-6m/y). Mine drainages from Brunner Coal Measures in New Zealand have low pH, high Lewis acidity and elevated concentrations of trace elements such as Zn, Ni & Mn. Mine drainage chemistry differs slightly at each mine site due to changes in the coal measures sedimentology [1, 2]. At historic sites and upstream of mine drainage treatment, acid flux is dependent on rainfall with minimal dilution even through two orders of magnitude change in mine drainage flow volume [3, 4]. Current research focuses on improved long term management of acid load from New Zealands bituminous coal mine sites [5, 6]. We present results from waste rock management trials, dump autopsies and temporal monitoring of mine drainage chemistry to improve prediction on the quantity and quality of acidic mine drainage from coal mines hosted in these rocks.

Sealed probes have been installed in four waste rock dumps and indicate the O_2 concentration in waste rock pore spaces decrease sharply with distance into the dump. At 2m into the dump, the oxygen content is often around 10% O_2 and between 4-25m into the dump the oxygen content is usually less than 3% and often less than 1%. Typically the decrease in O_2 content is related to an increase in CO_2.

An autopsy on a waste rock dump indicates the gradual development of a zone of Fe-rich secondary minerals about 2m below the dump surface that separates oxidised waste rock from less-weathered material [6]. This mineral zone probably forms as AMD with dissolved oxidised Fe(III) neutralises slightly through reaction with rocks or dissolved Fe(II) and causes precipitation of Fe(III) minerals. Where rubble zones permit increased oxygen ingress, the mineralised zones can be identified at least 5m inside the dump.

Combination of data from kinetic tests [7, 8] and field monitoring data from several mine sites indicates a general trend for acid release with time. Standard oxidised kinetic tests and humidity cell data reflect the outer skin of the dump during rapid oxidation. Long term field monitoring data available at occasional sites indicate a gradual decrease in acid release with time. This decreasing trend reflects the progressive weathering of the outer skin of the waste rock dump and reduction in the release of the products of sulphide oxidation.

The findings of oxygen probe studies, dump autopsy in combination with field data indicate the following:

- Brunner Coal Measures waste rock dumps can be divided into three zones, an outer skin that oxidises and releases acid, a zone where secondary Fe minerals concentrate and a central zone where anoxic and conditions prevent release of acid.
- Reduction in water ingress will minimise acid formation, because O_2 ingress only occurs in thin skin.
- These findings assist in long term prediction of acid release whereas previously long term acid release was based on assumptions of pyrite oxidation rates applied to poorly quantified proportion of the total waste rock dump.
- These datasets assist with optimal waste rock dump design and planning of successful rehabilitation.

Key words:
AMD, oxygen ingress, waste rock dump autopsy, acid evolution

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