An Insight into the Direction of Environmental Management in New Zealand's Coal Industry.

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Abstract

Adopting environmentally acceptable practices in New Zealand is a crucial requirement for mineral wealth development. Recent planned expansions in the coal industry have increasingly placed mining in the media spotlight. A lack of appropriate national environmental guidelines has resulted in inconsistent responses and assessments of current and prospective mine sites. Such inconsistencies have lead to delays in decisions on developing economic mineral deposits that may have only minor short-term impacts, and have also allowed unacceptable environmental management practices to continue elsewhere.

A research collaboration between CRL Energy, Landcare Research, University of Canterbury and University of Otago aims to provide regulator groups and the mining industry with a unified approach to the requirements of the Resource Management Act 1991, which is the legislation that predominantly drives the nation's environmental policies and guidelines. The tangible outcome of this research programme will be guidelines for an integrated decision-making framework based upon robust multidisciplinary science. The result of this unified process will facilitate the development of viable mineral deposits and prevent excessive environmental impacts.

The framework will be derived from a synthesis of four objectives. Objective 1 identifies potential water quality impact. This objective is based on a targeted geochemical study of the lithology and waterways of the West Coast and Southland. Objective 2 categorises the degree of impacts on the ecology of receiving aquatic ecosystems and determines the processes that drive aquatic ecosystem recovery. Objective 3 identifies best strategies to sufficiently manage impacted ecosystems, and to prevent future unacceptable impacts. Objective 4 combines the findings of Objectives 1-3 into a standard decision-making framework. The development of this framework development will include wide consultation with representatives of the mining industry and regulator groups. It is anticipated that this multidisciplinary approach will provide a robust and coherent, standardised system that will assist in achieving industry and environmental targets.

Impacts of coal mining: History and Management

Mining has been an integral part of New Zealand's landscape since the 1800's and has approximately $80 billion in potential wealth in known mineral deposits, comprised mainly of coal, gold, aggregate, and ironsands (NZMIA, 2003). Currently its estimated that $1 billion per annum is gained from mineral wealth and the industry target is to double this contribution within 10 years. This could be achieved by increasing coal production up to 6 million tonnes ($400 million), precious metals production to 3 million ounces ($750 million), aggregate to 37 million tonnes ($700 million) and ironsands to 3.5 million tonnes ($100 million) (NZMIA, 2003).

High profile cases have created a negative public image of mineral extraction. Recent media attention has focused on the both the positive (economics) and negative (environmental) aspects of the coal industry, particularly with the increase in planned coal production to meet the nation's supply needs for electricity. With the cancellation of the proposed hydro scheme planned for the South Island, coal is being touted as the solution to the country's increasing energy needs (SENZ, 2003). New Zealand's largest coal producer has committed to improve its environmental management practices, with its announcement in both the media and Annual Report of 'no net negative impacts' (SENZ, 2003).

AMD from coal mining has been recognised and assessed and documented at several sites in New Zealand (Alarcon, 1997; Black, 2000; Black et al., 2003; Black & Craw, 2001; de Joux 2003; Harbrow, 2001; Hewlett, 2003; Trumm et al., 2003). The aquatic impacts from AMD vary according to the geology of the area and the extraction method used. For example, the degree of natural buffering provided by a calcium-bicarbonate system will influence the severity of an impact i.e., soft, poorly buffered water, such as West Coast Streams are more severely affected by dissolved metals and pH levels than highly buffered streams, where metal precipitation is more likely to be the major source of impact.

However, not all coal mining in New Zealand have the ability to produce AMD. This is due to the geochemical nature of the coal bearing strata and the surrounding rocks. The ability to produce AMD is dependent on sulphide content and the neutralising capacity of the surrounding rocks. Limestones and calcite-rich sandstones provide good AMD neutralising capacities. Coals formed in marginal marine settings, such as the Brunner Coal Measures on the West Coast, typically have a higher occurrence of sulphide, (in the form of pyrite) and as a result, are more acid producing than other coal measures.

Most of New Zealand's high quality bituminous export coal comes from the Buller Coalfield in the West Coast region. Here, coal is typically mined using two basic extraction methods; surface mining (opencast or open cut mining) and underground mining (hydromining and bord and pillar methods), both have associated environmental impacts. On the West Coast, disused underground mines, have issues associated with continual drainage that have caused a legacy of environmental problems for example, the Sullivan Mine near Westport (Trumm et al., 2003).

Since the advent of the Resource Management Act (RMA 1991), many industries in New Zealand (especially extractive industries) have had to make major changes in the way they operate. Prior to 1991, mineral exploration, land access and extraction were the primary steps involved in generating mineral wealth. Subsequently, there has been an increasing emphasis on a further step prior to extraction, namely managing environmental impacts so as to ensure environmental sustainability.

While environmental sustainability should be an essential part of any development, the lack of national standards and inconsistent practices between the numerous parties involved in the resource management process has lead to confusion and significant delays in developing economically viable coal deposits. Often regulators request further information and clarification on the geochemical, rehabilitation and ecological aspects of the management proposal. Since there are no standardized methods of assessing these aspects, interpretations are often subjective.

The successful development and adoption of a standardised system is an essential element in developing New Zealand's coal resources. Recognising this the New Zealand Government, through the Foundation of Science Research and Technology, has approved funding for a research collaboration to provide industry and regulators with a robust standardized decision making framework.

Method

The regions chosen for this study are Southland and the West Coast region where much of the nation's coal deposits are located. In the West Coast region, acid mine drainage (AMD) is the main cause of aquatic ecosystem degradation associated with coal mining (Trumm et al., 2003). This AMD situation has resulted in a large amount of negative attention focused on the coal industry. This study focuses primarily on assessing the risks and impacts related to mine drainage and water quality, but it is anticipated that the process used to develop the framework will prove applicable to a much wider range of mining impacts. The study will determine potential environmental risks to water quality in the Southland and West Coast regions, by identifying the geochemical characteristics of regional mineral deposits and placing them into risk-based categories for each geographical region. Concurrent work will categorise the degree of impacts on the ecology of the receiving aquatic ecosystems when potential risks are realized, and determine the processes that drive aquatic ecosystem recovery. Work will also proceed on identifying best strategies to sufficiently mitigate impacted ecosystem by applying proven remediation and restoration techniques. The framework will be developed and will include wide consultation with representatives of the mining industry and environmental regulators.

Identifying Risk

New Zealand's geology, ecology, climate and topography vary considerably from region to region (Black et al., 2004). As a result, mines in different areas have different discharge water quality and environmental impacts. The impact of pH and dissolved metals from various mine discharges can range from benign to severe, with the presence of environmentally significant metals varying from site to site (Harding, 2004).

While the science behind the geochemical processes of acid generation and consequent contaminant problems are well understood (Gray, 1997), the extent of the potential risks of environmental impacts from different lithologies in the targeted regions remains largely undefined. A significant body of rock (geochemical) and water data (quality, flow, rainfall) already exists for some of the South Island's regions (Black 1999, 2000, 2001; Campbell 2001; James, 2003), and this information will be collated into a consistent format.

Lithologies containing economic amounts of coal and gold from up to six new sites in the West Coast and Southland regions will be geochemically assessed to determine the potential for environmental impacts through mine drainage. The geochemical assessments will lead to identification of areas that have the potential for "high", "medium" or "low" risk to water quality. The critical factor is to select appropriate sites and design an adequate spatial and temporal sampling regime. It is planned that a geochemical GIS map of the regions will be developed once all the necessary information has been collated.

Identifying the impacts on the aquatic ecosystem

Impacts of AMD on stream systems are well understood. However, much of the research has been focused on assessing the biota of systems in terms of species presence rather than on understanding the mechanisms that cause the impacts, and the processes that drive the recovery of an impacted system (Harding et al 1998; 1999; 2000; 2003; Stark 2001). Recovery of stream biotic communities is a complex situation and requires more than simply returning the physico-chemical parameters of the stream to levels considered acceptable. It is necessary to identify the biological factors that drive the recovery of streams. High endemism that occurs within the West Coast region will add difficulty to this work, which will include a process to integrate assessing the effects in a transferable manner (O'Halloran, 1998; 1999, 2001; Eason 1999, Cussins 2000; Harding, 2004)

From existing data on water chemistry and aquatic biota for the West Coast and Southland an initial draft of water quality thresholds will also be formulated and extensive algal surveys in a range of mine impacted systems will be used to identify taxonomic tolerances to impacts. Experiments designed to identify conditions limiting microbial processes will be conducted and ecotoxicological data on a representative range of endemic invertebrate taxa will be collected to substantiate pH and metal tolerances. On the basis of these experimental findings, the sequence of ecosystem recovery after threshold water quality conditions are reached will be identified. The effect of mine drainage on aquatic taxa in West Coast systems is complicated by the fact that many West Coast species show a wide tolerance to pH and metals. This suggests an adaptation to naturally acidic streams on the West Coast (Winterbourne et al., 2000)

Managing the risk

Based on findings from existing work at a severely impacted West Coast mining site (Lindsay et al., 2001; Black et al., 2003; O'Halloran et al., 2003; Trumm et al., 2003) a methodology to determine strategies for minor, moderately and severely impacted sites will be formulated. Small scale trial remediation systems using passive remediation techniques will be set up at minor and moderately impacted sites based on the results of these trials the methodology for determining the management strategy will be validated, or refined as determined appropriate.

The best means of managing the risk is to either prevent mine drainage or to treat mine drainage so that the physico-chemical parameters of the receiving water are not exceeded. The level of treatment required will depend on the source and amount of discharge in combination with physical parameters of the receiving water. The level of treatment will also be determined by the results of the previous section, namely the acceptable levels of impact based on the ability of an ecosystem to recover.

Building the framework

The purpose of the framework is to allow development of mineral resources by extraction while abiding by the requirements of the RMA. These requirements typically include land use consents from district and/or city councils in addition to discharge and water permits and discharge consents from the Regional Council. An assessment of environmental effects is prepared as an accompaniment to the various resource consents as a requirement of the RMA.

There will be consultation with end-users on the optimal way of combining the findings from the above three sections into a usable framework. Initially there will be an evaluation of the various types of framework already in existence (Cavanagh et al., 2003), leading to the construction of a prototype framework. This will be trialled by end users at sites within the targeted areas of the West Coast and Southland regions and modified and improved as required from the results of the trials and feedback from stakeholders.

The framework is envisaged as a multi-layered network containing numerous questions and answers and feedback loops. The initial output will be a document detailing the reasoning behind the questions and answers and the decisions regarding impacts of mining in a certain area, their consequences and the options available for managing the impacts. Although the framework will be built with an emphasis on mine drainage from coal and gold operations, the process used will be equally applicable to aggregate quarries.

An effective decision-enabling framework must be grounded in solid scientific understanding of the geochemistry of the rocks, the ecosystem and its response to natural and anthropogenic induced stress and remediation technologies. It is envisaged that recommendations will be developed to help guide future work in a number of areas of potential mineral wealth.

Conclusion

The strategic overview of this research is to provide a unified process to the requirements of the RMA and to promote good environmental management practices. Current policy guidelines require that long-term sustainable operations must be undertaken in an environmentally responsible way. However, it is recognized that temporary localized adverse effects may be unavoidable during mining and that policies need to ensure that there are no net negative environmental impacts.

Responding to regulatory and public concerns, the industry on a whole has improved their environmental management practices over the last 10 years. Management of the environmental effects of coal mining in New Zealand has become more contentious as a result of the increase in coal mining developments and the current lack of standardised guidelines. The mining of coal in New Zealand still has a negative image, despite the reliance of much of our economy on it as an export commodity and a energy source. In part, this image is understandable as some historic sites left in the same state as when closed many years ago, visibly affect streams (Trumm et al., 2003). Recent efforts by industry, regulators and scientists to make mining an environmentally sustainable operation have focused on developing a set of site-specific criteria which is effects-based rather than a generic criteria based on absolute numbers. Mining companies such as Solid Energy New Zealand have begun joint research to define site-specific criteria using acute ecotoxicology tests which have resulted in interim water quality targets (Harding, 2004).

The final Framework, incorporating the geochemical risk information, effects based water quality targets and management strategies for the West Coast and Southland regions will be completed and in place by June 2010.

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