



Sustainable development principles for the disposal of mining and mineral processing wastes

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ABSTRACT

This paper examines the minerals industry's response to sustainable development in the area of waste disposal and argues that leadership and guidance are still needed to forge collective agreement on norms and standards of practise. To encourage further debate, the paper develops a set of sustainable development principles for the disposal of mining and mineral processing wastes, and discusses the implications for current and future practise. In practise, the principles can guide waste disposal decisions through the consideration of what risk and magnitude, in any given local context, a particular management solution poses to their application. The sustainability challenge in the management of tailings and waste rock is to dispose of material, such that it is inert or, if not, stable and contained, to minimise water and energy inputs and the surface footprint of wastes and to move toward finding alternate uses. Future trends in mining and processing may compound the challenges of waste management, as lower ore grades increase the ratio of waste produced for a given unit of resource, and emphasise the urgency and need for the industry to adopt new approaches. New technologies and innovations, such as thickened tailings, dry stacking and paste backfill, have greatly increased the waste disposal methods available to meet the future challenges to sustainable development.

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Introduction

Incidents of poor waste management practise are amongst the most conspicuous features of the global minerals industry. Tailings spills, dam failures, seepage, unrehabilitated sites and cases of direct discharge into waterways can result in severe and long-term environmental and social consequences (Van Zyl, 1993; ICME and UNEP, 1998; Hart, 2007; Franks, 2007; Spitz and Trudinger, 2009; Fourie, 2009). Mine and mineral processing wastes have the potential to leave environmental, social and economic legacies for thousands of years (Kempton et al., 2010), as evidenced by sites such as the Rio Tinto estuary in Spain, where surface water contamination is still present from historic mining as early as 4500 years ago (Leblanc et al., 2000).

The legacy of poor waste management continues to disproportionately shape the reputation of the minerals industry, the willingness of governments and communities to support new operations, the approach of governments towards their choice of policy instruments, and the calculations of risk made by financial institutions and investors (Boger, 2009; Boger and Hart, 2008). Exploitation of lower ore grades and the associated increase in waste per unit resource (Mudd, 2010), and competition over water and other resources (Kemp et al., 2010), have the potential to compound the future challenges of waste management. While poor waste management can lead to substantial liabilities for the public, it can also impose costs on mining and minerals processing companies by eroding share value, increasing the risks of temporary or permanent shut down, exposure to compensation, fines and litigation costs, lost future opportunities and increased remediation and monitoring, to name a few.

Despite these risks, there remains a lack of consensus amongst companies, peak industry bodies, investors, international financial institutions, civil society organisations and governments on how waste management practices can meet the challenge of sustainable development (MMSD, 2002). For example, some resource companies, such as BHP Billiton, have now ruled out the practise of tailings disposal directly into waterways (see BHP Billiton, 2009), while

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others continue to utilise such techniques. The Norwegian Pension Fund Global has divested from a number of operations based on an assessment of their tailings disposal techniques, including cases of direct disposal (Government Pension Fund Global, 2008, 2009). The issue of direct disposal is contrasted by the increased use of paste and thickened tailings technologies which have the potential to dramatically improve the waste management outcomes with respect to sustainable development (Nguyen and Boger, 1998; Sofrá and Boger, 2002; Jewell and Fourie, 2006; Boger et al., 2006; Boger, 2009; Fourie, 2009). The diversity of perspectives reflects, in part, the individual circumstances faced by different governments, companies and investors and the local contexts in which they operate. However, it also arises as a consequence of an absence of clear policy guidance on the conditions that need to be met to ensure responsible waste disposal and the lack of a policy response by international institutions and peak industry bodies.

While the management of mining and minerals processing wastes encompasses a broad array of issues across the waste hierarchy (reduce–reuse–recycle–treat–dispose), this paper focuses on the issue of waste disposal. The reduction, reuse, recycling and treatment of mining and minerals processing waste are increasingly receiving greater research and development attention for their contribution to improving the sustainability of the minerals industry (see, for example, van Beers et al. (2007)). The reuse of mining and minerals processing waste, if inert, can offset the impacts that would have been generated by the replaced material, and reduce the amount of waste produced per given unit of resource. Reprocessing of waste has the potential to provide an economic opportunity to rehabilitate historical sites into stable landforms. Improved processing efficiency can provide the means for ore minerals to be recovered from historic mining and minerals processing waste, and an economic incentive for rehabilitation. There is, however, also much to be gained from better management of wastes, which continue to be produced in high volumes in most contemporary and foreseeable mineral developments.

This paper asks the questions: (1) what does the responsible disposal of mining and minerals processing waste look like in light of the sustainable development agenda? And (2) what policy guidance is available to the industry to help navigate the suitability of various waste disposal methods to their local context? To answer these questions, the paper traverses the various sustainable development initiatives of the global minerals industry, including the Global Mining Initiative, the World Bank Extractive Industries Review and the International Council on Mining and Metals (ICMM) with respect to the issue of waste disposal. In light of this analysis, the paper distils a set of principles to guide responsible disposal of mining and minerals processing wastes and discusses the implications for past, current and future practise.

Waste and the minerals industry response to sustainable development

Sustainable development is a concept which attempts to shape the interaction between the environment and society, such that advances in wellbeing are not accompanied by deterioration of the ecological and social systems which will support life into the future (WCED, 1987). Due to the importance of mineral resources to contemporary society, debates about mining and sustainability at the global and national level have focussed on the issue of renewability, resource access and endowment, consumption rates and appropriate use (Hilson and Murck, 2000). At the local scale, the issue of renewability is less relevant. While it is true that mineral resources are not readily renewable, due to the slow timescales by which bio-geophysical systems replenish ore bodies, it is also true that minerals targeted for extraction are less fundamental to the

function of ecosystems supported above them than the way that, for example, timber is fundamental to a forest.

Instead, much of the sustainable development debate at the scale of a mining or mineral processing operation is necessarily focused on the challenge of if, where, and/or how, the development might proceed without significantly disturbing the ecosystems, communities and economies overlying and surrounding mineral deposits and processing sites and the issues that need to be considered to make such a determination.

The management of mining and minerals processing wastes is therefore a fundamental sustainable development issue. The elements and compounds uncovered and liberated through mining and processing, which are not usually part of the ecological systems (in such a form or concentration) have the potential to alter the receiving environment to its detriment. Most mining and minerals processing wastes contain minerals which are formed at higher temperatures and pressures at the geological depth. When exposed to surficial conditions, or as a result of processing, minerals may breakdown releasing elements from their mineralogical bindings which may not be easily absorbed by unaccustomed ecosystems without impact. It is precisely, because these elements did not interact with the overlying ecosystems before mining that they may pose issues to ecosystems and communities post-mining.

Following the release of the Brundtland Report by the UN World Commission on Environment and Development in 1987 and the UN Conference on Environment and Development, held at Rio de Janeiro in 1992, the minerals industry undertook a series of consultations to better understand the relationship between resource extraction and sustainable development. Through such fora as the Global Mining Initiative (1999–2002), the World Bank's Extractive Industry Review (2001–2004), and the International Council on Mining and Metals (formed in 2001), the industry has sought to position itself as a positive contributor to the sustainable development agenda.

As part of the Global Mining Initiative, the World Business Council for Sustainable Development and the International Institute for Environment and Development undertook a review of the sustainability of the minerals industry called the Mining, Minerals and Sustainable Development Project (MMSD). The final report, *Breaking New Ground*, proposed a series of principles of sustainable development for the minerals sector, among them to promote responsible stewardship of natural resources, to remediate past damage and to minimise waste and environmental impacts along the supply chain (MMSD, 2002). The report urged that mining and minerals processing should not leave unacceptable legacies and long-term damage, should shoulder the costs of remediation, and should exercise prudence, where potential impacts are not known. With regard to the waste management, the report emphasised the need to ensure physical and chemical stabilities of the disposed waste, avoid the release of elevated metals and residual chemicals into the environment and minimise the water consumption. Finally, the report recommended:

Large-volume waste—the International Council on Mining & Metals (ICMM) and other appropriate convenors such as UNEP should initiate a process for developing guidance for the disposal of overburden, waste rock and tailings and the retention of water. *Marine disposal*—industry, governments and NGOs should agree on a programme of independent research to assess the risks of marine and, in particular, deep-sea disposal of mine waste. *Riverine disposal*—a clear commitment by industry and governments to avoid this practise in any future projects would set a standard that would begin to penetrate to the smaller companies and remoter regions, where this is still an accepted practice.

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