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# 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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## Research highlights

- Examines mining and mineral processing wastes with respect to sustainable development.
- Finds that there is still a need for collective agreement on standards of practise. ► Develops a set of principles and discusses implications for practise. ► Finds that future trends in mining and processing may compound the challenges. ► Emphasises the role of paste and thickened tailings to meet the future challenges.

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Sustainable development; Tailings; Waste management; Policy; Mining

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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 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, Government Pension Fund Global, 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.

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## Section snippets

## 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, ...

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

In the absence of an international consensus, this paper proposes a set of principles to guide the disposal of mining and mineral processing wastes. The question that directs the choice of principles is ‘what characteristics must a given waste disposal solution exhibit, in the context of local conditions, for mining and mineral processing to proceed, without significantly disturbing the ecosystems, communities and economies overlying and surrounding ore deposits and processing facilities?’ The ...

## Discussion: implications for current and future practise

The implications of the principles for common waste disposal techniques, including waste storage facilities (conventional tailings dams, paste and thickened tailings, overburden and waste rock dumps, and heap leach piles) and direct discharge of mine waste (river and submarine tailings disposal, and in-situ leaching) are now discussed in light of the principles outlined above. The suitability of each technique to the principles will depend on the context of each local situation. The following ...

## Conclusions

This paper has observed industry's response to sustainable development with regard to the disposal of mining and mineral processing wastes and argued that further guidance is needed to forge collective agreement on norms and standards of practise. Further, presented for ongoing discussion and debate is a set of principles for the disposal of mining and mineral processing wastes. These principles can be used to guide future practise by considering what risk and magnitude, in any given local ...

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