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Global trends in gold mining: Towards quantifying environmental and resource sustainability?

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Abstract

In recent years, due to public concern over perceived and actual environmental impacts, the global mining industry has been moving towards a more sustainable framework. For gold mining, there are a number of fundamental issues with regard to assessing sustainability. Commonly perceived as a finite and non-renewable resource, long-term gold production trends include declining ore grades and increasing solid wastes (tailings, waste rock) and open cut mining. Conversely, core sustainability issues include water, energy and chemical consumption and pollutant emissions—also known as 'resource intensity'. It is important to recognise the links between gold production trends and resource intensity, as this is critical for understanding future sustainability challenges. This paper links data sets on historic gold mining production trends with emerging sustainability reporting to estimate resource intensity, demonstrating the sensitivity of ore grade for gold production and sustainability. Final judgement of the sustainability of gold mining must take account of the sensitivity of the ore grade in the resource intensity of gold production. This has implications for environmental policy and sustainability reporting in the gold mining sector.

JEL classification: Q56; Q32; L72

Keywords: Gold mining; Resource intensity; Sustainable mining; Ore grade; Waste rock

Introduction

The mining and production of gold is indeed an ancient human tradition and presently occurs all over the world (Butterman and Amey, 2005). The history of gold mining is commonly associated with both positive and negative social, political, economic and environmental impacts (e.g. Ali, 2006; Corte and Coulston, 1998; Müezzinoğlu, 2003). In recognition of these impacts, the industry has in recent years been moving towards a more sustainable framework. An important development has been the adoption of recommendations in 'Minerals Mining and Sustainable Development' report (IIED and WBCSD, 2002), presented by the global mining industry at the Johannesburg Earth Summit in 2002. Many mining companies have begun to report on their sustainability performance alongside their financial performance, based on company standards or external guidelines such as the recently developed Global Reporting Initiative (GRI, 2006). The application of sustainable development concepts to mining remains problematic, however, especially in the gold sector of the global mining industry.

This paper compiles and analyses available sustainability data on gold mining for Australia, North America, Africa and the Asia-Pacific, including waste volumes, ore grades, economic resources and resource intensity. The paper presents a fundamental analysis of a major policy area—that of environmental and resource sustainability—which currently affects gold mining. It also provides a critical basis to underpin further policy debate through real data for life-cycle and sustainability assessments. Formal consideration of the social aspects of sustainability related to gold mining is beyond the scope of this paper.

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Sustainable development concepts for mining

The observation that mining has both positive and negative impacts is not new—with significant treatises dating back to Agricola (1556) and earlier. Following the near-continual global mining boom since about 1960, there has been a wide-ranging debate about the sustainability of modern mining. This section presents a broad review of this discussion with a summary relevant for gold mining in the context of this paper.

The most common starting point for discussing sustainability is the definition proposed by the 1987 World Commission on Environment and Development (WCED, or the 'Brundtland Commission'), namely 'to meet the needs of the present without compromising the ability of future generations to meet their needs' (WCED, 1990).

Although this is a somewhat open definition (Hilson and Basu, 2003), in the context of mining, this is generally taken to include the availability of resources and a productive environment and healthy community at both current and former mining sites (e.g. Azapagic, 2004; Cowell et al., 1999; Gordon et al., 2006; Yua et al., 2005).

The mining of a perceived 'finite' resource (i.e. mineral resources are non-renewable) has been commonly argued as intrinsically unsustainable, thereby reducing the ability of future generations to supply that particular mineral. The most cited study for this position is perhaps the 1972 Club of Rome analysis 'Limits to Growth' (Meadows et al., 1972), with numerous studies, reports and papers also continuing the perceived non-renewable nature of mineral resources (e.g. Bartlett, 2006; Whitmore, 2006; Young, 1992). Other commentators, including some from the mining industry, have argued in response that economic mineral resources are not a stationary, solitary figure, but rather a function of prevailing economic, social and environmental constraints (e.g. Hancock, 1993; Hore-Lacy, 1986; IIED & WBCSD, 2002; Tilton, 1996, 2003; Trubetskoi et al., 2002; Yua et al., 2005; Eggert, 2006).

Despite the perception that mineral resources are finite, there have been few systematic quantitative analyses of known mineral resources that assess the factors affecting known economic mineral resources and their potential extraction. There are selected data available in national mining industry periodicals (e.g. Geoscience Australia, var.; Natural Resources Canada, var.; US Bureau of Mines, var.; United States Geological Survey, var.a). However, these are not complete, as they do not present data for ore tonnage, ore grade, contained metal and associated waste rock. For gold, Craig and Rimstidt (1998) have provided a brief analysis of economic resources for the world and the United States, although their study does not include data on waste rock and tailings (ore) from mining or the ore grade of economic gold resources.

It is important to understand the nature of mineral resources, since issues such as ore grades, impurities (e.g. arsenic, mercury), waste rock, geological and mining constraints, technological requirements as well environmental issues such as water, chemicals, energy and pollutants and socio-economic constraints are all critical in determining whether a quantified mineral deposit is an extractable, valuable resource. In Australia, this recognition of the broader context of 'economic' mineral resources is embedded into the Joint Ore Reserves Code (JORC) code for reporting economic mineral resources (AusIMM et al., 2004; Stephenson, 2001).

The issue of 'non-renewable' mineral resources is critical in the sustainability debate as it relates to present generations meeting their needs for metals and minerals while still allowing for future generations to provide for their anticipated requirements (Cowell et al., 1999).

A major challenge in this regard is the evolving environmental and social costs of extracting mineral resources—especially, when compared to the equivalent costs from secondary sources and processes. This begs the question of whether future mining will cost more than at present.

The environmental and social health of a region and community as affected by mining—positively or negatively—remains a contentious area for the sustainability debate and the mining industry (Hancock, 1993), particularly for the developing world (e.g. Ali, 2006; Kumah, 2006).

Historically, the mining industry has caused significant environmental impacts through poor waste management, lack of or poor rehabilitation, an emphasis on production over environmental impacts, and so on. This in turn is closely related to social impacts and challenges of varying degrees of difficulty. Agricola (1556), a strong supporter of mining and its contribution to society, documented this dilemma eloquently in a regional and local context more than 450 years ago.

The context for sustainable development for mining is still essentially the same—balancing the potential environmental and social risks with the economic risks. The primary difference is now that the issue is of a truly global scale and concern rather than Agricola's locale of central Europe. For gold mining in particular, some continue to argue that there is net detriment or no net benefit from gold mining (see Ali, 2006; Whitmore, 2006).

Since about the 1970s onwards in most countries (especially developed nations with advanced mining industries), new and existing mining projects have been required to meet an array of environmental requirements set by legislation, policy and statutory authorities which emerged during this decade (e.g. an Environmental Protection Agency or EPA). The mining industry accepted the legitimacy of this changed landscape and worked to improve industry standards and performance throughout the 1970s–1980s, primarily to meet legal requirements but also to ensure social acceptance of existing and future mines (Hancock, 1993; Hore-Lacy, 1986; Mulligan, 1996).

The 1992 Rio Earth Summit focussed global attention on sustainability, with public sentiment beginning to accept