



Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Review

Submarine and deep-sea mine tailing placements: A review of current practices, environmental issues, natural analogs and knowledge gaps in Norway and internationally

Eva Ramirez-Llodra^{a,*}, Hilde C. Trannum^a, Anita Evenset^b, Lisa A. Levin^c, Malin Andersson^d, Tor Erik Finne^d, Ana Hilario^e, Belinda Flem^d, Guttorm Christensen^b, Morten Schaanning^a, Ann Vanreusel^f

^a Norwegian Institute for Water Research, NIVA, Gaustadalléen 21, 0349 Oslo, Norway

^b Akvaplan-niva, Fram Centre, High North Research Centre for Climate and the Environment, Tromsø, Norway

^c Center for Marine Biodiversity and Conservation and Integrative Oceanography Division, Scripps Institution of Oceanography, UC San Diego, La Jolla, CA 92093-0218, USA

^d Geological Survey of Norway, Postboks 6315 Sluppen, 7491 Trondheim, Norway

^e Departamento de Biologia & CESAM, Universidade de Aveiro, Portugal

^f Marine Biology Research Group, Ghent University, Krijgslaan 281, B-9000 Gent, Belgium

ARTICLE INFO

Article history:

Received 26 March 2015

Revised 21 May 2015

Accepted 24 May 2015

Available online xxxxx

Keywords:

Submarine
Tailing
Environment
Impact
Mining
Waste

ABSTRACT

The mining sector is growing in parallel with societal demands for minerals. One of the most important environmental issues and economic burdens of industrial mining on land is the safe storage of the vast amounts of waste produced. Traditionally, tailings have been stored in land dams, but the lack of land availability, potential risk of dam failure and topography in coastal areas in certain countries results in increasing disposal of tailings into marine systems. This review describes the different submarine tailing disposal methods used in the world in general and in Norway in particular, their impact on the environment (e.g. hyper-sedimentation, toxicity, processes related to changes in grain shape and size, turbidity), current legislation and need for future research. Understanding these impacts on the habitat and biota is essential to assess potential ecosystem changes and to develop best available techniques and robust management plans.

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* Corresponding author.

E-mail addresses: eva.ramirez@niva.no (E. Ramirez-Llodra), hilde.trannum@niva.no (H.C. Trannum), Anita.Evenset@akvaplan.niva.no (A. Evenset), llevin@sio.ucsd.edu (L.A. Levin), malin.andersson@ngu.no (M. Andersson), tor.finne@ngu.no (T.E. Finne), ahilario@ua.pt (A. Hilario), belinda.flem@ngu.no (B. Flem), guttorm.christensen@akvaplan.niva.no (G. Christensen), morten.schaanning@niva.no (M. Schaanning), ann.vanreusel@ugent.be (A. Vanreusel).

<http://dx.doi.org/10.1016/j.marpolbul.2015.05.062>

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1. Introduction

To date, there is no peer-reviewed overview of the environmental impacts of mine tailing disposal in the marine ecosystem at the global scale, with lessons learnt and knowledge gaps. Such a review can help compile lessons across regions and settings to promote more effective disposal practices and management. Furthermore, a large amount of the scientific data on STDs from Norway (the country with most inactive and active STDs) is in internal reports in Norwegian and, thus, not easily accessible to the international community. The current paper reviews STD/DSTP settings, environmental impacts, recovery potential, status of Norwegian studies, legal issues, natural analogs and knowledge gaps, providing a central and up to date source of information on this topic. We close with recommendations to advance scientific understanding, governance and decision making regarding submarine and deep-sea mine tailings placement.

1.1. Mining and economics

With increasing societal demands for mineral resources, mining at the global scale is in a phase of rapid growth (Vogt, 2013; Dold, 2014). However, the role and importance of the mining sector in individual countries' economies is not well established as a topic in economic analysis (Roe and Haglund, 2012). The nominal value of the world's mineral production was almost four times higher in 2010 than in 2008, caused by higher market prices and increased production volumes. Over the same period, increase in world mineral production value was clearly greater than world Gross domestic product (GDP). Statistics compiled by the International Organizing Committee for the World Mining Congresses show that from 2002 onwards, there has been marked increase in world mining production volumes, only interrupted by a minute decrease in 2009 (Reichl et al., 2014). Worldwide, the production has increased by 79% from 9418 megatons (Mt) in 1984 to 16863 Mt in 2012 (Fig. 1). During the same period, Asia has always been the largest

producer among the continents and its expansion over the period was 171%, so that from 2005 to date, more than half of the world's mineral production originated from Asian countries. By 2012, China was the number one country of mineral producers in all classes of commodities except noble metals. Sorted by commodities, production volumes worldwide over the period 1984–2012 increased from 62% for industrial minerals to 211% for iron and alloy metals used in steel manufacturing (Fig. 2).

The world data comprise computed amounts of the economic compound of the different products. Similar figures are available for the Norwegian mining industry for the period 2010–2013 (Neeb and Brugmans, 2011; Neeb, 2012, 2013, 2014). Norwegian figures are given as tonnes of concentrates produced and are grouped slightly differently than the international data, but they nevertheless show a similar increase in produced volumes over

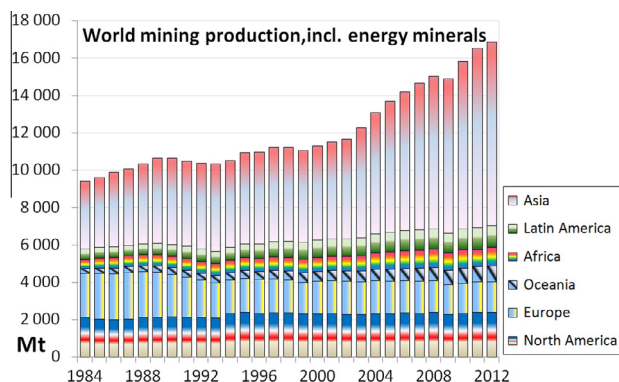


Fig. 1. Annual mineral production by continent, based on evaluation of reports from National Committees of member countries of the World Mining Congress. Numbers (million tonnes) are calculated content of valuable element or compound, not mine production or produced concentrate. Data from Reichl et al. (2014).

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