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SCIENCE DIRECT
Chemie der Erde 65 (2005) S1, 43–63
CHEMIE der ERDE GEOCHEMISTRY
www.elsevier.de/chemer

A fly ash/biosludge dry cover for the mitigation of AMD at the falun mine

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Received 13 December 2004; accepted 15 January 2005

Abstract

The sulphide mine tailings in Falun, Sweden is covered with a mixture of fly ash and biosludge as a measure against acid mine drainage. This is a study of the tailings geochemistry by means of pH, Eh, iron, sulphate, calcium and organic carbon concentrations from a field control site and field studies of the covered deposit. The sulphate/iron mole ratios of the interstitial solutions can be used as a proxy to indicate dominating chemical processes in the tailings. In the Falun tailings no ferric iron oxidation of the mining waste seems to take place. Thermodynamic calculation of the redox potential demonstrates which half-cell reaction is governing the redox potential variations. The organic carbon concentrations are very high in the covered Galgberget tailings deposit compared to the control site. This carbon originates from the cover material and is used as a measure against oxygen penetration to the mine tailings. The drawback of the dissolved organic material is that it can act as complexing agents for heavy metals. Also, the dissolved organic material is according to an empiric model decreasing rapidly and of negligible importance after a short time, approximately 30 years. The Galgberget tailings deposit is greatly oversaturated with respect to gypsum making the formation of hardpans possible.

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0009-2819/$ - see front matter
doi:10.1016/j.chemer.2005.06.008

Compared to the uncovered control site the field studies of the covered Galgberget tailings deposit show a decrease in the oxidation of iron sulphide minerals and an increase in pH of the leachate with time.

Keywords: Acid mine drainage; Mine waste; Dry cover; Interstitial water; Organic material; Sulphate/iron mole ratio

1. Introduction

1.1. Background

Mining of metals is and has been a fundamental industry of the Swedish economy since many centuries. The mining activities, however, have like most other industries generated waste materials which are hazardous to the ambient environment. The tailings and waste rock from the mining industry are considered to be the largest and most severe environmental problem in Sweden today.

The waste materials from sulphide mining operations represent a broad spectrum of toxic metals that are polluting the ambient environment. This type of waste is exposed to natural leaching where bacterial processes catalyse the leaching process. These organisms are aerobic and require oxygen for their metabolism. The result is an environmental problem usually referred to as acid mine drainage (AMD).

The waste material from a pit or underground mine is usually placed on the ground where it becomes part of the local hydrological system. The water moving into, through and out of the waste material represents the primary pathway for acidity and leached metals into ambient surface water and aquifers. The water also carries with it oxygen and carbon dioxide which stimulates the biogeochemical processes in the waste, leading to the leaching of metals.

By employing a process where the depository is covered with suitable material the flow of oxygen is halted and the leaching process is inhibited.

There are several ways to treat the environmental impact of mining wastes (Evangelou and Zhang, 1995; Ledin and Pedersen, 1996). A dry cover can be installed. Various studies (Nicholson et al., 1989; Broman et al., 1991; Evangelou and Zhang, 1995) have proposed the use of either till, clay or some mixed artificial material such as fly ash and sludge or cement-stabilized fly ash.

The waste can be disposed of underwater, the site can be revegetated or the drainage water can be treated with chemicals or wetlands (Kalin 1989; Broman and Göransson, 1994; Evangelou and Zhang, 1995; Ledin and Pedersen, 1996). For a thorough bibliography on these topics the reader is referred to Younger et al. (2002) or Lottermoser (2003).

The two most common methods in Sweden are the construction of dry covers and disposal under water. Underwater disposals have been used, for example, in the decommissioning of the waste at the Stekenjokk zinc and copper mine (Broman and Göransson, 1994; Holmström et al., 2000). The flooding was completed in 1991 and