

Characterisation of gold tailings dams of the Witwatersrand Basin with reference to their acid mine drainage potential, Johannesburg, South Africa

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Abstract

Factors which play a role in acid mine drainage (AMD) formation were investigated over a period of 12 months. These include climatic, mineralogical, hydrological and oxygen diffusion parameters. The oxygen diffusion data reveal that the flow of oxygen in the Witwatersrand tailings dams is controlled by secondary porosity (i.e. cracks caused by roots on the dam surface). The age of the dam does not have a significant bearing on the extent to which the oxidised zone development and subsequently AMD can progress. Most of these processes take place within the first 3 m of the dams. The amount of rainfall plays a crucial role in determining the extent to which an oxidised zone progresses. The average oxidised zone in the 5 sites is 2.4 m ranging from 2.2 to 3.5 m.

Keywords: oxidised zone, oxygen diffusion, pH, acid mine drainage

Introduction

In tailings storage facilities, AMD occurs when sulphide minerals in tailings are oxidised, because of exposure to moisture and oxygen. This results in the generation of sulphates, metals and acidity that can have manifold environmental consequences.

When AMD is generated, it can have undesirable effects on the ecosystem. Results can include contaminated water, disrupted growth and reproduction of aquatic plants and animals. Dissolved metals and acidity can also affect plant and animal populations.

Seven sites across the Witwatersrand Basin were identified for this study. However, two of the sites, i.e. F and G were only used to acquire the oxygen diffusion data. This means that only 5 sites were studied comprehensively. This is why in many instances in the paper only five sites are referred to. The sites are: Site A (Brakpan), Site B (Knights), Site C (Edenvale), Site D (Roodepoort), and Site E (Klerksdorp). Sites F and G are in Carletonville (Fig. 1 and Table 1).

The Witwatersrand Basin has a temperate climate, with the summer temperature averaging about 24°C and winter temperatures being about 13°C, only occasionally dipping below the freezing point. Annual rainfall in Johannesburg is about 750 mm (Tyson and Wilcocks, 1971).

The prerequisite for AMD is the generation of acid at a faster rate than it can be neutralised by any alkaline materials in the waste. The most common culprit in AMD formation is pyrite. The oxidation of pyrite occurs in the following four steps:

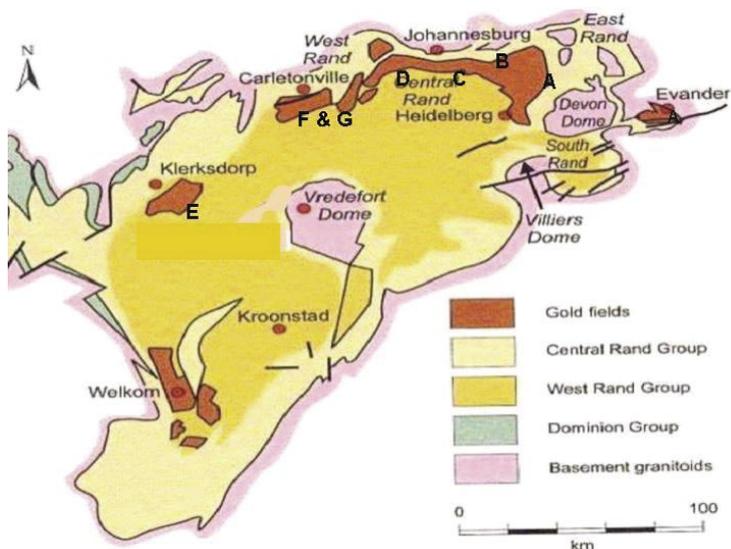
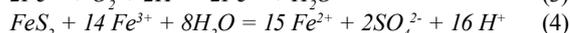
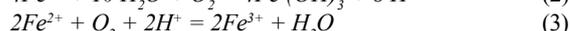
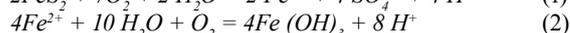
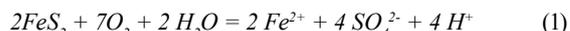


Figure 1
Geological map of the Witwatersrand Basin showing the locations of the 7 sites (Gold Fields, Driefontein Gold Mine, 2004)



The intensity of acid generation by these primary factors is determined by chemical parameters such as pH, temperature and oxygen concentration in the gas and water phase and the surface area of the exposed metal sulphides (Ferguson and Erickson, 1988). Oxygen concentration inside a tailings dam varies depending on the degree of water saturation, temperature, the rate of water infiltration and the rate of

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Received 16 May 2006; accepted in revised form 22 August 2006.