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ACID MINE DRAINAGE MANAGEMENT IN INDONESIAN MINES

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ABSTRACT

The Indonesian mining industry is experiencing significant progress due to a more investment - friendly mining policy. At present Indonesia is considered as an important global producer of tin, copper, nickel, gold and coal. Most of the mine sites in this country are surface mines and are generally having the potential to generate Acid Mine Drainage (AMD) that could generate serious environmental problems. Several laws and regulations are issued by the government to minimize environmental problems in mining area, including AMD. Since the decree of a new Indonesian mining law which underlines the important of environmental management and the obligation of every mine to prepare a mine closure plan, there is increased attention to develop a more appropriate and sustainable AMD management among mining companies. Interest in research on AMD among the researchers in several universities and research institutes is also increasing. In 2009 the Indonesian Network for Acid Drainage (INAD) was initiated to join INAP. A workshop on AMD management was implemented for the first time in 1998. Our observation showed that large scale mining companies generally implement an integrated approach in AMD management. On the contrary, medium and small scale mines usually implement only the neutralization of acid drainage using lime.

1.0 INTRODUCTION

Modern mining activity in Indonesia started at the end of 19th century. Some commodities, such as gold, tin, diamond were mined and traded internationally by the Dutch East India Company. Since the 1970s the Indonesian mining industry has experienced significant progress due to the more investment friendly mining policy. Many mines, some of which are large scale and operated by international mining companies, have been developed. At present Indonesia is considered as an important global producer of tin, copper, nickel, gold and coal, particularly thermal coal. Indonesia is the second largest thermal coal exporter. Figure 1 shows some of the mining locations in Indonesia.

The mining sector becomes one of the important income sources for the country. Following the decree of Indonesia's first environmental law in 1982, the attention on environmental impacts of mining has grown, and the Environmental Impact Assessment Study is obligatory for every mine.

One of the important environmental issues is AMD due to the fact that 95% of mining sites are surface mines and most of them, particularly copper, gold as well as coal mines, are generally having the potential to generate AMD. Efforts have been made by the government agencies in mining and the environment to control such issues in mining activities.

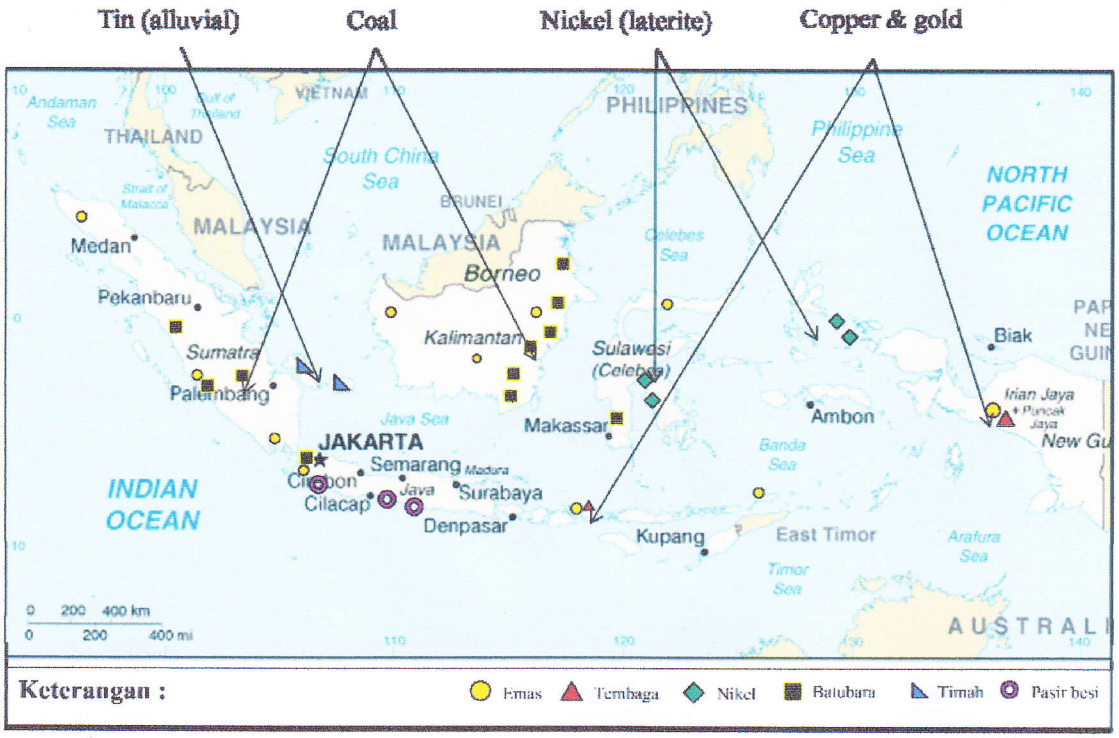

Fig. 1. Mining Map of Indonesia

2.0 ISSUES AND POLICY ON AMD

Concern about AMD issues started in the late 1980s. The Department of Mines and Energy included training on AMD in the mine inspector training program – assisted by the US OSM (Office of Surface Mines). Some international mining companies also developed AMD management in their operations which included AMD potential characterization and mitigation. Involvement of international consultants, particularly Australian-based consultants, played an important role. In line with increasing attention for AMD management, research and development on AMD was initiated in the companies, university and research institutions.

Workshops on AMD were conducted for the first time in 1996, as the first national AMD seminar. This forum was used for sharing experiences on AMD issues among the mining community. The second AMD seminar was held in 2004 and the third was in 2008. In the future, we plan to conduct this workshop and seminar regularly.

Several laws and regulations underline the obligation of mining companies to minimize environmental impacts of mining operations, including the impact on water quality. The new Mining Law Nr. 4 year 2009 and Law No. 32 year 2009 on Environmental Protection and Management emphasized the importance of the Environmental Impact Assessment Study. On the operational level, Government Regulation Nr. 82 year 2001 regarding Water Quality Management and Water Pollution Prevention is used as reference in the management of water resources based on the water use. The Department of Energy and Mineral Resources and the Ministry of the Environment have issued technical guidelines to promote the AMD management in mining operations. Furthermore the State Ministry of the Environment has issued Ministry's decrees and regulations on the standard of liquid effluent from mining

activity, namely Decree Nr. 113 year 2003 for coal mining, Decree Nr. 202 year 2004 for copper and gold mining, Regulation Nr. 4 year 2006 for tin mining and Regulation Nr. 9 year 2006 for nickel mining.

3.0 INDONESIAN NETWORK FOR ACID DRAINAGE (INAD)

To increase collaboration and understanding about AMD among institutions in Indonesia, INAD was initiated in 2009 by Mr. Sujatmiko (Directorate of Mining Technique and Environment of the Department of Energy and Mineral Resources), Prof. Rudy Sayoga Gautama (ITB), Prof. Bostang Rajaguguk (UGM) and Dr. Iskandar (IPB). Figure 2 show logogram of INAD.

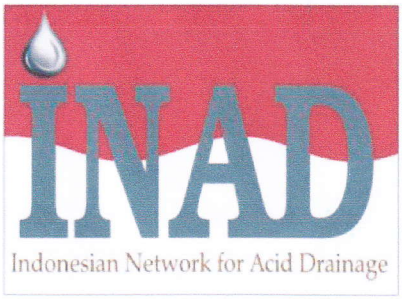

Fig. 2. Logogram of Indonesian Network for Acid Mine Drainage

The objectives of INAD are:

a) To increase understanding of processes contributing to production of acidic drainage in mining operations and in agricultural lands.
b) To contribute to the development of management strategies to avoid or minimize the production of acidic drainage and to control or alleviate the impacts of acidic drainage on-site and off-site.
c) Through application of appropriate science disciplines, to contribute to rehabilitation and management of lands disturbed by acidic drainage.

4.0 STATUS OF AMD MANAGEMENT

4.1 Company Practice

Integrated approach in AMD management generally includes a range of activities. Most large mining companies have implemented an integrated approach in managing the AMD in their mine sites which include the development of a geochemical overburden/waste rock model, AMD prevention through encapsulation of PAF material and active as well as passive treatment methods. Overburden management, with the aim to encapsulate the PAF material, is considered the best practice to avoid AMD generation (Figure 3). If necessary, this method is combined with liming to neutralize the acid effluents to meet the water effluent standard quality (Figure 4).

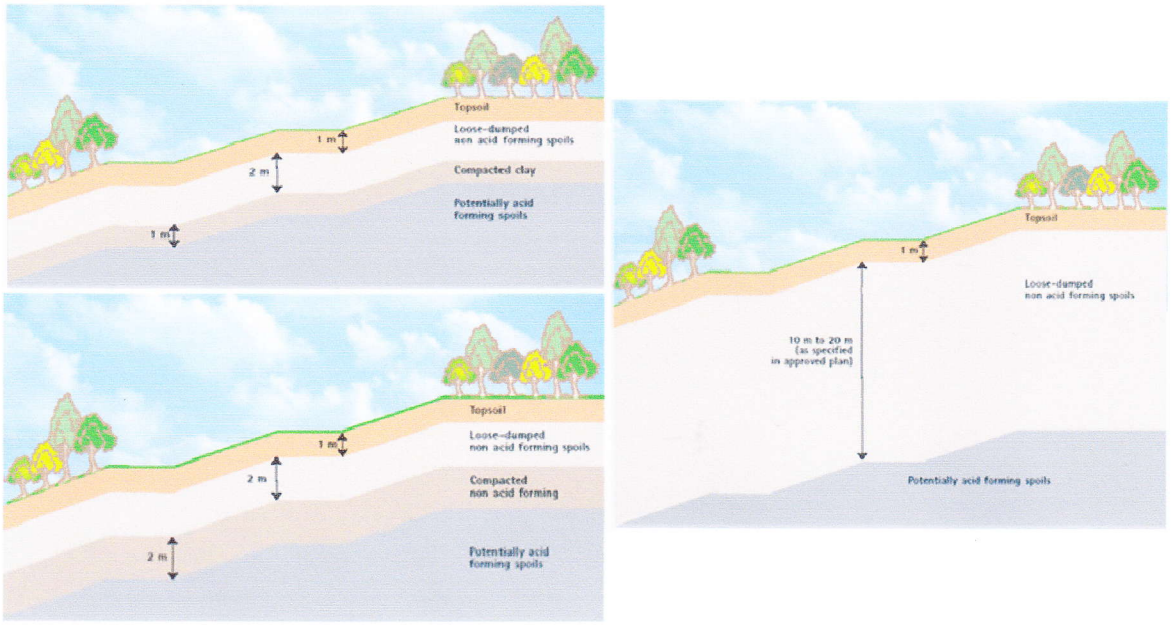

Fig. 3. Overburden dumping standard at PT Kaltim Prima Coal

Fig. 4. Liming of AMD at PT. Kaltim Prima Coal

The geochemical overburden/waste rock model is developed by geochemical characterization of overburden/waste rock samples collected during the exploration drilling campaign. It determines the distribution of Potentially Acid Forming (PAF) and Non Acid Forming (NAF) materials in overburden/waste rock. Such a model is then used to develop a day to day overburden excavation and dumping strategy and planning to prevent AMD generation. Selective dumping or encapsulating of the PAF material with NAF rocks becomes the standard in overburden/waste rock management.

4.2 RESEARCH AND DEVELOPMENT

In order to increase knowledge about AMD management, intensive research and development has been conducted. Gautama and Hartaji (2004) studied the comparison between the geochemical model and the actual type of rocks identified through blast hole sampling (see Figure 5). Such comparison for 2007 was also discussed in Sinatra et al. (2008). The studies indicated that, in most cases, the geochemical rock model developed during pre-mining phase is over estimating the quantity of actual PAF material in the overburden (Table 1). This pessimistic approach is in general considered better for operational AMD management, but on the other hand, it could under estimate the amount of NAF material for covering purpose in the dump site.

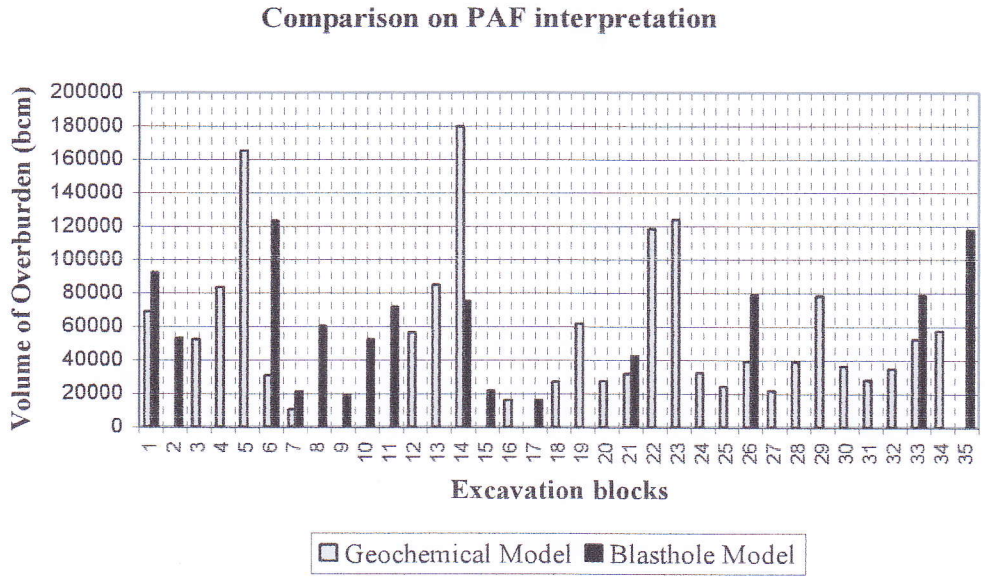

Fig. 5. Comparison between geochemical and blast hole model (Gautama and Hartaji 2004)

Table 1. Comparison of NAF material in Geochemical Model and actual moved in 2007 (Sinatra et al. 2008)

Pit	Waste removed (bcm)	Insitu Model (bcm)		Actual moved (bcm)		Actual NAF (%)
		NAF	PAF	NAF	PAF	
AB	29,474,000	25,052,900	4,421,100	23,549,726	1,503,174	94
Bendili	48,300,771	41,055,655	7,245,116	34,486,750	6,568,905	84
Harapan	14,404,439	12,531,862	1,872,577	8,897,622	3,634,240	71
J	44,370,532	31,946,783	12,423,749	25,876,894	6,069,889	81

Rusdinar and Prasetyo (2008) conducted an experiments on blending of PAF and NAF material and a limestone cover to study the best blending and covering option in the Grasberg copper open pit mine in Papua. They found that limestone cover increased the pH-value of the waste (Figure 6).

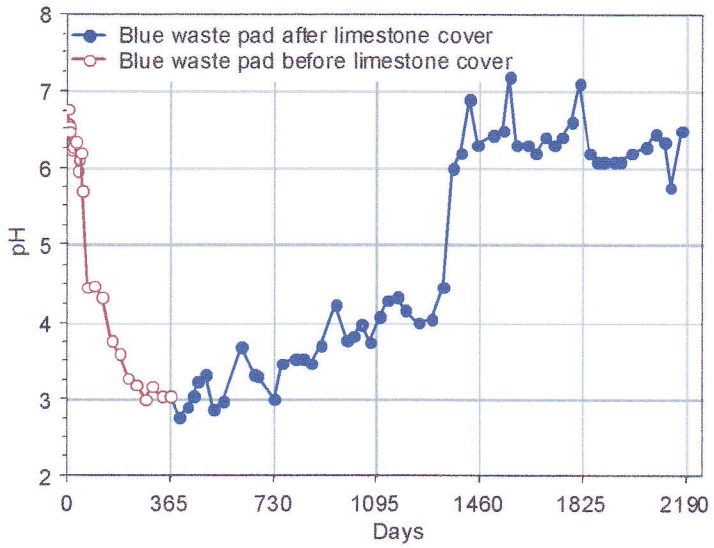

Fig. 6. Performance of limestone cover in Manado leach testpad (Rusdinar and Prasetyo 2008)

Study on passive treatment methods such as successive alkaline producing system (SAPS) and aerobic wetlands was conducted by Wiedhartono and Fajrin (2008) and Akhmad *et al.* (2008). Furthermore Wiedhartono and Fajrin (2008) used fly ash to study several options of treatment method (active and passive). Widyati and Mansur (2008), Widyati and Kresno, (2008) and Saria (2008) used different kind of plants, plant debris as well as microbes to manage AMD. Gautama and Kusuma (2008) identified PAF/NAF using static and kinetic tests method. Studies on pit lake chemistry was conducted by Rahmawati and Gautama (2010) and Saputri and Gautama (2010).

5.0 LATEST DEVELOPMENT

Since the decree of new Indonesian mining law which underlines the important of environmental management and the obligation of every mine to prepare a mine closure plan, the attention to develop more appropriate and sustainable AMD management among mining companies increases. Government is paying more attention to promoting AMD management to the mining companies, particularly small and medium scale.

Interest in research on AMD among the researchers in several universities and research institutes is also increasing. National AMD workshops, which have already been conducted in 1996, 2004 and 2008, are the forum for the mining community to share experiences in AMD management practices as well as the results of research and development.

A national network on AMD has been initiated since the 2008 national workshop. In 2009 INAD was developed and application to join Global Alliance was submitted in the same year.

6.0 CLOSING REMARKS

Indonesia has experienced a significant development of its mining industry since the late 1970s and is now considered as global producer of tin, copper, nickel and thermal coal. Due to this increasing industry, AMD is now one of the most important impacts of mining

activities, both in coal and ore mining. Government promotes the improvement of environmental management in the mining sector (including AMD management) through intensive supervision, inspection as well as through law enforcement. Big mining companies implement an integrated AMD management in their mine operations, whereas lime treatment is mostly applied in the small and medium scale mines.

There are increasing interests in research and development on AMD management, both in companies and among the academia and researchers – to develop more understanding of AMD characterisation as well as more appropriate prevention and remediation methods. In the case of medium and small scale mine operations, there is an interesting challenge to improve the AMD management.

In order to increase collaboration and understanding about AMD among researcher and institutions, a formal national network on AMD (INAD) was initiated in 2009.

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