

MINERAL RESOURCES — IMPACT OF EXPLOITATION ON ENVIRONMENT IN THE PHILIPPINES¹

by

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The Philippines, which is located some 965 kilometers from the southeast coast of the mainland of Asia, is considered one of the highly mineralized countries of the world. Although only about 5 percent of its total land area of 30 million hectares has been covered by detailed geologic surveys and 60 percent by reconnaissance survey, the findings show that the Philippines has rich metallic and non-metallic mineral deposits. As of 1974, the metallic ore reserves are estimated at 12.2 billion metric tons. Nickel accounts for 10.0 percent of the total metallic reserves followed by iron and copper with 9 percent and 8.5 percent, respectively. Nickel deposits are mainly found in Surigao and Palawan, while copper deposits are largely found in Negros Occidental, Cebu, Benguet, and Marinduque. Majority of the iron deposits are found in Surigao Province, while the best known deposits of chromite are located in the province of Zambales. Gold is highly concentrated in Camarines Norte and the Mountain Provinces.

The non-metallic reserves of the Philippines as of 1974 amounted to 24.0 billion metric tons. Cement raw materials constitute 34 percent of the total reserves followed by limestone, marble, clay, and other refractory minerals. Coal reserves are estimated at 104 million MT. A few weeks ago evidence has been discovered that the oil found in northwest Palawan is of good commercial quality and quantity. The actual oil reserve is however still being determined. An 857 lineal miles seismic survey is now being conducted by Cities Services, Inc. to define the location and delineation of exploratory and production wells in the service contract area.

The mineral production of the Philippines continue to increase as the demand for more minerals to meet the needs of the world's industrial civilization keeps on increasing. For the period from 1969 to 1974 the leading metallic product is copper, contributing roughly 60 percent of the total mineral production followed by gold, silver, iron

¹ Presented during the conference on: Resources and Environment in Developing Countries: The Role of Science Education, held at Kuala Lumpur, Malaysia, April 12-16, 1976.

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and chromite. The non-metals, though constituting only 22.4 per cent of the total value of mineral production, continue to increase its contribution. Among the leading non-metallic minerals are cement raw materials, clay and other refractory minerals.

The mining industry contributes a sizeable amount to the economy not only because of its contribution to the GNP (3% of the GNP) but also it is a dollar earner and a source of employment. In 1974 the mineral exports was valued at \$46.2 million comprising 17 percent of total Philippine exports. On the other hand, the mineral imports for the same year amounted to only \$11.4 million showing a favorable balance of trade. Metallic exports consist of ores and concentrates of copper, manganese, chromite, and iron while the imports consist mainly of crude minerals and crude fertilizers. The principal trading partners are Japan and USA.

In accordance with our fundamental laws, the capitalization of the mining companies are now at least 60 percent owned by Filipino citizens. In a survey conducted in 1974, about 20 companies employ about 31,000 people. The Atlas Consolidated Mining and Development Corporation, which is operating a copper mine in Cebu, employs about 24 percent of this total. The total capitalization for the four sectors of the industry namely, copper, gold, iron, and chrome amounted to \$491 million of which 96.7 percent is invested in the copper mineral industry.

The mineral industry, like the other sectors of the economy, is faced with problems that range from economic to environmental in nature. These include the high risk of nature and big capital requirement of the mining industry; high operating costs and the difficulty of acquiring mining equipment; shortage of trained manpower; and the government's anti-pollution drive on the treatment and disposal of mine tailings. The plan of the government to process our mineral ores, particularly copper and iron, will certainly increase our environmental problems.

The environmental effects of mining operations in the Philippines involve four related areas of concern: (1) dumping of mine and mill tailings into the local rivers and streams; (2) uncontrolled deforestation and resulting soil erosion; (3) discharge of highly mineralized or acid mine waters into the drainage system; and (4) ground subsidence due to collapse of underground workings after abandonment of the mine.

Disposal of mine and mill tailings. — The disposal of mine and mill tailings and mine waters is a major problem. These tailings constitute almost 98 percent of the run-of-mine ore in a typical, low-grade copper ore milling plant. If one considers the amount of deposit that is processed during the operating life of the mine, the total quantity of

tailings that must be disposed will easily amount to several hundreds of millions of tons. (Atlas Consolidated Mining and Development Company's ore reserve estimated about 600 million tons).

Generally, tailings are impounded in dams created out of areas with favorable topography and ground structure. A significant amount of capital is needed for its construction and operation; they should be stable long after the mine is exhausted. Proper engineering design and construction can ensure stability of a dam. In tropical countries with heavy rainfall, the possibility of dam failure due to saturation can not be overlooked. An earthquake in Chile on March 25, 1965 resulted in the liquefaction of eleven (11) tailing dams at El Cobre causing the liquefied tailings to travel 12 kilometers down the valley which destroyed part of the town and reported killed more than 200 people.

In the Philippines the common method utilized by most mining companies, e.g. Philex Mining, Baguio Gold, etc. is the construction of dams or ponds where tailings are dumped. Water is flushed from the tailings and purified and/or used for other purposes. Atlas Consolidated uses a especially designed nozzle to accomplish reslurrying, the tailings being pumped in a slurry pipeline to a deep fall area in the ocean, a distance of 16 miles. Some underground mines are able to utilize their tailings to fill stopes. An advantage of the latter method over the first two is that it poses no pollution threats. In fact, the method reduces the extent of caving and the resulting surface subsidence.

The more common problem associated with mine and mill tailings disposal is the erosion of waste dumps and eventual transport to drainage areas below the dumps. In the Philippines, the various gold and copper mines operating in the Baguio District, 150 miles north of Manila, have long been blamed for the widespread siltation of agricultural farms and irrigation canals as well as the windling fish production from inland waters in the populous, northern portion of the Central Plain of Luzon, the principal island in the Philippine archipelago. Table 1 shows the operating characteristics of some mines in the Baguio District which have an environmental impact.

Although the mining companies are spending considerable amount of money for the operation of their tailing disposal system, the present practice does not appear to be satisfactory, especially in the case of two small mines (Black Mountain and Benguet Exploration). During the wet season when heavy rains occur the tailings are flushed down the Agno and Bued Rivers which drain the area, contributing heavily to the amount of silt carried down to the farming areas. In fairness to the mining companies, it must be mentioned that there were other activities that contributed to the silting problem: natural erosion of steep hills, illegal lumbering, poor forestry practices, shifting agriculture (kaingin) and burning of grass lands and tree areas.

TABLE 1. MINING DATA OF OPERATING MINES IN THE BAGUIO DISTRICT, PHILIPPINES.

Name of Company	Mill Capacity	Mining Method	Milling Method	Mill Products	Mill Reagents	Tailing Disposal
1. Benguet Consolidated	3,500 tpd	Underground	Cyanidation Flotation	Au bullion Cu Concentrate	CaC ₂ , CaO Zn dust	Tailing dam and pond
2. Philex Mining	20,000 tpd	Underground (block caving)	Tables, flotation and Magnetic separators	Cu conc. & Au bullion	Conditioners Frothers	Tailing dam and pond
3. Itogon-Suyoc	500 tpd	Underground	Flotation cyanidation	Au bullion	C ₂ C ₂ , CaO Zn dust & flotation reagents	Tailings used for filling stopes excess to creek
4. Atok Big-Wedge	100 tpd	Underground	Flotation cyanidation	Au bullion	C ₂ C ₂ , CaO Zn dust & flotation reagents	Tailing dam and pond
5. Black Mountain	—	Open Pit	Flotation	Cu conc.	Flotation reagents	To river banks w/ constructed dikes
6. Benguet Exploration	2,000 tpd	Underground	Flotation	Cu conc.	Flotation reagents	To riverbanks w/ dams & dikes
7. Western Minolco	—	Open Pit	Flotation	Cu conc.	Flotation reagents	Tailing dams and ponds
8. Sto. Nino	—	Open Pit and block caving				To creek before reaching tailings pond.

In 1971, the government took official cognizance of the problem and a government committee was designated to look into the mine tailing disposal problem in the area. After two years of study, the committee proposed the construction of a pipeline system into which the mines along its route will discharge their respective tailings to be ultimately piped into the sea (Lingayen Gulf), a distance of some 26 kilometers. To determine the effects of mine tailings on marine life, a study conducted by the National Science Development Board found out "that marine life and the marine environment was not greatly disturbed." The test fishes exhibited a 100 percent survival at all percentage dilution during a 96-hour bioassay of mine tailings. The toxic metals found to be present were Hg, Cu, Al, Ni and Fe; their concentrations were all found to be below allowable limits.

The pipeline proposal was later reviewed by a UNDP technical personnel and was claimed to be uneconomical and impractical. An individual approach to the problem was recommended through the construction of properly designed tailing dam by each of the mines involved.

Total approach to environmental problems. — The most recent action taken by the government to control the ecological problems resulting from mining operations was the creation of an inter-agency committee in July 1975 with the coordination of Man and the Biosphere (MAB). Composed of representatives from the Bureau of Mines, Bureau of Soils, Bureau of Fisheries and Aquatic Resources, and Bureau of Forest Development, the committee looked into several areas of interaction peculiar to the mining operations in the Baguio District, on a pilot project basis. The results of this pilot study will become the basis of a national action for the mining industry.

The first phase of the project was completed in February, 1976. The technical staff of the committee consisting of mining engineers, metallurgists, soil technologists, geologists, fishery specialists, foresters, and agriculturists combined their efforts in observing and studying the current mine practices in the following key areas: (1) slope stabilization or revegetation of mine heaps and dumps; (2) regeneration of mill tailing-covered areas; (3) fish production and/or water conservation measures or reclamation; (4) watershed reforestation; (5) tailing disposal; and, (6) socio-economic development.

The following measures were recommended and are now in various stages of implementation:

Reforestation. — Establishment of nurseries, planting of 3 to 50 hectares with commercial, fast-growing tree varieties adopted to high altitude (elevation of Baguio is 5000 feet) e.g., pine, alnus, narra, teak, acacia, and ipil-ipil. The Bureau of Forest Development provides technical assistance and the mining company supplies manpower and material requirements.

Regeneration of tailing-covered areas. — Studies are being conducted by scientists from the participating agencies to determine the best conditions for the growth of crops in the tailing areas. These soils are usually deficient in nitrogen, phosphorus, and potassium and being sandy, have low water-holding capacity. Initial results on the revegetation of a tailing-covered valley (893 Has, tailing thickness, 10-14 ft), formerly planted to rice, coconuts and vegetables, indicate the possibility of large-scale planting to yam, sweet potato, sugar cane, ginger, mango, peanuts, string beans and tomato.

Watershed development. — Most mining operations depend on significant water supply. As part of the socio-economic aspect of the project, the Bureau of Fisheries personnel have studied the possibility of utilizing the dams, ponds, and other man-made or natural water reservoirs for fish culture. The government provides the fingerlings of fresh water species, notably tilapia, carp, catfish, mudfish, and goby.

Slope stabilization. — Most of the producing mines in the Baguio District are situated in highly fractured and unstable geological formations. Slope stability of dumps, tailing dams, road embankments and other earth structures, drainage and major geotechnical problems associated with landslides, rock fractures, soil and mud creeps and talus movements are of major importance. The private mining companies have requested the Bureau of Mines to study and make recommendations on this problem.

A large measure of the success of this total approach project depends on the support and cooperation of the mining companies. In less than a year of implementation, the representatives of the mining industry have demonstrated an eagerness to contribute their share, to demonstrate that the industry, too has a social conscience.

A mine environmental section has been created in the Bureau of Mines to ensure continued government follow-up of the pilot project. New regulations have since been promulgated, providing for the growth and development of activities other than mining so that when the mine is exhausted or become no longer profitable for mining purposes, the people residing therein will have a substitute industry or business activity to provide for their livelihood.

The proposed construction of copper smelters in the Philippines should be considered, not only from the economic, but also from the environmental point of view. In 1972, the Lepanto Consolidated Mining Company established the Philippine Copper Smelting Corporation for the purpose of building a \$100 million smelter along the coast of San Fernando, La Union, Lepanto copper concentrates have a very high arsenic content. Considering that arsenic is poisonous and that 44 per-

cent of the smelter feed will come from Lepanto, measures have to be taken to ensure that no pollution will result from the smelter. It is of extreme importance that the ecological balance is not irreversibly disturbed by these pollutants. For this reason it is very necessary that scientists and technologists should conduct environmental studies on the effects of operating mines and the processing of their mineral ores and concentrates on the flora and fauna including man of the surrounding regions.