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## **Sustainable Mining in Myanmar**

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### **Abstract**

Myanmar is endowed with abundant natural and mineral resources. However, environmental degradation and social impacts have increased in recent years due to foreign investment in the mining sector and the application of modern technology in mining and processing methods to increase productivity. The growing trend towards new mining methods, particularly the shift from underground to open-cut method to mine and process low-grade ores contribute to generation of large volumes of waste rock and tailings, presenting a major disposal challenge. Wastes containing sulfides will further degrade the environment.

Absence of an efficient legal framework for Artisanal and Small Scale Mining (ASM) for gold and gemstones, and the application of mechanized mining both contribute to adverse environmental and social impacts of mining operations. Myanmar's newly-promulgated environmental law (2012) provides no details about environmental and social impact assessment and participation of communities and their role in conservation of the environment. Efficient guidelines are needed and continuous monitoring and Life Cycle Assessment (LCA) are essential for the greening of Myanmar's mining sector.

**Keywords:** sustainable mining; national sustainable development strategy (NSDS); life cycle assessment (LCA); rotary kiln electric furnace (RKEF), agenda 21

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### **Introduction**

This paper aims to describe the history of mining in Myanmar through periods of different governments, and summarize the social and environmental impacts of mining operations. The legal framework for mining and environmental conservation and its weaknesses are discussed, emphasizing the challenges and potential strategies for development of sustainable mining.

### **Importance of mining to Myanmar's economy**

Myanmar is endowed with many mineral resources and has a long history of mining. The country is still underexplored and under

exploited of its various mineral commodities. Precious metals (gold, platinum and silver), gemstones (ruby, sapphire and jade), tin and tungsten, copper, lead, zinc, nickel, chromium and antimony are important minerals (Figure 1). Limited resources of iron and brown coals are also important for local industries. Granites and lime stones are abundant aggregate resources for new development projects and for the cement industry. The history of mining in Myanmar can be divided into six periods, viz. (1) pre-colonial period (2) colonial period (1885 to 1947), (3) post-independence period (1948 to 1962), (4) first military government period, (5) second military

government (1988 to 2010) and (6) newly elected democratic government period (2011 to present).



**Figure 1** Map showing British annexation of Burma (Myanmar).

### 1.1 Pre-colonial period

Early mining in this period was dominated by mining for gold for ornaments and for religious monuments (pagodas), iron for weaponry and clays for buildings and monuments. During this period, oil was discovered in the central region and extracted using traditional hand-dug wells. Gemstones were mined in Lon-kin and Hpakant (Kachin State) for jade and in Mogok (Mandalay Division) for ruby, sapphire and semi-precious stones. The earliest record of silver mining was in the 14<sup>th</sup> Century by the Chinese in Bawd win (Shan State) in the northeast frontier region. The Chinese extracted the silver by smelting and left huge slag dumps. This first sign of major environmental impact is still visible today from the deforested landscape. Serious health impacts might also be expected from the crude smelting practices in use at that time. The other distinct evidence of environmental impact was from brick manufacturing, needed to construct numerous pagodas in the area around the famous ancient city of Pagan in central Myanmar. Deforestation was the obvious result of brick manufacturing during that period. Mining of gemstones and gold at that time was artisanal; the small-scale mining used primitive manual methods and caused less impact on the environment, as compared with modern large-scale mining activities. Social impact was not an issue at that time because most mining activities were operated and managed by local communities from where the mineral resources were located.

### 1.2 Colonial period

Burma (Myanmar) was annexed by the British after three successive Anglo-Burmese wars in 1824, 1855 and 1885, respectively. After the first war, lower Burma and Arakan (Yakhine) were annexed and tin, tungsten, antimony, coal and petroleum resources were investigated; production of tin, tungsten and coal subsequently began in Taninthayi Division of southern Myanmar. After the second war, when Arakan, Tenasserim, and Pegu were united as British ("Lower") Burma (within British India), oil extraction expanded

and some gold and steatite resources were investigated. During this period, small-scale tin and antimony mining was also practiced. After the third war, the whole country was annexed and modern methods were introduced to mine for lead, zinc, antimony, gemstones, tin and tungsten throughout the country. From 1885 to the outbreak of the second World, Myanmar's mining industry enjoyed a boom.

Throughout the colonial period, more infrastructure (roads, railways and electric power) were built to serve mining towns and open up many remote parts of the country. No environmental or social impact was reported from the mining industry at that time.

### *1.3 Post-independence period*

Although Burma (Myanmar) gained her independence on 4<sup>th</sup> January, 1948, an anti-government insurgency was born at the same time. The new government's two year economic plan in 1948 incorporated a development plan for the mineral resources sector [1] (Figure 2). Subsequently, in 1953 consultants from the USA were hired to draw up a national economic and engineering development plan [2]. The consultants recommended to develop the coal deposit at Kalewa in Sagaing Division, and also recommended to produce zinc metal by the electro thermic process using zinc oxide ore from Longkhen in the southern Shan State. In 1951, the government entered into several joint ventures with foreign oil and mining companies. Many foreign companies, especially from Germany, Japan and Yugoslavia, were involved in the investigation of iron, coal, nickel, chromite and copper resources. UNDP was also involved in supporting the development of the lead-zinc and tin-tungsten industries. However, progress of the mining industry was slow except for some well-established operations.

### *1.4 First military government period*

A military government first came into power in 1962, at a time when illegal mining for jade, ruby, sapphire, gold, tin and tungsten were the most active mining business.

Production from state owned mines had slumped due to poor management, underinvestment and lack of spare parts for processing plants and smelters. Rising gold prices stimulated artisanal gold mining across the country, and environmental and social impacts began to emerge as issues. When primary gold deposits were discovered by the artisanal miners, they were later confiscated by the government. Although cyanidation was used in 1903 at the Kyau-kpazat mine, the first gold mine in Myanmar, the government subsequently banned the use of cyanide in gold mining.

During this period, a metallurgical research centre was established at Ela in central Myanmar with support from the Japanese government. Tests were conducted at the centre, including the cyanideation process for gold. Following training at the research centre, its staff introduced the cyanidation process to artisanal gold miners when they left the centre. From that time, environmental and social impacts became increasingly serious issues. The lack of an appropriate legal framework for mining and environmental protection allowed a proliferation of environmental degradation as well as deep social impacts wreaked by the illegal gold and gem mining industries.

Modern geological mapping and mineral exploration in the country were conducted by UNDP-assisted programmes, along with bilateral government's aid programmes from Japan, United Kingdom, Yugoslavia, Canada, the Soviet Union and Germany. An Australian mining assistance programme was implemented from 1985 to 1988. Four state-owned gold mines (three hard rock and one alluvial) were in operation, but production was small and inefficient due to lack of experienced staff and technology. Production of copper concentrates from Monywa copper mines started in 1980 with aid from the Yugoslav government. The largest nickel laterite deposit was discovered in 1981 by German teams. However, all mining activities were disrupted in 1988 by the country-wide uprising.

### 1.5 Second military government period

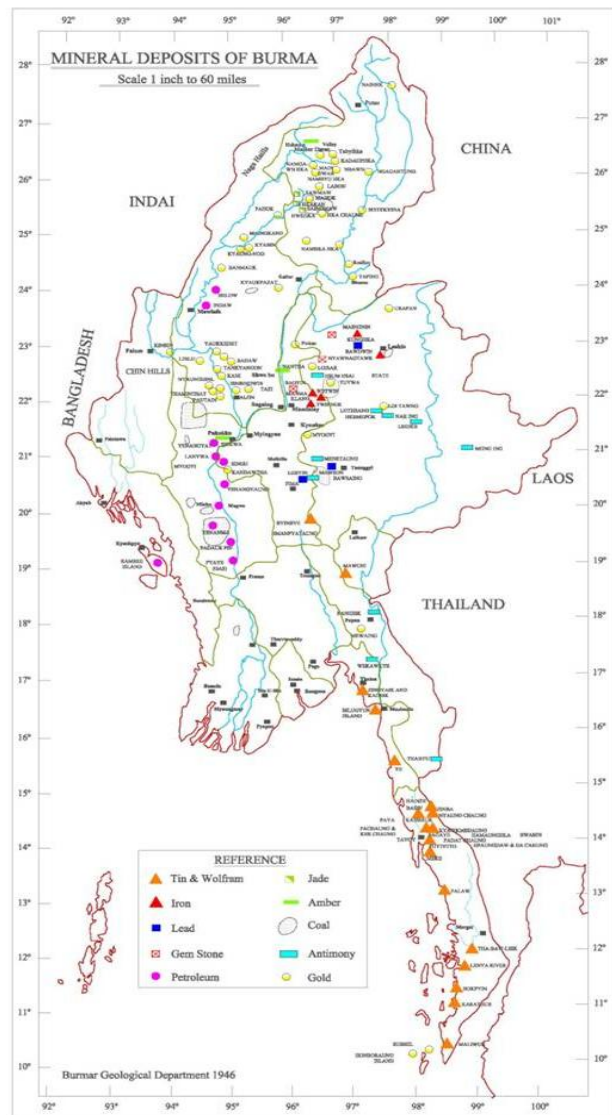
A new military government came into power in 1988 and in 1989 opened up the country for foreign investment through the promulgation of the Foreign Investment Law. Subsequently, in 1994 the new Mine Law was promulgated, and rules were issued under the law in 1996. Bidding for exploration blocks were held three times in 1995. Players at that time included several Canadian companies and one US gold mining company. Details about the companies and mining activities of this period were described as “grave diggers” by Roger Moody, 1999 [3].

For the mining sector, perhaps the most significant events in this period were the entry of two military companies the Union of Myanmar Economic Holding Limited (UMEHL) and the Myanmar Economic Corporation (MEC) into the gem and metal mining industry. Two significant mining projects in this period were the Monywa copper project operated by the Myanmar Ivanhoe Copper Company Limited (MICCL) and the Tagaung taung nickel project operated by the China Nonferrous Mining Company CNMC). When MICCL transferred its Monywa project to a third party trust to sell, Wan-baung, a subsidiary of a Chinese arms manufacturing company (Norinco) purchased the Monywa project, signed a joint venture agreement with UMEHL and took over the Monywa project. The Monywa project comprises several mines Sabei taung, Sabei taung south, Kyesin taung SK mine and the larger Letpadaung taung mine. The mining agreement between the Ministry of Mines and UMEHL is the only agreement investigated by the Letpadaung taung investigation committee.

### 1.6 New Myanmar period

The new democratic civilian government inherited a plethora of complex and non-transparent projects in all economic sectors from the previous military governments, and mining projects were no exception. Western sanctions were finally lifted due to the new government’s concerted efforts to

transform the country into a new and open democratic system. To boost the economy through foreign investment, the government promulgated a new Foreign Investment Law in 2012, as a result of which many countries are exploring major investment opportunities in various sectors in Myanmar. But what is situation for the mining industry? Is today’s legislative framework attractive and practicable for foreign and local investors in the mining sector? Are there any environmental laws covering responsible mining? What are the rights of affected communities in mining projects? These will be discussed in the following paragraphs.



**Figure 2** Mineral deposit map included in 2 Year Economic Plan in 1948.

### **Mining legislation in Myanmar**

The Mogok gemstones were very important to the British after annexation of the whole of Burma in 1885; the Upper Burma Ruby Regulations were issued in 1887 as Myanmar's first piece of mining legislation. Burma was separated from India in 1935 and The Burma Metalliferous Mines Manual was promulgated in 1937. The Mineral Concession Rules 1913 and the Burma Mineral Concession Directions, 1947 were adopted during the colonial period. After gaining independence, the Myanmar government with the assistance of UN consultants, the Union of Myanmar Mines and Minerals Act was promulgated in 1961. The New Myanmar Mines Law was subsequently promulgated in 1994 and all the previous laws were repealed. In the new Mines Law there is no description covering details of environment impacts or degradation, or social impact. The Law contains an important clause, covering rights to utilize land and water for mineral production. Chapter 5, paragraph 14 states *"the holder of permit for mineral production within an area under the Ministry's administrative control or which does not lie within the Mineral Reserve Areas or Gemstone Tract, shall carry out such production only after coordinating and receiving agreement from the individual or organization having the right of cultivation, right of possession, right of use and occupancy, beneficial enjoyment, right of possession or transfer of the said land [4]"*.

### **Environmental legislation in Myanmar**

A National Commission for Environmental Affairs (NCEA) was organized in 1990 under the Ministry of Foreign Affairs and announced the National Environmental Policy on 5 December 1994. The aim is to establish sound environmental policies in utilization of water, land, forest, minerals, marine resources and other resources in order to conserve the environment and prevent its degradation. The objective of Myanmar's environmental policy is aimed at achieving harmony and balance among people, environment and natural resources through the integration of environmental considerations into the development process

to enhance the quality of life of all its citizens. The National Environmental Conservation Committee (NECC) was formed in place of NCEA in April 2011; the Ministry of Forestry was also upgraded and renamed as the Ministry of Environmental Conservation and Forestry (MOECAF). In 2012, an Environmental Conservation Department was formed under MOECAF.

Myanmar has adopted Agenda 21 and the Rio Declaration on environment and sustainable development. The Formulation of Myanmar Agenda 21 (as a country level response) was completed in 1997. The purpose is to provide framework of programmes and actions for achieving sustainable development in the country. The detailed programmes and activities in Agenda 21 have been drawn by the NCEA in collaboration with government ministries and departments concerned. In 2009, Myanmar launched a National Sustainable Development Strategy [9] to provide a strategic long term framework for sustainable development. The NSDS covers the three pillars of sustainability (environmental, economic and social) in articulating its vision: "Wellbeing and Happiness for Myanmar People". The three goals of the NSDS are as follows:

- (1) Sustainable management of natural resources;
- (2) Integrated economic development; and
- (3) Sustainable social development

One of eleven areas under the strategy for sustainable management of natural resources is sustainable management of mineral resources utilization. Sustainable mining sector development is also named as one of nine themes under integrated economic development. Two important components for sustainable social development are the creation of a knowledge-based society and strengthening of border areas and national races. NSDS also recommended formation of a National Commission for Sustainable Development (NCSA) to administer implementation of Myanmar's NSDS. Actions proposed to support implementation for NSDS are listed as follows:

- (1) Policy framework;
- (2) Advocacy, awareness raising and education;
- (3) Capacity building;
- (4) Adequate financing and technology; and
- (5) Monitoring and evaluation

The Myanmar Environmental Conservation Law was promulgated on 30 March 2012 and includes 14 chapters and 42 articles. Chapter 7 (Environmental conservation) Article 13 (c) is related to waste disposal from exploration, production, and treatment of minerals, industrial minerals, raw materials and gems. Chapter 9 (Conservation of Natural Resources and Cultural Heritage), Article 18 (d) cover mineral resources. However, environmental degradations and impact assessment are not elaborated in detail.

### **Sustainable mining**

Environmental impacts are generated through out a mine's life cycle, from exploration, development, production, through to mine closure. The main environmental impacts are air and water pollution, noise, dust, solid waste and toxic tailings. Social impacts from mining activities include large-scale human displacement and resettlement, migration related impacts, loss of access to clean water, impacts on livelihoods and public health and on cultural and aesthetic resources. The term sustainable mining is controversial, interpreted by many civic groups and academics as an oxymoron. The debate is centered on the availability of nonrenewable mineral resources and some describe the economic exploitation of mineral resources as a function of technology, exploration and markets [6, 7, 8]. There are few references in the mining literature to Agenda 21, which was approved at the 1992 Earth Summit in Rio de Janeiro. At the World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002, the mineral sector was included as Paragraph 46 of the Plan of Implementation for Agenda.

The concept of sustainable mining is based on depletion/availability of mineral, resources and environmental and social impacts by mining operations; descriptions

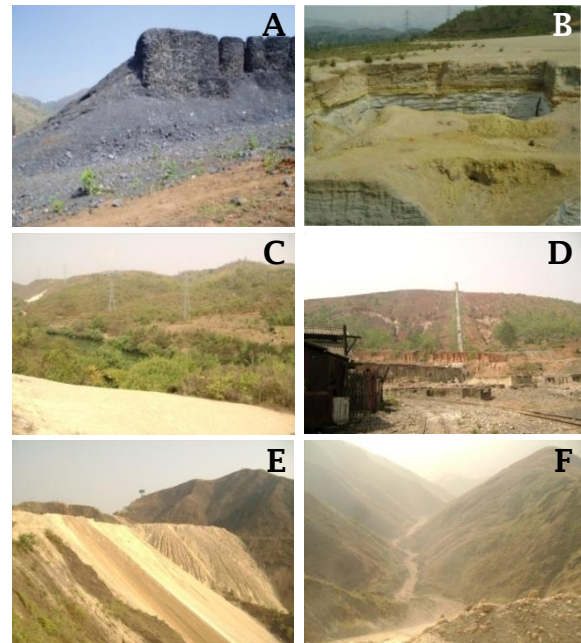
of "sustainable mining" range considerably among industry, government and civic groups [9]. The issues of resources technology environmental social aspects are inextricably linked due to the increasing scale of modern mining which exploits lower grade but larger ore bodies, often through sizeable open cut mines [10]. Prediction of future sustainability of mining can be made by examining the trends of ore grade, the amount of waste materials produced for a given level of production, and the extent and success of rehabilitation [11]. It is also argued that sustainable mining can be achieved by safe operation, demonstrating best practice in environmental management and by community engagement and efficient use of mineral resources [12].

### **Sustainable mining in Myanmar**

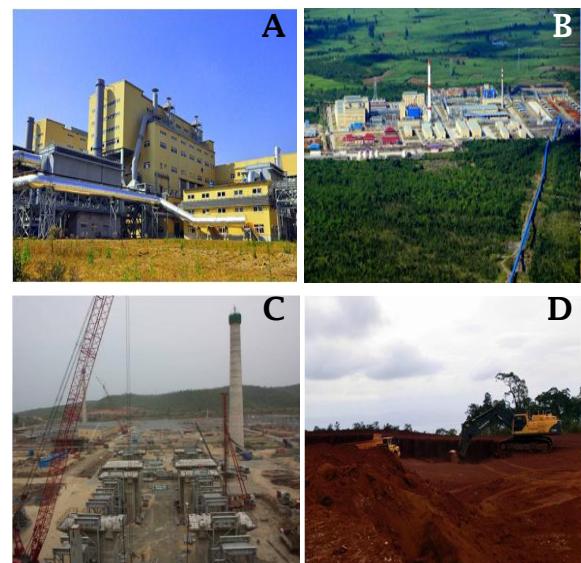
Mining activities in Myanmar can be divided into artisanal and small-scale mining (ASM) and large-scale mining. The sustainability of mining operations depends on the mining and processing methods used and the scale of operation. The most distinct impact from past mining activities was deforestation caused by the world class Namtu-Bawdwin lead-silver mine (Figure 3). Timbers were used in underground and smelting operation to extract silver from the ore for many centuries. During the colonial era, the initial operation by the British company was resmelt the Chinese slags to extract lead; later development of the Chinese workings led to discovery of the high grade ore body. The ore body was mined using the square set stopping method, which required a large volume of timber wood. Deforestation was the major recorded impact from the mining operation; impacts from the smelting were not recorded. By the time the mine was nationalized in 1965, most of the high grade ores had already been extracted and production fell due to lack of investment funds and poor management. Since 1981, low grad ores surrounding the mined-out area have been mined by the open cut method. Waste rock was dumped into the Er valley without any impounding structure. The sulfide content of this waste rock is likely to generate acid drainage into the Nam Pang

Yun River, which flows into the larger Namtu River. In addition, pit slope was steeper than the design angle and posed slope stability problems, threatening safety of the work force and equipment. Due to lack of maintenance of the water supply, rail system and underground workings, environmental conditions in the mine deteriorated, impacting on the local community. Environmental and social impact assessments are urgently needed in this kind of large idle mine before revival of interest by foreign companies to refurbish the mine by planning bigger open pit with increased through put and generation of even larger amounts of waste rock and tailings. This is the present situation at the once-world-class lead silver deposits of Namtu-Bawdwin mine.

Another mining project is the Tagaung taung Nickel Project (Figure 4). The project is a Greenfield project, launched by the BGR from the Federal Republic of Germany in 1981 to exploit a newly discovered nickel laterite deposit. The deposit is located at an isolated, sparsely populated area near the ancient city of Tagaung. In 1981, the only accessible route was via the Irrawaddy River. Although the deposit was large, (40 million metric tonnes with 2% nickel), electricity was not available at that time. However, after construction of a 600 MW hydropower plant on the Shweli River by the Chinese government, development of the Tagaung taung nickel deposit became feasible and the CNMC from China and the No. 3 Mining Enterprise of the Ministry of Mines entered into a Production Sharing Contract (PSC agreement) to produce 85,000 metric tonnes of ferro-nickel per annum. The mining is done by open cut and pyrometallurgical Rotary Kiln Electric Furnace RKEF process for ferronickel production. No environmental impact assessment for the project can be found.

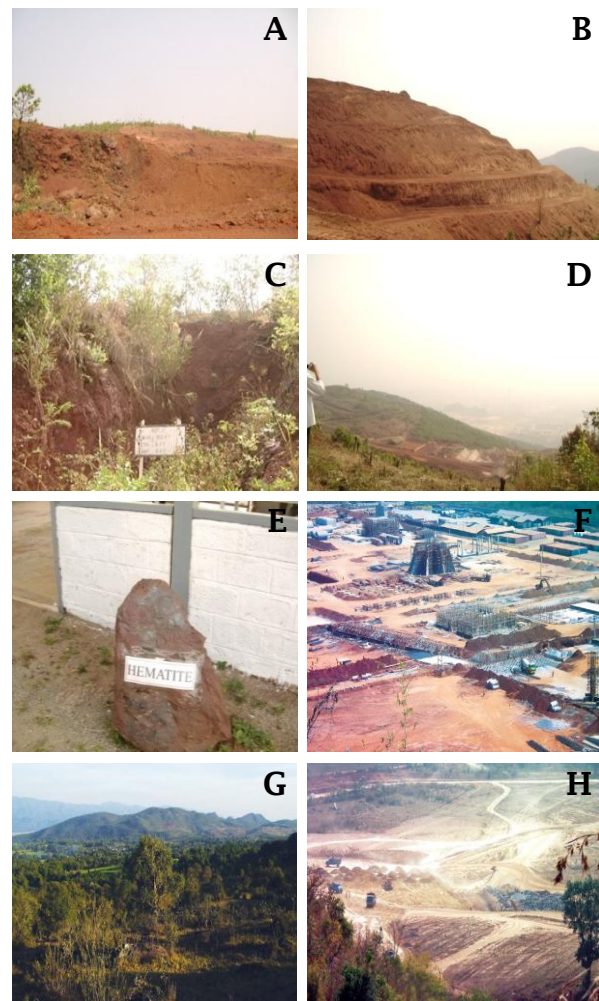


**Figure 3** Lead smelter slag dump (A), tailing dump from pre-war concentrator (B), tailing dump near Namtu River (C), Smelter stack (D), Waste dump from Baedein open pit (E), and Waste dump in the Er valley (F).



**Figure 4** Smelting plant at Tagung taung (A), smelting complex (B), plant construction (C), nickel laterite at Tagaung taung (D).

The Pinpet iron project is another green field project with social and environmental impacts from mining activities (Figure 5). Initially, Myanmar Economic Corporation (MEC) developed this project as the No. 5 Iron and Steel Plant Project. Recently the project was handed over to the Ministry of Industry. The iron ore deposit was explored by Krupp Company and Demag Co. from Germany in 1960. Latest exploration was conducted by BGR, also from Germany. The iron ore also contains copper, uranium and rare earths. The project began in 2004 and the Russian Tyazhpromexort Co. and Italian Dsanieli Co. are also involved in the project. A mining agreement with the Ministry of Mines cannot be found, and an environmental and social impact assessment was not prepared before project start. Many lands were confiscated and communities were poorly informed about the project. Potential environmental impacts from mining and smelting processes are high, with serious issues including emissions from the smelter, contamination of air and water, as well as increased exposure to the inherent radioactivity of the ore. Construction of beneficiation and smelting plants are underway. The community's views were described by the Pa-O Youth Organization [13]. In the same autonomous Pa-O region, mining of lignite and a coal fired power station started in 2002. The design capacity of the plant is 60 MW for the two units, but only one unit is currently operating because of the poor quality of coal. No environmental and social impact assessment was conducted prior to project development, and regular monitoring of air and water quality is not practiced. Serious impacts directly attributable to the project include poor air and water quality around the mine and the plant, confiscation of agricultural land, migration of people, deterioration of health of local people and damage to religious buildings. A comprehensive report on the project's impacts was prepared by the Pa-O Youth Organization [14].



**Figure 5** Pinpet iron mine (A), Pinpet open cut (B), Pinpet adit number 2 (C), crusher site at Pinpet (D), hematite iron ore (E), plant installation at Pinpet (F), panoramic view of Pinpet (G), and plant site of Pinpet (H).

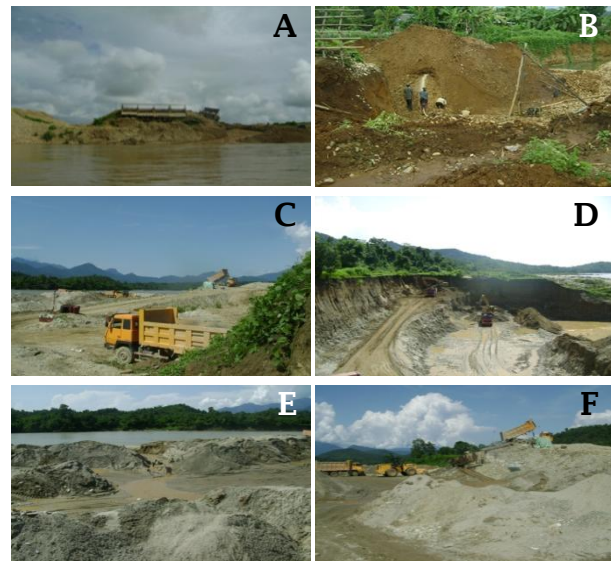
Since 1994, following the ceasefire agreement between the Kachin Independence Army (KIA) and the government, large scale mining of jade using large earthmoving equipment caused extensive deterioration of land and the Uru River. Process wastes were simply dumped into the river, which is now choked with wastes, resulting in frequent flooding during the rainy season. HIV, drugs, prostitution and poor health are the main social impacts from the jade mining. The occurrence of gold and mining the river bed and terraces make the situation worse (Figure 6). Ruby mining at Mogok and Mong Hsu have also impacted upon the environment and social life because of the reliance on large-scale mechanized mining. In contrast, history has shown that artisanal mining using



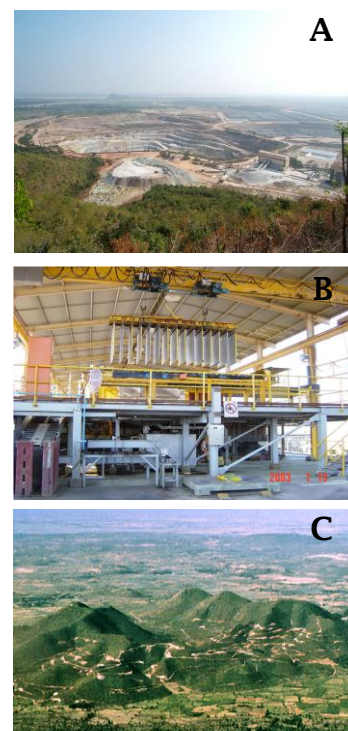
traditional methods had only a limited impact on the environment. However, widespread expansion of artisanal and small-scale mining (ASM) as well as large-scale gold mining have recently been the most detrimental to the environment as a result of the rising price of gold. It is easier to mine and the product can be easily sold. Amalgamation and cyanidation methods are the most common extraction methods. The use of cyanidation is officially banned in Myanmar, but used illegally in all gold mining areas; the Ministry of Mines has no control and monitoring practice. Even in large scale gold mining where cyanidation is permitted, there is no cyanide management system or audit. The most serious impacts have been deforestation, mercury contamination in soil and water, and leakage of cyanide into surface and underground water. Social impacts include migration of local people, destruction of the landscape, poor health, and drugs problems. Illegal gold and gem mining for small scale and large scale operations in Kachin and Karen State were described by Images Asia and Pan Kachin Development Society [15] and the Kachin Development Networking Group KDNG [16]. The impacts of artisanal and small scale mining for gold and gemstones in Mandalay Division, Bago Division and Mon state have been documented by Earth Right International (RI) and the Karen Environmental and Social Action Network [17].

The recent conflict between local affected communities and the mining company at Letpadaung taung copper mine has become the largest sustainable mining issue in Myanmar (Figure 7). The Monywa copper mine is the largest copper mine in Myanmar, comprising three separate ore deposits namely Sabei taung, Sabei taung South, Kyesin taung and Letpadaung taung (the largest deposit). The first three deposits are grouped as the 'SK Mine'. As noted above, the Monywa copper project was first operated by MCCL as a 50-50 joint venture company between Ivanhoe Mines and Number One Mining Enterprise ME1, a State-owned enterprise. The first phase of the project began commercial production in 1998 with annual

production of 25,000 tonnes of grade LME grade Acathode copper.



**Figure 6** Gold sluicing in the Uru River (A), alluvial gold mining at Uru River terrace (B), gold mining in Mae Kha River terrace in Kachin State (C), gold mining in Maekha terrace (D), Waste dump and Maekha River (E), and mechanized alluvial gold mining (F).



**Figure 7** Monywa open pit copper mine (A), Cathode copper plant (B), and Letpadaung taung (C).

The second phase was to develop the Letpadaung deposit. In 2007 Ivanhoe sold 50% of its interest to the Chinese weapon manufacturing company Norinco through an independent trust. Norinco joint ventured with Union of Myanmar Economic Holding limited UMEHL to form Myanmar Yang Tse Copper limited to operate the SK mine and Myanmar Wanbao Company to develop Letpadaung taung deposit. The agreement with the MEI is not transparent. The SXEW process is used to produce cathode copper and environmental impact assessment is performed by third party in MICCL. No government body has monitored the operation for environmental impact and therefore there is no information on the actual impact. Since the Lepadaung taung deposit is large (1.069 billion tonnes at 0.4% Cu measured and indicated) and production will be high, a higher level of environmental impact can be anticipated. Local communities were severely affected by confiscation of their land and below-market compensation. They are not well-informed and therefore conflict with the local affected communities has become a major issue in the country. These are comprehensively reported by the Burma Environmental Working Group [18].

### Conclusions

Myanmar is richly endowed with mineral resources that are underexplored and underexploited. Past environmental impacts from early centuries by mining activities such as deforestation can still be observed in the country. In the colonial era, mining methods were mainly underground except some alluvial tin mines. Ores were high grade and therefore impacts were low. Insurgency during the post-independence period hindered development of the industry; the population of artisanal and small scale mining (ASM) was small and environmental impacts were therefore not major issues. However, during the period of military socialist government, illegal artisanal and small-scale mining for alluvial gems and gold expanded rapidly because of rising prices, resulting in major issues of environmental degradation as well as adverse social impacts. The liberalization ushered in

by the second military government took power in 1988-89 attracted foreign investment, resulting in a revival of the mining sector. Because of the increasing numbers engaged in ASM, use of mechanized mining, mercury and cyanide in gold mining, environmental and social impacts became an increasingly serious political problem. The industry's trend to shift from underground to open cut methods, along with mining of low grade ore deposits generate larger amounts of waste rock and tailings from the processing plants. Smelter emissions add to the heavy potential environmental and social impacts from such operations. The rights and participation of affected communities are critical factors in implementing sustainable mining projects, whilst strong and efficient legal frameworks, guidelines and enforcement are needed to provide effective control and monitoring of environmental and social impacts from the mining industry. The use of Life Cycle Assessment (LCA) from cradle to grave is a must for all (stake holders, communities and citizens of Myanmar) to transform the Myanmar mining industry from the status of "Grave diggers" to sustainable and responsible miners.

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