Sumber mineral dan alam sekitar

Dr. Wan Zuhairi Yaacob

Program Geologi

UKM

MINING

- **Mining involves the extraction of large quantities of rocks, liquids and gases from the depths of the earth**

DIFFERENT VIEWS

- **"Mining makes a mess of the countryside"**
  - **Disturb the land**
  - **Overturn vegetables**
  - **Destroy wildlife shelter**
  - **Disrupt farming**
  - **Waste piles**
  - **Abandoned shafts/adits**

- **"We have to mine minerals where we find them"**
  - **Essentiality of minerals**

Sumber Mineral
(*Mineral resources*)

Definasi Umum

Unsur, sebatian, mineral atau batuan yang berada dalam kepekatan tinggi dalam bentuk yang boleh dilombong untuk mendapatkan bahan berharga/berguna

Definasi yang lebih pragmatik

Kepekatan bahan semulajadi (pepejal, cecair, gas) yang berada di dalam atau di atas kerak bumi, berpotensi dan boleh dikeluarkan secara **ekonomi** (menguntungkan)

Bijih (Ore)

Mineral logam berkepekatan tinggi yang boleh dilombong secara ekonomi

– Cth: Gold ore – rock contains only minute amount of gold but can be profitably extracted

2 ppm = 2 biji kacang dalam satu lori 1 tan berisi pasir

Bijih Perbandaran (*Urban Ore*)

- Bahan (terutama logam) yang berakhir di landfill
- Concept of “urban ore” bermula di Palo Alto, California
- Incineration of sewage sludge→ ash → landfill
- Large conc. Of metals:
  - Gold : 300 ppm
  - Silver : 660 ppm
  - Copper : 8000 ppm

Simpanan Longgokan (Reserve)

Sebahagian dari simpanan mineral yang telah dikenalpasti (dari kajian & penyiasatan) dan boleh dikeluarkan secara sah (legal) dan ekonomi semasa penilaian dilakukan.

Sumber dikenalpasti (Identified resource)

1) **Measure-identified resources** **high level of confidence**
   1) Well known and measured
   2) Total tonnage or grade is well established
2) **Indicated-identified resources** **reasonable level of confidence**
   1) Not so well known and measured
   2) Cannot be outlined completely by tonnage or grade
   3) Total tonnage or grade can be estimated, not as well as measure-identified
3) **Inferred-identified resources** **low level of confidence**
   1) Quantitative estimate based on broad geologic information of the deposit
   2) Total tonnage or grade can only be crudely estimated

Faktor kepekatan, FK
(concentration factor)

- Mineral memerlukan FK kerana mineral mempunyai nilai ekonomi yang berbeza (rendah dan tinggi)

- FK = kepekatan yg diperlukan utk dilombong secara ekonomi terhadap kepekatan purata logam dalam kerak bumi

$$\textit{FK} = \frac{\textit{Concentration in ore}}{\textit{Natural concentration}}$$

Table 14.4 Approximate concentration factors of selected metals necessary before mining is economically feasible

Metal	Natural Concentration (Percent)	Percent in Ore	Approximate Concentration Factor
Gold	0.0000004	0.001	2,500
Mercury	0.00001	0.1	10,500
Lead	0.0015	4	2,500
Copper	0.005	0.4 to 0.8	80 to 160
Iron	5	20 to 69	4 to 14
Aluminum	8	35	4

Source: Data from U.S. Geological Survey Professional Paper 820, 1973

Impacts and benefits of mines and quarries

Impacts	Benefits
Landuse changes	Economic advancement
Surface habitat changes	Employment
Surface water changes	Social & medical enhancements
Groundwater changes	Stimulation of secondary industry
Blasting vibration	Provision of mineral resources
Noise	Enhancement of technical skills
Elevated dust levels	Enhancement of educational levels
Subsidence	Access and infrastructure enhancements
Health impacts	
Aesthetic changes	
Chemical toxicity	
Traffic changes	

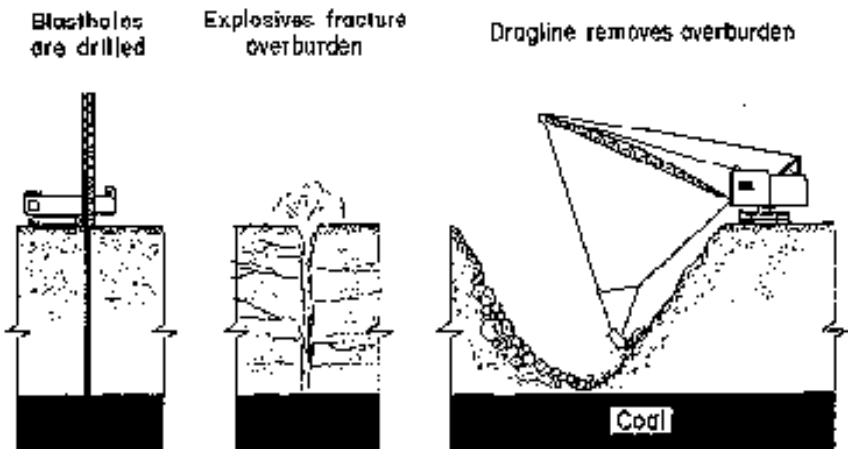
Environmental impact of mineral development

Keller , E.A

1. Impact of mineral exploration and testing
2. Impact of mineral extraction and processing
   a. Waste from mines
   b. Types of mining and their impact
   c. Air and water pollution impact on the biological environment
   d. Social impact

Types of mining

- **SURFACE** ← **Highest impact!!**
  - Area strip mining
  - Contour strip mining
  - Open pit mining
  - Auger mining
  - Placer mining



- **SUBSURFACE**
  - Longwall mining
  - Room & Pillar

Lowest impact!!

IMPACT OF MINING ON THE LITHOSPHERE

- **Damage on surface & subsurface**
- **Geomorphic change**
- **Surface subsidence**
- **Waste dumps**
  - **Wind blown dust; spontaneous combustion**
- **Landslides, rock & mud flows**
  - **Bournville landslide & Aberfan disaster**

IMPACT OF MINING ON THE BIOSPHERE

- **Loss of farming land**
- **Degradation of ecological systems**
- **Land subsidence**
- **Waste tips**
- **Acid Mine drainage – pollutes water/soil**
- **Timber for roof support**
- **Plants are susceptible to atmospheric pollution**
  - **Photosynthesis is affected by SO_2, CO, CH_4**
  - **Acid rain on soil, water, biota**

IMPACT OF MINING ON THE ATMOSPHERE

- **Dust & Gases**
  - **Opencast mining – blasting**
  - **Escaping gases from rock/mineral masses & machinery**
  - **methane, carbon monoxide, nitrogen oxide, sulphur compounds**
- **Burning waste tips – noxious gases(SO_2, NO_2, CO, H_2S)**
- **Respiratory diseases**

IMPACT OF MINING ON THE HYDROSPHERE

- **Lowering of water table**
- **Mine water discharge to river**
- **Seepage from settling tanks**
  - **Eg: Cyanide extraction (sodium cyanide, Zn, sulphuric acid)**
- **Water is pumped into ground to extract minerals (eg. Salt)**

Water flume

Water cannon

ACID MINE DRAINAGE (AMD)

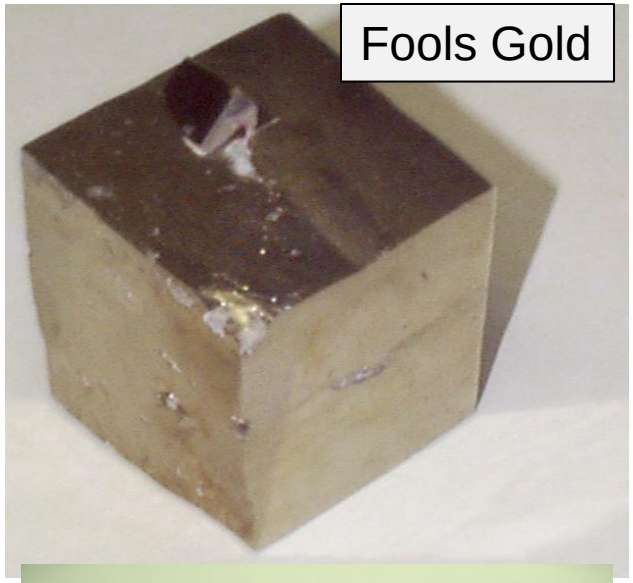
- **Acid Mine Drainage**
  - **Produce acid (H_2SO_4)**
  - **Yellow Boy**
  - **High heavy metals in water**

- **Interaction of 4 spheres**
  - **Lithosphere = minerals**
  - **Hydrosphere = water**
  - **Atmosphere = oxygen**
  - **Biosphere = bacteria** *Thiobacillus ferrooxidans*

ACID MINE DRAINAGE (AMD)

ACID ROCK DRAINAGE ??

Metal-bearing sulphide minerals



Mineral	**Composition**
Pyrite	FeS2
Marcasite	FeS2
Chalcopyrite	CuFeS2
Chalcocite	Cu2S
Sphalerite	ZnS
Galena	PbS
Millerite	NiS
Pyrrhotite	Fe1-xS (where 0<x<0.2)
Arsenopyrite	FeAsS
Cinnabar	HgS

(Source: Ferguson and Erickson 1988)

Chemical reactions

- $4FeS_2(s) + 14O_2(g) + 4H_2O(l) \text{ ---> } 4Fe^{2+}(aq) + 8SO_4^{2-}(aq) + 8H^+(aq)$ (1)
- $4Fe^{2+}(aq) + O_2(g) + 4H^+(aq) \text{ ---> } 4Fe^{3+}(aq) + 2H_2O(l)$ (2)
- $4Fe^{3+}(aq) + 12\ H_2O(l) \text{ ---> } 4Fe(OH)_3(s) + 12H^+(aq)$ (3)

$4FeS_2(s) + 15O_2(g) + 14H_2O(l) \text{ ---> } 4Fe(OH)_3(s) + 8SO_4^{2-}(aq) + 16H^+(aq)$ (4)

pH acidic

Yellow Boy

Mine Tailings

Yellow Boy [$4Fe(OH)_3$]

Kaedah kawalan kesan pembangunan mineral

1. **Environmental Regulation**

2. **Biotechnology**

Bab 19 : Alam Sekitar dan Pengurusan Mampan Sumber Asli

(Rancangan Malaysia ke 8)

- Model **Enakmen Mineral Negeri**, yang membolehkan usaha cari gali dan perlombongan mineral yang tersusun, cekap dan **mesra alam**

- memastikan **aktiviti selepas perlombongan dijalankan untuk menukar tanah bekas lombong bagi kegunaan lain-lain aktiviti ekonomi**.

Enakmen Melombong (sekitar 1930an)

Mining Enactment 1936 [FMS Cap. 147] –
(Perak, Selangor, Negeri Sembilan, **Pahang**)

Akta Pembangunan Mineral, 1994

(Dikuatkuasakan oleh agensi Persekutuan)

ENAKMEN MINERAL, 2001

(Dipertanggungjawabkan ke atas negeri-negeri)

(Pejabat Tanah dan Galian)

1. **Royalti**
2. **JK Sumber Mineral Negeri**
3. **Urusan kerja carigali**
4. **Pemulihan alam sekitar**
5. **Jaminan atas pajakan**
6. **Lesen melombong tuan punya**
7. **Timbang tara masalah**

Dasar Mineral Negara 2 ini mempunyai objektif:-

1) Untuk memastikan **pembangunan mapan** dan **penggunaan optimum sumber mineral**.

2) Untuk menggalakkan penerajuan kitaran hayat bagi memastikan sumber mineral negara **dibangunkan secara mesra alam sekitar**, **bertanggungjawab** dan **mapan**.

3) Untuk mempertingkatkan daya saing dan kemajuan sektor mineral di arena global.

4) Untuk mempertingkatkan penggunaan mineral tempatan dan menggalakkan lagi pembangunan produk berasaskan mineral.

5) Untuk menggalakkan perolehan dan kitar semula logam dan mineral.

DIKELUARKAN OLEH KEMENTERIAN SUMBER ASLI & ALAM SEKITAR

SEMBILAN TERAS DMN2

Bagi memastian pencapaian objektif, DMN2 disokong oleh sembilan (9) teras utama:

Baca article dalam SPIN

Teras 1 : Pengembangan Sektor Mineral
Thrust 1 : Expansion of the Mineral Sector

Teras 2 : Iklim Perniagaan yang Kondu
Thrust 2 : Conducive Business Climate

Teras 3 : Penerajuan Alam Sekitar
Thrust 3 : Environmental Stewardsh

Teras 4 : Peningkatan Penyelidikan d
Thrust 4 : Research and Development (

Teras 5 : Pembangunan Sumber Manusia
Thrust 5 : Human Resource Development

Teras 6 : Pewujudan Informasi Mineral yang Bersepadu
Thrust 6 : Establishment of Integrated Mineral Information

Teras 7 : Penglibatan Komuniti dan Tanggungjawab Sosial
Thrust 7 : Community Involvement and Social Responsibility

Teras 8 : Promosi, Pemasaran dan Penjenamaan
Thrust 8 : Promotion, Marketing and Branding

Teras 9 : Publisiti dan Perhubungan Awam
Thrust 9 : Publicity and Public Relations

Teras 1 : Pengembangan Sektor Mineral
Thrust 1 : Expansion of the Mineral Sector

Teras 3 : Penerajuan Alam Sekitar
Thrust 3 : Environmental Stewardship

Pemulihan Alam Sekitar di bawah EMN

- **Pemuliharaan alam sekitar**
  - **Kajian kebolehlaksanaan (feasibility study)**
  - **Pelan Pemulihan lombong**
  - **Penilaian Kesan Alam Sekeliling (EIA)**
  - **Peruntukan penggunaan air**
    - **tidak boleh mengganggu bekalan kepada pengguna lain serta tidak merosakkan sungai dan punca air tersebut.**
- **Pemulihan kawasan bekas lombong**

  - Tabung Pemulihan Lombong atau Tabung Pemulihan Bersama

JK Sumber Mineral Negeri (JSMN)

JK Sumber Mineral Negeri = PT, Jabatan Perhutanan, JAS, JMG, etc.

2. Penggunaan kaedah bioteknologi dalam mengurangkan impak perlombongan

- Metal extraction and processing
  - Bioassisted leaching or bioleaching
  - Use microorganisms to recover metals (in gold processing)
- Treatment of acid mine drainage
  - Use acid tolerant plant to remove metals and neutralize acid
- Treatment of polluted water
  - Use artificial wetland

Mine reclamation techniques

- Removing, relocating or demolishing buildings and physical infrastructure;
- Closing pits and shafts;
- Stabilizing underground workings, soils and slopes;
- Treating tailings and waste water;
- Revegetating land
- Good engineering practice and design
- Exclusion zones

Terima kasih