EBS 201 MENDAPAN MINERAL

INTRODUCTION INTO MINERAL DEPOSIT (MENDAPAN MINERAL)

Prof Madya Dr Kamar Shah Ariffin
Dr Zakaria Endut
Pusat Peng. Kejuruteraan Bahan Dan Sumber Mineral

COURSE OUTCOME EBS 201

No.	Course Outcomes	PO	PO detail
1.	Able to apply the basic categories, genesis, classification of ore deposits formation, its main characteristics and the important to economic developments and market requirements.	PO 1	**Engineering Knowledge : Include Natural Science**
2.	Able to compare variety of metallic and non-metallic ore deposits	PO 2	**Problem Analysis**
3.	Able to describe the uneven distribution of ore deposit formations in space and time	PO 2,	**Problem Analysis**
4.	Able to analyse various factors that influence the complexity of ore mineral formation	PO 3	**Design / Development of Solutions**

Assessments

Final Examination	**60%**
Coursework	40%

Assessment Methods	%
Test	10
Assignment (3 or 4 assignment)	30

- **Come to class on time (Be punctual); Hand in assignments on time, Be prepared**
- **Quiz, test & assignment: Be responsible for your own learning.**

Course Delivery & Assessment Plan:

Details will vary depending on the preference of the lecturer, subject being covered, and the need and/or curiosity of students.

CO	LT	PO	Measuring Tools							Total marks
			Quiz (5 %)	Test (5%)		Assignment (30 %)			Exam (60 %)	
			1	1	2	1	2	3		
CO 1	C_1	PO_1	5						15	20.0
CO 2	C_2	PO_1				10			15	25.0
CO 3	C_3	PO_1			5		10		15	30.0
CO 4	C_1	PO_5						10	15	25.0

Revised Bloom's Taxonomy:
Level 1: Remembering
Level 2: Understanding
Level 3: Applying
Level 4:Analyzing
Level 5: Evaluating
Level 6: Creating

- Exams will cover all COs and all the CO s should be attained by the students.
- Format D;

Part A
- Q1-CO1 (ZE)
- Q2-CO2 (ZE)

Compulsory

Part B
- Q3-CO3 (KSA)
- Q4-CO4 (KSA)
- Q5-CO1 (HZ)

Answer min 2 Question for each part

Part C
- Q6-CO3 (ZE)
- Q7-CO4 (HZ/ZE)

Answer min 1 Question for each part

Mineral & Mining Engineering

Discover the world's top universities that specialise in Mineral & Mining Engineering with the **QS World University Rankings by Subject 2017**.

35	Universiti Sains Malaysia (USM)	
37	Michigan Technological University	

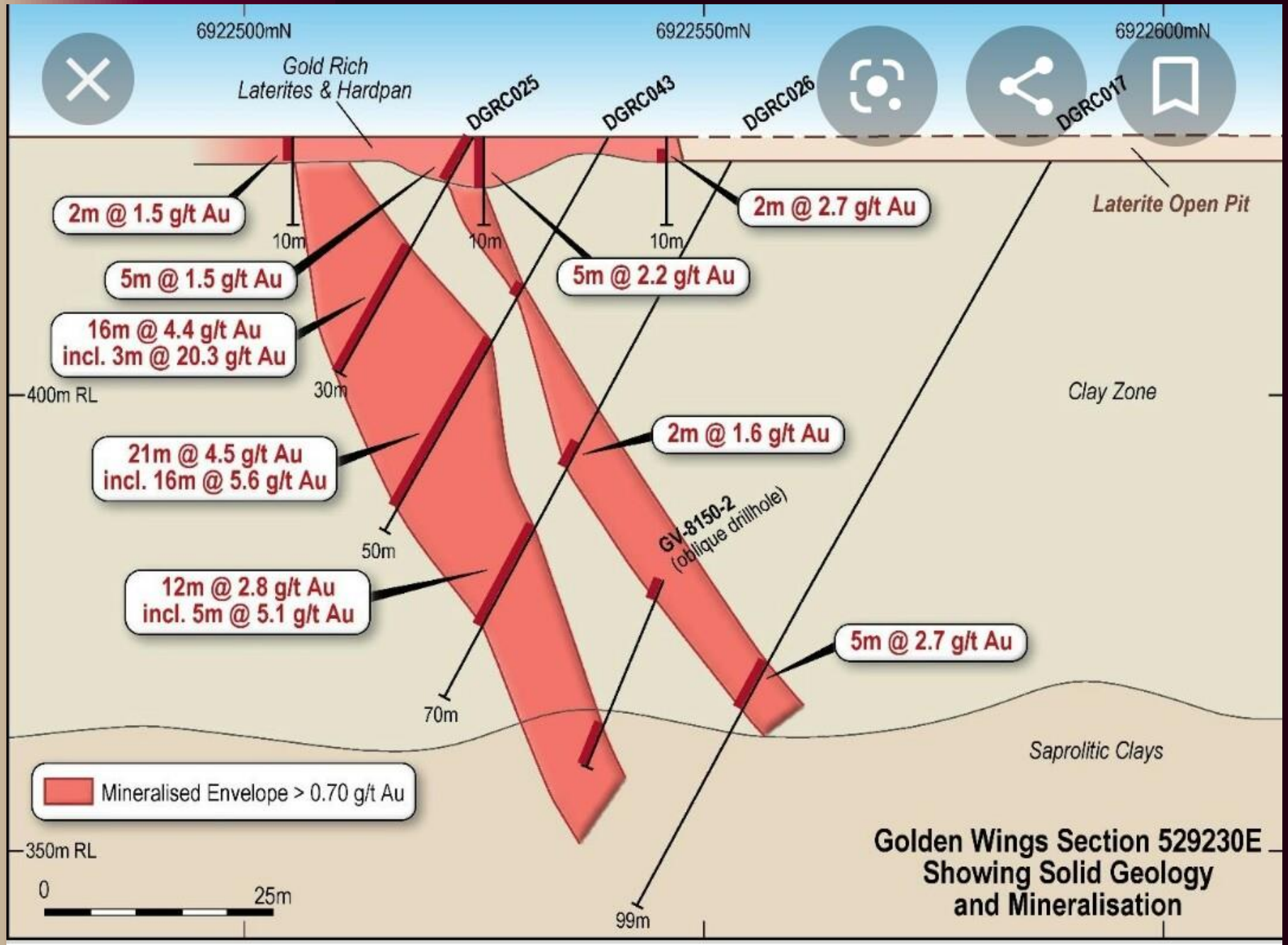
COURSE TOPIC

- Introduction and Definitions (3w-week)
- Ore deposit types, group, characteristics (1.5w)
- Hydrothermal, Orogenic, magmatic deposit (2.5w)

  – Semester break

- Hydrothermal and Metasomatism deposit (2w)
- Sedimentary deposit (2w)
- Supergene, Residual, Ion-adsorption clay, Evaporite deposit (2w)

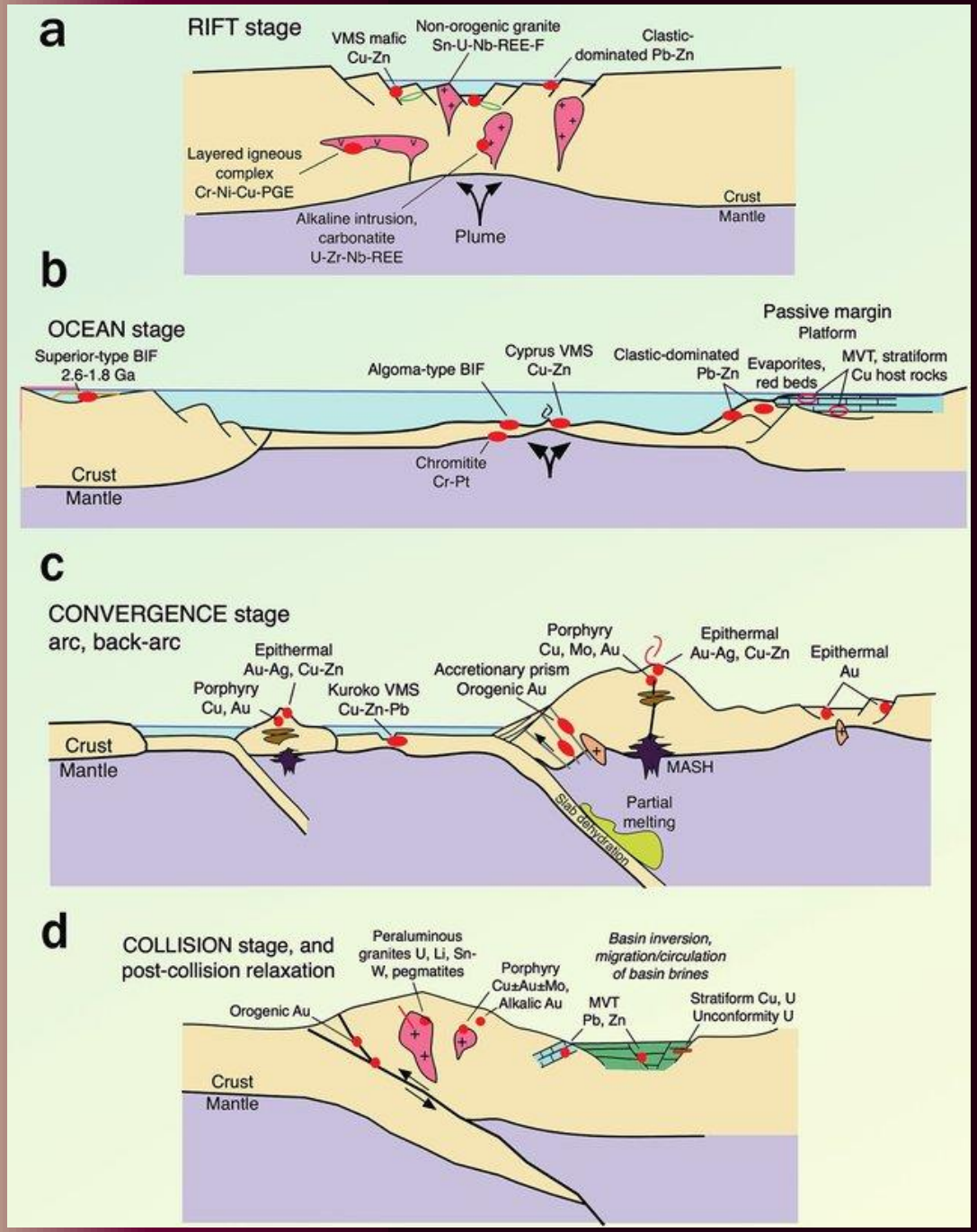
Mine and orebody


6922500mN
6922550mN
6922600mN
Gold Rich
Laterites & Hardpan
DGRC025
DGRC043
DGRC026
DGRC017
Laterite Open Pit
2m @ 1.5 g/t Au
2m @ 2.7 g/t Au
10m
10m
10m
5m @ 1.5 g/t Au
5m @ 2.2 g/t Au
16m @ 4.4 g/t Au
incl. 3m @ 20.3 g/t Au
30m
400m RL
Clay Zone
21m @ 4.5 g/t Au
incl. 16m @ 5.6 g/t Au
2m @ 1.6 g/t Au
50m
GV-8150-2
(oblique drillhole)
12m @ 2.8 g/t Au
incl. 5m @ 5.1 g/t Au
5m @ 2.7 g/t Au
70m
Saprolitic Clays
Mineralised Envelope > 0.70 g/t Au
350m RL
0
25m
99m
Golden Wings Section 529230E
Showing Solid Geology
and Mineralisation

From a geological point of view, a simple genetic classification of mineral deposits encompasses four main groups:

- Magmatic,
- Hydrothermal,
- Sedimentary,
- Metamorphic/metamorphosed,

Each of them with several types and subtypes.



Geological environment

Introduction

- Ore, ore/mineral deposits and Ore Mineral
- Economic Geology
- Ore deposit formation Environments
  - ❖Geochemical Traps

Ore minerals

- Minerals with economic value are ore minerals
- Minerals often associated with ore minerals but which do not have economic value are gangue minerals
- Key to economic deposits are geochemical traps → metals are transported and precipitated in a very concentrated fashion
  - Gold is almost 1,000,000 times less abundant than is iron

Definitions

- Ore: Type of rock that contains mineral with important element that can be extracted at a profit under current economic condition.
- Gangue mineral: Commercially worthless materials that surround, or is closely associated with a wanted mineral in an ore deposit.
- Mining: Extraction of ore or other valuable minerals from the ore deposit

Economic mineral

- Minerals, metals, rocks and hydrocarbon that are extracted from the earth by mining, quarrying, pumping and used in a wide range of application

Gold ore → Au

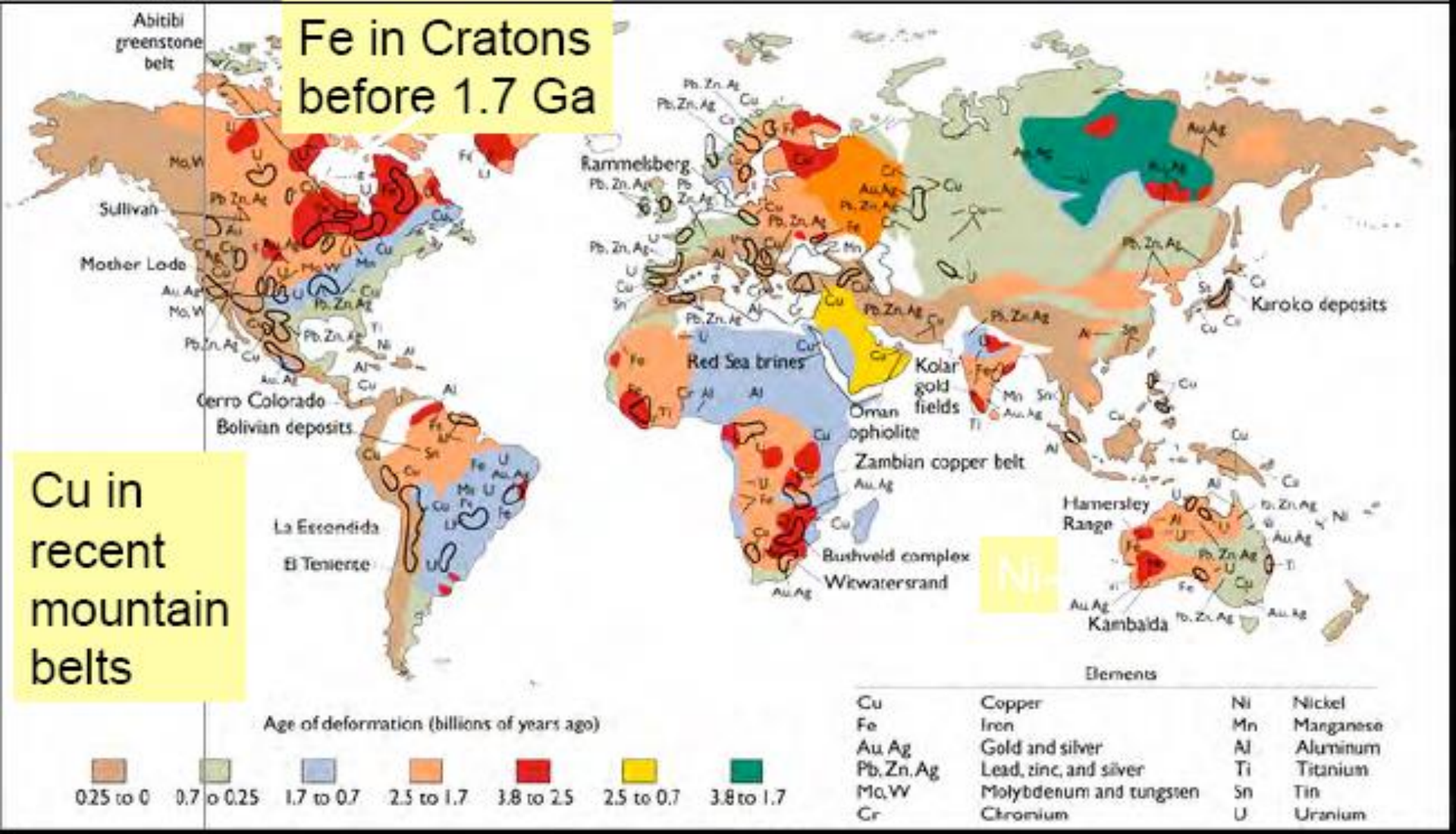
- Distribution of Au in the crust = 3.1 ppb by weight → 3.1 units gold / 1,000,000,000 units of total crust = 0.00000031% Au
- Concentration of Au needed to be economically viable as a deposit = few g/t → 3 g / 1000kg = 3g/ 1,000,000 g = 0.00031% Au
- Need to concentrate Au at least 1000-fold to be a viable deposit
- Rare mines can be up to a few percent gold (extremely high grade)!

Economic Geology

- Understanding of how metalliferous minerals become concentrated key to ore deposits…
- Getting them out at a profit determines where/when they come out

Ore deposit environments

- **Magmatic**
  - **Cumulate deposits – fractional crystallization processes can concentrate metals (Cr, Fe, Pt)**
  - **Pegmatites – late staged crystallization forms pegmatites and many residual elements are concentrated (Li, Ce, Be, Sn, and U)**
- **Hydrothermal**
  - **Magmatic fluid - directly associated with magma**
  - **Porphyries - Hot water heated by pluton**
  - **Skarn – hot water associated with contact metamorphisms**
  - **Exhalatives – hot water flowing to surface**
  - **Epigenetic – hot water not directly associated with pluton**

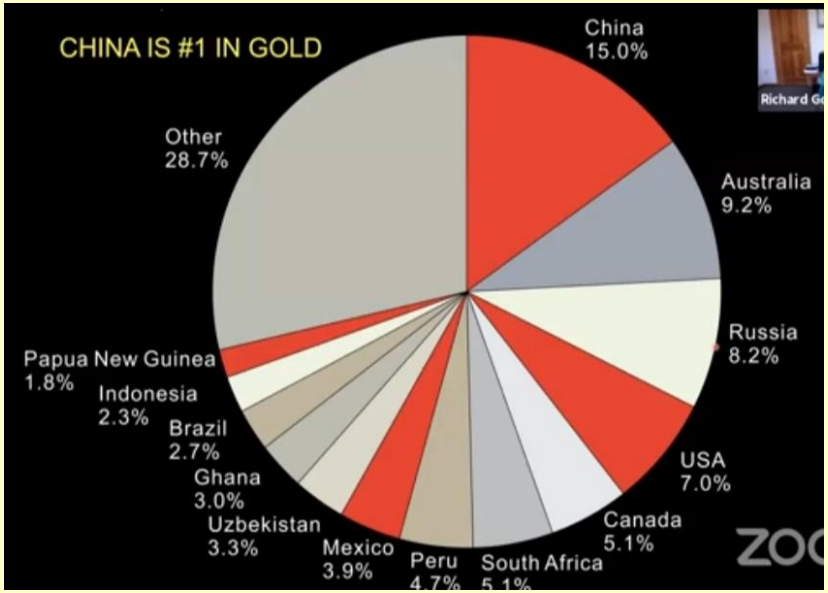


Ore deposits occur where processes of nature formed them:
integral part of the earth's tectonic & geochemical architecture
evolved through time as continents evolved- transport engines

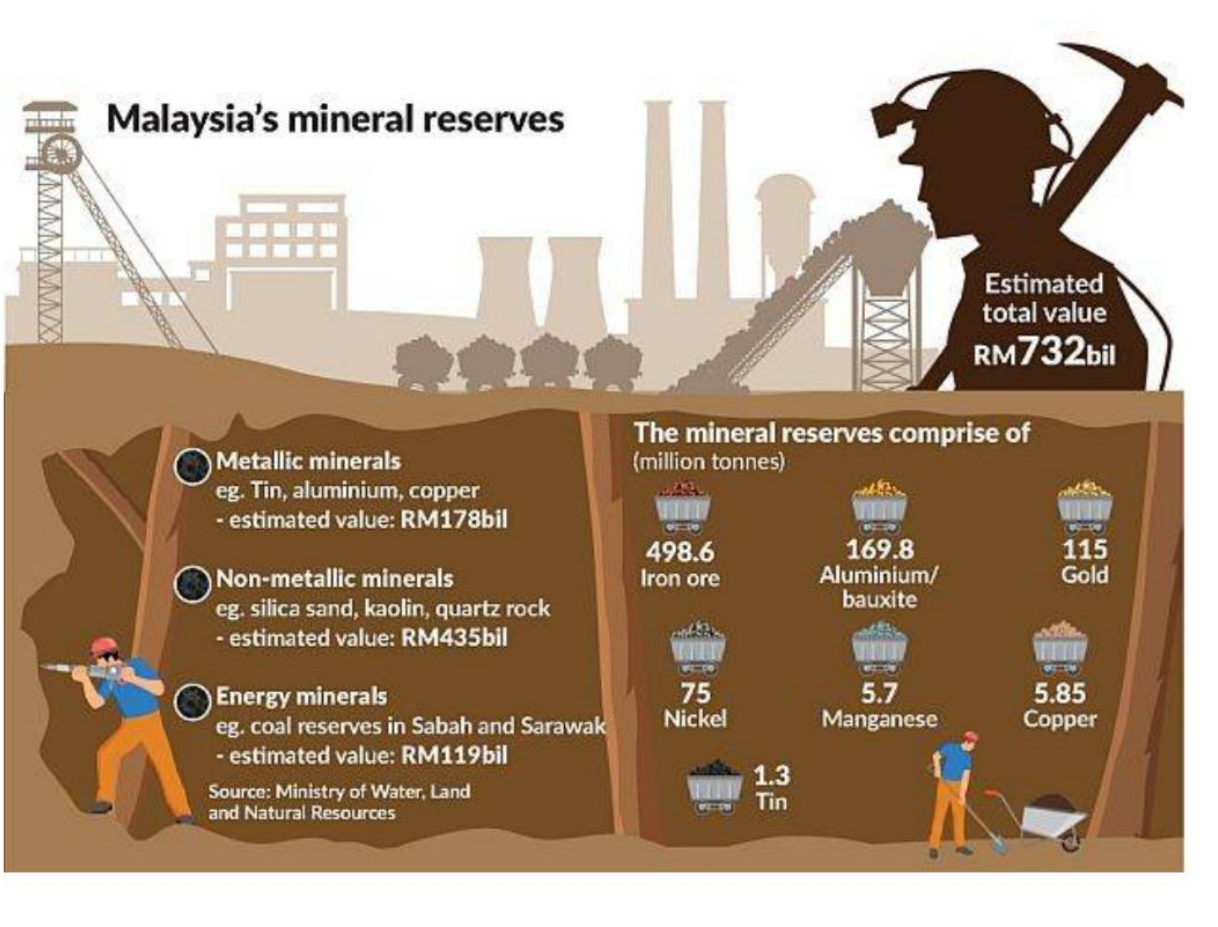
http://eps.berkeley.edu/courses/eps50/documents/lecture31.mineralresources.pdf

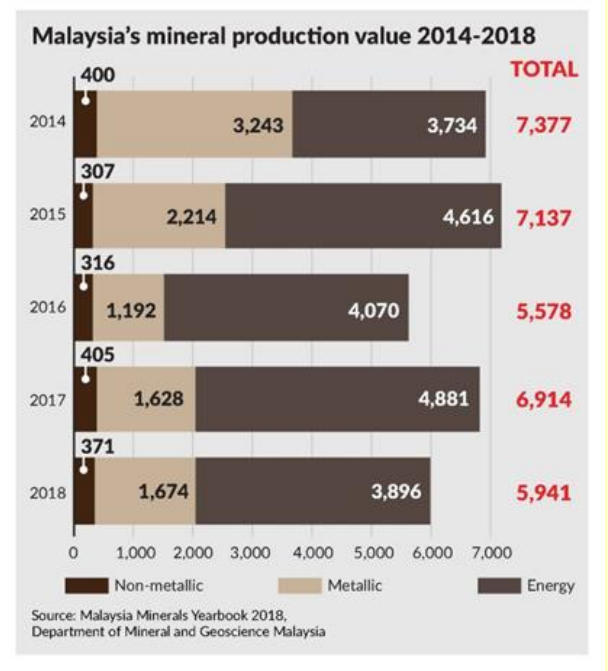
The ten largest gold mines in the world: (Mining Technology, Jan 2020)

1. South Deep gold mine, South Africa
2. Grasberg gold mine, Indonesia
3. Olimpiada gold mine, Russia
4. Lihir gold mine, Papua New Guinea
5. Norte Abierto gold mine, Chile
6. Carlin Trend gold mine, USA
7. Boddington gold mine, Western Australia
8. Mponeng gold mine, South Africa
9. Pueblo Viejo gold mine, Dominican Republic
10. Cortez gold mine, USA

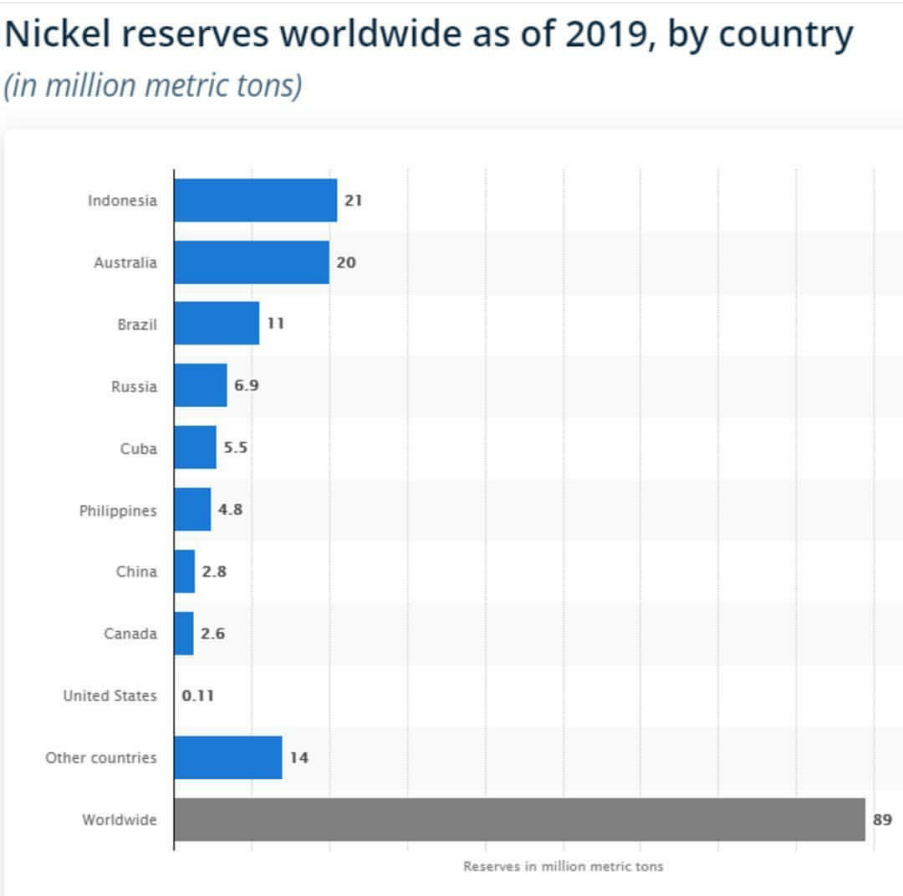


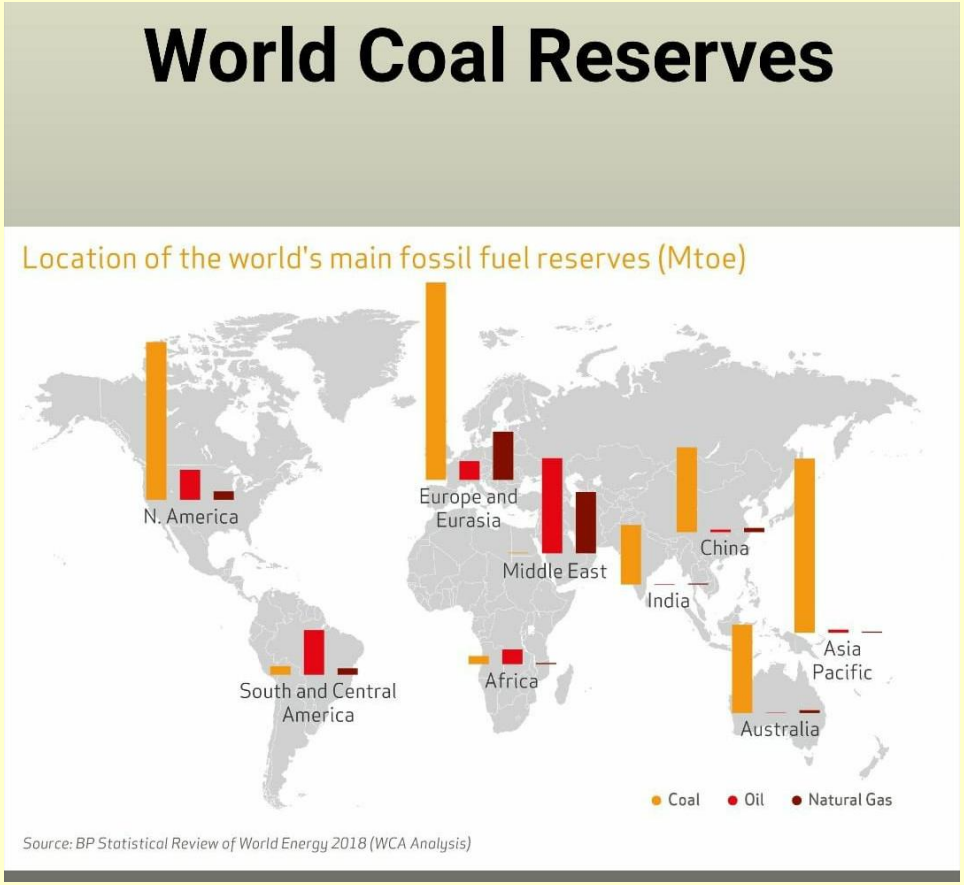
Malaysia mineral reserves, 2020





Other metal and energy mineral



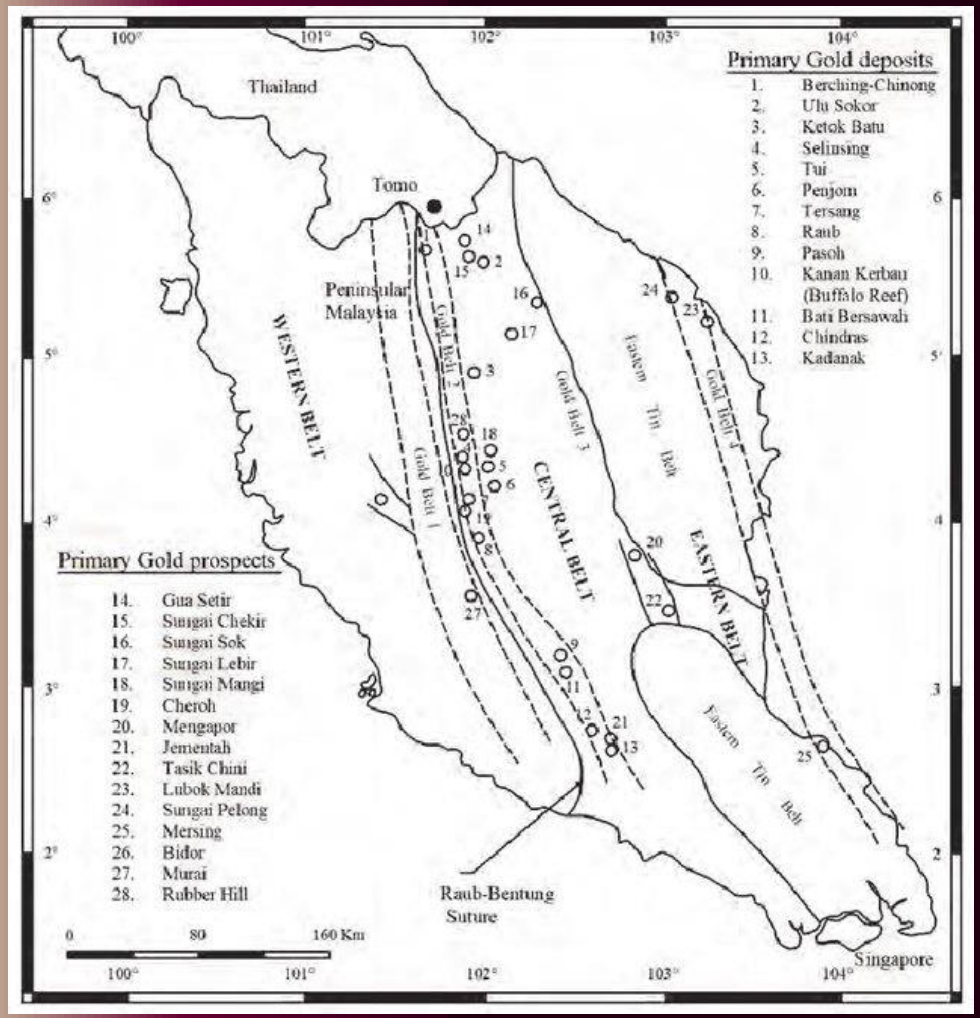


Using Mineral Resources

Average *annual per capita consumption* in US (pounds)

Construction, roads, housing, work, food, agriculture, transportation, water distribution, vitamins, electricity ...

http://eps.berkeley.edu/courses/eps50/documents/lecture31.mineralresources.pdf



A **mineral occurrence** is any locality where a useful mineral or material is found.

A **mineral prospect** is the property containing a mineral deposit that need further evaluation to confirm economic resources

Need to determine some of the more important characteristics of the deposit. Among these are its size, shape, orientation in space, and location with respect to the surface, as well as the mineral quality and quality distribution and the quantities

The terms **mineral occurrence** and **mineral prospect** do not have any resource or economic implications.

A **mineral deposit** is any occurrence of a valuable commodity or mineral that is of sufficient size and grade (concentration) that has potential for economic development under past, present, or future favorable conditions.

An **ore deposit** is a well-defined mineral deposit that has been tested and found to be of sufficient size, grade, and accessibility to be extracted (i.e. mined) and processed at a profit at a specific time. Thus, the size and grade of an ore deposit changes as the economic conditions change. **Ore refers to industrial minerals as well as metals.**

Generally, industrial minerals are any rock, mineral, or naturally occurring substance or closely related man-made material of economic value, generally excluding metals, fuels, and gemstones.

- *“Without a market, an industrial mineral deposit is merely a geological curiosity”*
- Demand feeds back from the end-use market, to the end product, to the intermediate end product, and finally back to the mineral supplier.
- Customer specifications include physical and chemical and other criteria

LIFE CYCLE OF A MINE

Stages of Mining

- Exploration (discovery)
- Feasibility study
- Mine development
- Extraction/production
- Processing/beneficiation/milling
- Marketing
- Closure/post-mining use

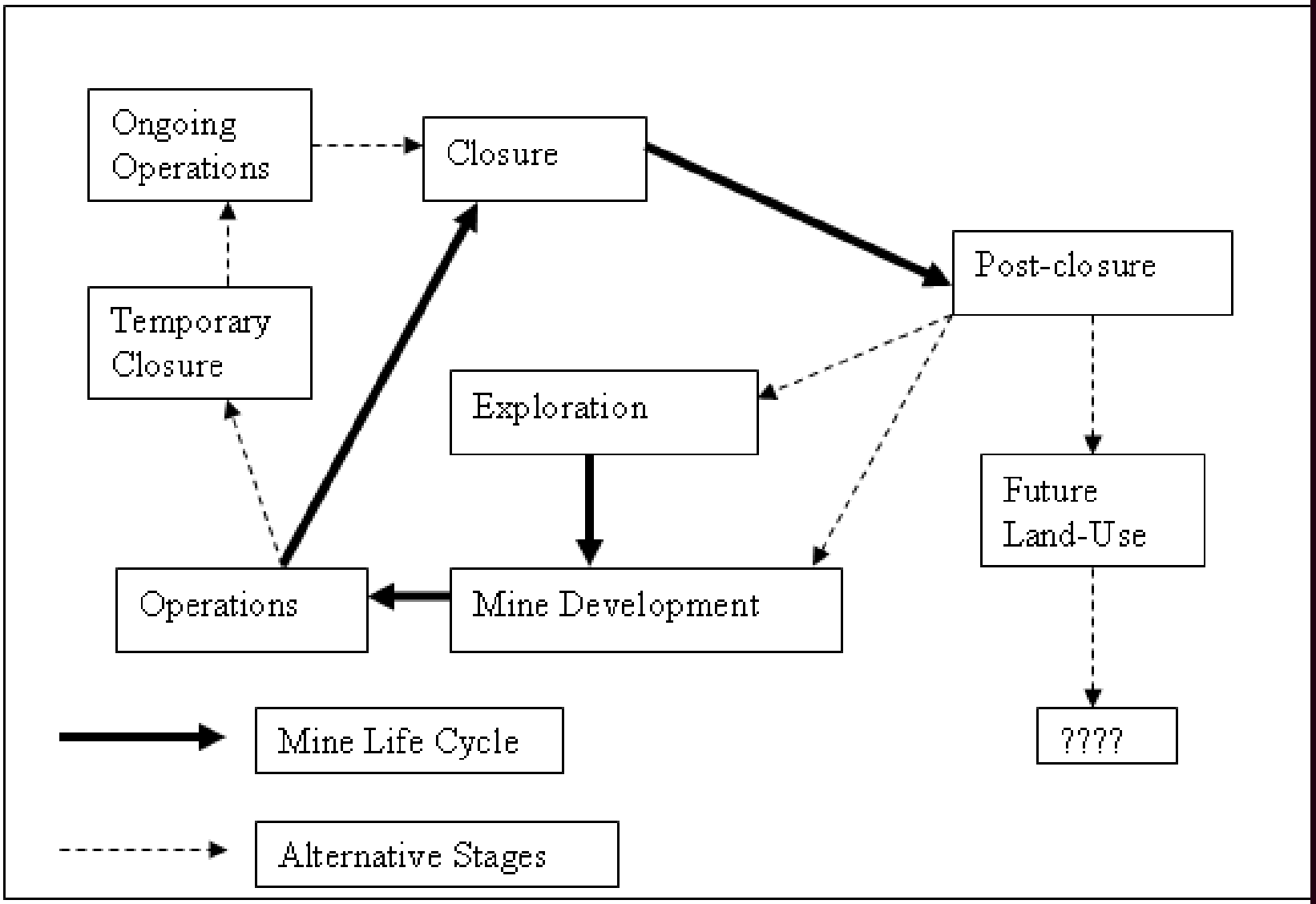
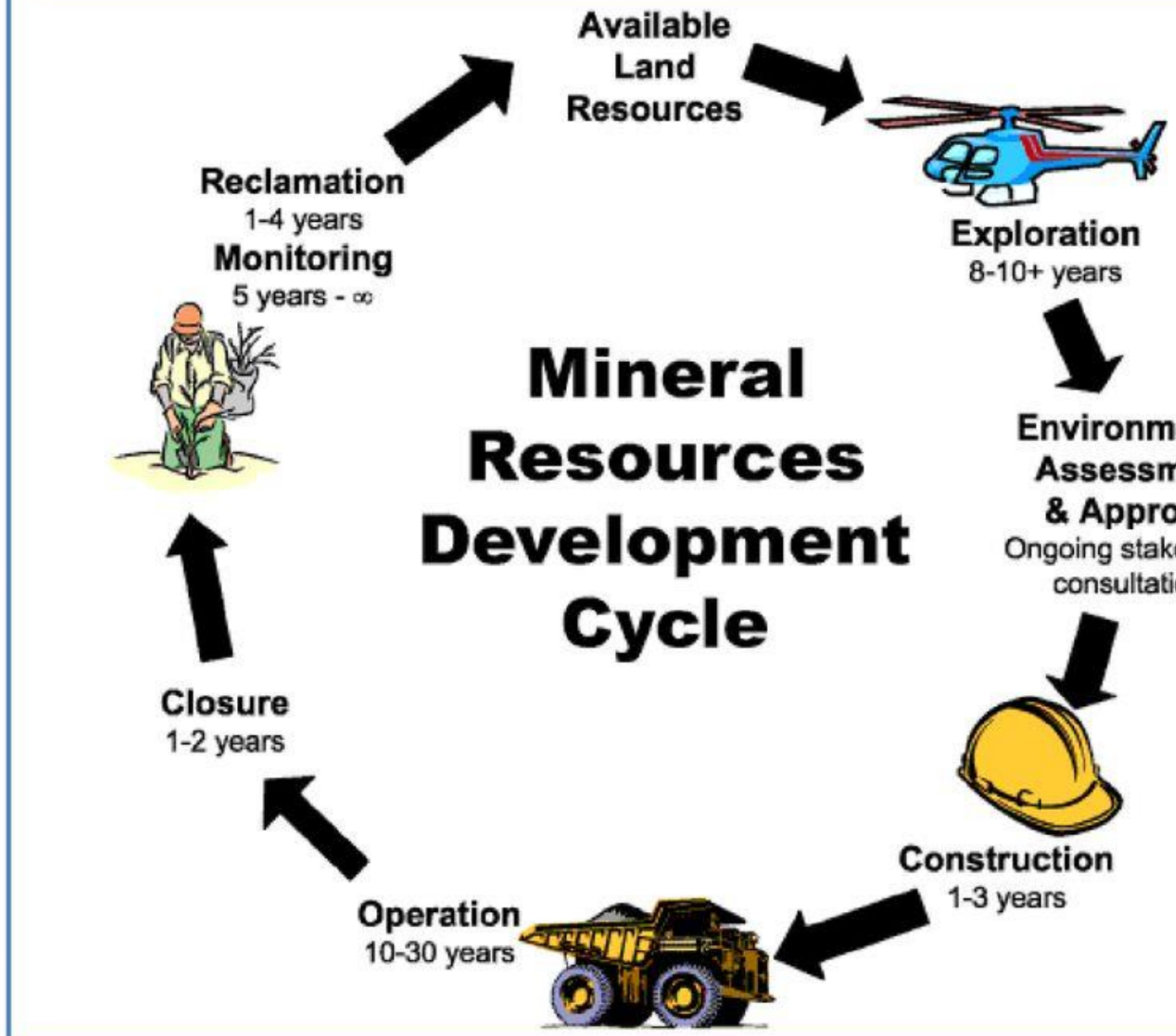


Figure 13. Mine Life Cycle Stages (Dirk van Zyl, written communication, March 27, 2002).

Mining Cycle



EXPLORATION

Exploration

- identification of areas with potential for discovery of an economic mineral deposit
- geology governs the quest
- surveys
- sampling
- geophysics
- drilling
- pits
- shafts, adits
- base-line/pre-existing conditions

Generation of new project ideas/targets

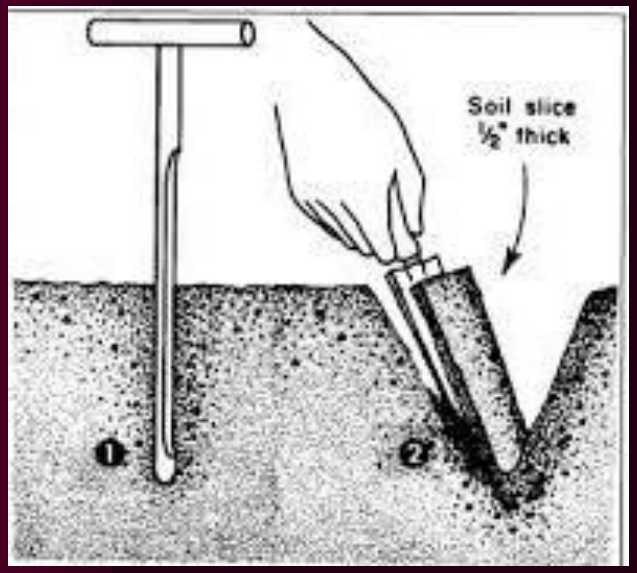
- Corporate objectives
- Previous experience or knowledge
- Old mining districts
- Recent information
- Literature, including unpublished reports, theses, news releases
- New developments by other companies

Land Access

- Is the area open to mineral exploration
- Who owns the land
  - federal government
  - state government
  - private
  - other
- Transportation

SAMPLING AND ANALYSES

- How are you going to sample?
- What are the end-use specifications?
- What processing must occur?



FEASIBILITY STUDY

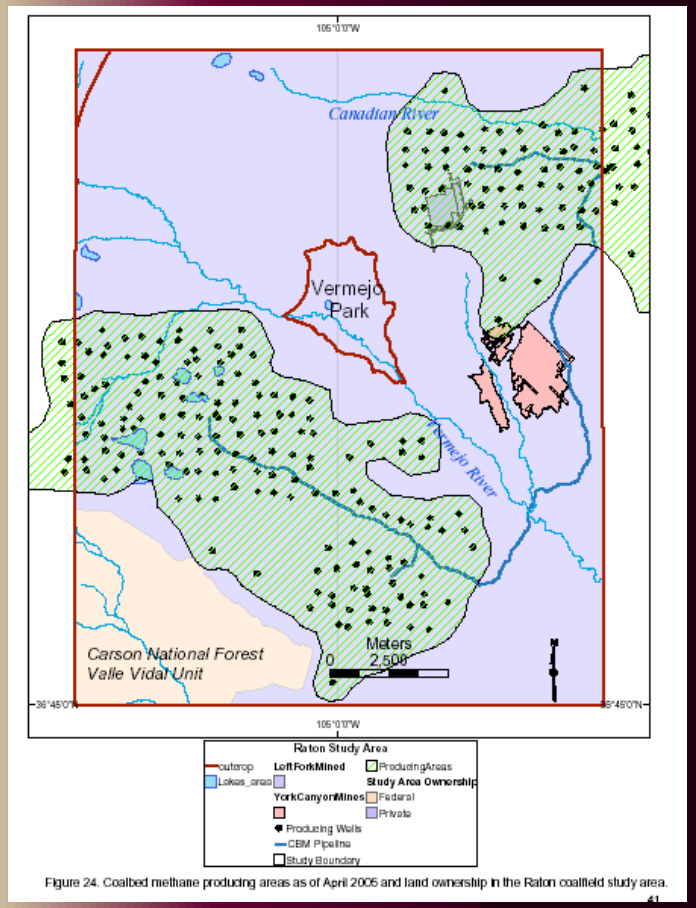
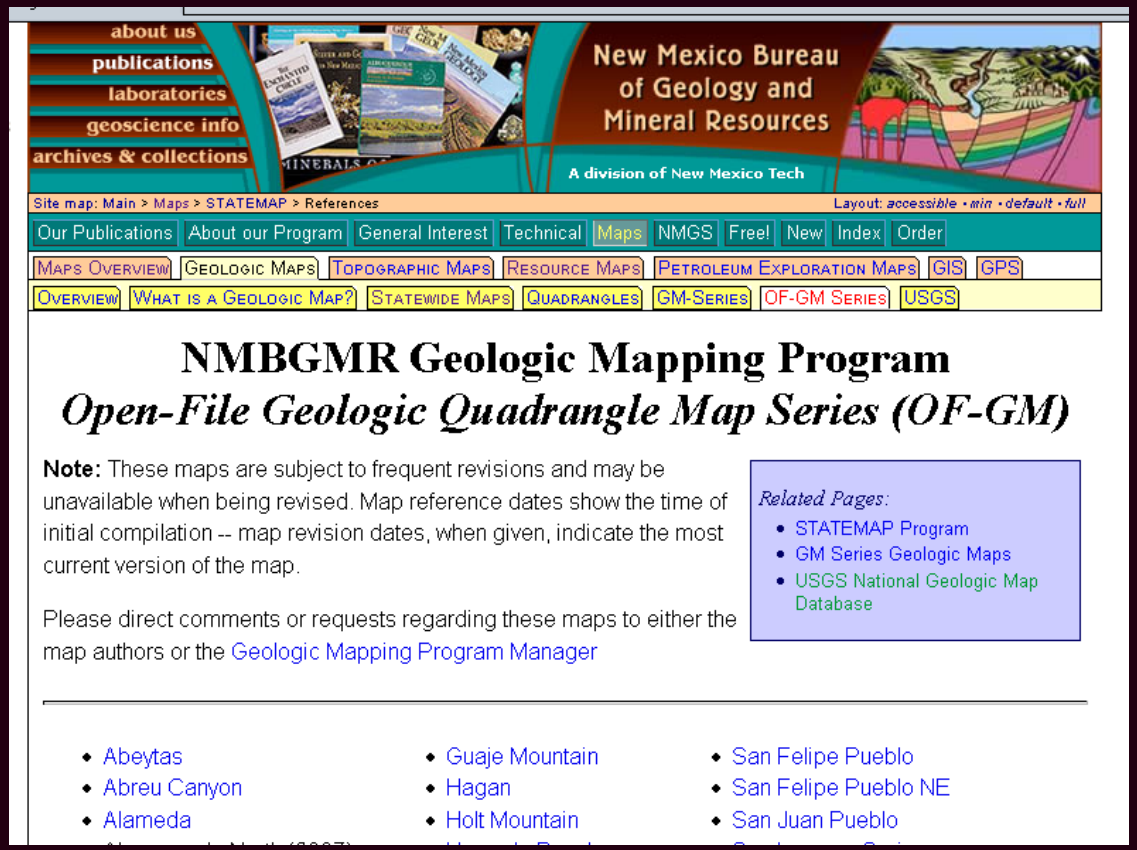


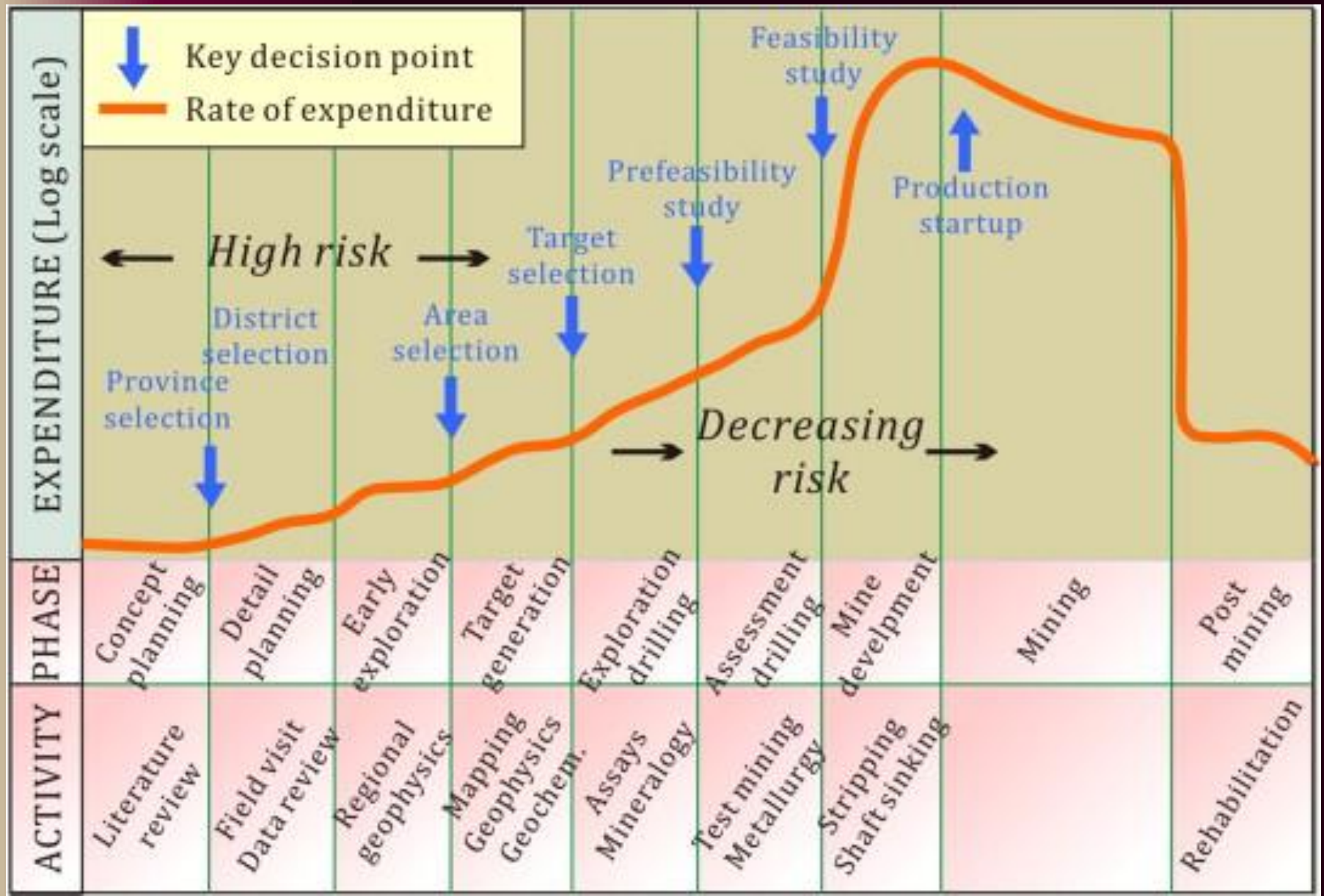
Figure 24. Coalbed methane producing areas as of April 2005 and land ownership in the Raton coalfield study area.



FEASIBILITY STUDY

- Is this property economic?
- What are the reserves?
- Can we mine this property?
- Can we market this product?
- What are the environmental consequences?
- What is the land status?

Rate of expenditure



New technologies are being developed that will increase the chance of finding a new deposit, save money, disturb less land, and minimize affects on local communities and cultures.

Geologic methods

- Robust thermodynamic and kinetic geochemical data and models
- New ore deposit models, especially for deposits with minimal impact on the environment
- More sophisticated 3-dimensional geological and ore reserve models
- Better geohydrologic models relating to mineral deposits, including industrial minerals deposits
- Geologic maps of mineralized areas
- Databases of mineral deposits and mineralized areas

Geochemical and geophysical methods

- Hand-held and down-hole analytical instruments
- Improved cross-bore hole correlation methods and characterization
- Better understanding of element mobility in soils and water
- Drones (unmanned aircraft) for airborne geophysical methods
- Low-cost, seismic methods
- Better interpretation of remote sensing and hyperspectral data (Livo and Knepper, 2004)
- More sophisticated 3-dimensional geochemical, hydrological, and geophysical models

UNMANNED AIRBORNE MAGNETICS

(MagSurvey Ltd., http://www.magsurvey.co.uk/)

Drilling technologies

- Application of existing petroleum and geothermal techniques to mineral exploration
- Improvements in drilling methods

Required geologic data

- size, shape, and variability of the ore deposit
- location information
- lithology
- mineralogy--abundance and morphology
- alteration
- structural
- rock competency data

Report on reserves

- Data Density Integration of Geological Information
- Listing/Recording of Data Set
- Data Analysis
- Sample Support
- Economic Parameters
- Mineral resource Model
- Interpolation Method
- Mineral Resource Validation

Evaluation of potential orebody

- Ore grade: lots of different units, cut-off grade, homogeneity
- By-products: commonly critical to success; Au, Ag, W
- Commodity prices: forcasting the future
- Mineralogical form: native vs sulfide vs oxide vs silicate

Evaluation of potential orebody

- Grain size and shape: McArthur River 200Mt, 10%Zn, 4%Pb, 0.2%Cu, 45ppmAg
- Undesirable substances: As, Sb; calcite in acid leachable U ores
- Size and shape of deposits: underground vs open pit; Fig 1.16
- Ore character: hard vs soft (blasting, wall support) cost and safety

Evaluation of potential orebody

- Cost of capital
- Location: infrastructure and transportation
- Environmental considerations: VERY important
- Taxation: involved subject: depreciation,
- Political factors: nationalization, foreign exchange

Classification of mineral resources on U.S. Federal Land

Locatable Minerals are whatever is recognized as a valuable mineral by standard authorities, whether metallic or other substance, when found on public land open to mineral entry in quality and quantity sufficient to render a claim valuable on account of the mineral content, under the United States Mining Law of 1872.

Mineral deposits available for acquisition through this act are commonly called "locatable minerals."

Leasable Minerals The passage of the Mineral Leasing Act of 1920, as amended from time to time, places the following minerals under the leasing law: oil, gas, coal, oil shale, sodium, potassium, phosphate, native asphalt, solid or semisolid bitumen, bituminous rock, oil-impregnated rock or sand, and sulfur in Louisiana and New Mexico.

Salable Minerals The Materials Act of 1947, as amended, removes petrified wood, common varieties of sand, stone, gravel, pumice, pumicite, cinders, and some clay from location and leasing. These materials may be acquired by purchase only.