



Module 4:

Basic geology as guide on how to discover mineral deposits

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Outline of presentation

- 1. Earth processes in forming rocks and minerals**
- 2. Types of mineral deposits**
- 3. Processes that lead to the formation of mineral deposits**
- 4. How to identify Interesting minerals**
- 5. How do Minerals Frequently Exploited by ASM Operators in Ghana Occur?**
- 6. How to Follow-Up on a Promising Mineral Discovery**



1.0 Understanding the Earth's Processes in Forming Rock and Mineral Deposit



Classification of rocks

Three principal types of rocks:

***Igneous rocks**

***Sedimentary rocks**

***Metamorphic rocks**



A, Igneous Rocks

Igneous rocks are aggregates of minerals that crystallize from molten material that is generated within the earth's mantle.

Example:

granite



B, Sedimentary rocks

Sedimentary rock usually is formed by the deposition, compaction, and cementation of rock that has experienced weathering.

It also may be formed as a result of chemical precipitation.



C, Metamorphic rocks

Metamorphic rock is formed through the alteration of preexisting rock as a result of changes in temperature, pressure, or the activity of fluids.

These changes are known as metamorphism.





migmatite



The layering within metamorphic rocks is called foliation and it occurs when a rock is being shortened along one axis during recrystallization.

2.0 Types of Mineral Deposits

Definitions

- i) A mineral deposit refers to an aggregate of mineral in an unusually high concentration.**
- ii) A mineral deposit that is sufficiently rich to be exploited at a profit is referred to as an Ore deposit.**



Types of mineral resources

classification

metallic mineral resources

non-metallic mineral resources

energy minerals

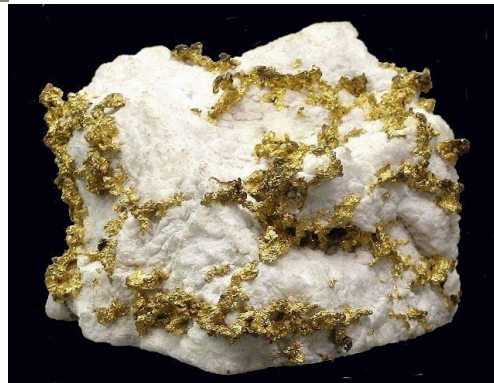
groundwater and gas minerals



(1) metallic mineral resources



Al (Aluminium)



Au (Gold)



Mn (Manganese)



(2) non-metallic mineral resources



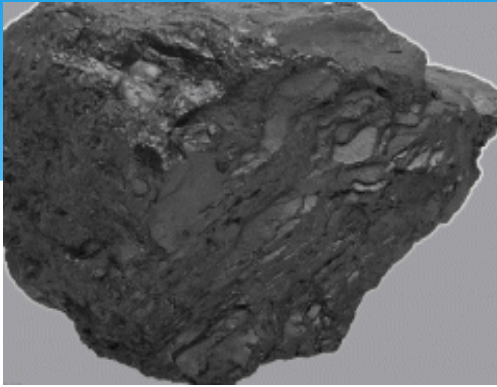
Limestone



Mica



(3) energy minerals



Coal



Oil



Uranium

3.0 What are the processes and factors leading to the concentration of elements and minerals in the crust?



Processes that lead to the formation of mineral deposits

➤ Endogenous (Subsurface) processes

Resulting from the dynamics of the Earth's interior that are ultimately driven by the Earth's heat flow.

- Actions of Fluids
- Magmas, Brines, Groundwater
- Chemical and Physical processes

➤ Exogenous (Surface) processes

Exogenous processes take place at the Earth's surface and are mainly due to the flow of energy from the sun.

- Weathering, Sedimentation
(clastic and chemical)



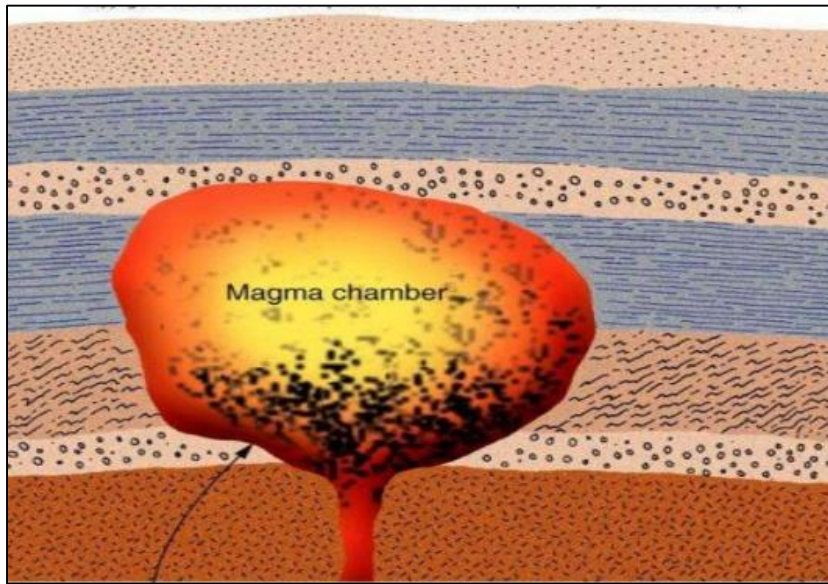
Processes that lead to the formation of mineral deposits

Endogenous (Subsurface) processes

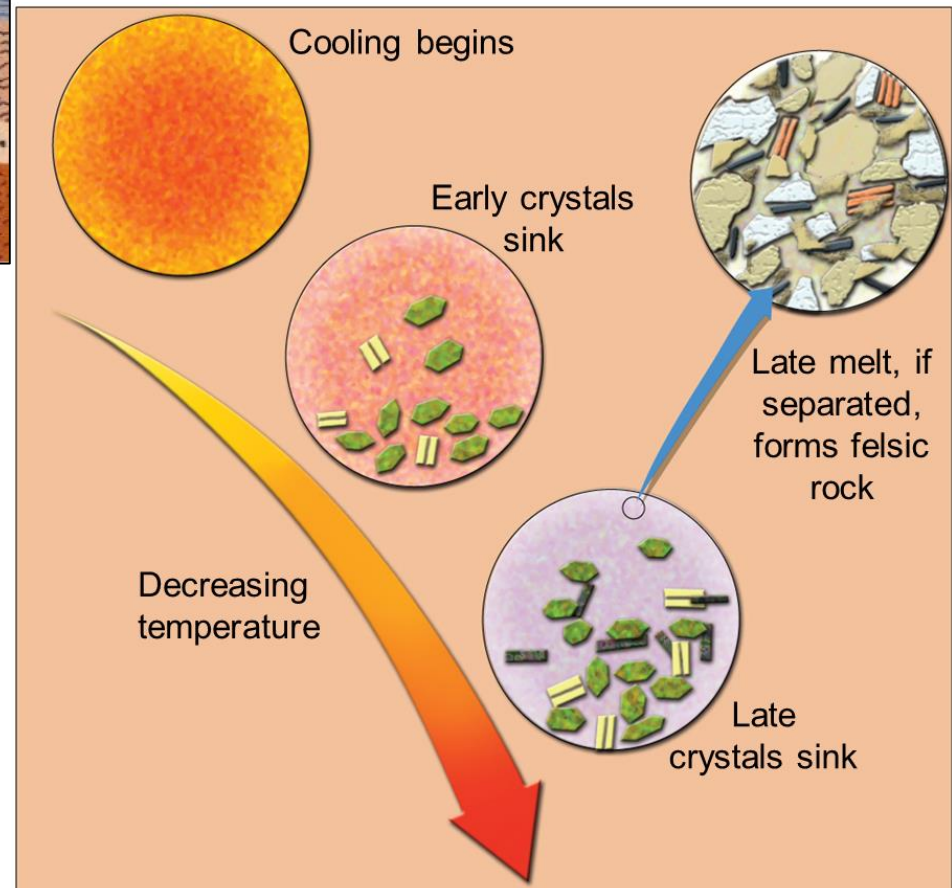
1. Magmatic deposits
2. Hydrothermal deposits



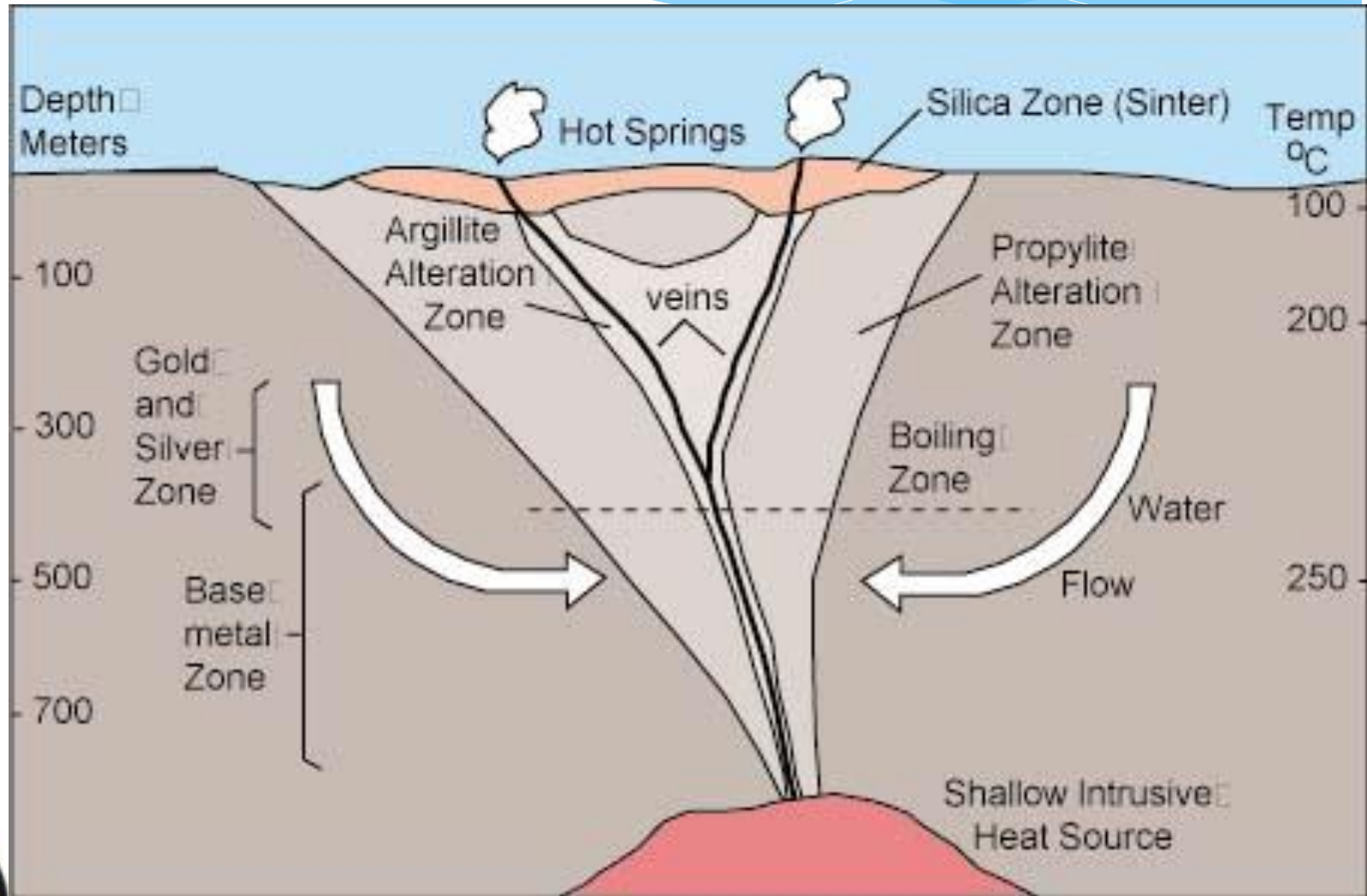
1. Magmatic deposits



- **Fractional crystallisation (e.g. chromite and magnetite ore)**
- **Liquid immiscibility (sulphide ores containing Cu, Ni or platinum)**



2. Hydrothermal deposits



e.g. Au, Ag



b) Exogenous (Surface) processes

1. Weathering

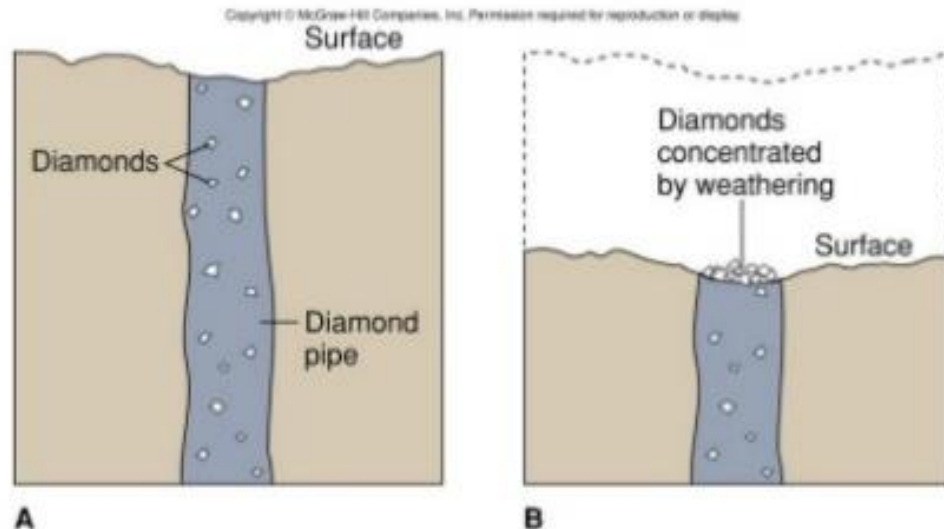
2. Sedimentation



1. Deposits formed by weathering

i) Placer mineral deposits

- Formed by mechanical weathering of primary minerals and transport by streams
- *Example; Au, Ti, diamonds and others*



1. Deposits formed by weathering (cont'd)

ii) Residual (eluvial or laterite) deposits

- Formed by chemical weathering reactions at the earth's surface
- Leaching of rocks leaves residual materials behind (i.e. formed by the removal of soluble minerals)
- Intense chemical weathering is favoured by tropical climate
- Iron rich limonite, aluminium rich bauxite
- *Example; Al, Fe, Ni*

2. Deposits formed by sedimentation

Minerals are concentrated by chemical precipitation from lake and sea water

i) Ironstone, Limestone, Chert, Jasper, and manganese deposits

ii) Evaporite salt deposits

- ✓ Minerals like gypsum, halite are deposited this way
- ✓ Evaporation of lake or sea water results in the loss of water and thus concentrate dissolved minerals in the remaining water

iii) Phosphate deposits

4.0 How to identify interesting minerals

a) Colour

b) Hardness

c) Streak

d) Specific gravity, G:

$$G = W_1 / (W_1 - W_2),$$

where W_1 = the weight in air, and W_2 = the weight in water



e) Cleavage E.g. mica



4.0 How to identify interesting minerals – cont'd

e) Acid test – e.g. limestone

f) Magnetism

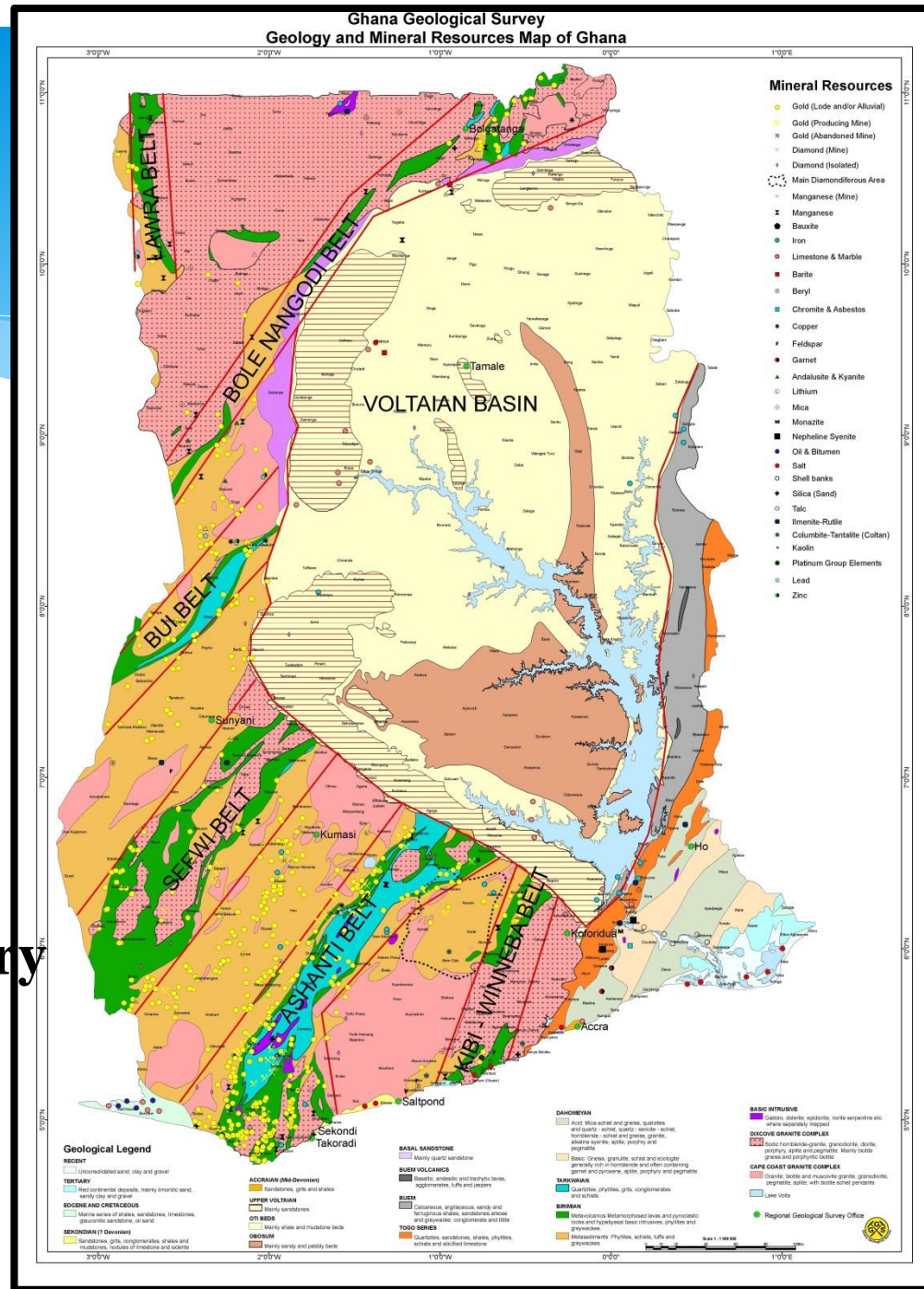
- **Ferromagnetism-strong attraction to magnetic field. e.g. magnetite and pyrrhotite**
- **Paramagnetism-weak attraction to magnetic field. e.g. hematite**
- **Diamagnetism- e.g. Bi, it is repelled from magnetic field.**





5.0 How do Minerals Frequently Exploited by ASM Operators in Ghana Occur?

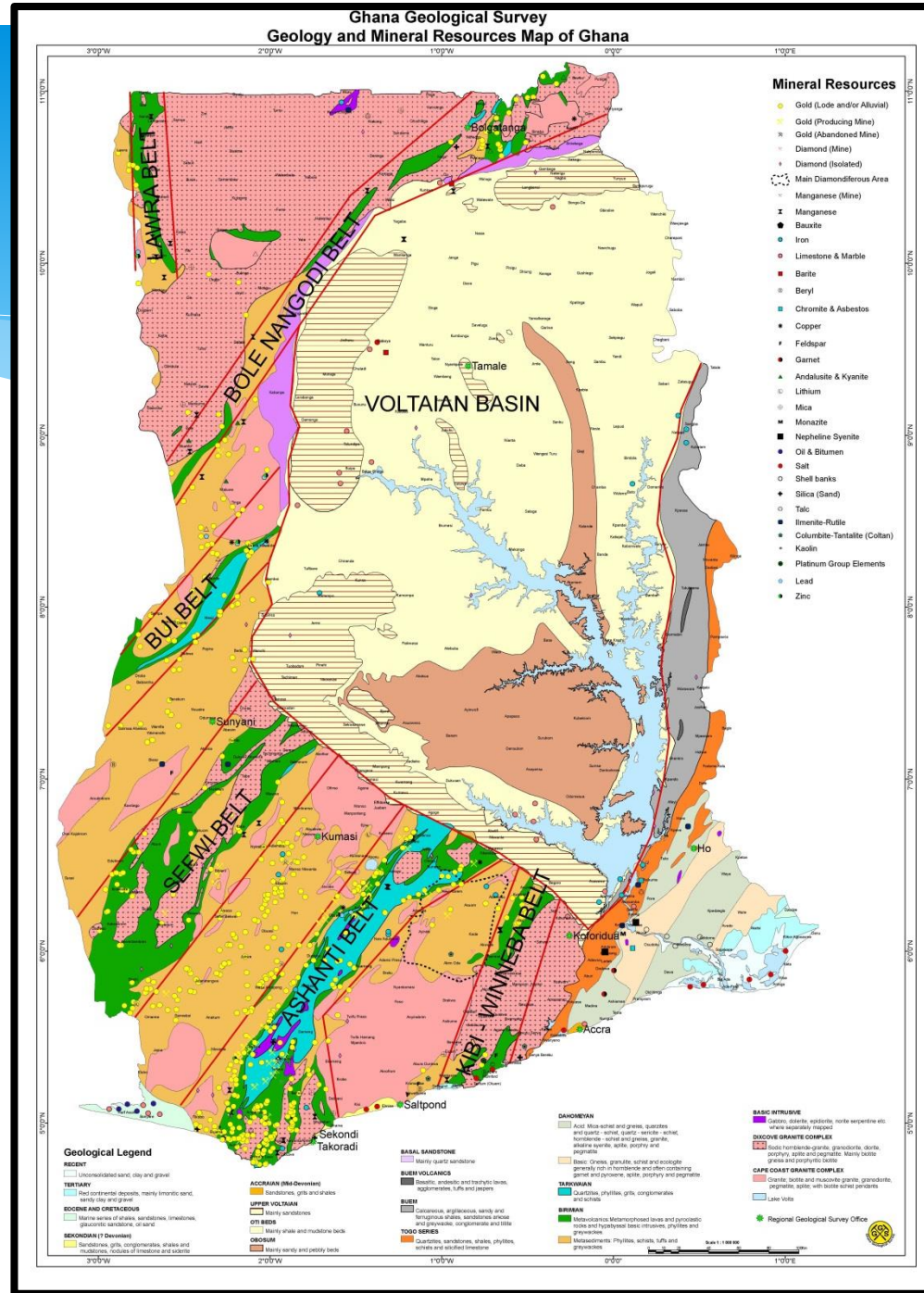
- **Birimian Supergroup**
- **Tarkwaian Group**
- **Felsic and mafic intrusions**
- **Voltaian Supergroup**
- **Togo Belt and Buem**
- **Dahomeyan**
- **Coastal sediments and tertiary basins**



Gold belts of Ghana

- Kibi-Winneba

- **Kibi-Winneba**
- **Ashanti**
- **Sefwi**
- **Bui**
- **Bole-Nangodi**
- **Lawra Belt**



Birimian gold mineralisation (cont'd)

b) There are two (2) types of auriferous ore bodies:

- disseminated-sulphide type (DST)
- quartz vein type (QVT)



Gold mined by ASM operators in Ghana usually occurs as:

a) Alluvial deposits



b) Hard rock gold deposits



c) Eluvial deposits



5.0 How do Minerals Frequently Exploited by ASM Operators in Ghana Occur? Cont'd

b) Diamond



- **ASM has taken place along the Birim diamondfield and Bonsa River areas**
- **Diamonds mined by ASM operators in Ghana are from alluvial deposits**

5.0 How do Minerals Frequently Exploited by ASM Operators in Ghana Occur? Cont'd

c) Industrial Mineral

- Brown Clays-exploited by local populace throughout Ghana to make pottery and other household items.
- Kaolins - Several deposits of kaolin are currently being exploited in Ghana. These include the Abandze-Saltpond, Teleku Bokazo-Aluku, Wassaw Akropong, and Anfoega deposits. Kaolin is part of the clay group of minerals.
- Jasper - Jasper occurs in Kwamikrom, Jasikan and Hohoe area of Volta Region. Jasper is commonly used in making abrasives, decorative objects and ornaments.



6. How to Follow-Up on a Promising Mineral Discovery

When a promising mineral occurrence has been found, the next step is to discover whether it is big enough.....

6. How to Follow-Up on a Promising Mineral Discovery (cont'd)

Vein deposit

When a vein has been located,

- Its width must be found as well as how far it can be traced
- The concentration of the commodity must also be estimated
- Small pits or trenches have to be dug down to the bedrock
- The grade of the vein has to be evaluated.
- This will require sampling and analysing a number of samples across the width of the vein and along the vein.

6. How to Follow-Up on a Promising Mineral Discovery (cont'd)

Alluvial deposit

1. Cutting and surveying a base line parallel to the stream. Cross lines are then cut and surveyed, for example, every 800 metres along the baseline, with pickets placed at say 100 metre intervals along these lines.
2. Sinking of pits after first marking out a one metre by one metre square area, by using a native “soso” or narrow spade-like digging tool and a pick axe to excavate the overburden down to the bedrock (usually severely weathered).
3. It is important to take accurate measurements regularly to ensure that the excavation was straight and the walls were square. To avoid caving in by pit walls from groundwater inflows, water pump and small buckets can be used to remove the water as digging progresses.

6. How to Follow-Up on a Promising Mineral Discovery (cont'd)

Alluvial deposit

4. The gravels are then collected from pit by buckets on ropes. Gravel samples are separated into 0.5m intervals as the pit is deepened. Once the bedrock has been reached, another sample should be taken, 30 cm into bedrock to check for gold that may have migrated downwards.
5. All the 0.5 m samples should be piled individually on tarpaulins around the perimeter of the pit collar.
6. Washing of the samples involves the use of wooden sluice boxes. Concentrates are recovered in the sluice box which is fitted with astro turf matting or jute sacks.

6. How to Follow-Up on a Promising Mineral Discovery (cont'd)

Alluvial deposit

7. The jute sacks which were used as linen in the sluice box should be removed after washing each heap of material (0.5m^3 volume of approximately) and then washed into big washing bowl before the final panning to recover the free gold.

8. The free gold is then weighed and expressed in terms of the volume of the material treated.

6. How to Follow-Up on a Promising Mineral Discovery (cont'd)

Eluvial deposit

1. This would involve the collection of representative samples in a given exploration area in order to determine the quality and tonnage of reserve.
2. Test pits are dug on a surveyed grid pattern and (in the case of kaolin / clay deposits) the chemical and physical properties of the samples collected are assessed in the laboratory.
3. Laboratory tests involve mineralogical, chemical, and physical techniques that will determine the appropriate use for any given clay.



THANK YOU