



Well Logging

GAMMA-RAY LOGS

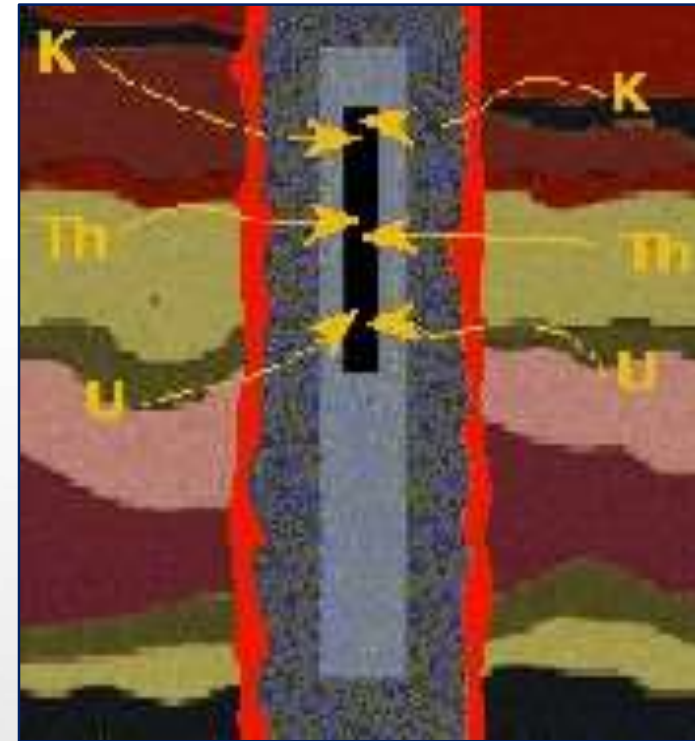
Mining Engineering Department/ 3rd Year

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GAMMA-RAY LOGS

Gamma ray (GR) log: is log measures the total natural gamma radiation in formation. This gamma radiation originates from Potassium (K^{40}), and Thorium (Th), Uranium (U) series. The gamma ray log is commonly given the symbol **GR**.

- *The unit of GR is API (American Petroleum Institute).*
- In sedimentary formations, the GR log normally *reflects the shale content of the formations. This is because the radioactive elements tend to concentrate in clays and shales.*

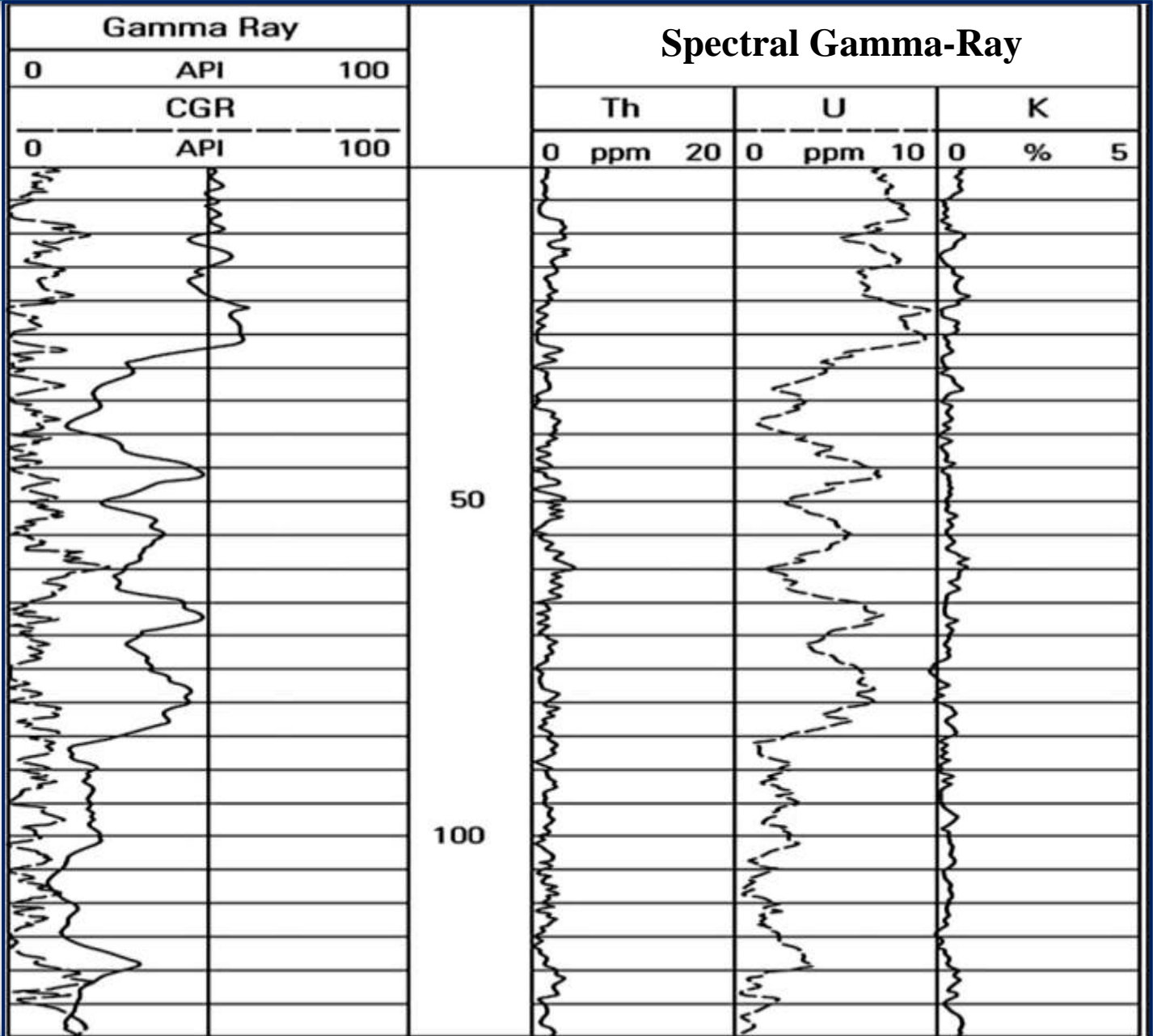


The Gamma Ray and Spectral Gamma-Ray Log

The spectral gamma ray log is displayed as *three curves* of **Thorium** (ppm), **Uranium** (ppm), and **Potassium** (%), while the gamma ray track records two gamma ray curves:

1- The Spectral (Standard) Gamma-Ray log (SGR)

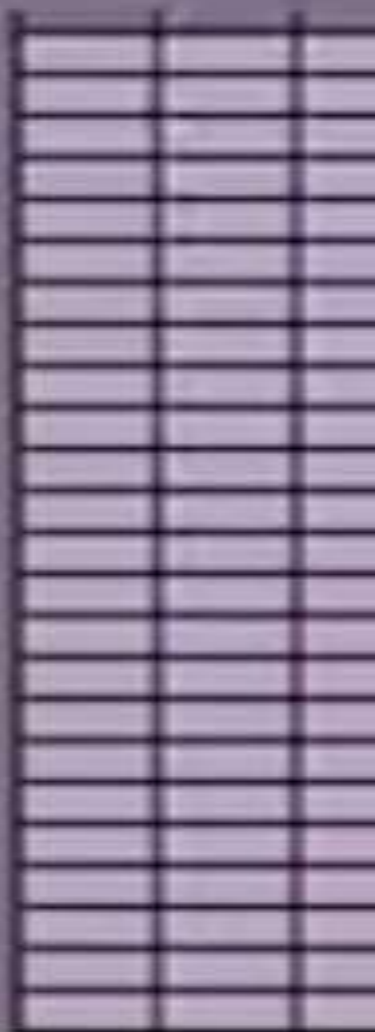
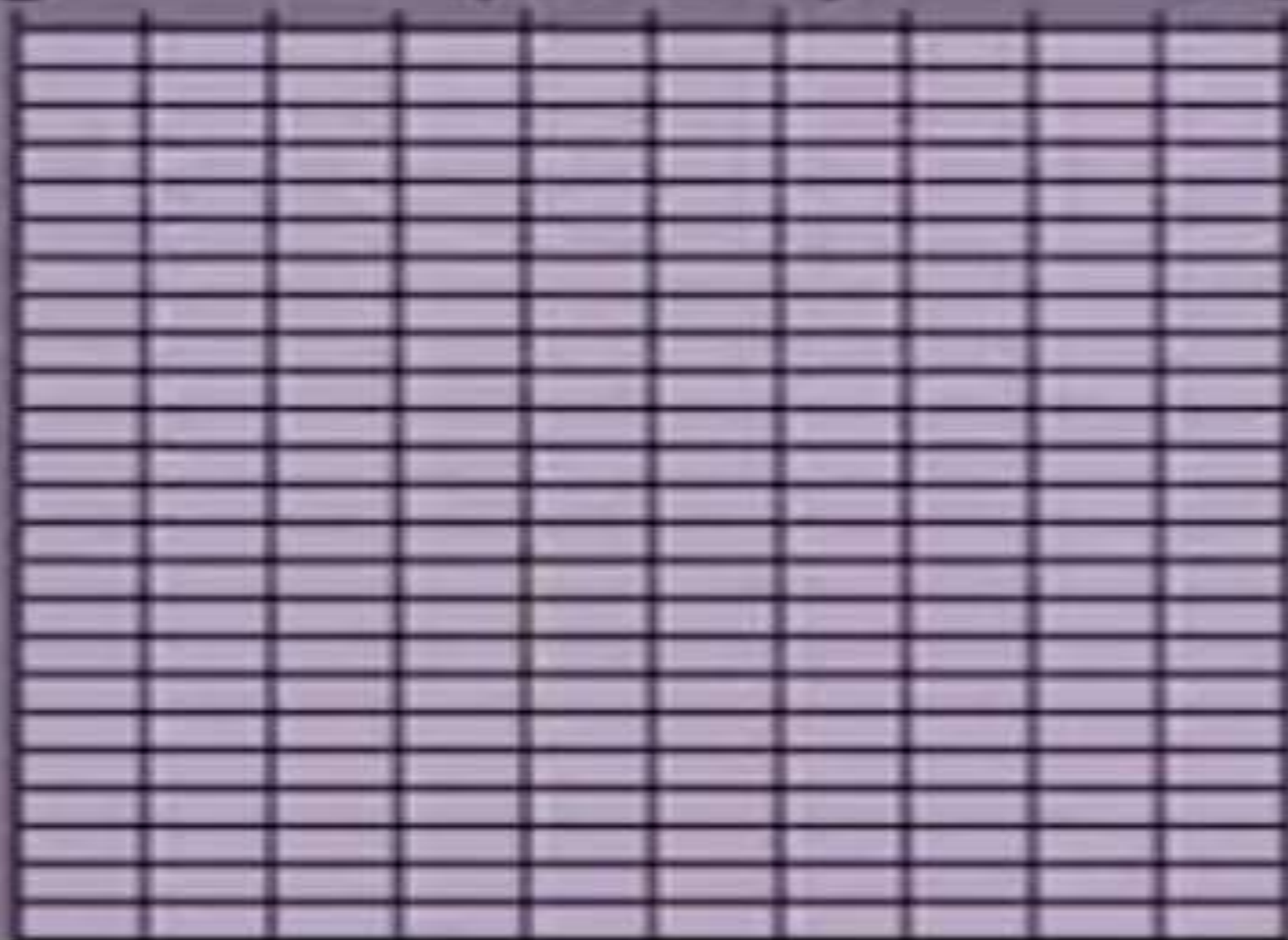
2- The Computed Gamma-Ray log (CGR)



GR (GAPI)

0

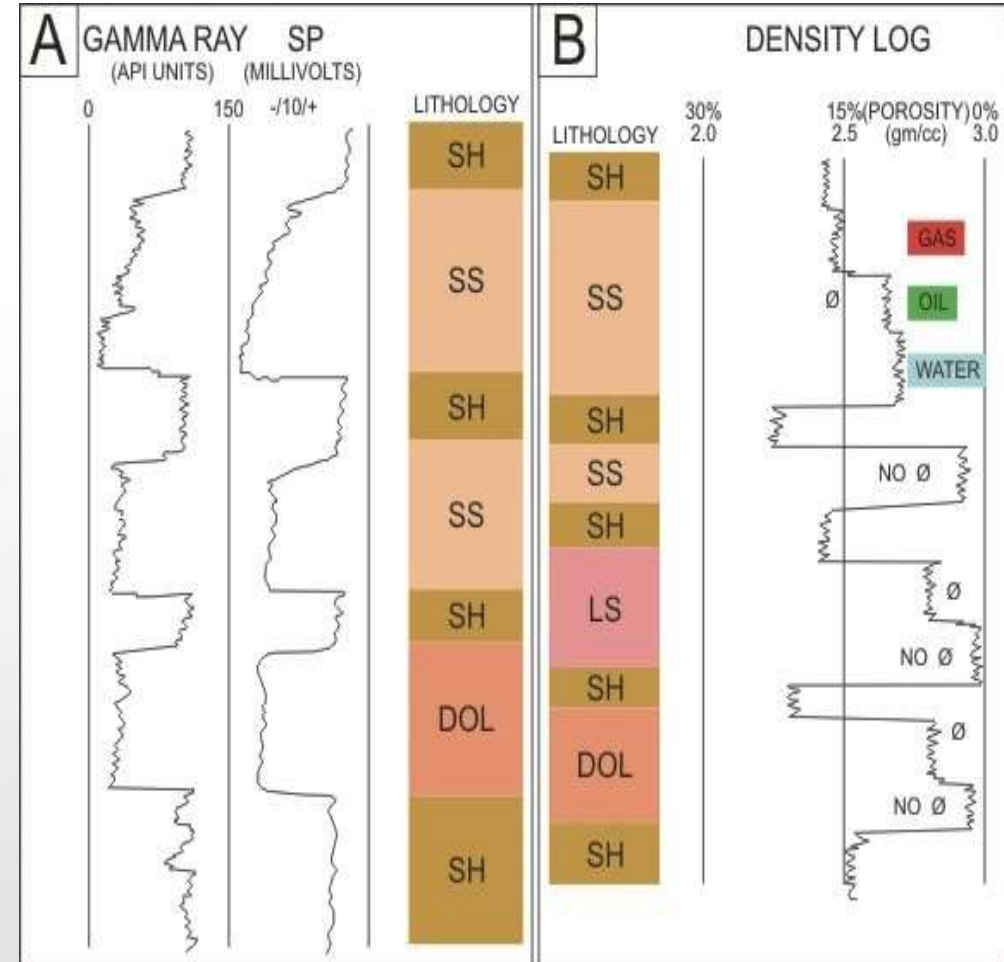
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Uses of Gamma Ray Log

1. Determination of Lithology:

- Shales, organic rich shales and volcanic ash show the **Highest** gamma ray values.
- halite, anhydrite, coal, clean sandstones, dolomite and limestone have **Low** gamma ray values.



2. Determining Volume of Shale:

- In most stratigraphic and petroleum geological applications, the gamma ray log is used as a *"shale log"* to *discriminate shales from "clean" formations*, and to estimate the *relative shale proportions in shaly reservoir units*.
- The volume of shale expressed as a *decimal fraction or percentage* is called **Shale Volume (V_{sh})**.

3. Unconformity Detection:

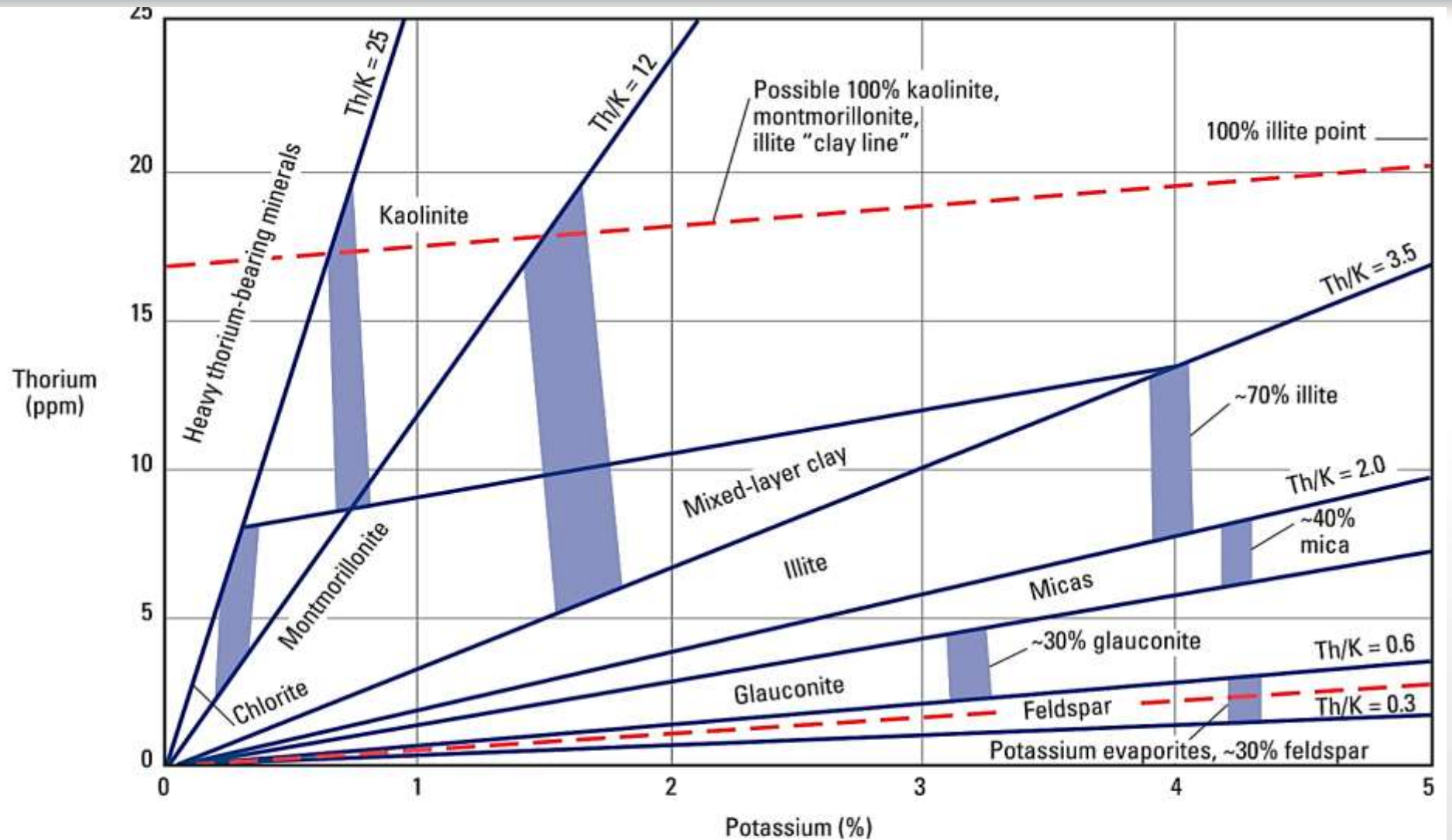
- The mean Th/K ratio of large intervals of formations is usually approximately constant. This is because it depends ultimately upon the depositional conditions.
- Any **sudden changes** in the mean Th/K ratio can act as an indicator of sudden change in depositional environment, such as at an **Unconformity**.

4. Sedimentology and Depositional Environments:

The spectral gamma ray log provides a large amount of data that can help discriminate between depositional environments

SGR Observation	Sedimentological Inference
Presence of glauconite	Marine, mainly continental shelf origin.
Phosphatic deposits	Marine, mainly continental shelf origin, with warm water in a reducing environment.
Uranium	Low energy, reducing conditions
Clay type	Analysis of depositional environment.
Bauxite	Warm, humid, continental environment with good drainage.
Feldspars	Indicator of the degree of evolution of sand facies, only found in abundance close to the igneous source.

**This chart
is not
included in
the exam**



5. Recognition of Radioactive and Non-Radioactive Mineral Deposits:

- The gamma ray log can be used to recognize certain radioactive deposits, the most common of which are *potash deposits and uranium ores*.
- Note that some evaporites have a large concentration of **potassium** and can be very radioactive



6. Fracture detection

7. Geologic correlations

8. Source-rock evaluation

Question for you



- What three major radioactive elements does the gamma ray tool respond to?
- Why the GR is used to detect shale beds?
- How many the forms of gamma ray logs curves?

Question for you

- ✓ How does an increase in clay content affect the gamma ray response?
- ✓ Name three uses of the gamma ray log.
- ✓ How is the gamma ray log used to detect the unconformity?