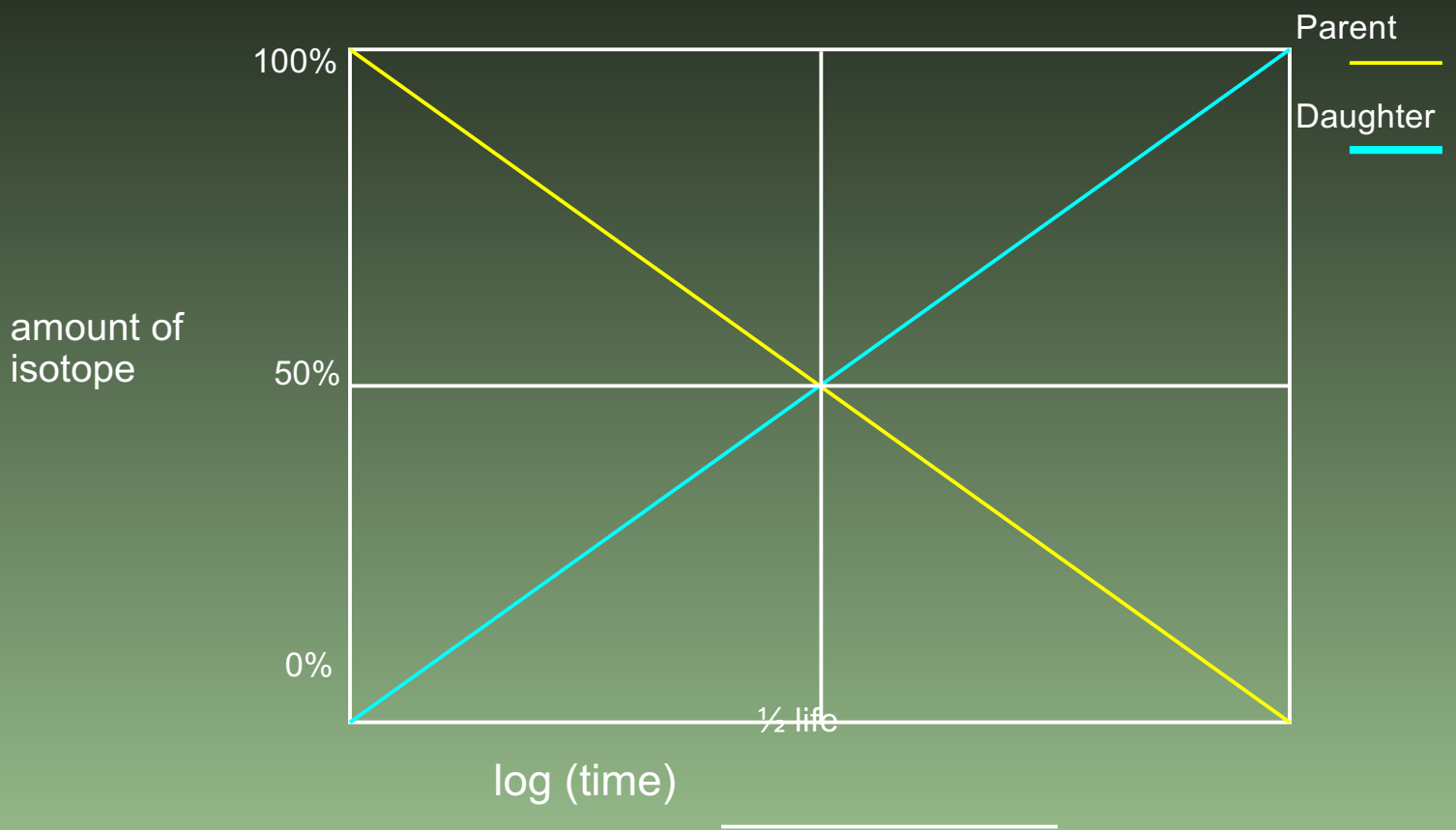
GY360 Structural Geology

Radiometric dating methods lecture

Radioactive Decay

parent to daughter decay properties



Geologic Radiometric Systems

(half-lives long enough to cover geologic time spans)

Parent	Daughter	Half-life
^{14}C	^{14}N	5,730 years
^{40}K	^{40}Ar	1.4 Billion years
^{238}U	^{206}Pb	4.468 Billion years
^{87}Rb	^{87}Sr	48.8 Billion years
^{147}Sm	^{143}Nd	106.0 Billion years

Radiometric Dating Restrictions

Problems associated with geologic systems

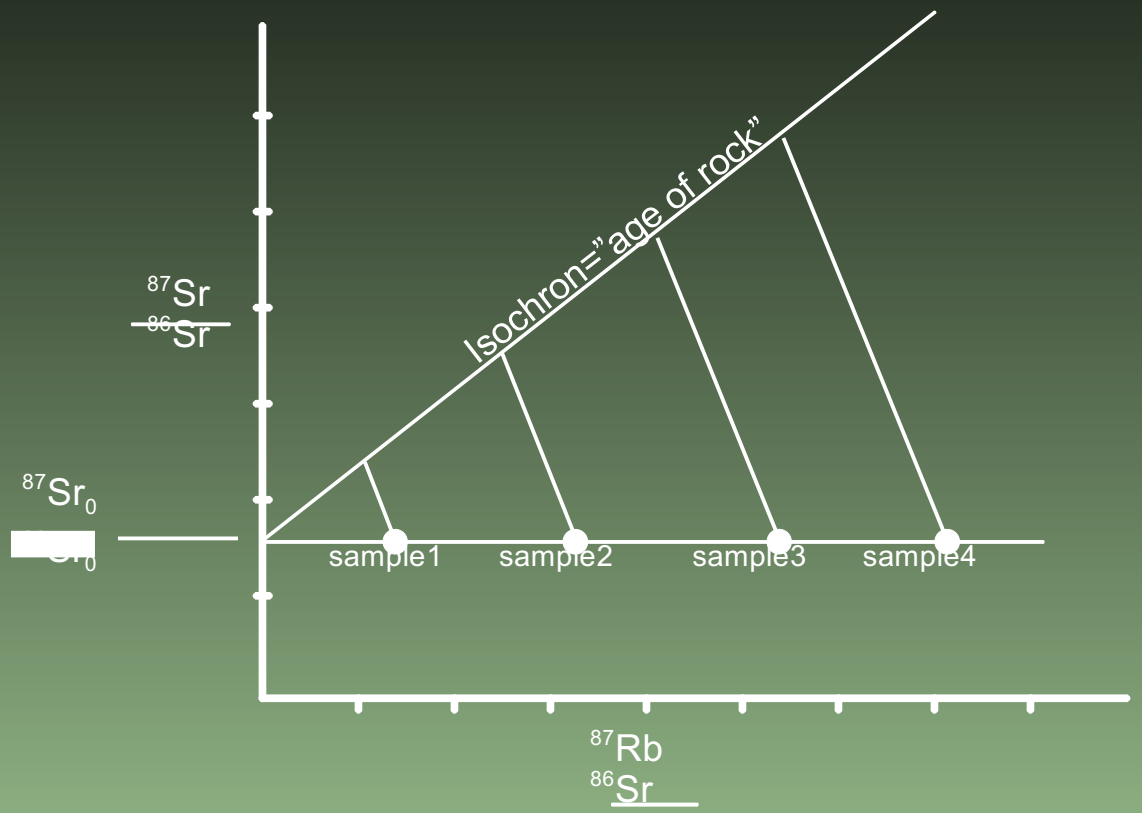
- Most systems are restricted to felsic rocks
- Ar is a volatile gas that does not fit into mineral lattices
- Radiogenic Pb is easily contaminated by a variety of anthropogenic activities
- C14 can date only 100,000 year or less events
- U-Pb minerals are refractory
- Cannot date sedimentary rocks
- Metamorphic events reset mineral isotopic ratios

Isochron Diagrams

Rb-Sr system as an example

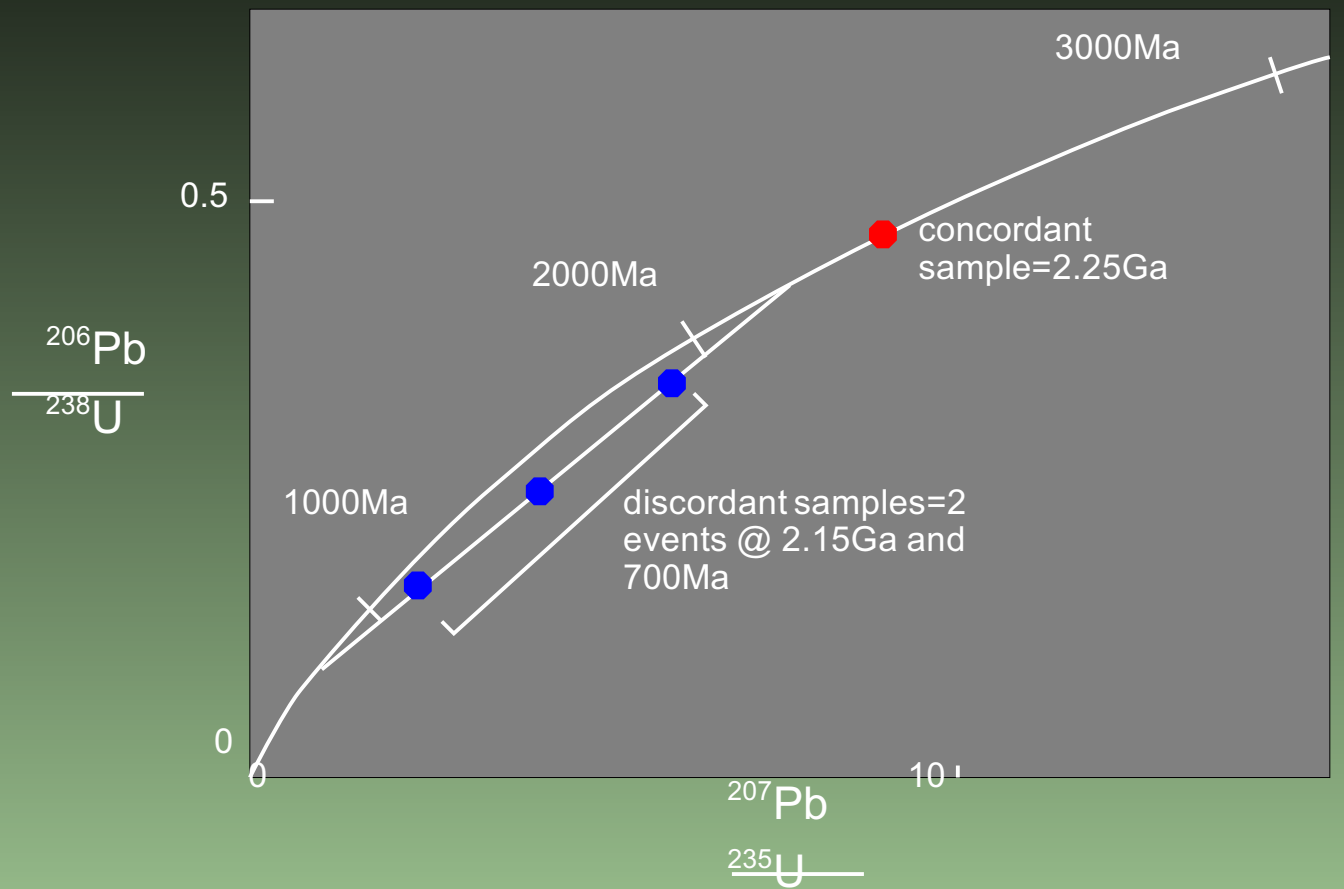
$$\frac{[^{87}Sr]}{[^{86}Sr]} = \frac{[^{87}Sr]_0}{[^{86}Sr]_0} + \frac{[^{87}Rb]}{[^{86}Sr]}\,\lambda t$$

$$\lambda = 1.42 \times 10^{-11}$$



Concordia Diagram

U-Pb system as an example



K-Ar Blocking Temperatures

for common silicates

K-Ar Mineral	Temperature
Hornblende	500°C
Muscovite	350°C
Biotite	250°C

Uplift Rate Calculation

from K-Ar age estimates

Given: Hornblende K-Ar age of 360Ma and biotite K-Ar of 300Ma. Geothermal gradient was 25°C/km. Assume a surface T = 25°C.

Find: The uplift rate in mm/year.

Depth to Hbl. @ 360Ma = (500°C-25°C)/(25°C/km) =19km

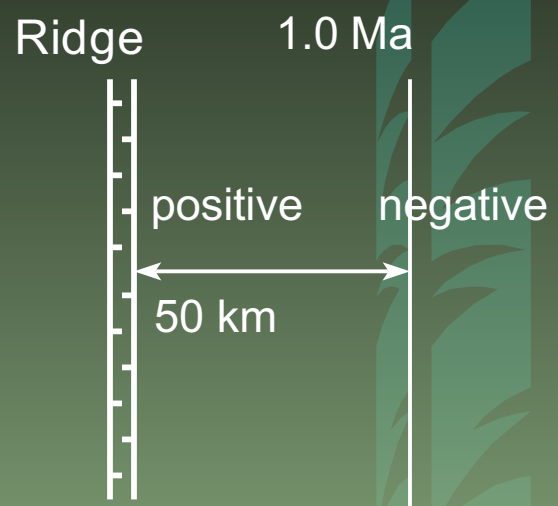
Depth to Bi. @ 300Ma = (250°C-25°C)/(25°C/km) = 9km

Average uplift rate = (19km-9km)/(360Ma-300Ma) = 10km/60Ma = $1x10^7$mm/$6x10^7$year = 0.16mm/year

Paleomagnetic Data

calculation of spreading rates

Given: A map of the seafloor with the boundary between paleomagnetic “stripes” dated by radiometric analysis. Measurement of map yields a distance of 50 km and a date of 1.0 Ma.



Find: Spreading rate at ocean ridge in cm/year.

rate = 50km/1.0Ma = 5×10^{6}cm/1×10^{6}year = 5cm/year