The Sm-Nd System

- Both Sm and Nd are LREE
  - Incompatible elements fractionate → melts
  - Nd has lower Z → larger → liquids > does Sm
\(^{147}\text{Sm} \rightarrow^{143}\text{Nd}\) by alpha decay

\[ \lambda = 6.54 \times 10^{-13} \text{ a}^{-1} \text{ (half life 106 Ga)} \]

- Decay equation derived by reference to the non-radiogenic \(^{144}\text{Nd}\)

\[ \frac{^{143}\text{Nd} / ^{144}\text{Nd}}{\left( ^{143}\text{Nd} / ^{144}\text{Nd} \right)_o} + \left( ^{147}\text{Sm} / ^{144}\text{Nd} \right)(e^{\lambda t} - 1) \]
Sm-Nd Evolution curve is opposite to Rb - Sr

The U-Pb-Th System

A little more complex system…….

- 3 radioactive isotopes of U: $^{234}\text{U}$, $^{235}\text{U}$, $^{238}\text{U}$
- 3 radiogenic isotopes of Pb: $^{206}\text{Pb}$, $^{207}\text{Pb}$, and $^{208}\text{Pb}$
  - Only $^{204}\text{Pb}$ is strictly non-radiogenic
- U, Th, and Pb are incompatible elements, & concentrate in early melts
- Isotopic composition of Pb in rocks = function of
  - $^{238}\text{U} \rightarrow ^{234}\text{U} \rightarrow ^{206}\text{Pb}$ ($\lambda = 1.5512 \times 10^{-10} \text{ a}^{-1}$)
  - $^{235}\text{U} \rightarrow ^{207}\text{Pb}$ ($\lambda = 9.8485 \times 10^{-10} \text{ a}^{-1}$)
  - $^{232}\text{Th} \rightarrow ^{208}\text{Pb}$ ($\lambda = 4.9475 \times 10^{-11} \text{ a}^{-1}$)
The U-Pb-Th System

Concordia = Simultaneous co-evolution of $^{206}\text{Pb}$ and $^{207}\text{Pb}$ via:

$^{238}\text{U} \rightarrow ^{234}\text{U} \rightarrow ^{206}\text{Pb}$

$^{235}\text{U} \rightarrow ^{207}\text{Pb}$

The U-Pb-Th System

Discordia = loss of both $^{206}\text{Pb}$ and $^{207}\text{Pb}$

The U-Pb-Th System

Concordia diagram after 3.5 Ga total evolution

Figure 9.17. Concordia diagram for three discordant zircons separated from an Archean gneiss at Morton and Granite Falls, Minnesota. The discordia intersects the concordia at 3.55 Ga, yielding the U-Pb age of the gneiss, and at 1.85 Ga, yielding the U-Pb age of the depletion event. From Faure (1986). Copyright © reprinted by permission of John Wiley & Sons, Inc.