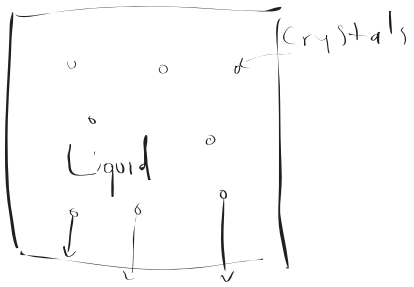
Zoned crystal

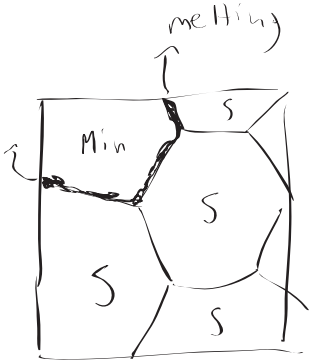
Can our Batch equilbrium model explain the variations?

Fractional crystallization

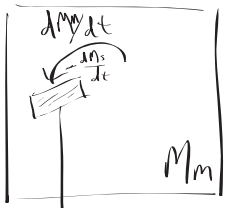


open system

Fractional melting



open system



$\frac{dM_0}{dt}$ $F = \frac{M_m}{M_0}$

change in mass of melt = rate of crystal segregation

$$\frac{dM_m}{dt} = -\frac{dM_s}{dt}$$

$$\frac{d(C_m M_m)}{dt} = -\frac{C_s\, dM_s}{dt}$$

chain rule ↓

$$C_m dM_m + M_m dC_m = -C_s dM_s$$

$D = \frac{C_s}{C_m}$

$$C_m dM_m + M_m dC_m = -D C_m dM_s$$

$-dM_s = dM_m$

$$C_m dM_m + M_m dC_m = D C_m dM_m$$

$$M_m dC_m = D C_m dM_m - C_m dM_m$$

$$M_m dC_m = (D-1) C_m dM_m$$

$$\int_{C_{m_0}}^{C_m} \frac{dC_m}{(D-1)C_m} = \int_{M_0}^{M_m} \frac{dM_m}{M_m}$$

$$(D-1)^{-1} \ln \frac{C_m}{C_{m_0}} = \ln \frac{M_m}{M_0}$$

$$(D-1)^{-1} \ln \frac{C_m}{C_{m_0}} = \ln F$$

$$\ln \frac{C_m}{C_{m_0}} = (D-1) \ln F = \ln F^{D-1}$$

fractional crystallization

$$\boxed{\frac{C_M}{C_{M_0}} = F^{D-1}}$$