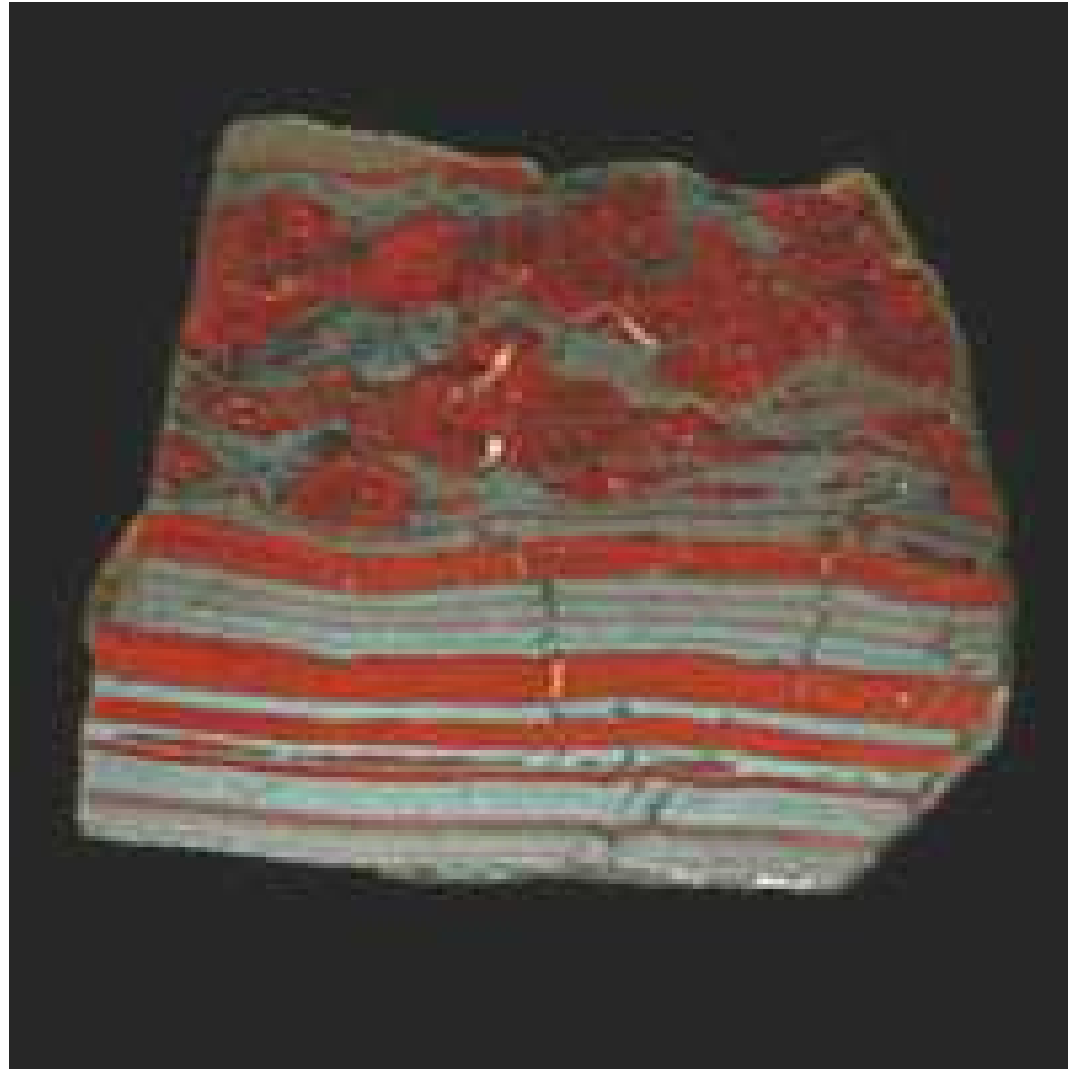


Review of early Earth

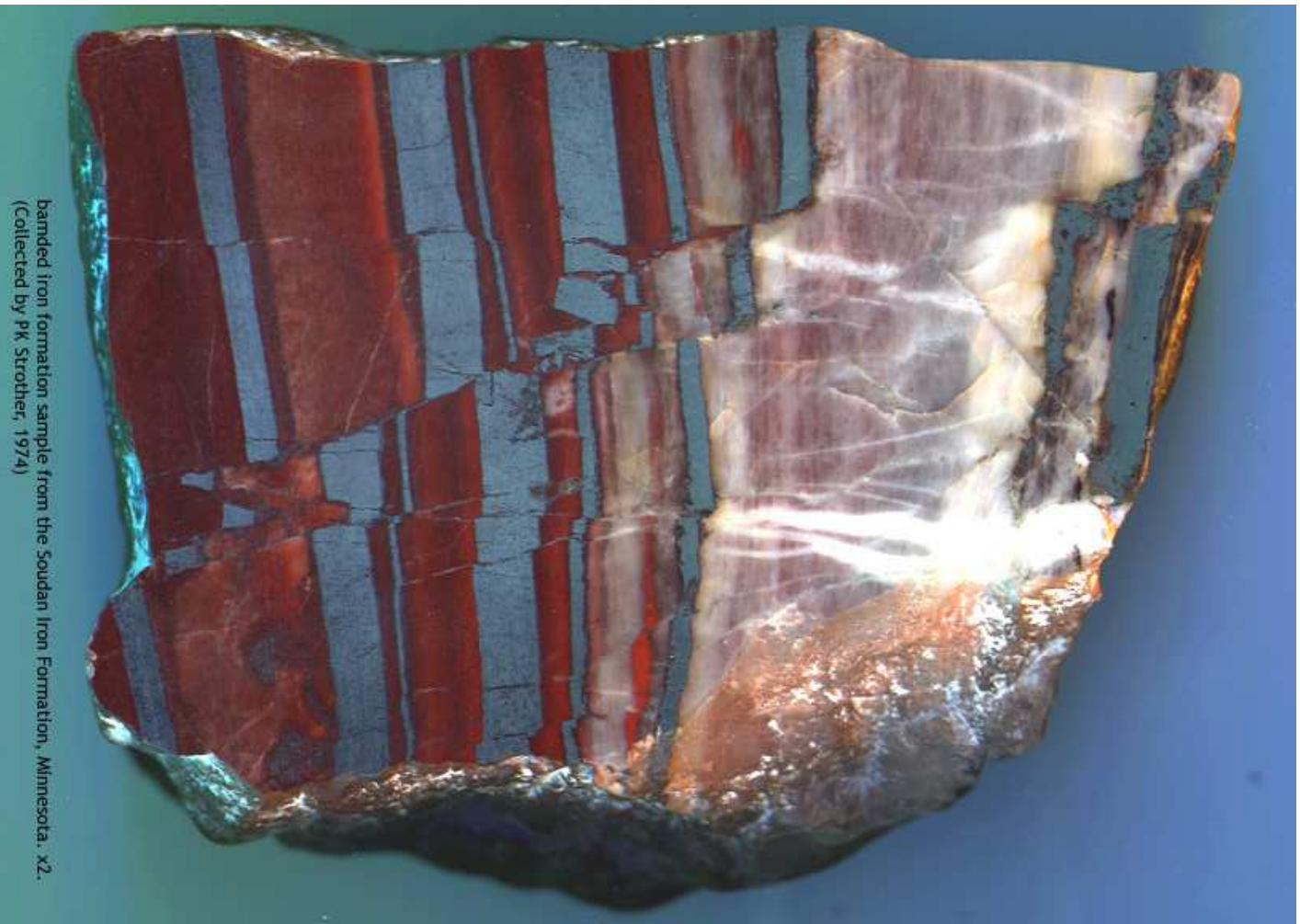
- Age: 4.56 billion years (from rock dating)
 - Accretion of solar gases and dust
 - Likely the result of a supernova explosion in this area
- Favorable position in solar system
- First atmosphere mostly lost to space (H_2 , He)
- Early atmosphere from degassing (volcanic + metamorphic): N_2 , CO_2 , H_2O , noble gases (traces of CH_4 , NH_3 , H_2S , etc.) → reducing
- Slow cooling led to “torrential rain storm”
- Liquid water then “removed” soluble gases
- Life likely appeared first in newly formed oceans

First metabolic pathways

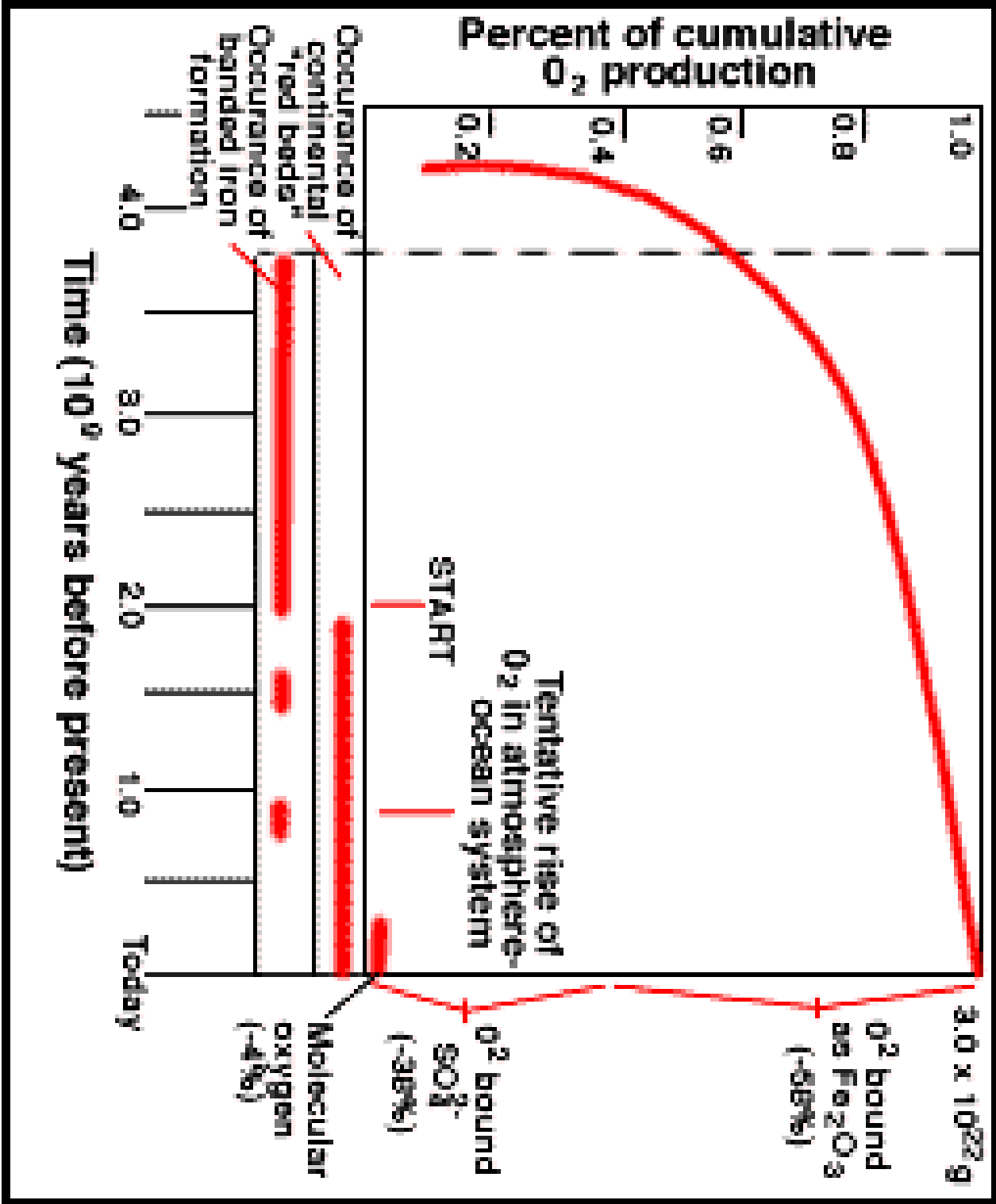
- $\text{CH}_3\text{COOH} \rightarrow \text{CO}_2 + \text{CH}_4 + \Delta\text{E}$ (scavengers)
- $\text{CO}_2 + 4 \text{H}_2 \rightarrow \text{CH}_4 + 2 \text{H}_2\text{O} + \Delta\text{E}$
(methanogenesis; Archaeobacteria)
- $2 \text{CH}_2\text{O} + 2 \text{H}^+ + \text{SO}_4^{2-} \rightarrow \text{H}_2\text{S} + 2 \text{CO}_2 + 2 \text{H}_2\text{O}$
(after availability of sulfate in the oceans)
- $\text{CO}_2 + \text{H}_2\text{S} + \Delta\text{E} \rightarrow 2 \text{S} + (\text{CH}_2\text{O})_n + \text{H}_2\text{O}$
(sulfide photosynthesis; sulfur bacteria)
- $\text{CO}_2 + \text{H}_2\text{O} + \Delta\text{E} \rightarrow \text{O}_2 + (\text{CH}_2\text{O})_n$
first occurrence ~3.8 Ga ago

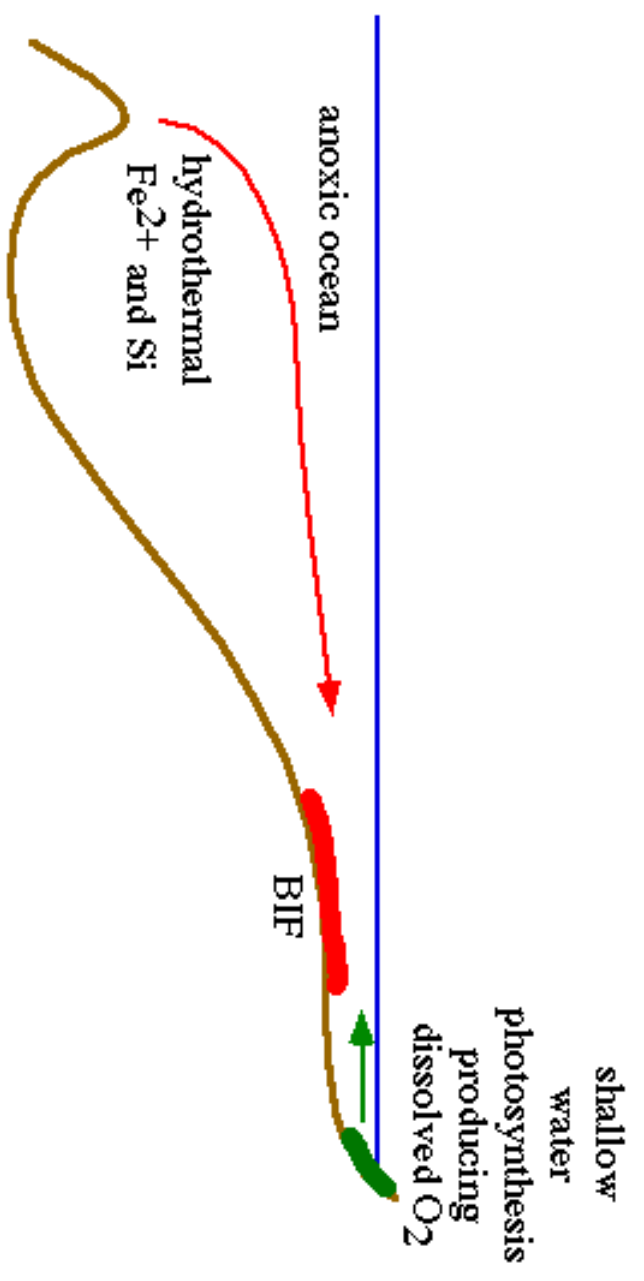
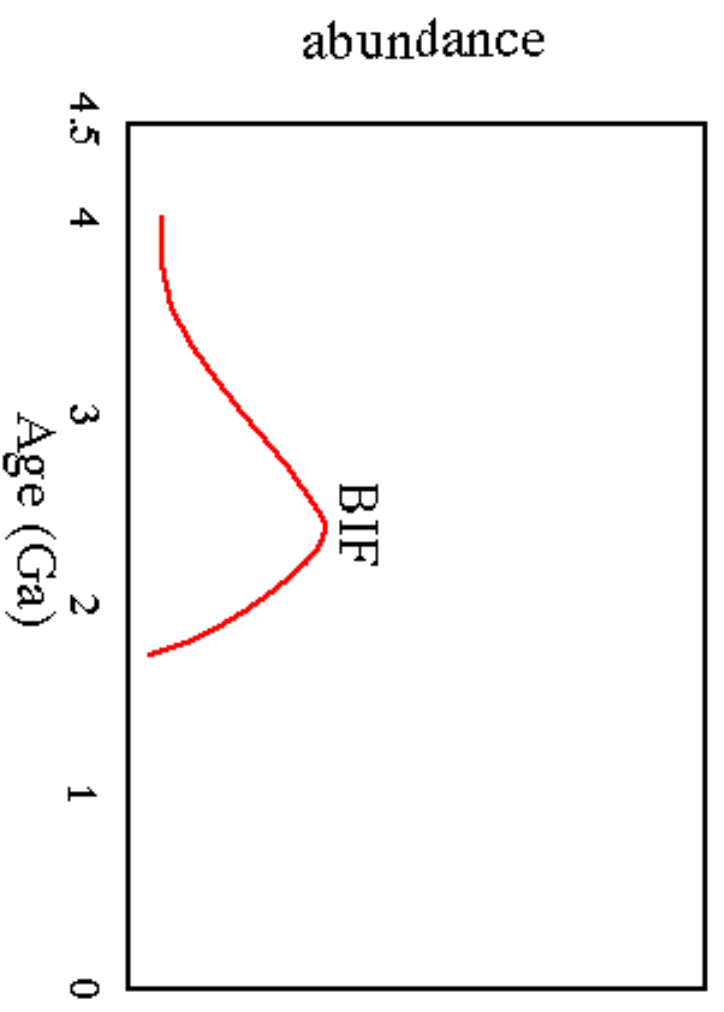


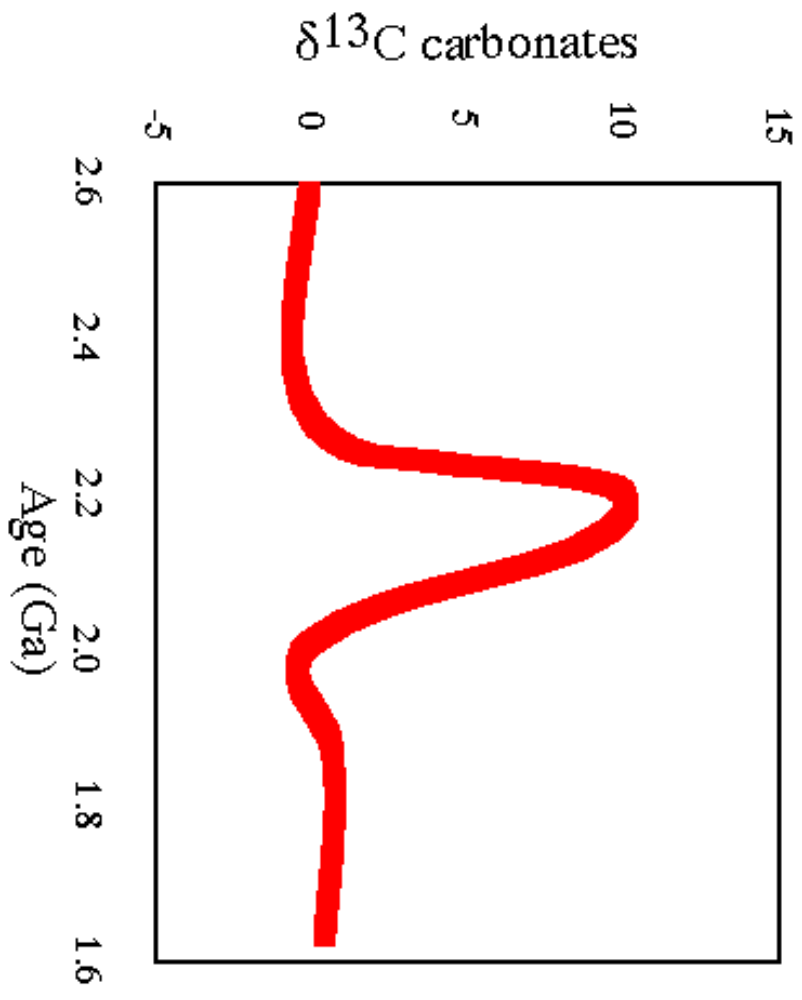
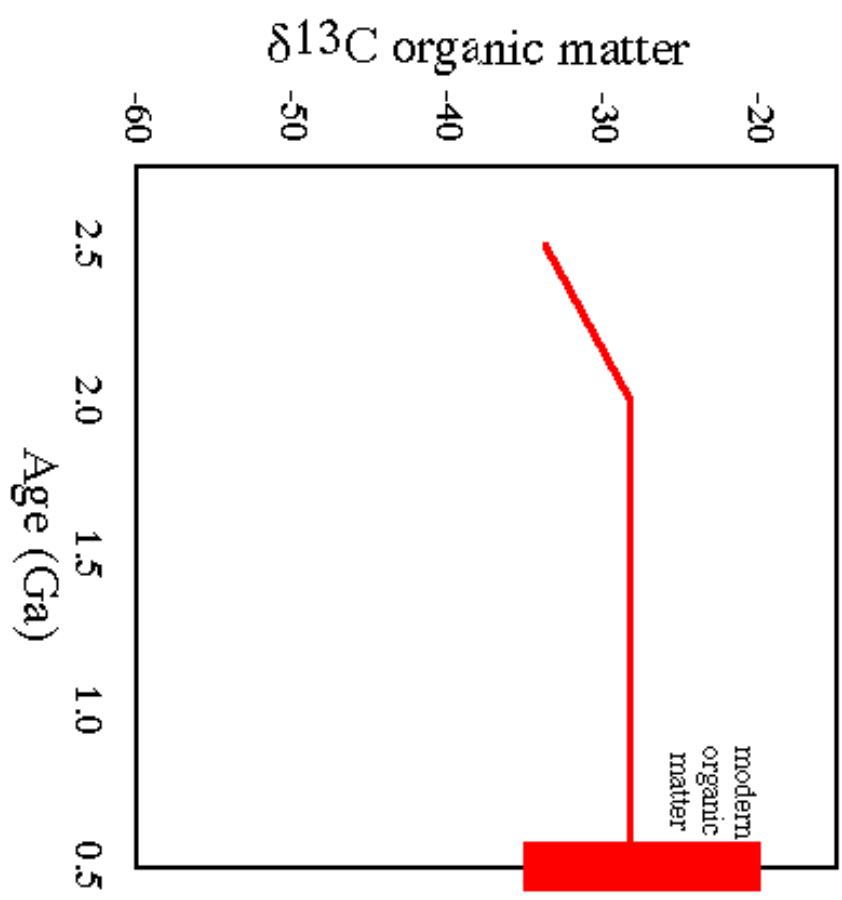
Banded Iron Formation (BIF)



banded iron formation sample from the Soudan Iron Formation, Minnesota. x2.
(Collected by PK Strother, 1974)







Metabolic pathways using oxygen

- $(\text{CH}_2\text{O})_n + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ (respiration)
- $2 \text{NH}_4^+ + 3 \text{O}_2 \rightarrow 2 \text{NO}_2^- + 2 \text{H}_2\text{O} + 4 \text{H}^+$
 $2 \text{NO}_2^- + \text{O}_2 \rightarrow 2 \text{NO}_3^-$ (nitrification)
- $2 \text{S} + 2 \text{H}_2\text{O} + 3 \text{O}_2 \rightarrow 2 \text{SO}_4^{2-} + 4 \text{H}^+$
(Thiobacilli)

Geological Time Arrow

