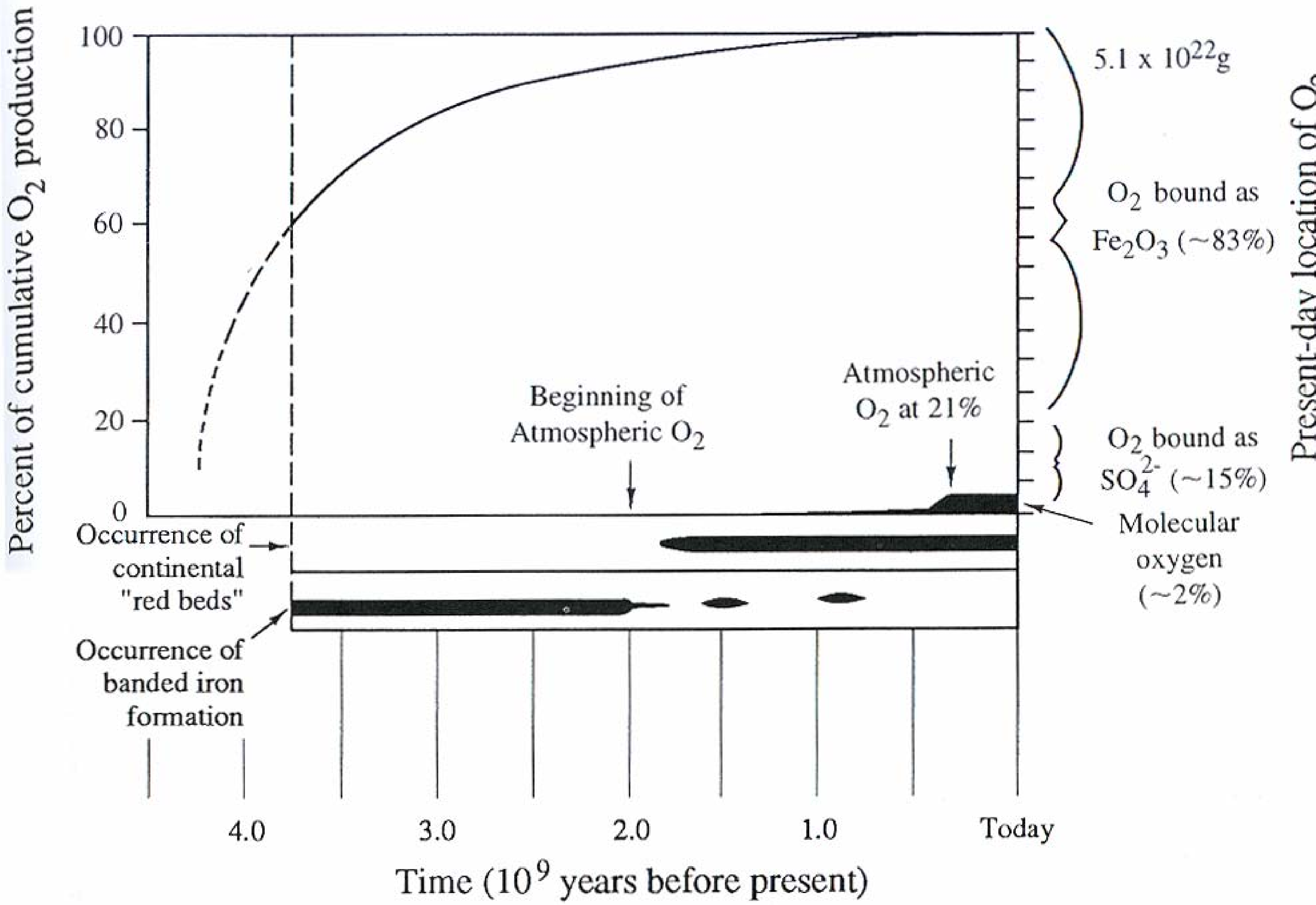
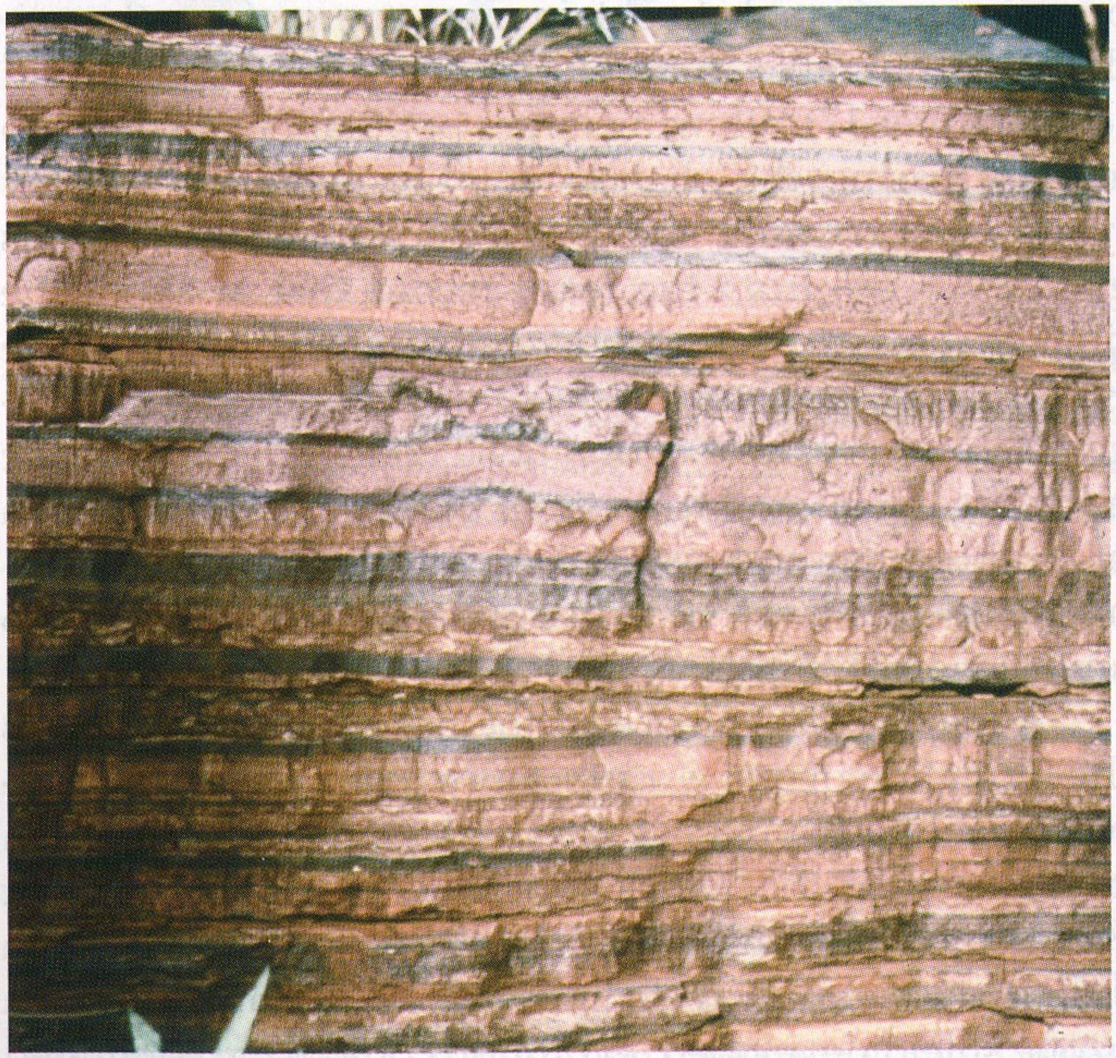


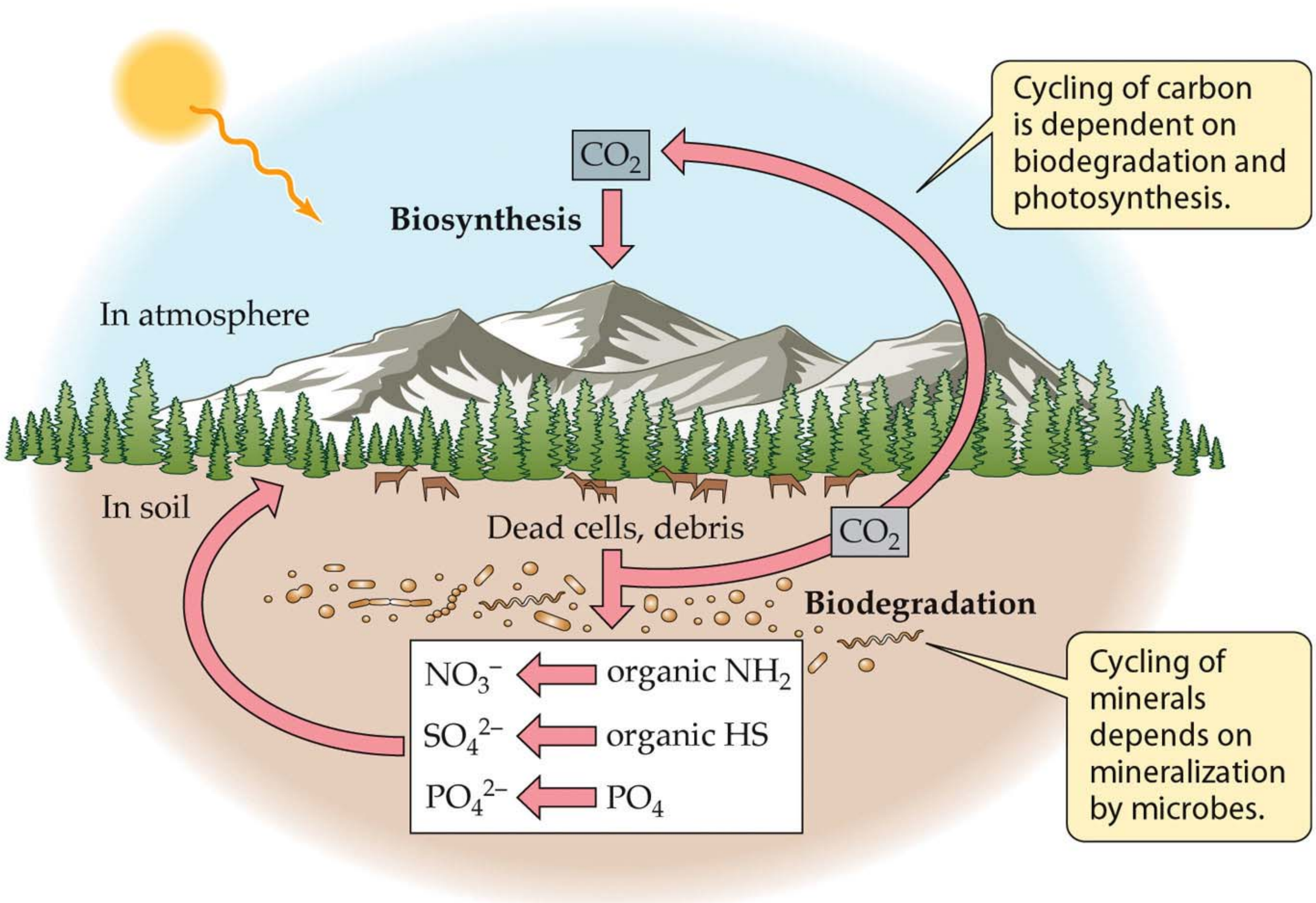
Figure 2.7 Cumulative history of O_2 released by photosynthesis through geologic time. Of more than 5.1×10^{22} g of O_2 released, about 98% is contained in seawater and sedimentary rocks, beginning with the occurrence of Banded Iron Formations at least 3.5 billion years ago (bya). Although O_2 was released to the atmosphere beginning about 2.0 bya, it was consumed in terrestrial weathering processes to form Red Beds, so that the accumulation of O_2 to present levels in the atmosphere was delayed to 400 mya. Modified from Schidlowski (1980).



John M. Hayes

Figure 11.7 **Banded iron formations.** An exposed cliff about 10 m in height containing layers of iron oxides interspersed with layers containing iron silicates and other silica materials. Brockman Iron Formation, Hammersley Basin, Western Australia. The iron oxides contain iron in the ferric (Fe^{3+}) form produced from ferrous iron (Fe^{2+}) primarily by the oxygen released by cyanobacterial photosynthesis.

Balance between biosynthesis and biodegradation



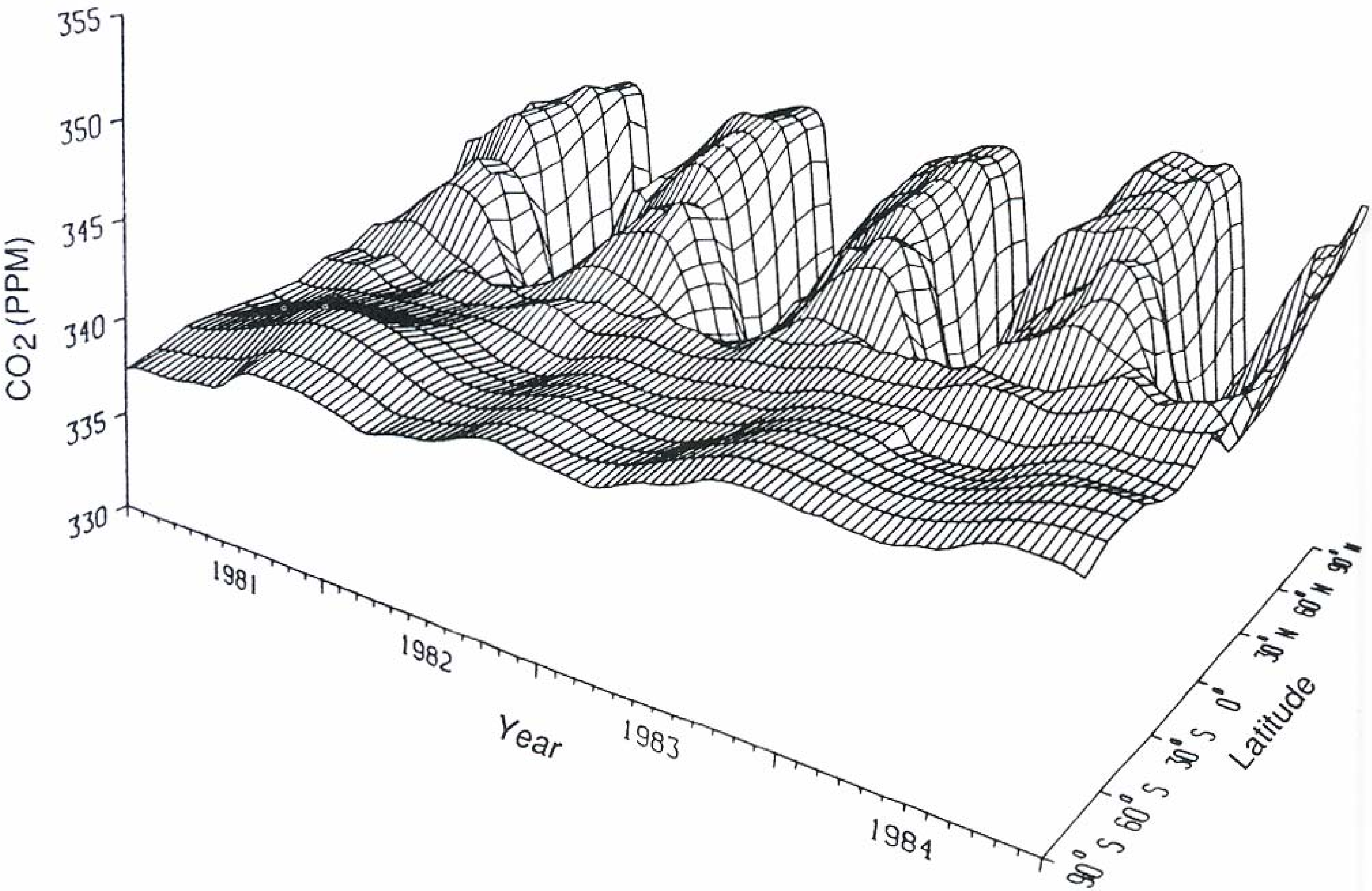
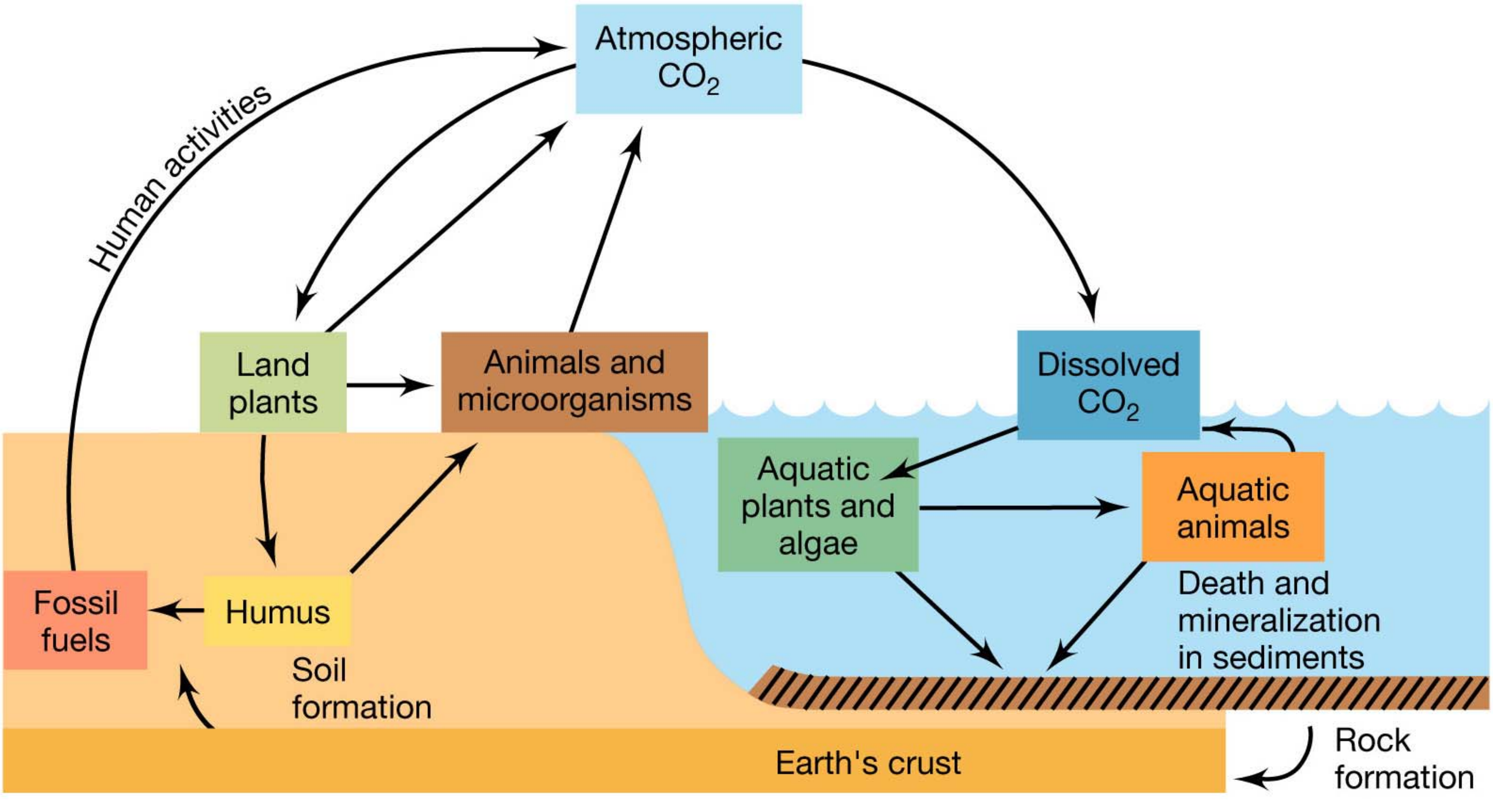


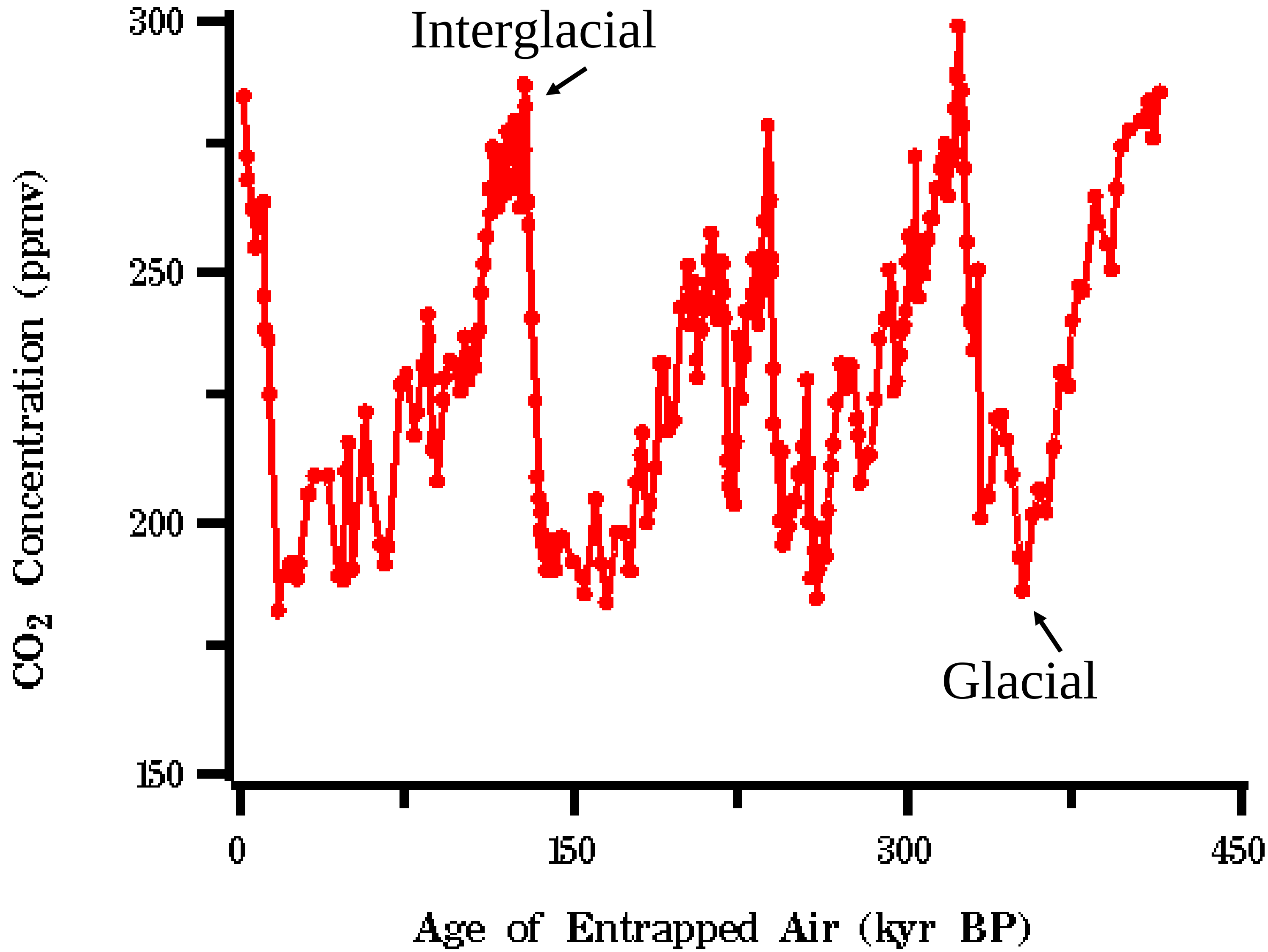
Figure 3.6 Seasonal fluctuations in the concentration of atmospheric CO_2 (1981–1984), shown as a function of 10° latitudinal belts (Conway et al. 1988). Note the smaller amplitude of the fluctuations in the southern hemisphere, reaching peak concentrations during northern hemisphere minima.

The carbon cycle, closely connected with oxygen cycle

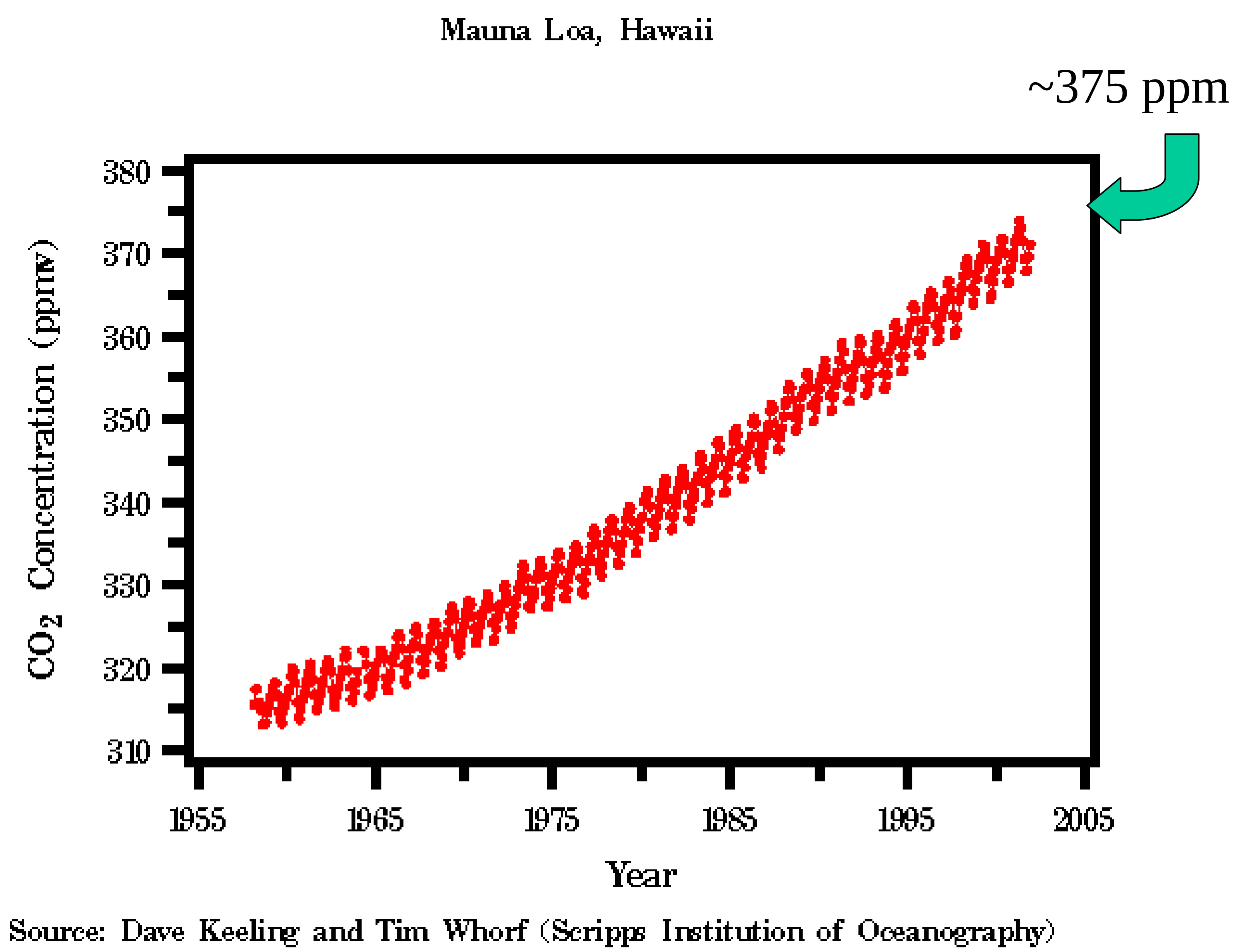


Most carbon in carbonate rocks & sediments

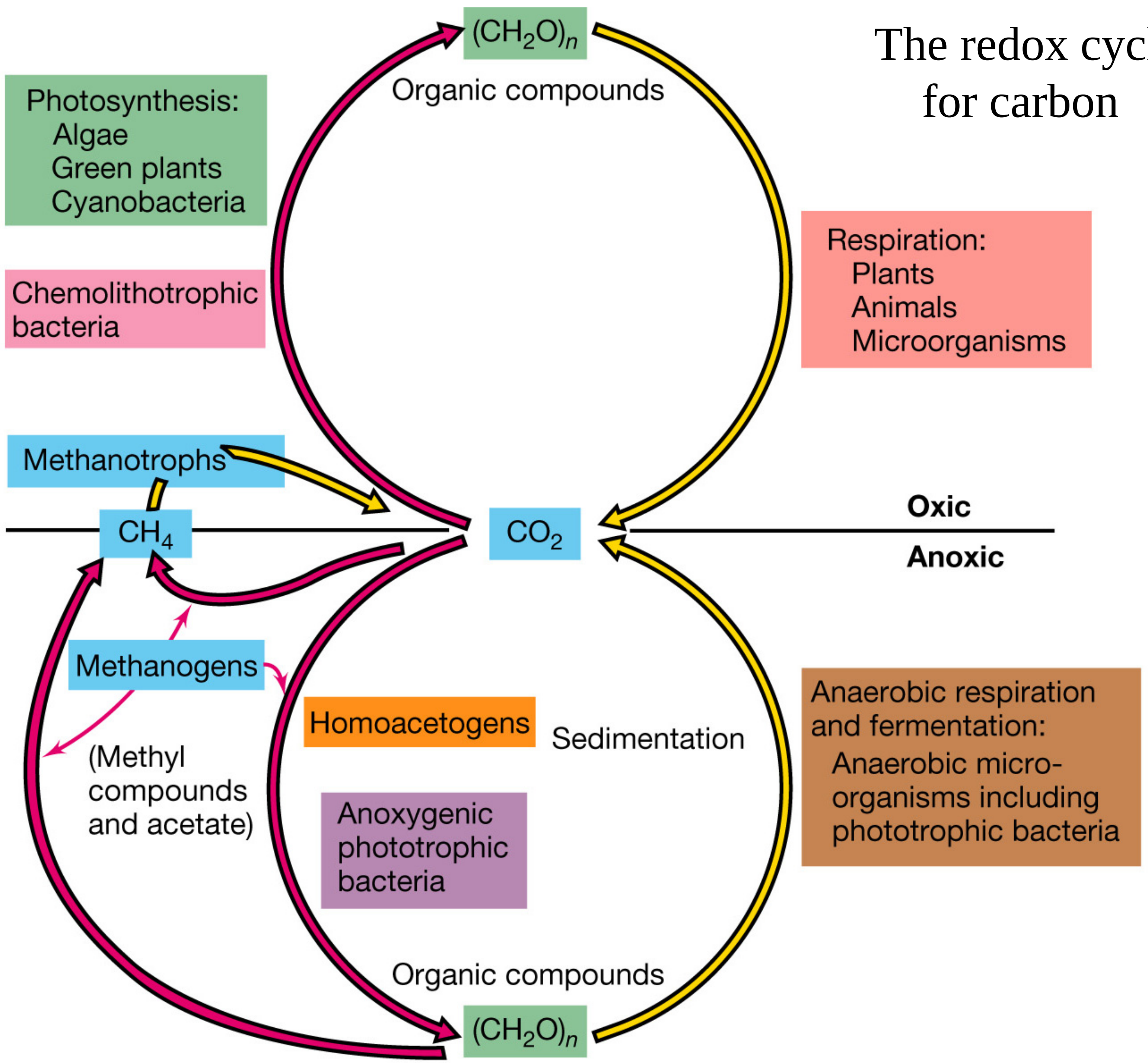
Vostok, Antarctica Ice Core Atmospheric Carbon Dioxide Record



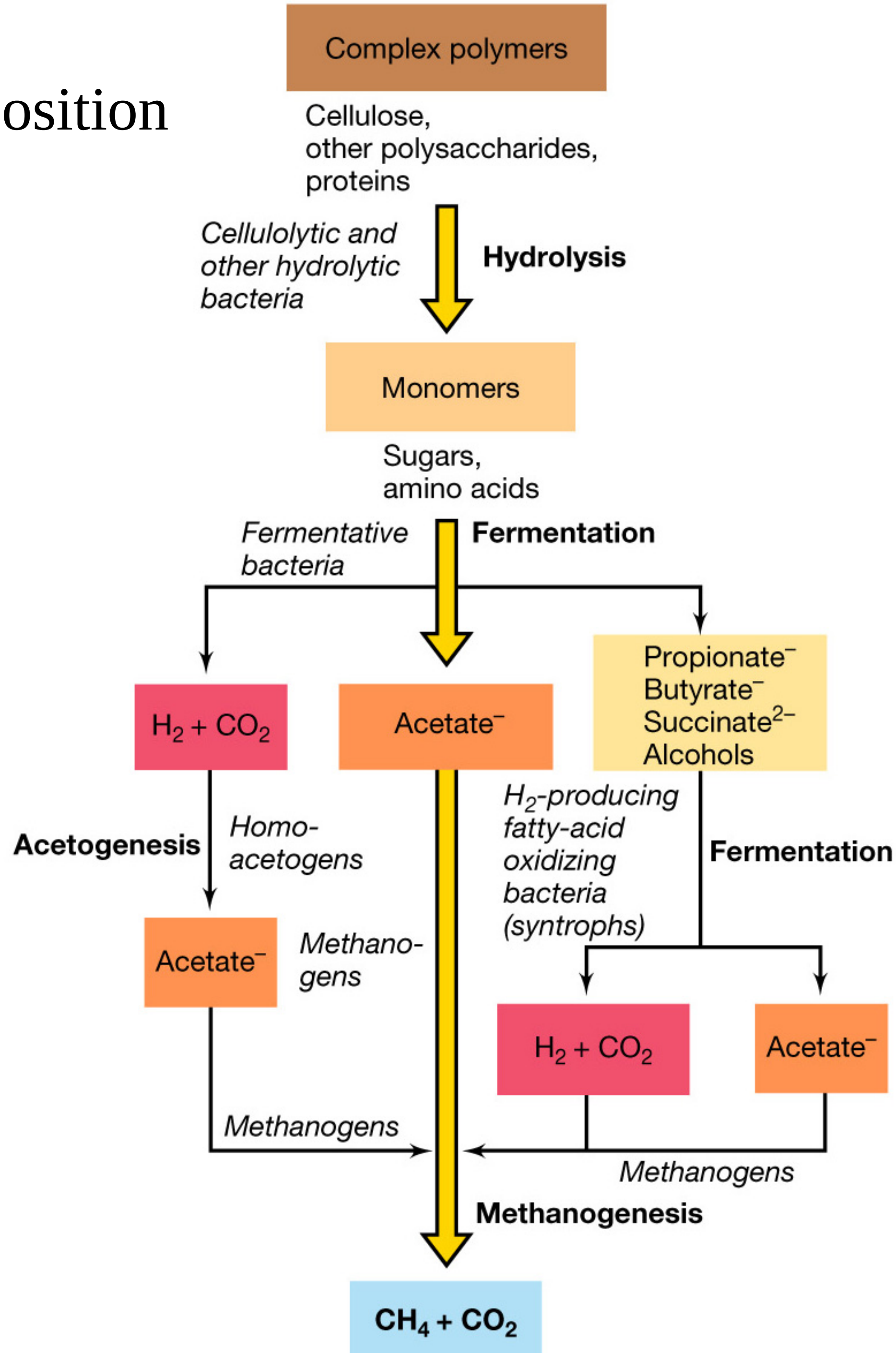
Source: Jean—Marc Barnola et al.


Mauna Loa, Hawaii
~375 ppm
380
370
360
350
340
330
320
310
CO_2 Concentration (ppmv)
1955
1965
1975
1985
1995
2005
Year
Source: Dave Keeling and Tim Whorf (Scripps Institution of Oceanography)

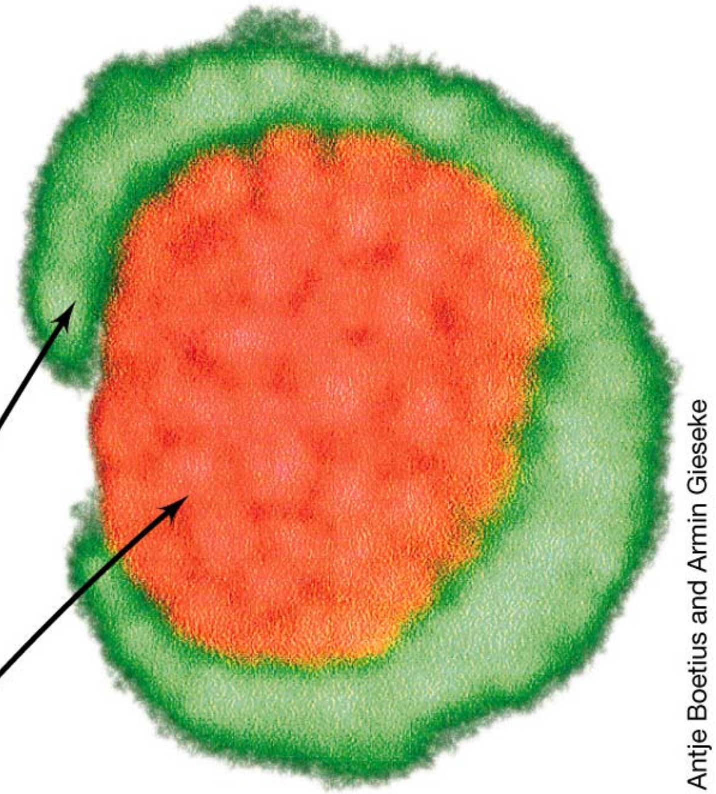
The redox cycle for carbon



Anoxic decomposition



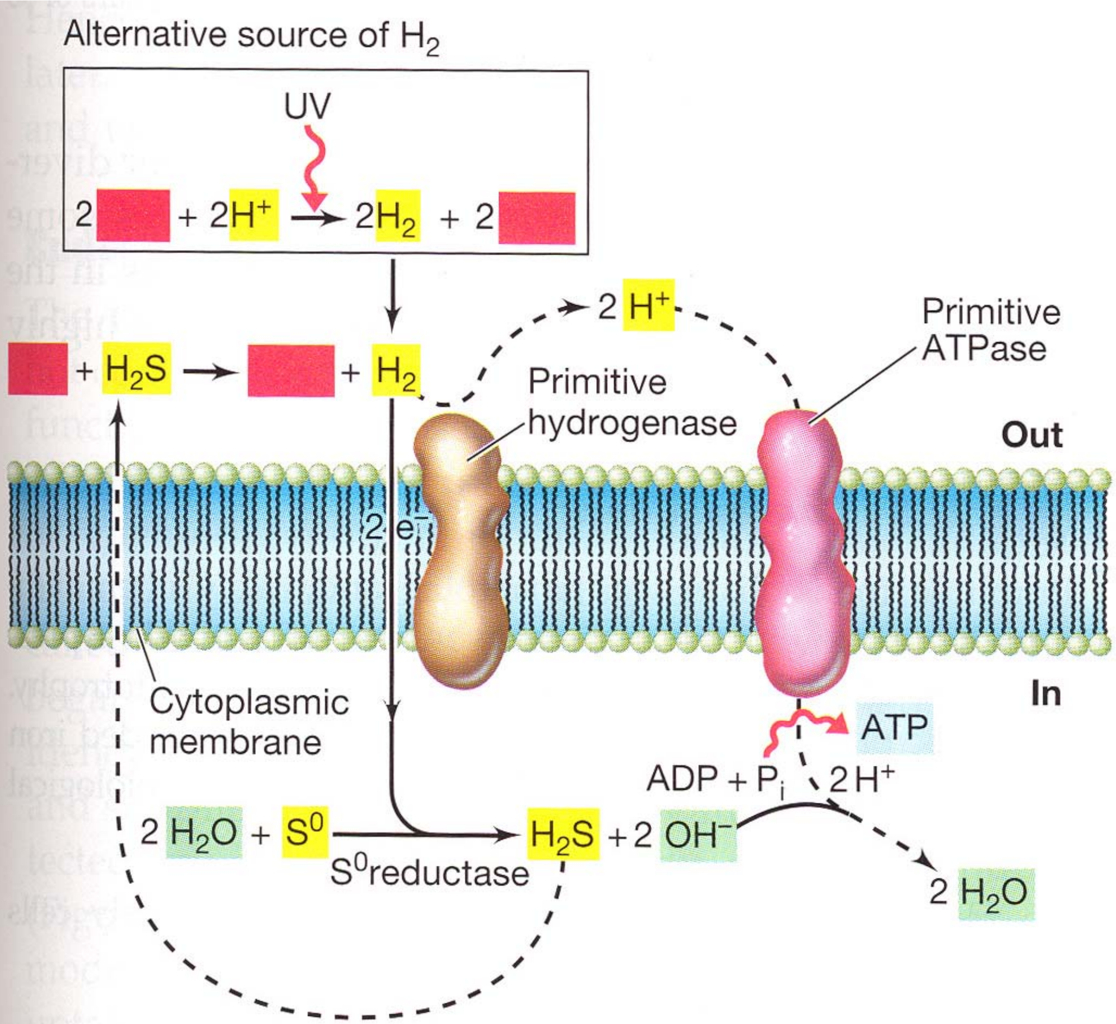
AMO is backwards and requires a friend



(a)

Reaction			Organism	$\Delta G^{0\prime}$(kJ)
	$CH_4 + 2\,H_2O$	$\longrightarrow CO_2 + 4\,H_2$	Methanogen	+131
	$SO_4^{2-} + 4\,H_2 + H^+$	$\longrightarrow HS^- + 4\,H_2O$	Sulfate-reducer	−156
Sum:	$SO_4^{2-} + CH_4$	$\longrightarrow HCO_3^- + HS^- + H_2O$	Syntrophic reaction	−25

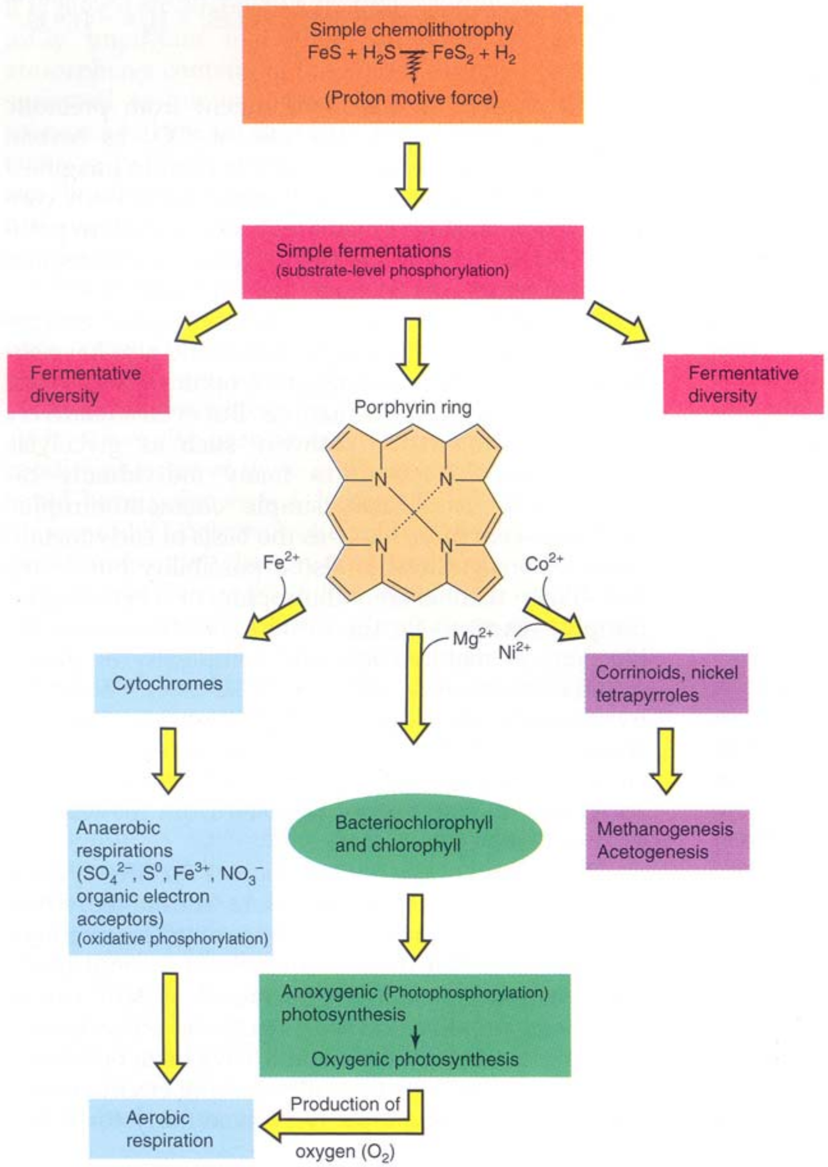
(b)



• Figure 11.6 A possible energy-generating scheme for primitive cells. Formation of pyrite leads to H_2 production and S^0 reduction, which fuels a primitive ATPase. Note how H_2S plays only a catalytic role; the net substrates would be FeS and S^0. Also note how few different proteins would be required. The $\Delta G^{0'}$ of the reaction $FeS + H_2S \rightarrow FeS_2 + H_2 = -42$ kJ. An alternative source of H_2 could have been the UV-catalyzed reduction of H^+ by Fe^{2+} as shown.

Chemosynthesis or Photosynthesis???

Simple hydrogenase or simple rhodopsin???



Porphyrin ring opens many possibilities for metabolic diversity!!!

Which ones are Domain specific?

Cytochromes: Bacteria…
Chlorophyll: Bacteria…
Corrinoids: Archaea only