Geokimia –TKG 2201

Geokimia Organik: Siklus Karbon

Ferian Anggara

Curriculum vitae

- Name : Ferian Anggara, Dr. Eng
- Research interests:
  - Coal geology
  - Coal bed methane
  - CO_2-geological storage
- Email : ferian@ugm.ac.id
- Mobile : +62 812 275 8490
- Publication: please visit ferian.staff.ugm.ac.id

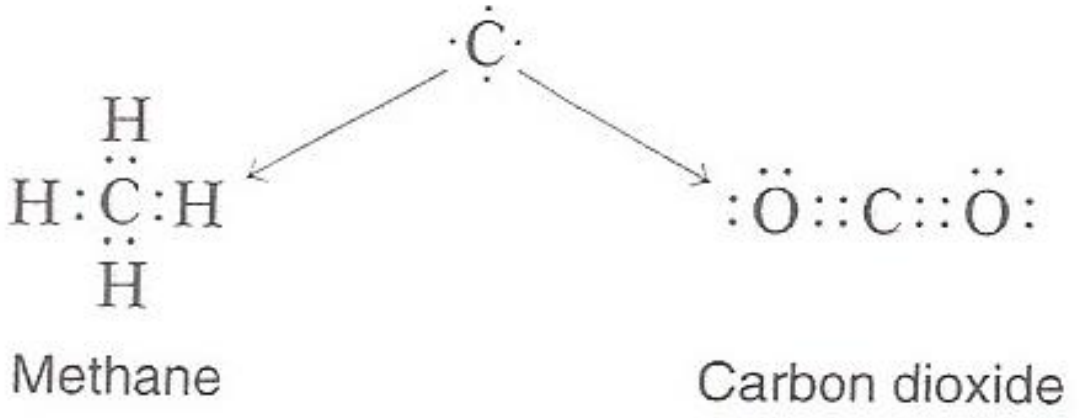
Syllabus

- Thermodynamic (2x)
- Environmental Geochemistry (1x)
- Isotope (2x)
- Organic geochemistry (2x)
  - Carbon cycle
  - Organic matter

* After midterm test

Carbon

- *Carbo*: charcoal
- Fourth group of periodic table
- 4 electron in its outermost electron shell
- Organic chemistry : chemistry of carbon



Carbon cycle

- Short-term
  - “the carbon cycle”
  - occurs on time-scale less than millions years
  - involves photosynthesis, respiration, air–sea exchange of carbon dioxide and humus accumulation in soils
- Long-term
  - take places over geologic time
  - involves the exchange of carbon between rocks and the Earth’s surface

Berner (2003, 1998)

Long-term cycle

Berner (2003)

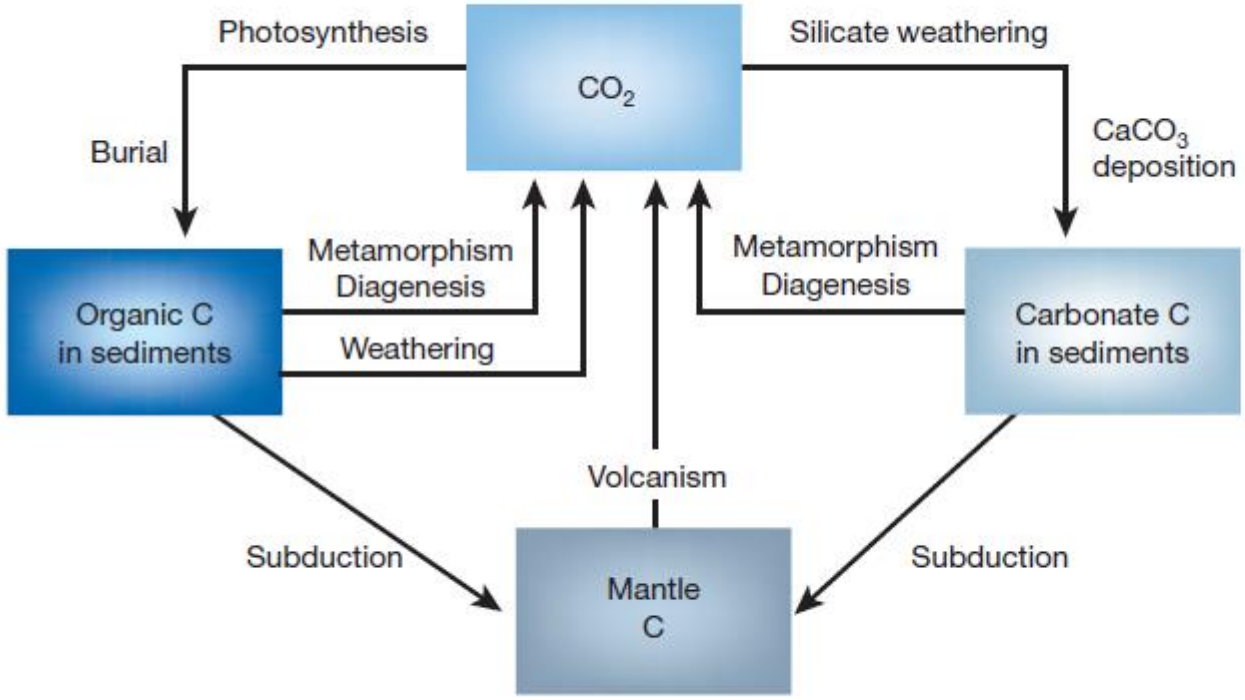


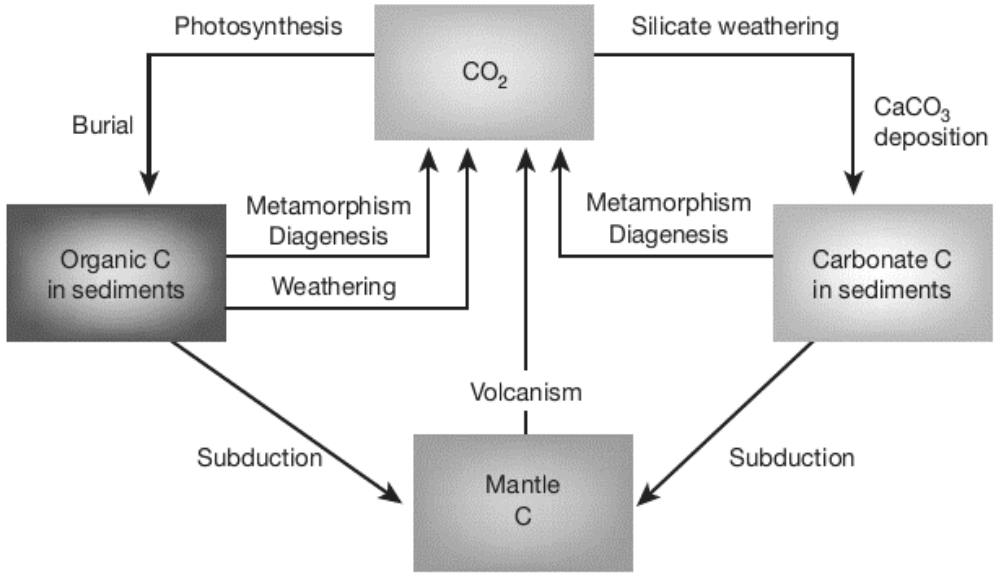
Figure 1 A model of the long-term carbon cycle. The deposition of carbonates derived from the weathering of carbonates is not shown because these processes essentially balance one another over the long term as far as carbon dioxide is concerned. However, carbonate deposition derived from carbonate weathering leads to additional degassing of carbon dioxide upon deep burial and thermal decomposition. Diagenesis, chemical changes at low temperatures during burial. The cycle can be subdivided into two subcycles involving organic matter (left side of figure) and silicate weathering and carbonate deposition (right side of figure).

$$CO_2 + CaSiO_3 \leftrightarrow CaCO_3 + SiO_2 \quad (1)$$

$$CO_2 + H_2O \leftrightarrow CH_2O + O_2 \quad (2)$$

Quiz

Summarize the generalized reactions of long-term carbon cycle over a geological time scale as presented below:



$$CO_2 + CaSiO_3 \leftrightarrow CaCO_3 + SiO_2 \quad (1)$$

$$CO_2 + H_2O \leftrightarrow CH_2O + O_2 \quad (2)$$

Long-term cycle

- Equation (1):
  - *left to right*: atmospheric carbon dioxide (CO_2) is up-taken during the weathering on land of calcium (Ca, and magnesium-Mg) silicates, resulting dissolved Ca^{2+}, Mg^{2+} and HCO_3^-. The weathering products are precipitated as calcium and magnesium carbonates in sediments.
  - *right to left*: CO_2 is released to atmosphere and ocean as a result of deep burial and thermal decomposition of carbonates.
- Equation (2):
  - *left to right*: organic matter (CH_2O) in sediments are the manifestation of the photosynthesis process in left side. Hydrocarbon (oil, gas and coal) is generated from the transformation of organic matter to kerogen.
  - *right to left*: the weathering process of organic matter by erosion.

Homework

How to control the balance between CO_2 input and CO_2 output during Phanerozoic eon?

- Hints:
  - Geological processes
  - Check geologic time scale !!

Deadline: 1 December 2014

Maximum 500 words and 1 picture (1 page A4).

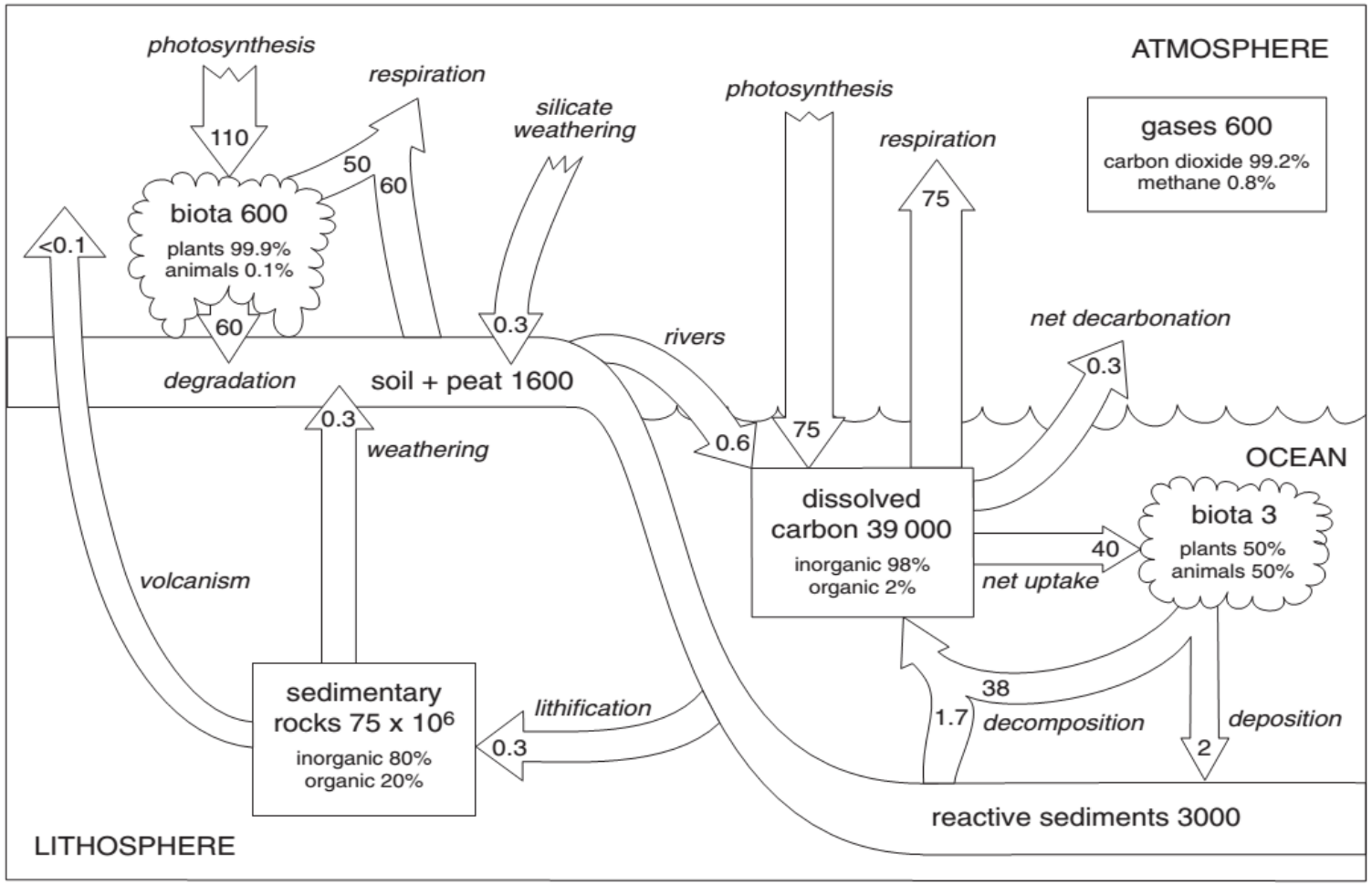
Origin of Life

- Video
- Quiz:
  - What is the goldilocks condition for the origin of life?
  - 2nd Question:

    -Give a short explanation about mankind role in global warming !!

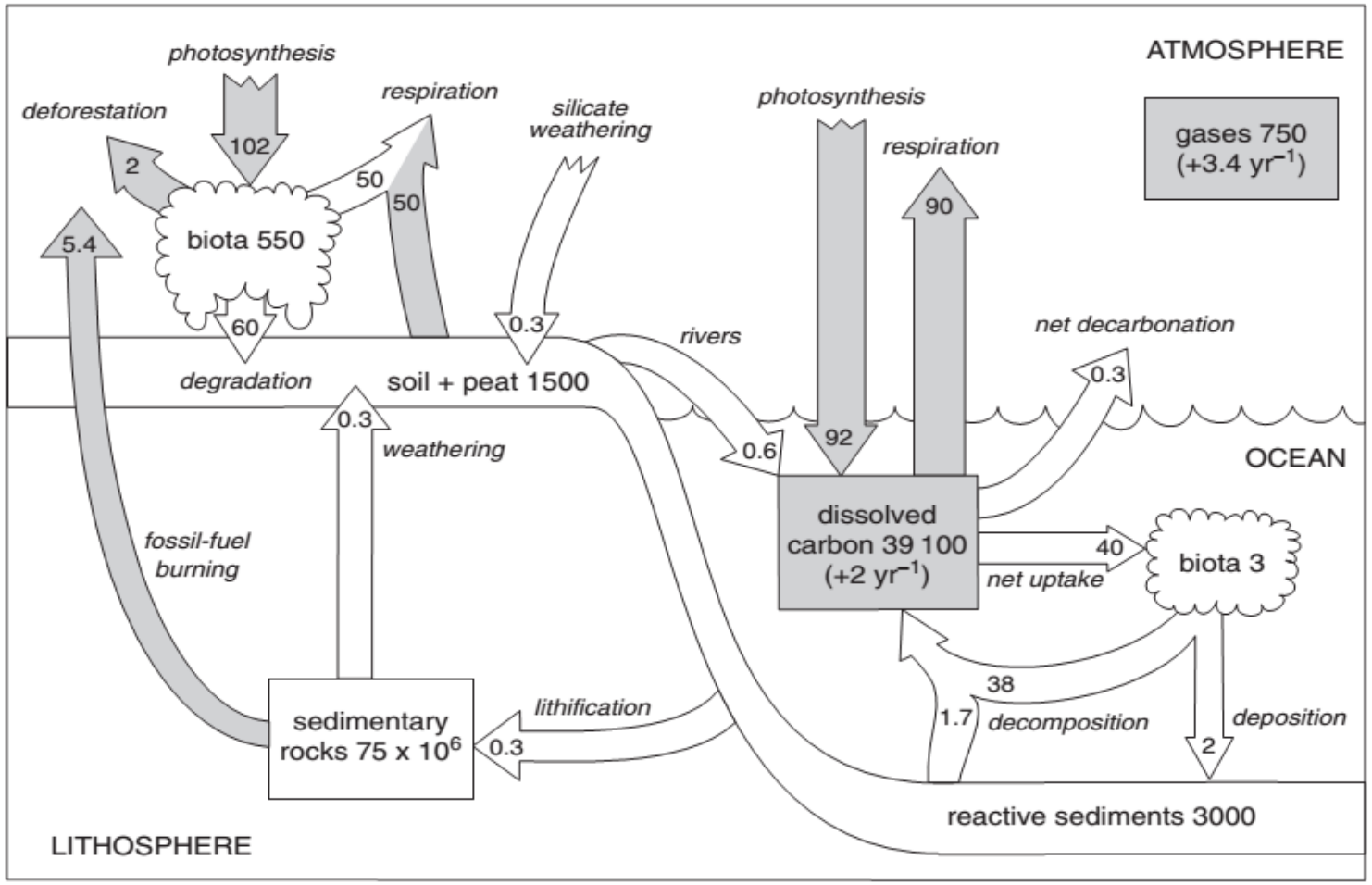
*https://www.youtube.com/watch?v=qt6MZ3dJaoU

Pre-industrial global carbon cycle



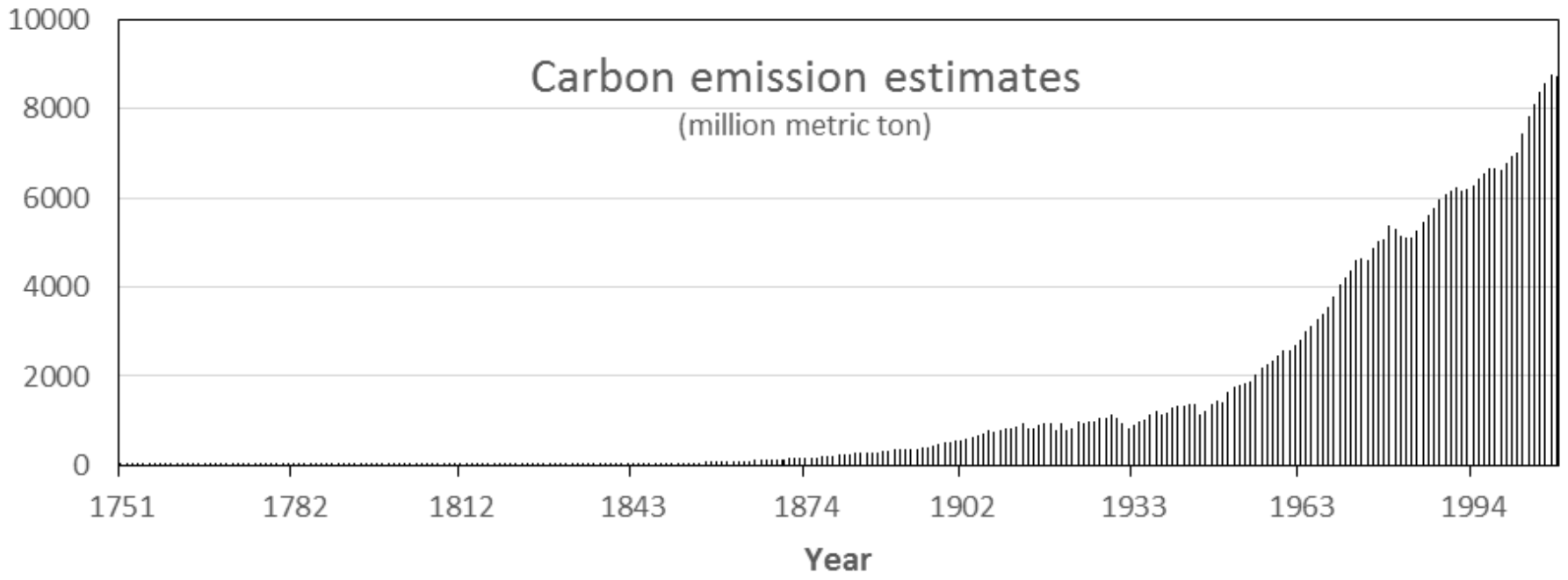
annual fluxes (arrows) in Gt (10^{15} g)

Global carbon cycle for the 1980's



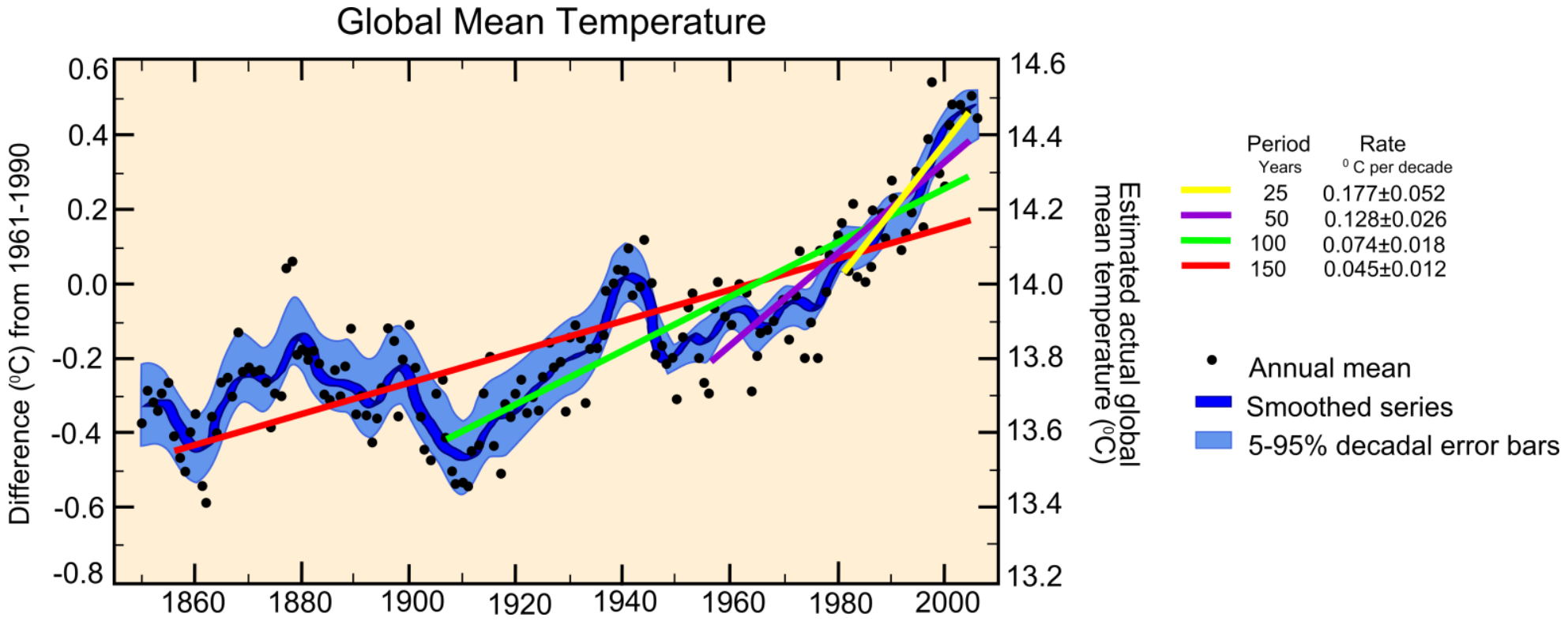
annual fluxes (arrows) in Gt (10^{15} g)

Global CO_2 emission from fossil fuels (1900-2008)



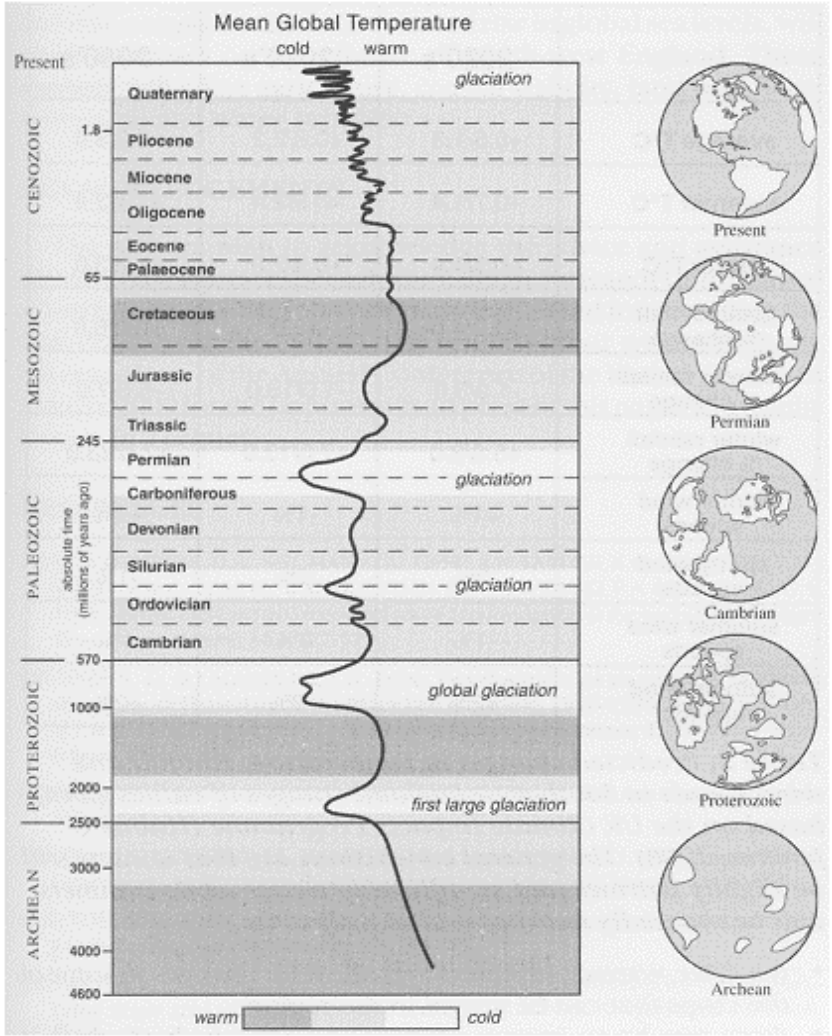
Boden et al., 2012

Annual global mean observed temperature



IPCC, 2007

Generalized temperature history of the Earth



Hart and Hart, 2000

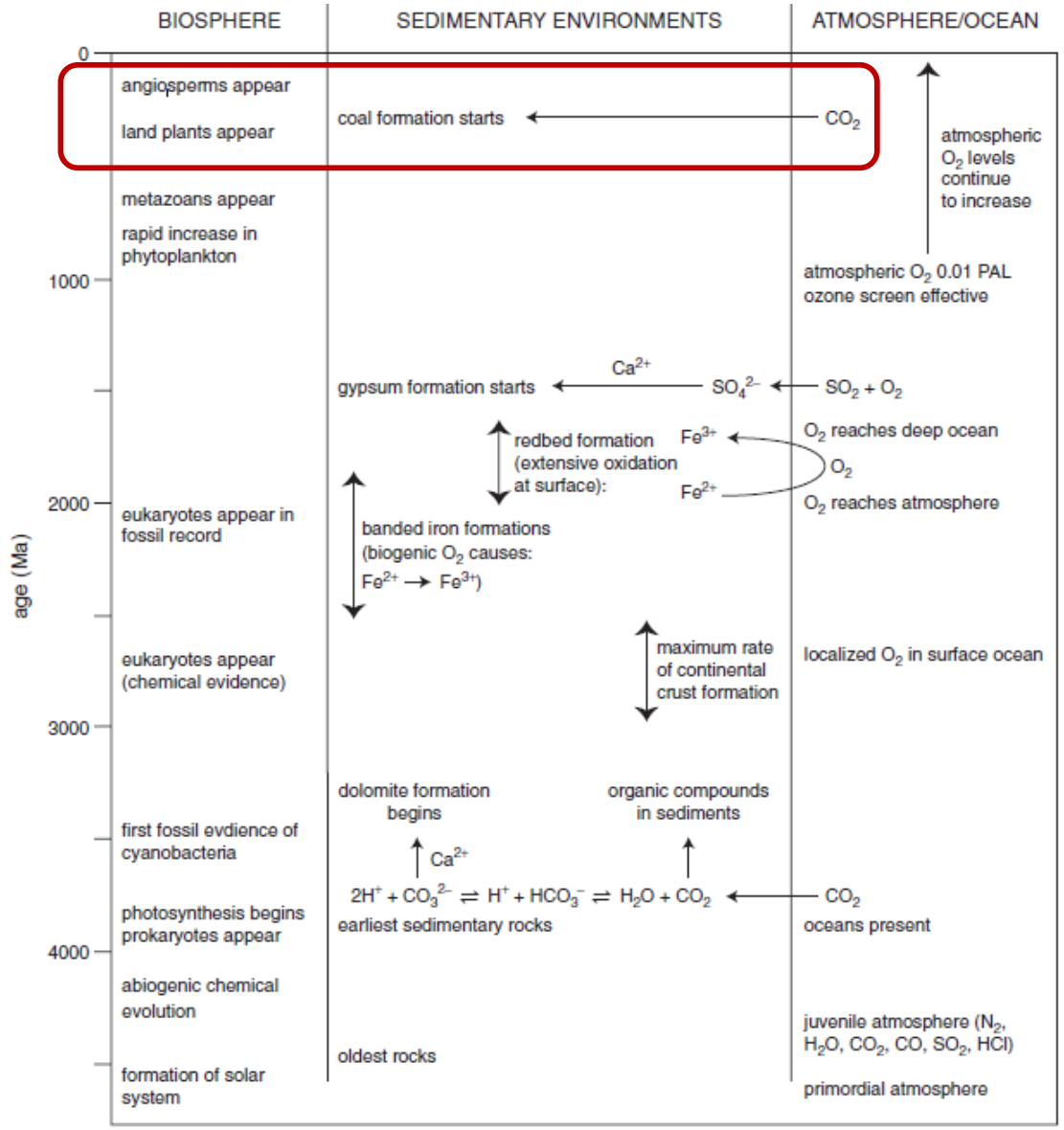
Summaries

- Throughout geological time, the Earth has migrated between “greenhouse” and “icehouse” condition
- Experiencing warmer temperature compared to todays
- Some scientist believed that increasing temperature is natural process
- Warmer temperature in the past was not a major problem since there was no human activity
- It became a disaster when the human activity is disturbed
- Disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources (ISDR, 2009)

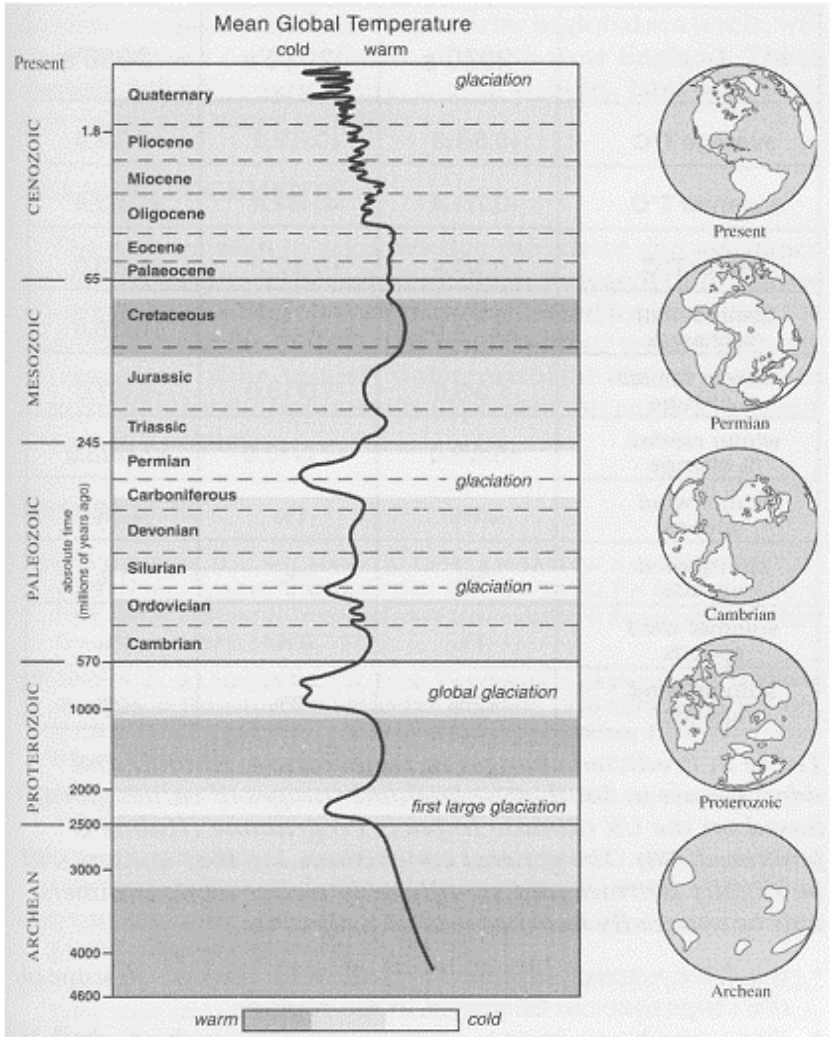
Take-home message

Whatever the cause (of global warming), the outcome is the same. The Earth is experiencing a rapid rise in global temperature and this, coupled with the associated rise in global sea levels, will directly impact on human life

Important events in the evolution of the Earth and life.



Pangaea in the Early Permian (c.280 Ma)



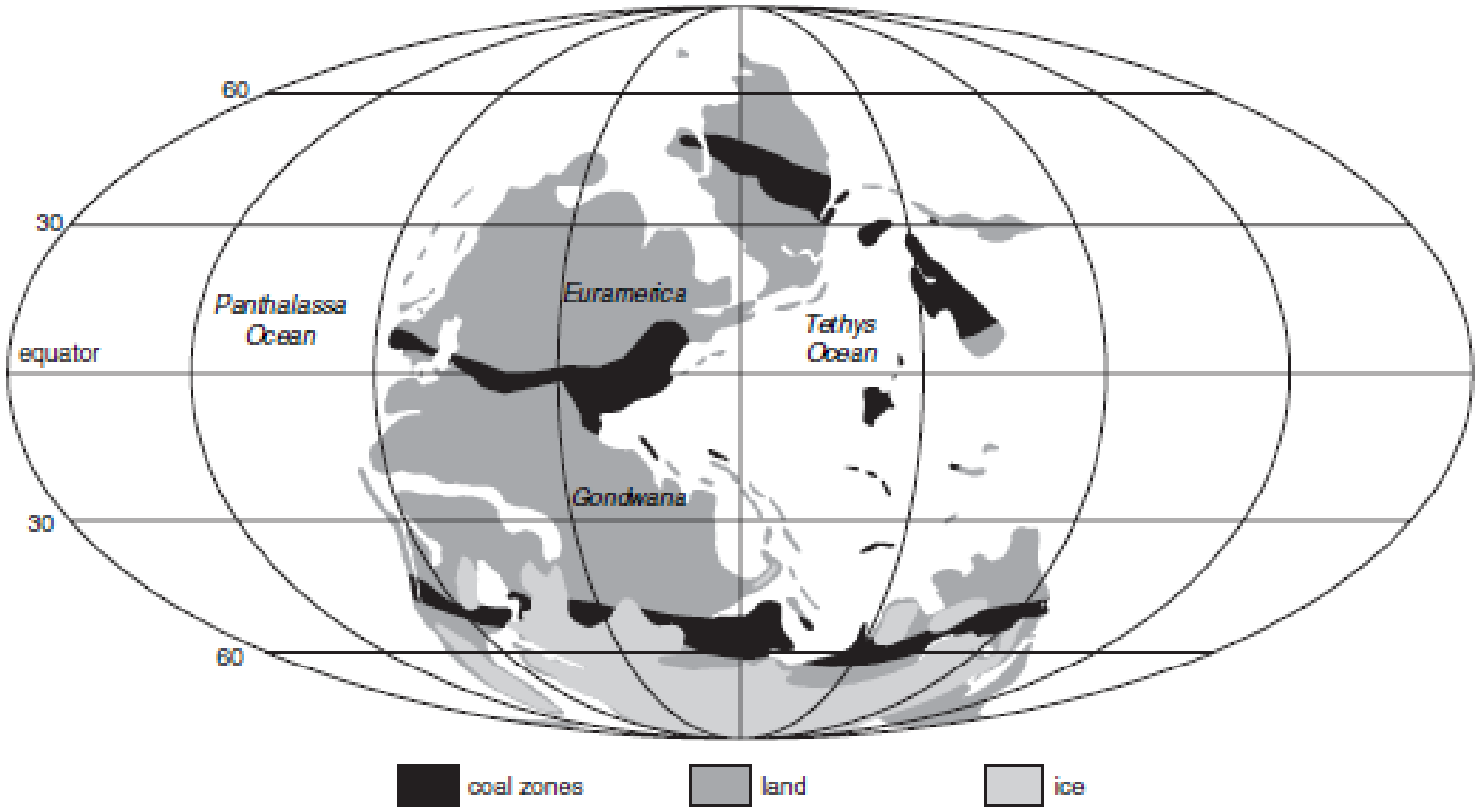


Fig. 6.19 Pangaea in the Early Permian (*c.*280 Ma), showing southern ice cap and zones of coal deposition (after Zeigler et al. 2001; Scotese 2003).

Killop and Killop (2005)

Mid-Cretaceous paleography (Cenomanian,c.95 Ma)

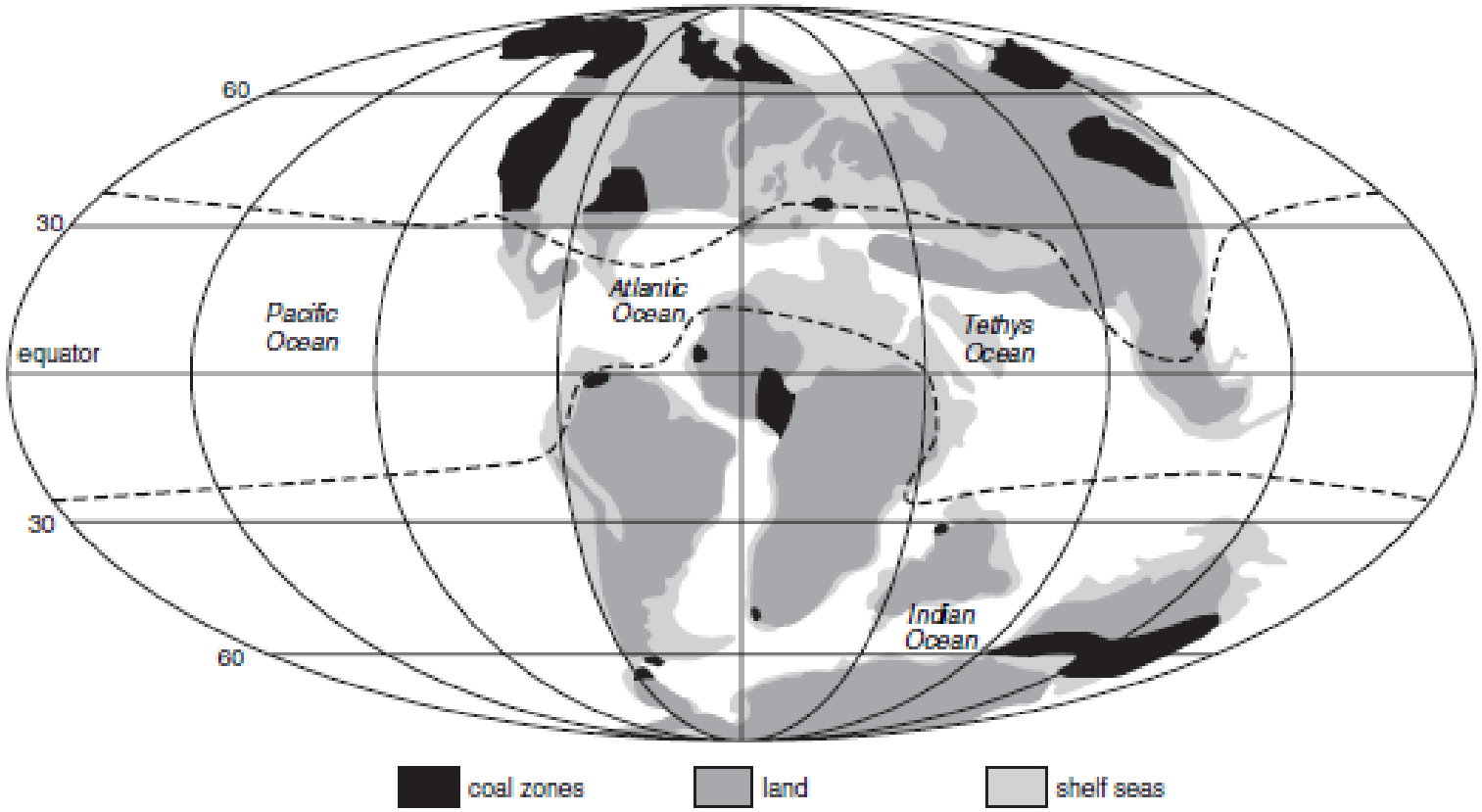


Fig. 6.21 Mid-Cretaceous palaeography (Cenomanian, *c.*95 Ma), showing zones of coal deposition and shallow seas on flooded continental shelves (after Parrish et al. 1982; Scotese 2003). Carbonate platforms developed between the broken lines in warm shallow waters (after Sohl 1987).

Killop and Killop (2005)

Processes and pathways involving Carbon

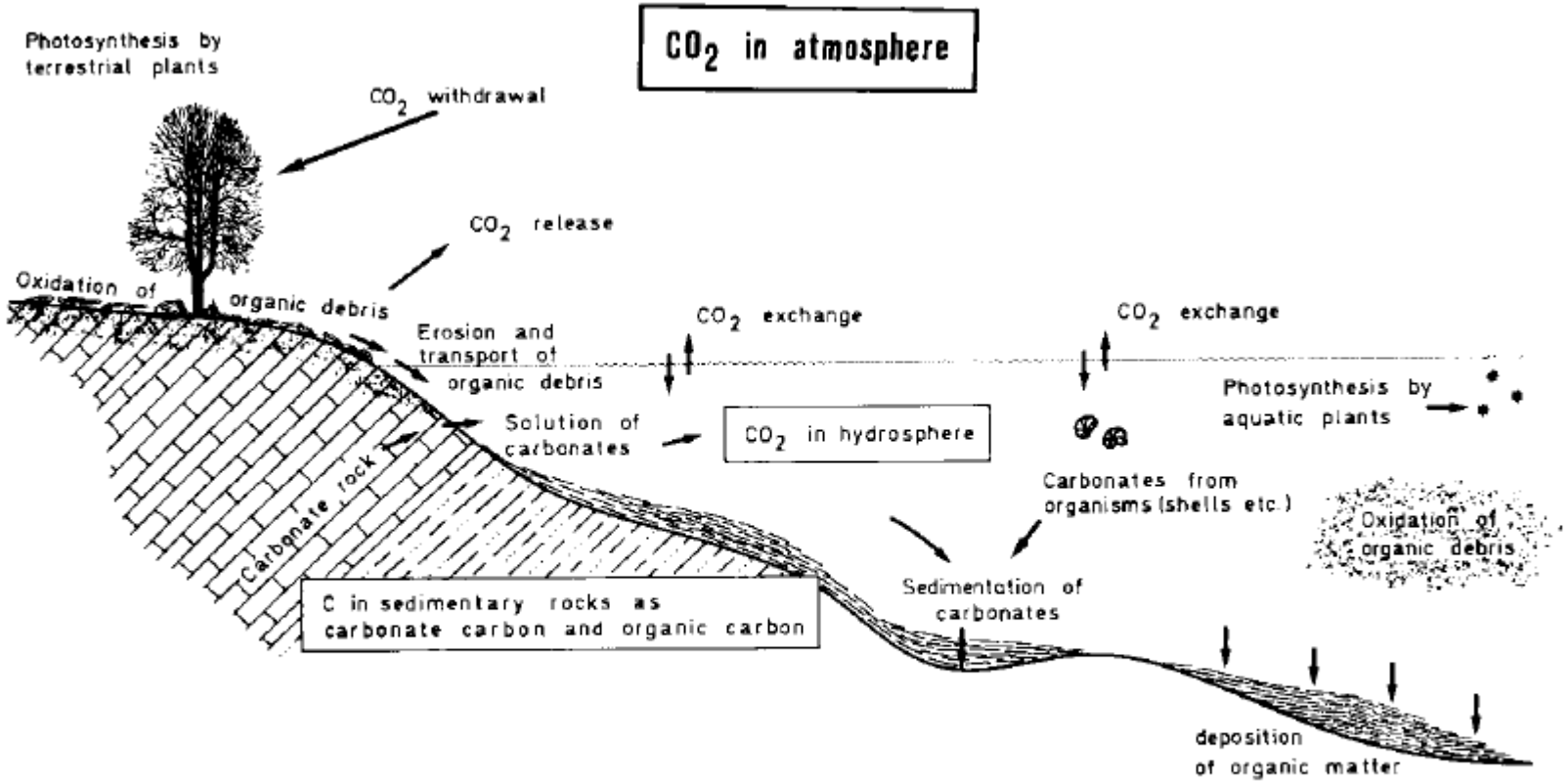


Fig. I.1.5. Main processes and pathways involving the element carbon. Most carbon on earth is concentrated in sediment, about 18% as organic, and about 82% as carbonate carbon. Most organic carbon produced by organisms is quickly oxidized to CO_2 and recycled to the atmospheric and hydrospheric CO_2 reservoirs

Tissot and Welte (1984)

Next class

- Organic matter
- References:
  - Killop and Killop (2005)
  - Hunt (1996)
  - Tissot and Welte (1984)

End