

**Modern versus ancient controls on sedimentary systems**

the present is not always the key to the past

and: many people (also geologists) only see what they know


Ocean circulation

Oceanic anoxic events and source rock formation

How to remove the present excess CO<sub>2</sub> ?

Deposition along platform margins

Why did the dinosaurs disappear?



Poppe de Boer  
Utrecht University

**Uniformitarianism**

*The present is the key to the past*



James Hutton 1726 – 1799

*the history of the Earth can be reconstructed by understanding how processes such as erosion and sedimentation work today*



Charles Lyell 1797 – 1885

James Hutton

*popularized James Hutton's concepts of uniformitarianism*

The present is the key to the past ?

K/T boundary; meteorite impact; flood basalts; *end of the dinosaurs and many other species; before and after the K/T boundary the world looked different*

The world also looked different, when there were no land plants (pre-Ordovician)

In the middle Cretaceous so-called Oceanic Anoxic Events (OAEs) occurred

Enormous amounts of organic matter were stored in deep-marine sediments

More than half of the global oil reserves date from that period

*Why is there not such widespread anoxicity today?*

Quartzites (silicified quartz sandstones) are abundantly present in early Palaeozoic and pre-Cambrian sedimentary deposits.

They are not or hardly found in younger sedimentary successions. *Why not?*

We look at the past (and the future) with the present-day world in our mind

Are our views of today representative for the past (and for the future)?

What do we concentrate on when we look at something?

National Gallery
Leonardo da Vinci 1452-1519
Louvre

*Virgin of the Rocks*



Which is the original and which is the copy?

National Gallery
Leonardo da Vinci 1452-1519

*Virgin of the Rocks*



Louvre

The art in Geology: see what you don't know

**Hummocky cross stratification**

**Wave action in deep water**

First seen and understood in 1975

Da Vinci – 500 years ago

Before 1975 hummocky stratification (or some other descriptive term) was not mentioned in the literature

many geologists only see what they know

Deep water: no wave action,

just ocean currents driven by . . . .

differences in temperature, salinity and thus in density

?

heavy, cold and saline waters go down

how do they get back to the surface?

waves and tides!

Dissipation of tidal energy (3.5 TW)

Deep ocean 1 TW Shelves 2.5 TW

recirculation of deep ocean water by dissipation of wind and tidal energy together ~ 2 TW

Present deep ocean mixing: 50% driven by tides ~ 1 TW (of 3.5 TW)

50% wind driven ~ 1 TW

*Is the present the key to the past?*

Recirculation of deep ocean water by wind and tidal energy

Dissipation of tidal energy (3.5 TW)

Deep ocean 1 TW Shelves 2.5 TW

recirculation of deep ocean water by dissipation of wind and tidal energy together ~ 2 TW

Present deep ocean mixing: 50% driven by tides ~ 1 TW (of 3.5 TW)

50% wind driven ~ 1 TW

Ice ages: shallow seas were dry

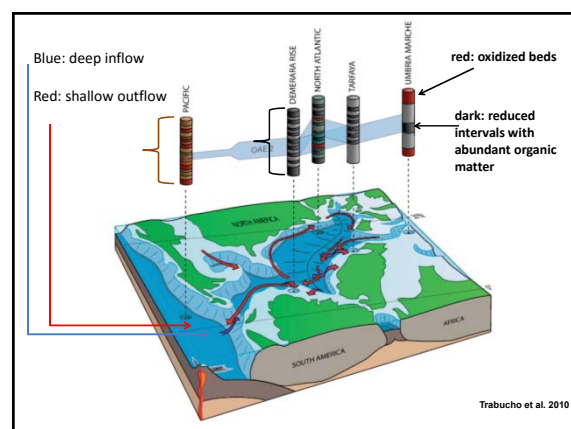
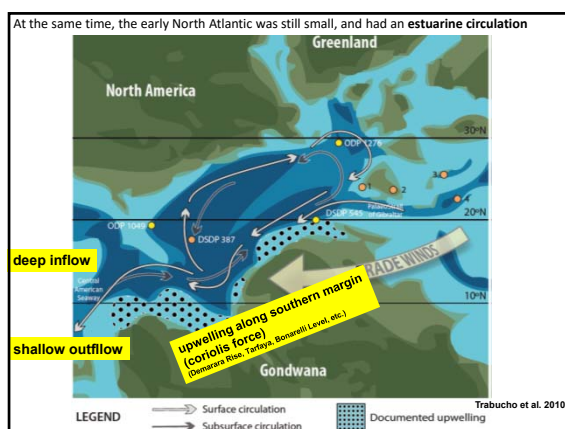
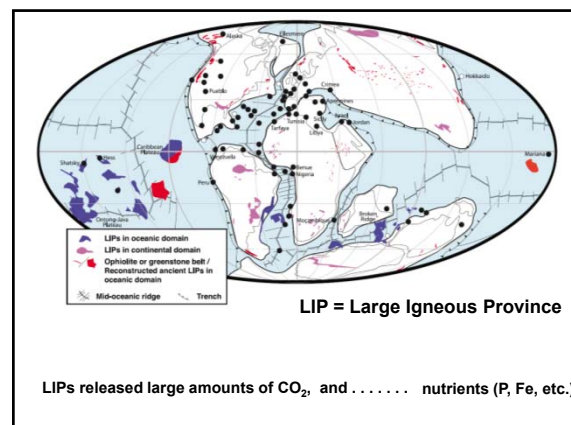
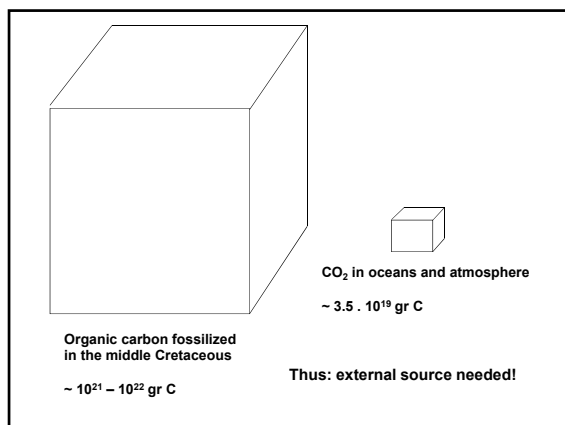
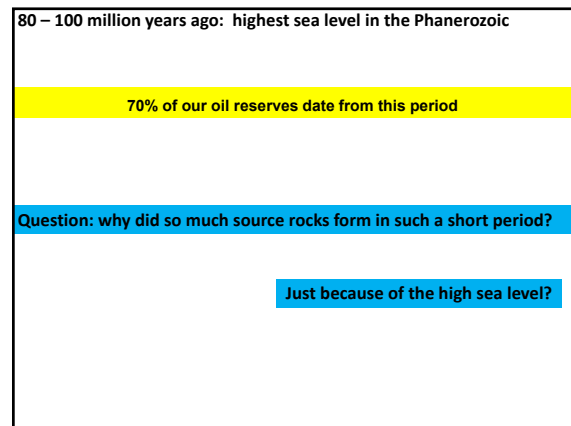
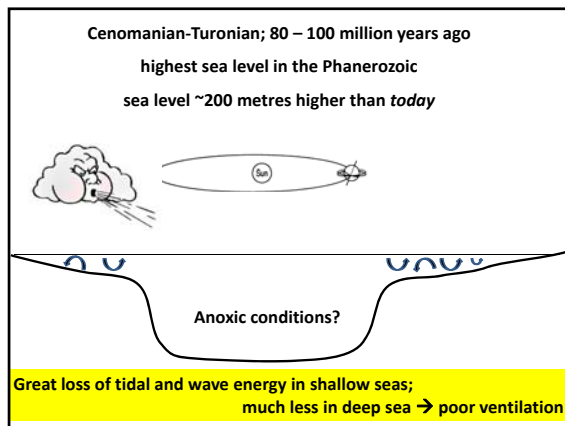
If sea level falls below the shelf edge: no tidal dissipation in shelf seas

and deep water dissipation of tidal energy triples (Egbert & Ray, 2000)

energy dissipation in deep ocean ~ 4 TW = doubling

ORBs (oceanic red beds)

OAEs (oceanic anoxic events)



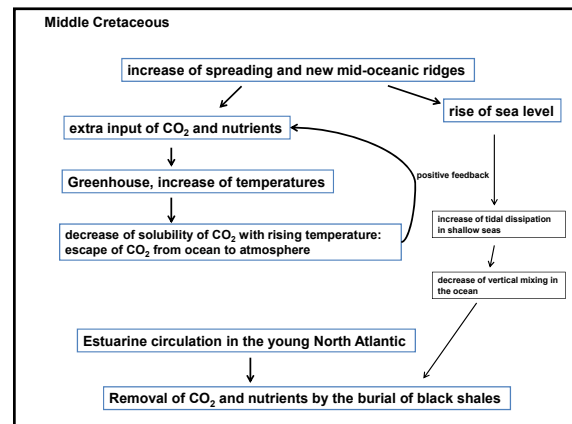
Large storage of organic matter in middle Cretaceous pelagic sediments; maximum at Cenomanian-Turonian boundary

High sea level because of increased ocean ridge spreading

High CO<sub>2</sub> level in atmosphere due to volcanism related to increased spreading → warm climate

Abundant nutrients released by LIPs (Large Igneous Provinces)

19




Thus: large-scale storage of organic matter in pelagic sediments during the middle Cretaceous led to the creation of a very large part of our oil sources rocks in some 20 million years only (not seen today)

Since ~150 years, mankind is burning these (and other) fossil fuels at increasing rates

This results in greenhouse effects, global warming and ocean acidification

How would Nature deal with this problem? (and how do we do?)



Hay (2016)

PARADOX: ARE UNDEVELOPED FUTURE TO CONSIDER REINVENTING?

Carbonate-platform margin deposits



**Porosity up to 60% and more**

**Carbonate components**

- Grains
- Matrix (*micrite*)
- Cement (*sparite*)

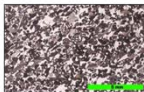


Fig. 10. Micrite matrix

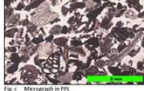

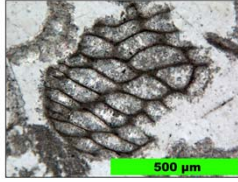


Fig. 11. Micrite matrix



500 μm



500 μm



