The Global Change - what we can learn from the last 250 Million years of the Earth's geological history?

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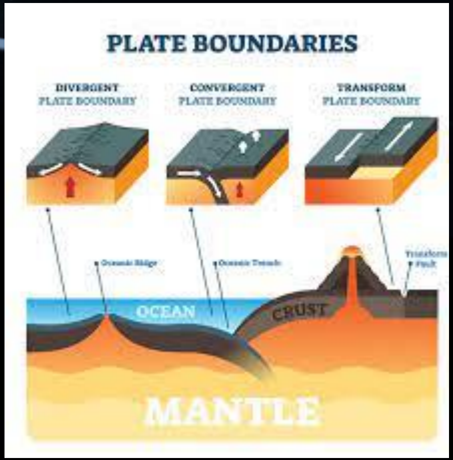
Global Change

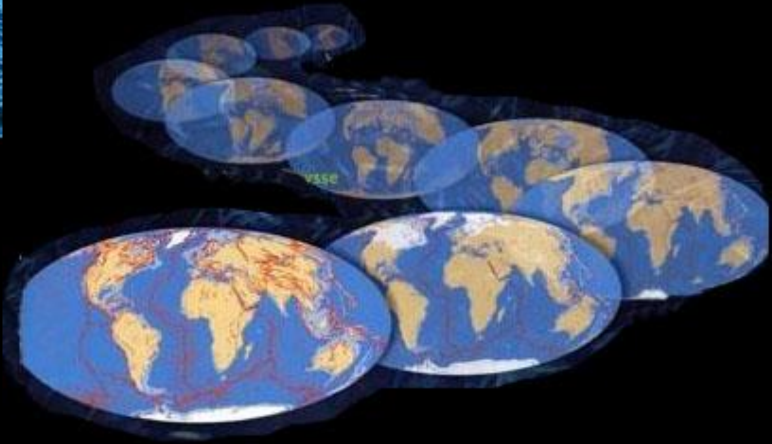
- Global Change - rapid changes of the Earth system in the history of the Earth
- Catastrophic impacts on the Geosphere, Hydrosphere, and Biosphere
- ?The Anthropocene (time we are living in)

Global Change

The Changing Face of the Earth



The face of the Earth is changing permanently due to always ongoing geological and biological processes, mainly triggered by Plate Tectonics

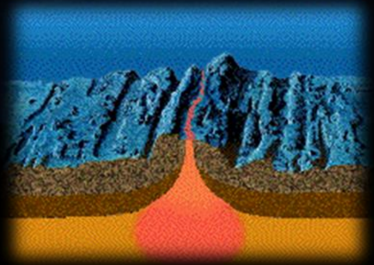


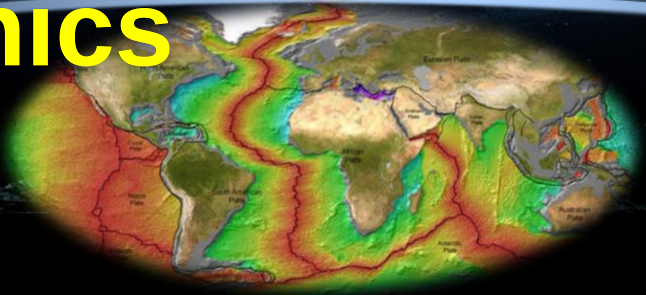
Global Change

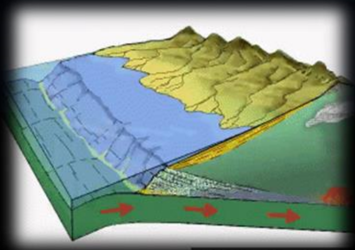
Gradual environmental changes

- Changes in the biosphere (evolution) are forced by environmental changes. Changes are gradual and not sudden events – Plate Tectonics.
- Environmental changes are the response of climate change, sea-level fluctuations, ocean circulation and geochemical changes, mainly triggered by Plate Tectonics – Gradual changes.

Plate Tectonics







Gradual environmental changes

- The main driving force are plate tectonic changes, i.e. the opening and closure of oceans and mountain building processes.

- Environmental changes forced by plate tectonics are gradual and need sometimes millions of years. The biosphere and geosphere have enough time for adaptation.

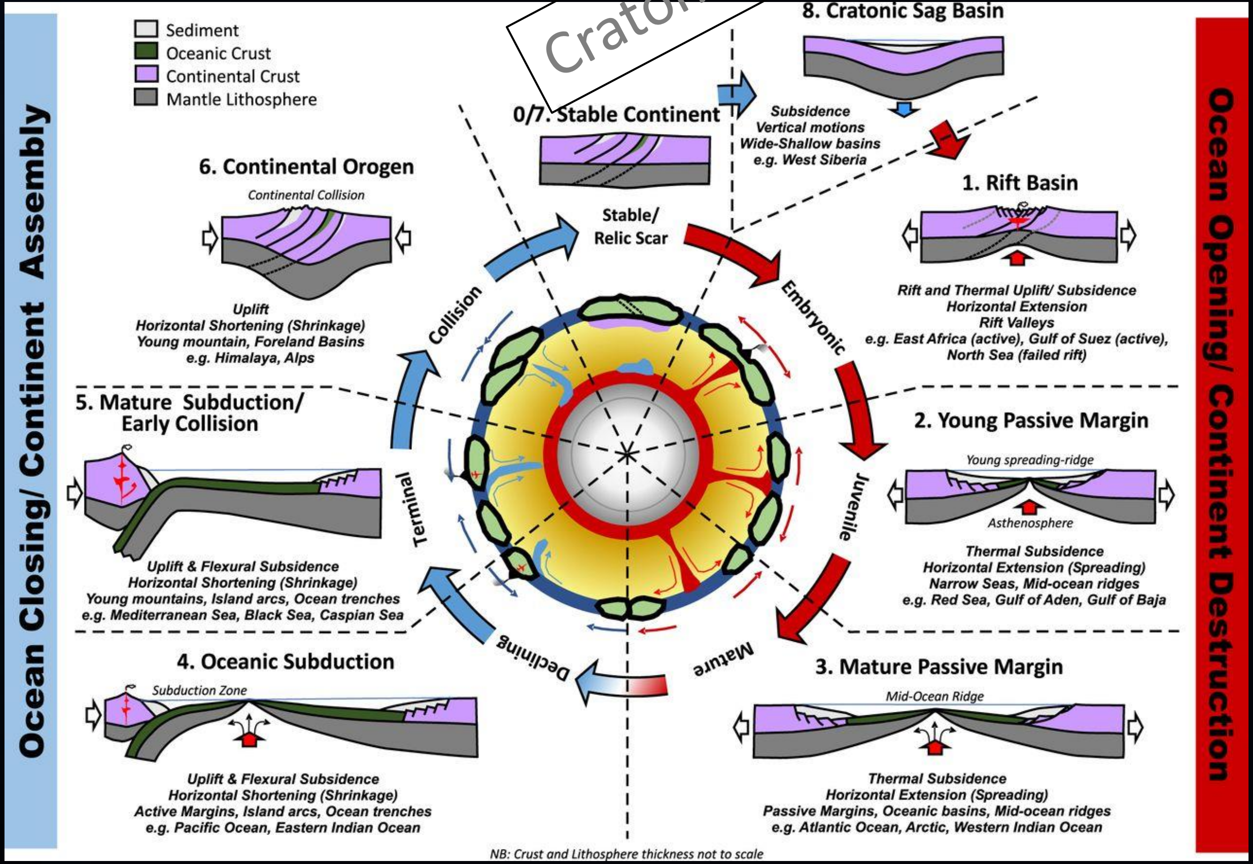
Plate Tectonics

The Wilson Cycle

After J. Tuzo Wilson, the Canadian geologist, the discoverer of the transform faults.

1. Graben stage.
2. Oceanic stage (ophiolites) with passive margins (2 stages).
3. Active margin stage with collision or ophiolite obduction.

Followed by mountain uplift and unroofing.



Global Change: mass extinction

Rapid environmental changes: events

Impacts: meteorites

Global Change: mass extinction

Megavolcanoes: Large Igneous Provinces (LIP)

Rapid environmental changes.

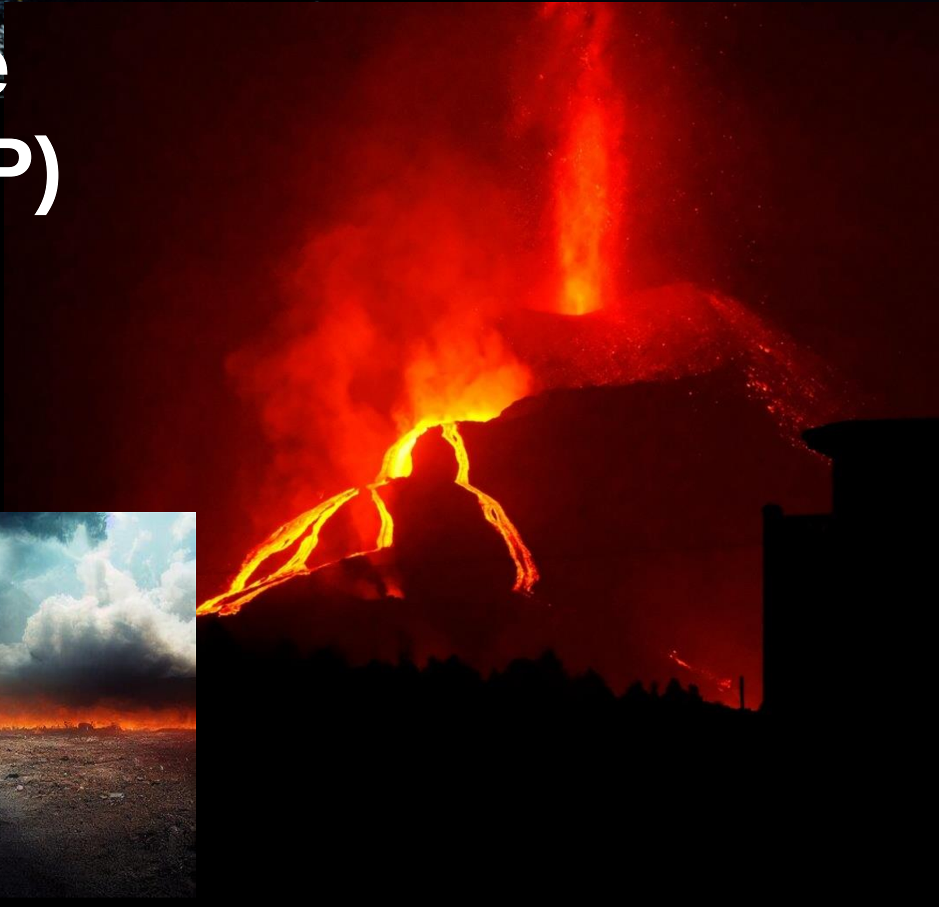
Ocean acidification!

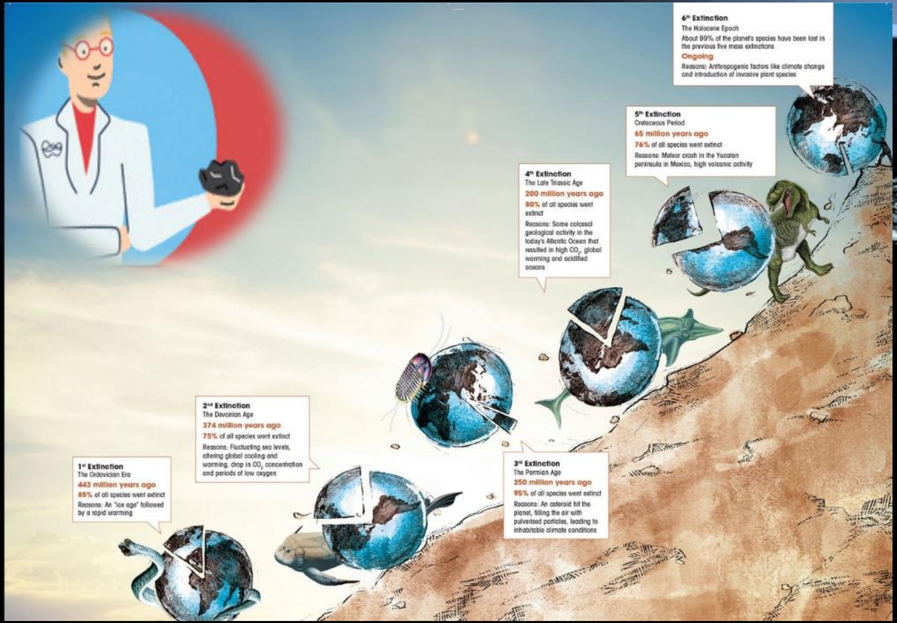
Anoxia events!

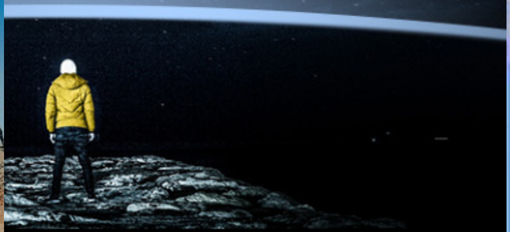
Climate change!

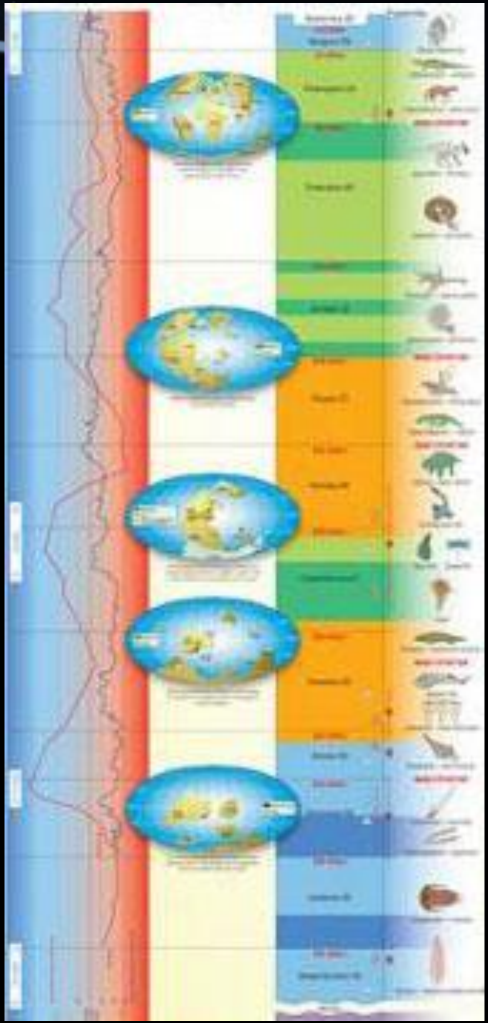
Pollution!

Black shale event!









In the geological history of the Earth such Global Changes with mass extinctions appear from time to time.

Geoscientists use the geological time scale to assign relative age names to events and rocks, separating major events in Earth’s history based on significant changes as recorded in rocks and fossils.

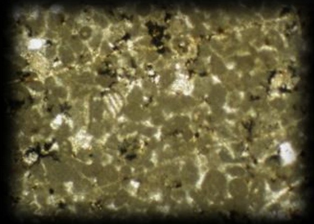
The books of Geoscientists

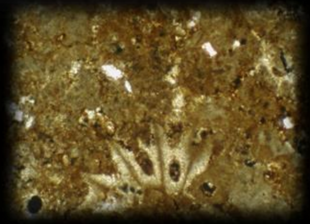
How we now?

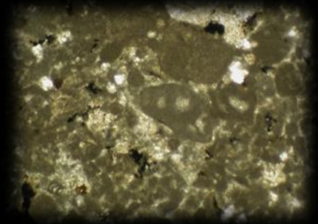
Every rock has a story to tell if you know how to read it.

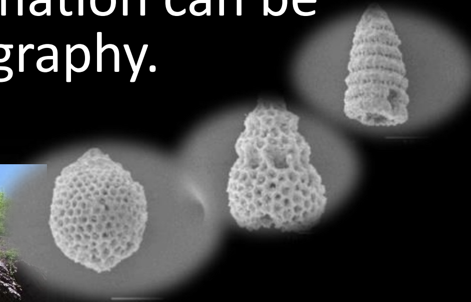
Within the unique composition and arrangement of materials that compose different rocks, you can find patterns that are evidence of the processes that formed them,

and the age of deposition or formation can be determined: e.g. biostratigraphy.



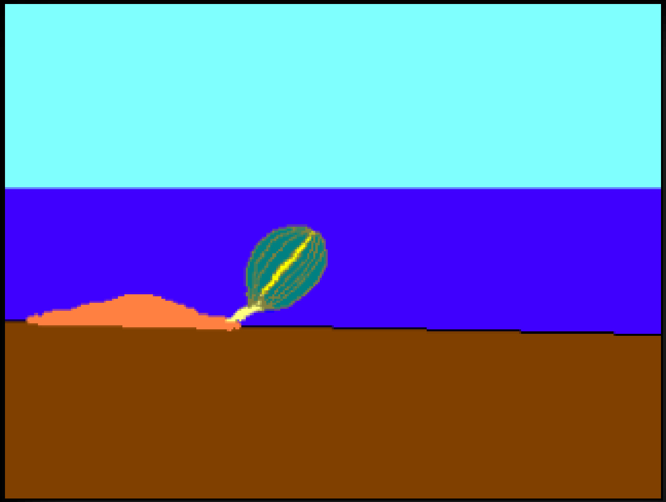






Organisms: to find them and to extract them

Games of chance



- Fossilization is more likely to occur in marine environments.
- The hard skeletons and shells of animals are more likely to become fossilized than the soft tissues of organisms.
- Even if fossils are able to form, they may not be preserved intact.
- In order for a fossil to form, the remains must not be destroyed by natural forces.

Organisms tell us the age

Games of chance

Cretaceous ammonites, Zaječar area

- In sedimentary rocks, the preserved remains of organisms that lived in former oceans and seas - fossils.
- Fossilization is a rare event.
- The chances of a given individual plant or animal becoming a fossil are very small.

Cretaceous rudist, Novi Pazar area

Our area, our time, our history

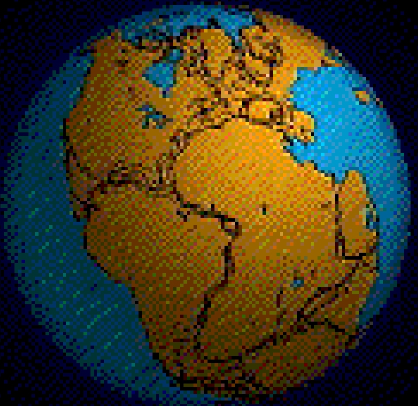
The Mediterranean orogens

- History of the last 250 Million years (Mesozoic and Cenozoic).
- The Dinarides as important and crucial part with a complicated plate tectonic history and preserved Global Changes.

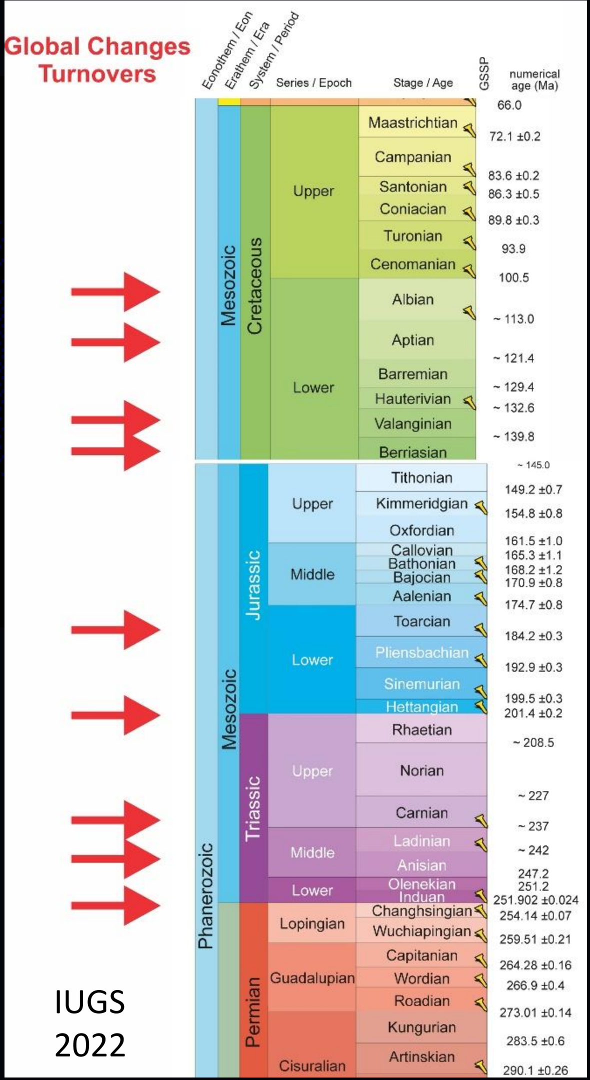
Our area, our time, our history

The Mesozoic

- Several turnovers
- Mass Extinctions
- Global events and overregional events recorded in the sedimentary rocks



Reasons?



Our area, our time, our history

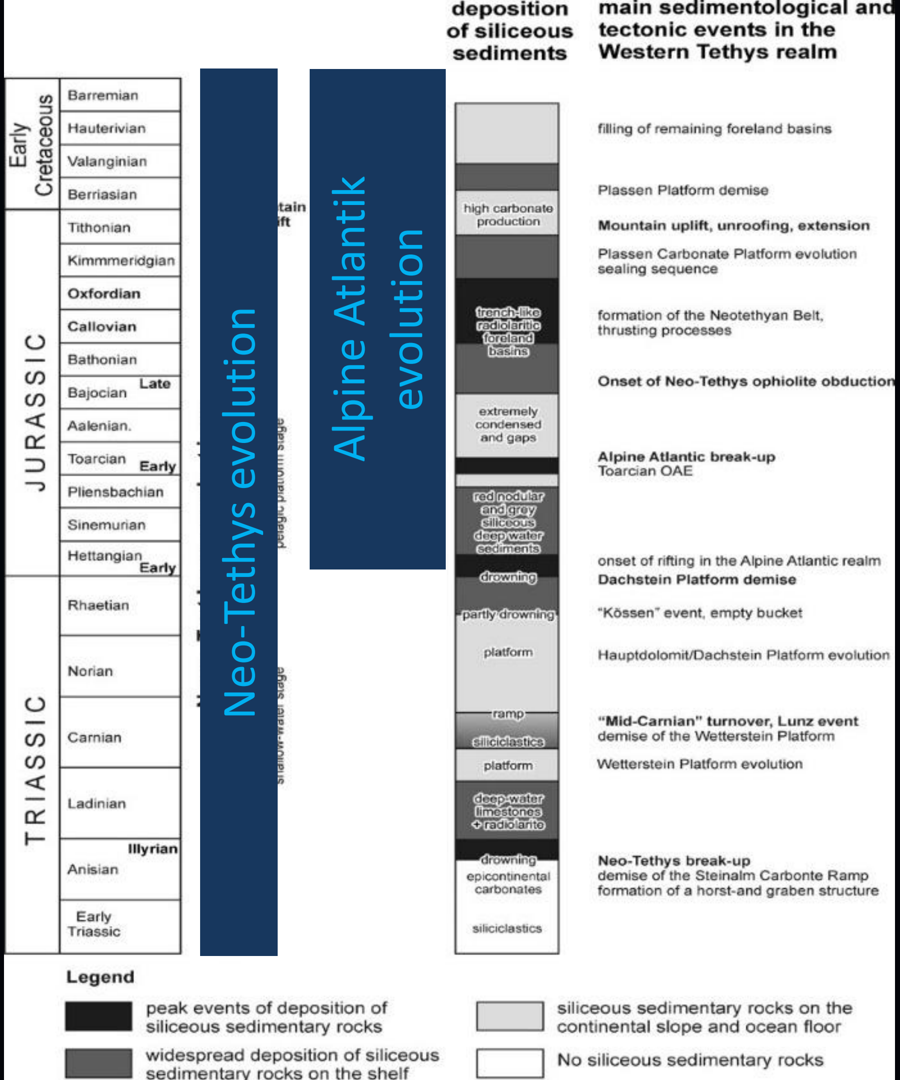
Serbia under water

tropical to subtropical clima

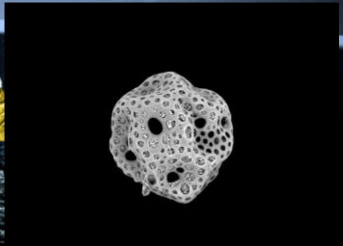
During almost the entire Meso-zoic we can track the evolution of 2 oceans.

Carbonates – formed by organisms: sensitive to environ-mental changes

Radiolarites – crucial and indicative for environmental changes



Our story



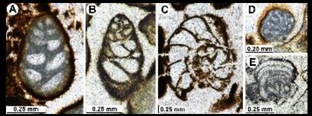
Crucial

Carbonate producers

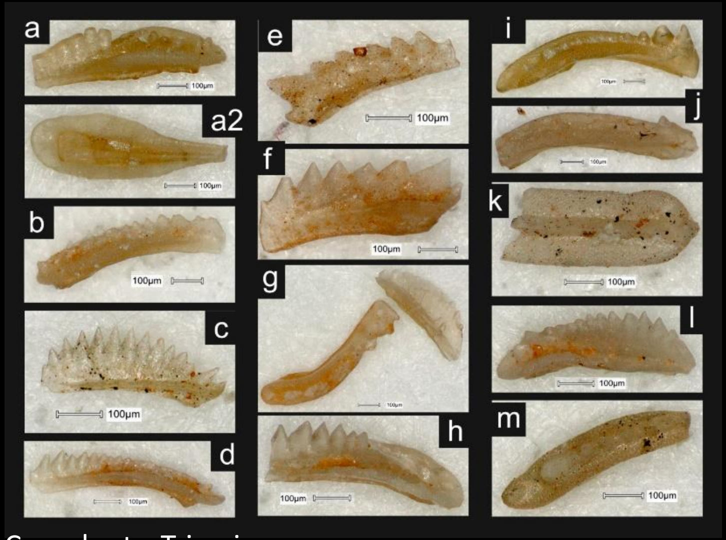
Biogenic quartz producers

Sedimentary rocks & fossils

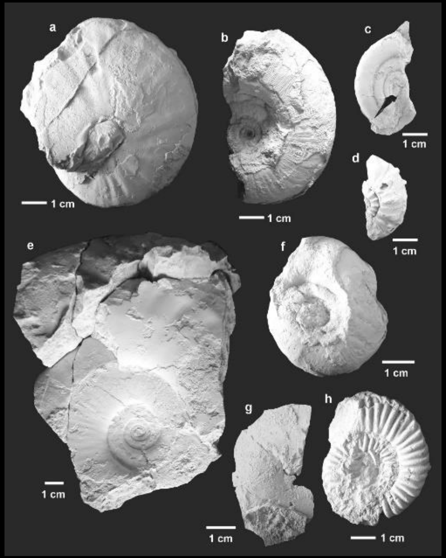
Algae, Triassic



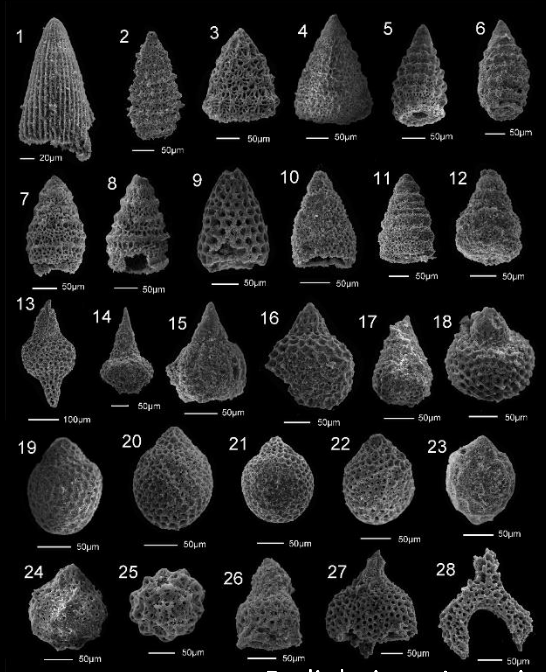
Forams, Triassic



Conodonts, Triassic

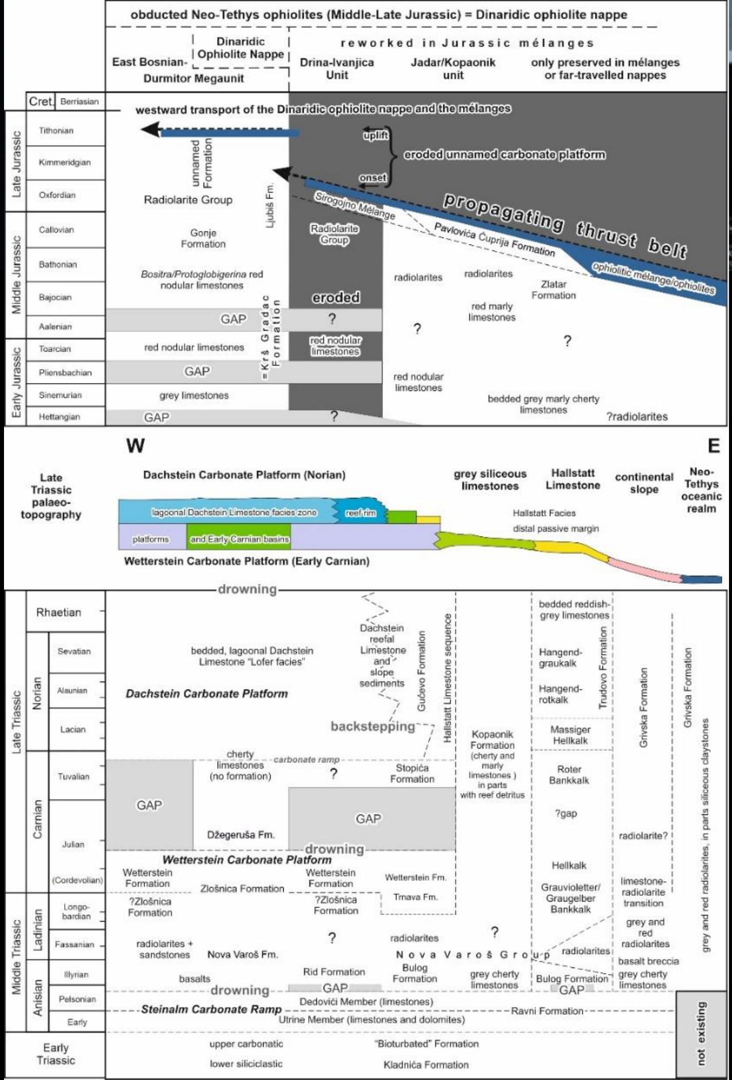


Ammonites, Triassic

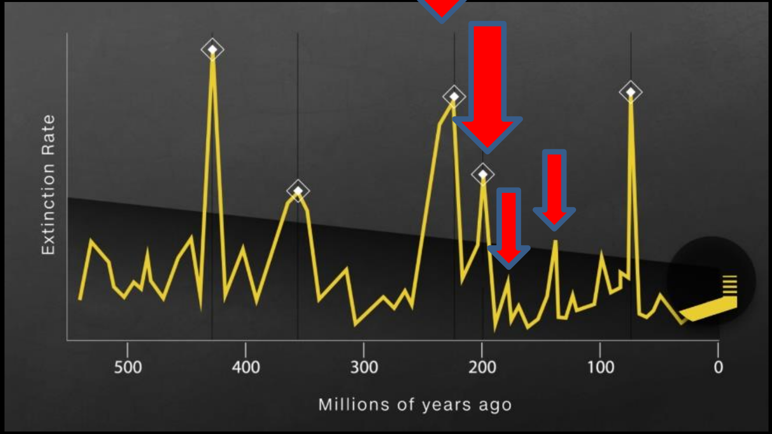


Radiolarians, Jurassic

Sensitive carbonate organisms



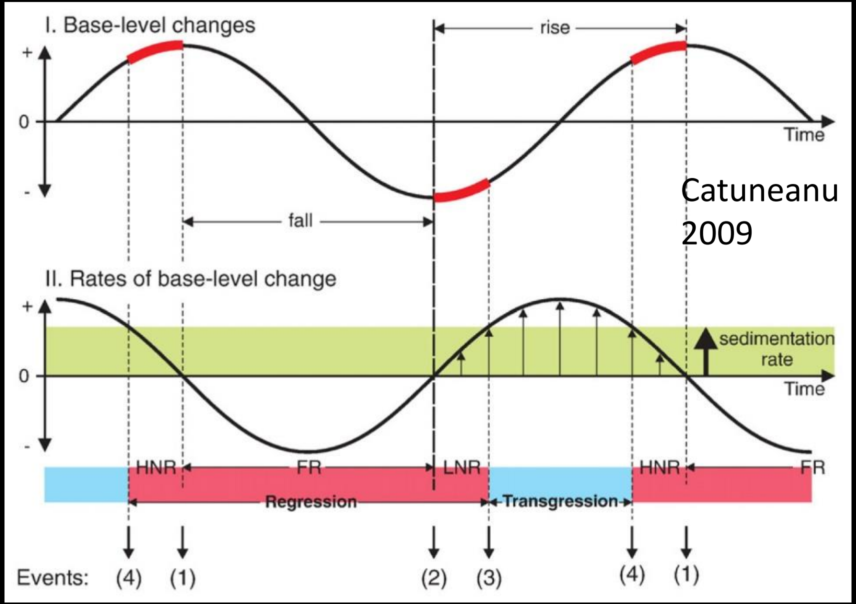
- Shallow-water cycles
- Middle Triassic: Anisian
- Late Triassic: Early Carnian and Norian-Rhaetian
- Early Jurassic
- Late Jurassic

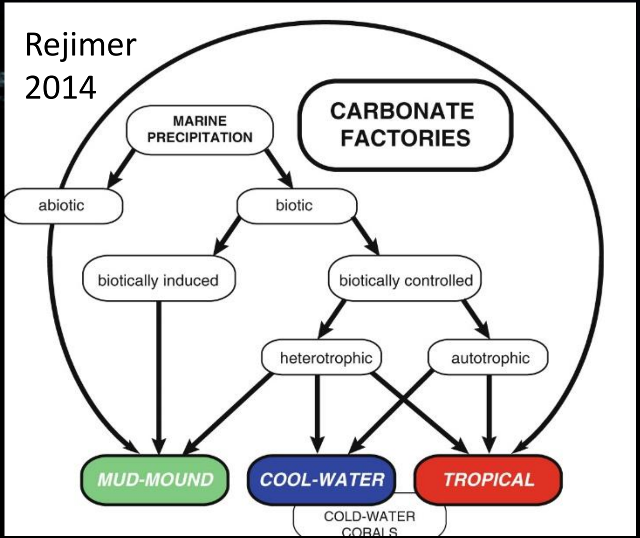


Sea-level changes and carbonates

Sea-level rise: several reasons

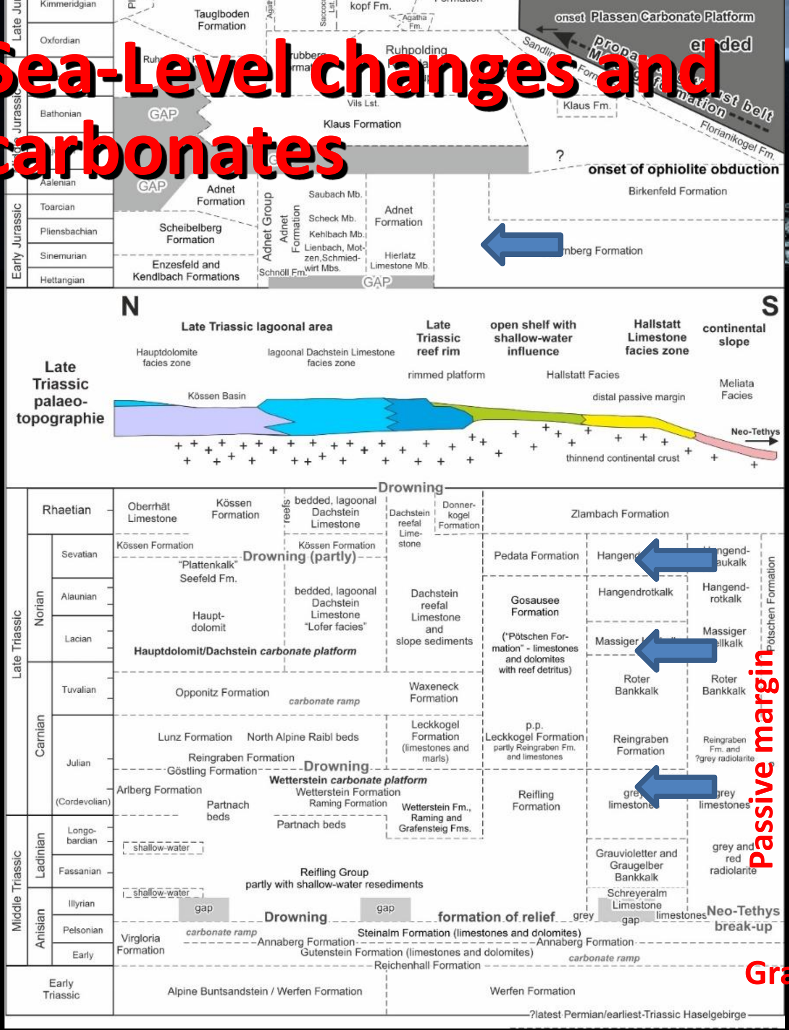
General: warmer climate (greenhouse) – higher sea-level – higher carbonate production – highstand shedding





Sea-level curve for siliciclastic sediments: carbonates as part of the biosphere react opposite.

Sea-Level changes and carbonates



Passive margin

Low Sea-level High

Mass Extinction

Passive margin configuration

Mass Extinction

Highstand Shedding

Highstand Shedding

Mass Extinction

Highstand Shedding

Carbonate recovery phase

Break-up

Graben stage

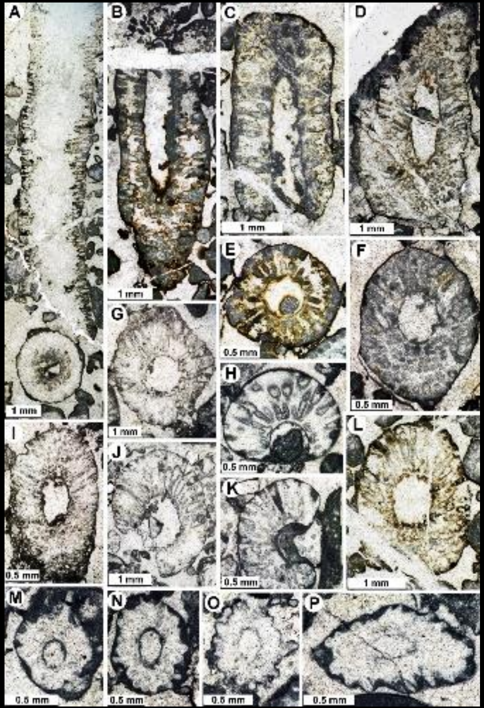
Mass Extinction

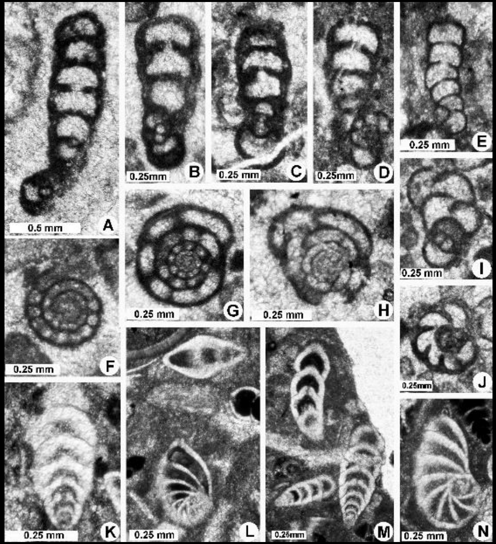
The Anisian extinction

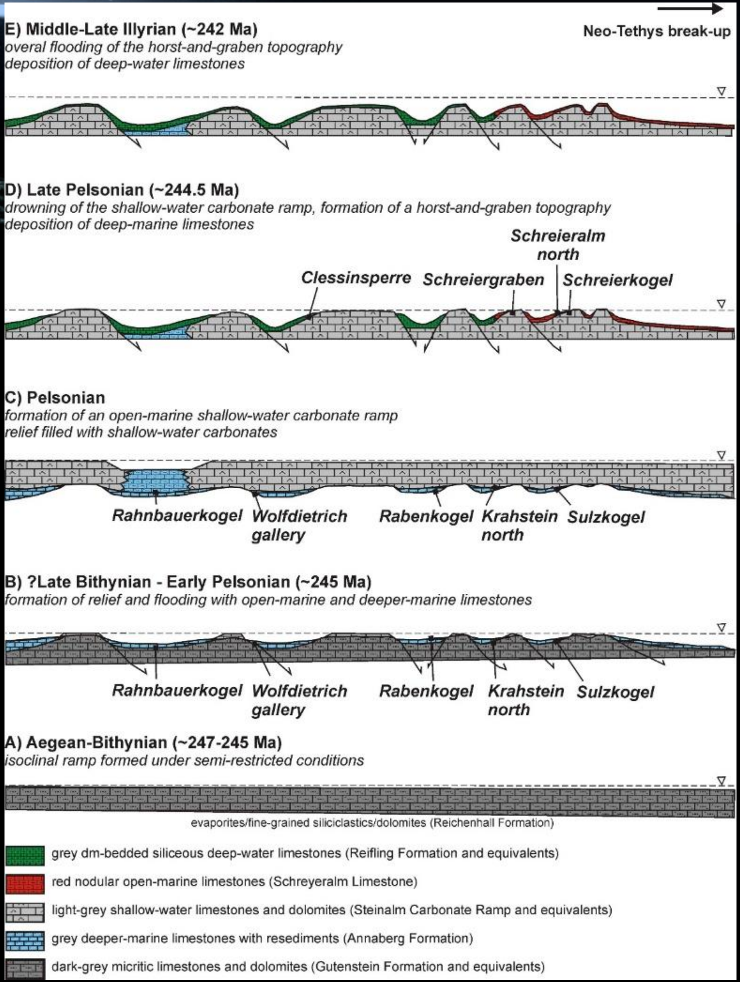
Opening of an ocean: the Neo-Tethys is born

Collapse of the carbonate system

Algae and foraminifera

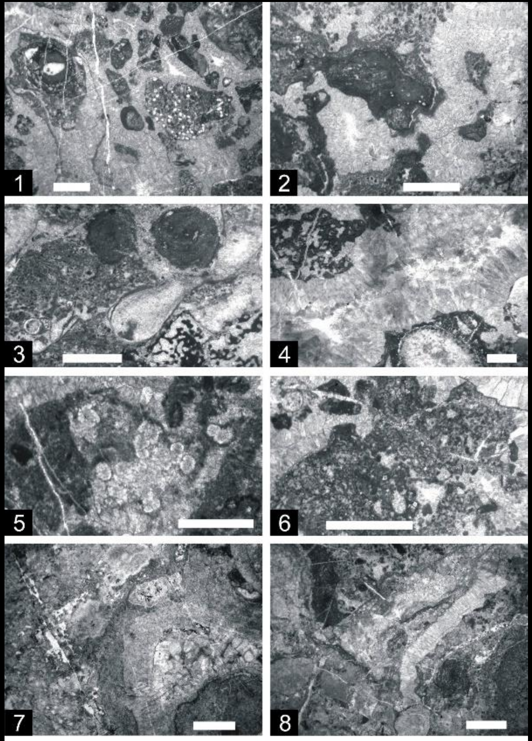






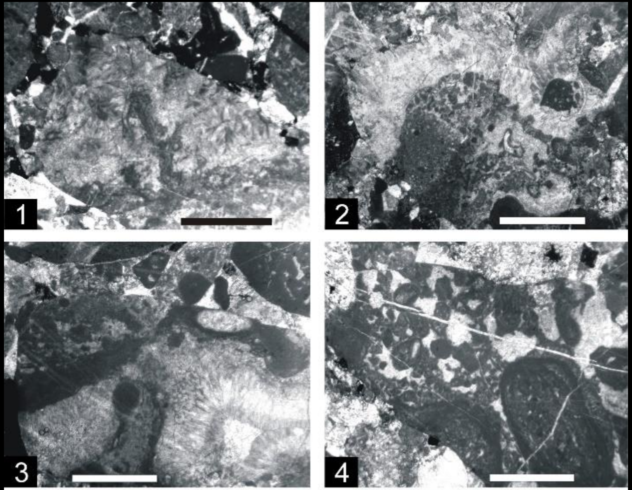
The Early Carnian extinction

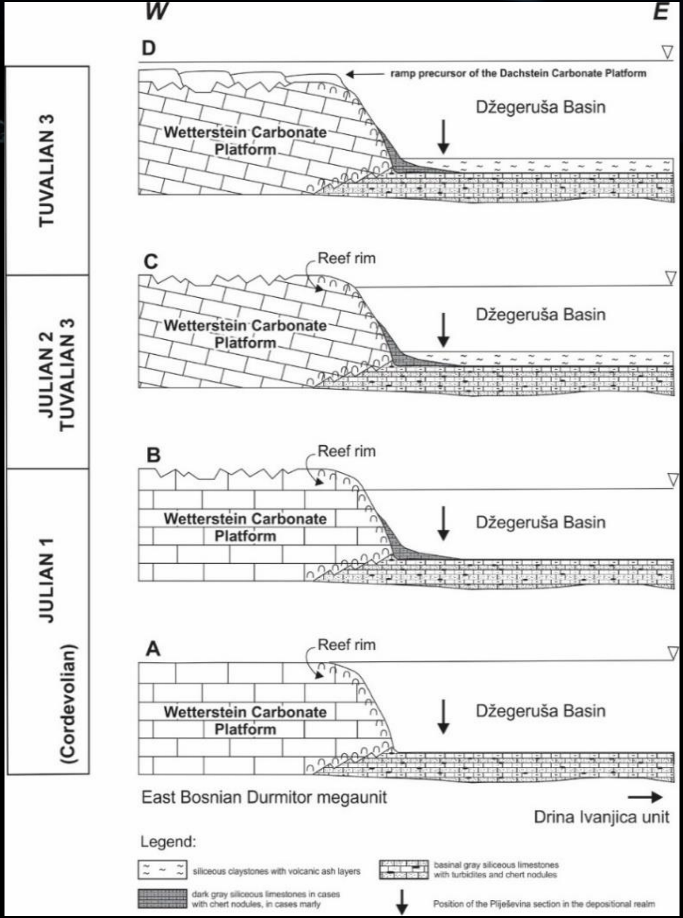
Large Igneous Province (LIP)
Our modern world evolved after this turnover



Collapse of the carbonate system

Cement-crust reefs



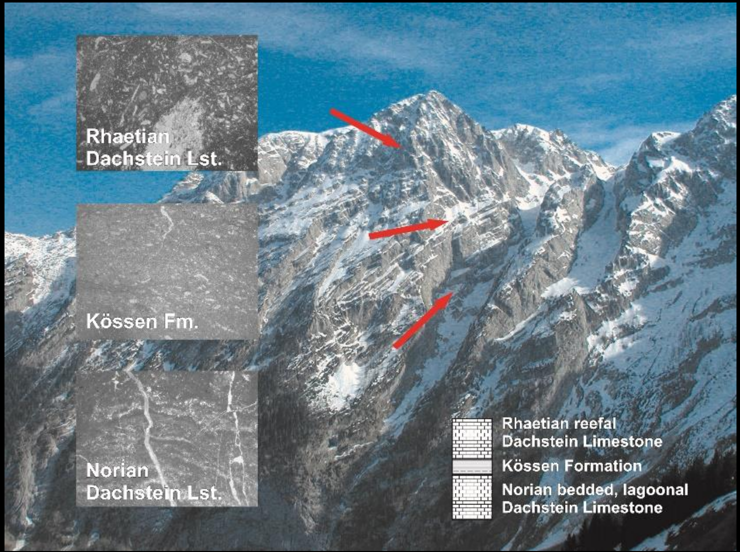


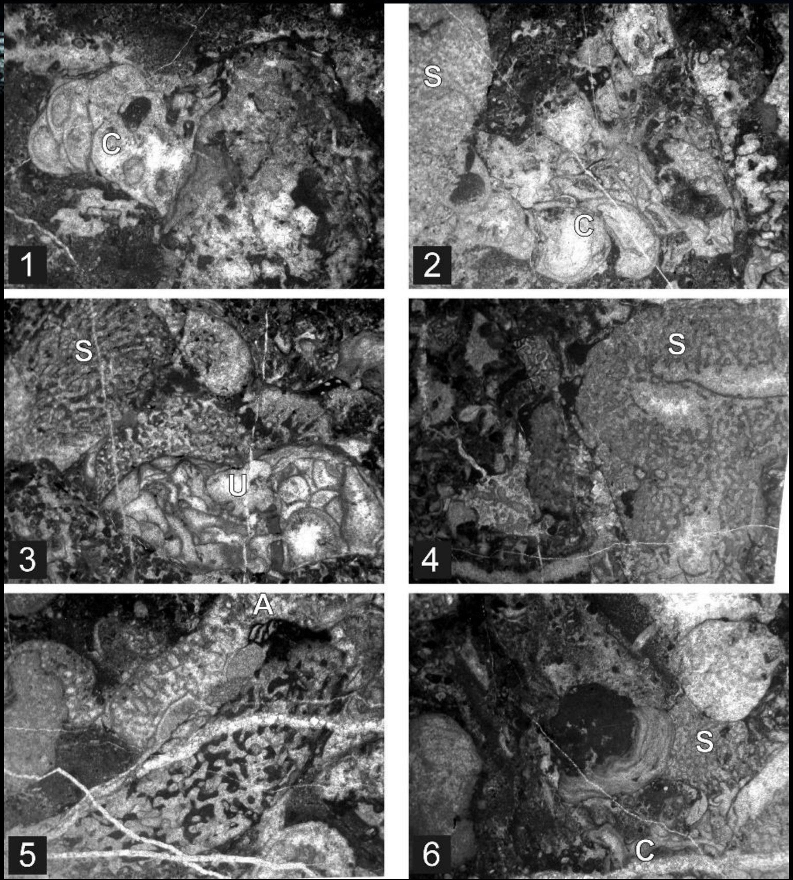
The Triassic/Jurassic boundary extinction

Large Igneous Province
The dead of the largest carbonate platform in Earth history

Collapse of the carbonate system

Coral-Sponge reefs



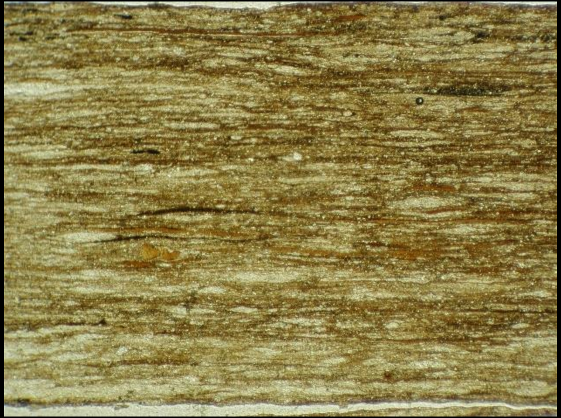


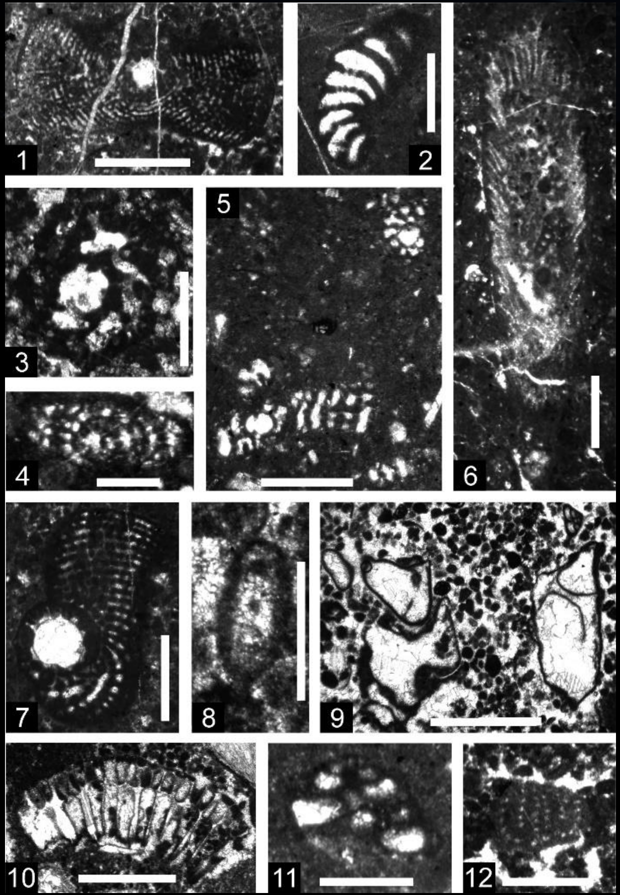
The Early Jurassic (Toarcian) extinction

Large Igneous Province
and opening of the Alpine Atlantic

Collapse of the carbonate system

Lithiotis platform

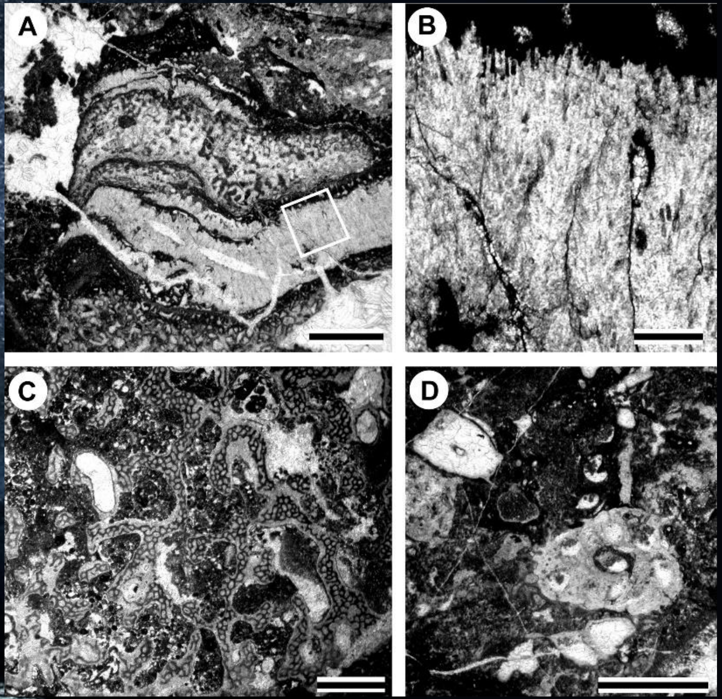


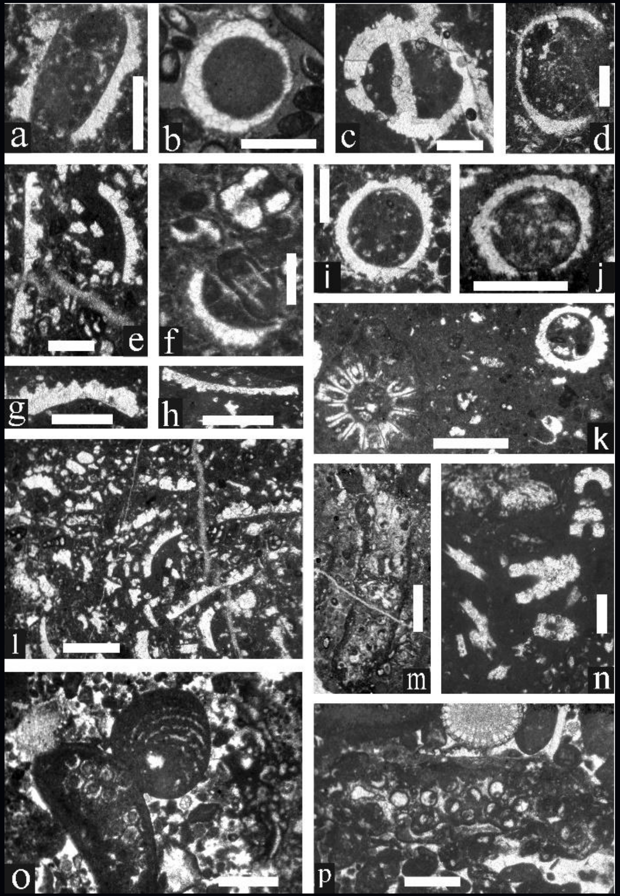


The Early Cretaceous extinction

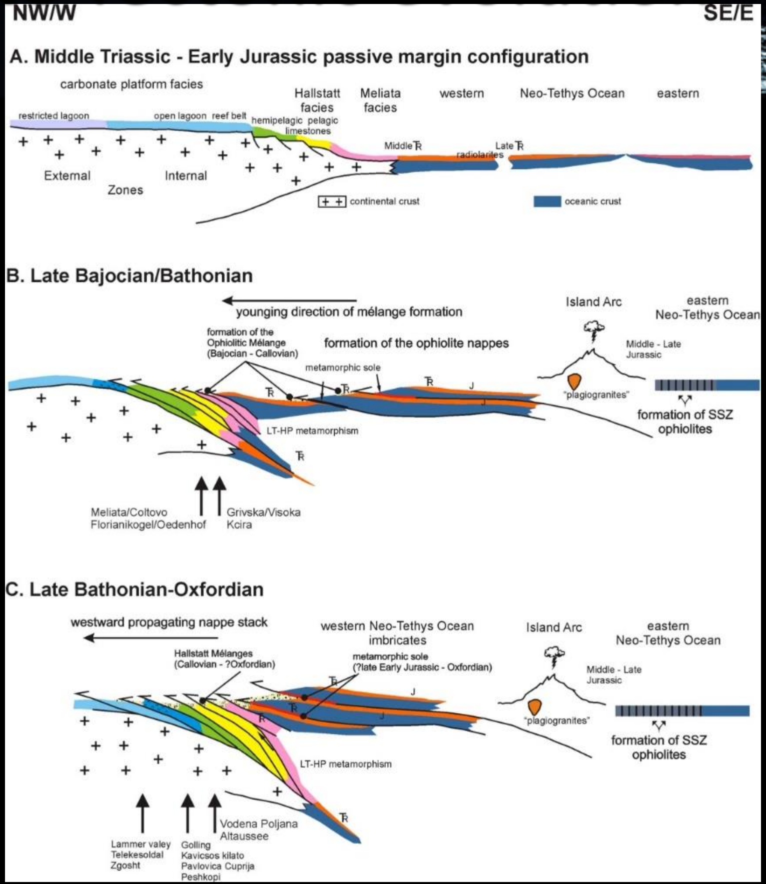
?Large Igneous Province

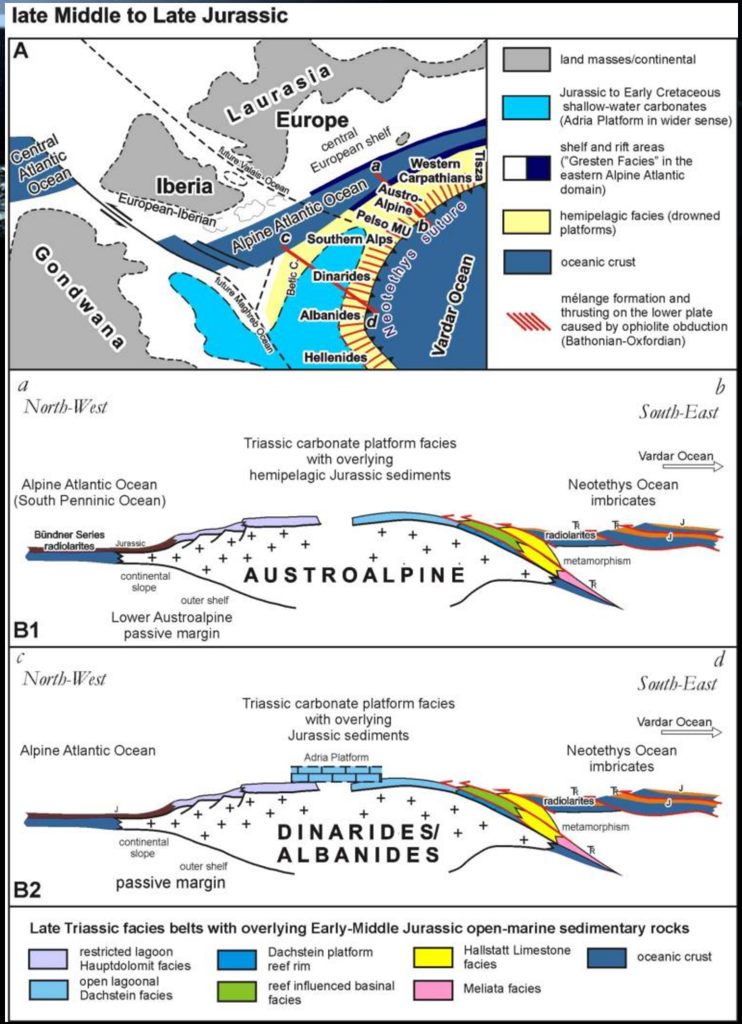
Collapse of the carbonate system





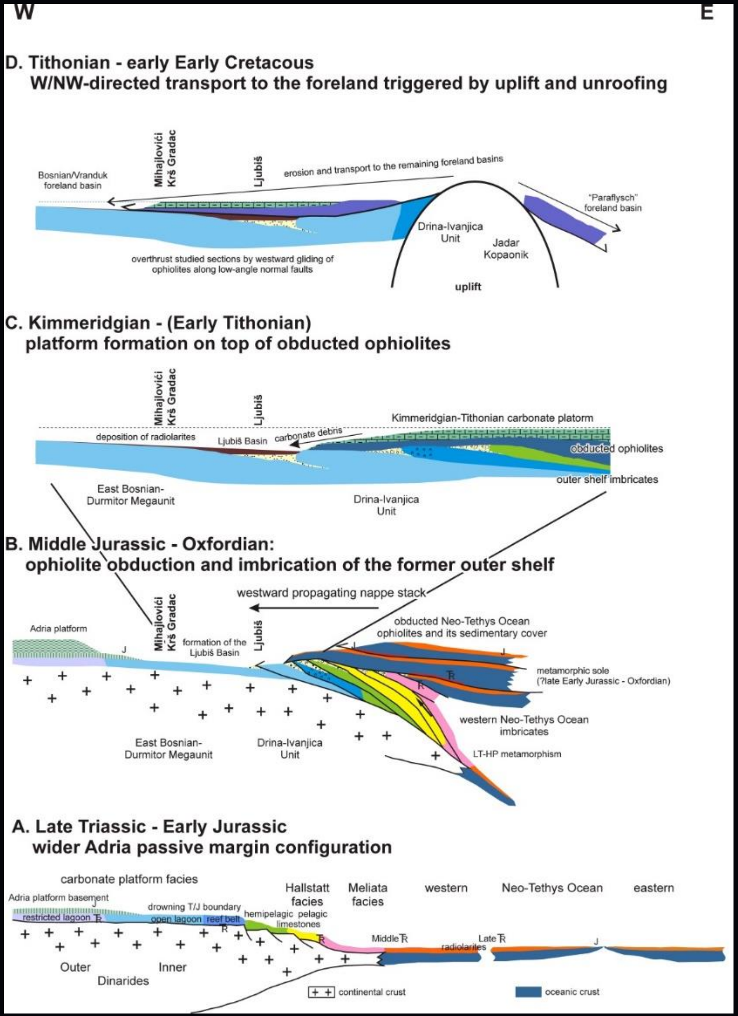
Triassic to Early Cretaceous Plate Tectonic evolution





Late Jurassic – Early Cretaceous Plate Tectonic evolution

- Ophiolite obduction
- Carbonate platform evolution
- Mountain uplift and unroofing/erosion



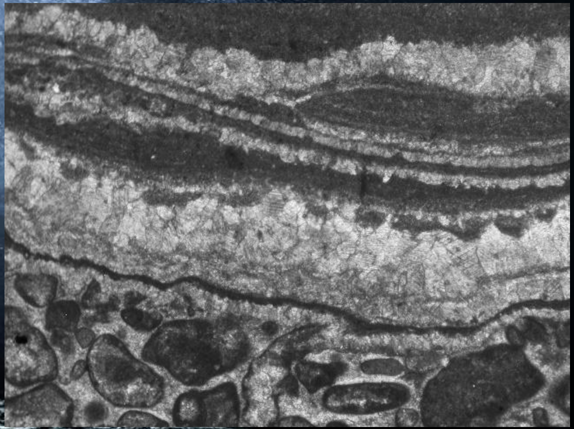
Global Change: Extinction events

Collapse of the Biosphere: 2-5 Million years recovery

Ocean acidification or Anoxia

Large Igneous Provinces, Meteorites, Plate Tectonic reasons and/or a combination

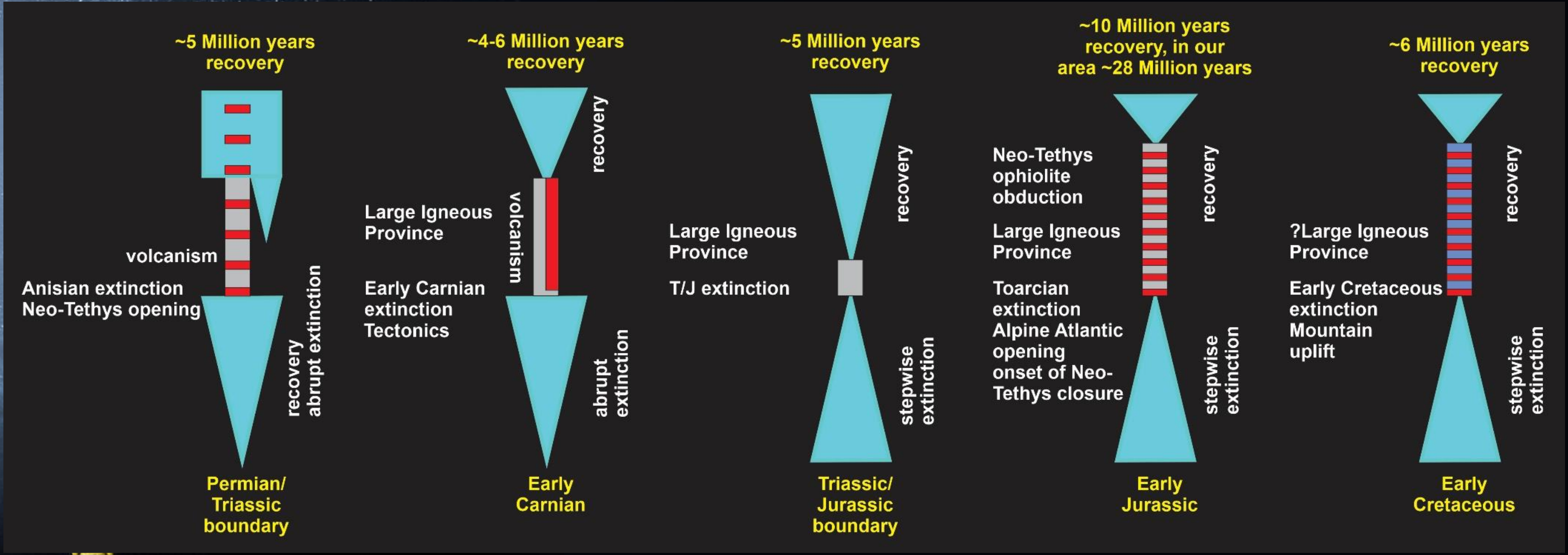
Crucial: change from carbonate to condensed and siliceous sedimentary rocks



Global Change: Extinction events

Mesozoic examples: some differences

In cases not fully explained yet



The Anthropocene

Time for a Global Change?