

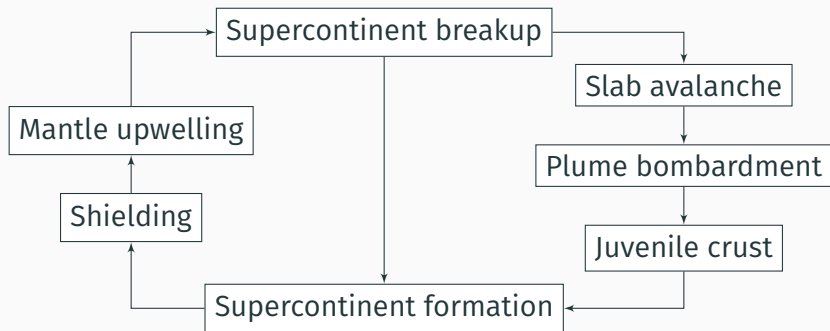
Supercontinents and Superplumes

in the Precambrian

November 14, 2019

Indian Institute of Science Education and Research, Kolkata

Supercontinents



A **supercontinent** is the assembly of most or all of Earth's cratons to form a single large landmass.

Superplumes

A **mantle plume** is an upwelling of abnormally hot rock within the Earth's mantle.

A **superplume** event is a short lived mantle plume event during which several plumes rose to the base of lithosphere.

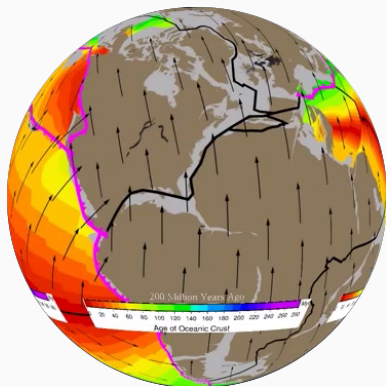
Superplumes

A **mantle plume** is an upwelling of abnormally hot rock within the Earth's mantle.

A **superplume** event is a short lived mantle plume event during which several plumes rose to the base of lithosphere.

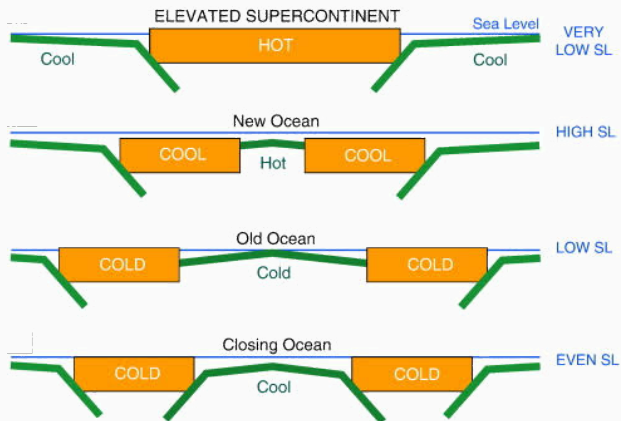
Short lived = less than 100 million years

Plate spreading



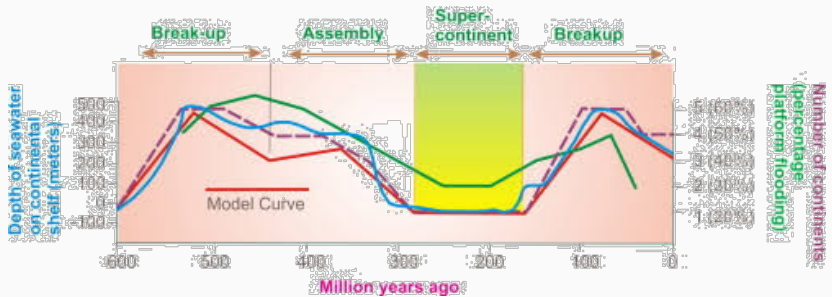
Superplumes increase plate tectonic activity, hence the *plate spreading* rate increases tremendously.

Sealevels



supercontinent \Rightarrow lots of old seafloor \Rightarrow low sea level

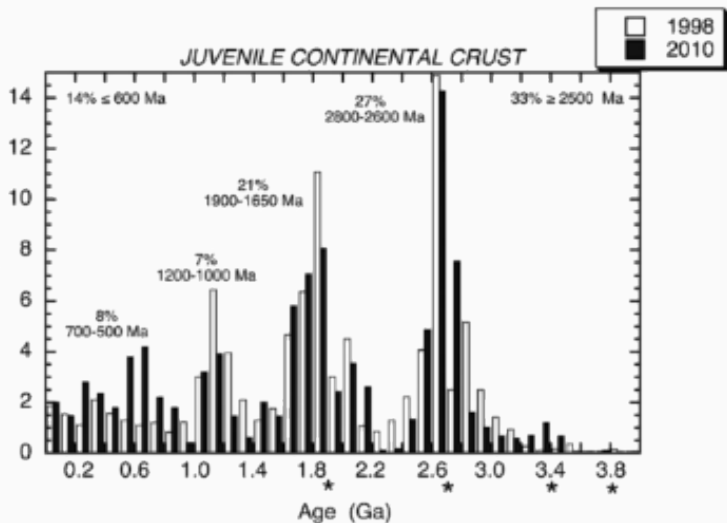
Supercontinent cycle vs sealevel



Evidence for superplume events

- Increase in *surface temperature*.
- Deposition of black shale sediments with *elevated* $\delta^{13}\text{C}$ in sea water.
- Increased production of *juvenile crust*.
- Rise in *sea level*.

Juvenile crust



Carbon reservoirs

Pool	Quantity (gigatons)
Atmosphere	720
Biosphere	2,000
Oceans	3,840
Fossil fuels	4,130
Lithosphere	75,000,000

Supercontinent breakup

- Tectonic plates get *subducted* with lots of carbon deposits.
- *Volcanism* at mid-oceanic ridges releases CO_2 .
- Continental rift systems also release CO_2 .

Supercontinent cycle vs carbon cycle

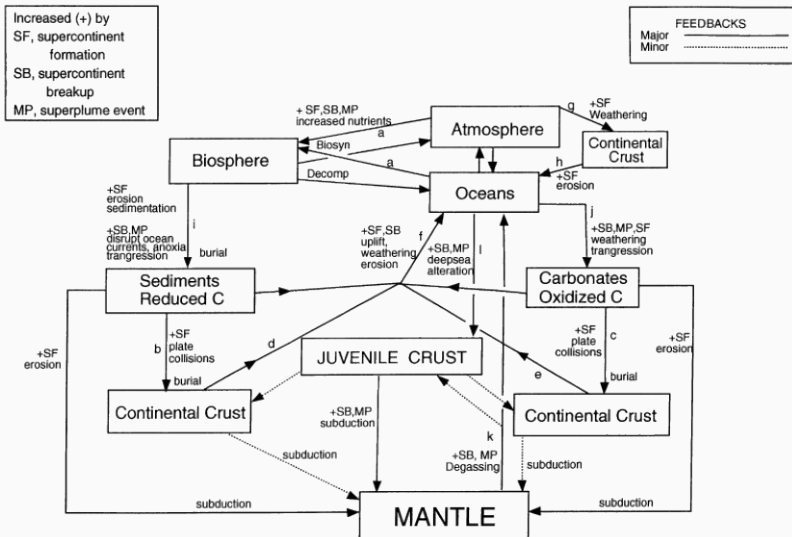
Supercontinent breakup

- Tectonic plates get *subducted* with lots of carbon deposits.
- *Volcanism* at mid-oceanic ridges releases CO_2 .
- Continental rift systems also release CO_2 .

Supercontinent formation

- *Collision of plates* destroys rocks containing carbonates.
- *Surface area* of the supercontinent increases, hence weathering of rocks lowers CO_2 levels.

Supercontinent cycle vs carbon cycle



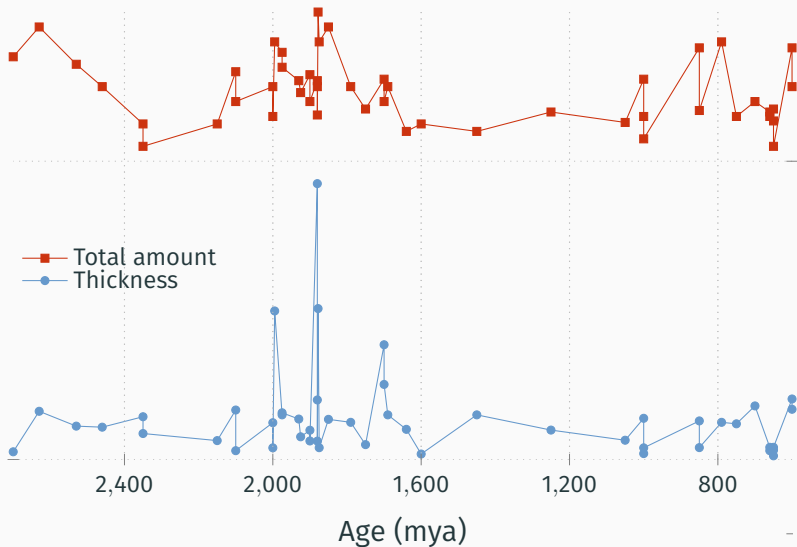
Black shale

Black shale is a fine grained, sedimentary rock.

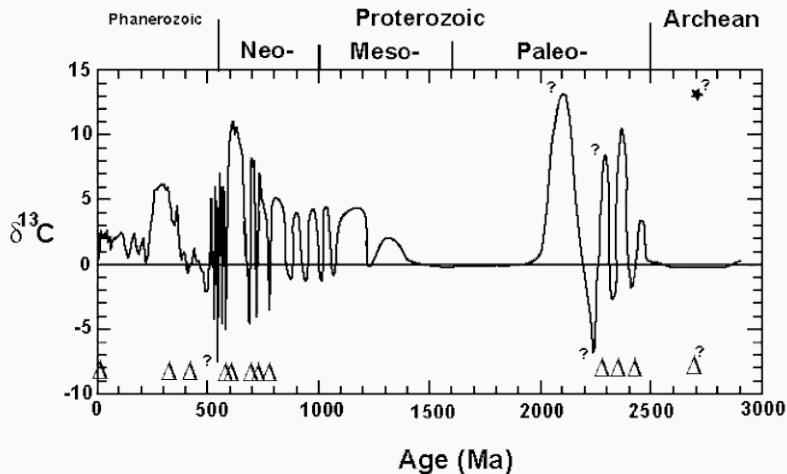
It is formed in *anoxic* and *reducing* environments.



Black shale deposits in the Precambrian



$\delta^{13}\text{C}$ in black shale



Summary

Supercontinents \longleftrightarrow Superplumes

Juvenile crust \longleftrightarrow Black shale \longleftrightarrow $\delta^{13}\text{C}$

Thank you!

IMAGINE EARTH'S HISTORY AS A FOOTBALL FIELD, FROM THE PLANET'S FORMATION AT ONE END TO TODAY AT THE OTHER.

COMPLEX LIFE WOULD BE LARGELY LIMITED TO THE FINAL TEN YARDS.

DINOSAURS APPEAR AT THE FIVE-YARD LINE, THE AGE OF MAMMALS HAPPENS IN THE LAST 1½ YARDS, AND HUMANS ARISE IN THE FINAL FEW MILLIMETERS.

ALL OF WRITTEN HISTORY WOULD FIT IN A STRIP NARROWER THAN A SINGLE HAIR.

"TWO WEEKS" WOULD BE TOO SMALL TO SEE EVEN WITH A POWERFUL MICROSCOPE.



GEOLOGISTS ALWAYS TRY THIS WHEN THEY'RE LATE TURNING SOMETHING IN.

References

Kent C. Condie, David J. Des Marais, Dallas Abbott
*Precambrian superplumes and supercontinents: a record in
black shales, carbon isotopes, and paleoclimates?*
(Precambrian Research, 2000)