

Long-Term Climate Change in the Paleozoic Era

Late Ordovician Glaciation

glacial tillites and striations found in north Africa and the Arabian peninsula
oxygen isotope data (shift to heavier ratios) in late Ordovician marine strata indicates
the glacial event was short, no longer than 0.5 - 1 m.y.

Polar Position Hypothesis

north Africa/Arabia, as part of the supercontinent Gondwana, were near the south pole
at the time; so no surprise that a continental ice sheet formed
however, Gondwana drifted over the south pole between about 450 and 250 m.y. ago,
but there is no evidence for glaciation through much of that time
so, being at the pole is not a sufficient condition to cause glaciation (though it helps)

mountain building, weathering, and CO₂ drawdown?

the Taconic Orogeny (mountain building) affected eastern North America at this time
resulting from the collision of a volcanic island arc with the continent

increase in biomass & CO₂ drawdown?

carbon isotopes (shift to heavier ratios) indicate rapid burial of much organic matter
perhaps removal of organic carbon due to some biological event caused a sudden
reduction in the concentration of CO₂ in the atmosphere
the first primitive plants began to invade swampy areas at this time

Late Paleozoic Glaciation

Glaciers covered the southern Gondwana which was coalescing into Pangea.
Glaciers waxed and waned producing rhythmic sea level rise and fall producing the
“mid-continent cyclothems.”

What caused the glaciation? What factors may have played a role?

The spread of forests:

A shift toward heavier carbon in seafloor carbonates in the Carboniferous indicates an
increase in removal of light carbon via increased photosynthesis & burial.

The Devonian saw the spread of vegetation across the continents, but mostly of primi-
tive spore-bearing plants which required water-borne fertilization and thrived in low-
lying and moist areas.

Seed-bearing plants which reproduced by airborne fertilization evolved in the
Carboniferous could now spread into upland and dry regions.

Massive amounts of coal from the Carboniferous period resulted from the spread of for-
ests and lack of termites, which had not yet evolved.

More global vegetation and burial as coal = less atmospheric CO₂

Pangea mountain building:

Collisions of Gondwana with North America-Europe and Siberia with Europe produced extensive new mountain ranges. The new areas of uplifted fresh rock increased the global rate of weathering, thereby removing more CO₂ from the atmosphere.

Mechanical weathering via active faulting, frost wedging, stream abrasion breaks rock into many small particles increasing the surface area for chemical weathering.

Chemical weathering proceeds very rapidly (using CO₂ as carbonic acid) on freshly exposed surfaces.

Uplifted areas are also steep - more stream erosion and mass wasting to keep fresh surfaces exposed.

Uplifted areas may be high enough to yield mountain glaciers which produce lots of broken and ground rock, fresh for chemical weathering.

Pangea Climate at the end of the Paleozoic

The supercontinent stretched from pole to pole and had vast interior areas and large mountain ranges (rain shadows).

Climate Models and Geologic Evidence:

model: very dry conditions in interior

evidence: extensive evaporites (salt deposits)

model: extremely continental climate - very hot summer, very cold winter

evidence: no polar ice caps (because snow melts in hot summer)

model: supermonsoons - season reversal of atmospheric flow

ocean to continent in summer bringing voluminous rain

continent to ocean in winter bringing cold, dry conditions

evidence: redbeds, rust-red sedimentary strata were common in Pangea. They commonly form today in climates with big difference in seasonal rainfall