

**March 21, 2022**

## **News and notes**

This week we'll be looking at the world and events of the [Permian Period](#); but first we'll take a look at some news items that I thought were interesting.

## **Geopolitics**

The tragedy in Ukraine continues. I don't know how it will end, other than with the death of many people who didn't deserve to die that way. Here are some interesting stories on the effects of the war:

- [Daily situation reports](#) from the Institute for the Study of War.
- [Ukraine invasion: China braces for effects of global fertiliser shortage on food security](#); related: [Wheat prices skyrocket by 40% amid Russia's invasion of Ukraine](#) and [Canada's scrambling to fill a massive global fertilizer deficit](#).
- From Victor Davis Hanson: [10 Realities of Ukraine](#).

## **Earthquakes, Volcanoes and Geohazards**

- Big earthquake off shore of Japan: [A magnitude 7.3 earthquake struck offshore of Namie, Japan on March 16, 2022 at 11:36 pm local time \(March 16 14:36 UTC\)](#); related: [Death toll from major Japanese earthquake rises to at least 4](#) and [Toyota Slammed by More Supply-Chain Woes Due to Japan Earthquake](#) (behind paywall).
- Hawai'i: [M 4.5 Earthquake: Northeast Flank of Mauna Kea](#).
- [Groundbreaking earthquake discovery: Risk models overlook an important element](#).
- Historical volcanism: [Magnitude, frequency and climate forcing of global volcanism during the last glacial period as seen in Greenland and Antarctic ice cores \(60–9 ka\)](#).
- [Worldwide Volcano News and Updates](#).
- Geology Hub on YouTube: [This Week in Volcano News; Problems at 9 Alaskan Volcanoes, La Soufriere Update](#).

## **Plate Tectonics**

- [Hot Springs Reveal Where Continental Plates Collide Beneath](#).
- In the Apennine Mountains: [A likely geological record of deep tremor and slow slip events from a subducted continental broken formation](#).

## **Paleontology Research**

- [What Were Humans Doing in the Yukon 24,000 Years Ago?](#) Probably looking for something to eat.

- Here kitty, kitty: [This Saber-Tooth Predator Was Likely One of The First True Carnivores.](#)

### **Other Research**

- [Rare earths show potential for quantum communications, processors](#), original research paper [here](#).
- [Pyrite mega-analysis reveals modes of anoxia through geological time.](#)
- [A truly Canadian sport, throwing rocks on ice.](#)

### **Climate and Weather Events**

- [An Atmospheric River of Saharan Dust Blankets Western Europe.](#)
- Volatile climate: [Understanding the Changing Nature of Marine Cold-Spells](#); includes a plain language summary.
- [A global variable-resolution model helps meteorologists understand the hydrological cycle throughout the Tibetan Plateau.](#)

### **Mining and Energy**

- [Powerful X-rays reveal the birth of giant rare earth element deposits and may give clues for sustainable mining.](#)
- From the United States Energy Information Administration (USEIA): [U.S. coal exports increased 23% between 2020 and 2021.](#)
- Also from the USEIA: [EIA projects that renewable generation will supply 44% of U.S. electricity by 2050](#); possibly optimistic.
- [Nickel price drops 12% in another glitchy start to London trading](#); there has been lots of volatility in trading nickel on the London Metals Exchange, see: [LME rips up its free-market rule-book to tame wild metals.](#)
- Large scale trends: [5 CHARTS: Mining supercycle – how soon is now?](#)
- [IEA Releases Plan To Cut Oil Use By 2.7 Million Bpd](#); dealing with the reality of resource constraints.

### **From Out of This World**

- This could ruin your day: [A Huge Beam of Antimatter Has Been Caught Streaming From This Runaway Pulsar.](#)

### **Geologists**

- [Hazards Scientist David Applegate Nominated for USGS Director.](#)

March 21, 2022

## The Permian Period

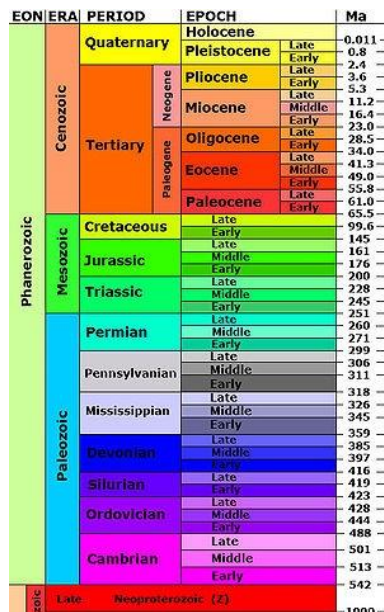


Figure 1 - Phanerozoic Time Scale

Credit: Modified from File: [Geologic time scale.jpg](#),  
[United States Geological Survey](#), public domain

The [Permian Period](#) is that time between the end of the [Pennsylvanian \(Late Carboniferous\) Period](#), 298.9 million years ago (Mya) and the beginning of the [Triassic Period](#), 251.9 Mya. It is the last period in the [Paleozoic Era](#). The period was named by Sir [Roderick Murchison](#) in 1841 after the region of [Perm](#) in Russia. This week we'll look at the paleogeography of the Permian, the major divisions of the period and the catastrophic end of the Permian Period in the [Permian-Triassic Mass Extinction Event](#).

### Pangaea and the Paleogeography of the Permian

During the Permian, almost all the continental [cratons](#) had consolidated into the supercontinent [Pangaea](#). East of Pangaea was a collection of [microcontinental terranes](#) called [Cathaysia](#). This was all part of the [Wilson Cycle](#) whereby the tectonic movement of continental cratons results in the periodic compilation of a supercontinent that is later broken as the result of same tectonic forces that brought it together.

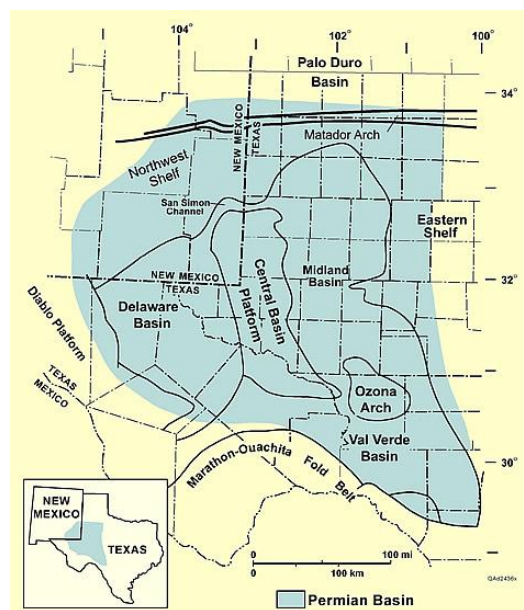
Outside of Pangaea were the major water bodies of the [Panthalassa Ocean](#), the [Paleo-Tethys Sea](#) and the later [Neo-Tethys Sea](#). During the tectonic movements that assembled Pangaea, the [Cimmerian](#) terrane moved northward from [Gondwana](#) to [Laurasia](#) linking the two continents into Pangaea and closing off the Paleo-Tethys Sea. However at the same time, the Neo-Tethys Sea

opened up. Other terranes that collided with Pangaea during the Permian include the [Kazakhstania](#) block, which collided with the [Baltica](#) portion of Pangaea, the [North China Craton](#), the [South China Block](#) and [Indochina](#). Sea levels dropped slightly during the Early Permian, remained stable, approximately 10 metres above current sea levels, and then dropped sharply later in the period, to near current levels and rose slightly at the end of the period.

One of the result of the accretion of Pangaea was the growth of the [Central Pangean Mountains](#). These mountains began forming during the Carboniferous and were complete during the Permian. Reaching as high as the current Himalaya Mountains, they were subjected to intense erosion throughout the Permian.

Pangaea straddled the equator during the Permian. As a large continental landmass, Pangaea had extremes of hot and cold as well as wet and dry climatic conditions. Much of the interior of Pangaea was a desert, as witnesses by the red desert sandstones that are often associated with the period such as the British [New Red Sandstone](#). Glaciers grew around the [Transantarctic Mountains](#) near the South Pole and in the parts of Pangaea that now northern Siberia. Overall, the Permian climate has been described as part of the [Late Paleozoic icehouse](#).

Notable large deposits from the Permian Period include the [Siberian Traps](#), those of the [Ural Mountains](#) (where Perm itself is located), China, and the southwest United States. Southwest American deposits include the [Texas red beds](#) and the [Permian Basin](#). The Permian Basin is one of the thickest deposits of Permian rocks in the world and is home to a [significant shale oil and natural gas play](#).



**Figure 2 - The Permian Basin**

**Credit: [National Energy Technology Laboratory](#), public domain**

## Major Divisions of the Permian Period

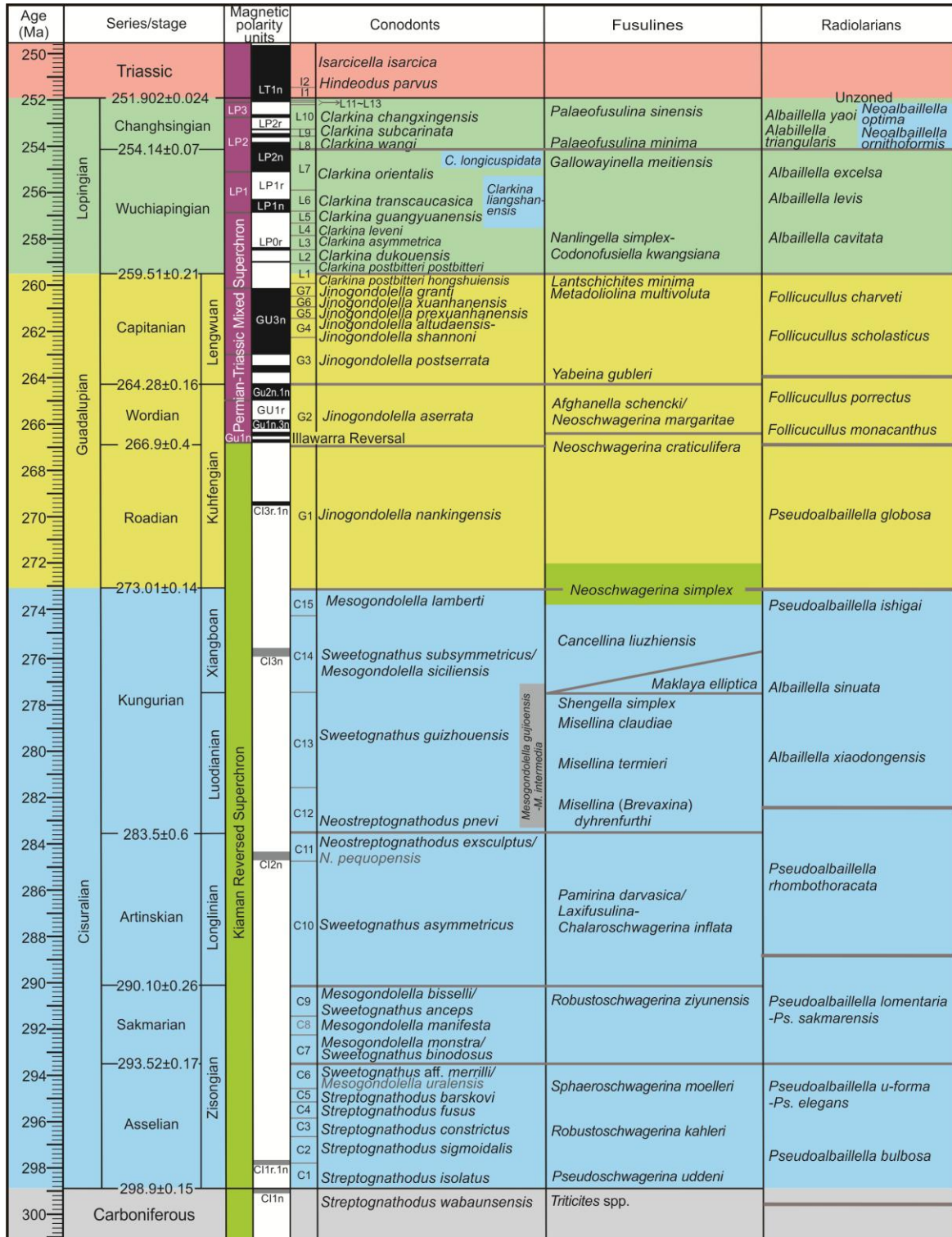
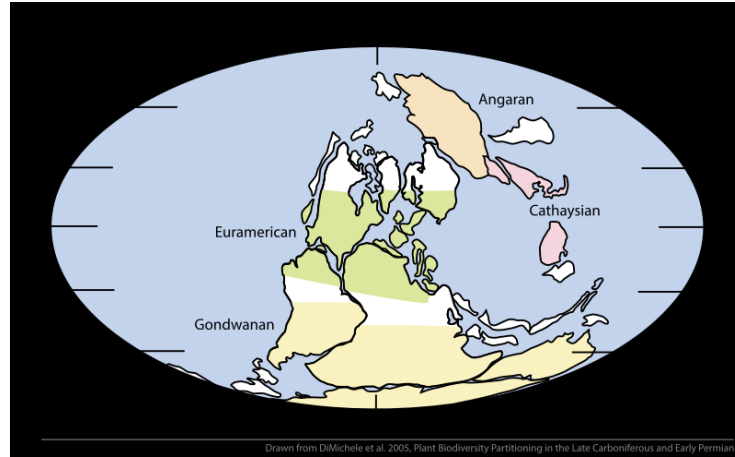


Figure 3 - Subdivisions of the Permian Period  
Credit: Subcommittee on Permian Stratigraphy

The Permian Period is divided into three epochs, from oldest to youngest: the [Cisuralian](#), the [Guadalupian](#), and the [Lopingian](#).

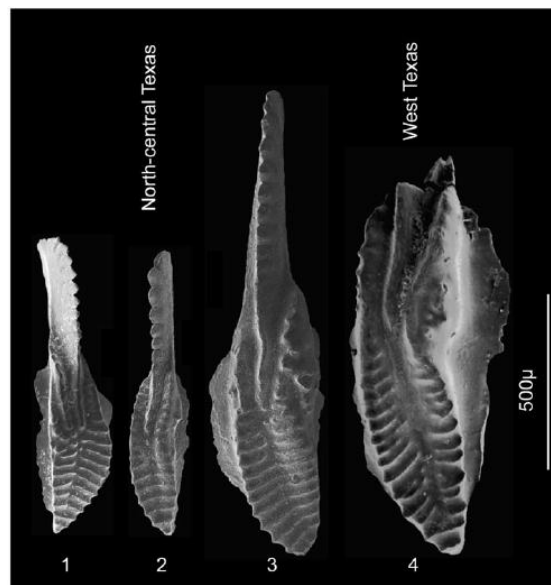
### **Cisuralian Epoch**



**Figure 4 - The World of the Carboniferous-Permian Boundary**

**Credit: [RoRo](#), [Creative Commons CC0 1.0 Universal Public Domain Dedication](#)**

The Cisuralian Epoch lasted from 298.9 to 272.3 Mya, being preceded by the Pennsylvanian Period and followed by the Guadalupian Epoch of the Permian. The Cisuralian Epoch is named after the western slopes of the Ural Mountains in Russia and Kazakhstan.



1- *Streptognathodus binodosus* transitional to *S. isolatus* from the Camp Creek Shale; 2-juvenile and 3-adult *Streptognathodus isolatus* from the Stockwether Limestone; 4- *Streptognathodus isolatus* from the Neal Ranch Formation, Geologist Canyon Section, Glass Mountains, West Texas.

**Figure 5 - *Streptognathodus***

**Credit: [Merlynd K. Nestell](#), from [Wardlaw, B. & Nestell, M., 2014](#)**

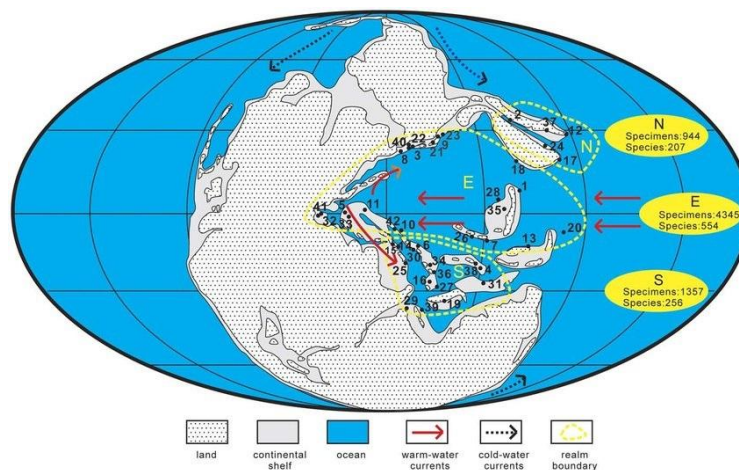
The base of the Cisuralian is marked by the first appearance of fossils of the conodont *Streptognathodus isolatus*. The global reference profile for the base (the [GSSP or golden spike](#)) is near [Aqtöbe](#) in the Ural Mountains of Kazakhstan, in the valley of the Aidaralash River.

The Cisuralian is further divided into:

- the Asselian stage (298.9 – 294.6 Mya);
- the Sakmarian stage (294.6 – 290.1 Mya);
- the Artinskian stage (290.1 – 283.5 Mya); and
- the Kungurian stage (283.5 – 272.3 Mya).

The end of the Kungurian stage is marked by an extinction event, [Olson's Extinction](#). Olson's Extinction was marked by a sudden change in the kinds of animal fossils (fauna assemblage) as you went from the Early Permian to the Middle Permian.

### **Guadalupian Epoch**



Middle Permian paleogeographic map showing three realms and blocks containing fusulinoideans in the analysis (base map modified after [68]).  
 Abbreviations/key: N, north transitional zone; E, equatorial zone; S, south transitional zone; 1, Akiyoshi Terrane; 2, Altaid Belt; 3, Armenia; 4, Baoshan Block; 5, Carnic Alps; 6, Central Iran; 7, Changning-Menglian Belt; 8, Crimea; 9, Darvaz; 10, exotic Karakaya complex in Turkey; 11, Greece; 12, Hida Gaien Belt; 13, Indochina Block; 14, Iraq; 15, Israel; 16, Karakorum; 17, Kitakami Terrane; 18, Kunlun-Qadani Block; 19, Lhasa Block; 20, exotic blocks in New Zealand; 21, north Afghanistan; 22, north Caucasus; 23, north Pamir; 24, northern margin of North China Block; 25, Oman; 26, Qamdo Block; 27, Qiangtang Block; 28, Qinling Belt; 29, Salt Range; 30, Sanandaj-Sirjan zone of Iran; 31, Sibumasu Block; 32, Sicily; 33, Slovenia; 34, south Afghanistan; 35, South China; 36, south Pamir; 37, South Primorye; 38, Tengchong Block; 39, Tethys Himalaya; 40, Transcaucasia; 41, Tunisia; 42, Turkey. doi:10.1371/journal.pone.0038603.g001

**Figure 6 - Middle Permian Paleogeographic Map**  
**Credit: Jonathan Louis Payne, from Payne, J. L., 2012**

Named after the [Guadalupe Mountains](#) in New Mexico, the Guadalupian Epoch lasted from 272.3 to 259.5 Mya and was previously known as the Middle Permian. The Guadalupian is between the Cisuralian and the Lopingian Epochs of the Permian. The beginning of the epoch is defined by the first appearance of the conodont *Jinogondolella nankingensis*.

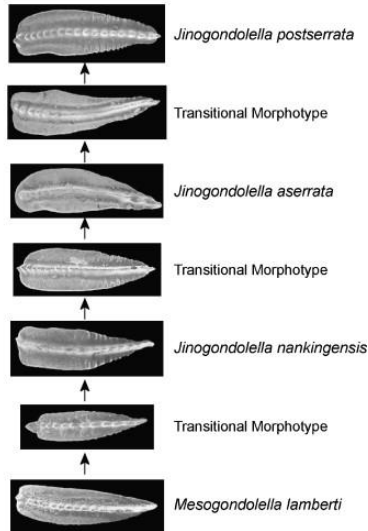
The Guadalupian is further divided into:

- the Roadian Stage (272.3 – 268.8 Mya);

- the Wordian Stage (268.8 – 265.1 Mya); and
- the Capitanian Stage (265.1 – 259.5 Mya).

The end of the Capitanian Stage was marked by the [Capitanian Mass Extinction Event](#).

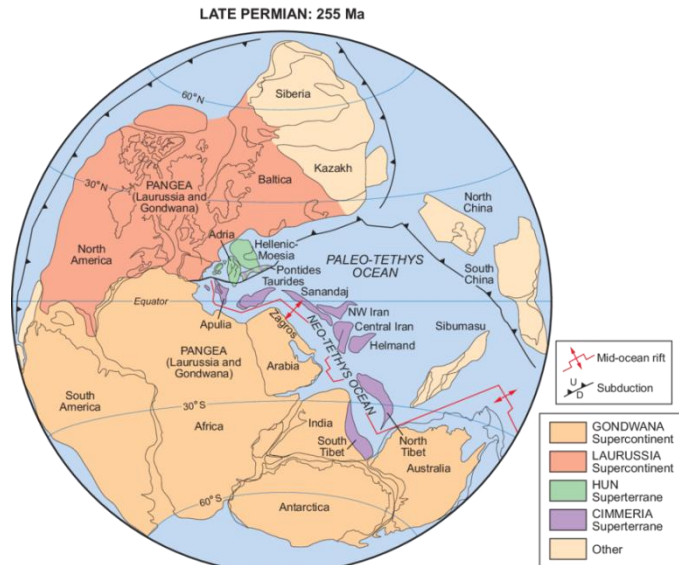
Defining Evolutionary Lineage of *Jinogondolella* for the stages of the Guadalupian



**Figure 7 - Middle Permian Conodonts**

**Credit: Lambert, L., Wardlaw B., and Henderson, C., 2007**

**Lopingian Epoch**



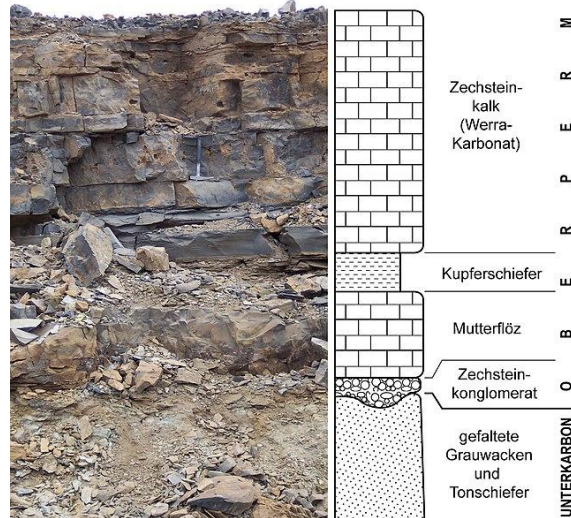
**Figure 8 - Plate-tectonic reconstruction of the late Permian**

**Credit: Dmitry A. Ruban, D., and Al-Husseini, M., 2007**

Also called the Late Permian, the Lopingian Epoch lasted from 259.5 to 251.9 Mya and marks the end of the Permian Period and the Paleozoic Eon. The name was introduced by Amadeus William Grabau in 1931 and derives from [Leping](#), Jiangxi in China.

The Lopingian Epoch is further divided into :

- The Wuchiapingian Stage (259.5 and 254.1 Mya); and
- The Changhsingian Stage (254.1 - .251,9 Mya).



**Figure 9 - Rocks of the Wuchiapingian Stage Werra Formation**

**Credit: [Gretarsson](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) licence**

The Lopingian Epoch ended with the Permian-Triassic Mass Extinction Event.

### The Permian-Triassic Mass Extinction Event



**Figure 10 - Permian-Triassic Boundary at [Frazer Beach NSW](#)**

**Credit: [Dippiljemmy](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license.**

Sometimes called the End-Permian Extinction or the Great Dying the Permian–Triassic (P–T, P–Tr) Extinction Event is one of the most horrific events in the history of Planet Earth. The extinction event included the extinction of 57% of [biological families](#), 83% of [genera](#), 81% of [marine species](#); and 70% of [terrestrial vertebrate species](#). Animals that went extinct at the end of the Permian included: [trilobites](#), [tabulate corals](#), [rugose corals](#), goniatitic [ammonoids](#), productid [brachiopods](#), and cladid [crinoids](#).

The destruction of the corals, crinoids and brachiopods meant that there were few reef building organisms in the seas. Major reef building did not occur again until the middle of the Triassic Period, with the appearance of [scleractinian corals](#).

### **Causes**

So what happened?

The best explanation we have for the End-Permian Extinction is that the volcanic eruptions which deposited the [Siberian Traps](#) injected a vast amount of carbon dioxide into the atmosphere. The volcanic eruptions may also have been co-incident with or caused the thermal decomposition of hydrocarbon deposits, thus releasing more carbon dioxide into the atmosphere.

The increase in carbon dioxide in the atmosphere led to an increase in the carbon dioxide in the oceans, causing it to become [acid](#). The carbon dioxide also led to a retention of heat in the atmosphere - global warming. This had severe consequences on the oceans, the water temperature went up, possibly as much as 8 degrees Celsius. The [dissolved oxygen concentrations dropped](#) and the ocean became a toxic, anaerobic soup that killed most living organisms and favoured anaerobic organisms such as [methanogenic microorganisms](#). Aquatic life only survived in rivers and estuaries where conditions were more favourable.

On land, the rising temperatures furthered the [desertification](#) already occurring, severely altering many ecosystems and killing 70% of terrestrial vertebrate species.

In short, it was a horrible time for life on the planet.

### **Recent Research**

The Permian–Triassic Extinction Event continues to be studied. Recent research papers mentioned in previous postings of this weblog include:

- [Machine learning identifies ecological selectivity patterns across the end-Permian mass extinction.](#)
- [Secondary cratering on Earth: The Wyoming impact crater field.](#)

That's a quick look at the events of Permian Period, next week we'll look at plant life during that period.

### **Standard Caveat**

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

In science, the only authority is the evidence