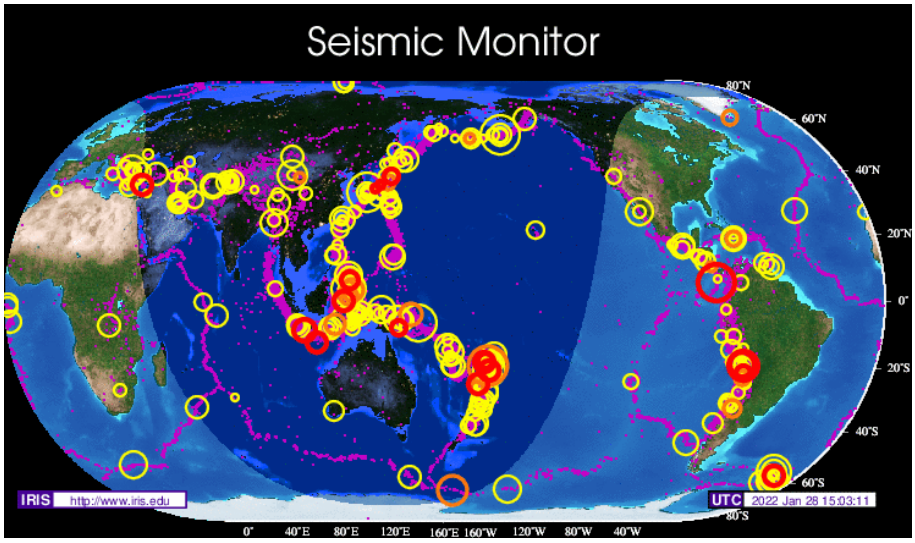
January 31, 2022

News and Views



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Before going on with a look at the Devonian Period, let's see what's in the news these days.

Earthquakes

- From the United States Geological Survey (USGS): The Entire U.S. West Coast Now Has Access to Shake Alert Early Earthquake Warning System.
- The USGS Earthquake Hazards Program.

Volcanoes

- It really was an earth shattering kaboom: NASA Says Tonga Eruption Was More Powerful Than an Atomic Bomb.
- Volcano Discovery latest news.
- Volcanoes on Mars: Volcano and impact craters seen in geologically rich new image from ESA's Mars Express.

Energy and Mining

- Los Angeles weighs phasing out oil and gas drilling; the comfortable California lifestyle was made possible by abundant energy resources.
- Add another 1m tonnes to annual copper demand from EVs; supply and demand. Related: Biden administration kills Antofagasta's Minnesota copper project.

- Lithium under a California lake could help U.S. gain energy autonomy; take the headline with a grain of salt, the reporter confuses energy storage with energy production. However, having a domestic source of lithium is probably good for the USA.
- Canada says it saw no need to block China firm's bid for lithium miner; "it saw no risk to national security"; we are ruled by fools and/or traitors.
- When Will The U.S. Tap its Massive Geothermal Energy Potential? Answer, when the market demands it.
- Upcoming event series, from the Geological Society of London: The Energy Geoscience Conference Series.

Research

- From the USGS: An unexpected thing happened on the way to publishing a geology research paper recently; the original research article is here.
- Mushroom Growing Out of 50-Million-Year-Old Fossilized Ant Reveals New Fungal Parasite; parasites have been around for a long time.
- New Mineral Described From Uranium Mine In Utah.
- Fossil of a Giant Millipede Reveals 'The Biggest Bug That Ever Lived'; from the Carboniferous Period.
- Ancient ice reveals mysterious solar storm; clues from ancient ice.
- Cambrian fossils: 500 million-year-old, bug-like fossils have stunningly preserved nervous systems.
- Plate tectonics research from the Geological Society of America: Wild New Paper Suggests Earth's Tectonic Activity Has an Unseen Source; original paper here.
- Climate Change in the Early Holocene; original research paper here.

Geology is Beautiful

Link: Complex Color Explosion – Beautiful Earth

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The Devonian Period, Part 1

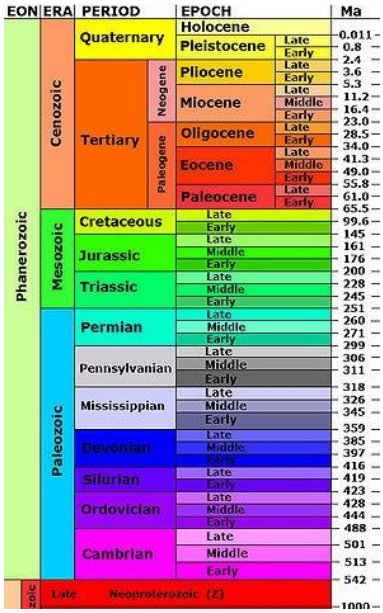

Figure 1 - Phanerozoic Time Scale
Credit: Modified from File: Geologic time scale.jpg, United States Geological Survey, public domain

Also called, The Age of Fishes, the Devonian Period lasted from the end of the Silurian, 419.2 million years ago (Mya), to the beginning of the Carboniferous, 358.9 Mya. The Devonian Period is named after Devon, a county in southwestern England where formations of the period were first described in the 1830s.

If you're thinking that the process of naming the period was uncontroversial, you don't know geologists. There was a long period of vigorous argument and counter-argument between one party, led by Roderick Murchison and Adam Sedgwick, and another party led by Henry De la Beche supported by George Bellas Greenough. The Great Devonian Controversy was a early case of a scientific dispute resolved, in the end, by the **evidence**. In the end the position championed by Murchison and Sedgwick won the debate and they named the period the Devonian. The plus side of this kind of debate is that it stimulated research, in this case extending as far as Russia, and thus all the parties to the debate helped to add to the knowledge base of geological science.

This week's posting will be on the paleogeography, climate and subdivisions of the period; next week we'll take a closer look at life during the Devonian.

Paleogeography

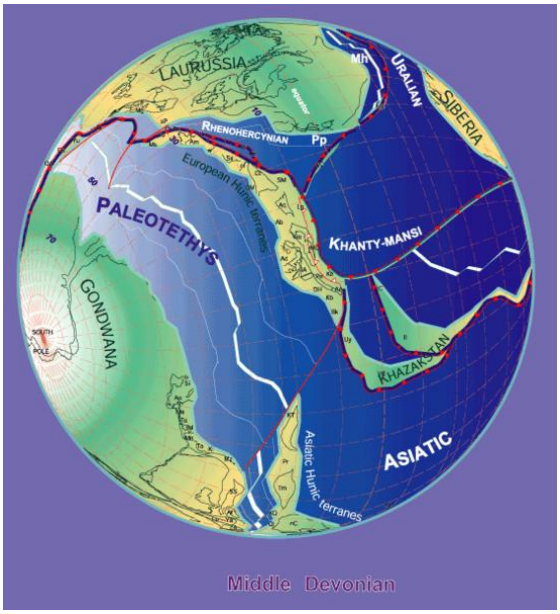

Figure 2 - The Earth During the Middle Devonian
Credit: Stampfli & Borel, 2000, Tethyan Plate Tectonic Working Group
Institut de Mineralogie et Petrographie, Université de Lausanne

During the early Devonian Period tectonic activity led to the collision of Laurentia and Baltica, creating Euramerica (also called Laurussia). During this time, Euramerica was in the naturally dry zone of the Tropic of Capricorn. The Old Red Sandstone Formation in Britain was deposited during this time; the red colour coming from oxidized iron (hematite) characteristic of drought conditions.

On the west coast of what was to become North America, there were deep silty embayments, river deltas and estuaries. In today's Idaho and Nevada, a volcanic island arc system began to accrete onto the craton, uplifting deep water deposits. Eventually the island arc would collide with the craton during Late Devonian time as part of the Antler orogeny.

Elsewhere on Euramerica, where an epicontinental sea lay over what would become the Western Canada Sedimentary Basin, reef forming organisms laid down vast formations of carbonate rocks. In Alberta, Devonian reef deposits were a major location of petroleum deposits.

Tectonic activity during the Devonian Period brought Euramerica and Gondwana closer together, beginning the early stages of assembling Pangaea. This tectonic activity is evidenced in the northern Appalachian Mountains and the Caledonian Mountains in Great Britain and Scandinavia.

In general, sea levels during the Devonian were high. Epicontinental seas, such as those that deposited the Devonian reefs in Alberta, covered much of the continental cratons. An enormous

ocean, called Panthalassa (the "universal ocean") covered the rest of the Earth. Other, smaller, oceans included Paleo-Tethys, Proto-Tethys, Rheic Ocean, and Ural Ocean. The Ural Ocean was closed by the collision with Siberia and Baltica.

Climate during the Devonian

Figure 3 - Stromatoporoid Reef, Devonian Cairn Formation, Alberta
Credit: Georgialh, Creative Commons Attribution-Share Alike 4.0 International license

The evidence suggests that the Devonian was a relatively warm period without any extensive glaciation. Examination of apatite in conodont fossils suggests an average tropical sea surface temperature of 30 °C (86 °F) in the Early Devonian and that the temperature gradient between the equatorial and polar regions was probably not as great as it is today.

Carbon dioxide concentrations in the atmosphere dropped during the period, possibly as the result of the proliferation of forests on the land. As the result, temperatures dropped during the Middle Devonian, although they appear to have recovered in the Late Devonian. The climate changes affected all the dominant organisms. The Late Devonian warming may have contributed to the extinction of the stromatoporoid sponges, such as the fossils in Figure 3 that are on display at the Geological Survey of Canada building, Calgary, Alberta.

At the end of the Devonian, a cooling period, the Famennian glaciation set in, leading to a major extinction event, called the Hangenberg event also called the End Devonian Extinction.

Subdivisions of the Devonian Period

The Devonian Period is typically divided into the Lower, Middle and Upper Epochs. Each epoch is further divided into the stages shown in Figure 4, let look at them.

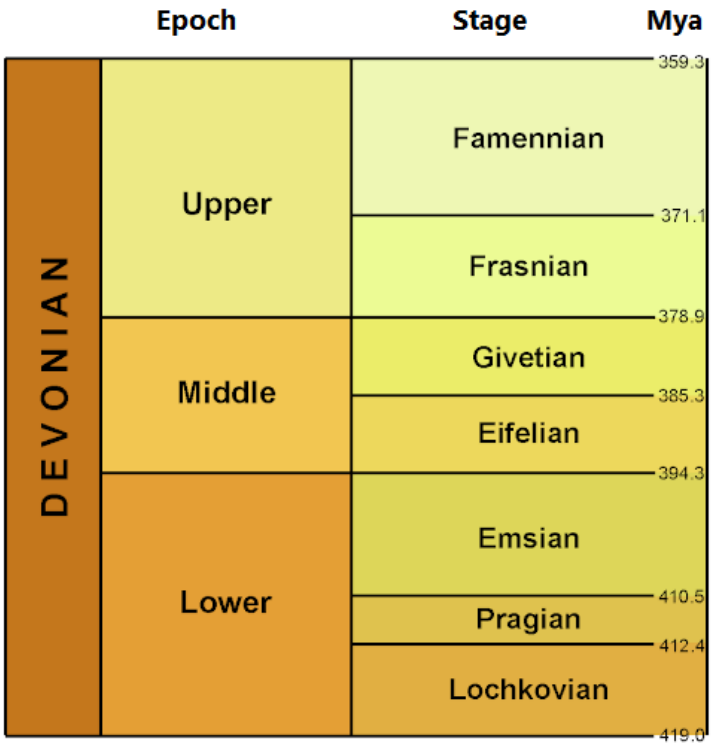

Figure 4 - Subdivisions of the Devonian Period
Credit: the Subcommission on Devonian Stratigraphy

Upper Devonian

The Upper Devonian Epoch (378.9 to 359.3 Mya) is divided into the Famennian and the Frasnian Stages.

Figure 5 - *Clymenia laevigata*, Upper Devonian
Credit: Wikipek, Creative Commons Attribution 3.0 Unported license

The Famennian Stage (371.1 to 359.3 Mya) began with a major extinction event, the Kellwasser Event, and ended with another extinction event, the Hangenberg Event. Tetrapods first appeared during the Famennian Stage. In the oceans, a new group of ammonoid cephalopods called clymeniids evolved, diversified and then went extinct ; *Clymenia laevigata* in Figure 5 is one of them.

The Frasnian Stage (378.9 to 371.1 Mya) was marked by major reef-building, particularly in Western Canada and Australia. The first forests appeared on land during this time. Tectonically, the Antler Orogeny peaked and in Europe the Variscan Orogeny took place. One interesting feature of the Frasnian is the second "charcoal gap" in the fossil record (the first was in the Middle Devonian). This was a time when atmospheric oxygen levels were below 13 percent, the minimum necessary to sustain wildfires.

Middle Devonian

The Middle Devonian (394.3 to 378.9 Mya) is divided into the Eifelian and the Givetian Stages.

Figure 6 - *Phacops rana*, Middle Devonian
Credit: Didier Descouens, Creative Commons Attribution-Share Alike 4.0 International licence

Named after the city of Givet, in the French Ardennes, the Givetian Stage to (385.3 Mya to 378.9 Mya) was marked by the appearance of the first forests and the extinction of ammonoids Taghanic event in the upper middle Givetian. The beds of the Givetian stage are represented by marine, lagoon, and continental sediments in Europe.

The Eifelian Stage (394.3 to 385.3 Mya) was marked by a biological crisis called the Kačák Event, a two part extinction event that consisted of an to an ecological turnover among ammonoids,

conodonts and other free swimming animals. The Kačák Event is also marked by the deposition of anoxic black shales and an apparent marine transgression or sea-level rise. The Kačák Event included a warming period that severely affected diversity of sea life. Fauna in the Eastern Americas Realm was gradually replaced by creatures originating in the Old World Realm which invaded through a seaway cutting along a flooded continental arch on the western edge of Euramerica.

Lower Devonian

The Lower Devonian (419.0 to 394.3 Mya) is typically divided into three: the Lochkovian, Pragian, and the Emsian Stages.

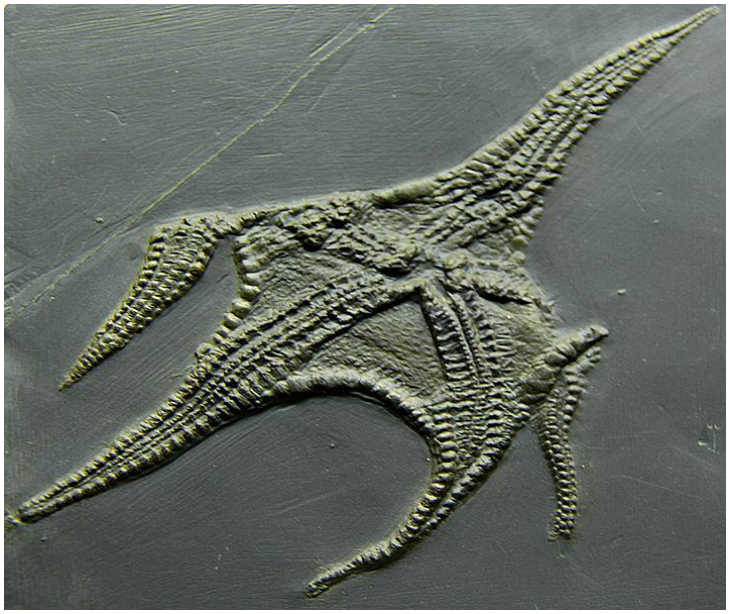

Figure 7 - *Euzonosoma tischbeiniana*
Credit: Dwergenpaartje, Creative Commons Attribution-Share Alike 4.0 International licence

The Emsian Stage (410.5 to 394.3 Mya), named after the Ems River, in Germany, is best known for its proliferation of ammonoids such as *Anetoceras*, *Teicherticeras*, *Convoluticeras*, *Talenticeras*, *Mimagoniatites*. Also found in the Emsian is the Hunsrück Slate from Germany, famous for exceptional preservation of a highly diverse fossil fauna assemblage including *Euzonosoma tischbeiniana*, a seastar (a.k.a a starfish).

Named after the city of Prague in the Czech Republic, the Pragian (412.4 to 410.5 Mya) is known for the first ammonoid fossils, Order Agoniatitida. It is also known for the preservation terrestrial fossils in the Rhynie Chert. The fossils in the Rhynie Chert include a diversity of very primitive terrestrial plants, minute arthropods and even a fungus, *Paleomyces*, that was found infecting the soft tissues of the Rhynie Chert plants.

The Lochkovian Stage (419.0 to 412.4 Mya) is the oldest stage in the Devonian, is named after the village of Lochkov in the Czech Republic. The type section of the stage consists of sequence comprises interbedded limestones and shales. A Lochkovian aged formation in Oklahoma USA contains a well known deposit of trilobite fossils, the Trilobites of Black Cat Mountain, as in the fossil of *Kettneraspis williamsi* in Figure 8.

Figure 8 - *Kettneraspis williamsi*
Credit: James St. John, Creative Commons Attribution 2.0 Generic license

That kind of rounds up the Devonian Period, we'll take a closer look at life in the Devonian, especially the evolution of fishes, in next week's post.

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.