

May 9, 2022

News and views

Before going on to a look at the events of the Jurassic Period, here are some news items that I thought were interesting

Geopolitics

The war in Ukraine continues. Remembering that all wars involve deception, here are a few sites to observe changes in the war:

- Daily updates at the [Institute for the Study of War](#).
- [Live Map](#); regular updates to the changes in the on ground situation.
- Oryx: [Assessments of battlefield losses](#).

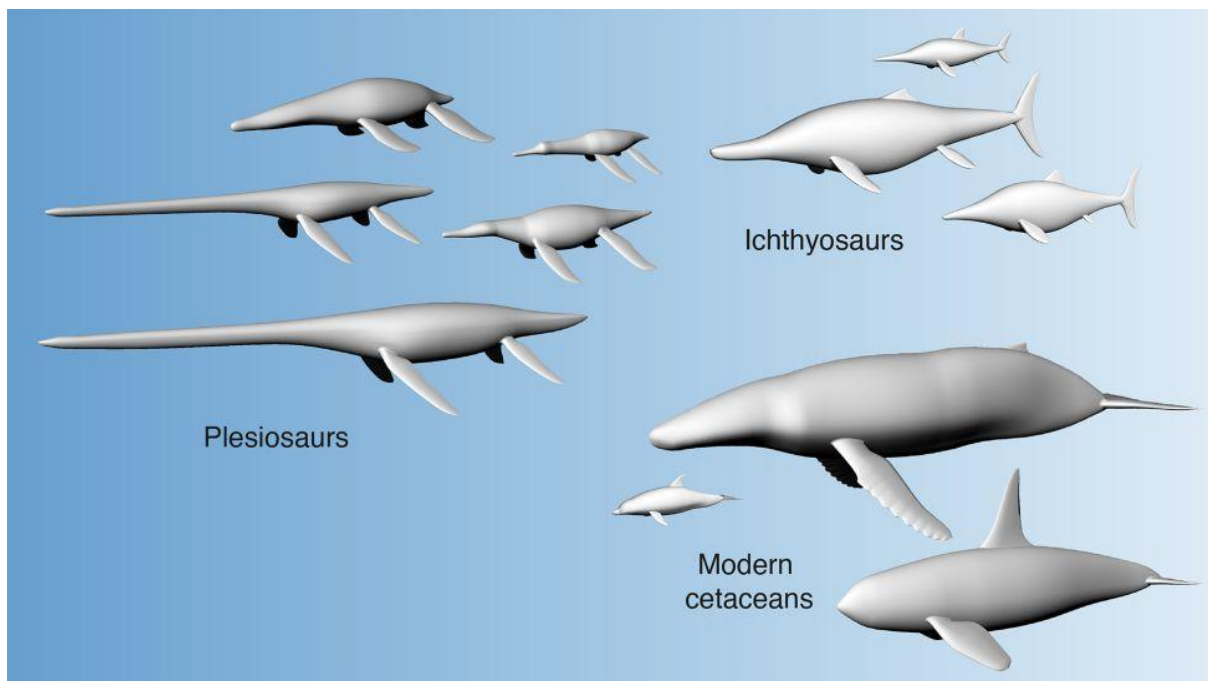
Whoever wins, in the end it will be a "[Pyrrhic victory](#)".

Research

- From the Geological Society of America: [New Geology articles published online ahead of print in April](#).
- Research into the Earth's core: [Primordial Helium-3 Exchange Between Earth's Core and Mantle](#), includes a plain language summary; Phys.org article on the research: [here](#).
- More research into the Earth's interior: [Deciphering the State of the Lower Crust and Upper Mantle With Multi-Physics Inversion](#), includes a plain language summary; Phys.org article on the research: [here](#).
- Ancient climate change: [Nd isotopic evidence for enhanced mafic weathering leading to Ordovician cooling](#); behind a paywall.
- During the last interglacial, 125,000 years ago: [Extensive evidence for a last interglacial Laurentide outburst \(LIL\) event](#); behind a paywall.
- Carbonate rock studies: [Exploring grain sizing of sedimentary calcareous rocks using Raman spectroscopy](#); Phys.org article on the research: [here](#).
- What happen to big deposits of carbonate rocks that get deeply buried: [Diapirism of carbonate platforms subducted into the upper mantle](#).
- Mineralogy: [Fluorite Mineralization at the Dwyer Mine, Wilberforce Area, Ontario, Canada: Microtextural Indications of a Fluor-Calciocarbonatite](#); behind a paywall.
- [Two New Vanadium Minerals from the Wilson Springs Vanadium Mine, Wilson Springs, Arkansas, USA](#); behind a paywall.
- [Bogs, lakebeds, and sea floors compete to become Anthropocene's 'golden spike'](#); some geologists want to establish a new epoch in the [Neogene](#).

Paleontology

- [Reassessment of *Faxinalipterus minimus*, a purported Triassic pterosaur from southern Brazil with the description of a new taxon](#); paleontologists identify a new Triassic reptile species in fossils from Brazil.
- Giant Miocene beavers: [How Scientists Resolved the Mystery of the Devil's Corkscrews](#).
- The sex life of trilobites: [Claspers in the mid-Cambrian *Olenoides serratus* indicate horseshoe crab-like mating in trilobites](#); more fascinating finds from the [Burgess Shale](#).
- [Taphonomic history and trophic interactions of an ammonoid fauna from the Upper Triassic Polzberg palaeobiota](#); the fossil remains of almost an entire ecosystem.
- [Giant 'Death Shadow' Dinosaur Found in Argentina Is Largest Megaraptor on Record](#).



3D Models of Aquatic Tetrapods

[Credit: S. Gutarra Díaz](#)

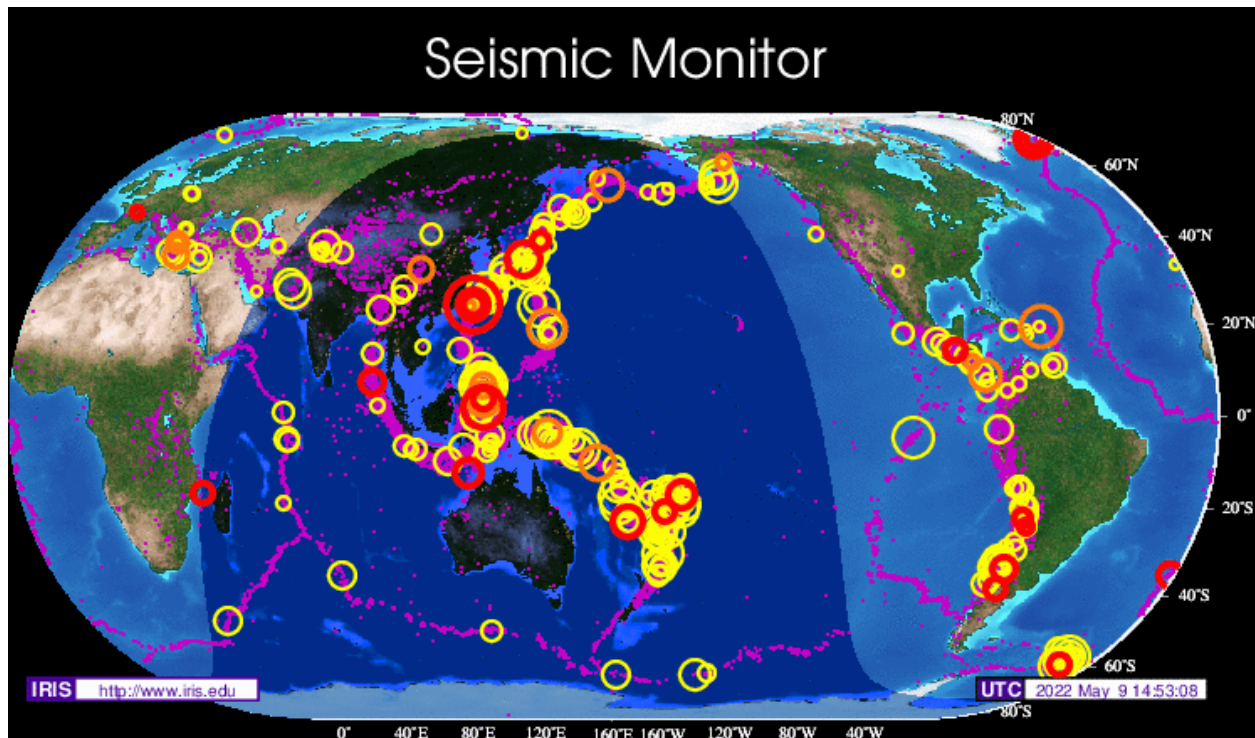
- Evolution of Mesozoic sea animals: [Large size in aquatic tetrapods compensates for high drag caused by extreme body proportions](#); Live Science report [here](#).

Environmental Geology and Hydrogeology

- Environmental geology: [Portable X-ray fluorescence \(pXRF\) analysis of heavy metal contamination in church graveyards with contrasting soil types](#); Phys.org article on the research: [here](#).
- Urbanization has caused severe negative impacts on rivers in China: [Evaluation of polluted urban river water quality: a case study of the Xunsi River watershed, China](#).

- Salty groundwater in Antarctica: [A dynamic saline groundwater system mapped beneath an Antarctic ice stream](#); Phys.org article on the research: [here](#).
- From Phys.org, water quality in wells: [Climate change is pushing toxic chemicals into drinking wells](#).
- Hydrogeology of turbidites: [How do turbidite systems behave from the hydrogeological point of view? New insights and open questions coming from an interdisciplinary work in southern Italy](#).

Volcanoes, Earthquakes and Geohazards



[Seismic Monitor Link](#)

- [Worldwide Volcano News and Updates](#).
- [World Earthquake Report for Monday, 9 May 2022](#).
- One earthquake sets off another: [Cascading rupture of a megathrust](#); Phys.org article on the research: [here](#).
- Dating an ancient catastrophic eruptions: [Geochemical ice-core constraints on the timing and climatic impact of Aniakchak II \(1628 BCE\) and Thera \(Minoan\) volcanic eruptions](#); Phys.org article on the research: [here](#).
- [The 2019–2020 volcanic eruption of Late'iki \(Metis Shoal\), Tonga](#).
- Articles on the European Cenozoic Volcanic Province: [Part 1](#) and [Part 2](#); "because volcanoes are awesome".
- [Volcanic Lightning: The Science Behind This Spectacular Phenomenon](#).

Mining and Energy

- Basic research that affects petroleum production: [The influence of grain shape and size on the relationship between porosity and permeability in sandstone: a digital approach.](#)
- Ore body research: [Supergiant porphyry copper deposits are failed large eruptions;](#) porphyry copper deposits are the principal source of copper and molybdenum.
- From the United States Energy Information Administration (USEIA), [quarterly report on United States uranium production.](#)
- Also from the USEIA: [In 2021, value of energy trade between the United States and Canada rose from 2020 lows.](#)
- [Rio Tinto becomes first North American producer of scandium oxide;](#) the uses for [scandium](#) include: aluminum alloys, sports equipment, firearms, dentistry, metal-halide lamps and solid oxide fuel cells.
- Minnesota: [EPA deals fresh blow to PolyMet's \\$1 billion copper-nickel mine.](#)
- [U.S. Natural Gas Prices Could Soon Hit \\$10/MMBtu.](#) (MMBtu= million British thermal units).

Pretty, Shiny Rocks

- [Treasure Hunter Unearths 2.38-Carat 'Frankenstone' Diamond;](#) from the [Crater of Diamonds State Park](#) in Arkansas.
- Artificial diamonds: [Proponents say not only are they here to stay, they've also re-energized the jewelry industry.](#)
- [De Beers Plans To Make All Its Diamonds Trackable.](#)

Upcoming Events

- [The General Assembly of the European Geosciences Union](#) will take place 23–27 May 2022 in Vienna, Austria and online.
- Geological Association of Canada: [GAC-MAC Halifax 2022.](#)

Book Review

- [An encyclopedia of geology that's less a reference than a journey;](#) Geopedia by Marcia Bjornerud.

May 9, 2022

The Events of the Jurassic Period

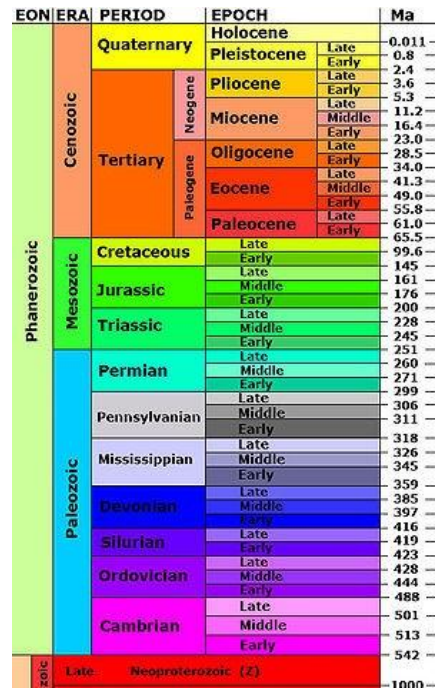


Figure 1 - Phanerozoic Time Scale

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

In this week's blog we'll look at the [Jurassic Period](#). After an introduction we'll look at the major events through the paleogeography, orogenies and climate of the period. We'll wind it up by examining the subdivisions of the period.

Introduction

The Jurassic Period lasted from 201.3 million years ago (Mya) to approximately 145 Mya; it is preceded by the [Triassic Period](#) and followed by the [Cretaceous Period](#). Together, the Triassic, Jurassic and Cretaceous Periods make up the [Mesozoic Era](#). The [Triassic–Jurassic Extinction Event](#) marks the beginning of the Jurassic Period.

There is no clear boundary for end of the Jurassic. [The Jurassic/Cretaceous System Boundary Working Group](#) (J/K BWG) is working on it. For practical purposes, the date of 145 Mya is sufficient until the J/K BWG completes their work. However, they work on a geological timescale, so don't expect an answer anytime soon.

In 1795, [Alexander von Humboldt](#) described the carbonate deposits within the [Jura Mountains](#) of France and Switzerland, calling them *Jura-Kalkstein* ('Jura limestone'). The French naturalist

[Alexandre Brongniart](#) used the term Jurassic (*terrains jurassiques*) to describe the rocks of the Jura Mountains in France in his 1829 book [Tableau des terrains qui composent l'écorce du globe ou essai sur la structure de la partie connue de la terre](#).



Figure 2 - Portrait of Alexandre Brongniart
Credit: [Emile-Charles Wattier \(1800-1868\)](#), [public domain](#)

Other geologists: [Leopold von Buch](#), [William Conybeare](#), [William Phillips](#), [Alcide d'Orbigny](#), [Friedrich August von Quenstedt](#), and [Albert Oppel](#) contributed to the further definition of the Jurassic Period with the [Colloque du Jurassique à Luxembourg, 1962](#) providing the most common modern definition of the period.

Jurassic Paleogeography, Orogenies, and Climate

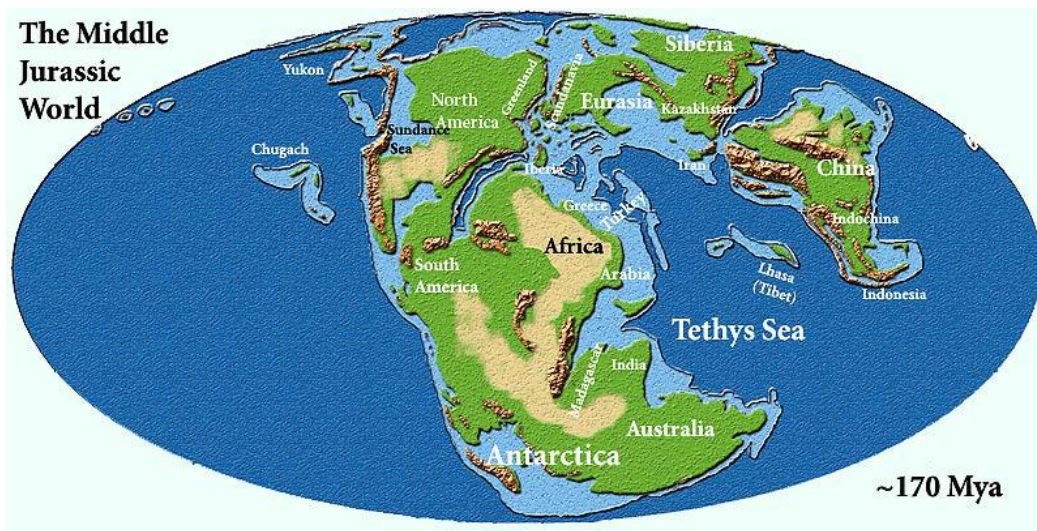


Figure 3 - The World during the Middle Jurassic Period
Credit: [Paleos](#), [Creative Commons CC0 1.0 Universal Public Domain Dedication](#)

The Jurassic Period began with a mass extinction, the Triassic–Jurassic extinction event, which was probably caused by the volcanic eruptions of the [Central Atlantic Magmatic Province](#). This series of volcanic eruptions marked the beginning of the breakup of [Pangaea](#) with the opening up of the Atlantic Ocean. The first rifting was that that separated North America from Europe and Africa. Later, in the Cretaceous, further rifting would lead to the separation of South America from Africa.



Figure 4 - Triassic /Jurassic Boundary at [Five Islands Provincial Park](#), Nova Scotia
[North Mountain Basalt](#) (Early Jurassic) overlies the [Blomidon Formation](#) (Late Triassic)
Credit: [Michael C. Rygel](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#) license

The southern part of Pangaea, [Gondwana](#), and the northern part, [Laurasia](#), also continued to grow apart with the expansion of the [Tethys Sea](#). Gondwana began to break up with the eruption of the [Karoo-Ferrar Large Igneous Provinces](#). This led to the opening up of the western Indian Ocean and the separation of Madagascar and Antarctica from Gondwana. Also, on the western side of Gondwana, in what is now South America, the [Andean Orogeny](#) began, a mountain building process that continues today.

In the part of Laurasia that is now North America, the [Nevada Orogeny](#), which began during the Triassic, continued, closing off the [Cache Creek Ocean](#). Also in the future North America, various terranes including the large [Wrangellia Terrane](#) accreted onto the western margin of North America.

Offshore of western Laurasia, other terranes such as the [Chugach-Prince William Terrane](#) and the [Yukon–Tanana Terrane](#) were forming up. During the Jurassic these two terranes gradually moved toward North America and were accreted onto it during the Cretaceous Period.

On the western side of Laurasia the various orogenies and movements of terranes set the boundaries of the [Sundance Seaway](#), a shallow epicontinental sea. On the eastern side of

Laurasia, in what is now Siberia, the [Siberian Plate](#) collided with the [North China-Amuria](#) block and [closed off the Mongol-Okhotsk Ocean](#).

Much of the world was covered by [Panthalassa](#), the world ocean. Under Panthalassa, three oceanic plates, the [Farallon](#), [Phoenix](#), and [Izanagi](#) tectonic plates, [coalesced into the Pacific Plate](#) during the Jurassic Period.

Also in the world ocean, there were long term cyclical variations in sea level. [Research published in 2018](#) indicated that there were around 64 measurable fluctuations in [eustatic sea level](#), 15 of which were greater than 75 metres. Also within the world's oceans, [the chemistry changed](#) from one that favoured the precipitation of [aragonite](#) to one that favoured the precipitation of [calcite](#). One effect of this change was the accumulation of calcite of [calcareous plankton](#) on the sea floor that in turn acted to [buffer changes in ocean pH](#).

[Climate during the Jurassic](#) was generally warmer than today. Among the indications of a warmer climate are:

- Substantial deposits of evaporites (notably gypsum, anhydrite, and halite) indicating conditions of both warmth and aridity such as the [Amaranth Formation](#) in Manitoba.
- Coal deposits from hot and humid climates such as the Jurassic aged coal deposits in the Russian [Irkutsk Coal Basin](#).
- The [growth of coral reefs](#) grew 10° of latitude further north and south.



Figure 5 - Late Jurassic Carbonate Deposit, [Malton Oolite](#), Yorkshire, England
Credit: [Wilson44691](#), [CC0 1.0 Universal Public Domain Dedication](#)

Climate also varied within the Jurassic Period, beginning with a spike in temperature corresponding to the Triassic–Jurassic extinction and eruption of the Central Atlantic Magmatic Province. Later on, rising temperatures and increasing ocean acidity occurred during the

[Toarcian Oceanic Anoxic Event](#) (TOAE). The cause of the TOAE appears to have been the eruptions of the Karoo-Ferrar Large Igneous Provinces. One of the deposits that record the TOAE is the [Ziliujing Formation](#) of the [Sichuan Basin](#) in China. The rocks of the Da'anzhai Member of the Ziliujing Formation record that during the [Toarcian Age](#), the Sichuan Basin was transformed into a giant lake, probably three times the size of modern-day Lake Superior.

Subdivisions of the Jurassic Period

Series/epoch	Stage/age	Lower boundary
Lower/Early Cretaceous	Berriasian	~145 Mya
Upper/Late Jurassic	Tithonian	152.1 ±0.9 Mya
	Kimmeridgian	157.3 ±1.0 Mya
	Oxfordian	163.5 ±1.0 Mya
Middle Jurassic	Callovian	166.1 ±1.2 Mya
	Bathonian	168.3 ±1.3 Mya
	Bajocian	170.3 ±1.4 Mya
	Aalenian	174.1 ±1.0 Mya
Lower/Early Jurassic	Toarcian	182.7 ±0.7 Mya
	Pliensbachian	190.8 ±1.0 Mya
	Sinemurian	199.3 ±0.3 Mya
	Hettangian	201.3 ±0.2 Mya

Figure 6 - Jurassic Subdivisions

[Credit: Subcommittee on Jurassic Stratigraphy](#)

The Jurassic Period has conventionally been divided into the Lower, Middle and Upper Series corresponding to the Early, Middle and Late Epochs. This division was first proposed by the German geologist Leopold von Buch in 1839 who called the Lower Series the "[Black Jurassic](#)",

the Middle Series the "[Brown Jurassic](#)" and the Upper Series, the "[White Jurassic](#)". The stratigraphy of the Jurassic Period is mostly defined by ammonite index fossils.

Lower/Early Jurassic

There are four further subdivisions to the parts Lower/Early Jurassic: the [Hettangian](#) (201.3 - 199.3 Mya), the [Sinemurian](#) (199.3 - 190.8 Mya), the [Pliensbachian](#) (190.8 - 182.7 Mya) and the [Toarcian](#) (182.7 - 174.1 Mya).

The Hettangian Stage or age was first named by the Swiss palaeontologist, [Eugène Renevier](#), in 1864. The first appearance in the stratigraphic record of the ammonite genus [Psiloceras](#) marks the base of the Stage.

The French palaeontologist Alcide d'Orbigny first named the Sinemurian Stage in 1842. The first appearance in the stratigraphic record of the ammonite genera [Vermiceras](#) and [Metophioceras](#) defines the base of the Stage.

The Pliensbachian Stage was first named by German palaeontologist Albert Oppel in 1858; he named it after the village of Pliensbach, approximately 30 km east of Stuttgart, Germany. The base of the Stage is marked by the first appearance in the stratigraphic record of the ammonite species [Bifericeras donovani](#) and genera [Apoderoceras](#) and [Gleviceras](#).

In 1842, the French palaeontologist Alcide d'Orbigny named the Toarcian after the city of Thouars, just south of Saumur, France. The Toarcian Oceanic Anoxic Event and the first appearance in the stratigraphic record of the ammonite genus [Eodactylites](#) define the base of the stage.

Middle Jurassic

The Middle Jurassic is also divided into four Stages of ages; the [Aalenian](#) (174.1 - 163.5 Mya), the [Bajocian](#) (170.3 - 174.1 Mya), the [Bathonian](#) (168.3 - 170.3 Mya), and the [Callovian](#) (166.1 - 168.3 Mya).

The Swiss geologist [Karl Mayer-Eymar](#) first named the Aalenian in 1864 after the German town of Aalen, located about 70 km east of Stuttgart. The first appearance in the stratigraphic record of the ammonite genus [Leioceras](#) defines the base of the Stage.

The Bajocian Stage was named after Bayeux, France (*Bajocae* in Latin) by the French palaeontologist Alcide d'Orbigny in 1842. The first appearance in the stratigraphic record of the ammonite genus [Hyperlioceras](#) defines the beginning of the stage.

In 1852 the French palaeontologist Alcide d'Orbigny named the Bathonian after the town of Bath, England. The base of the stage is marked by the first appearance in the stratigraphic record of the ammonite species [*Parkinsonia \(Gonolkites\) convergens*](#).

The first appearance of ammonite genus [*Keplerites*](#) in the stratigraphic record marks the base of the Callovian Stage. French palaeontologist Alcide d'Orbigny named the stage in 1852 after the Latin name of the English village of Kellaways Bridge, located 3 km north-east of Chippenham, England.

Upper/Late Jurassic

There are three Stage/ages in the Upper/Late Jurassic: the [Oxfordian](#) (163.5 - 157.3 Mya), the [Kimmeridgian](#) (157.3 - 152.1 Mya) and the [Tithonian](#) (152.1 - ~145 Mya).

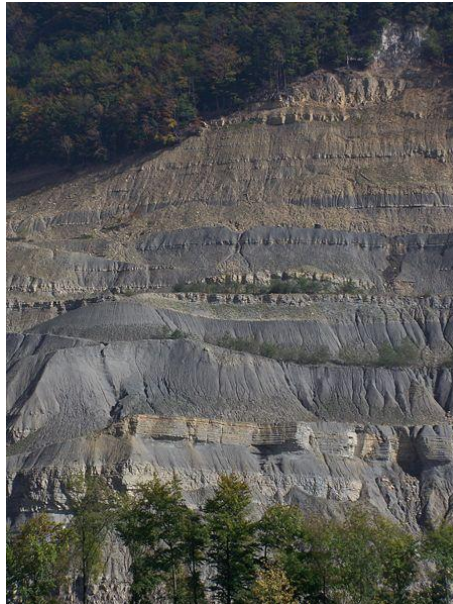


Figure 7 - Outcrop of Oxfordian Age Rocks, Péry-Reuchenette, Switzerland
Credit: [Woudloper](#), public domain

Named after Oxford, England, Alcide d'Orbigny first coined the name Oxfordian for the stage in 1844. However, rock formations in the stage had earlier been described by [William Smith](#) and [William Buckland](#). The first appearance in the stratigraphic record of the ammonite species [*Brightia thuouxensis*](#) marks the beginning of the stage.

Marked by the first appearance of ammonite species [*Pictonia baylei*](#) in the stratigraphic column, the Kimmeridgian stage was named by Alcide d'Orbigny in 1842 after the village of Kimmeridge on the Dorset coast of England.

The German geologist Albert Opper named the Tithonian, final stage in the Upper/Late Jurassic, in 1865 after character in Greek mythology, [Tithonus](#). The first appearance of the ammonite

biozone of [Hybonoticeras hybonotum](#) in the stratigraphic record marks the base of the Tithonian. The top of the Tithonian and the bottom of the first stage in the Cretaceous Period, the Berriasian, is defined by the first appearance in the stratigraphic record of small globular [calpionellids](#) of the species [Calpionella alpina](#). Calpionellids are the fossil remains of a single cell organism that arose in the Upper Jurassic and went extinct in the Lower Cretaceous.

Winding it Up

You might have noticed that the same names show up among the geologists who established the subdivisions of the Jurassic. We should remember the work of these pioneers. Here is one of them, in Figure 8.



Figure 8 - French Geologist Alcide d'Orbigny in 1802
Credit: [Cernuelle](#), public domain

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.