

**June 27, 2022**

## **News and notes**

Before going on to look at the events of the [Cretaceous Period](#), here are some news items that I thought were noteworthy.

## **Research**

- Ice ages: [The importance of Canadian Arctic Archipelago gateways for glacial expansion in Scandinavia](#); behind a paywall, Phys.org summary [here](#).
- Dust storms and quartz: [A Novel Proxy for Tracking the Provenance of Dust Based on Paired E1'-Peroxy Paramagnetic Defect Centers in Fine-Grained Quartz](#); Phys.org summary [here](#).
- Stable isotope analysis: [Hydrological control of river and seawater lithium isotopes](#); Phys.org summary [here](#).
- Pangaea research: [Increased Terrigenous Supply to the Pelagic Panthalassa Superocean Across the Carnian Pluvial Episode: A Possible Link With Extensive Aridification in the Pangean Interior](#).
- Pretty rocks: [The structural origin of the efficient photochromism in natural minerals](#); Sci-News.com summary [here](#).
- For geological engineers and engineering geologists who love math: [An investigation of integrating the finite element method \(FEM\) with grey system theory for geotechnical problems](#).

## **Plate Tectonics**

- Plate tectonics: [Earth's anomalous middle-age magmatism driven by plate slowdown](#).
- [Evidence for a lithospheric step and pervasive lithospheric thinning beneath southern New England, northeastern USA](#); behind paywall.
- [What controlled the thickness of continental crust in the Archean](#); behind paywall.
- San Andreas Fault: [Crustal transpressional fault geometry influenced by viscous lower crustal flow](#); behind paywall.

## **Paleontology and Evolution**

- Vampire squids: [Exceptional soft-tissue preservation of Jurassic \*Vampyronassa rhodanica\* provides new insights on the evolution and palaeoecology of vampyroteuthids](#); Live Science summary [here](#).
- From Live Science: [Lost fossil 'treasure trove' rediscovered after 70 years](#).

- From Peter Turchin, human evolution during the Holocene: [Disentangling the evolutionary drivers of social complexity: A comprehensive test of hypotheses](#); Eureka Alert summary [here](#).
- Improving systems for naming fossil species: [Revision of 18 ichneumonid fossil species \(Hymenoptera, Ichneumonidae\) highlights the need for open nomenclature in palaeontology](#).
- [30,000-Year-Old Baby Mammoth Found Almost Perfectly Preserved in Canadian Gold Fields](#).
- [A European giant: a large spinosaurid \(Dinosauria: Theropoda\) from the Vectis Formation \(Wealden Group, Early Cretaceous\), UK](#); Geology Page summary [here](#).
- [A new gigantic carnivore \(Carnivora, Amphicyonidae\) from the late middle Miocene of France](#).
- The [Journal of Paleontology](#) has published the memoir naming one a new trilobite (*Glossopleura youngi*) after [Dr. Graham Young](#), Curator of Geology & Paleontology at the [Manitoba Museum](#).

## Energy and Mining

- From Energy Now: [Quebec Gets Sued: Bill 21: Utica Resources sues the Quebec government for \\$18 Billion for violating Article 6 of the Quebec Charter of Rights and Freedoms](#).
- Mineral deposit research: [Qia'erdunbasixi Fe–Cu Deposit in Sawur, Xinjiang: A Case Study of Skarn Deposit Hosted by Volcanic Rock](#).
- Mining wastes: [Influence of clay mineral content on mechanical properties and microfabric of tailings](#).
- This is one of the things that affects retail prices, from the United States Energy Information Administration (USEIA): [Refinery Capacity Report](#).
- Price crash: [Metals haven't crashed this hard since the Great Recession](#); demand destruction?
- [Romania Bets On Nuclear Energy To Reduce Dependence On Russian Gas](#); related: [French Energy Companies Ask Customers To Use Less Gas](#).
- Tight oil and gas: [New Regulations In Permian Could Deter Drilling](#).

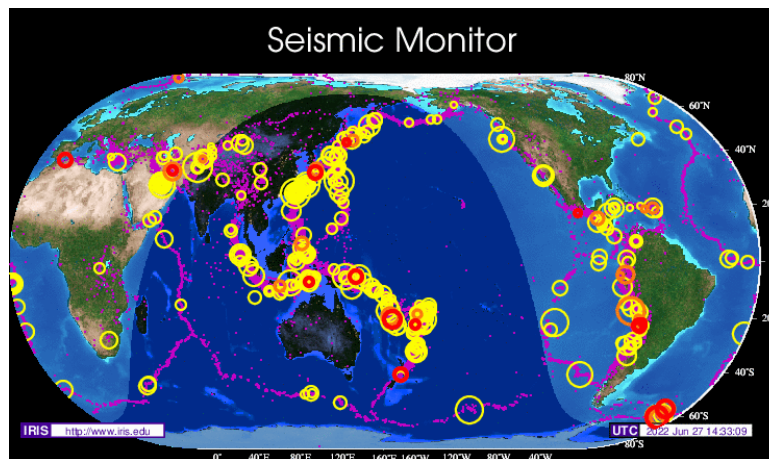
## Environmental Geology and Hydrogeology

- No evidence for methane leaks from shut-in wells: [Constraining well integrity and propensity for fugitive gas migration in surficial soils at onshore decommissioned oil and gas well sites in England](#); Phys.org summary [here](#).

## Climate Change

- [Sea level rise drives carbon and habitat loss in the U.S. mid-Atlantic coastal zone](#); Phys.org summary [here](#).
- Ancient climate change and plate tectonics: [Transient mobilization of subcrustal carbon coincident with Palaeocene–Eocene Thermal Maximum](#); Phys.org summary [here](#).
- More ancient climate change, End Permian Mass Extinction; [Marine siliceous ecosystem decline led to sustained anomalous Early Triassic warmth](#); Phys.org summary [here](#).
- Glaciers and climate change: [Arctic glaciers and ice caps through the Holocene: a circumpolar synthesis of lake-based reconstructions](#).
- From Eos, carbon cycle and climate change: [Mysteries of the Global Carbon Cycle](#).

## Geohazards, Volcanoes and Earthquakes



### [Seismic Monitor Link](#)

- Earthquakes triggered by wastewater injections: [Slip Characteristics of Induced Earthquakes: Insights From the 2015 M w 4.0 Guthrie, Oklahoma Earthquake](#); Eos summary [here](#).
- Alaskan volcanoes: [Structure of the magma plumbing system beneath Semisopchnoi Island \(Aleutian Arc\) inferred from seismic tomography](#).
- From Eos: [Unlocking the Magmatic Secrets of Antarctica's Mount Erebus](#).
- [June 22, 2022 Afghanistan earthquake](#) in Afghanistan.
- Geophysics and earthquakes: [Transient variation in seismic wave speed points to fast fluid movement in the Earth's outer core](#); Phys.org summary [here](#).
- More geophysics and earthquakes: [Complex trans-ridge normal faults controlling large earthquakes](#).
- [Worldwide Volcano News and Updates](#).

June 27, 2022

## The Cretaceous Period

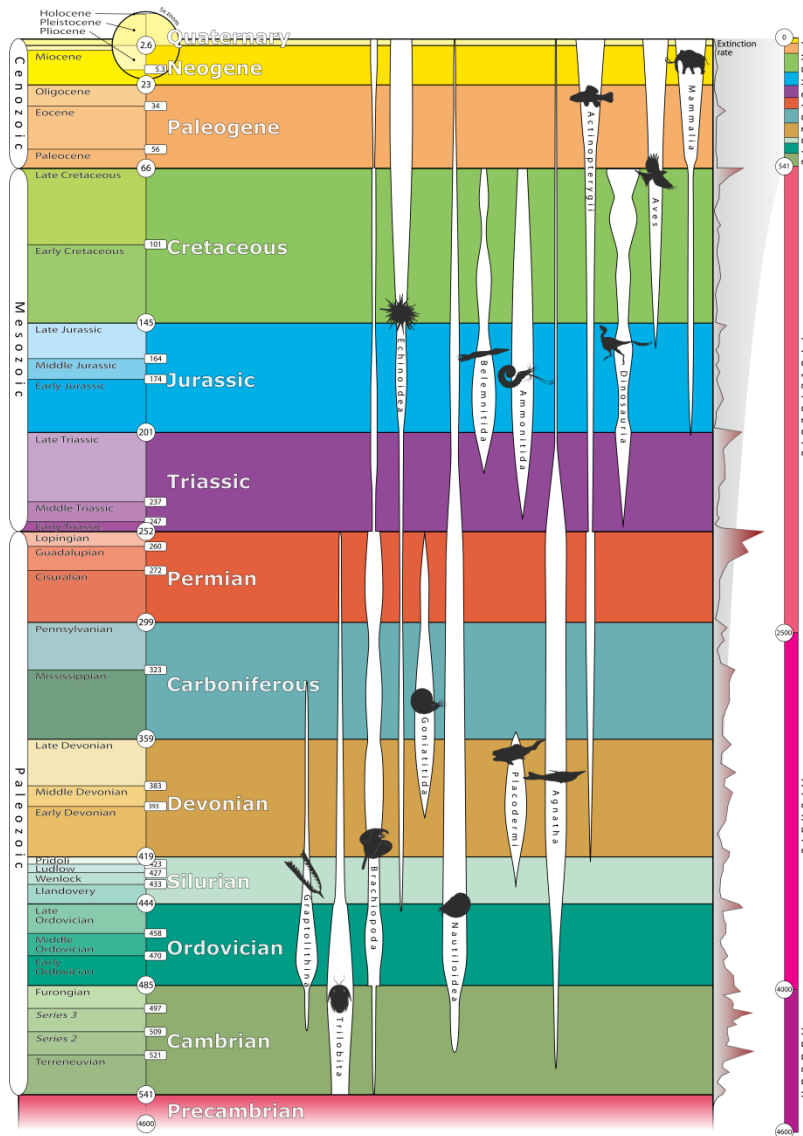


Figure 1 - Geological Time Scale

Credit, Frederik Lerouge, [Creative Commons Attribution-Share Alike 4.0 International license](https://creativecommons.org/licenses/by-sa/4.0/)

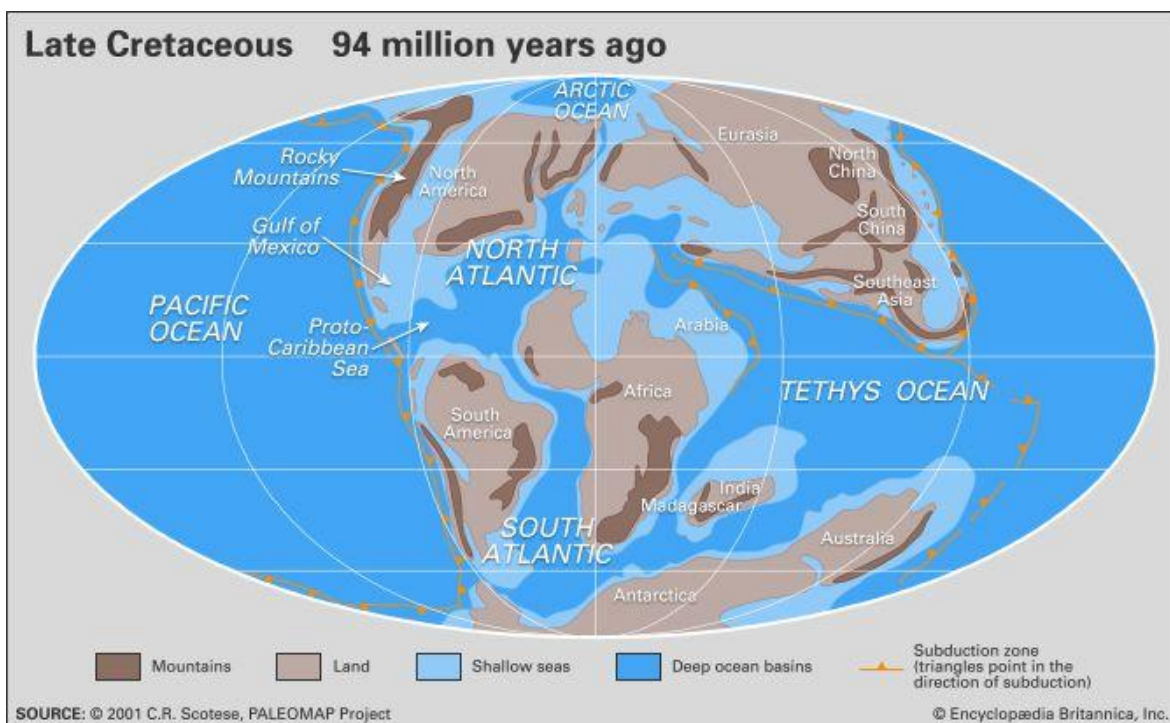
The [Cretaceous Period](#) is one of the longest geological periods, lasting about 79 million years from about 145 to 66 million years ago (Mya). It is preceded by the [Jurassic Period](#) and followed by the [Paleogene Period](#). The end of the Cretaceous marks the end of the [Mesozoic Era](#).

Many Cretaceous formations in Europe are chalk and the name, Cretaceous, comes from the Latin name for chalk, *creta*. The abbreviation for the period is K, from the German name for chalk, *kreide*.

The beginning of the Cretaceous Period is not well defined; it has been traditionally accepted to be the first occurrence in the fossil record of [Berriasella jacobi](#); however since 2016 geologists have used the first occurrence of [Calpionella alpina](#). The [end of the Cretaceous](#), on the other hand, is unambiguous, a layer of rock containing an abundance of iridium, coincident with the [Cretaceous–Paleogene extinction event](#) (K/Pg Event, formerly called the K/T Event).

In this week we'll look at the Cretaceous Period, its paleogeography, climate, subdivisions, and how it came to an end in the K/Pg Event. In the following weeks we'll take a look at the fossils from the period.

## Paleogeography



**Figure 2 - Cretaceous Paleogeography**

**Credit: Encyclopædia Britannica**

The periodic amalgamation and breakup of [supercontinents](#) in [plate tectonics](#) is called the [Wilson Cycle](#). The Cretaceous Period was one where [Laurasia](#) and [Gondwana](#), broke up into their constituent [cratons](#). Earlier, during the [Triassic Period](#), the supercontinent [Pangaea](#), split up into Laurasia and Gondwana, and this process of continental separation continued during the Cretaceous.

The breakup of Laurasia, which began in the [Jurassic Period](#) with the split between the North America and African plates, continued during the Cretaceous with the separation of the [North American Plate](#) from the [Eurasian Plate](#) to widen the Atlantic Ocean. Gondwana also began to

breakup during the Jurassic and it continued to separate into the plates making up [South America](#), [Antarctica](#), [Australia](#), [India](#) and [Madagascar](#).

Then, as now, oceans and seas covered most of the world. The major oceans were the Pacific and [Tethys](#). [Epicontinental seas](#) covered central North America as well as parts of all the other continents, as shown in Figure 2, above.

## Climate

One of the consequences of the widespread inundation of many continents was the efficient transfer of heat from the tropical regions to the high latitudes. As well, [increased volcanic activity](#) seems to have led to higher temperatures, especially as the Cretaceous Period went on. As the result, the climate during the Cretaceous was generally warmer than present day. While there is evidence for [glaciation in Australia](#) during the [Early Cretaceous](#), overall, the presence of forests throughout the world at all latitudes suggest a generally warm climate.

Figure 3, below shows a computer-simulated model of mid-Cretaceous surface temperatures, around 100 Mya. The model suggests that the average global temperature was about 4.8 °C warmer than the present.

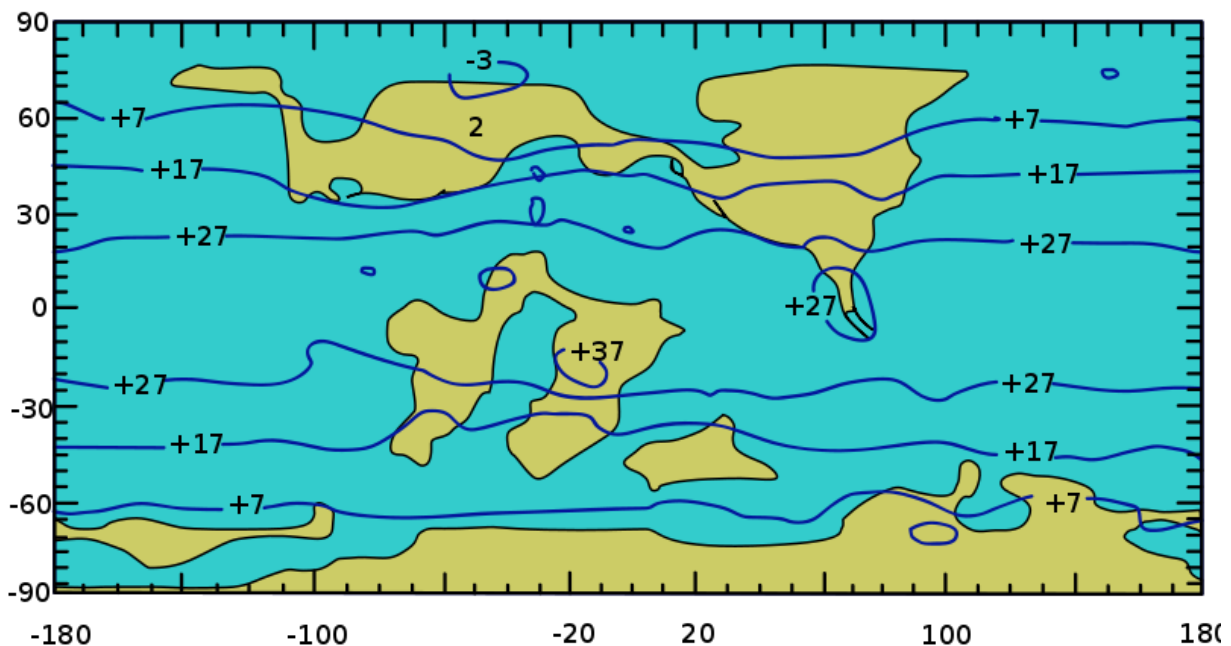


Figure 3 - Isotherm Map of the World, ~ 100 Mya, °C

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

The efficient transfer of heat from the equatorial regions to the poles also meant generally gentler winds. This in turn led to a decrease in upwelling of deep ocean water and an increase

in the number of anoxic zones as is shown by an increase in the deposition of black shales. As well, overall [ocean temperatures](#) increased during the Cretaceous.

## Divisions

Subperiod or Epoch	Stage or Age	Start (Mya)	End (Mya)	Definition	Etymology
Late Cretaceous	<a href="#">Maastrichtian</a>	72.1 ± 0.2	66	top: <a href="#">iridium anomaly at the Cretaceous–Paleogene boundary</a> base: <a href="#">first occurrence of <i>Pachydiscus neubergicus</i></a>	<a href="#">Maastricht Formation</a> , Maastricht, Netherlands
	<a href="#">Campanian</a>	83.6 ± 0.2	72.1 ± 0.2	base: <a href="#">last occurrence of <i>Marsupites testudinarius</i></a>	<a href="#">Champagne</a> , France
	<a href="#">Santonian</a>	86.3 ± 0.5	83.6 ± 0.2	base: <a href="#">first occurrence of <i>Cladoceramus undulatoplicatus</i></a>	<a href="#">Saintes</a> , France
	<a href="#">Coniacian</a>	89.8 ± 0.3	86.3 ± 0.5	base: <a href="#">first occurrence of <i>Cremnoceramus rotundatus</i></a>	<a href="#">Cognac</a> , France
	<a href="#">Turonian</a>	93.9 ± 0.8	89.8 ± 0.3	base: <a href="#">first occurrence of <i>Watinoceras devonense</i></a>	<a href="#">Tours</a> , France
	<a href="#">Cenomanian</a>	100.5 ± 0.9	93.9 ± 0.8	base: <a href="#">first occurrence of <i>Rotalipora globotruncanoides</i></a>	<a href="#">Cenomanum</a> ; <a href="#">Le Mans</a> , France
Early Cretaceous	<a href="#">Albian</a>	113.0 ± 1.0	100.5 ± 0.9	base: <a href="#">first occurrence of <i>Praediscosphaera columnata</i></a>	<a href="#">Aube</a> , France
	<a href="#">Aptian</a>	125.0 ± 1.0	113.0 ± 1.0	base: <a href="#">magnetic anomaly M0r</a>	<a href="#">Apt</a> , France
	<a href="#">Barremian</a>	129.4 ± 1.5	125.0 ± 1.0	base: <a href="#">first occurrence of <i>Spitidiscus hugii</i> and <i>S. vandeckii</i></a>	<a href="#">Barrême</a> , France
	<a href="#">Hauterivian</a>	132.9 ± 2.0	129.4 ± 1.5	base: <a href="#">first occurrence of <i>Acanthodiscus</i></a>	<a href="#">Hauterive</a> , Switzerland
	<a href="#">Valanginian</a>	139.8 ± 3.0	132.9 ± 2.0	base: <a href="#">first occurrence of <i>Calpionellites darderi</i></a>	<a href="#">Valangin</a> , Switzerland
	<a href="#">Berriasian</a>	145.0 ± 4.0	139.8 ± 3.0	base: <a href="#">first occurrence of <i>Berriasella jacobi</i></a> (traditionally) <a href="#">first occurrence of <i>Calpionella alpina</i></a> (since 2016)	<a href="#">Berrias</a> , France

**Table 1 - Subdivisions of the Cretaceous**

**Credit:** based upon the [Subcommission on Cretaceous Stratigraphy](#)

The rocks of the Cretaceous were first described in Europe, so they got to name the subdivisions, usually after localities in Europe that had the type section for the subdivision. The geologists divided the Cretaceous into two epochs: [Early Cretaceous](#) and [Late Cretaceous](#) each of which was divided into six ages, as in Table 1 above.

## The End of the Cretaceous - an [Earth Shattering Kaboom](#)

The end of the Cretaceous in the [K/Pg Mass Extinction Event](#) is one of those fascinating stories of how science works. First, geologists have known for a long time that something dramatic happened at the end of the Cretaceous that led to the extinction of approximately three-quarters of the plant and animal species on Earth approximately 66 Mya. Major groups of animals that disappeared included the [dinosaurs](#) and [ammonites](#) as well as [many others](#).

Among the proposed causes were:

- Disease;
- Heat waves and resulting sterility;
- Freezing cold spells;
- Pesky egg-eating mammals;
- The rise [angiosperm](#) plants that dinosaurs couldn't eat;
- X-rays from a nearby exploding supernova;
- Senescence, inability to adapt to changing conditions; and
- The wrath of an angry God.

A lot of these hypotheses were based on little more than the reputation of the geologist making the speculation. However, beginning in 1980, geologist [Walter Alvarez](#) and his father, the physicist [Luis Alvarez](#) began, as all good geology begins, with the rocks. Specifically they looked at the deposits at the boundary between the Cretaceous and the Paleogene (K/Pg boundary).



**Figure 4 - K/Pg Boundary, Drumheller AB**  
**[Credit: Glenlarsen, public domain](#)**

In many places the K/Pg boundary is marked by a black, or dark layer of clay, as in Figure 4. Walter and Luis Alvarez, together with chemists [Frank Asaro](#) and [Helen Michel](#) found that this layer had [elevated concentrations](#) of [iridium](#), a finding consistent with an asteroid impact. [Subsequent investigations](#) identified a buried crater with the right age in the Yucatan Peninsula of Mexico that they called [Chicxulub](#), after the town of [Chicxulub](#). Argon-argon dating of rock associated with the K/Pg boundary [nailed down the date of the event](#) to 66.043 Mya ( $\pm 0.011$ ), Drilling [investigations in 2016](#) confirmed the theory.

The effects of the impact was truly horrific. Debris from the impact sparked fires around the world, darkening the sky for months or years. The darkening sky also stopped vegetative growth. The destruction of their food supply doomed the herbivorous dinosaurs and the predators that relied on them. In the oceans, disruption of the ecosystems by climate change and acidification also doomed animals like the ammonites.

As if the impact wasn't bad enough, there is evidence to believe that it triggered [volcanic eruptions on the Indian Plate, the Deccan Traps](#). In fact, the impact, and [other events](#) probably worked together to make the mass extinction a case of [Murphy's Law](#), where anything that can go wrong, will go wrong, and at the worst possible time. It was not a good time to be alive.



**Figure 5 -Artist's Conception of K/Pg Asteroid Impact**  
**Credit: [Don Davis/NASA, public domain](#)**

Lots more has been written on the K/Pg Mass Extinction Event, so follow up if this interests you.

### **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.