January 12, 2026

News and notes

Hoarfrost on trees, January 6, 2026

I welcome comments and after last weeks posting, one of my readers, Marcus S., suggested taking a deeper look at the fossils found in Morocco. Also, my sister has repeatedly told me how much she likes the posts on interesting animals from the past. So the paleontological treasures of Morocco will be the theme of this week's post.

However, before going on to take a look at some of the neat fossils from Morocco, we will first look at some news items I thought were interesting. The picture above is from Island Park, Portage la Prairie.

If you enjoy my blogs, bookmark the site and check on Mondays rather than relying on social media postings which can get lost in the shuffle. For my news items, I try to stick to open access papers.

Comments

If anyone has comments on any of my postings, please leave a comment on the Linkedin page for the posting or email me at raymondreichelt@gmail.com.

Geopolitics

- Venezuela:
  - Uninvestable: Why Big Oil Is Apprehensive About Trump's Venezuela Deal.
  - Trump’s Venezuela Oil Gambit Sparks Alarm Across the U.S. Shale Patch.
  - Trump says US oversight of Venezuela could last years.
  - Breaking: U.S. Forces Seize Russian-Flagged Oil Tanker, Escalating Clash Over Post-Maduro Venezuela.
  - Dense, sticky and heavy: why Venezuelan crude oil appeals to US refineries.
- Iran
  - Iran Protests Live: Iran unrest worsens with nearly 500 killed as internet blackout continues.
  - Why Images Of Iranian Women Lighting Cigarettes With Khamenei's Photo Are Going Viral.
- Greenland
  - Greenland should hold talks with the US without Denmark, opposition leader says;
  - Greenland is rich in natural resources – a geologist explains why.
- Russian Oil Squeezed Out of Global Markets: From Breadwinner to Niche Revenue as the Kremlin’s Core Revenue Collapses.

Research and News

- Beyond the Bulk: Magnetic Property Variations With Sediment Grain Size. Insights Into Process and Provenance.
- Crushing rocks in the lab: Measuring Stress in High-Pressure Deformation Experiments with High-Speed Fiber Optics.
- Landslide influence on delta stratigraphy, northeastern Gulf of Mexico.
- Evaluating the possible role of bottom currents and internal waves in shaping seafloor morphology in a mesophotic reef.
- Effects of Aging on Magnetic Mineralogy of Natural Volcanic Glass: Implications for Geomagnetic Paleointensity Recorders.
- Geomagnetic Variability in a Post-Superchron Geodynamo: Insights From the Deccan Traps.
- A Mesoproterozoic mixed siliciclastic–carbonate deposit from the Kurnool sub-basin, India: implications for the Proterozoic non-skeletal carbonate factory dynamics and post-Columbia intracratonic rifting.

- A rare occurrence of garnet–aluminosilicate (kyanite, sillimanite, andalusite)-bearing anatectic metapelites from the northern Indo-Burma region, Dibang Valley, NE India: a comprehensive synthesis of chemical, mineralogical and petrological approach.

- Video: You Are In the Precambrian Eons (Compilation)

Plate Tectonics

- Late Miocene garnet-bearing andesites in the Northern Andes and their tectonic implications.

- Deep crustal hot zones control shallow magma reservoirs in an active transcrustal magmatic system.

- Self-organized thermoelectric conversion systems on the deep seafloor.

- Intraplate Volcanism Driven by Slab-Plume Interaction: Numerical Modeling and Its Application to the Eifel, Massif Central and Hainan Volcanic Areas.

- Lithospheric models supported by the Caribbean and Levant examples help rethink transpression at plate boundaries.

- Tectonic implications of transitional melting regimes from petrological, geochronological, and compositional characterization of the ophiolitic Seventymile terrane, Alaska, USA.

- Anatomy of Rift-Segmenting Transfer Zones: New Insights From the 3D Integrated Interpretation of the Southeastern Sector of the Basque-Cantabrian Basin and the Pamplona Fault (Pyrenees, N Spain).

Paleontology

- A highly diverse Pennsylvanian tetrapod ichnoassemblage from the Semily Formation (Krkonoše Piedmont Basin, Czechia).

- Mass extinction triggered the early radiations of jawed vertebrates and their jawless relatives (gnathostomes).

- A hidden diversity of ceratopsian dinosaurs in Late Cretaceous Europe.

- High paleolatitude onychodont and rhizodont remains from the upper Famennian (Upper Devonian) Waterloo Farm lagerstätte of South Africa.

- Horses and elephants: Blancan climate and feeding strategies of proboscideans and equids revealed by a multi-proxy geochemical analysis from a new locality in north-western Mexico.

- An unusual harvestman from Eocene Baltic amber presenting a previously unknown morphology of the pedipalps.

- Organic-walled microphytoplankton from the West Midlands, England, following the end-Triassic mass extinction: palynological evidence from the Prees 2 borehole, Cheshire Basin.

- The petrosal and bony labyrinth of extinct horses (Perissodactyla, Equidae) and their implications for perissodactyl evolution.

Mining and Energy

- Egypt Announces Oil and Gas Discoveries in Western Desert.
- Copper geology: Copper-rich fluids arising from sulfide resorption by hydrous arc melts; related Dominant monosulfide solid solution fractionation causes Cu deficit in continental crust.
- Trump, Congress move to overturn Minnesota mining ban.
- First Mining Gold promises thousands of jobs with northwest Ont. mine project.
- From Nomi Prins: Five Key Commodities On Our Radar in 2026.
- 43 Million Tons: Germany Confirms One of the World's Largest Lithium Deposits in Former Gas Field.
- Ore geology: Controls on REE mineralization in the Tioueine ring complex (Western Hoggar, Algeria): examination of magmatic vs hydrothermal processes.
- Opposition to a graphite mine: 'Our minerals could be used to annex us': why Canada doesn't want US mining.

Environmental Geology and Hydrogeology

- Arizona Comes to Agreement With Major Dairy Farm to Cut Groundwater Pumping That Is Draining Wells.
- Seismicity diagnostic of permeability creation from centimeter to subkilometer scales in crystalline rock during shear stimulation.

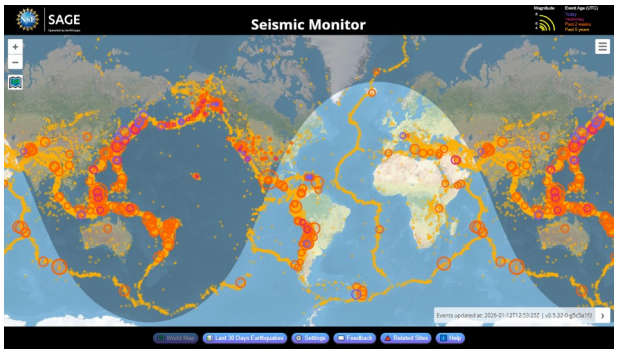
Glaciers and Climate Change

- Scientists hit bedrock in Antarctica and uncover 1.2 million years of Earth's history.
- "Communication Efforts to Educate the Public about Vanishing Glaciers, 1958-2025"
- Giant Iceberg Implodes in Antarctica, Creates Refraction Waves (Video).
- Soft-bedded ice sheet in hummocky terrain of north-central Poland: Origin of rim ridges and subglacial processes.
- In memory of Kari-Huayra-Razu, a recently ice cap disappeared in the inner tropics.
- A new era of bioclimatic extremes in the terrestrial Arctic; Phys.org summary here.
- The climatic constraints on speleothem deposition in SW Asia.
- Deglaciation of the Prudhoe Dome in northwestern Greenland in response to Holocene warming; Phys.org summary here.

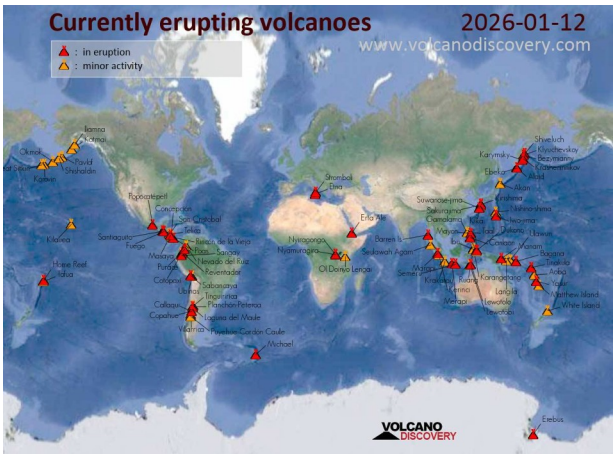
Bad Science

- Professor suspended after Japanese university finds fishy results in sushi paper.
- Watchdog halts nuclear plant safety review after seismic data found to be fabricated.
- The junkification of research; summary in The Conversation here.

Volcanoes, Earthquakes and Geohazards



Seismic Monitor



Active Volcano Map

Volcanoes

- Smithsonian / USGS Weekly Volcanic Activity Report.
- United States Geological Survey (USGS) Volcano Observatories:
  - Caldera Chronicles: It's baaaaaack… The Norris Uplift Anomaly.
  - Cascades Volcano Observatory Weekly Update.
  - Volcano Watch – A look back on the episodic Kīlauea Iki eruption in 1959.
- Hydroacoustic Observations of the 15 January 2022 Hunga Tonga-Hunga Ha'apai Eruption: The Role of Bathymetry Along the Path.
- As if Iran doesn't have enough problems already: Volcano wakes up after 700,000 years, is now considered 'stirring'.

Earthquakes

- Euro-Mediterranean Seismological Centre (EMSC).
- Earthquakes Monitoring Live Worldwide.
- An Entropic Explanation for Gutenberg-Richter Scaling.

- Spatial Interactions Govern Tectonic Tremor Activities in the Nankai Trough: A Statistical Approach for Spatiotemporal Pattern Modeling and Anomaly Detection.
- Earthquakes Deep Below Antarctic Waters Seem to Have Surprising Effects on Life at the Surface.
- M5.7 earthquake in western Japan causes minor damage; USGS summary here.
- Magnitude Conversion Relations Create Substantial Differences in Seismic Hazard Models.

Free Geology Books and Other Stuff

Free geology books can be downloaded from these sites:

- OreZone Readers and Experts Telegram Channel; the Ore Zone channel also shows employment opportunities for geologists.
- The Groundwater Project has many groundwater geology books for free download together with free online courses, listed here.
- Free Groundwater Modeling Courses from the HydroGeoCenter.
- From Western Australia: Carbonatite, lamprophyre and host rocks in the northern Aileron Province.
- The Geology of Indonesia: Volume 1 and Volume 2.
- Brett Davis' book on veins in a deforming rock mass: "The Veining Bible"; also at this site.
- From the Mineralogical Society of America: Handbook of Mineralogy.
- Free communications courses for Canadian P.Geo. or GIT from Geoscientists Canada.

Upcoming Events

- January 14, 2026 from 9am to 4:30pm GMT, IAH (Irish Group) CPD Course: Groundwater, Hydrology and Climate Change.
- Feb. 16-18, 2026, Inaugural Mineralogical Society of America Annual Meeting, Tuscon AZ
- GAC-MAC 2026 St. John's NL, St. John's Convention Center, May 25-28, 2026.
- PEG2026: 11th International Symposium on Granitic Pegmatites; 16th–19th August 2026, in Perth, Western Australia.
- 14-18 September 2026 , IAH 2026, 53rd Congress of the International Association of Hydrogeologists; Budapest Congress Center.
- Society of Petroleum Engineers Distinguished Lecturer Schedule.
- American Geophysical Union List of Upcoming Meetings.
- The Geological Society: Events & Courses.

January 12, 2026

Paleontology of Morocco

Introduction

Figure 1 – Fossils from Morocco
Credit: Yair Haklai, Creative Commons Attribution-Share Alike 4.0 International license

With it's long geological history, Morocco has a wealth of fossils. Fossils found in Morocco range in age from the Ediacaran Period of the Neoproterozoic Era to the Quaternary Period of the current Cenozoic Era. Fossils are also a commercial commodity in Morocco, so if you want, you can have your very own piece of Morocco's past.

So let's get started with the ancient days of the Neoproterozoic and work our way to more modern times.

Neoproterozoic

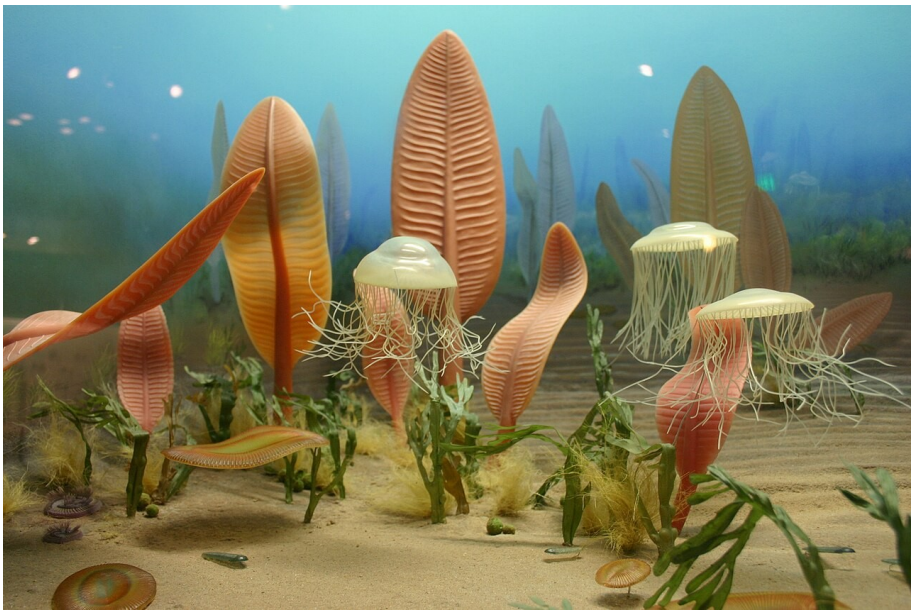


Figure 2 – Ediacaran Biota
Credit: Ryan Somma, Creative Commons Attribution-Share Alike 2.0 Generic license

Most living things that die do not make fossils. Usually, if something dies, some other living thing will consume it, be that thing a large predator or a tiny microbe. However, given favourable circumstances, the remains of a living thing can leave something behind for future creatures, like us, to ponder. The most favourable circumstances for fossil preservation, such as deep sedimentary basins with anaerobic conditions, can lead to the formation of lagerstätte, locations of exceptional fossil preservation. In Morocco we have a lagerstätte in the Adoudou Biota, a group of fossils from the Tabia Member of the Adoudou Formation in the western Anti-Atlas of Morocco. The Adoudou Formation was deposited at the boundary between the Ediacaran and Cambrian periods and includes trace fossils, trackways and burrows the substrate, as well as body fossils. Trace fossils from the Adoudou Formation include *Treptichnus*, *Bergaueria*, and *Helminthopsis*. Body fossils include *Aspidella* and *Nimbia occlusa*.

Figure 3 – Aspidella Fossil
Credit: Cg.ediacaran, Creative Commons CC0 1.0 Universal Public Domain Dedication

Paleozoic Fossils

Figure 4 - *Furca mauritanica* from the Fezouata Formation
Credit: Didier Descouens, Creative Commons Attribution-Share Alike 3.0 Unported license

A spectacular lagerstätte in Morocco is the Upper Ordovician aged Fezouata Formation. The fossils from the Fezouata Formation occur within 500 square kilometres in southeast Morocco's Draa Valley, north of Zagora. Most of the fossils are found in a 1.1 kilometres thick column of rock that spans the Tremadocian and Floian epochs. Over 1,500 non-mineralized specimens, representing 50 distinct taxa, have been found in the Fezouata Formation including: arthropods such as radiodonts, and trilobites; echinoderms; molluscs; conodonts; graptolites; brachiopods; sponges (but not this one); and other animals. While I can't list them all, here are a few examples:

Radiodonts, Trilobites and other Arthropods

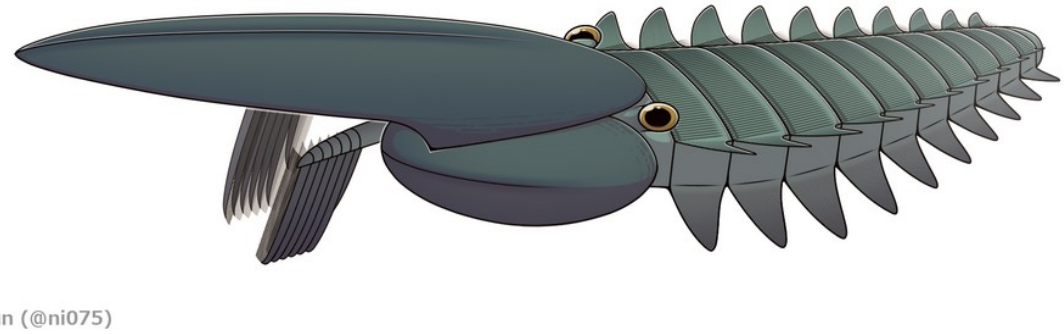


Figure 5 – Reconstruction of *Aegirocassis sp.*
Credit: Junnn11, Creative Commons Attribution-Share Alike 4.0 International license

Radiodonts are an extinct order of stem-group arthropods that lived from the Cambrian till the Early Devonian. Besides *Aegirocassis sp*., other genera of radiodonts found in the Fezouata Formation include *Falciscaris sp*., and *Pseudoangustidontus sp*.

Trilobites

Figure 6 - *Asaphellus sp.*
Credit: Daderot, Creative Commons CC0 1.0 Universal Public Domain Dedication

Trilobites are another order of extinct arthropods. Very successful in their time, trilobites lived throughout the Paleozoic, arising in the Cambrian and going extinct at the end of the Permian Period. Some 38 separate genera of trilobites have been found in the Fezouata Formation, so far. Besides five species of *Asaphellus sp*., other genera of trilobites found in the Fezouata include: *Ampyx sp*.,

Anacheirurus sp., *Basilicus sp.*, *Bathycheilus sp.*, *Bavarilla*, *Colpocoryphe sp.*, *Foulonia sp.*, *Geragnostus sp.*, *Harpides sp.*, *Megistaspis sp.*, *Ogyginus sp.*, *Selenopeltis sp.*, and *Symphysurus sp.*

Molluscs

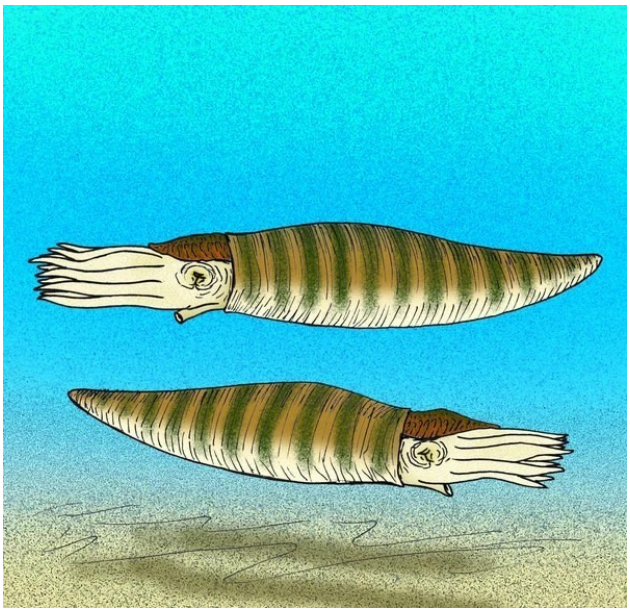


Figure 7 – *Bathmoceras sp*.
Credit: Extinct Animals Wiki, CC-BY-SA

About 22 genera of molluscs are found in the Fezouata Formation including bivalves, gastropods, and cephalopods like *Bathmoceras sp*., shown above. Other mollusc genera in the Fezouata Formation include: *Bactroceras sp.*, *Calvapilosa sp.*, *Ribeiria sp.*, and *Rioceras sp.*

Sponges

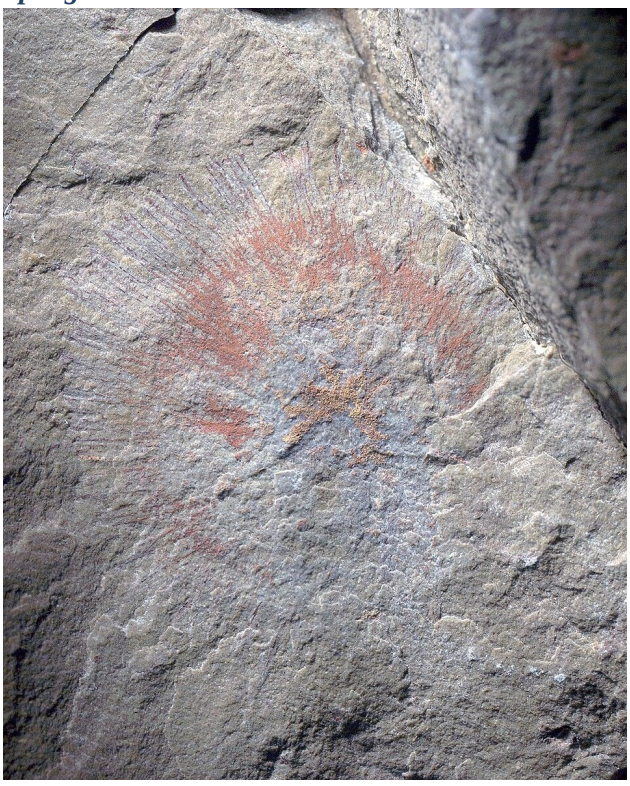


Figure 8 – *Choia sp*.
Credit: Utrup, J., Creative Commons CC0 1.0 Universal Public Domain Dedication

Sponges have been around for a long time, but are rarely found in the fossil record. But in the Fezouata Formation we have four of them including: *Choia sp.*, *Choiaella sp.*, *Hamptonia sp.*, and *Pirania*.

There are lots more fossils from the Fezouata Formation, a more complete list is found in the Wikipedia page on the formation.

Mesozoic Fossils

Jurassic

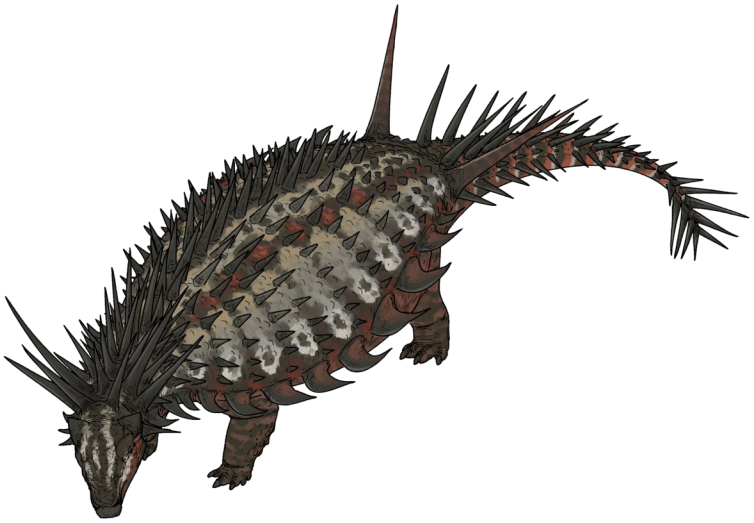


Figure 9 – Life reconstruction of *Spicomellus afer*
Credit: Connor Ashbridge, Creative Commons Attribution-Share Alike 4.0 International license

Jurassic aged formations in Morocco have yielded an impressive array of fossils, including *Spicomellus afer*, depicted above. *S. afer* was found in the El Mers Group in the Middle Atlas Range. The el Mers Group was deposited in a coastal to shallow marine depositional environment beginning in the Bajocian Age until the Callovian Age. Besides dinosaurs, the El Mers Formation includes fossils of: foraminifera, dinoflagellates, brachiopods, ostracods, xiphosura (horseshoe crabs), molluscs, echinoderms, fishes, turtles, crocodiles, algae (dasycladales and charophyta), and plants.

Other Jurassic aged formations with impressive fossil include:

- The Tafraout Group (Toarcian–Aalenian) deposited in a succession of fluvial to tidal flat to inner platform to open marine settings; fossils include: foraminifera, tubes of serpulid worms, sponges, anthozoa, brachiopods, molluscs, echinoderms, annelid worms, dinosaurs (such as *Berberosaurus*), and various plants.
- The Guettioua Formation (Bathonian–Callovian), continental sandstone, contained a fossil of *Atlasaurus*.
- The Anoual Formation (Bathonian), marine limestones, marl, and mudstone, fossils include: brachiopods, crustaceans, molluscs, fish, amphibians, turtles, scaled lizards, choristoderes

reptiles, dinosaurs, pterosaurs, crocodiles, early mammals such as Amphitheriidae, charophyte algae, and various plants.

- The Ksar Metlili Formation (Tithonian–Berrasian) crosses the Jurassic-Cretaceous boundary mudstone and sandstone deposited in a near shore deltaic environment, fossils include: fish, amphibians, scaled lizards, turtles, choristoderes reptiles, crocodiles, pterosaurs, dinosaurs, early mammals such as cynodonts, and plants.

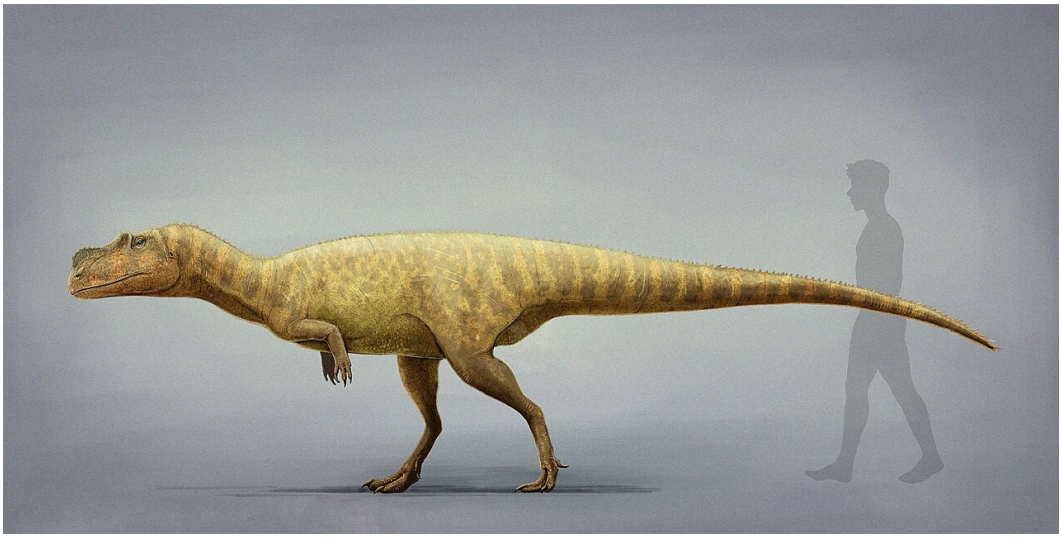


Figure 10 – Life restoration of *Berberosaurus*
Credit: Mario Lanzas, Creative Commons Attribution-Share Alike 4.0 International license

Cretaceous

Figure 11 - Life reconstruction of *Anhanguera sp.*
Credit: Matt Martyniuk, Creative Commons Attribution-Share Alike 3.0 Unported license

The most prolific source of Cretaceous aged fossils in Morocco are those deposited during the Late Cretaceous, especially those deposited in the the Kem Kem Group. Deposited in a deltaic environment, the Kem Kem Group has yielded fossils of cartilaginous fish, ray finned fish, lobe finned fish, amphibians, lizards, snakes, plesiosaurs, turtles, crocodiles, dinosaurs, and pterosaurs (like *Anhanguera sp.* above).

In addition to the links noted above, here are a couple of articles on the Kem Kem Group for further reading:

- Giant sea lizards: fossils in Morocco reveal the astounding diversity of marine life 66 million years ago, just before the asteroid hit.
- Geology and paleontology of the Upper Cretaceous Kem Kem Group of eastern Morocco

Cenozoic Fossils

Figure 12 – Early *Homo Sapiens* skull from Jebel Irhoud
Credit: Jonathan Chen, Creative Commons Attribution-Share Alike 4.0 International license

Many of the Cenozoic aged fossils in Morocco are from the Rif region of Morocco. A well studied locality is the Jebel Irhoud. Fossils recovered from Jebel Irhoud include rodents, golden jackal, various alcelaphines, gazelle, leopards, lions, small cats, hyena, wild boar, and some 16 specimens of early *Homo Sapiens*. Ella Al-Shamahi presents an interesting discussion of the Jebel Irhoud *Homo sapiens* fossils here.

More recently, the fossils of even earlier hominins have been reported from the Thomas Quarry I in Casablanca, Morocco.

Summary

Figure 13 – Paleontologist Nizar Ibrahim
Credit: Evolution Soup, Creative Commons Attribution-Share Alike 4.0 International license

I have only scratched the surface here. Whole books await to be written on the paleontology of Morocco. So if any of this interests you, follow up on the links above. Better yet, if you are an aspiring paleontologist, Morocco would be a great place to do your studies.

Standard Caveat

J. Robert Oppenheimer on freedom and scientific inquiry

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.