June 1, 2026

Apple Blossoms May 28, 2026

News and notes

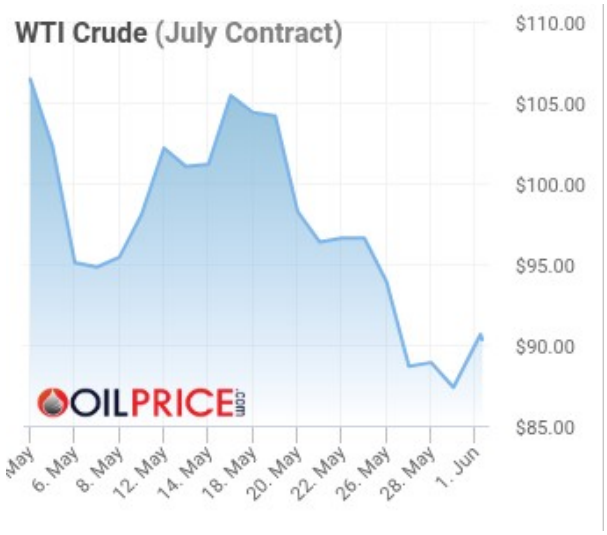
Here are some news items that I thought were interesting. For my news items, I try to stick to open access papers. The photo above is from the apple tree in my yard.

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.

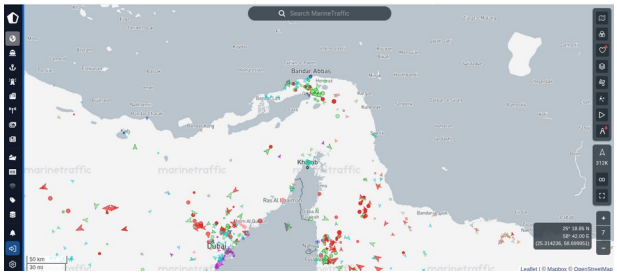
Comments

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



Oil prices up to June 1, 2026
Credit: Oilprice.com



Marine Traffic in the Strait of Hormuz
Credit: marinetraffic.com

Iran War

- On going coverage of the Iran War from Al Jazeera, based in Qatar.
- Iran and Qatar share this field: Three offshore platforms resume production at Iran's South Pars gas field, IRNA reports.
- Chevron CEO: Multiple Ships Attacked In Strait of Hormuz.
- Impacts of Middle East conflict set to reshape energy investment plans as disruptions put focus on security.
- Iran war splits global markets into clear winners and losers.
- From the WSJ: The High-Seas Black Market That Keeps Iran's Illicit Oil Flowing.

Other Geopolitics

- Riots erupt across France after PSG Champions League victory; related: Le Pen Leads Every Major Rival In New French Presidential Runoff Polling.
- Demographics is destiny: Japan population sees record five-year drop: Census.
- Myanmar: A Rare Earth War the World Can No Longer Ignore.
- Military-backed intruders occupy huge cobalt deposit in Congo.

Research and News

- Mechanisms of water incorporation into enstatite with Al substitution: Density functional theory-based analysis.
- A record of biological nitrogen limitation and metamorphic overprinting in the Mesoarchean Red Lake carbonate platform, Canada.
- Origin and emplacement of the Variscan Lizard Ophiolite, and underlying thrust sheets, Cornwall, SW England.
- Sunshuite, $FeBi_2S_4$, a new member of the pavonite homologous series from the Jiawula-Chaganbulagen Ag-Pb-Zn ore field, Inner Mongolia, China.
- Mineral weathering: Mineral phase transformation drives molecular fractionation of dissolved organic matter during organic acid-driven weathering of bauxite residue.
- Estimating particle size in silty lake sediments using a fine-tuned deep learning model on hyperspectral imagery.
- Modern IUGS terminology for carbonatites and carbothermalites.
- Earth's molten outer core is behaving in chaotic, unexpected ways.

Planetary Geology

- Meteor over Massachusetts causes explosion reports, sightings from Delaware to Montreal.
- When wet meets dry: An Ivuna-like impactor triggered volatile loss on the angrite parent body.
- Mantle melting and magma ocean dynamics on Mercury impacted by sulfur in reduced mafic magmas.

Plate Tectonics

- Sanukitoid stable isotopes reveal complex crust-mantle dynamics in the early Earth.
- The Seismic Signature of the Atlantis Massif Oceanic Detachment Fault Determined From Crystallographic Preferred Orientation and Microstructure.
- Foreland Flexure and Lower Crustal Flow as Controls on Cenozoic Subsidence Anomalies in the Zengmu (Sarawak) Basin, South China Sea.
- Rift Development, Tectonic Forcings, and Magmatic Feedbacks at Santorini and Kolumbo Volcanoes Constrained by Scientific Drilling and Core-Seismic Integration.
- Complex Shear-Wave Splitting Behavior in the Northern Andes and Possible Implications for Mantle Flow Around the Caldas Tear.
- Anomalously Low $^{3}He/^{4}He$ and Elevated Heat Flow in the Northern Apennines Explained by Lithospheric Delamination: A Modeling Approach.
- Two-Layer Anisotropy Beneath Subduction Zones: Bayesian Inversion.
- Eohellenic subduction and Alpine collision of the Preveli nappe (Uppermost Unit of Crete, Greece): constraints on the kinematics and age of deformation events.
- Evidence for a Sharp, Negative Velocity Gradient at the Lithosphere Asthenosphere Boundary From Array Analysis of Ambient Noise Autocorrelograms Near Sweetwater, Texas.
- Characterization of newly identified N–S shear zones in the Egyptian Nubian Shield by integrating geophysical, remote sensing and field data.

Paleontology

- New insights into the postcranial anatomy of *Paludidraco multidentatus* (Sauropterygia, Simosauridae), from the Late Triassic of Spain.
- Postcrania and locomotor function of *Mesocyon coryphaeus* (Canidae, Carnivora) from the Arikareean of North America.
- New exceptionally preserved arthropod from the Furongian of Canada; summary in The Conservation here.
- A small Miocene peafowl (Galliformes, Phasianidae) from the high-elevation Linxia Basin of China illuminates the evolution of the clade and its paleobiology.

- Ediacaran or late Paleozoic? Integrating trace fossils and U–Pb geochronology to resolve paleoenvironmental and stratigraphic ambiguities.
- Paleoenvironmental reconstruction of Bohai Bay Basin, Northern China, during the Paleocene–Eocene thermal maximum (PETM): insights from mineralogy, geochemistry and microfossils.
- The phylogenetic origin of turtles.
- New unenlagiid from the Chorrillo Formation (Late Cretaceous, Maastrichtian), SW Patagonia, Argentina.
- Hyperelongate ornamental tail feathers in a new early Cretaceous enantiornithine bird; Gizmodo summary here.
- 200 years of dinosaur discoveries –a visual portrayal of their geographic and historical origins.
- A new shuvosaurid (Archosauria, Poposauroidea) from the Late Triassic (Norian) Hayden Quarry of New Mexico, U.S.A.; summary from the Natural History Museum of Los Angeles County here.
- Review of Tridactyl Avian Footprints (Ichnofamily Avipedidae) with Emphasis on Type Material from the Miocene of the Carpathians (Ukraine, Hungary and Romania).
- A marine geosaurine crocodylomorph from the Kimmeridgian Sabinal Formation of Oaxaca, southern Mexico.
- 3D animation design process for Sri Lankan palaeoart; Phys.org summary here.

Ore Deposit and Petroleum Geology

- Source rock geology: Porosity Preservation in Deeply Buried (8500 m) Jurassic Calcareous Mudstones of the Vienna Basin (Austria).
- Selenium in stibnite as a pathfinder towards high-grade Au ores in epizonal orogenic Au-Sb systems.
- Advanced Targeting of Rare Earth Elements in the Gabal Umm Naggat Pluton: A Combined Geophysical and Radiogenic Approach with Mineralization and Environmental Implications.

Mining and Energy

- Indonesia’s Septembergate: How the new export regime impacts global nickel and coal markets.
- South Africa: Petra shutters Finsch mine, cuts jobs as diamond slump bites.
- Norway Lobbies to Persuade EU to Drop Arctic Drilling Ban.
- US EIA: Natural gas for power generation flat this summer, record high expected in 2027.
- Valorization of lithium hardrock concentrates into battery raw materials and commodity products; MIT News summary here.

- Artisanal mining: Illegal miners extract billions in Amazon gold despite Brazil crackdown, Greenpeace finds.
- CHARTS: How the sulphuric acid crunch is driving up critical minerals costs.
- Defence-driven demand powers surge in US listings by mining firms.
- New magnesium-tin alloy lasts 1,300 hours, boosts battery life by more than 400 times.
- Could sodium replace lithium as the dominant ingredient in batteries?

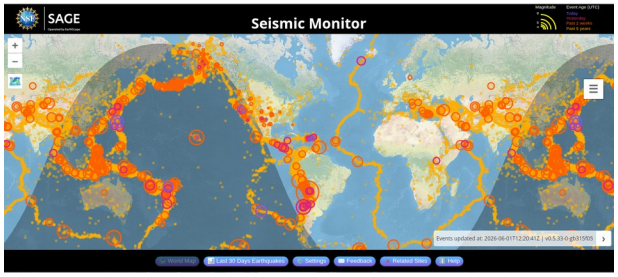
Environmental Geology and Hydrogeology

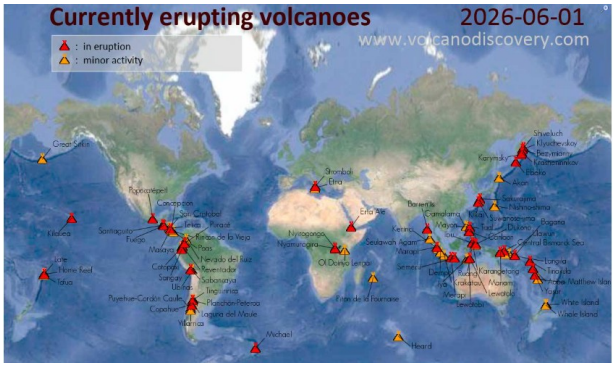
- Denitrification in carbonate aquifers: a literature review.
- Ogallala Aquifer: The Largest US Groundwater Supply Is Running Out.
- Thermal refuges in rivers: when groundwater saves fish from overheating.
- Thermal flow in porous media: Dynamic confinement controls the porous-to-free convection transition.
- Peru's Quellaveco mine tied to water scarcity, contamination, investigation finds.

Glaciers and Climate Change

- Lots of recent papers on glaciers in The Cryosphere from the EGU.
- Geothermal heat flow under glaciers: Community heat flow recommendations: suitable basal boundary conditions for Greenland and Antarctica in ISMIP7.

Volcanoes, Earthquakes and Geohazards





Seismic Monitor **Active Volcano Map**

Volcanoes

- Smithsonian / USGS Weekly Volcanic Activity Report.
- United States Geological Survey (USGS) Volcano Observatories:

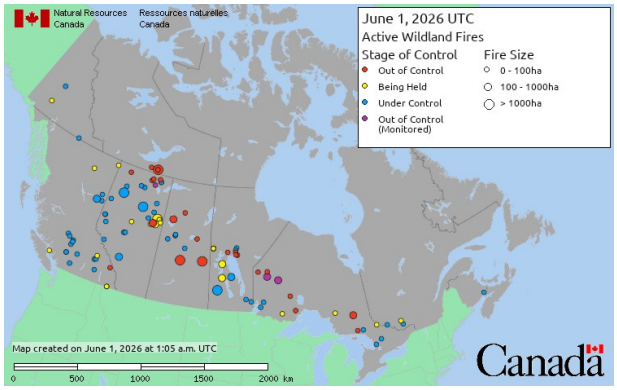
- Yellowstone Caldera Chronicles.
- Cascades Volcano Observatory Weekly Update.
- Hawaiian Volcano Watch – What caused the shake up on Friday night?

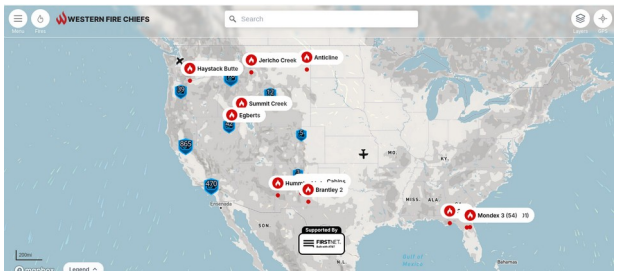
- Multidisciplinary Investigation of Healy Submarine Volcano (Kermadec Arc, New Zealand) Using AUV and Submersible Data: Structural Control on Magmatic and Hydrothermal Processes.
- NASA Image of the Day for May 27, 2026: Ever Restless Mount Dukono Erupts.

Earthquakes

- Multi-Scale Rate- and Roughness-Dependent Frictional Constitutive Law and Dynamic Earthquake Sequence Simulation.
- Swarm cessation and aftershock drivers following the pressure release of a four-year-long seismic sequence at the Noto Peninsula.

Geohazards





Canadian Wildfire Map here. **USA Wildfire Map here.**

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.
- Lectures on groundwater from the IAH, on YouTube.
- 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.
- Systematic geochemical classification of felsic igneous rocks of the Yilgarn Craton.
- From the Arizona Geological Survey: Geochemistry Diagram Generator v 1.0.
- Online app: Australia's full national topographic library at your fingertips.
- Paleolatitude; what was a place's latitude in the geological past.

Upcoming Events

- June 8 – 11, 2026, World Geothermal Congress 2026, Calgary Telus Convention Center.
- June 9 – 10, 2026, Critical Minerals for Defence, Marriott Downtown CF Toronto Eaton Centre.
- August 16 – 19, 2026, PEG2026: 11th International Symposium on Granitic Pegmatites; Perth, Western Australia.
- August 23 – 28, 2026, 24th Annual Conference of the International Association for Mathematical Geosciences, Montreal, Canada.
- 14-18 September 2026 , IAH 2026, 53rd Congress of the International Association of Hydrogeologists; Budapest Congress Center.
- September 24, 2026, 25 years of Extraordinary, Oakridges Moraine Groundwater Program, The Village of Black Creek, 1000 Murray Ross Pkwy, Toronto, ON.
- September 30 - October 3, 2026 SEG 2026 Conference Salt Lake City, United States.
- 5 - 7 October 2026 International Mine Health and Safety Conference 2026, Perth, Australia.
- October 14 – 17, 2026, Paleoamerican Odyssey 2026, Santa Fe Convention Center, Santa Fe, New Mexico.
- November 2-3, 2026 CCMEC 2026 Victoria Inn Hotel & Convention Centre, Winnipeg, Manitoba.
- 12-20 August 2028, Geosciences for Humanity, 38th International Geological Congress, in the BMO Centre, Calgary.
- Society of Petroleum Engineers Distinguished Lecturer Schedule.
- American Geophysical Union List of Upcoming Meetings.
- The Geological Society: Events & Courses.
- Upcoming Distinguished Geoscience Australia Lectures (DGALs).

June 1, 2026

Geology and Mineral Resources – Qatar

Introduction

Figure 1 – Qatar
Credit: Mapsland, Creative Commons Attribution-Share Alike 3.0 Licence

The State of Qatar is a country of 2,532,104 people on the northeast corner of the Arabian Peninsula. The country has an area of 11,581 square kilometres and has a land border with Saudi Arabia. Qatar juts into the Persian Gulf. The Gulf of Bahrain separates Qatar from Bahrain. North across the Persian Gulf is, of course, Persia a.k.a. Iran.

Qatar is a very prosperous country with a per capita GDP (PPP) of $121,610 (the fourth highest GDP per capita in the world) and a very high Human Development Index of 0.886. Oil production is the largest part of the economy followed by services.

In the past year,the top exports of Qatar were petroleum gas, crude petroleum, refined petroleum, nitrogen fertilizers, and ethylene polymers. In the same period, the top imports were motor vehicles, financial instruments (documents), gold, gas turbines, and telephones. In February 2026, Qatar exported mostly to China, India, the United Arab Emirates, South Korea, and Singapore; and imported mostly from China, the United States, the United Arab Emirates, Japan, and Germany.

For more details on the country, check out the Wikipedia and Grokipedia articles on the country.

Geology

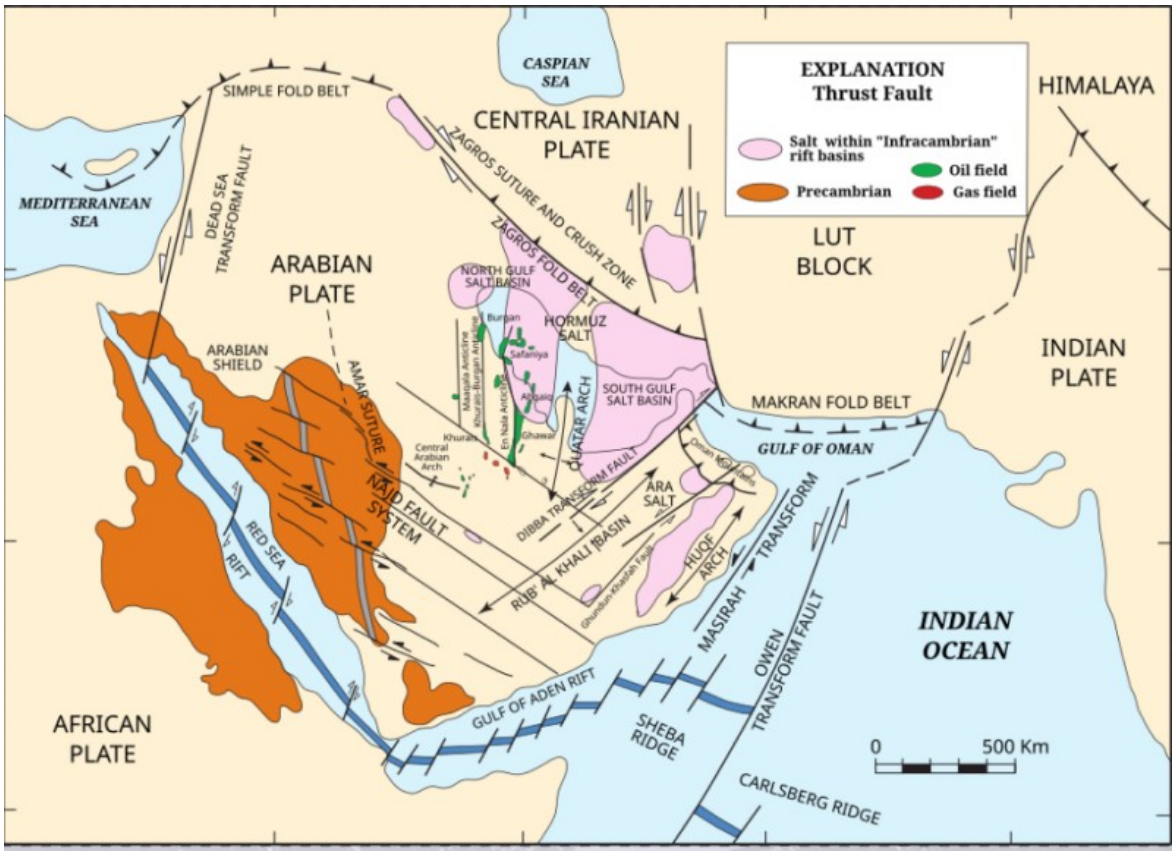


Figure 2 - Arabian Plate Showing General Tectonic and Structural Features
Credit: Richard M. Pollastro, USGS Bulletin 2202-H, public domain

Qatar sits on the Arabian Plate, specifically a feature called the Qatar Arch.

The surface geology of Qatar is fairly boring, the bedrock consists of Paleogene and Neogene aged carbonate and evaporite deposits.

- Around 80% of Qatar's surface area consists of outcrops of the Lower Eocene aged Dammam Formation. The Dammam Formation consists of limestone, dolostone, and marl.
- Other outcrops from the Lower Eocene include the Rus Formation, mostly dolomitic limestone.
- Neogene formations in Qatar include the limestones of the Miocene aged Dam Formation, and sandstones of the Late Miocene to Pliocene aged Hofuf Formation.
- Also found in Qatar are Quaternary aged sabkha deposits.

Figure 3 links to an interactive map and geological column of the surface and subsurface formations in Qatar. The subsurface formations of Qatar are the most significant and include the rocks that host the oil and gas reservoirs of Qatar.

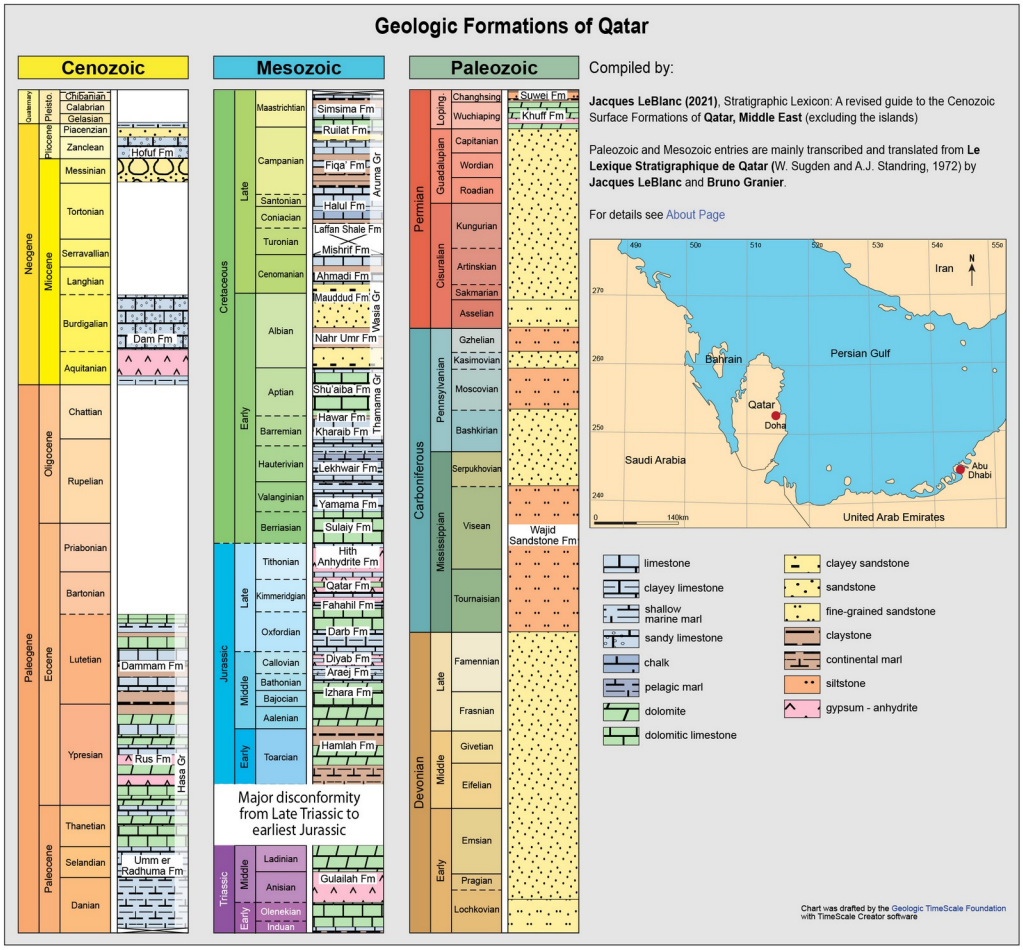


Figure 3 – Geological Formations of Qatar
Credit: Jacques LeBlanc, Qatar Lexicon of Stratigraphic Units

To look into the details of the geological formations at Qatar, open the Qatar Lexicon of Stratigraphic Units page and click on the formation name.

Paleontology

Salwasiren qatarensis

Figure 4 – Fossilized Dugong Rib Bones, Qatar
Credit: Alex Sergeev, Creative Commons Attribution-Share Alike 3.0 Unported license

The fossils found in Qatar are fairly limited. However, a recent discovery of Miocene aged sea cows in the Dam Formation is interesting. Called *Salwasiren qatarensis*, the fossils give insight into the evolution of dugongs in the ancient Tethys Sea and their role in the evolution of the ecosystem. Unfortunately, modern dugongs in the Persian Gulf may be on their way to extinction due to war and general environmental stress.

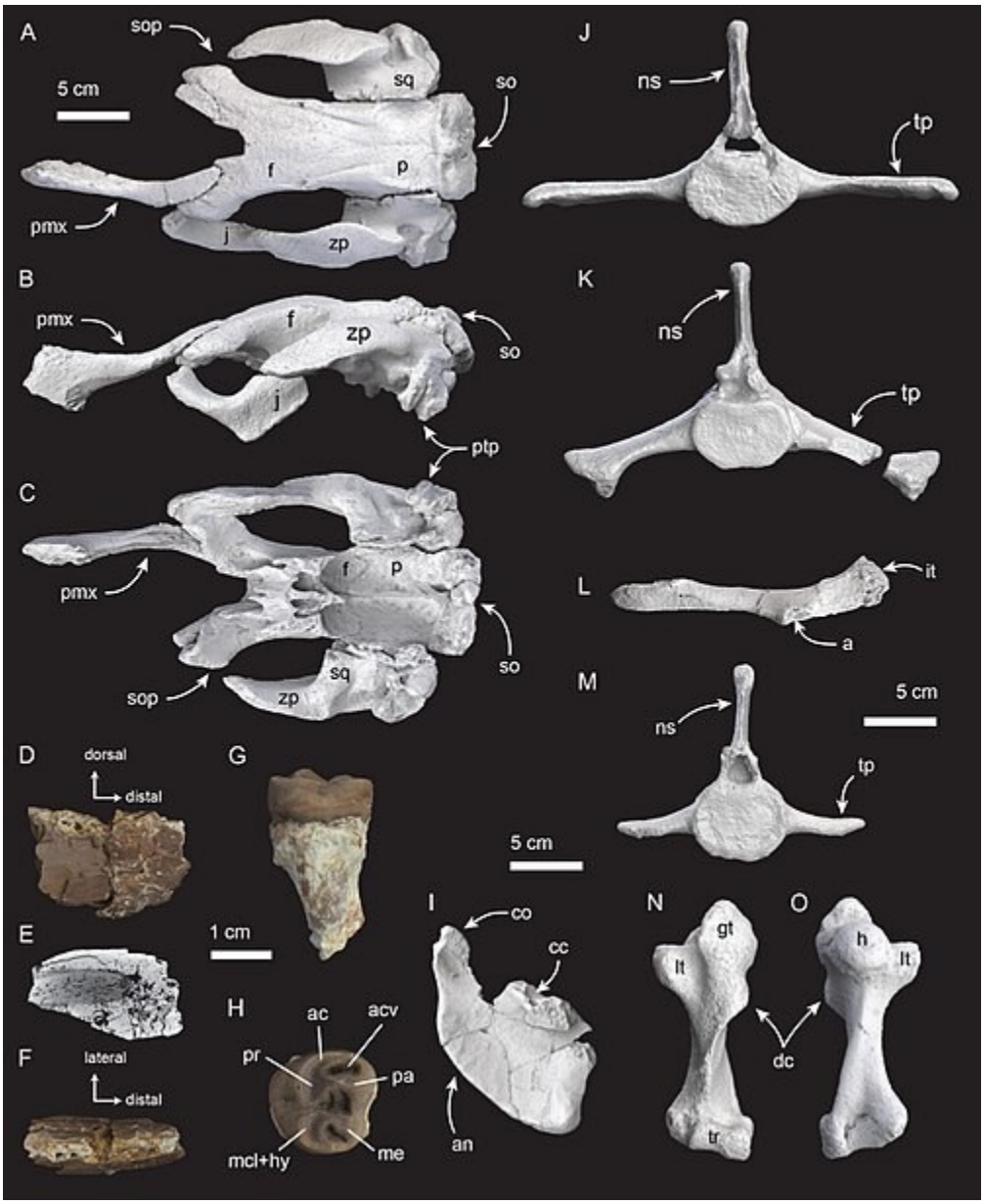


Figure 5 – Bones of *Salwasiren qatarensis*
Credit: Pyenson *et al*, 2025, Creative Commons CC0 1.0 Universal Public Domain Dedication

Mineral Resources

Figure 6 – Gas Flare, Halul Island
Credit: Alex Sergeev, Creative Commons Attribution-Share Alike 3.0 Unported license

The most recent USGS Minerals Yearbook for Qatar describes the minerals industry of Qatar and the country has the usual industrial mineral extraction industries of an advanced state: cement, dimension stone, aggregate, etc. However, the real significant mineral industry of Qatar is petroleum and especially natural gas. Rather than just listing the oil and gas fields in Qatar, which are in the USGS Yearbook, lets first look at how we get oil and gas deposits . After that we can briefly examine the geology of the oil and gas deposits in Qatar.

Starting from first principles, what do we need for an oil and gas deposit? The answer is that you need a geological history that includes:

- A source rock where organic matter can accumulate under anaerobic conditions, thus not decaying.

- Burial of the source rock and the creation of a substance called kerogen and the subsequent transformation of the kerogen into oil and gas, under heat and pressure. There is a sweet spot for this transformation or catagenesis. If the temperature in the buried source remains below 60 ºC, the kerogen remains within the source rock, usually forming an oil shale. If the temperature rises to between 60 ºC and 120 ºC petroleum forms. If the source rock is buried deeper, the heat cracks the petroleum into natural gas, i.e. the long chain hydrocarbons of the petroleum are broken down into short chain hydrocarbons, like methane (CH_4). Both petroleum and natural gas are fluid and can migrate through porous rocks.

- Finally, we need a geologic trap where the hydrocarbons can accumulate. In a trap, an impervious formation overlies a permeable formation preventing further migration of the petroleum and natural gas, as in Figure 7, below.

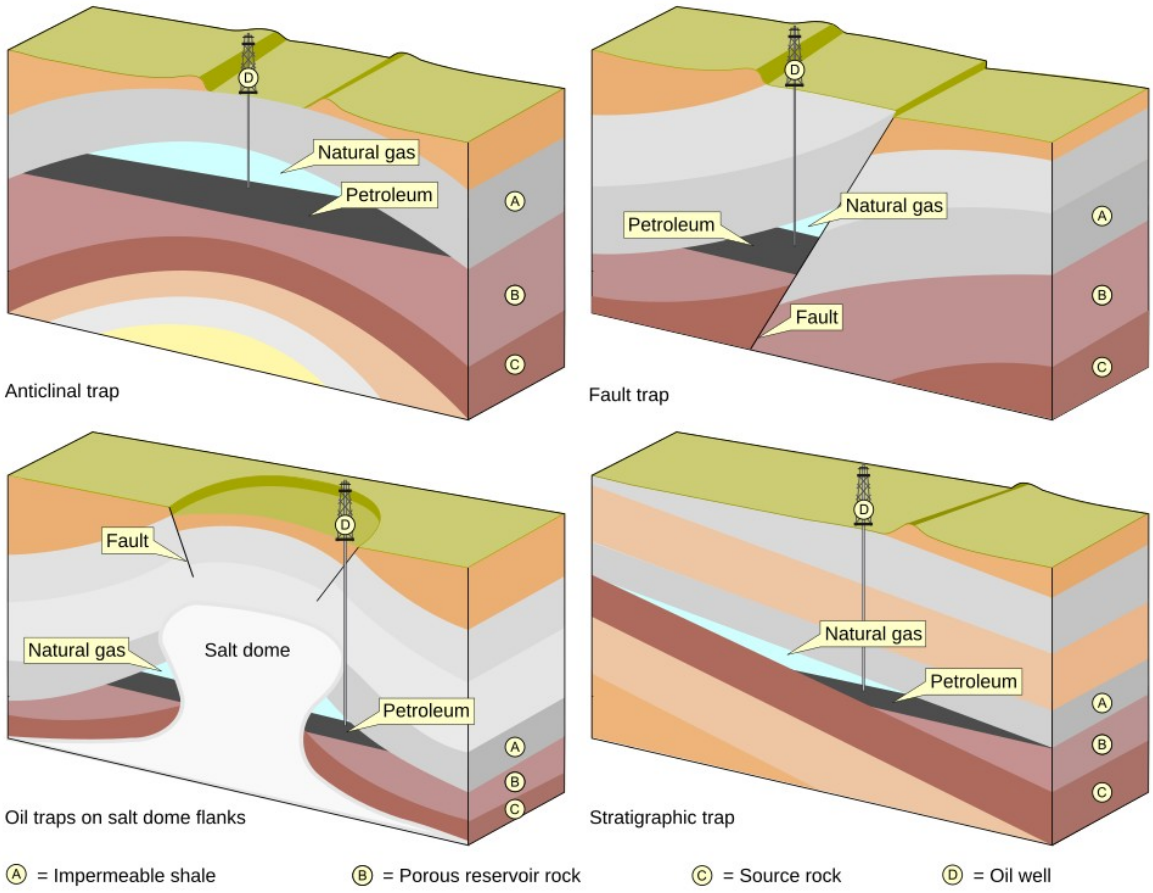


Figure 7 – Varieties of Hydrocarbon Traps
Credit: MagentaGreen, Creative Commons Attribution-Share Alike 3.0 Unported license

So, what is the situation that led to the formation of the oil and gas in Qatar?

Where was the source rock? Remember Tethys? The formations shown in Figure 3 originated in the ancient Tethys Ocean. Sediments began accumulating in this basin during the Paleozoic and the best candidates for source rocks in the Qatari fields are the Silurian aged Qusaiba and Sharawra formations, which apparently generated oil and gas until the Jurassic.

So, what formed the traps? To answer this we have to look into the formation of the Qatar Arch; the origin of which lies in the Alpine Orogeny.

To illustrate the structures created by the orogeny, it helps to look at a cross-section of formations in Arabia, as in Figure 8.

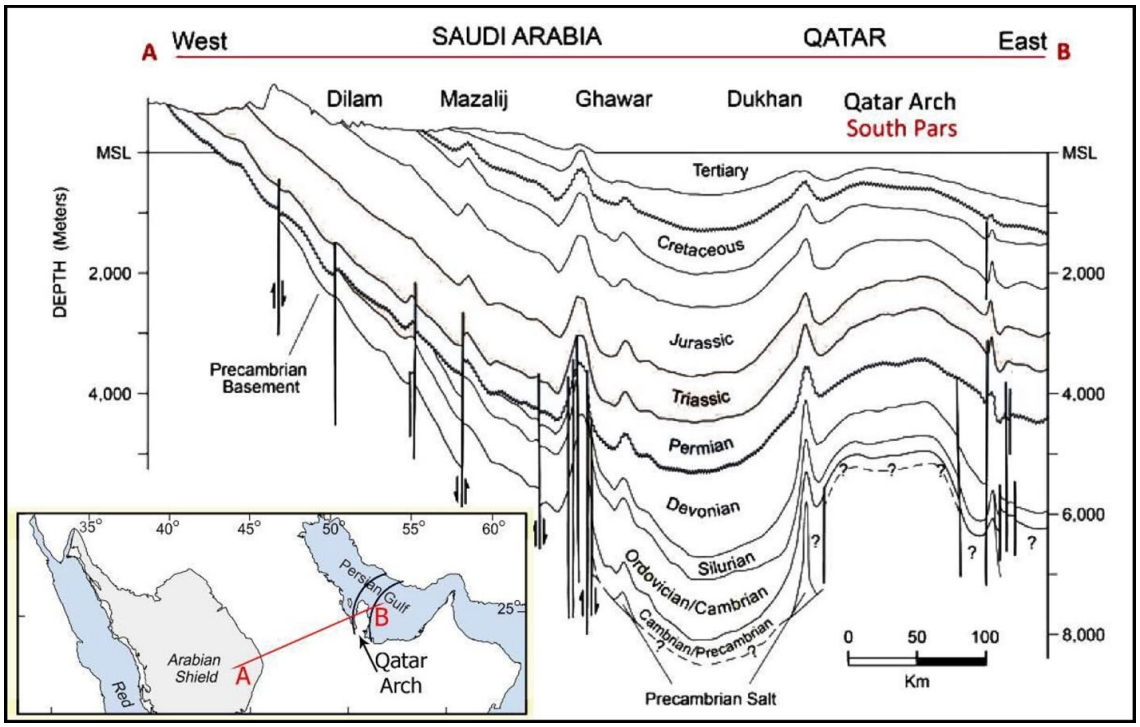


Figure 8 – Cross-section Across the Qatar Arch and into Arabia

[Credit: Figure 6 in Daneshvar et al 2023](), [Creative Commons Attribution 4.0 International]() **licence**

As you can see, the formation of the Qatar Arch created many structural traps for the accumulation of hydrocarbons in the region. Figure 9 shows the location of oil and gas fields in and around Qatar.

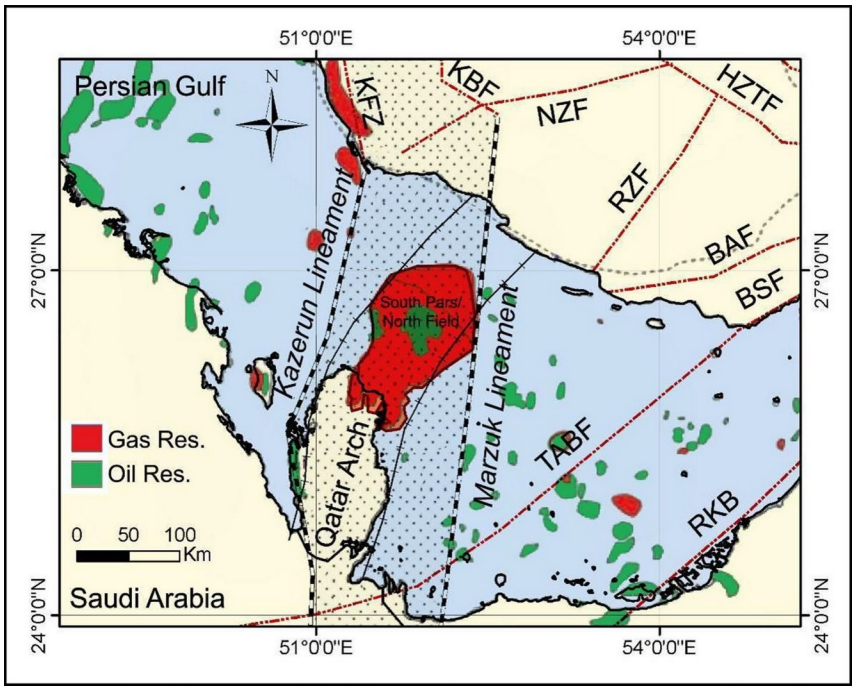


Figure 9 – Oil & Gas Fields together with Structural Elements

[Credit: Figure 5 in Daneshvar et al 2023](), [Creative Commons Attribution 4.0 International]() **licence**

So, all in all, given the geological history of Qatar, there were plenty of opportunities for the accumulation of hydrocarbons in that country – much to the joy and enrichment of its inhabitants (remember that they have a per capita GDP (PPP) of $121,610).

For further reading on the petroleum geology of Qatar, here are a few references to follow up on if you like to dig deeply into these things (and I know that some of you do):

- Pollastro, Richard M., 2003, T*otal Petroleum Systems of the Paleozoic and Jurassic, Greater Ghawar Uplift and Adjoining Provinces of Central Saudi Arabia and Northern Arabian-Persian Gulf*, U.S. Geological Survey Bulletin 2202-H, https://pubs.usgs.gov/bul/b2202-h/b2202-h.pdf.

- Jafar Aali, Hossain Rahimpour-Bonab, Mohammad Reza Kamali, 2006, *Geochemistry and origin of the world's largest gas field from Persian Gulf, Iran*, Journal of Petroleum Science and Engineering, Volume 50, Issues 3–4, 2006, Pages 161-175, ISSN 0920-4105, https://doi.org/10.1016/j.petrol.2005.12.004. This is on the geology of the South Pars Field.

- Al-Siddiqi, A. & Dawe, Richard., 2007, *Qatar's oil and gasfields: A review*, Journal of Petroleum Geology. 22. 417 – 436.,https://doi.org/10.1111/j.1747-5457.1999.tb00477.x

- Perotti CR, Carruba S, Rinaldi M, Bertozzi G, Feltre L, Rahimi M., 2011, *The Qatar–South Fars Arch Development (Arabian Platform, Persian Gulf): Insights from Seismic Interpretation and Analogue Modelling*, New Frontiers in Tectonic Research - At the Midst of Plate Convergence, https://doi.org/10.5772/20299.

- Daneshvar, M.R.M., Mansouri-Daneshvar, P., Moussavi-Harami, R. et al., 2023, *A new insight into the evolution of the Qatar Arch to recognize faults and a new gas field,* J Petrol Explor Prod Technol 13, 2157–2170 (2023), https://doi.org/10.1007/s13202-023-01674-7.

Summary

Figure 10 – Hot Desert Landscape – Qatar
Credit: Matt Kieffer, Creative Commons Attribution-Share Alike 2.0 Generic license

Qatar is an interesting place with an interesting history. Oil enriched the country, turning a trading post into an industrial and financial centre. It's also the home of Al Jazeera, an influential news service. Without oil, and it will run out some day, Qatar will return to being a trading post on the Persian Gulf. The Qataris know this, why do you think they are importing gold?

For now, however, Qatar remains a place with good opportunities for geoscientists, especially in oil and gas exploration/development. Almost all the technical specialists in Qatar are foreigners and it is a good place to make a career in the oil business.

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.