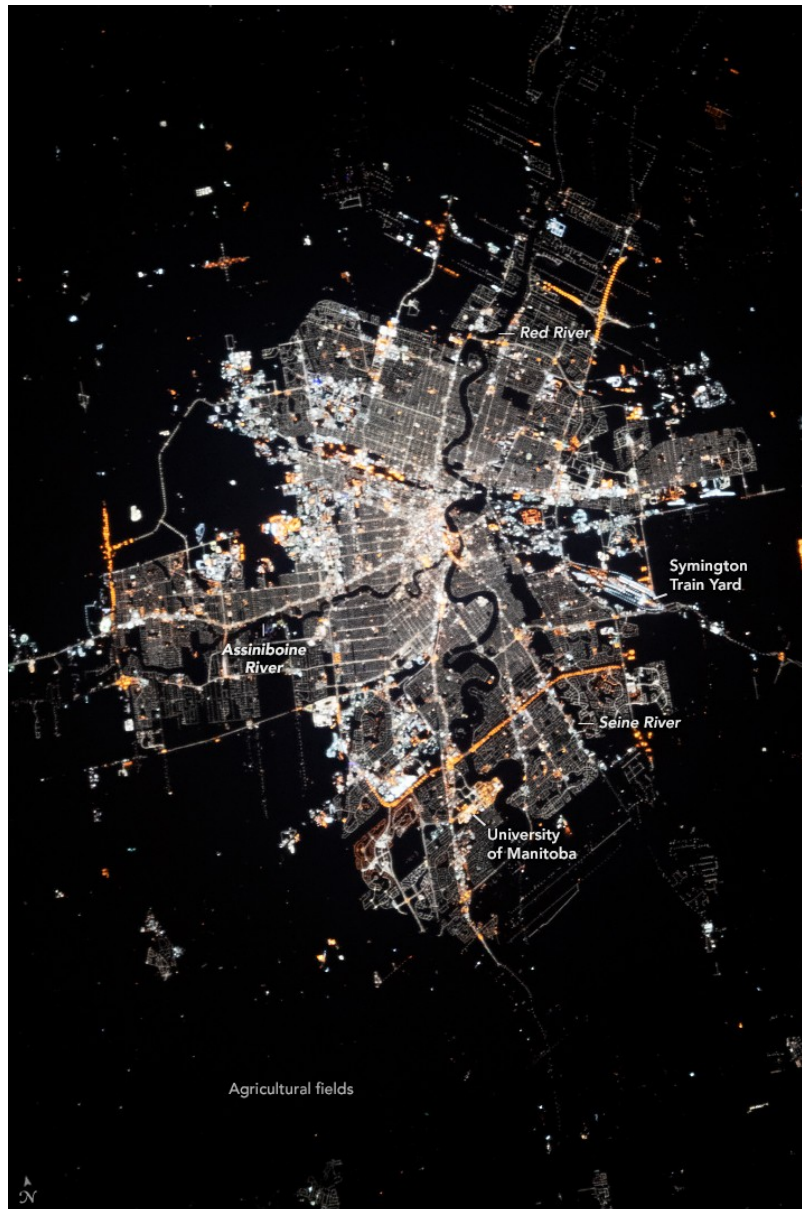


December 8, 2025

News and notes



Winnipeg at Night

Credit: NASA Earth Observatory; public domain

This week, before going on to discuss the geology and mineral resources of [Monaco](#), we will first look at some news items I thought were interesting. The picture above is from the [NASA Earth Observatory](#) and shows the [City of Winnipeg](#) at night.

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:
 - [The US-Venezuela relationship as seen through the price of an oil-linked bond.](#)
 - [President Trump, Venezuela, and 4GW.](#)
- [Paramilitary Seizes Key Oil Field in Sudan as Conflict Rages](#)
- [US vows over \\$1 billion for Congo critical minerals supply chain.](#)
- [Oil Tanker Rates Skyrocket by 467% Amid Shipping Chaos.](#)
- [The US' F-35 Sale To Saudi Arabia Might Be Part Of Trump's Ultimate Plan To Revive IMEC; India-Middle East-Europe Economic Corridor.](#)
- [Devastating toxic spill seen as test of whether African countries will stand up to China.](#)

Research and News

- [The regional evolution of a dryland fluvio-aeolian and lacustrine succession in response to allocyclic forcing: insights from the Early Permian Cutler Group, Utah, USA.](#)
- Playing with dirt for fun and science: [Thermal Reactions of Smectite Minerals at Earthquake Timescales.](#)
- [Apatite geochemistry as a tool for understanding the petrogenesis of layered mafic-ultramafic rocks in the Bushveld Complex, South Africa.](#)
- [Geochemistry of the Wyoming Craton from eclogite and pyroxenite xenoliths from the Aultman, Maxwell, and Schaffer kimberlites at the Colorado-Wyoming State Line.](#)
- [Carbonate burial regimes, the Meso-Cenozoic climate, and nannoplankton expansion.](#)
- [Viscosity of Dry and Hydrous Diopside Melts at High Pressures: Implications for Upper Mantle Magma Dynamics.](#)
- [Petrographic, Geochemical and Geotechnical Properties of Laterites from Two Quarries in the Diass Horst \(Senegal, West Africa\).](#)
- [Microstructural and geochemical response of muscovite to impact metamorphism.](#)
- Lacustrine geology: [Decadal, sediment-driven sulfur isotope evolution in Lake Cadagno.](#)
- [Testing *ab initio* garnet-clinopyroxene Ca-isotope fractionation models with natural data.](#)
- [Grahampearsonite, Ca₂P₂O₇, a new mineral found in a super-deep diamond from Juína, Brazil.](#)

- [Permian fluid circulation and deformation along a crustal-scale shear zone in the Montagne Noire gneiss dome \(southern French Massif Central\).](#)
- [Single-crystal X-ray diffraction on \$\text{Ba}_{1-x}\text{Ca}_x\text{CO}_3\$ \(\$0 \leq x \leq 0.79\$ \) solid solutions from 100 to 500 K: Implication for thermal expansivity of disordered calcite.](#)
- [Redox evolution of carbon- and sulphur-bearing clinopyroxenites as proxies of deeply recycled crustal material.](#)
- [Vulnerability of blue carbon stocks to disturbance in sediments with low burial efficiency.](#)
- [Mantle-driven, climatically modulated landscape evolution in Southern Patagonia.](#)
- [December 2025 issue of GSA Today.](#)
- [December 2025 issue of Sedimentologica.](#)
- [Holocene tephrochronology in the Northern Cordilleran Volcanic Province, northwestern British Columbia.](#)
- Geologic history: [Volcanic forcing of the Lomagundi–Jatuli carbon isotope excursion.](#)
- Mineralogy of PGM: [Formation of natural \$\text{IrO}_2\$ through Os–Ir–Ru alloy oxidation.](#)
- [Hydrogen incorporation in orthopyroxene from Southern Patagonian mantle xenoliths: the role of cooling upon emplacement.](#)
- [Synthesis of zircon-hafnon to determine oxygen isotope matrix effects in secondary ionization mass spectrometry.](#)

Coastal Geology

- [Morphodynamics of a composite barrier system, Westward Ho!, North Devon, UK.](#)
- [Shoreline evolution in a low-lying coastal region under anthropogenic influence.](#)
- [Decadal shoreline variability in urban beaches: Contributions from structural changes, storms, and nourishments to tipping points.](#)

Planetary Geology

- [Ultramafic float rocks at Jezero crater \(Mars\): excavation of lower crustal rocks or mantle peridotites by impact cratering?](#)
- Sulphur: [Curiosity Cracked Open a Rock on Mars And Revealed a Big Surprise.](#)
- [Bio-essential sugars in samples from asteroid Bennu.](#)
- [Impact-induced nano-sized rare mineral kuratite with correlated disorder on near and far sides of the Moon using 3DED method.](#)
- Clay minerals: [Alteration history of aluminum-rich rocks at Jezero crater, Mars.](#)

Plate Tectonics

- [Inferring Long-Term Tectonic Uplift Patterns From Bayesian Inversion of Fluvially-Incised Landscapes.](#)
- [Receiver Function Insights into Crust and Lithospheric Fabric in Northern Canada.](#)
- [Autochthonous crustal growth and sedimentation in the Superior Province recorded by xenocrystic and detrital zircon.](#)
- [Variable roles of oceanic transform faults in plume dispersion along segmented mid-ocean ridges.](#)
- [Seismic Insight on Basement Structure of the Extinct Mid-Oceanic Ridge in Canada Basin, Arctic Ocean.](#)
- [Characteristics of ~40 Ma Mafic Rocks in North Tibet and Their Tectonic Implications.](#)
- [Oligocene—Miocene Tectono-Stratigraphic Development of the Southern Levant Basin, Eastern Mediterranean Sea.](#)
- [Evolving Strain Partitioning Driven by Multiple Plate Interaction-Paleotectonic Reconstruction of Northwestern South America During the Cenozoic.](#)
- [Xenolith hydrogen isotope evidence for lower crustal hydration during cycles of flat slab subduction.](#)

Paleontology

- [Ichnological insights into deoxygenation across the Cenomanian–Turonian Boundary Oceanic Anoxic Event 2 in the northern extent of Western Interior Seaway \(west-central Alberta\).](#)
- [Largest fossil database ever compiled rewrites the human origin story.](#)
- [The cranial, mandibular, and hyoid anatomy of softshell turtles \(Trionychidae\): A revised character list for phylogenetic analysis.](#)
- [Fossil insects of Chile, including arachnids and myriapods: a systematic literature review and checklist.](#)
- [Application of blender modeling techniques in the restoration of 3D morphology of fossil insects reconstructed via micro-computed tomography.](#)
- [Synopsis of the Triassic reptiles from Germany.](#)
- [Assessing the effect of sampling proxies on plesiosaur taxic diversity with comments on implications for Mesozoic sampling design.](#)
- [A dinosaur with skin still in the game: Rare mummy undergoes study in Minnesota.](#)
- [Trace fossils: Chemosynthetic microbial communities formed wrinkle structures in ancient turbidites.](#)

- Video: [Minute By Minute Through the Worst Day in Dinosaur History](#).
- Early development of eukaryotes: [Dated gene duplications elucidate the evolutionary assembly of eukaryotes](#); Phys.org summary [here](#).
- [Morphotypes, preservation, and taphonomy of dinosaur footprints, tail traces, and swim tracks in the largest tracksite in the world: Carreras Pampa \(Upper Cretaceous\), Torotoro National Park, Bolivia](#); Science Alert summary [here](#).
- [New skull of *Megantereon inexpectatus* \(Carnivora: Machairodontinae\) and its implications on evolution of *Megantereon* in North China](#).
- [An early origin of gigantism in anacondas \(Serpentes: *Eunectes*\) revealed by the fossil record](#); Phys.org summary [here](#).
- [The enigmatic ailurid *Magerictis imperialensis* \(Mammalia: Carnivora\) unveiled: a systematic approach to the early Ailuridae](#).
- [A new Late Miocene small vertebrate assemblage from the Ouarzazate Basin \(High Atlas, Morocco\) and its biochronological and paleoenvironmental significance](#).
- [Reptile footprints on a pelagic seafloor as a vestige of a synsedimentary seismic event in the lower Campanian Scaglia Rossa basin of the Umbria-Marche Apennines \(Italy\)](#); Phys.org summary [here](#).
- [U-Pb calcite age dating of fossil eggshell as an accurate deep time geochronometer](#); Brighter side news summary [here](#).

Ore Deposit and Petroleum Geology

- [Ore Formation: A Surface Level Look](#).
- [Analysis of trajectories and developmental prospects of research on carlin-type gold deposits on the basis of big data community detection algorithms](#).
- [Machine learning investigation of pyrite and chalcopyrite compositions to distinguish SEDEX and VMS deposits: An examination of the genesis of the Dongshengmiao deposit, Inner Mongolia, China](#).
- [Two-stage Ni-Cu sulfide mineralization of high-Mg basaltic magma: The Lubei example in the western segment of Eastern Tianshan orogenic belt, NW China](#).
- [Magmatism and mineralization potential of the Paertagexi copper deposit, Eastern Tianshan](#).
- [Multi-mineral U-Pb geochronology of the Ban Phuc disseminated Ni sulfide deposit, Ta Khoa District, northern Vietnam: Implications for genesis and exploration](#).
- Fracking research: [The Effect of Pressurization Rate and Pattern on Injection-Induced Seismicity in Highly Permeable Sandstone: An Experimental Study](#).

- [Petrogenesis of the Tailaihua ore-forming granites in the southern Great Xing'an Range, NE China: Implications for magma evolution and Be-Nb-Ta mineralization in Late Mesozoic.](#)
- [Constraints of scheelite and wolframite on multiple magmatic fluid generations and W mineralization of the Lijia Sn deposit, South China.](#)
- Reservoir geology: [Assessing the Impact of Reservoir Heterogeneity on Carbon Capture and Storage Feasibility through Numerical Simulation.](#)
- [Geological and geochemical characteristics of the Duobaoshan carbonate-hosted Pb-Zn deposit in the Karakorum Range, NW China.](#)
- [Integrating trace element chemistry, and sulfur isotope systematics of alunite in the Zhule \(Xizang\), central Lhasa terrane: implications for porphyry-high sulfidation epithermal Cu-Au exploration targeting.](#)

Mining and Energy

- [Copper price climbs to fresh high on China outlook boost.](#)
- [French Major TotalEnergies Scales Up North Sea Operations.](#)
- [UK Grid Operator Scraps 300 GW of Zombie Energy Projects.](#)
- [China Oil Imports Surge To Two-Year High.](#)
- What small modular reactors are and how these could support world's rising electricity demand; related stories [here](#) and [here](#).
- [Equinor Makes Two Large Gas Discoveries in Norway's North Sea.](#)
- [Congo sets new export conditions to keep tight grip on cobalt.](#)
- [British Columbia court rules Indigenous rights legally enforceable in mineral claims staking.](#)
- [Energy employment has surged, but growing skills shortages threaten future momentum.](#)
- Wyoming: [After 100 years of extraction, how much oil and gas remains undiscovered in the US?](#) USGS report [here](#).
- [Argentina's Shale Boom Is Offsetting Falling Conventional Production.](#)

Environmental Geology and Hydrogeology

- [New 3D model to help mitigate groundwater flooding.](#)
- [Impacts of an industrial deep-sea mining trial on macrofaunal biodiversity.](#)
- Remediation: [New fast-acting material removes stubborn forever chemicals from water in seconds.](#)
- [Jeff Bezos's Blue Origin Wants to Dump Millions of Gallons of Waste Into a Protected Lagoon.](#)

- Whiskey’s for drinking, water’s for fighting: [A Water War Is Brewing In Texas](#).
- France: [Groundwater levels: assessment of changes in levels in 2024-2025](#).
- [Microbially-Induced Carbonate Precipitation in Low pH Cement; Potential for Self-Healing in Radioactive Waste Geodisposal Systems](#); Phys.org summary [here](#).

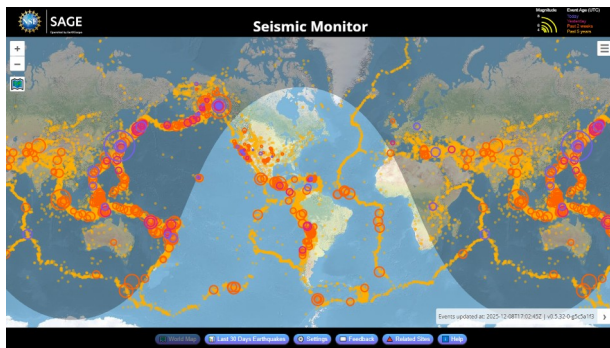
Glaciers and Climate Change

- [From short-term uncertainties to long-term certainties in the future evolution of the Antarctic Ice Sheet](#).
- Robot monitor: [Circulation and ocean–ice shelf interaction beneath the Denman and Shackleton Ice Shelves](#); Phys.org summary [here](#).
- [Climate-driven changes in Mediterranean grain trade mitigated famine but introduced the Black Death to medieval Europe](#); IFL Science summary [here](#).
- [The Big Glacial Erratic Rock near Young, Saskatchewan](#).
- [Satellites Detect Seasonal Pulses in Earth’s Glaciers](#).
- The Cryogenian Period: [Seafloor weathering can explain the disparate durations of Snowball glaciations](#).

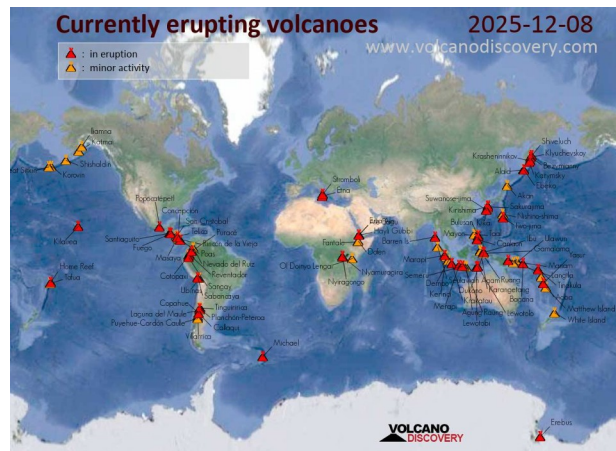
Bad Science

- [Influential study on glyphosate safety retracted 25 years after publication](#).
- [The case of the fake references in an ethics journal](#)

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: [How GPS data navigate from satellites to your screen.](#)
 - [Cascades Volcano Observatory Weekly Update.](#)
 - Volcano Watch – [Tracking the growth of a new pu‘u at Kīlauea.](#)
- [Eruption Wipes Out Live Webcam With Lava Fountains! Episode 38 of Kīlauea.](#)
- [Hayli Gubbi’s Explosive First Impression.](#)
- [Automatic Analysis of Hydroacoustic Signals Related to the Activity of the Fani Maoré Submarine Volcano.](#)
- [Magma Ascent and Accumulation Drives Surface Deformation and Ring Fault Seismicity Preceding the 2024 Eruption of Fernandina Volcano, Galápagos Islands.](#)
- Video from Shawn Willsey: [Will Iceland Erupt This Year Or In 2026? Geologist Analysis.](#)
- [Geochemistry of La Fossa fumaroles \(Vulcano Island, Aeolian Islands\) unveils the evolving magmatic sources of the fluid before and during the 2021 unrest.](#)

Earthquakes

- [Euro-Mediterranean Seismological Centre \(EMSC\).](#)
- [Earthquakes Monitoring Live Worldwide.](#)
- [M7.0 earthquake strikes Alaska-Canada border;](#) Earthquakes Canada summary [here](#); Alaska Earthquake Center report [here](#).
- [Insights into ShakeAlert Earthquake Early Warning Alert Delivery by the MyShake Platform from Rapid Post-Event Analyses.](#)
- [M5.8 in northwestern China: aftershock of 2024 M7.0 Wushi earthquake;](#) USGS summary [here](#).
- [Earthquake Rupture Dynamics From Graph Neural Networks.](#)
- 12/03 [Seismic Source Spectral Properties of Dynamic Rupture With a Self-Similar, Self-Healing Slip Pulse: Origins of Double-Corner Displacement Spectra and Implications for Small Earthquake Rupture Modes.](#)
- [Tidal and hydrological seismicity modulations reveal pore fluid diffusion during earthquake nucleation.](#)

Geohazards

- Video: [Major Disaster Strikes Indonesia; 10,000+ Landslides, Geologist Analysis.](#)
- [Aseismic Slip on the Ilyak Strike-Slip Fault \(Tajikistan\) and Active Fault and Landslide Hazards in and Around the Tajik Basin Revealed by InSAR.](#)

- [Searching for Seismic Precursors—The Barry Landslide Hazard](#); SciTechDaily summary [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 Course – [HydroGeoCenter](#).
- From Western Australia: [Carbonatite, lamprophyre and host rocks in the northern Aileron Province](#).
- Two volumes of Geology of Indonesia now can be accessed for **FREE/GRATIS**. The books can be accessed from: vol 1 <https://lnkd.in/eH6Gcka4>; vol 2 <https://lnkd.in/egTYmpjk>.
- 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](#).

Upcoming Events

- [Groundwater Week 2025, December 9-11, 2025 in New Orleans](#).
- [Stratigraphic Discussion Group Updated granite classification and recognizing sanukitoids 2:00 to 5:00pm, Thursday, 11 December, Joe Lord Core Library, Kalgoorlie Stratigraphic Discussion Group](#).
- [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](#).

December 8, 2025

Geology and Mineral Resources – Monaco

Introduction



Figure 1a – Monaco

Credit: [CIA World Factbook](#), public domain



Figure 1b – Location of Monaco

Credit: [CIA World Factbook](#), public domain

This week we will look at the [Principality of Monaco](#). We will also look at Monte Carlo simulations in geological sciences.

Monaco is a [city-state](#) of 38,423 people on the [French Riviera](#). The country has an area of 2.08 square kilometres and borders on [France](#) and the [Mediterranean Sea](#).

The people of Monaco are extremely well off with a per capita [GDP \(PPP\)](#) of \$270,100! The [economy](#) of Monaco consists of [banking](#), [tourism](#), and [gambling](#). So if you have money to burn, they are happy to take it.

For more details on the country, check out the [CIA World Factbook on Monaco](#) as well as the [Wikipedia article](#).

Geology and Mineral Resources

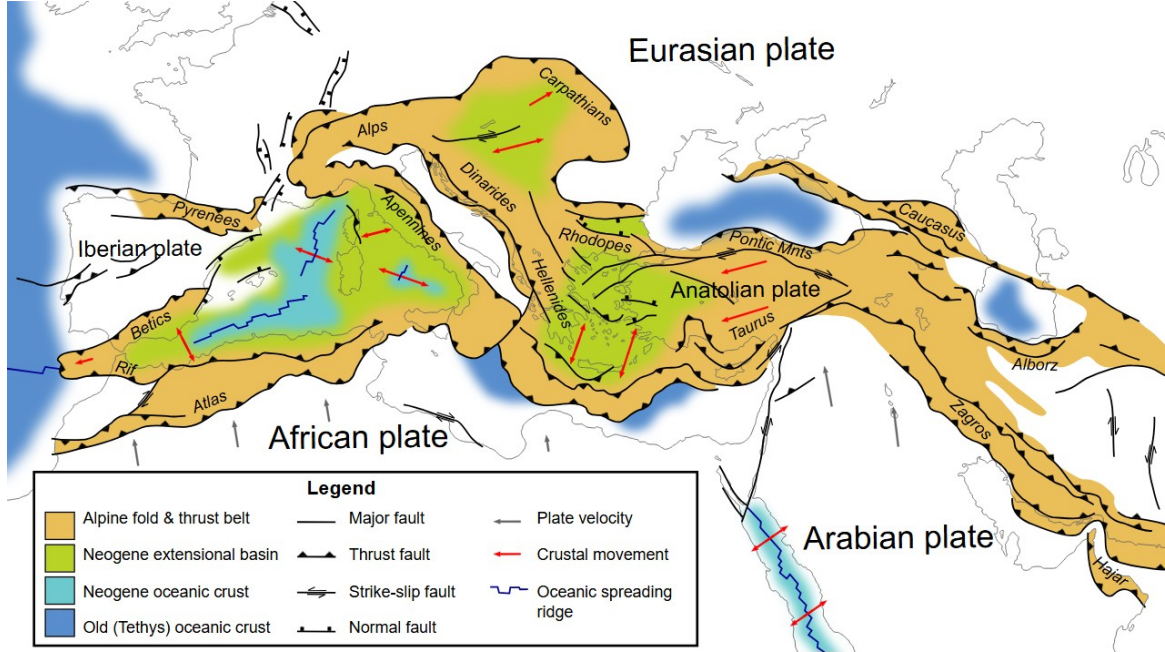


Figure 2 - Tectonic map of southern Europe, North Africa and the Middle East
 Credit: [Woudloper](#), [Creative Commons Attribution-Share Alike 1.0 Generic](#) license

Tectonically, Monaco sits on a small part of the [Alpide orogenic belt](#). The [geology of Monaco](#) was deposited in the ancient [Tethys Ocean](#) and made into their present form by the [Alpine Orogeny](#) which began during the the Late [Mesozoic](#) and continues to the present [Cenozoic Era](#). Monaco sits on the [Eurasian Plate](#); and to the south the [African Plate](#) is moving northward forming a [convergent tectonic boundary](#).

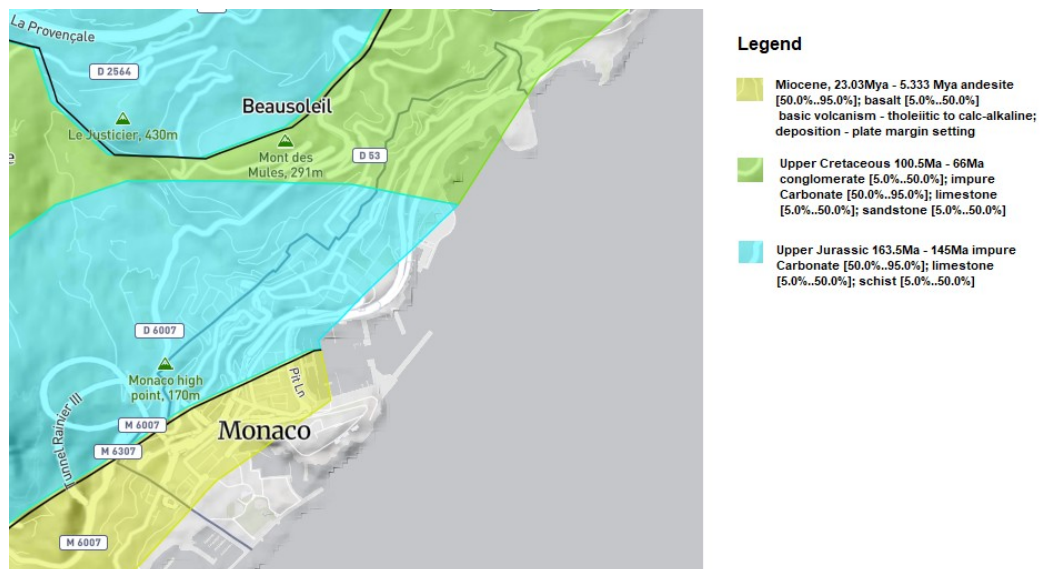


Figure 3 – Geology of Monaco
 Credit: [Macrostrat](#), [Creative Commons Attribution-Share Alike 4.0 International](#) license

The bedrock geology of Monaco consists of three formations:

- The youngest deposits are [Miocene](#) aged [basic volcanic rocks](#) originating from [tholeiitic](#) to [calc-alkaline](#) magma and forming a mix of [basalt](#) and [andesite](#); these volcanic rocks were deposited along a [tectonic plate margin](#).
- Next oldest are [Upper Cretaceous](#) aged [conglomerate](#), impure [carbonate rocks](#), [limestone](#), and [sandstone](#).
- The oldest bedrock under Monaco consists of [Upper Jurassic](#) aged impure carbonate rocks, limestone, and [schist](#).

Monaco has no developed mineral deposits, and while their undersea claims reach out into the Mediterranean Sea, there have been no offshore petroleum or natural gas developments in that zone.

Monte Carlo Simulations and Geology



Figure 4 – Monte Carlo Casino

Credit: [zeisel](#), [Creative Commons Attribution 3.0 Unported](#) license

Not everything in nature can be described by deterministic methods, sometimes only probabilistic methods can explain the results of an investigation. This brings us to the mathematical method called [Monte Carlo Simulation](#), named by mathematician [Stanisław Ulam](#) after one of Monaco's most famous landmarks, the [Monte Carlo Casino](#). It's an interesting story, Ulam was one of the scientists on

the [Manhattan Project](#). When they were looking for a name for the new probabilistic mathematical methods that they had developed, Ulam suggested the term Monte Carlo, after the casino that his uncle liked to frequent.

The [Monte Carlo Simulation](#) is used in many sciences, including geological sciences. If you are interested in the rather elegant mathematics of the Monte Carlo method, you can start by checking out the [AAPG Wiki](#) article on the subject as well as these references:

- Eric Marsden, (no date) Risk Engineering: [Monte Carlo sampling methods](#).
- Zhenyi Chen, March 2025, [Theoretical and Natural Science: A Review of Research Progress in Monte Carlo Methods](#).
- Jiajie Li, May 2025, Highlights in Science Engineering and Technology: [Study of Monte Carlo Simulation: Principles, Methods, and Applications](#).

If you are looking for software to do the mathematical work, start with the [FREE software offered by the USGS](#).

So where do we use Monte Carlo methods in geology? The quick answer is in any application that involve uncertainty and complex modeling. Examples include:

1. Quantifying uncertainty in geological models

Monte Carlo methods are used in modelling subsurface conditions, i.e. for [fluid flows](#) and [resource evaluation](#). The method can also be used to update geological models using [data from boreholes](#).

2. Seismic and geophysical studies

[Monte Carlo methods can be used in geophysics](#) to estimate subsurface properties from seismic data. Examples include estimating [seismic velocity](#) parameters, [monitoring rock deformation](#), and [reservoir characteristics](#).

3. Earthquake hazard assessments

[Monte Carlo simulations](#) can be used in [earthquake hazard simulations](#). While predicting earthquakes can be risky – [in Italy you might be thrown into jail](#) if you get it wrong – mathematical modelling can at least show the likelihood of a seismic event. (The Italian geologists were eventually [exonerated](#)).

4. Other geohazard risk assessment

Other geological risks from geohazards can also be analyzed for probabilistic assessments of geological risks such as in [drilling projects](#) and [underground rock excavation projects](#).

5. Contaminant transport models and environmental geology

Monte Carlo methods are frequently used in contaminant transport modelling, examples [here](#), [here](#) and [here](#). The US EPA has published a guideline [Guiding Principles for Monte Carlo Analysis](#). Monte Carlo methods can also be used in the [selection of QA/QC samples](#) in field projects; this is where I first encountered the method.

Monte Carlo methods are an improvement over simply rolling the dice – go to the Casino for that.

Summary



Figure 5 - Panoramic View of Monaco

Credit: [Tobi 87](#), [Creative Commons Attribution-Share Alike 3.0 Unported](#), [2.5 Generic](#), [2.0 Generic](#) and [1.0 Generic](#) license

There is not much more to say about the geology of Monaco. It looks like a pleasant place to visit and it might be fun to look at the rocks and take in the sights. Just don't bet more than you can afford to lose.

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.