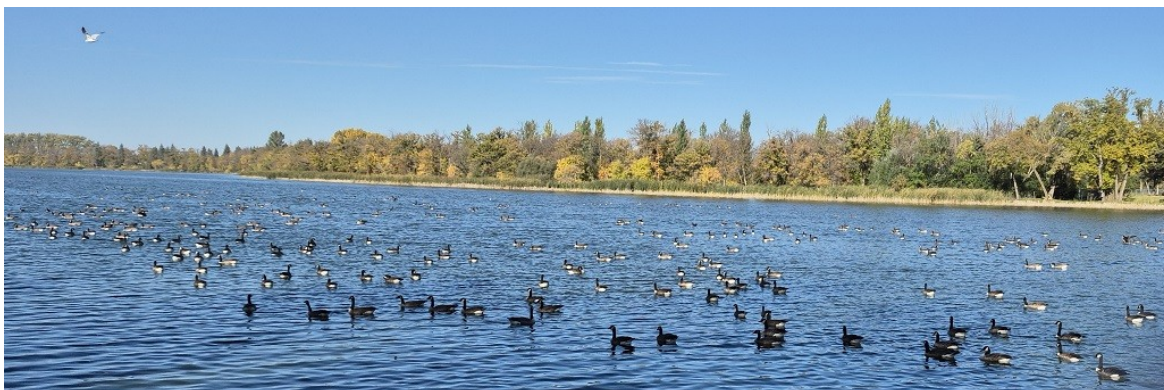


October 6, 2025

News and notes



Fall Colours and Geese on Crescent Lake – October 2, 2025

This week, before going on to discuss the geology and mineral resources of Malta, we will first look at some news items I thought were interesting. If you enjoy my blogs, bookmark the site and check Monday mornings rather than relying on social media postings which can get lost in the shuffle.

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.

Last week, Marcus S. commented that:

“the lithium in Mali could have had a bit more of a plug, as there are two significant spodumene projects there - Goulamina and Bougoni.”

I missed that, so here is an update.

Goulamina. Located in southern Mali, approximately 150 kilometers from Bamako and 50 kilometers west of Bougoni, the [Goulamina Lithium Project](#) began [production](#) in May 2024. The first [shipment](#) of lithium concentrate was sent to China in June 2025. Originally a joint venture between [Leo Lithium](#) and [Ganfeng Lithium](#), the project is now a 100% Ganfeng operation. The lithium is contained in the mineral [spodumene](#), found within [pegmatite](#). Annual expected production in the first phase of the project is 506,000 tonnes of lithium concentrate. The geology of the Goulamina spodumene pegmatite field is described [here](#).

Bougoni. Kodal Minerals is developing the [Bougoni Lithium Project](#) at a site in southern Mali, west of Sikasso. Also located within spodumene in pegmatite, the Bougoni Project consists of three distinct deposits: Sogola-Baoulé, Ngoualana, and Boumou. Lithium concentrate [production](#) at the Ngoualana deposit began in February 2025, with expected production of 125 000 tonnes/year. The second stage of the project will process spodumene from all three deposits. [Export permits](#) for the lithium concentrate were issued in September 2025. The geology of the Bougoni region is described [here](#) and [here](#).

Geopolitics

- [Trump administration mulls stake in Greenland rare earth miner.](#)
- In the spirit of Jean Lafitte: [Putin Blasts French 'Piracy' After 'Russia-Linked' Tanker Boarded, Captain Arrested.](#)
- [Calculating the odds of a civil war in the United States.](#)
- [EU confirms it has reinstated sanctions against Iran.](#)
- [Putin Orders Highest Fall Conscription Target in 9 Years.](#)

Research and News

- Igneous intrusions: [Seismic Characteristics and Morphology of an Igneous Intrusion in the Vøring Basin, Offshore Norway: New Insights on the Lateral Evolution of Elongated Intrusions.](#)
- [Magma Differentiation, Phase Separation, and Volatiles: Factors Controlling Chemistry of Submarine Hydrothermal Fluids.](#)
- [Coupled fluorine and hydroxyl incorporation into forsterite..](#)
- [Carbon Isotope and Abundance Systematics Reveal an Insignificant Crustal Sink of Mantle-Derived CO₂ in On-Land Rift Zone Geothermal Systems.](#)
- [Pressure-induced phase transitions in rhodonite and related chain silicates.](#)
- [Central Texas' Llano Uplift: The Keystone for Reconstructing the Mesoproterozoic through Cambrian History of Southern Laurentia.](#)
- Geophysics, structural geology, and stratigraphy: [Consistency Between the Slip History Implied by in Situ ³⁶Cl Exposure Dating on an Active Normal Fault and the Timing of Holocene Coastal Notch Formation, Central Greece.](#)
- This looks like it could be useful: [Estimating grainsize using the thermal infrared spectral features of quartz and carbonate.](#)
- Petrology: [The Energy of Grain Boundaries and Interfaces in High-Grade Metamorphic Rocks: Inferences from the Dihedral Angle Method.](#)
- [High-Fidelity Cretaceous-Paleogene Boundary Investigations: Records of Impact and Transport.](#)
- Shale geology: [Characterizing low-permeable shales using Rock-Eval pyrolysis and nuclear magnetic resonance for reconstruction of fluid saturation model.](#)
- [Determination of Fe³⁺ and Fe²⁺ Partition Coefficients between Pyroxenes and Basaltic Melt with in-Situ Synchrotron Mössbauer Spectroscopy.](#)
- [Aligned hydrothermal fluid-flow pathways in Middle Permian near-shore marine sediments beneath a basaltic lava flow.](#)

Planetary Geology

- Lunar mineralogy: [Microstructural and chemical responses of lunar pyroxene to shock shearing under low to moderate shock conditions.](#)
- [Consolidating the isotopic trichotomy of planetary materials with new evidence.](#)
- [Metasomatism and Mélange Development at the Conditions of Modern Deep Slow Slip: P-T-t Evolution of Metasomatic Rocks \(Pimu'nga/Santa Catalina Island, CA\).](#)
- Book Review: [Exoplanets: Compositions, Mineralogy, Evolution.](#)
- [Nonuniform water distribution in Jupiter's midlatitudes: Influence of precipitation and planetary rotation.](#)

Plate Tectonics

- [Lowermost Mantle Flow at Thermochemical Piles Constrained by Shear Wave Anisotropy: Insights From Combined Geodynamic and Mantle Fabric Simulations at Global Scale.](#)
- [Late Cretaceous to early Paleogene syntectonic deposition of the Show Goat formation in the northern Chiricahua Mountains, southeast Arizona.](#)
- [Quantifying Miocene thin- and thick-skinned shortening in the Baous thrust system, SW French Alpine Front.](#)
- [Using calcite deformation twins to constrain subduction-related paleostress state and deformation temperatures: A case study using the exhumed Sestola-Vidiciatico unit of the Northern Apennines, Italy.](#)
- [Characterizing an Incipient Fault System: Insights From the Morphometric Analysis of the North-South Faults \(Alboran Sea\).](#)
- [The Role of the Overriding Plate and Mantle Viscosity Structure on Deep Slab Morphology.](#)
- [Investigating the Antarctic Lithosphere Through Sp Receiver Function Analysis.](#)
- [Constraints on the Dehydration Systematics of Subducted Oceanic Crust Across the Blueschist-to-Eclogite Facies Transition \(Eclogite Zone, Eastern Alps\).](#)
- Videos on plate tectonics history: [Trashing continental drift, Part 1](#), part 2 [here](#).
- [Kink strengthening and rank-1 connection of crustal rocks](#); Phys.org summary [here](#).

Paleontology

- [Manouria morla sp. nov., the Ancient One: an Early Miocene large tortoise from the Swamps of Ahníkov, Czechia.](#)
- [Marine origins and freshwater radiations of the otophysan fishes](#); Phys.org summary [here](#).

- [A new Late Cretaceous abelisaurid species from La Rioja Province, northwestern Argentina;](#) SciNews summary [here](#).
- [Aquatic sloths \(*Thalassocnus*\) from the Miocene of Chile and the evolution of marine mammal herbivory in the Pacific Ocean.](#)
- [Neutron Computed Tomography: A Novel High-Resolution, Non-Destructive Method for Screening Fossil Coral for Diagenetic Alteration for Geochronologic and Paleoclimatic Reconstructions.](#)
- [The first leech body fossil predates estimated hirudinidan origins by 200 million years.](#)
- [First fossil frog and snake assemblage from southern Taiwan: a window into Pleistocene herpetofauna and palaeoenvironments in subtropical East Asia.](#)
- [Redefinition of the Sandbian–lower Katian conodont biozonation of Baltoscandia.](#)
- [Testudinid turtle remains from the Late Miocene palaeo-island of Gargano, Italy, and an overview of Mediterranean insular tortoises.](#)

Ore and Petroleum Geology

- [Overpressure](#) is an issue in petroleum development: [Modeling Overpressure Development and the Mechanical Behavior of Sediments in a Complex, Tectonically Active Setting: East Coast Basin, New Zealand.](#)
- [Revisiting redox-driven pathways of tin cycle from source to economic deposit.](#)
- Ore geology and mineralization potential: [Fertility Assessment of Tectono-Magmatic Cycles in the Tres Cerrillos Prospect \(Western Cordillera of Ecuador\).](#)
- VMS deposit geology: [Syn- and Postdepositional Controls on the Composition of Pyrite and Pyrrhotite in the Windy Craggy Cu-Co Volcanogenic Massive Sulfide Deposit, British Columbia, Canada.](#)

Mining and Energy

- Australia: [Victorian gold sector: Resurgence or just talk?](#)
- [Fire At U.S. West Coast's Most Important Refinery Contained.](#)
- [Shell Prepares to Double Output Capacity at LNG Canada Project.](#)
- More trouble: [Mali army holds back 70 Allied Gold trucks as militants block fuel imports.](#)
- [Nuclear fusion, the 'holy grail' of power, was always 30 years away—now it's a matter of when, not if, fusion comes online to power AI.](#)
- [These Are The 5 Largest Gold-Producing Countries.](#)
- [Imperial Oil plans to cut 20% workforce by end of 2027.](#)

- Geothermal: [62,000,000 GWh jackpot hits America - Superhot rock reservoirs across four states promise ages of energy.](#)
- England: [Council blocks geothermal power plant.](#)
- [The AAPG Bulletin has a special issue on geothermal energy.](#)

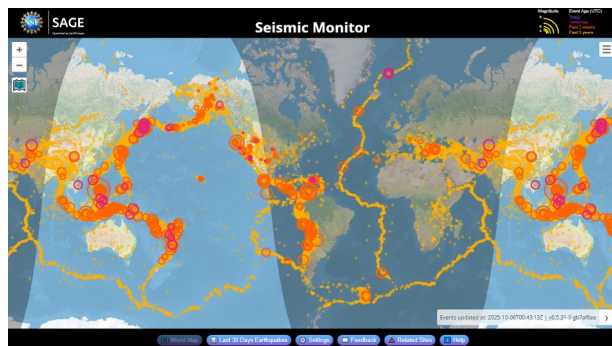
Environmental Geology and Hydrogeology

- [Ecuador revokes environmental license for DPM to develop gold project.](#)
- [Solar-powered farming is digging Pakistan into a water catastrophe.](#)
- [Quality controlled, reliable groundwater level data with corresponding specific yield over India.](#)
- [Multidecadal Change in Pesticide Concentrations Relative to Human Health Benchmarks in the Nation's Groundwater.](#)

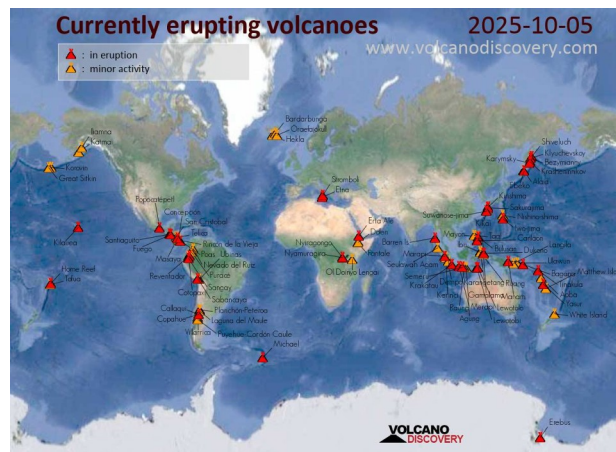
Glaciers and Climate Change

- [Earth system response to Heinrich events explained by a bipolar convection seesaw.](#)
- [Orbital and millennial-scale forcing of the Patagonian Ice Sheet throughout the Last Glacial Cycle.](#)
- [Learning From Finland: Variability of Subglacial Heat Flow in Greenland Explored From Geological Units and Radiogenic Heat Production.](#)
- Ancient climate change: [Tectonic-astronomical interactions in shaping late Paleozoic climate and organic carbon burial.](#)
- [Glaciers in California's Sierra Nevada are likely disappearing for the first time in the Holocene;](#) Phys.org summary [here.](#)

Volcanoes, Earthquakes and Geohazards



[Seismic Monitor](#)



[Active Volcano Map](#)

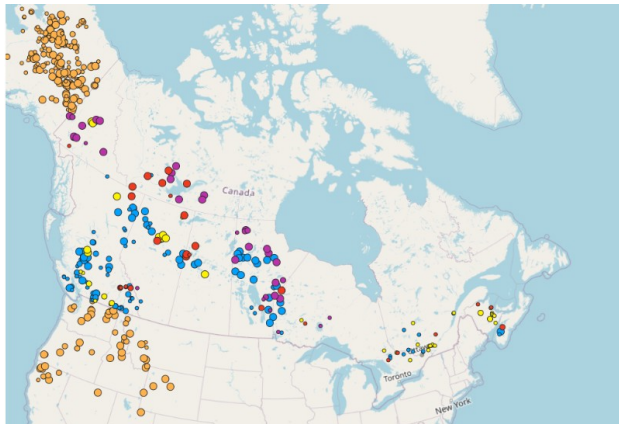
Volcanoes

- [Smithsonian / USGS Weekly Volcanic Activity Report](#).
- United States Geological Survey (USGS) Volcano Observatories:
 - [Cascades Volcano Observatory Weekly Update](#).
 - Yellowstone Caldera Chronicles: [How does water from snow and rain get to the numerous hot springs in Yellowstone?](#)
- Book review: [Volcanology. Processes, deposits, geology and resources](#).

Earthquakes

- [Euro-Mediterranean Seismological Centre \(EMSC\)](#).
- [Earthquakes Monitoring Live Worldwide](#).
- [The First Three Months of Postseismic Deformation of the 29 July 2021 Mw 8.2 Chignik Earthquake Provides New Constraints on the Down-Dip Extent of Coseismic Slip](#).
- [Earthquake Magnitude and Source Parameter Estimation with a Distributed Acoustic Sensing Dataset in the Gorda Subduction Zone](#).
- [Deadly M6.9 earthquake strikes central Philippines](#); USGS summary [here](#).
- [Unravelling the dance of earthquakes: Evidence of partial synchronization of the northern San Andreas fault and Cascadia megathrust](#); Phys.org summary [here](#).

Wildfires and Other Geohazards



Interactive Wildfire Map October 5, 2025
[Credit: ©Canadian Wildland Fire Information System](#)

- [Increasing flood hazard in the Lower Mississippi River due to extreme storm clustering](#).
- [Death toll in Philippine typhoons climbs to 27, 16 missing](#).
- Indonesia: [New report sets pathway to reduce the impacts of geohazards in one of the world's most hazard-prone nations](#).

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; also they now have a [Free Online Learning Module: Pumping Test Analysis](#).
- 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

- Australia: [12–18 October 2025, Earth Science Week](#).
- November 3 – 4, 2025 [Central Canada Mineral Exploration Convention 2025](#) Victoria Inn Hotel & Convention Centre, 1808 Wellington Avenue, Winnipeg, Manitoba R3H 0G3, Canada.
- [5th International Professional Geology Conference \(IPGC\), November 5 to 7, 2025, Zaragoza, Spain](#).
- [Saskatchewan Geological Open House, December 1 to 3, 2025, Delta Bessborough Hotel, Saskatoon](#); Registration for the 2025 Conference now open.
- [Groundwater Week 2025, December 9-11, 2025 in New Orleans](#).
- [GAC-MAC 2026 St. John's NL, St. John's Convention Center, May 25-28, 2026](#).
- [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](#).
- [International Union of Geological Sciences calendar of geoscience events](#).
- [“Geology Hour” Online](#), evenings on the 3rd Monday of the Month from the Geological Society of the Oregon Country.
- [Canadian Energy Geoscience Association Upcoming Events](#).

October 6, 2025

Geology and Mineral Resources – Malta

Introduction



Figure 1a – Malta

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



Figure 1b – Location of Malta

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

A former [British](#) colony, the [Republic of Malta](#) is an island country of 469,730 people on an archipelago in the [Mediterranean Sea](#) between [Sicily](#) (80 km to the north) and [Tunisia](#) (284 km to the west). The three main islands, and the only inhabited ones, are: [Malta](#), [Gozo](#), and [Kemmuna](#). The total land area of the country's islands is 316 square kilometres. The Maltese are a fairly prosperous people; the per capita [GDP \(PPP\)](#) is \$67,682 and the [Human Development Index](#) is very high at 0.924. The main elements of the Maltese economy are foreign trade (serving as a freight trans-shipment point), manufacturing (especially electronics and textiles), and tourism. For more details on the country, check out the CIA World Factbook on [Malta](#) as well as the [Wikipedia article](#).

Geology

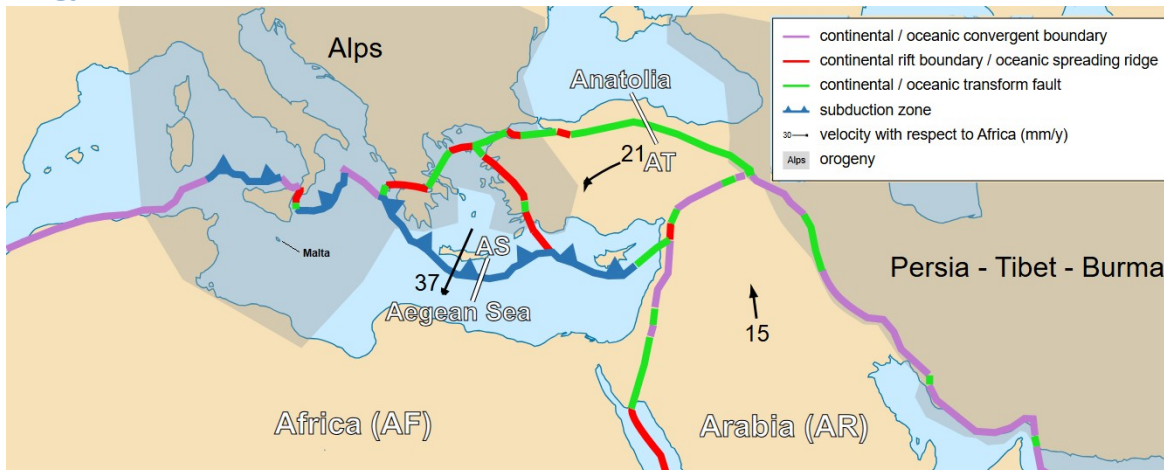


Figure 2 – Tectonic Framework of the Mediterranean

Credit (modified): Eric Gaba ([Sting – fr:Sting](#)), [Creative Commons Attribution-Share Alike 2.5 Generic](#) license

The Maltese Archipeligo is a small portion of the former [Tethys Ocean](#) seabed that has been thrust up by the [Alpine Orogeny](#) into a [horst and graben system](#). In the Alpine Orogeny, the [African Plate](#) collided with the [Eurasian Plate](#), closing the Tethys Ocean. The [Alpine Orogeny](#) began during the [Cretaceous Period](#) and continues to the present.

The [principal tectonic phases](#) in the formation of Malta were:

1. The break-up of [Pangea](#) (see an interactive map of the breakup [here](#)) during the [Triassic Period](#) and the [Early Jurassic Period](#).
2. [Plate divergence](#) and [formation of the Tethys Ocean](#) during [Middle Jurassic](#) and [Early Cretaceous](#) periods.
3. [Convergence of the African and Eurasian plates](#) that lead to a [collision](#) in the [Late Cretaceous](#).
4. The [consumption of the African and European](#) continental margins beginning in the [Eocene Epoch](#) of the [Paleogene Period](#) and continuing into the present [Quaternary Period](#).
5. Concurrent with item 4, the [dextral movement of Europe with respect to Africa](#) giving rise to renewed rifting during the [Neogene Period](#).

The [bedrock geology of Malta](#) reflects its origin in the seabed of the ancient Tethys Ocean. Most of the exposed rocks are marine sediments deposited during the [Oligocene](#) and [Miocene](#) epochs. Overlying the Neogene and Paleogene rocks, in some places, are [Pleistocene](#) aged [carbonate](#) deposits and more recent, [Holocene](#) aged [aeolian](#) and [alluvial](#) deposits. Figure 3 is a surface geology map of Malta. Figure 4 is a stratigraphic column of Malta's geology.

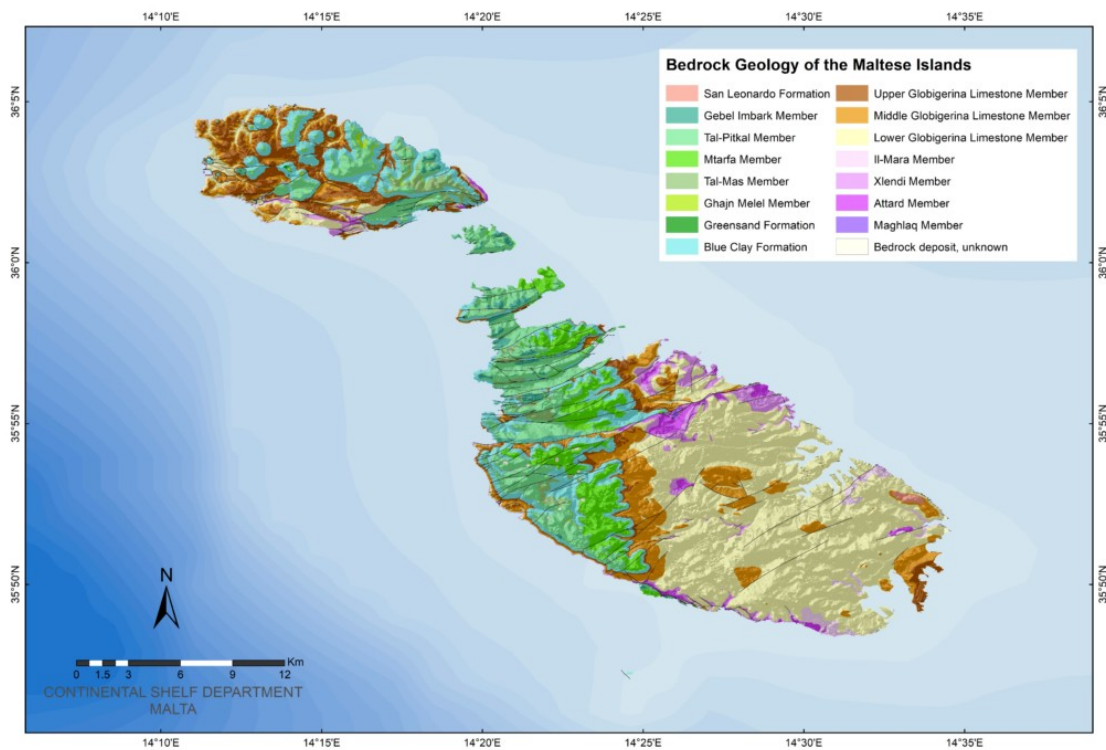


Figure 3 – Geological Map of Malta
Credit: [Continental Shelf Department, © Government of Malta 2023](#)

PERIOD	FORMATION	MEMBER
Quaternary	San Leonardo	
Tertiary (Neogene and Paleogene)	Upper Coralline Limestone	Gebel Imark
		Tal -Pitkal
		Mtarfa
		Tal-Mas
		Għajn Melel
	Greensand	
	Blue Clay	
	Globigerina Limestone	Upper Globigerina
		Middle Globigerina
		Lower Globigerina
	Lower Coralline Limestone	Mara
		Xlendi
		Attard
		Magħlaq

Figure 4 – Stratigraphic Column of Maltese Geology
Credit: Continental Shelf Department, © Government of Malta 2023

The youngest rocks of Malta are discontinuous Quaternary aged deposits. Many of these are: infills in surface depressions, fissures and caves; [lacustrine](#) deposits; [caliche and calcrete](#) material; [alluvial fan deposits](#), and [raised beaches](#). Some of the cave fillings contain the remains of [Pleistocene aged fauna](#) including [dwarf elephants](#), [hippos](#), [deer](#), and [giant tortoises](#). Also within the Quaternary deposits are the marine limestones of the [San Leonardo Formation](#).

The next oldest is the [Upper Coralline Limestone](#), deposited during the [Tortonian](#) and [Messinian](#) ages of the Miocene Epoch. The Upper Coralline is further subdivided into the the Għajn Melel, Tal-Mas, Mtarfa, Tal-Pitkal and Ġebel Imark members. Overall, the Upper Coralline is a hard pale-grey

[limestone](#) deposited in shallow waters characterized by the presence of abundant [corals](#) and [coralline algal fossils](#).

Going deeper, we have the [Greensand](#) and [Blue Clay](#) formations. Both these are also Miocene in age, with the Greensand deposited during the Tortonian Age and the Blue Clay deposited from the [Langhian](#) to Tortonian. The Greensand Formation, as the name suggests, consists of friable, brown to greenish [glauconite-rich sands](#). The Blue Clay Formation is made up of soft, medium grey [marl](#) deposited in a [pelagic environment](#).

Underlying the Blue Clay formation is the [Globigerina Limestone Formation](#) deposited from the [Chattian Age](#) of the Oligocene Epoch until the Langhian Age of the Miocene. The formation is named after the abundant fossils of [Globigerina](#) forams and is a soft, yellow, fine-grained limestone. The Formation is further divided into three members: the Upper, Middle and Lower Globigerina Limestone separated by two [phosphorite conglomerate](#) beds.

The oldest exposed formation on Malta is the [Lower Coralline Limestone](#), also deposited during the Chattian Age. The Lower Coralline Limestone consists of a hard, pale grey limestone consisting of beds containing marine calcareous coralline algae deposited in a [shallow water environment](#). The formation is further subdivided into the Magħlaq, Attard, Xlendi and Il-Mara members.

Mineral Resources



Figure 5 – Limestone Quarry on Gozo

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

The pictures that I have seen of Malta show lots of stone buildings, many [dating from antiquity](#). That's not surprising given the geology of the island archipelago. According to the USGS [National Minerals Information Center's report](#), the mineral industry of Malta consists of [industrial mineral](#) production from some 50 limestone quarries together with artisanal salt production by solar salt pans on [Salina Bay](#) on Malta Island and [Xwejni Bay](#) on Gozo Island. The most recent production statistics on mineral production from the USGS are [here](#).

Limestone production in Malta consists of quarrying for [dimension stone](#) – stone blocks for construction – and [crushed stone](#) for various building projects, especially road [subbase](#). The Government of Malta lists an archive of permits for limestone quarries [here](#). A common dimension stone is quarried from the Lower Globigerina Member of the Globigerina Limestone and locally called "[hardstone](#)".



Figure 6 – Salt Pans at Gozo

Credit: [Kritzolina, Creative Commons Attribution-Share Alike 4.0 International license](#)

Artisanal salt production is an [ancient practice](#) in Malta and may be its most [ancient industry](#). The salt works are often [multi-generational enterprises](#). The [process](#) is fairly simple: sea water is directed into enclosures, called salt pans, and then closed off. The water in the pans evaporates off and the salt is collected.

Other undeveloped potential mineral resources in Malta include the phosphorite beds, in the Globigerina Limestone, and possible off-shore oil & gas deposits. The geology of the phosphorite beds has been studied ([here](#) and [here](#) for example). Recently, [this study](#) proposed recovering rare earth elements (REE) from phosphorite beds and the Maltese deposits may be suitable for this exploitation.

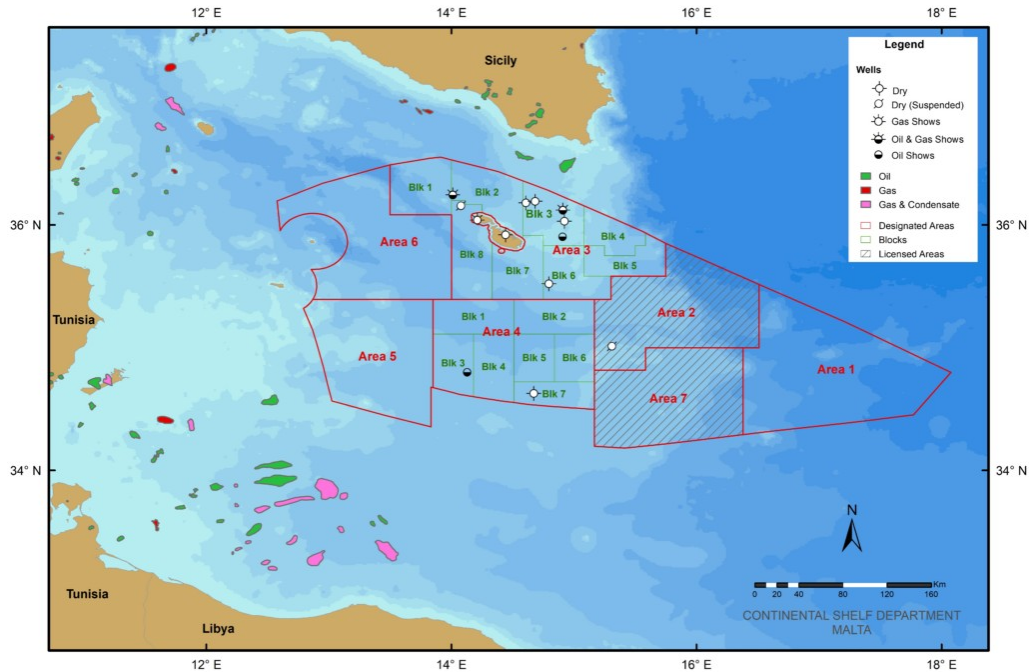


Figure 7 – Malta’s Designated Areas for Oil and Gas Exploration
Credit: [Continental Shelf Department, © Government of Malta 2023](#)

There are no current production wells for oil and gas within Malta’s territorial seabed claims. While there has been [exploration projects](#) in the past, [further development appears to be stalled](#) by competing territorial claims for the seabed. However, geologists are an optimistic bunch and [hope springs eternal](#).

A final note needs to be made on groundwater resources. Malta is entirely dependent on groundwater for fresh water supply. There are [five main aquifers](#) on the islands, most appear to be hosted in fractured limestone. There are justifiable concerns with [overuse of groundwater](#) and [seawater intrusion](#) into the aquifers.

Figure 8 links to an [interactive mineral occurrence map](#) of Malta.

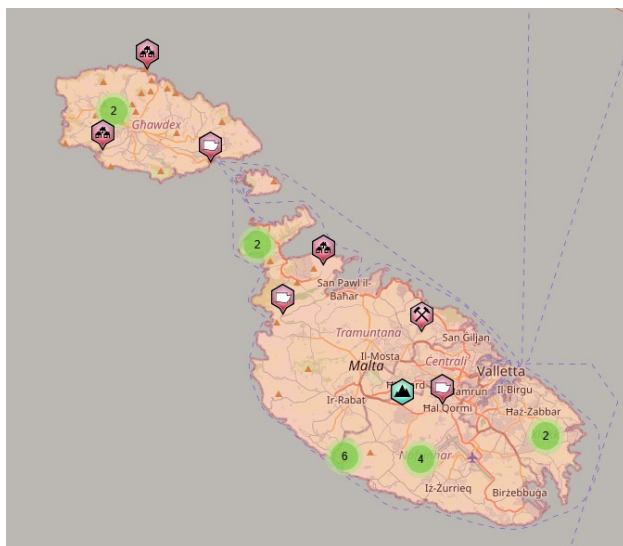


Figure 8 - Mineral Occurrence map of Malta
Credit: [Mindat.org](#)

Summary



Figure 9 - Panorama of [Ghajn Tuffieha](#) Sunset

Credit: Andrea Scanu, [Creative Commons Attribution-Share Alike 4.0 International](#) license

While it looks like a [great place to visit](#), with its interesting geology and [fascinating history](#), Malta does not appear to have many prospects for mineral development. That could change if the oil and gas sector opens up for exploration work. Another prospect is the recovery of REE from the phosphorite beds. Also, academics in hydrogeology may have opportunities to better characterize the groundwater resources of the islands.

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.