

= Seamount =

A seamount is a mountain rising from the ocean seafloor that does not reach to the water's surface (sea level) , and thus is not an island . Seamounts are typically formed from extinct volcanoes that rise abruptly and are usually found rising from the seafloor to 1 @, @ 000 ? 4 @, @ 000 metres (3 @, @ 300 ? 13 @, @ 100 ft) in height . They are defined by oceanographers as independent features that rise to at least 1 @, @ 000 metres (3 @, @ 281 ft) above the seafloor , characteristically of conical form . The peaks are often found hundreds to thousands of meters below the surface , and are therefore considered to be within the deep sea . During their evolution over geologic time , the largest seamounts may reach the sea surface where wave action erodes the summit to form a flat surface . After they have subsided and sunk below the sea surface such flat @-@ top seamounts are called " guyots " or " tablemounts "

A total of 9 @, @ 951 seamounts and 283 guyots , covering a total of 8 @, @ 796 @, @ 150 km² (3 @, @ 396 @, @ 210 sq mi) have been mapped but only a few have been studied in detail by scientists . Seamounts and guyots are most abundant in the North Pacific Ocean , and follow a distinctive evolutionary pattern of eruption , build @-@ up , subsidence and erosion . In recent years , several active seamounts have been observed , for example Loihi in the Hawaiian Islands .

Because of their abundance , seamounts are one of the most common oceanic ecosystems in the world . Interactions between seamounts and underwater currents , as well as their elevated position in the water , attract plankton , corals , fish , and marine mammals alike . Their aggregational effect has been noted by the commercial fishing industry , and many seamounts support extensive fisheries . There are ongoing concerns on the negative impact of fishing on seamount ecosystems , and well @-@ documented cases of stock decline , for example with the orange roughy (*Hoplostethus atlanticus*) . 95 % of ecological damage is done by bottom trawling , which scrapes whole ecosystems off seamounts .

Because of their large numbers , many seamounts remain to be properly studied , and even mapped . Bathymetry and satellite altimetry are two technologies working to close the gap . There have been instances where naval vessels have collided with uncharted seamounts ; for example , Muirfield Seamount is named after the ship that struck it in 1973 . However , the greatest danger from seamounts are flank collapses ; as they get older , extrusions seeping in the seamounts put pressure on their sides , causing landslides that have the potential to generate massive tsunamis .

= = Geography = =

Seamounts can be found in every ocean basin in the world , distributed extremely widely both in space and in age . A seamount is technically defined as an isolated rise in elevation of 1 @, @ 000 m (3 @, @ 281 ft) or more from the surrounding seafloor , and with a limited summit area , of conical form . If small knolls , ridges and hills less than 1 @, @ 000 m in height are included there are over 100 @, @ 000 seamounts in the world ocean .

Most seamounts are volcanic in origin , and thus tend to be found on oceanic crust near mid @-@ ocean ridges , mantle plumes , and island arcs . Overall , seamount and guyot coverage is greatest as a proportion of seafloor area in the North Pacific Ocean , equal to 4 @. @ 39 % of that ocean region . The Arctic Ocean has only 16 seamounts and no guyots , and the Mediterranean and Black seas together have only 23 seamounts and 2 guyots . The 9 @, @ 951 seamounts mapped cover an area of 8 @, @ 088 @, @ 550 km² (3 @, @ 123 @, @ 010 sq mi) . Seamounts have an average area of 790 km² (310 sq mi) , with the smallest seamounts found in the Arctic Ocean and the Mediterranean and Black Seas , whilst the largest mean seamount size occurs in the Indian Ocean 890 km² (340 sq mi) . The largest seamount has an area of 15 @, @ 500 km² (6 @, @ 000 sq mi) and it occurs in the North Pacific . Guyots cover a total area of 707 @, @ 600 km² (273 @, @ 200 sq mi) and have an average area of 2 @, @ 500 km² (970 sq mi) , more than twice the average size of seamounts . Nearly 50 % of guyot area and 42 % of the number of guyots occur in the North Pacific Ocean , covering 342 @, @ 070 km² (132 @, @ 070 sq mi) . The largest three guyots are all in the North Pacific : the Kuko Guyot (estimated 24 @, @ 600 km² (9 @, @ 500 sq mi)) , Suiko

Guyot (estimated 20 @, @ 220 km² (7 @, @ 810 sq mi)) and the Pallada Guyot (estimated 13 @, @ 680 km² (5 @, @ 280 sq mi)) .

= = = Grouping = = =

" Seamount chain " redirects here ; for a broader coverage related to this topic , see Undersea mountain range .

Seamounts are often found in groupings or submerged archipelagos , a classic example being the Emperor Seamounts , an extension of the Hawaiian Islands . Formed millions of years ago by volcanism , they have since subsided far below sea level . This long chain of islands and seamounts extends thousands of kilometers northwest from the island of Hawaii .

There are more seamounts in the Pacific Ocean than in the Atlantic , and their distribution can be described as comprising several elongate chains of seamounts superimposed on a more or less random background distribution . Seamount chains occur in all three major ocean basins , with the Pacific having the most number and most extensive seamount chains . These include the Hawaiian (Emperor) , Mariana , Gilbert , Tuomotu and Austral Seamounts (and island groups) in the north Pacific and the Louisville and Sala y Gomez ridges in the southern Pacific Ocean . In the North Atlantic Ocean , the New England Seamount chain extends from the eastern coast of the United States to the mid @-@ ocean ridge . Craig and Sandwell noted that clusters of larger Atlantic seamounts tend to be associated with other evidence of hotspot activity , such as on the Walvis Ridge , Bermuda Islands and Cape Verde Islands . The mid @-@ Atlantic ridge and spreading ridges in the Indian Ocean are also associated with abundant seamounts . Otherwise , seamounts tend not to form distinctive chains in the Indian and Southern Oceans , but rather their distribution appears to be more or less random .

Isolated seamounts and those without clear volcanic origins are less common ; examples include Bollons Seamount , Eratosthenes Seamount , Axial Seamount and Gorringer Ridge . If all known seamounts were collected into one area , they would make a landform the size of Europe . Their overall abundance makes them one of the most common , and least understood , marine structures and biomes on Earth , a sort of exploratory frontier .

= = Geology = =

= = = Geochemistry and evolution = = =

Most seamounts are built by one of two volcanic processes , although some , such as the Christmas Island Seamount Province near Australia , are more enigmatic . Volcanoes near plate boundaries and mid @-@ ocean ridges are built by decompression melting of rock in the upper mantle . The lower density magma rises through the crust to the surface . Volcanoes formed near or above subducting zones are created because the subducting tectonic plate adds volatiles to the overriding plate that lowers its melting point . Which of these two process involved in the formation of a seamount has a profound effect on its eruptive materials . Lava flows from mid @-@ ocean ridge and plate boundary seamounts are mostly basaltic (both tholeiitic and alkalic) , whereas flows from subducting ridge volcanoes are mostly calc @-@ alkaline lavas . Compared to mid @-@ ocean ridge seamounts , subduction zone seamounts generally have more sodium , alkali , and volatile abundances , and less magnesium , resulting in more explosive , viscous eruptions .

All volcanic seamounts follow a particular pattern of growth , activity , subsidence and eventual extinction . The first stage of a seamount 's evolution is its early activity , building its flanks and core up from the sea floor . This is followed by a period of intense volcanism , during which the new volcano erupts almost all (e.g. 98 %) of its total magmatic volume . The seamount may even grow above sea level to become an oceanic island (for example , the 2009 eruption of Hunga Tonga) . After a period of explosive activity near the ocean surface , the eruptions slowly die away . With eruptions becoming infrequent and the seamount losing its ability to maintain itself , the volcano

starts to erode . After finally becoming extinct (possibly after a brief rejuvenated period) , they are ground back down by the waves . Seamounts are built in a far more dynamic oceanic setting than their land counterparts , resulting in horizontal subsidence as the seamount moves with the tectonic plate towards a subduction zone . Here it is subducted under the plate margin and ultimately destroyed , but it may leave evidence of its passage by carving an indentation into the opposing wall of the subduction trench . The majority of seamounts have already completed their eruptive cycle , so access to early flows by researchers is limited by late volcanic activity .

Ocean @-@ ridge volcanoes in particular have been observed to follow a certain pattern in terms of eruptive activity , first observed with Hawaiian seamounts but now shown to be the process followed by all seamounts of the ocean @-@ ridge type . During the first stage the volcano erupts basalt of various types , caused by various degrees of mantle melting . In the second , most active stage of its life , ocean @-@ ridge volcanoes erupt tholeiitic to mildly alkalic basalt as a result of a larger area melting in the mantle . This is finally capped by alkalic flows late in its eruptive history , as the link between the seamount and its source of volcanism is cut by crustal movement . Some seamounts also experience a brief " rejuvenated " period after a hiatus of 1 @.@ 5 to 10 million years , the flows of which are highly alkalic and produce many xenoliths .

In recent years , geologists have confirmed that a number of seamounts are active undersea volcanoes ; two examples are Lo ? ihi in the Hawaiian Islands and Vailulu 'u in the Manu 'a Group (Samoa) .

== Lava types ==

The most apparent lava flows at a seamount are the eruptive flows that cover their flanks , however igneous intrusions , in the forms of dikes and sills , are also an important part of seamount growth . The most common type of flow is pillow lava , named so after its unusual shape . Less common are sheet flows , which are glassy and marginal , and indicative of larger @-@ scale flows . Volcaniclastic sedimentary rocks dominate shallow @-@ water seamounts . They are the products of the explosive activity of seamounts that are near the water 's surface , and can also form from mechanical wear of existing volcanic rock .

== Structure ==

Seamounts can form in a wide variety of tectonic settings , resulting in a very diverse structural bank . Seamounts come in a wide variety of structural shapes , from conical to flat @-@ topped to complexly shaped . Some are built very large and very low , such as Koko Guyot and Detroit Seamount ; others are built more steeply , such as Loihi Seamount and Bowie Seamount . Some seamounts also have a carbonate or sediment cap .

Many seamounts show signs of intrusive activity , which is likely to lead to inflation , steepening of volcanic slopes , and ultimately , flank collapse . There are also several sub @-@ classes of seamounts . The first are guyots , seamounts with a flat top . These tops must be 200 m (656 ft) or more below the surface of the sea ; the diameters of these flat summits can be over 10 km (6 @.@ 2 mi) . Knolls are isolated elevation spikes measuring less than 1 @,@ 000 meters (3 @,@ 281 ft) . Lastly , pinnacles are small pillar @-@ like seamounts .

== Ecology ==

== Ecological role of seamounts ==

Seamounts are exceptionally important to their biome ecologically , but their role in their environment is poorly understood . Because they project out above the surrounding sea floor , they disturb standard water flow , causing eddies and associated hydrological phenomena that ultimately result in water movement in an otherwise still ocean bottom . Currents have been measured at up to

0 @. @ 9 knots , or 48 centimeters per second . Because of this upwelling seamounts often carry above @-@ average plankton populations , seamounts are thus centers where the fish that feed on them aggregate , in turn falling prey to further predation , making seamounts important biological hotspots .

Seamounts provide habitats and spawning grounds for these larger animals , including numerous fish . Some species , including black oreo (*Allocyttus niger*) and blackstripe cardinalfish (*Apogon nigrofasciatus*) , have been shown to occur more often on seamounts than anywhere else on the ocean floor . Marine mammals , sharks , tuna , and cephalopods all congregate over seamounts to feed , as well as some species of seabirds when the features are particularly shallow .

Seamounts often project upwards into shallower zones more hospitable to sea life , providing habitats for marine species that are not found on or around the surrounding deeper ocean bottom . Because seamounts are isolated from each other they form " undersea islands " creating the same biogeographical interest . As they are formed from volcanic rock , the substrate is much harder than the surrounding sedimentary deep sea floor . This causes a different type of fauna to exist than on the seafloor , and leads to a theoretically higher degree of endemism . However , recent research especially centered at Davidson Seamount suggests that seamounts may not be especially endemic , and discussions are ongoing on the effect of seamounts on endemism . They have , however , been confidently shown to provide a habitat to species that have difficulty surviving elsewhere .

The volcanic rocks on the slopes of seamounts are heavily populated by suspension feeders , particularly corals , which capitalize on the strong currents around the seamount to supply them with food . This is in sharp contrast with the typical deep @-@ sea habitat , where deposit @-@ feeding animals rely on food they get off the ground . In tropical zones extensive coral growth results in the formation of coral atolls late in the seamount 's life .

In addition soft sediments tend to accumulate on seamounts , which are typically populated by polychaetes (annelid marine worms) oligochaetes (microdrile worms) , and gastropod mollusks (sea slugs) . Xenophyophores have also been found . They tend to gather small particulates and thus form beds , which alters sediment deposition and creates a habitat for smaller animals . Many seamounts also have hydrothermal vent communities , for example Suiyo and Loihi seamounts . This is helped by geochemical exchange between the seamounts and the ocean water .

Seamounts may thus be vital stopping points for some migratory animals , specifically whales . Some recent research indicates whales may use such features as navigational aids throughout their migration . For a long time it has been surmised that many pelagic animals visit seamounts as well , to gather food , but proof of this aggregating effect has been lacking . The first demonstration of this conjecture was published in 2008 .

= = = Fishing = = =

The effect that seamounts have on fish populations has not gone unnoticed by the commercial fishing industry . Seamounts were first extensively fished in the second half of the 20th century , due to poor management practices and increased fishing pressure seriously depleting stock numbers on the typical fishing ground , the continental shelf . Seamounts have been the site of targeted fishing since that time .

Nearly 80 species of fish and shellfish are commercially harvested from seamounts , including spiny lobster (*Palinuridae*) , mackerel (*Scombridae* and others) , red king crab (*Paralithodes camtschaticus*) , red snapper (*Lutjanus campechanus*) , tuna (*Scombridae*) , Orange roughy (*Hoplostethus atlanticus*) , and perch (*Percidae*) .

= = = Conservation = = =

The ecological conservation of seamounts is hurt by the simple lack of information available . Seamounts are very poorly studied , with only 350 of the estimated 100 @, @ 000 seamounts in the world having received sampling , and fewer than 100 in depth . Much of this lack of information can be attributed to a lack of technology , and to the daunting task of reaching these underwater

structures ; the technology to fully explore them has only been around the last few decades . Before consistent conservation efforts can begin , the seamounts of the world must first be mapped , a task that is still in progress .

Overfishing is a serious threat to seamount ecological welfare . There are several well documented cases of fishery exploitation , for example the orange roughy (*Hoplostethus atlanticus*) off the coasts of Australia and New Zealand and the pelagic armorhead (*Pseudopentaceros richardsoni*) near Japan and Russia . The reason for this is that the fishes that are targeted over seamounts are typically long lived , slow growing , and slow maturing . The problem is confounded by the dangers of trawling , which damages seamount surface communities , and the fact that many seamounts are located in international waters , making proper monitoring difficult . Bottom trawling in particular is extremely devastating to seamount ecology , and is responsible for as much as 95 % of ecological damage to seamounts .

Corals from seamounts are also vulnerable , as they are highly valued for making jewellery and decorative objects . Significant harvests have been produced from seamounts , often leaving coral beds depleted .

Individual nations are beginning to note the effect of fishing on seamounts , and the European Commission has agreed to fund the OASIS project , a detailed study of the effects of fishing on seamount communities in the North Atlantic . Another project working towards conservation is CenSeam , a Census of Marine Life project formed in 2005 . CenSeam is intended to provide the framework needed to prioritise , integrate , expand and facilitate seamount research efforts in order to significantly reduce the unknown and build towards a global understanding of seamount ecosystems , and the roles they have in the biogeography , biodiversity , productivity and evolution of marine organisms .

Possibly the best ecologically studied seamount in the world is Davidson Seamount , with six major expeditions recording over 60 000 species observations . The contrast between the seamount and the surrounding area was well marked . One of the primary ecological havens on the seamount is its deep sea coral garden , and many of the specimens noted were over a century old . Following the expansion of knowledge on the seamount there was extensive support to make it a marine sanctuary , a motion that was granted in 2008 as part of the Monterey Bay National Marine Sanctuary . Much of what is known about seamounts ecologically is based on observations from Davidson . Another such seamount is Bowie Seamount , which has also been declared a marine protected area by Canada for its ecological richness .

= = Exploration = =

The study of seamounts has been stymied for a long time by the lack of technology . Although seamounts have been sampled as far back as the 19th century , their depth and position meant that the technology to explore and sample seamounts in sufficient detail did not exist until the last few decades . Even with the right technology available , only a scant 1 % of the total number have been explored , and sampling and information remains biased towards the top 500 m (1 640 ft) . New species are observed or collected and valuable information is obtained on almost every submersible dive at seamounts .

Before seamounts and their oceanographic impact can be fully understood , they must be mapped , a daunting task due to their sheer number . The most detailed seamount mappings are provided by multibeam echosounding (sonar) , however after more than 5000 publicly held cruises , the amount of the sea floor that has been mapped remains minuscule . Satellite altimetry is a broader alternative , albeit not as detailed , with 13 000 catalogued seamounts ; however this is still only a fraction of the total 100 000 . The reason for this is that uncertainties in the technology limit recognition to features 1 500 m (4 921 ft) or larger . In the future , technological advances could allow for a larger and more detailed catalogue .

Observations from CryoSat 2 combined with data from other satellites has shown thousands of previously uncharted seamounts , with more to come as data is interpreted .

= = Deep @-@ sea mining = =

Seamounts are a possible future source of economically important metals . Even though the ocean makes up 70 % of Earth 's surface area , technological challenges with deep sea mining have severely limited its extent . But with the constantly decreasing supply on land , many see oceanic mining as the destined future , and seamounts stand out as candidates .

Seamounts are abundant , and all have metal resource potential because of various enrichment processes during the seamount 's life . An example for epithermal gold mineralization on the seafloor is Conical Seamount , located about 8 km south of Lihir Island in Papua New Guinea . Conical Seamount has a basal diameter of about 2 @.@ 8 km and rises about 600 m above the seafloor to a water depth of 1050 m . Grab samples from its summit contain the highest gold concentrations yet reported from the modern seafloor (max . 230 g / t Au , avg . 26 g / t , n = 40) . Iron @-@ manganese , hydrothermal iron oxide , sulfide , sulfate , sulfur , hydrothermal manganese oxide , and phosphorite (the latter especially in parts of Micronesia) are all mineral resources that are deposited upon or within seamounts . However , only the first two have any potential of being targeted by mining in the next few decades .

= = Dangers = =

Some seamounts have not been mapped and thus pose a navigational danger . For instance , Muirfield Seamount is named after the ship that hit it in 1973 . More recently , the submarine USS San Francisco ran into an uncharted seamount in 2005 at a speed of 35 knots (40 @.@ 3 mph ; 64 @.@ 8 km / h) , sustaining serious damage and killing one seaman .

One major seamount risk is that often , in the late of stages of their life , extrusions begin to seep in the seamount . This activity leads to inflation , over @-@ extension of the volcano 's flanks , and ultimately flank collapse , leading to submarine landslides with the potential to start major tsunamis , which can be among the largest natural disasters in the world . In an illustration of the potent power of flank collapses , a summit collapse on the northern edge of Vlinder Seamount resulted in a pronounced headwall scarp and a field of debris up to 6 km (4 mi) away . A catastrophic collapse at Detroit Seamount flattened its whole structure extensively . Lastly , in 2004 , scientists found marine fossils 61 m (200 ft) up the flank of Kohala mountain in Hawaii (island) . Subsidence analysis found that at the time of their deposition , this would have been 500 m (1 @,@ 640 ft) up the flank of the volcano , far too high for a normal wave to reach . The date corresponded with a massive flank collapse at the nearby Mauna Loa , and it was theorized that it was a massive tsunami , generated by the landslide , that deposited the fossils .