Smithsonian Associates – Underwater Volcanoes lecture

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Answers to the Q+A

1. **Lo'ihi is forming off of the Big Island of Hawaii**
    a. Correct. Lo'ihi (recently renamed Kamaʻehuakanaloa Seamount in 2022) is an underwater volcano just a few miles south of Big Island, Hawai'i. It last erupted in 1996 and is anticipated to merge as a new island (or join with Hawai'i) anywhere from 10,000 – 100,000 years from now.

2. **In the Tonga surtseyan eruption you showed in one slide, how tall above ocean surface were the explosive clouds?**
    a. The main eruption of Hunga volcano (Kingdom of Tonga) on January 15, 2022, reached heights in excess of 30 miles, whereas the smaller surtseyan eruptions only reach height of a couple of km high, maybe a little higher.

3. **Are there any Submarine Super Volcanos similar to those on Land such as Yellowstone's Caldera?**
    a. We know less about these about submarine "supervolcanoes" than we do those on land. The terms "supervolcano" itself is only really used to apply to volcanoes that have had a "supereruption" – an eruption volume of over 1000 km^3 , that's over 300 times that of Mt. St Helens in 1980. We have no known evidence of submarine supereruptions as such, but there are huge submarine volcanic lava fields and plateaus. Check out the Ontong-Java plateau. However, there is no reason why an underwater supereruption can't occur…

4. **When were pumice rafts first described?**
    a. There is very good recollection of pumice rafts washing ashore in East Africa after the devastating 1883 Krakatoa eruption in Indonesia, even with reports of bodies rafting across on the pumice. Earlier in 1650 AD, the eruption of Kolumbo, offshore Santorini, there was also observation of pumice in water. However, earliest common records would go back to Pompeii in 79 AD with pumice in the Bay of Naples.

5. **Is there or could there be a market or use for the pumice floating on the ocean surface?**
    a. Pumice is commonly smoothed out on its surface and commercialized as an exfoliating stone for skin… after all, it's mostly just a micro-jagged natural glass. Pumice is also commonly quarried in many places for building stone and infrastructure use. It is very easy to crush into fine grains and powders but is

actually relatively strong as a fine material. Although, it's natural porous and permeable properties make some pros and cons.

6. **Is there any evidence that underwater life senses underwater volcanic eruptions and relocates to be safe?**
    a. Preceding seismic and acoustic activity to an underwater volcanic eruption would certainly create a disturbance and irregular environment – especially as sound and pressure waves attenuate (move) easily and far through water. So it would be surprising if life doesn't react. In reality, this behaviour is very difficult to monitor and study due to a combination of pure luck and having the right observations and equipment on the seafloor.

7. **Do submarine volcanic eruptions contribute to the warming of the ocean and thus climate change? Do we know if submarine volcanic eruptions are increasing in frequency?**
    a. There is no evidence to suggest that submarine volcanic activity is increasing. Also, the majority of gases/vapor produced by volcanoes is actually H2O, and any carbon dioxide and sulfur released is quickly cycled and chemically-exchanged in the oceans. The ocean itself does take up atmospheric CO2, which is why we are seeing some effects of ocean acidification from rising atmospheric CO2 levels, but the oceans do not readily exchange CO2 up into the atmosphere, so even if underwater volcanoes provided large amounts of CO2 to the oceans, that CO2 would not make it into the atmosphere. And any heat from submarine eruptions deep down very quickly dissipates. Ocean warming is a consequence of slowly rising averages of global surface air temperature.

8. **If some continental shelves are drifting apart, does it impact the number of subduction movements? What does the drift do to the earth's circumference? Does it grow?**
    a. The Earth has been kept in balance by its tectonic plates' movement through a constantly shifting (geologically-speaking) equilibrium of divergence (drifting apart) and convergence (subduction) between numerous plates. There is no evidence to suggest that the Earth has ever shrunk or grown due to imbalance. Over 100's millions of years, the locations and speeds of plate divergence and convergence has significantly changed, but the crust has always remained in balance in its overall size and circumference (apart from its earliest history).

9. **Is it possible that some of the increase in global seawater temperature being reported today is due to underwater volcanic activity rather than "climate change"?**
    a. Heat from volcanic eruptions dissipates very quickly in the ocean and the amount of volcanic heat (by volume) is negligible compared to the size of the entire ocean. However, the entire ocean's surface in contact with a slowly rising global air surface temperature means a lot of water comes into contact with heat constantly, with ocean currents cycling huge volumes in contact with air.

10. **Thoughts on recent activity in the Bay of Naples?**

a. The period of seismic earthquake activity was closely monitored by local scientists, but similar events have happened in the past around Vesuvius and/or the Flegrean Fields. In fact, Vesuvius last erupted in only 1944! Both are still considered "active" volcanic systems" so periods of seismic activity are not completely unexpected. Scientists closely monitor the size, number and depth of earthquakes during these times, along with checking for rising ground (inflation). Activity far beyond background levels could indicate movement and/or rise of magma, but there is little evidence to suggest this in the recent episode.

11. If water can put out lava, like in Iceland, why doesn't all the seawater put out the lava of an underwater volcano?

a. Lava flows erupting on land lose their heat naturally by radiating heat from their surface into the surrounding air, by heating up the loose, free air molecules. However, it *is* much harder to heat water, instead it is done by conduction and not radiative heat transfer. So instead, the lava surface underwater very rapidly (cools) into solid rock/volcanic glass. However, because of the challenge of heat loss, the interiors of submarine lava flows can retain their heat for much longer than on land (generally speaking). So lava flows in the ocean can flow for very long distance and duration. These thick quickly-forming crusts act as a very good insulator for heat.

12. Can creatures live on or near underwater volcanoes?

a. Not really the ones violently erupting, but there are entire ecosystems that thrive on the heat and nutrients around hydrothermal fields or "recently-erupted" volcanic systems. As there have been very few video observations of erupting underwater volcanoes, it is difficult to know. However, the few videos we do have show that some life may still stick around. But after erupting, volcanic seamounts are a source of heat, nutrients, habitat protection, and good surface for life to colonise and thrive.

13. Are there underwater volcanoes erupting in the Mid Atlantic Ridge?

a. Essentially, the MAR could be classified as one very long volcanic ridge that lava sometimes erupts out of. There are no real identifiable volcanoes that sit directly on top of the ridge itself. But the MAR has been erupting lava ever since the beginning of the split of the supercontinent Pangea around 200 million years ago, and will continue to do so for many millions more.

14. Benefits from volcanic activity could include the formation of valuable mineral deposits for future extraction? Also, potential capture of heat for electricity generation?

a. Geothermal exploration of volcanoes *is* a huge source of energy in some parts of the world. And yes, older volcanic systems also provide fantastic areas of mineral resources, especially for valuable metals such as copper, gold, silver and even lithium. However, the technology required to extract geothermal heat

from the seafloor is significantly more costly and complicated to install and maintain so it is not really explored, especially for very deep volcanic systems.

15. Do underwater volcanoes form lava tubes?

a. Absolutely. As in Q11, underwater lava flows can cool very rapidly on their outside, but it is harder from them to lose their interior heat, so in theory, it may be easier to create lava tubes for longer underwater than on land. Underwater lava flows have been found to travel up to even 10 km!

16. Do underwater volcanoes release CO2 into the atmosphere and affect climate like terrestrial volcanoes do?

a. If the eruptions breach the ocean surface, then yes, they can release CO2 into atmosphere, but this does not happen often, usually only with the shallowest underwater volcanoes. Even then, volcanic eruptions on land are only responsible for 3% of global CO2 emissions when compared to human-produced CO2 release. It is a very very rare occasion when an underwater eruption can impact Earth's climate.

17. Do sea birds or marine mammals like seals ever "ride" pumice rafts?

a. Sea birds have certainly been observed temporarily resting on pumice rafts as they are solid surfaces (when still thick and not spread apart), however I'm yet to see an account of larger marine mammals relaxing on a pumice raft… I look forward to it happening one day for a fantastic photograph!

18. When do scientists anticipate the newest Hawaiian island to break the surface?

a. Kamaʻehuakanaloa Seamount (previously known as Lo'ihi) is expected to breach the surface anywhere from 10,000 – 100,000 years from now. The reason this estimate is so wide is a lack of knowledge of the current seamount's growth history. It would take drilling a core right through the whole seamount to fully establish its average growth rate over time.

19. Have you ever travelled in a submersible? If so, what research were you doing?

a. In April 2023, I was part of the Galapagos Deep 2023 Expedition, which was exploring the deep-sea coral reefs and platform edge of the Galapagos Islands. Every science member in the cruise (23) dove in the submersible Alvin (Woods Hole). My deepest dive was 800 meters below the surface. It took us 20 minutes to descend to that depth and we were down there for four hours.

20. Can you speak to the new discoveries about life forms (extremophiles, etc) found in areas with underwater volcanoes

a. Every journey down to the deep seafloor reveals new species, especially in areas around hydrothermal vents and black smokers with a huge diversity of life from bacteria to tubeworms, shrimp and crabs. The chemical- and nutrient-rich fluids exiting hydrothermal vents may be up to 360°C, and bacteria have been found within feet of these fluids.

21. **Can you comment on the danger to rare submarine life from mining of minerals around deep sea volcanic vents?**
    a. This is a topic of hot discussion, especially surrounding mining of deep-sea manganese nodules that might take thousands to millions of years to form only to be extracted in a matter of hours. These nodules were also found in a recent study to be responsible for providing some critical oxygen to an, otherwise, very anoxic deep-sea environment. While it is true that these underwater volcanic and hydrothermal systems host rich resources of minerals and metals, many sites are home to endemic (ecologically unique) ecosystems. Operations should require detailed image-observed analysis of the existing ecosystems and assess what detrimental harm could be possible.

22. **Do you share data with the oil industry?**
    a. More scientific literature is becoming free and publicly available, and there are efforts to better collate raw data to make it available for other scientists or other industries. Likewise, data collected in some research expeditions is actually data collected *by* the marine oil and gas industry e.g. seismic surveying of the seafloor subsurface during hydrocarbon exploration.

23. **Isn't NASA involved in the Santorini Kolumbo project?**
    a. Kolumbo, as a shallow, easily accessible, submarine volcano with hazardous potential is a key area of underwater volcanic science, so there are many groups and research areas interested in studying it. This also includes the NASA Astrobiology group looking at life in extreme environments.

24. **What can we do to encourage more exploration of the sea floor?**
    a. The key thing is helping pursue an intrigue for the deep seafloor amongst all generations, whether they are ocean-based or not. Many countries or areas around the world still lack what we call “ocean literacy”. This is expanding people’s perspectives and preconceptions of the ocean to just how woven into society the ocean and the seafloor is. Part of this is also “ocean optimism” creating a sense of hope that there is till more we can do for the ocean and that the ocean can teach us.

25. **What are the most surprizing chemicals, elements in thermal vents?**
    a. Elements of particular importance are iron, copper, sulfur, manganese, but people may also be surprised that these vents can also be sources of gold, silver, mercury, zinc, lead, lithium and even arsenic. They are *many* elements within magmatic melt that come from deep in the crust (even in tiny proportions), but these can be concentrated in the hot fluids that rise of magma and up into hydrothermal systems.