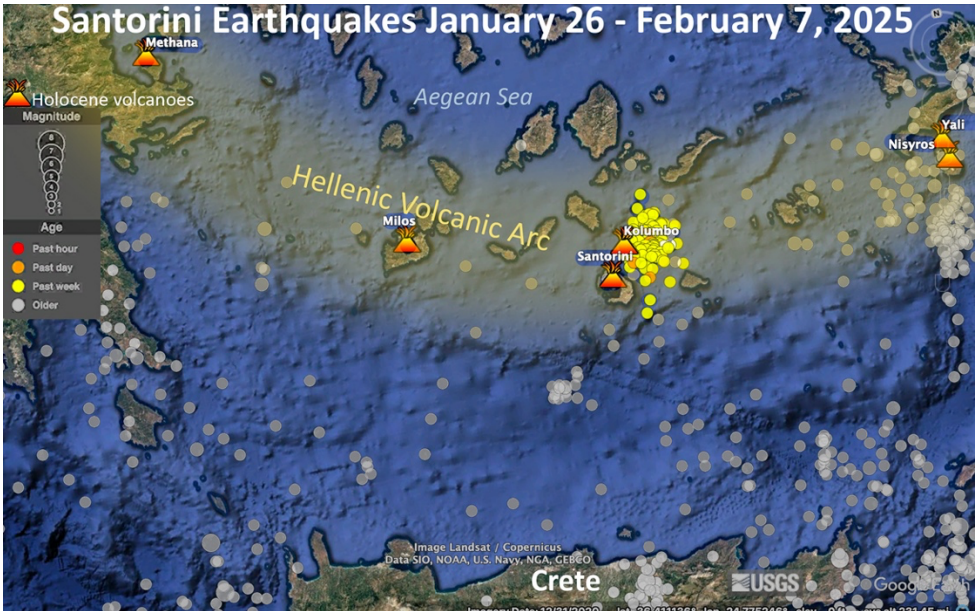
Times Standard

Not My Fault: What is brewing in the Mediterranean?

Lori Dengler for the Times-Standard

Posted February 8, 2025
https://www.times-standard.com/2025/02/08/lori-dengler-what-is-brewing-in-the-mediterranean/



Earthquakes of the past week in the Aegean Sea north of Crete (yellow and orange) superimposed on regional earthquakes (grey) since 2012. Six volcanoes in the Hellenic Volcanic Arc are noted, all have erupted in the last 10,000 years (Holocene) times.

This week's seismic surprise came from the Aegean Sea north of Crete. In the past week, the USGS has recorded more than 100 earthquakes in the magnitude 4 to 5 range clustered in a small area just offshore of the island of Santorini. The National Observatory of Athens operates a much denser network of seismic stations and has detected nearly 7000 earthquakes in this same time window.

The Aegean Sea is no stranger to earthquakes. It is laced with faults related to the slow collision between the African and Eurasian plates. But the intensity of this week's swarm is so unusual that the Greek government declared a State of Emergency and the population of nearby islands has dwindled by 90% as most residents have evacuated.

The first I became aware of this seismic burst was last Tuesday when I noticed a 5.3 near Santorini while compiling my daily earthquake recording. Santorini always perks up my interest as it was the site of a catastrophic volcanic eruption and tsunami about 3600 years ago and it's on my bucket list of places I want to visit.

The USGS defines an earthquake swarm as a series of earthquakes that occur in a concentrated area over a short period of time without a single large "mainshock". Often relatively small in magnitude, a swarm may include hundreds of earthquakes over days or weeks without the discernable pattern of smaller earthquakes following a larger mainshock like our current aftershock sequence post December 5. Most swarms are associated with geothermal activity where fluids play a role by changing pore pressures and facilitating fault slip.

Swarms are common in Southern California south of the Salton Sea where the San Andreas fault transitions to the spreading center in the Gulf of California. At least six identifiable earthquakes swarms have been noted since 2000. In August 2012 more than a 1000 earthquakes were recorded near Brawley including ten in the M4 range and a 5.3 and 5.4 that caused minor damage.

Swarms occur in northern California as well, although not with the vigor and size of those in the Salton Sea region. An extreme example of a “swarm” is the Geysers Geothermal area where the injection of water as part of energy production boosts the natural seismicity of the region to produce a nearly constant stream of small quakes.

The overwhelming majority of earthquake swarms in California have not triggered damaging earthquakes, but there are studies from Japan suggesting the January 1, 2024, M7.5 Noto earthquake was preceded by swarm activity and Kate Scharer of the USGS notes that swarms near locked fault segments like the San Andreas can change the nearby stresses and make a larger quake slightly more likely.

Earthquake swarms are also common in volcanic areas. As magma moves upwards or laterally in the earth’s crust, it pushes the overlying rock causing fractures. These swarms can be an important sign of an impending eruption and all countries with volcanic hazard zones use seismic monitoring as a way to forecast eruptions. Seismic networks and ground surface monitoring in Iceland have facilitated successful evacuations of vulnerable communities a few hours before lava reaches the surface.

When I first saw the seismic activity in the Aegean Sea, I immediately though magma must be on the move. The earthquake swarm was in the Hellenic Volcanic Arc, a sweeping zone of volcanic activity the stretches from Methana, a volcano only 30 miles from Athens to the Kula volcanic field in western Turkey. These earthquakes were only a few miles from Santorini and nearly directly beneath the submarine volcano Kolumbo. The swarm behavior and proximity to sources seemed to be indicators of an imminent eruption.

First impressions are not always accurate, and I am not a volcanologist or an expert in Aegean Sea tectonics. The answer is more complex and uncertain. Volcanoes aren’t the only tectonic feature of the region. The relentless convergence between the African and Eurasian plates is slowly compressing the Mediterranean, producing a web of faults both on and offshore.

The earthquakes in the Aegean swarm provide more information on what might be going on. They didn’t just start a week ago, the increase was first noticed last December but the earthquakes were very small and didn’t make the USGS list of global quakes. On January

26 the activity suddenly accelerated with more earthquakes and larger magnitudes. They are all roughly at the same depth between six and ten miles deep, but the epicenter locations have moved, starting beneath Santorini and migrating to the northeast.

The larger earthquakes all show similar faulting – extension along NE-SW oriented faults. At first glance that might seem odd. How do you get stretching when the African plate is plowing into Eurasia? Because it's complicated, the earth's surface isn't uniform and pushing in one place causes rotation and stretching in others. There are a number of normal faults (two sides move apart) in the Hellenic Volcanic Arc and the recent earthquakes are consistent with the trend of these mapped faults and lie suspiciously close to the Santorini-Amorgos fault.

Greek seismologists and volcanologists note that the earthquakes in this swarm show none of the hallmarks of moving magma. No ground deformation has been observed, the locations have not become shallower, and they align with the fault fabric in the region. At present, the consensus is tectonic in origin.

That doesn't mean there is no reason for concern. In 1956 a magnitude 7.7 occurred on the Santorini-Amorgos fault, followed 13 minutes later by a 7.2. The two earthquakes bracketed the zone of the current swarm. The 1956 mainshock is the largest earthquake in Greece since the era of seismic instrumentation, and like the recent earthquakes, was on a normal fault. Damage was severe on Santorini and compounded by a tsunami that arrived only minutes later.

There is no data suggesting the 1956 earthquake was preceded by a swarm of smaller earthquakes such as the sequence unfolding at present. Swarms have been observed in the region, typically lasting a few weeks but none have led to a major earthquake. The current sequence has many experts scratching their heads. Greek authorities have declared a State of Emergency at least until March 4 covering the four nearby islands, schools are closed, and public events discouraged. Most of the island residents have evacuated – feeling 20 to 30 earthquakes a day is a strong incentive.

What will happen next is the big question. Activity could continue at the present level for a while and then abate with no serious consequences. Activity could ramp up with earthquakes in the magnitude 6 or 7 range. At the extreme end on the earthquake side is another quake in the upper 7s similar to 1956 that could trigger a damaging tsunami.

While the present signs don't suggest volcanic activity, that can never be ruled out in this region. Strong earthquakes have been known to upset the delicate balance in volcanic systems and lead to eruptive activity. My good friend Costas Synolakis is a tsunami expert from the University of Southern California and a member of the Academy of Athens. He thinks that rising fluids are involved and may signify profound changes in the plumbing beneath Santorini and Kolumbo volcanoes perhaps leading to the formation of a new volcanic center.

I will be watching closely.

Lori Dengler is an emeritus professor of geology at Cal Poly Humboldt, and an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times--Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/taxonomy/term/5 and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@humboldt.edu for questions and comments about this column or to request copies of the preparedness magazine "Living on Shaky Ground."