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# **Not My Fault:** Iceland is not the only region of volcanic concern

Lori Dengler for the Times-Standard

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I've been watching Iceland with interest over the past month, in part because I was there in July, but also the massive instrumentation that allows a terrific glimpse into the processes that lead to an eruption and the limitations of our data to predict precise volcanic outcomes.

The Icelandic Meteorological Agency has backed off their assessment that an eruption is imminent. Earthquake activity and deformation continues to slow. But the threat of an eruption is not over. A new influx of magma could quickly change the threat assessment – either in the vicinity of the intrusion or in an adjacent region. Blue Lagoon has not reopened and residents of Grindavik are still displaced from their homes and businesses.

But Iceland's Reykjanes Peninsula was not the main volcano story this week. Mt. Marapi on the Indonesian island of Sumatra erupted a week ago. The volcano is a popular hiking destination, and 75 people were on the slopes that day. The majority were safely evacuated, but 23 did not survive the modest explosive ash eruption and 12 were severely injured.

Marapi (not to be confused with Merapi on the island of Java), is one of 136 potentially active volcanoes in Indonesia. The country has more volcanoes and has suffered greater volcanic loss than any other place in the world. NOAA's Notional Centers for Environmental Information global volcano database notes 126 Indonesian eruptions since 1900, 93 of which caused fatalities. Far more catastrophic eruptions have occurred in the past. The 1883 eruption of Krakatoa killed at least 36,000 (some estimates as high as 120,000) and the 1815 Tambora blast is the largest in written historic times, claiming upwards of 90,000 lives when the post-eruption global famine impacts are factored in.

Volcanic hazards are recognized as a high priority in Indonesia. The Volcanological Survey of Indonesia established in 1919 has the responsibility of assessing volcano hazards and issuing alerts. They have a four-tiered warning system similar to that of Iceland and the U.S. and monitor seismicity throughout the country. What went wrong on December 3?

Monitoring volcanic activity in Indonesia is a more difficult undertaking than in Iceland. The reasons are geographic, geologic, and political. Indonesia is the largest single state island archipelago in the world with more than 6000 populated islands. The larger islands are rugged. The complex and steep topography has isolated cultural groups for millennia, reflected in 700 distinct language groups. Monitoring every volcano with the density of instrumentation of Iceland is an impossibility.

The volcanoes of Indonesia are larger and more explosive than those in Iceland. They are caused by subduction, and a very messy subduction zone system indeed. If you are a reader of this column, the Cascadia subduction zone of the Pacific Northwest is familiar to you. A slab of the earth's surface, in our case the Gorda and Juan de Fuca plates, is pulled by gravity beneath the North American plate. Pressure holds much of the interface between the two plates tightly together. This locked zone maintains relatively stable for hundreds of years at a stretch until the strength is overcome and a very large earthquake and tsunami result.

Earthquakes and tsunami surges are not the only hazards of subduction zones. As the plates are pulled deeper and deeper rocks experience higher temperatures and pressures, changing their chemical properties. At depths of roughly 60 miles beneath the surface, some of the rock melts begins a slow upward migration. In our area, the high Cascade mountains are the result, a spectacular chain of twenty major volcanoes in a rough line extending from Lassen to the Garibaldi Volcanic Belt in British Columbia. Indonesia is like the Cascadia region only larger and more complex.

The magma source of the current volcanic unrest in Iceland is very near the surface, from the Mid-Atlantic ridge. The recent Icelandic eruptions produced basaltic lava that is relatively fluid and allows gasses to readily escape. The magma fueling subduction volcanoes has a more complicated history, migrating slowly upwards from greater depth and interacting with the crustal rock it passes through. This process produces far stickier magma, one that traps gasses and is much more likely to be explosive.

All magma whether viscous or runny produces signs that it is moving upwards. Small earthquakes, surface deformation, and gas emissions are indications of unrest whether near a spreading ridge or subduction zone. There had been signs of potential activity at Marapi since 2011 when the Volcanological Survey declared a level II alert for the region, recommending barring people from the summit and slopes. A small eruption occurred last January but caused no casualties.

But only regional governments can bar access in Indonesia, and hikers are a source of revenue. In this case, the jurisdiction was the provincial government of West Sumatra. Persons climbing Marapi must pay for permits and the fee goes to the government. The hiking trails had been closed after the January eruptions but reopened in June.

It's still early to know all the contributing factors to the Marapi tragedy. It's unclear if instruments had detected any anomalies shortly before the eruption. Jurisdictional boundaries and competing priorities appear to have played a role.

Marapi is only one of 16 current eruptions noted by the Smithsonian's Global Volcanism Program's most recent weekly report. Some of the others includes names you may be familiar with like Etna in Sicily, and Krakatau (the real name of Krakatoa) in Indonesia. But most like Bagan in Papua New Guinea and Sheveluch in Kamchatka are likely unknown. In any given week there are between 14 and 40 actively erupting volcanoes on the planet. Fortunately, most are in remote areas with little human impact.

The threat of a reawakening volcanic giant is always with us. Most everyone has heard of Yellowstone and Vesuvius (both still slumbering), but what about Campi Flegrei? Known in English as the Phlegraean Fields, it's a cousin of Vesuvius about 15 miles to the west and both are part of the same volcanic system near Naples. An article in this month's Scientific American explains why it might become the next big eruption story (https://www.scientificamerican.com/article/a-huge-italian-volcano-could-be-ready-to-erupt/).

Campi Flegrei has produced monstrous eruptions in the past. Active for at least 80,000 years, its explosive history is documented by thick ash and ignimbrite (pumice from pyroclastic flows) deposits. Some have postulated that an eruption roughly 37,000 years ago contributed to the extinction of Neanderthals. It's been quietly dozing since the 16th century.

The reason for current concern is troubling signs that dormancy may be ending. Ground deformation has been observed for several decades. This October, an increase in earthquakes may be signaling magma is on the move. The ground in some places of Naples has risen over four feet since 2005 and the rate of deformation is increasing. Campi Flegrei is withing the Naples city limits and over 2.1 million are at direct threat of eruptive products. Italian authorities believe they may have 72 hours warning that a major eruption is about to occur and plans have been made to evacuate the area but the uncertainties are still large and evacuation poses additional risk, especially if an eruption doesn't ensue.

View Nova's "The Next Pompei" for an excellent introduction to volcanic threat of Campi Flegrei.

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