Study rewrites the recent history of productive Cascade Arc volcanoes

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Volcanic eruptions in the Cascade Range of the Pacific Northwest over the last 2.6 million years are more numerous and closely connected to subsurface signatures of currently active magma than commonly

thought, according to newly published research.

A synthesis of volcanic vents on the surface and data that probes the structure and composition of the crust to a depth of 20 kilometers (12.4 miles) makes clear new connections between surface and subsurface evidence of past volcanic eruptions. The activity has stretched far beyond the 11 well known stratovolcanoes lining the Cascade Arc between northern California and northern Washington.

The study, led by University of Oregon scientists, catalogued almost 3,000 volcanoes associated with the mountain range. It was published July 13 in the journal *Geology*.

The research reveals new details about the complex and time-evolving patterns of rising magma in the region, said study co-author Leif Karlstrom, a professor in the UO Department of Earth Sciences and Oregon Center for Volcanology.

"Anyone who has ever flown between San Francisco and Seattle has probably marveled at the massive stratovolcanoes lined up between northern California and southern British Columbia," he said. "Remarkably, these landforms represent less than 1 percent of the volcanoes in the Cascades that have erupted in the geologically recent past."

The three-member research team examined 2,835 vents. They used freely available satellite-derived 3-D digital terrain models to update estimates of eruption rates and synthesize subsurface observations over recent decades to map where signs of active magma in the crust correlates with edifices on the surfaces around the region's volcanos.

Edifices refer to the main portion of volcanoes built by erupted lava, rock projectiles, mud and debris flows, and mixture of rock fragments,

gas and ash.

The 3-D models allowed the research team to associate volcanic edifices with underlying seismic velocities, heat flow, gravity and deformation that are sensitive to the presence of magma, Karlstrom said. The work, he added, showed where surface vents seem to overlay currently active magma transport structures in the crust.

"Previous studies have analyzed single volcanoes or volcanic clusters with satellite data, but this is the first study to constrain volcano geometries over an entire arc in a self-consistent manner," said the study's lead author, Daniel O'Hara, a UO doctoral student. "We estimate that volcanic edifices represent about 50 percent of total volcanic output during the time-period we examined."

The research, he added, indicated a systematic decrease in the strength of these relationships, suggesting that eruptions as well as their underlying plumbing systems have migrated during the past 2.6 million years.

The National Science Foundation-funded research can help guide more in-depth studies of distributed volcanic vents and in assessing hazards and risks to people and infrastructure, said co-author David W. Ramsey of the U.S. Geological Survey's Cascades Volcano Observatory in Vancouver, Washington.

Distributed volcanic vents are associated with small cinder cones that cover much of the central Oregon Cascades, and area such as the Boring Lava Field in the city of Portland and the Medicine Lake volcano in California.

"This research used a consistent methodology to analyze volcanic vents spanning the entire U.S. Cascade Range over the last 2.6 million years,"

Ramsay said. "It helps to highlight recently active volcanic vents, particularly in central Oregon and northern California, and shows that the locations of potential future eruptions are not limited to the snow-capped stratovolcanoes on the horizon."

The region's major stratovolcanoes stretch along the junction of the Juan de Fuca and North American plates. From north to south, they are Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, Mount Adams, Mount Hood, Mount Jefferson, Three Sisters, Crater Lake/Mount Mazama, Mount Shasta and Lassen Peak.

More information: Daniel O'Hara et al, Time-evolving surface and subsurface signatures of Quaternary volcanism in the Cascades arc, *Geology* (2020). DOI: 10.1130/G47706.1

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