

Long-Term Geochemical Monitoring of the Tatun Volcanic Group, Taiwan: Insights from Continuous Soil Gas, Fumarole, and Hot Spring Observations

**HSIAO-FEN LEE¹, YA-CHUAN LAI¹, CHENG-HORNG
LIN², MIN-HUNG SHIH¹, AI-TI CHEN³, GUO-TENG HONG⁴
AND HSIN-CHIEH PU⁵**

¹National Center for Research on Earthquake Engineering,
National Applied Research Laboratories

²Institute of Earth Sciences, Academia Sinica

³National Taiwan University

⁴Geological Survey and Mining Management Agency, MOEA

⁵Central Weather Administration

The Tatun Volcanic Group (TVG) in northern Taiwan is classified as an active volcano due to the presence of a subsurface magma reservoir, despite its current stable state. Given its proximity to the densely populated Taipei metropolitan area, any volcanic activity could have significant societal and environmental impacts. To better assess potential changes in TVG's activity, long-term geochemical monitoring has been conducted, including the collection and analysis of volcanic gases and hot spring water. In addition, two continuous soil gas monitoring stations for carbon dioxide (CO₂) have been established, providing an extensive high-resolution dataset over time.

Since 2018, significant variations have been detected in key geochemical indicators. Observations from fumaroles indicate an increase in hydrogen chloride (HCl) and helium (He) concentrations, followed by a sharp rise in cation concentrations in hot spring water. Concurrently, fluctuations in soil gas CO₂ levels were also observed, though their temporal variations did not completely align with other geochemical markers, suggesting complex interactions within the magmatic-hydrothermal system.

At the same time, seismic activity in the TVG region has intensified, with multiple $M > 3$ earthquakes recorded. Additionally, anomalous surface changes have been observed, including widespread mud ejections. GNSS monitoring recorded notable vertical displacement in the main geothermal area in 2021, potentially reflecting subsurface geodynamic changes. These observations suggest that TVG may have undergone a transient phase of instability during specific periods. Further monitoring is required to evaluate its ongoing activity and potential future developments.