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Uzon-Geysernaya volcano-tectonic depression: geodynamics phenomena last years

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One of the most active volcanic arcs in the Pacific Rim, Kamchatka is also one with poor geophysical constraints on its shallow magma plumbing systems. Uzon calderas lie within a graben approximately 20 km wide running beneath the eastern Kamchatka volcanic group. Cross sections of the shallow crustal graben show that it steps WNW from its southeasterly bounding fault beneath Kikhpinych volcano, deepening toward Uzon caldera.

Uzon Caldera Summary (by Global Volcanism Program, http://www.volcano.si.edu):
Country, Subregion Name: Russia; Kamchatka Peninsula
Volcano Number: 1000-17
Volcano Type: Calderas
Last Known Eruption: 200 AD +/- 300 years
Summit Elevation: 1617 m (5,305 feet)
Coordinates: 54.50ºN, 159.97ºE

Kikhpinych volcano Summary (by Global Volcanism Program, http://www.volcano.si.edu):
Country, Subregion Name: Russia, Kamchatka Peninsula
Volcano Number: 1000-18
Volcano Type: Stratovolcanoes
Last Known Eruption: 1550 (?)
Summit Elevation: 1552 m (5,092 feet)
Coordinates: 160.253ºN, 160.253ºE

The twin Uzon and Geysernaya calderas, containing Kamchatka's largest geothermal area, from a 7x18 km Uzon-Geysernaya volcano-tectonic depression that originated during multiple eruptions during the mid-Pleistocene. Post-caldera activity was largely Pleistocene in age and consisted of the extrusion of small silicic lava domes and flows, maar formation and several Holocene phreatic eruptions. The extensive high-temperature hydrothermal system includes the many hot springs, mudpots, and geysers of the Valley of the Geysers on the SE margin of the Uzon-Geysernaya depression. Hydrothermal explosions took place in the western part of caldera in 1986 and 1989.

The Valley of the Geysers in the far eastern portion of Uzon caldera is considered derived from shallow meteoric water in contact with a heat source associated with Kikhpinych volcano The general structure places a deep aquifer shallower than a depth of about 2 km with the top of a cooling magma chamber at depths greater than 4 km from beneath the eastern side of the caldera complex. Geological observations of extruded lavas and other deposits over the course of Uzon's history show that there have been episodic basalt intrusions into a granitic magma chamber, with the system becoming progressively more crystallized and lower in temperature with time [Belousov et al., 1984; Leonov et al., 1991].

By study of RADARSAT-1 synthetic aperture radar (SAR) data the interferometric SAR (InSAR) images of surface deformation at Uzon caldera was computed [Lundgren and Lu, 2006]. From 2000 to 2003 approximately 0.15 m of inflation occurred at Uzon caldera, extending beneath adjacent Kikhpinych volcano. This contrasts with InSAR data showing no significant deformation during either the 1999 to 2000, or 2003 to 2004,

time periods. The preferred source model is an irregularly shaped, pressurized crack, dipping near 20º to the NW, 4 km below the surface. The geometry of this solution is similar to the upper boundary of the geologically inferred magma chamber. In the judgment of the authors, extension of the surface deformation and source to adjacent Kikhpinych volcano, without an eruption, suggests that the deformation is more likely of hydrothermal origin, possibly driven by recharge of the magma chamber.

A natural disaster - big landslide with volume estimated 20x10ˆ6 mˆ3 - occurred on June 3, 2007 in the Valley of the Geysers (Leonov, 2007, Kugaenko, 2008). The results of landslide investigation show that heated rocks were involved in failure. One of the main reasons of landslide is weakening of semi-rock pumice soils due to their steaming during hidden unloading of hydrothermal system.

Local field observations were organized in the eastern part of the Uzon-Geysernaya depression in 2008 and 2009. Main results of seismic investigation:
- Shallow weak seismicity connected with Kikhpinych volcanic center and eastern part of the Uzon-Geysernaya depression was discovered;
- Seismicity has spasmodic (swarm) type.
- The majority of earthquakes are connected with areas of hydrothermal activity in western slop of Kikhpinych volcanic massif.
- Seismicity is located in part of caldera displacement, discovered by INSAR data.
- By our mind, the seismicity and Uzon caldera inflation (as a result of activation of magma chamber or hydrothermal system) effected and destructed the caldera slop by activation of fissures and by change of pore-fracture configuration.

Summarizing data about the tectonics, the raising of east slope of depression, the landsliding and local seismicity, we can suppose that all these phenomena are connected with the deep processes under Uzon-Geysernaya depression and Kikhpinuch volcano are the reason of all these events. It is the indication of the renewal of the dynamics within eastern part of the calderas.

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