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A new concept of magmatism

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A new concept of magmatism consists of the shock-wave fracturing pipe model, the pressure relief theory, and the caldera chain is summarized as follows.

(1) Magma migration. The magma rapidly rises in place of the stoping rocks in vent-forming.event. Following the event the magma seeps through the vent. The whole vent is rarely filled up with magma. The magma moves according to the pressure difference that results from low density of magma and geopressure variation. It moves intermittently.

(2) Duration of vent. In case of high temperature and small scale magmatism the vent is plugged and never be alive. In the low-temperature or large-scale cases the vent acts as a conduit of magma for long.

(3) Magma reservoir (MR) after vent-forming. The reasons for forming MR are; the inverted pressure due to topographic change, plugging at the top of vent, and static condition of magma filled in the vent just below the cater.

(3-1) Inverted pressure. The magma below the caldera stays in the same position as the pressure is lower than that of the surrounding area. The magma starts moving when the pressure rises with expansion by increasing volume of magma.

The pressure inversion is also formed in front of the central part of volcanoes neighboring the caldera due to the load of mountain. An example of this is the estimated reservoir at 8 km northwest of the Shinmoe-dake that erupted in 2011. The secondary MR was formed by the magma generated below the Kakuto caldera to northwest.

An earthquake swarm occurs when the magma below the caldera starts moving as it makes the overlying ground unstable. The Ebino earthquake in 1968 is such swarm. The magma migrated around 12 km for 41 years. Similarly the earthquake swarm occurred in the caldera 46 years before the 1959 eruption of Shinmoe-dake.

Based on GSI data the swelling of the MR started in December 2009. Following the quick shrink with the eruption in January 2011, it swelled again until November 2011 when the swell reached to 90% of the limit level. The magma inflow to the MR lasted a little less than two years. Concordantly the Ebino earthquake swarm lasted for about two years. At the time of next swarm in the caldera that is the time of magma discharge next eruption will be induced with the expansion of the secondary MR caused by the pressure rise of the hypercritical water in the intermediate vent.

(3-2) Plugging. This is a case of magma accumulation in the shallow level due to the plugging of the top vent. Such plugging may happens by quick consolidation of the high temperature magma and also by viscous slow magma. Owing to low load pressure the MR is hardly collapsed and grows huge with long-term magma supply from deep. In case of collapsing a caldera is formed. In case of no collapsing it is consolidated to form a plutonic intrusion.

(4) Phenomena in the overlying levels above MR in caldera. The earthquake swarm is induced by the unstable condition caused by magma migration. The dyke intruded from the MR upward rarely burst into eruption. Majority of the magma takes its way to the curve vent. The swarm in the east of Izu peninsula is such case, and the MR beneath the swarm supplies magma to the Izu-Oshima and Mt. Fuji. The hydrothermal activity above the MR forms epithermal gold mineralization. The Matsushiro earthquake swarm is due to the migration of magma to the Mt. Asama. The anomalous rise of land with the swarm is inferred to be caused by the hydrothermal activity that induced swelling of clay in the mid-Miocene thick shale.

Keywords: magma reservoir, earthquake swarm, epithermal mineralization

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