

Pressure relief theory of magma genesis

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The depression at the 1914 eruption of Sakura-jima was centered in the northern Kagoshima bay neighboring the volcano. Omori (1916; Bull. Imp. Earthq. Inv. Comm., vol.8, no.2, 152-179) estimated magma underlying the depressed area. He indicated the same situation in other areas where the combination of volcanoes and lakes/bays were seen. Such idea of lateral and shallow magma generation was disregarded since then, and the subduction zone magmatism in the deep became the established theory. The vertical vent and vertical migration of magma is believed by the absolute majority without doubt.

Apart from such common knowledge a new theory of vent-forming process was proposed last year (Iida, 2011a; shock-wave fracturing pipe model). In this model the vent is subhorizontal near the reservoir. The dip is getting steep upward to be subvertical at the crater. While the current model looks like a thermometer, the new model is similar to the plesiosaur that looks upward. Examples of such curve shape are as follows. (A) The distribution of focuses before and after the eruption of Unzen (Ohta, 1993; Jour. Geol. Soc. Japan, 99, 835-854; Fig.28). (B) Seismic depth imaging in the Death Valley (Chavez-Perez et al.; 1998; Geophysics, 63, 223-230; Fig.6). A conduit of magma along a normal fault from the bright spot to a cinder cone is interpreted here. (C) 3-D seismic structure of the Kirishima (Nishi and Kagiya, 2002; Abstracts, Japan Earth Planet. Sci. Joint Meeting, V032-034; and material for 119th meeting of Coordinating Comm. Predict. Volc. Erupt. Japan). A low velocity zone extends from 4 km below the Ebino-dake to the crater of Shinmoe-dake.

Taking into account of the cases of estimated magma generation under the caldera, it was considered that the magma was generated by the sudden unload at the caldera-forming event, and such process was succeeded as a chain reaction (Iida, 2011b). The caldera chain forms the graben or lift in the continent, the moat in the sea floor, and the plain in plateau basalt region. As the chain reaction is non-contact type, the generated magmas in a chain are not always the same type.

The mechanism of magma generation is classified as follows. (1) The slow growth of huge magma reservoir in shallow level makes the underlying rocks increase in temperature and pressure. The sudden unload with formation of caldera induces magma generation within or underneath the crust below the caldera. (2) The lateral migration of magma generated with mechanism 1 reduces the pressure of underlying rocks that turns to be a new magma generation zone. (3) The kimberlite magma is generated by the pressure relief with the abrupt melting of ice sheet. (4) The mid-oceanic ridge magma is produced by the pressure relief under the tension field.

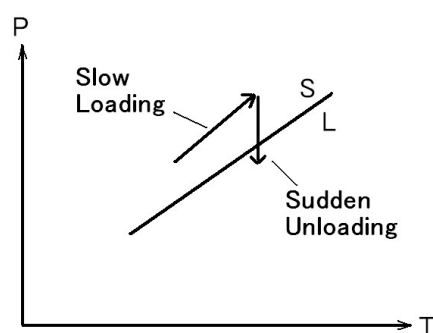
Yoder (1952) already proposed the stress relief concept of magma generation. He thought of gentle arching and faulting of overlying rock as the mechanism of pressure relief. The arching may be the mechanism for the petit-spot (Machida et al., 2005) in the outer-rise. The faulting applies to the case of (4) with normal faulting in the ridge.

The characteristic of subduction magmatism such as the zonal distribution of rock types is not the proof of magma generation by subduction. It can be interpreted that the distribution is formed by the zonal crust structure.

Iida (2011a) http://www2.jpгу.org/meeting/2011/yokou/SVC047-P10_E.pdf

Iida (2011b) http://www2.jpгу.org/meeting/2011/yokou/SVC070-P01_E.pdf

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Sudden Unloading Theory