Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SVC047-P10 Room:Convention Hall Time:May 24 14:00-16:30

A thought experiment on the volcanic eruption by means of the shock-wave fracturing pipe model

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The above-mentioned model was proposed as an ore-forming model for the unconformity-related uranium deposits in the Proterozoic continental basin such as the Athabasca basin, Canada (Iida, 2008; Society of Resource Geology the 58th Annual Meeting, P-32). The scenario is as follows. (1) A buried monadnock at the basin bottom exists as a low-pressure pod owing to the overlying sandstone dome roof that supports the load. (2) The roof is crushed by increasing load pressure with deeper burial. Two shock waves are discharged into the opposite directions of the subhorizontal major axis of the pod. (3) The shock wave tends to concentrate on the center instead of diffusing because the intense fracturing slows the wave speed. As the result the fracturing pipe is formed in the track of the shock wave. (4) A shock wave directed to the updip side is refracted upward due to slower wave speed in the upper levels. The other shock wave to the downdip side gradually attenuates into a normal push wave without fracturing. (5) The created pipe hydraulically connects the basin bottom with the surface level, and makes a long term circulation of ground water (ca. 400 million years), that forms the ore deposit (the later process is omitted).

In general any pipe structure is formed by the shock wave discharged with the crush of the low pressure pod. For example the breccia pipes in the Grand Canyon area seem to be formed by the shock waves discharged with the crush of buried limestone caves (they are normally explained with collapsing above the cave). Also the large vertical holes on the Guiana Highlands may be formed by the same process.

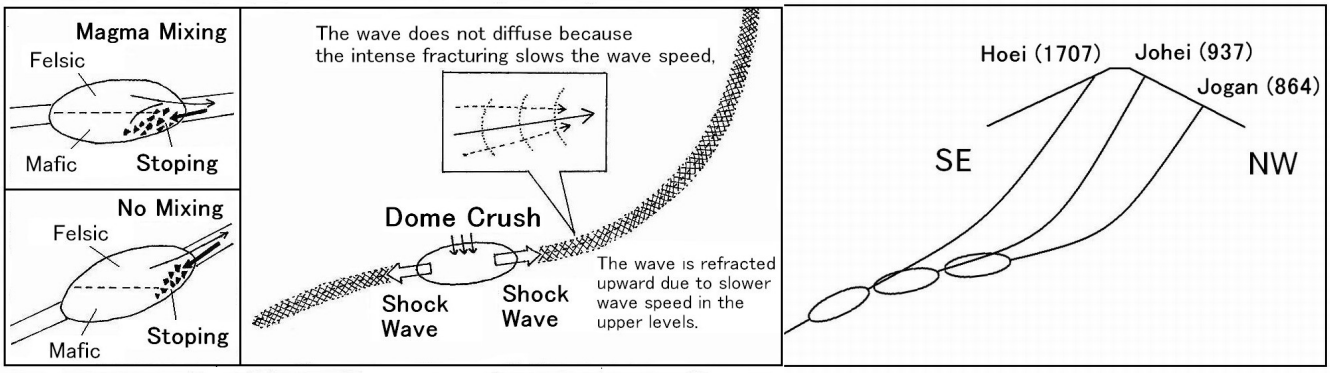
I propose to apply the model to the formation of the volcanic vent. The established theory explains that the eruption happens by pressure rise caused by boiling in the magma reservoir. The boiling, however, should stop when the pressure rises under the closed condition, and the explosive pressure rise can not be expected. The explosive boiling happens under the open condition that is on the way of the vent. In addition, if the eruption is due to the pressure rise, then the tension cracks could be formed above the reservoir, but the pipe shaped vent can not be formed.

The magma reservoir is supported by the dome roof in the course of lowering the magma pressure with the volume loss due to the crystallization. The vent forming process with the crush of the low-pressure pod is same as the above-mentioned ore-forming process. The rock fragments in the fracturing pipe on the up-dip side flow into the reservoir gravitationally (same as the stoping of mining). In place of the rock flow the magma rises in the pipe. If the magma is differentiated into the felsic and mafic magmas, and the reservoir is flat shaped, then the magma mixing occurs with the stoping. In the case of inclined reservoir, the mixing does not occur; but firstly the overlying felsic magma spouts out in order that is followed by the mafic magma (the Hoei eruption of the Mt. Fuji in 1707 is regarded as this case). The rising magma boils on the way, and erupts explosively. In case of the viscous magma, it takes time to rise, and the secondary reservoir may be formed, that may eject the pyroclastic flow.

After the eruption, the magma should step back to the pipe of the downdip side gradually. The next eruption should move to that direction. As the result of the repeated magma migration, the craters should line up. A linier distribution of the craters is commonly regarded as a tectonic line control, but it is not the case; the major axis of the reservoir is reflected on the lineup.

If the proposed model is correct, the eruption should be able to be induced by blasting the dome top. I expect that the induced eruption prior to the occurrence of dangerous eruption will come true in the future. Similarly I would like to expect the progress of the research into the induced earth quake.

P.S. the eruption of the Mt. Shinmoe-dake will be discussed.



Keywords: shock wave, pipe structure, volcanic eruption, stoping, magma mixing