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High Decompression Rate of the Youngest Toba Tuff Eruption

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Toba Caldera Complex, North Sumatra, Indonesia is well known as the largest Quaternary caldera (87×33 km) that formed by four major eruptions with magnitude of VEI 8 among which the biggest one is the latest eruption of the Youngest Toba Tuff (YTT) about 74,000 years ago. The conduit dynamics of Toba caldera forming eruption is still poorly understood. Bubbles in pumice, which are produced by an explosive eruption possibly record dynamic processes in the conduit during eruption. This study aims to estimate the decompression rate of the biggest event of Toba eruption (YTT) by using textural data from Bubble Number Density (BND) together with geochemical, petrographical, grain size distribution (GSD), and bulk density data.

In general, only a few data of decompression rate from caldera forming eruption events are available because the products were mostly welded and the original texture has been erased. Meanwhile, Toba eruption produced non-welded to welded deposit. Therefore, we focus on the non-welded part of the biggest Quaternary caldera forming eruption localized on the northern part of the caldera in order to extract the original condition of the bubble formation. Samples from three different locations were employed for the analyses. Whole rock geochemical data of pumices were obtained by XRF. Petrography analysis for 21 thin sections were conducted using optical microscope. Bulk density measurement for 338 individual pumices with the size range of 4-8 mm and 8-16 mm were conducted using Laser 3D scanner. Textural analysis was carried out for 6 particles of 3 selected thin sections using microphotographs taken by SEM and further analyzed using image processing software.

Geochemical data showed that the YTT magma is rhyodacitic to rhyolitic in whole rock compositions with the narrow range of SiO_2 (69.15 - 72.17 wt. %). Phenocrysts are plagioclase, biotite, quartz, and sanidine, most of which are fractured. The vesicle has a variety in size from 2.5 μm to 97 μm and in shape from rounded, elongated, to complex. GSD for each location are dominated by fine size (φ=1). Bulk density of individual pumice ranges from 0.4 to 1.1 gcm^{-3}. BND calculation were done in carefully selected area where is uniform in size of bubbles to represent samples in estimating the decompression rate in the conduit. BND value ranges from $10^5 - 10^7$ mm^{-3} showing a wide range of BND magnitude. Qualitatively, higher magnitude of BND is correlated with higher silica content, higher frequency of crystal fracture, complex vesicle shape, smaller vesicle size, and lower bulk density, and *vice versa*. The decompression rate was calculated using the BND decompression rate meter from Toramaru (2006). The result showed that Toba caldera forming eruption has high decompression rate ranging from 10^7 – 10^8 Pa/s. This high decompression rate is one of the important factors in the conduit dynamics of YTT super eruption.

Keywords: Toba Caldera, the Youngest Toba Tuff (YTT), Conduit Dynamics, Bubble Number Density (BND), High Decompression Rate