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Fe-Ti oxide thermometry of the Ciomadul dacite

Katalin Mészáros (1), Szabolcs Harangi (1,2), Réka Lukács (2), Kata Molnár (1), István Dunkl (3), Marcel Guillong (4), Ioan Seghedi (5), and Andreas Kronz (6)

(1) Department of Petrology and Geochemistry, Eötvös Loránd University, Budapest, Hungary, (2) MTA-ELTE Volcanology Research Group, Budapest, Hungary, (3) Department of Sedimentology and Environmental Geology, Geoscience Center, University of Göttingen, Germany, (4) Institute of Geochemistry and Petrology, Department of Earth Sciences, ETH Zürich, Switzerland, (5) Institute of Geodynamics, Romanian Academy, Bucharest, Romania, (6) Department of Geochemistry, Geoscience Center, University of Göttingen, Germany

The Ciomadul (Csomád) volcano is the southernmost eruptive centre along the Calimani-Gurghiu-Harghita volcanic chain and it is the youngest one in the entire Carpathian-Pannonian region. It is a lava dome volcanic complex comprising two explosive craters and surrounded by older peripheral lava domes. The last eruption occurred at 32 ka, but results of geophysical studies indicate that melt-bearing magma body could be still present beneath the volcano, which can be potentially reactivated rapidly. Thus, constraints on the pre-eruptive conditions are important to understand the nature of the magmatic system.

Iron-titanium oxides are widely used to estimate the pre-eruption temperature and redox state. In case of the Ciomadul dacite, they can be hardly observed under the microscope, therefore we collected them from heavy mineral separates (magnetic fractions of 63-250 micrometer crystals). After textural characterization, we determined their composition along with the melt inclusions. Most of the oxide grains show various resorption features indicating disequilibrium and re-melting. This is also supported by the glass composition, which deviates from the glass of the melt inclusions in other phases and the groundmass.

Temperature and oxygen fugacity values were calculated after a rigorous equilibrium test. They can be determined by various techniques, which provide considerably different temperature and oxygen fugacity results. Comparing with the results of other mineral thermometers, we found that the Andersen and Lindsley (1988) method could yield the most reliable data. Focusing on the youngest eruption products, we got temperatures around 800 ˚C and oxygen fugacity values in a range from 0.95 to 1.79 [$\log_{10} fO_2(\Delta NNO)$] suggesting crystallization from a relatively warm storage and an oxidizing environment. This is consistent with the results obtained from amphibole and plagioclase compositions. In addition, we used these data to infer the Ti-activity and got 0.75-0.80 values. Zircon and titanite temperatures were calculated considering these values and we obtained fairly low temperatures ($<750^{o}$C) consistent with cold magma storage. Thus, we suggest that a long-standing low-temperature crystal mush was heated up above 800 ^{o}C in certain parts of the magma storage a few 10s ka prior to eruption, when zircon and titanite could not crystallize further. This led to a state of eruptible magma and finally an eruptive event.

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