(U-Th)/He geochronology of the Late Pleistocene dacite of the Csomád (Ciomadul) volcano (South-East Carpathians)

Kata Molnár[1], Szabolcs Harangi[2], István Dunkl[3], Réka Lukács[2], Axel K. Schmitt[4], Balázs Kiss[2]
[1]Eötvös Loránd University, Budapest, Hungary
[2]MTA-ELTE Volcanology Research Group, Göttigen, Germany
[4]University of California, Los Angeles, USA

In the last few years the number of geological researches using the (U-Th)/He geochronology has significantly increased. This method is able to calculate the cooling age of various geological formations. The principle of the method is the accumulation of ^{4}He from U and Th decay after the mineral reaches a so called closure temperature (or partial retention zone). This temperature value is defined for each and every mineral which contains U and Th (e.g., zircon, apatite, and titanite). Even a complex evolution history can be set up in a certain geological environment with dating the different minerals with different closure temperature values in a slowly cooled rock body. The other application of the (U-Th)/He-geochronology is in case of rapidly cooled rocks on the Earth's surface (e.g., volcanic rocks) where demonstration of quantitative retention at ~25°C is sufficient to successfully apply He dating (Farley, 2002). The importance of defining this eruption age in case of volcanoes is due to the significance age difference between the crystallization age of minerals (e.g., U-Pb or U-Th geochronology of zircon crystals) and the eruption age of the volcano. The (U-Th)/He method assumes zero initial ^{4}He in the crystal and secular equilibrium among all daughters in the decay chain, a condition guaranteed for crystals formed more than ~350 kyr prior to the onset of He accumulation. For most applications the second assumption is valid but in case of younger eruptions the effects of secular disequilibrium must be considered and He ages must be corrected considering the results of ^{230}Th/^{238}U dating (Schmitt, 2011).

In the Carpathian-Pannonian Region the youngest volcanic activities occurred at the Csomád (Ciomadul) volcano which is the southernmost eruptive center along the Kelemen-Görgény-Hargita (Calimani-Gurghui-Harghita) volcanic chain. The ages of the eruptions which were dated previously with different methods (e.g., K/Ar, Ar/Ar ^{14}C) vary in a wide range (from 30 kyr to ~600 kyr; Pécskay *et al*., 1995, Karátson, 2007, Harangi *et al*., 2010). In this study the samples were collected from several outcrops of the volcanic complex, pumices and lava dome rocks, as well. The aim was to get a certainty about the applicability of the combined ^{230}Th/^{238}U and (U-Th)/He dating of zircon. In case of two outcrops (Sepsibükszád/Bixad and Tusnádfürdő/Baile Tusnad) radiocarbon ages were available dated on charcoal fragments (Harangi et al, 2010). Therefore these samples are suitable for testing the applicability of the combined ^{230}Th/^{238}U and (U-Th)/He method. In case of the other samples we provide uncorrected zircon (U-Th)/He-ages.

The uncorrected zircon He-ages imply that the period of volcanic activity of the Csomád (Ciomadul) volcano is much younger (30-250 kyr) than it was thought based on the previous geochronological data. Data correction using U-series dating will modify the present ages with maximum few thousand years. In case of the samples from Sepsibükszád (Bixad) and Tusnádfürdő (Baile Tusnad) the ^{14}C-ages gave 31.5+/-0.26 kyr and 42.3+/-1 kyr, respectively. The combined ^{230}Th/^{238}U and (U-Th)/He ages on zircon gave the same ages within the error (31.9+/-3.3 kyr and 46.6+/-3.7 kyr, respectively). These results confirmed the young ages of the formations and revealed the applicability of this combined method in case of the Csomád (Ciomadul) volcano.

Farley, K. A. (2002): Mineral Soc Am Rev Minera. Geochem, 47: 819-844.
Harangi, Sz., Molnár, M., Vinkler, A. P., Kiss, B., Jull, A. J. T., Leonard, A. G. (2010): Radiocarbon, 52/2-3: 1498-1507.
Karátson, D. (2007): A Börzsönytől a Hargitáig. Typotex Kiadó, Budapest, ISBN 978-963-9664-66-1, pp. 463.
Pécskay, Z., Edelstein, O., Seghedi, I., Szakács, A., Kovacs, M., Crihan, M., Bernad, A. (1995): Acta Vulcanol, 7: 53-61.
Schmitt, A. K. (2011): Ann Rev Earth Planet Sci, 39: 321-349.