Data Article

LA-ICP-MS U-Pb zircon geochronology data of the Early to Mid-Miocene syn-extensional massive silicic volcanism in the Pannonian Basin (East-Central Europe)

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\textbf{Abstract}

This article provides LA-ICP-MS in-situ U-Pb zircon dates performed on single crystals from dacitic to rhyolitic ignimbrites of the Bükkalja Volcanic Field (Hungary, East-Central Europe) temporally covering the main period of the Neogene silicic volcanic activity in the Pannonian Basin. The data include drift-corrected, alpha dose-corrected, Th-disequilibrium-corrected, and filtered data for geochronological use. The data presented in this article are interpreted and discussed in the research article entitled "Early to Mid-Miocene syn-extensional massive silicic volcanism in the Pannonian Basin (East-Central Europe): eruption chronology, correlation potential and geodynamic implications" by Lukács et al. (2018) [1].

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Specifications Table

| Subject area                  | Earth Sciences                        |
|------------------------------|---------------------------------------|
| More specific subject area   | Geochronology, Geochemistry           |
| Type of data                 | Tables                                |
| How data was acquired        | Laser-ablation inductively coupled mass spectrometry (LA-ICP-MS); Thermo Element XR Sector Field (SF)-ICP-MS with Resonetics Resolution 155 laser ablation system (ETH Zürich) and Thermo Element 2 SF-ICP-MS with Resonetics Resolution 155 laser ablation system (Göttingen University) |
| Data format                  | drift-corrected, filtered, alpha-dose and Th-disequilibrium corrected data in .xlsx format |
| Experimental factors         | Zircon grains were extracted from bulk volcanic rocks (pumices, fiamme and bulk pyroclastic rocks) |
| Experimental features        | Separated zircon grains were mounted in epoxy resin, polished and mapped by cathodoluminescence technique. Two samples were pre-treated by chemical abrasion before mounting [2] |
| Data source location         | Bükkalja Volcanic Field, northern Hungary as reported in Table 1. |
| Data accessibility           | Supplementary materials               |

Value of the data

- These data provide high-spatial resolution U-Pb dates of zircon grains based on $^{206}\text{Pb}/^{238}\text{U}$ isotope ratios of the silicic volcanic rocks from Bükkalja Volcanic Field (Hungary), allowing better constraints on eruption chronology.
- These new data can be compared to other in-situ zircon U-Pb dates in central Europe in order to correlate Miocene silicic pyroclastic horizons and ash-bearing sedimentary deposits in regional scale.
- These data are also valuable for detrital zircon geochronology in the Pannonian Basin system and other peri-Alpine basins to reveal redeposition of the pyroclastic material and help provenance determination.

1. Data

In this article, we report in-situ U-Pb zircon geochronological data from dacitic to rhyolitic pyroclastic rocks of the Bükkalja Volcanic Field, northern Hungary [1]. More than 1400 individual zircon in-situ analyses of single zircon grains (from 24 different samples) are listed. Data were obtained during 19 sessions along with common zircon reference materials (e.g. GJ-1, [3] 91500 [4]). The dataset contains the LA-ICP-MS raw and processed data.

2. Experimental design, materials and methods

2.1. Sample collection

Localities with GPS coordinates and lithology of the samples are shown in Table 1.
Table 1
Details of sample localities.

| Sample name          | Locality, layer                        | GPS coordinates       | Lithological name of analysed sample                                      |
|----------------------|----------------------------------------|-----------------------|--------------------------------------------------------------------------|
| Harsány ignimbrite unit | Harsány ignimbrite unit                 |                       |                                                                          |
| Td-A: Td-A_CA        | Tibolddaróc, layer A                   | 47°55'31.59"N, 20°37'49.77"E | large pumice of rhyolite block-bearing lapilli tuff                       |
| Td-A_DX-46           | Tibolddaróc, layer A                   | 47°55'31.59"N, 20°37'49.77"E | large pumice of rhyolite block-bearing lapilli tuff                       |
| Tibolddaróc unit     | Tibolddaróc unit                       |                       |                                                                          |
| Td-E                 | Tibolddaróc, layer E                   | 47°55'36.64"N, 20°37'55.19"E | rhyolite lapilli tuff                                                    |
| Demjén ignimbrite unit | Demjén ignimbrite unit                 |                       |                                                                          |
| Td-H: Td-H_CA        | Tibolddaróc, layer H                   | 47°55'33.45"N, 20°37'55.55"E | rhyolite lapilli-bearing tuff                                            |
| Td-H_DX-47           | Tibolddaróc, layer H                   | 47°55'33.45"N, 20°37'55.55"E | rhyolite lapilli-bearing tuff                                            |
| FN-1                 | Felnémet, old quarry                   | 47°56'0.09"N, 20°22'58.88"E | rhyolite lapilli tuff                                                    |
| DEMNE-1              | Demjén, Nagyeresztvény quarry          | 47°50'1.51"N, 20°20'37.19"E | rhyolite lapilli tuff                                                    |
| DEMNE-1_DX-48        | Demjén, Nagyeresztvény quarry          | 47°50'1.51"N, 20°20'37.19"E | rhyolite lapilli tuff                                                    |
| DEMSPA               | Demjén, Spa side                       | 47°50'16.54"N, 20°20'20.78"E | rhyolite lapilli tuff                                                    |
| DEMSPA_DX-7          | Demjén, Spa side                       | 47°50'16.54"N, 20°20'20.78"E | rhyolite lapilli tuff                                                    |
| TAR-3                | Tar, Fehérkö quarry                    | 47°57'9.88"N, 19°45'46.45"E | pumice of lapillituff                                                   |
| Td-L                 | Tibolddaróc, layer L                   | 47°55'39.01"N, 20°37'59.68"E | rhyolite accretionary lapilli-bearing tuff                              |
| Bogács unit          | Bogács unit                            |                       |                                                                          |
| Td-S                 | Tibolddaróc, layer M (UMPU)            | 47°55'41.49"N, 20°37'58.37"E | "black scoria clasts of dacite scoria-bearing lapilli tuff               |
| Td-Hk1_CA            | Tibolddaróc, layer M (UMPU)            | 47°55'41.49"N, 20°37'58.37"E | "grey scoria clasts of dacite scoria-bearing lapillit tuff               |
| Td-H2N: Td-H2N_CA    | Tibolddaróc, layer M (UMPU)            | 47°55'41.49"N, 20°37'58.37"E | "grey scoria clasts of dacite scoria-bearing lapillit tuff               |
| Td-Fi; Td-Fi_CA      | Tibolddaróc, old quarry, layer M (LWPU) | 47°55'48.14"N, 20°37'56.92"E | rhyolite lapilli tuff                                                    |
| CSF-KEV              | Cserépfalu, Geosite                    | 47°56'34.42"N, 20°32'25.98"E | dacite scoria-bearing lapilli tuff                                       |
| CSF-KEV_DX-05        | Cserépfalu, Geosite                    | 47°56'34.42"N, 20°32'25.98"E | dacite scoria-bearing lapilli tuff                                       |
| Mangó ignimbrite unit | Mangó ignimbrite unit                  |                       |                                                                          |
| EG-2                 | Eger, Tihamér-quarry (upper, active)   | 47°53'8.04"N, 20°24'14.38"E | rhyolite lapilli tuff                                                    |
| EG-2_DX-56           | Eger, Tihamér-quarry (upper, active)   | 47°53'8.04"N, 20°24'14.38"E | rhyolite lapilli tuff                                                    |
| SZOM                 | Szomolya, fairy chimneys               | 47°53'29.74"N, 20°28'40.71"E | rhyolite lapilli tuff                                                    |
| SZOM_DX-49           | Szomolya, fairy chimneys               | 47°53'29.74"N, 20°28'40.71"E | rhyolite lapilli tuff                                                    |
| Mt-1                 | Cserépváralja, Mangó-tető              | 47°55'36.15"N, 20°34'17.11"E | large pumice of rhyolite block-bearing lapilli tuff                      |
| DEMHAN1              | Demjén, Hangács, old quarry            | 47°50'32.89"N, 20°20'21.98"E | rhyolite lapilli tuff                                                    |
| CSkly1               | Cserépfalu, Köporlyuk                  | 47°56'40.26"N, 20°32'30.01"E | rhyolite accretionary lapilli bearing tuff                              |
| CsO1                 | Cserépfalu, Ördögcsúszda               | 47°57'34.69"N, 20°32'47.72"E | large pumice of rhyolite block-bearing lapilli tuff                      |
2.2. Sample preparation

Zircon crystals were separated from the 63 to 125 μm size fraction of rock samples by standard gravity and magnetic separation methods. The amount of xenocrystic zircons was minimized by separating zircon grains solely from pumice clasts of the pyroclastic rock (when available), while in case of lapilli tuff samples we attempted to remove all lithic fragments before zircon separation.

In order to minimize the effects of lead loss, chemical abrasion (CA; [2]) was employed on two aliquots of zircons analysed by LA ICP-MS (TD-A_CA; TD-H_CA). Zircon grains of each sample were loaded into quartz crucibles and annealed in a high temperature furnace (900 °C) for 48 h. The zircons were transferred from the quartz crucibles into 3 ml Savillex PFA Hex beakers and concentrated HF + trace HNO₃ was added. The beakers were placed in a high pressure Parr bomb and the zircons were etched at 180 °C for 12–15 h. The zircons were rinsed with H₂O and acetone before being fluxed for 12 h in 6 N HCl at ~ 85 °C. The zircons were rinsed in H₂O and washed with acetone.

The separated zircon grains were mounted in 1 in. epoxy resin mount and polished to a 1 μm finish. Before dating, zircons were checked by optical microscopic and cathodoluminescence (CL) imaging. CL imaging was produced using an AMRAY 1830 SEM equipped with GATAN MiniCL and 3 nA, 10 kV setup at the Department of Petrology and Geochemistry, Eötvös University, Hungary and a JEOL JXA 8900 electron microprobe with 10 kV setup at the University of Göttingen.

2.3. LA-ICP-MS analyses

Analyses were performed in two laboratories: Department of Earth Sciences, ETH Zürich and Gōochron Laboratories, University of Göttingen. Analytical setups of the laboratories are presented in Tables 2 and 3.

2.4. Data handling

We filtered out the data that was > 10% discordant determined by the following equation:

\[
\text{Discordance} = 100 \times \frac{1 - \frac{\text{\(^{206}\text{Pb}}}{\text{\(^{238}\text{U}\)}}}{\text{\(^{207}\text{Pb}}}{\text{\(^{235}\text{U}\)}} \times \text{Age}}
\]
Validation reference materials were used to correct for alpha dose-dependent age offsets in non-CA treated zircons [18,19]. In short, accumulation of radiation damage in a zircon weakens the matrix, increasing the ablation rate and the effects of laser-induced elemental fractionation. This in turn imparts a differential downhole fractionation curve between calibration and validation reference materials, making low-dose (i.e. young and low-U) zircons appear anomalously young following downhole fractionation correction. This effect can be mitigated by modelling the dependence of age offset on total radiation dose, calculated from sample age and concentrations of U and Th [20]. Because thermal annealing repairs some matrix radiation damage [18,19], it is important that samples

| Laboratory name | Department of Earth Sciences, ETH Zürich |
|-----------------|-----------------------------------------|
| **Laser ablation system** | launder technics 155, constant geometry, aerosol dispersion volume < 1 cm³ |
| Make, Model & type | ASI Resolution 155 |
| Ablation cell & volume |禽禽 |
| Laser wavelength | 193 nm |
| Pulse width | 25 ns |
| Fluence | 〜 2 J cm⁻² |
| Repetition rate | 5 Hz |
| Spot size | 30 μm |
| Ablation rate | 〜 75 nm pulse⁻¹ |
| Sampling mode/pattern | Single hole drilling, 5 cleaning pulses |
| Carrier gas | 100% He |
| Ablation duration | 40 s |
| Cell carrier gas flow | 0.7 l/min |
| **ICP-MS Instrument** | Thermo Element XR SF-ICP-MS |
| Make, Model & type |禽禽 |
| Sample introduction |禽禽 |
| RF power | 1500 W |
| Make-up gas flow | 〜 0.95 l/min Ar (gas mixed to He carrier inside ablation cell funnel) |
| Detection system |禽禽 |
| Masses measured |禽禽 |
| Total integration time per reading | 0.202 s |
| Dead time | 8 ns |
| Typical oxide rate (ThO/Th) | 0.18% |
| Typical doubly charged rate (Ba⁺⁺ /Ba⁺) | 3.5% |
| Data blank |禽禽 |
| Calibration strategy |禽禽 |
| Gas blank |禽禽 |
| Calibration strategy |禽禽 |
| Reference material info | BAJ-1 used as primary calibration material in all sessions except for the two sessions with chemically abraded samples where chemically abraded BAJ-1 (BAJ-1_CA) was used as calibration reference material along with chemically abraded validation reference materials (Temora2, 91500, OD-3) |
| Data processing package used |禽禽 |
| Mass discrimination |禽禽 |
| Common Pb correction |禽禽 |
| Uncertainty level & propagation |禽禽 |
| References: |禽禽 |
| Plešovice [7,8], 91500 [4,8], Temora2 [9], OD-3 [10], AUSZ7-1 [11] and AUSZ7-5 [12], LG_0302 (pers. comm. von Quadt, 2017) |
| IOLITE v2.5, v3.4 [13,14] with VisualAge [15] |
| Mass bias correction for all ratios normalized to calibration reference material |
| No common-Pb correction applied |
| Ages are quoted at 2 SE absolute, propagation is by quadratic addition. Reproducibility of reference material uncertainty (i.e. external uncertainty) is propagated. |
and reference materials are either all thermally annealed, or all not thermally annealed. The age offset vs. alpha dose model also become inaccurate if some zircons have experienced natural thermal annealing through contact metamorphism or burial. However, given that the samples in question are young and show no signs of contact metamorphism, we can exclude this possibility. Possible natural annealing of zircons was also excluded based on Raman spectroscopy (i.e. alpha dose concentrations and Raman band parameters of zircon crystals are in agreement; [21]). At ETH Zürich, the relationship between age offsets and alpha dose concentrations were modelled in each session and this model was used to calculate the alpha-dose corrected ages. At Göttingen University, measurements were alpha dose corrected based on a global model of validation reference material measurements of all sessions between 2014 and 2017. In both cases, Th disequilibrium correction was performed after alpha dose-correction using the algorithm of [22], assuming a constant Th/U partition coefficient ratio of $0.33 \pm 0.063$ (1σ) [23].
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Transparency document. Supplementary material

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2018.05.013.

References

[1] R. Lukács, S. Harangi, M. Guillong, O. Bachmann, L. Fodor, Y. Buret, I. Dunkl, J. Sláma, I. Soós, J. Szepesi, Zircon geochronology and geochemistry to constrain the youngest eruption events and magma evolution of the Mid-Miocene ignimbrite flare-up in the Pannonian Basin, eastern central Europe, Contr. Miner. Petrol. 170 (2015) 52.

[2] J.M. Mattinson, Zircon U-Pb chemical abrasion (“CA-TIMS”) method: combined annealing and multi-step partial dissolution analysis for improved precision and accuracy of zircon ages, Chem. Geol. 220 (2005) 47–66.

[3] S.E. Jackson, N.J. Pearson, W.L. Grifflin, The application of laser ablation-inductively coupled plasma-mass spectrometry to in situ U-Pb zircon geochronology, Chem. Geol. 211 (2004) 47–69.

[4] M. Wiedenbeck, P. Allé, F. Corfu, W.L. Grifflin, M. Meier, F. Oberli, A. von Quadt, J.C. Roddick, W. Spiegel, Three natural zircon standards for U-Th-Pb, Lu-Hf, trace element and REE analyses, Geostand. Newslett. 19 (1995) 1–23.

[5] R. Lukács, S. Harangi, O. Bachmann, M. Guillong, M. Danišišk, Y. Buret, A. von Quadt, I. Dunkl, L. Fodor, J. Hasciánsk, I. Soós, J. Szepesi, Zircon geochronology and geochemistry to constrain the youngest eruption events and magma evolution of the Early to Mid-Miocene syn-extensional massive silicic volcanism in the Pannonian Basin (East-Central Europe): eruption chronology, correlation potential and geodynamic implications, Earth Sci. Rev. 179 (2018) 1–19.

[6] J.M. Mattinson, Zircon U-Pb chemical abrasion (“CA-TIMS”) method: combined annealing and multi-step partial dissolution analysis for improved precision and accuracy of zircon ages, Chem. Geol. 220 (2005) 47–66.

[7] S.E. Jackson, N.J. Pearson, W.L. Grifflin, The application of laser ablation-inductively coupled plasma-mass spectrometry to in situ U-Pb zircon geochronology, Chem. Geol. 211 (2004) 47–69.

[8] M. Wiedenbeck, P. Allé, F. Corfu, W.L. Grifflin, M. Meier, F. Oberli, A. von Quadt, J.C. Roddick, W. Spiegel, Three natural zircon standards for U-Th-Pb, Lu-Hf, trace element and REE analyses, Geostand. Newslett. 19 (1995) 1–23.

[9] R. Lukács, S. Harangi, O. Bachmann, M. Guillong, M. Danišišk, Y. Buret, A. von Quadt, I. Dunkl, L. Fodor, J. Hasciánsk, I. Soós, J. Szepesi, Zircon geochronology and geochemistry to constrain the youngest eruption events and magma evolution of the Mid-Miocene ignimbrite flare-up in the Pannonian Basin, eastern central Europe, Contr. Miner. Petrol. 170 (2015) 52.
[15] J.A. Petrus, B.S. Kamber, VizualAge: a novel approach to laser ablation ICP-MS U-Pb geochronology data reduction, Geostand. Geoanal. Res. 36 (2012) 247–270.

[16] J.B. Paces, J.D. Miller, Precise U-Pb ages of Duluth complex and related mafic intrusions, northeastern Minnesota: geochronological insights to physical, petrogenetic, paleomagnetic and tectonomagmatic processes associated with the 1.1 Ga Midcontinent Rift System, J. Geophys. Res. Solid Earth 98 (1993) 13997–14013.

[17] I. Dunkl, T. Mikes, K. Simon, H. von Eynatten, Brief introduction to the Windows program Pepita: data visualization, and reduction, outlier rejection, calculation of trace element ratios and concentrations from LA-ICP-MS data, in: P. Sylvester (Ed.), Laser Ablation ICP-MS in the Earth Sciences: Current Practices and Outstanding Issues, Miner. Assoc., Canada, 2008, pp. 334–340.

[18] E. Marillo-Sialer, J. Woodhead, J. Hergt, A. Greig, M. Guillong, A. Gleadow, N. Evans, C. Paton, The zircon ‘matrix effect’: evidence for an ablation rate control on the accuracy of U-Pb age determinations by LA-ICP-MS, J. Anal. At. Spectrom. 29 (2014) 981–989.

[19] E. Marillo-Sialer, J. Woodhead, J.M. Hanchar, S.M. Reddy, A. Greig, J. Hergt, B. Kohn, An investigation of the laser-induced zircon ‘matrix effect’, Chem. Geol. 438 (2016) 11–24.

[20] J. Sliwinski, M. Guillong, C. Liebske, I. Dunkl, A. von Quadt, O. Bachmann, Improved accuracy of LA-ICP-MS U-Pb ages in Cenozoic zircons by alpha dose correction, Chem. Geol. 472 (2017) 8–21.

[21] L. Nasdala, G. Irmer, D. Wolf, The degree of metamictization in zircons: a Raman spectroscopic study, Eur. J. Miner. 7 (1995) 471–478.

[22] U. Schärer, The effect of initial $^{230}$Th disequilibrium on young U-Pb ages: the Makalu case, Himalaya, Earth Planet. Sci. Lett. 67 (1984) 191–204.

[23] D. Rubatto, J. Hermann, Experimental zircon/melt and zircon/garnet trace element partitioning and implications for the geochronology of crustal rocks, Chem. Geol. 241 (2007) 38–61.