

Assessing reproducibility in detrital geochronology: an inter-laboratory comparison of detrital zircon age spectra

MAXIMILIAN DRÖLLNER^{1,2}, MILO BARHAM¹, CHRISTOPHER L. KIRKLAND¹, TARYN SCHARF¹, CHARLOTTE M. ALLEN^{3,4}, PAULA CASTILLO⁵, PETER A. CAWOOD⁶, DAVID M. CHEW⁷, NATHAN COGNÉ⁸, JOHN M. COTTLE⁹, JAMIE A. CUTTS¹⁰, JANINA CZAS¹⁰, FOTEINI DRAKOU^{11,12}, ISTVÁN DUNKL², MARLINA A. ELBURG¹³, MICHELLE L. FOLEY¹⁴, GEORGE E. GEHRELS¹⁴, MARCEL GUILLONG¹⁵, BENJAMIN D. HEREDIA¹⁶, MAURICIO IBAÑEZ-MEJIA¹⁷, DR. JARRED C. LLOYD, PHD¹⁸, CHRIS MARK¹⁹, HUGO MOREIRA²⁰, KARINE H. MOROMIZATO³, GUIDO PASTORE^{21,22}, LEIF-ERIK R. PEDERSEN²³, ANDREAS PETERSSON¹⁹, IRENA PEYTCHEVA^{24,25}, MARC POUJOL⁸, NICK M. W. ROBERTS²⁶, DELIA RÖSEL²⁷, EMMA SCANLAN²⁸, JIŘÍ SLÁMA²⁹, LUIGI SOLARI³⁰, CHRISTOPHER J. SPENCER²⁸, CRAIG STOREY²⁰, MARTIN SVOJTKA²⁹, PAUL J. SYLVESTER³¹, TONNY B. THOMSEN¹⁶, PIETER VERMEESCH²¹, HILMAR VON EYNATTEN², ALBRECHT VON QUADT¹⁵, ARMIN ZEH³² AND YOUSEF ZOLEIKHAEI⁶

¹Timescales of Mineral Systems Group, Curtin Frontier Institute for Geoscience Solutions, School of Earth and Planetary Sciences, Curtin University, Perth, WA 6103, Australia

²Department of Sedimentology and Environmental Geology, Geoscience Center Göttingen, University of Göttingen, 37077 Göttingen, Germany

³Central Analytical Research Facility, Queensland University of Technology, Brisbane 4000, Queensland, Australia

⁴School of Earth and Atmospheric Sciences, Queensland University of Technology, Brisbane 4000, Queensland, Australia

⁵Institut für Geologie und Paläontologie, University of Münster, Münster, Germany

⁶School of Earth, Atmosphere and Environment, Monash University, Melbourne, Victoria 3800, Australia

⁷Trinity College Dublin

⁸Université de Rennes, CNRS, Géosciences Rennes – UMR 6118, F-35000, Rennes, France

⁹Department of Earth Sciences, University of California, Santa Barbara, CA, USA

¹⁰Natural Resources Canada, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0G1, Canada

¹¹Department of Geology, School of Natural Sciences, Trinity College Dublin, Dublin 2, Ireland

¹²Mineral Deposit Research Unit, Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, Canada

¹³Department of Geology, University of Johannesburg, P.O. Box 524, Auckland Park, 2006 Johannesburg, South Africa

¹⁴Department of Geosciences, University of Arizona, Tucson, Arizona, USA

¹⁵Institute of Geochemistry and Petrology, Department of Earth Sciences, ETH Zürich, Clausiusstrasse 25, 8092, Zürich, Switzerland

¹⁶Department for Mapping and Mineral Resources, Geological Survey of Denmark and Greenland, Øster Voldgade 10, 1350 Copenhagen K., Denmark

¹⁷Department of Geosciences, University of Arizona

¹⁸School of Physics, Chemistry, and Earth Sciences, University of Adelaide, Adelaide, SA 5005, Australia

¹⁹Department of Geosciences, Swedish Museum of Natural History, Stockholm, Sweden

²⁰School of the Environment and Life Sciences, University of Portsmouth, Portsmouth, UK

²¹London Geochronology Centre, Department of Earth Sciences, University College London, London WC1E 6BT, UK

²²Laboratory for Provenance Studies, Department of Earth and Environmental Sciences, University of Milano-Bicocca, Milano 20126, Italy

²³Department of Earth Science, Center for Deep Sea Research, University of Bergen, Bergen, Norway

²⁴Geological Institute, Bulgarian Academy of Sciences

²⁵Geological Institute, Bulgarian Academy of Sciences, Acad. G. Bonchev, Bl.24, 1113 Sofia, Bulgaria

²⁶British Geological Survey

²⁷Department of Earth Sciences, University of Gothenburg, Medicinaregatan 19, 413 90 Göteborg, Sweden

²⁸Queen's University, Department of Geological Sciences and Geological Engineering, Kingston, Ontario, K7L 3N6, Canada

²⁹Institute of Geology of the Czech Academy of Sciences, Prague, Czechia

³⁰Centro de Geociencias, Universidad Nacional Autónoma de México, Querétaro, México

³¹Department of Geosciences, Texas Tech University, Lubbock, Texas 79409, USA

³²Institute for Applied Geoscience, Mineralogy and Petrology, KIT-Karlsruhe Institute of Technology, Adenauerring 20b, Geb. 50.4, 76131, Karlsruhe, Germany

Detrital zircon (DZ) U–Pb geochronology is the most applied technique in single-grain sedimentary provenance studies. With the advent of ‘big data’ in this field, computational and statistical methods are routinely used to compare detrital age spectra that serve as a provenance barcode for their sedimentary host. Provenance studies of large-scale systems often integrate DZ U–Pb data generated by different laboratories. However, the magnitude of quantitative differences in DZ age spectra that can stem from variations in sample processing and analytical protocols remains poorly understood. To address this issue, an inter-laboratory comparison was conducted. Subsamples from two geologically distinct heavy mineral placer deposits were processed and analysed for DZ U–Pb geochronology by multiple laboratories using their established workflows. The two samples include sample DZ, a zircon-rich concentrate from the Cenozoic Scott Coastal Plain in southwest Australia, and sample HM, a zircon-bearing heavy mineral concentrate from the Neogene Murray Basin in southeast Australia. This contribution presents preliminary results from ~12,000 individual zircon U–Pb analyses across ~50 subsamples, with each comprising a variable

number of analyses (*n*) measured using different laboratory-specific protocols. Both samples exhibit highly polymodal age distributions, with all major age modes qualitatively reproduced across the different subsamples. However, quantitative differences are evident. For example, a Kolmogorov–Smirnov (KS) test of the age spectra, after applying a discordance filter based on the conventional $\pm 10\%$ relative age difference between the $^{206}\text{Pb}/^{238}\text{U}$ and $^{207}\text{Pb}/^{206}\text{Pb}$ ages, reveals that for all pairwise comparisons, the KS-D values have interquartile ranges of 0.11 to 0.20 (median = 0.14) for the DZ sample and 0.14 to 0.25 (median = 0.19) for the HM sample, along with maximum values of 0.56 and 0.42, respectively. No apparent correlation between KS-D values and *n* for the DZ sample may indicate that methodological inconsistencies, in addition to random subsampling effects, have a considerable influence on the intra-sample variability observed. These findings, along with complementary contextualization of sample handling parameters and grain shape data, provide a ‘baseline’ of variability expected when comparing DZ U–Pb data collected under different conditions and help guide more robust interpretations of integrated datasets.