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A spectrum is haunting geochronology – the zircon age spectrum

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Zircon, a common and durable accessory mineral in silicic igneous rocks, is an unparalleled timekeeper of magmatic processes. Historically, the temporal resolution achievable by U-Th-Pb zircon geochronology limited the interpretation of zircon ages to a single event (e.g. eruption age, emplacement age). Due to recent methodological improvements, which have increased the accuracy and precision of this geochronometer, an extended record of zircon crystallization can now be resolved in single rock samples, with zircon crystals found to predate the eruption or final solidification of a magma body by hundreds of thousands to a few million years. In systems with sufficiently long duration, the distribution of individual ages as a function of time might thus represent a promising recorder of critical processes (e.g. recharge, cooling) that ultimately seal the fate of the host magmatic system (e.g. volcanic eruption, economic mineralization; [1],[2]).

Combining synthetic age distributions generated by forward modelling with the statistical analyses of a large CA-ID-TIMS dataset compiled from existing literature, this contribution explores the multitude of factors that influence observed zircon age distributions. The results of this analysis indicate that mechanical processes (e.g. truncation of zircon crystallization during eruptive events) might be more influential to the shape of zircon age distributions than magma dynamics (e.g. changes in magmatic fluxes). These findings provide a framework for interpreting newly published datasets and a timely assessment, including strengths and caveats, of the use of zircon age distributions to obtain petrologic information on silicic systems across time and tectonic settings [3].

[1] Caricchi et al. (2014), *Nature* 511, 457-461.
[2] Tavazzani et al. (2023), *Eart. Plan. Sc. Lett.* 623, 118432.
[3] Nathwani et al. (2025), *Geochronology* 7(1), 15-33.