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High-precision zircon U-Pb geochronology of astronomically tuned ash beds from the Mediterranean Miocene

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Prolonged crystallization and magma residence of zircon is well documented by in-situ U-Th dating in Pleistocene magmatic systems. Recent technical developments in U-Pb geochronology by (chemical abrasion) isotope dilution thermal ionization mass spectrometry (CA-ID-TIMS) allow dating of high uranium accessory minerals at permil precision and external reproducibility. Such high temporal resolution allows resolving time scales of magma accumulation and differentiation in Cenozoic magmatic systems, resulting in complex zircon age populations [1]. These complexities have been considered to systematically bias zircon U-Pb derived eruption ages, to compromise chronostratigraphic applications of high-precision zircon U-Pb geochronology and to contribute to the systematic offset between the K-Ar and U-Pb systems [2, 3].

We present high-precision zircon U-Pb dates from ash beds intercalated with astronomically tuned Miocene sediments, aiming to evaluate the effect of prolonged crystallization on zircon U-Pb derived ash bed deposition ages. All ash beds yield complex zircon age populations recording prolonged crystallization at the 10-100 ka scale. While the majority of zircons predate eruption, the youngest closed system zircons yield 206Pb/238U dates indistinguishable from the respective astronomical age and thus accurately date ash bed deposition. However, the conventional approach of averaging statistically equivalent zircon U-Pb dates to increase precision tends to overestimate the deposition age if complexities are masked by uncertainties of individual analyses. Accurate zircon U-Pb dating of ash bed deposition thus requires analytical precision only achievable by ID-TIMS.

[1] Schaltegger et al., 2009, EPSL, v. 286, p. 208-218
[2] Simon et al., 2008, EPSL, v. 266, p. 182-194
[3] Renne et al., 2010, GCA, v. 74, p. 5349-5367
[4] The research leading to these results has received funding from the European Community's Seventh Framework Program (FP7/2007-2013) under grant agreement no [215458].