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U-Th Dating of Oruanui Zircons, Taupo Volcanic Zone: Some Remarks on the Interpretation of U-series Mineral Isochron Data from Systems With Prolonged Crystallisation Histories

Bruce Charlier (b.l.a.charlier@open.ac.uk)[1] & **Georg Florian Zellmer** (georg.zellmer@bristol.ac.uk)[2]

[1] Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, UK
[2] Department of Earth Sciences, Wills Memorial Building, Queens Rd., Bristol, BS8 1RJ, UK

Mineral isochron dating is a frequently used geochronological tool. One of its assumptions is that the minerals grow over a time period that is small compared to the half-life of the radiogenic isotope system used. In recent years, increasing analytical precision has promoted the use of the short-lived U-series isotope system in order to date young crystallisation events (e. g. Allègre, 1968; Pyle et al., 1988; Reagan et al., 1992; Condomines, 1997). Three whole-rock magmatic-zircon U-Th isochrons from the 26.5ka Oruanui eruption in the Taupo Volcanic Zone, New Zealand, yield pre-eruptive model ages of 5.5 ±0.8ka, 9.7 ±1.7ka and 12.3 ±0.8ka for the sub-63µm, 63-125µm and 125-250µm zircon size fractions, respectively (see Figure 1a).

This suggests that in this case the assumption of instantaneous crystal growth breaks down. It can be shown that the U-Th data may alternatively be explained by continuous zircon nucleation and growth with a growth rate of 4.5µm/kyr over a period of ~ 90kyr (see Figure 1b).

However, cathodoluminescence shows that crystals are typically composed of an euhedral core surrounded by a sector-zoned euhedral rim, and the U-Th data can also be modelled by mixing an older (~ 28ka model age) population of zircon crystals with a young zircon rim that formed shortly prior to eruption of the Oruanui rhyolite (see Figure 1c).

This study indicates that detailed petrographic studies are critical for deciphering the histories of prolonged crystallisation in the magmatic environment. It is concluded that conventional U-series mineral isochrons may underestimate crystallisation ages by up to an order of magnitude. In future, microanalytical techniques will lead to significant advances in the understanding of crystallisation processes and timescales.

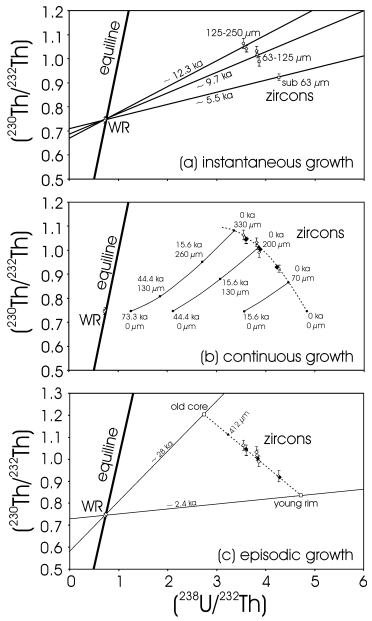

Figure 1: U-Th equiline diagrams with Oruanui whole rock and zircon mineral separate data. (a) Zircons cannot be modelled by instantaneous growth. Continuous (b) and episodic (c) growth models both give significantly different crystallisation timescales. Data as open diamonds, modelled U-Th composition as filled diamonds.

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