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HIGHLIGHTS AND BREAKTHROUGHS

Zircon dissolution and growth during metamorphism

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Abstract: Kohn et al. 2015 (this volume) present models of zircon dissolution and growth in hydrous MORB and metapelite bulk compositions under metamorphic conditions. They evaluate the propensity metamorphic minerals in equilibrium with zircon, to assess what minerals (besides zircon) affect whole rock Zr mass balance. Results indicate that mineral reactions over a range of metamorphic grades could play an important role in the dissolution and growth of metamorphic zircon, with Zr preferentially incorporated into melt, rutile, garnet, and hornblende with increasing temperatures and decreasing pressures. **Keywords:** Zircon, dissolution, growth, metamorphism, geochronology

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the timing of UHP metamorphism. In contrast, zircons separated from the quartzo-feldspathic gneiss that encapsulates the coesite eclogite yielded U-Pb depth profiles that indicate intragrain geochemical heterogeneities (variations in Hf, Ti, and Y) suggesting chemical disequilibrium over the interval of zircon growth at 3.66 ± 0.13 Ma (2σ), significantly post-dating the timing of UHP metamorphism (Zirakparvar et al. 2014).

U-Pb LA-ICPMS and chemical abrasion (CA)-TIMS zircon geochronology (DesOrmeau et al. 2014; Gordon et al. 2012) indicates that zircon crystallization at the Papua New Guinea UHP locality occurred from 9.1 to 3.7 Ma. As the Kohn et al. (2015) models predict, zircon growth occurred over a range of *P-T* conditions. Currently, the best estimate for the timing of UHP metamorphism is 7–8 Ma based on concordant ages for zircon (U-Pb), garnet (Lu-Hf), and phengite ($^{40}Ar/^{39}Ar$) from coesite eclogite as discussed above. Zircon in the felsic gneiss that hosts the coesite eclogite, crystallized ~4 million years later (Zirakparvar et al. 2014), at relatively low *P* as predicted by Kohn et al.'s (2015) models.

Another implication of Kohn et al.'s (2015) models is that zircon dissolution during prograde metamorphism rarely, if ever, approaches 100%, and subsequent zircon growth (rims) will likely occur on these relict cores. In the Alps, >25% of zircon grown during the Variscan orogeny was dissolved during Alpine metamorphism (Malusà et al. 2013). In this case dissolution most likely occurred during prograde Alpine metamorphism, with U-rich and strongly metamict zircon grains preferentially dissolved. Because considerable amounts of Zr become available during metamorphism, zircon can and often does recrystallize extensively on the retrograde path, dependent upon the bulk composition, and *P-T-t* path. Under some circumstances a reassessment of the interpretation of zircon U-Pb ages may be warranted in light of these models.

To summarize, from a theoretical framework, Kohn et al. (2015) further paves the way to understanding zircon dissolution and growth during metamorphism. Under most metamorphic conditions, zircon growth occurs well below the closure temperature for Pb loss (Cherniak and Watson 2001). U-Pb ages of metamorphic zircons can potentially reveal timescales of zircon growth, subduction and exhumation rates, and the *P-T* evolution of UHP rocks (McClelland and Lapen 2013; Rubatto and Hermann 2007) provided that methods capable of detailing spatial, temporal, and geochemical variations within metamorphic zones are employed (e.g., SIMS depth profiling) (Breeding et al. 2004; Trail et al. 2007; Zirakparvar et al. 2014). Analytical methods exist to document temperatures of crystallization (Ferry and Watson 2007), isotopic and geochemical heterogeneities within single zircon crystals, with results that can be related to transport through the rock cycle. Understanding the timescales and rates of zircon growth during metamorphism will be realized when geochronologists interpret zircon U-Pb data with respect to zircon dissolution and growth, as illustrated by Kohn et al.'s (2015) models. Only then can U-Pb zircon geochronology be used in general to constrain geodynamic models, and in particular to assess mechanisms of UHP exhumation.

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