Lifetime of zircons in mafic melts: The role of melt transfer and storage modes in the mantle and crust

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The high solubility of zircon in mafic melts makes it unstable in patially molten mafic-ultramafic systems. [e.g., 1]. For example, a spherical zircon crystal of any reasonable size would not survive more than a few days in a mafic melt at 1200 °C ($C_{Sat,}$ c. $2*10^4$ ppm and $D_{Zr,}$ c. $2.3*10^{-12}$ m^2/s, [cf., 2, 3]). Our experimental results confirm these predictions. Dissolution times do increase when a crystal is shielded by other phases, but not substantially. Yet, zircons have been found, for instance, in dunites [4] or Mid Atlantic MORB rocks [5, 6], and these are an enigma. To address this problem, we have carried out experiments where zircon crystals (several mm in size) were placed in contact with a very limited volume of melt (a film of few 100 nanometers thickness, deposited by pulsed laser deposition, PLD). We find that initial rapid dissolution of zircon gets retarded as the limited melt volume gets saturated with Zr. Eventually, the saturated melt actually acts as a protective, rather than a corrosive, layer. For example, even at 1300 °C, the melt is saturated within 16 hours, and no more dissolution occurs after that. Numerical calculations varying the amount of melt surrounding the zircon [cf., 7],allow the behaviour to be quantified and extrapolated. Based on these results we infer that zircon can survive in the presence of mafic melt for long times as long as the volume of melt that a crystal of zircon sees is limited in extent. This speaks for survival of zircon in the mantle in regions of porous flow (rather than in melt-rich channels) and in gabbros in mush zones and cumulates in contact with limited melt volumes rather than in large magma chambers.

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