Zircon stability grids in partial melts from different protoliths

FERNANDO BEA[1]; PILAR MONTERO[1] :JOSE F. MOLINA[1]; IRENE MORALES[1]: AITOR CAMBESES[1]

Dept. Mineralogy and Petrology, Univ. of Granada, Spain; fbea@ugr.es; pmontero@ugr.es; jfmolina@ugr.es; acambeses@ugr.es

Zircon survival in partial melts depends on four main factors: availability for the melt, the volume of melt in contact with the zircon, its solubility into the melt, and its dissolution kinetics. The last factor is of great importance for fast cooling mamas. The volume of melt pores in mushes is critical for controlling zircon saturation in crystallizing mafic rocks and ensuring the survival of zircon xenocrysts in them. In crust-generated magmas, however, these two factors usually are of limited importance because of (i) the long duration of anatexis, measured in millions of years, belittles the kinetics effects of zircon dissolution, (ii) the minimum volume of melt for escaping from the source is about 20-25 vol.% (Vigneresse et al., 1996). Therefore, the two most important factors for survival of source zircon in crustal magmas are the availability for the melt and the zircon solubility into it, both closely related to the source composition, melting temperature, and the melt fraction produced.

To understand the relationships among these parameters, we built grids relating temperature, water content, melt fraction, and zircon saturation for three different sources, a gabbro-diorite, a metaluminous tonalite, and a peraluminous granodiorite, that cover most of the spectrum of granite-producing crustal rocks.

Our results show that zircon survival during anatexis is much probable in felsic than in mafic protolith, and it strongly depends on the fraction of water present in the source because this controls the melting temperature and the volume of melt. The abundance of inherited zircon components in granite rocks is therefore indicative of wet anatexis. For example, to overcome the melt escape threshold in a felsic protolith requires only 730 ºC, with H_2O = 2 wt. %, and at this temperature, the melt gets zircon-saturated with just ≈ 100 ppm of zircon, less than commonly found in most potential crustal sources. Increasing H_2O until ≈ 6 wt.%, the melt fraction increases up to 60 wt.%, and the zircon saturation keeps nearly constant, being possible, therefore to generate batholitic high-zircon inheritance granites. In contrast, at H_2O ≈ 1 wt.%, to reach the melt escape threshold requires about 770ºC, and the resulting melt needs more than 250 ppm Zr to be saturated. These values increase until 890 ºC and 520 ppm Zr if H_2O ≈ 0.5 wt%, precluding so the survival of any zircon in contact with the melt. We conclude, therefore, that the "hot" - "cold" granite duality as a function of zircon inheritance (Miller et al., 2003) may be reformulated more precisely as "wet" (high inheritance) to "dry" (low inheritance) granitoids.

Miller, C.F., McDowell, S.M., and Mapes, R.W., 2003. Geology 31(6), 529–532

Vigneresse, J.L., Barbey, P., and Cuney, M., 1996. Journal of Petrology 37(6), 1579–1600.