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A new Zr-Hf geothermometer for magmatic zircon

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Published experimental data on the partitioning of Zr and Hf between felsic melts and Zircon (Zrn), and on the solubility of Zrn and hafnon, HfSiO4 in melts with variable ASI index have been used to derive an equation of the Zr-Hf geothermometer: T=1531/(lnKd+0.883), with Kd = (XZr,s*XHf,m)/ (XZr,m*XHf,s), where Xi,j–concentration of Zr and Hf in Zrn (s) and melt (m), ppm, and – temperature, . Constant concentration of Zr in Zrn of 480000 ppm is applied for temperature calculations. It is shown that the increase in the Hf content from cores to rims often documented in magmatic Zrn results from fractional crystallization of Zrn with preferential consumption of Zr from the melt. For differentiated granitoid series the temperature corresponding to the beginning of Zrn crystallization in the early (least evolved) cumulates should be estimated based on the composition of the central parts of large grains with the highest values of the Zr/Hf ratio. Application of the thermometer to mafic and intermediate rocks may be hampered due to co-crystallization of Zrn with oxides and Fe-Mg silicates with elevated Zr and Hf content. The new geothermometer has some advantages over those based on zircon saturation index (Watson, Harrison, 1983; Boehnke et al., 2013) and on Ti in Zrn (Ferry, Watson, 2007), as it does not depend on major oxides composition of the melts and on the correct estimates of the SiO_2 and TiO_2 activities. Calculations of the Zr and Hf fractionation trends with the assumption of Rayleigh fractionation allow estimating the temperature at which separation of the more evolved portion(s) has occurred.
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