U-Th-Pb geochronology and initial Pb composition of magmatic allanite by LA-MC-ICP-MS

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Allanite-group minerals are rare earth element-bearing epidotes that incorporate not only U and Th but also non-radiogenic Pb. Isotopic analyses can thus simultaneously reveal the magmatic or metamorphic crystallization age of allanite as well as the ambient Pb composition at the time of crystallization. Whereas the first aspect has been the main focus of several studies, the second one has received much less attention. We use a collection of Phanerozoic, allanite-bearing magmatic rock samples (volcanic, plutonic, pegmatite) to devise a strategy for accurate determination of both age and initial Pb composition in allanite. We show that allanite data acquired by laser ablation-multi collector-inductively coupled plasma-mass spectrometry can be corrected for mass bias and fractionation using zircon (for U/Pb and Th/Pb ratios) and glass (for Pb/Pb ratios) as reference material as long as allanite is not metamict. We highlight the need for initial ^{230}Th disequilibrium correction, as both the lower intercept age and the y-axis intercept Pb composition can be significantly affected. The accuracy of allanite U-Pb dates obtained by linear regression in a Tera-Wasserburg diagram is confirmed by the good agreement with published U-Pb zircon ages for the same localities. The accuracy of initial Pb compositions is validated by a fair agreement with Pb isotopic data measured on co-genetic feldspars from the same samples. The initial Pb composition of samples ranging from ca. 530 to 18 Ma reveals fluctuations in initial ^{207}Pb/^{206}Pb ratio, which points to different degrees of crustal (elevated μ = ^{238}U/^{204}Pb) contribution. These variations could be due to post-magmatic deformation, weathering or metamorphism, but we believe that they rather reflect differences in initial magma composition. We therefore emphasize the importance of constraining initial Pb compositions using magmatic allanite to discuss the source of igneous rocks.