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Dating multiple overprinted granites: the effect of protracted magmatism and fluid flow on zircon U-Pb dating (SHRIMP/SIMS, LA-ICP-MS, CA-ID-TIMS) – granites from the Western Erzgebirge (Bohemian Massif, Germany)

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The Variscan granites from the Western Erzgebirge were repeatedly dated by various methods, but no consensus has been reached about their exact intrusion ages. This study presents a multi-dating approach for the four largest intrusions from the Western Erzgebirge (Aue-Schwarzenberg, Bergen, Eibenstock, Kirchberg). We analysed several samples from each pluton/suite with zircon U-Pb CA-ID-TIMS (chemical abrasion-isotope dilution-thermal ionization mass spectrometry) to obtain robust temporal information on their age and tempo of intrusion. These data enabled us for the first time to define three intrusive episodes of 1-2 Ma each, separated by quiet periods of several Ma.
To compare with literature data, zircons from the same samples were dated by SHRIMP/SIMS (sensitive high mass resolution ion microprobe/ secondary ion mass spectrometry) and LA-ICP-MS (laser ablation inductively-coupled plasma mass spectrometry). Diverging ages were obtained by these methods compared to CA-ID-TIMS for most samples. The data show that SHRIMP/SIMS, and LA-ICP-MS are inaccurate and thus not suitable to date the intrusion sequence, since their analytical uncertainty of 1% at best is not able to accurately deconvolute complex effects of partial resetting of the U-Pb system in zircon, in contrast to the CA-ID-TIMS method that reaches a precision and accuracy of $\pm$0.1%. Therefore, only the latter provides accurate age information.
Protracted magmatism and late-/post-magmatic fluid flow partly and differentially reset the different isotopic systems of each magmatic episode. For the older granites, most zircons show pronounced Pb loss, most likely from thermal overprint from later intrusions. The degree of Pb loss is highest in LA-ICP-MS analyses, but detected only in few younger SHRIMP analyses, both from untreated zircon, while chemical abrasion (for CA-ID-TIMS dates) clearly minimizes or removes Pb loss. Zircons in samples with intense fluid flow show increased common Pb contents that often resulted in too young SHRIMP/SIMS and LA-ICP-MS ages due to its inadequate correction while this effect was overcome by chemical pre-treatment in CA-ID-TIMS.