Dating faults, metamorphism, diagenesis, and surface processes by U-Pb small scale isochrones

A. GERDES[1]

1Goethe University Frankfurt, 60438 Frankfurt/M, gerdes@em.uni-frankfurt.de

The U-Pb isotope system is widely applied for dating crystallization and re-crystallization of mineral assemblages during HT events in earth history. Alongside with improvements on instrumentation over the last decades, considerable efforts have been spent to develop and refine methods for dating single crystals or even individual growth domains of high-U (>30 ppm) accessory phases.

Whereas in general these methods are very successful to date magmatic and metamorphic events, there are rocks and processes that often cannot be dated as appropriate accessory minerals are absent and temperatures were below the closure temperature of common thermo-chronometers. Examples for such rocks can be found in many shear zones, e.g. mylonites and tectonic carbonates but extend to high-P/low-T metamorphic rocks, ore mineralsiations, diagenetic minerals/ cement, and sedimentary rocks as well as to different alteration assemblages.

This study focus on the application of in-situ U-Pb isotope analyses of low-U (e.g., 0.001 to 5 ppm) minerals in thin/thick sections by laser ablation ICP sector-field mass spectrometry (LA-ICP-SFMS). For this rock forming minerals and mineral assemblages that (re-)crystallised and equilibrated during an event, containing low but variable amounts of U and μ ($^{238}U/^{204}Pb$) will be analysed. Instead of dating domains of single accessory phases, multiple analyses with variable U/Pb within mm- to cm-areas of a rock section will form a linear array in the $^{207}Pb/^{206}Pb$ vs $^{238}U/^{206}Pb$ space; the lower intercept with the Concordia is interpreted as crystallisation age and the Y-intercept as the initial Pb isotope composition.

Over the last year this method has been applied at Goethe University to various rock types (e.g., mylonites, cataclasites, carbonatites, calcite slickenfibres, cherts, shales, calc-silicates, calcite veins and altered MORB) formed during Archean to Neogene time. Small scale isochrones (SSI) ages generally agree surprisingly well with the known age, if available, of these rocks and geological processes.