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In-situ U-Pb ages of multiple generations of calcite fabrics related to the Ivriz Detachment, Central Anatolia

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Carbonate precipitation spans almost the entire geologic timescale and takes place in various environments including in marine, lacustrine, and hydrothermal systems. Tectonic processes give rise to carbonate precipitation as breccia cement, vein filling and fault coating. Associated samples are often texturally complex at the sub-millimeter scale, with either slow-continued or multi-phase growth, making traditional U-Pb bulk analyses of such materials challenging. Recent analytical advances make it possible to obtain in-situ U-Pb ages of low U-concentration rocks (<10 ppm) and date diagenesis and deformation of calcite. The in-situ approach has the advantage that it allows the accurate analysis of crystal subdomains within their structural context, while ideally avoiding possible mixing or averaging ages of different mineral generations and phases. After carefully sampling the part of the system one tries to date, combining in-situ absolute U-Pb ages of carbonates with their structural analysis has the potential to contribute greatly to tectonic studies.
In the Mediterranean region, tectonic fabrics are frequently contained in Mesozoic carbonates. The Ivriz Detachment, Central Anatolia bounds the Tauride carbonate platform, which in places has undergone HP-metamorphism. This structure played a key role in the exhumation of HP-metamorphic rocks from greenschist-facies conditions by normal-sense structural attenuation of the overriding plate. Related calc-mylonites and calc-schists show semi-ductile to brittle deformation with a normal sense of shear. The Ivriz Detachment and related rocks allow to apply and test the recent advances in the in-situ U-Pb dating of calcite. In this case study, we targeted structural domains of several generations of overprinting structures marked by calcite fabrics in eleven samples and report in-situ U-Pb ages for diagenetic and subsequent deformation events. The oldest obtained U-Pb ages reflect Mesozoic carbonate precipitation as part of the Tauride platform. A latest Cretaceous-Paleocene age is evident from mylonitic fabrics in two samples and overlaps with the onset of exhumation of the Afyon HP-rocks and the deposition of an extensional forearc basin in the hanging-wall of the detachment. A subsequent extensional event is recorded in shear bands in six samples ranging from ~60-56 Ma, consistent with U-Pb zircon crystallization ages of syn-kinematic granite intrusions of the same age, which we interpret as the main phase of activity of the Ivriz Detachment. Two younger events in Mid to Late Eocene time may be assigned to regional exhumation. The younger of these two events is associated with purely brittle deformation fabrics and may represent final unroofing of the Taurides in the footwall of the Ivriz Detachment. Our results show that in-situ U-Pb dating of calcite fabrics can be successfully used to constrain absolute ages of diagenesis and deformation when put into context with relative constraints coming from field relations and microstructural techniques. In-situ dating of tectonic structures and related overprinting fabrics is vital for comprehending the relative timing, duration and rates of deformation at shallow crustal levels.