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Rapid phase identification of apatite and zircon grains for geochronology using micro-computed tomography

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Apatite and zircon are among the best-studied and most widely used accessory minerals for geochronology and thermochronology. Given that apatite and zircon are often present in the same lithologies, distinguishing the two phases in crushed mineral separates is a common challenge that many laboratories face and can require the use of toxic heavy liquid density separation. Here we present a method for efficient and accurate apatite and zircon mineral phase identification using X-ray micro-computed tomography (microCT) of grain mounts that provides additional 3-dimensional grain size, shape, and inclusion suite information. In this study, we analyzed apatite and zircon grains from Fish Canyon Tuff samples that underwent methylene iodide (MEI) and lithium heteropolytungstate (LST) heavy liquids density separations. We validate the microCT results using known standards and phase identification with Raman spectroscopy demonstrating that apatite and zircon are distinguishable from each other and other common phases, e.g., titanite, based on microCT X-ray density. We present recommended microCT scanning protocols after systematically testing the effects of different scanning parameters and sample positions. This methodology can help to reduce time spent performing density separations with highly toxic chemicals and visually inspecting grains under a light microscope. Furthermore, improved mineral identification and characterization can make geo- and thermochronologic data more robust.