Zircon formation *versus* zircon alteration – New insights from combined U-Pb and Lu-Hf *in situ* LA-ICP-MS analyses, and consequences for the interpretation of Archean zircon from the Limpopo Belt

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We demonstrate that the combination of U-Pb and Lu-Hf isotope data obtained by LA-ICP-MS provides a powerful tool, which allows distinguishing zircon domains grown during several metamorphic-magmatic events from altered domains affected by complete single and/or multiple Pb-loss. This discrimination is possible, because the U-Pb and Lu-Hf isotope systems are decoupled during zircon alteration. We show that the initial $^{176}Hf/^{177}Hf$ ratio once "incorporated" into the zircon lattice remains nearly unaffected during later alteration processes which cause Pb loss. Newly formed zircon overgrowths always have higher initial $^{176}Hf/^{177}Hf$ than previously grown domains, due to the incorporation of additional radiogenic ^{176}Hf formed by ^{176}Lu decay in the rock's matrix between the different zircon growth events. Such ^{176}Hf is not incorporated into zircon domains affected by post-growth alteration. By applying the U-Pb and Lu-Hf systems, in combination with cathodoluminescence (CL) imaging, we can show that zircon grains in the Sand River gneiss of the Limpopo Belt grew during three events; during magma crystallization at 3.28 Ga, a first anatexis at 2.64 Ga, and a second anatexis at 2.02 Ga. Our data also show that abundant zircon domains underwent multiple Pb loss, and that many of the 2.02 Ga old zircon domains result from complete Pb-loss of zircon domains already formed at 2.64 Ga. In contrast, all domains of complex zoned zircon grains from the Zanzibar granodiorite gneiss were formed during a single magmatic event at 2.61 Ga, but most of them suffered single and/or multiple Pb loss.

Recent bimodal eruptions from the Torfajökull-Veidivötn volcanic system, south-central Iceland: Insights into magmatic processes and their rates

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Historical bimodal composition eruptions spanning Torfajökull central volcano and neighbouring Veidivötn fissure swarm in southeastern Iceland were studied to examine the nature and timing of basalt and rhyolite petrogenesis at an active divergent plate boundary. Post-glacial eruptions in the area have sampled both tholeiitic and transitional alkali basalts as well as co-eruptive high-K rhyolites. Physical mixtures of these magmas were erupted at the boundary between these volcanoes, although this study focuses instead on lavas and tephras that most closely approach the mafic and felsic endmember magma compositions that fed the most recent eruptions in 871AD and 1477. Major and trace element data demonstrate that the samples sit near the ends of previously defined regional mixing trends. Whole rock and mineral U-Th-Ra-Sr isotopic compositions are consistent with both limited compositional variation in magma sources and relatively rapid petrogenetic timescales. Rhyolites display the greatest ^{230}Th excesses of up to 17%, yet have only slightly lower ($^{230}Th/^{232}Th$) activity ratios than coeruptive Veidivötn basalts. Both magma types display small but significant ^{226}Ra excesses, up to ~ 10% in the rhyolites and ~ 60% in the basalts. Trace element and isotopic data are consistent with crustal melting of a mafic source protolith of Holocene age to generate the 871 and 1477 rhyolites. The requirement for a young rhyolite protolith is inconsistent with previously suggested models involving old silicic segregation lenses or isostatically subsided source rocks to make Icelandic rhyolites. Mineral separates yield zero-age U-Th isochrons, and Ra-Th isochrons of a few kyrs, indicating that the crystals formed shortly prior to eruption, consistent with petrographic and mineral chemistry indicators that they are phenocrysts. We propose a model to explain the compositional similarity of west Torfajökull rhyolites with historically erupted rhyolites in which the former are produced by partial melting of transitional alkali basalts, while the latter are sourced from mafic protoliths that are chemically similar to the Veidivötn tholeiites but have suffered extensive K-metasomatism prior to melting.