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Genesis of high-Si rhyolite constrained by zircon and its melt inclusions from the Huckleberry Ridge Tuff

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The Yellowstone Plateau, one of the largest active continental silicic volcanic fields on Earth, produces voluminous high-Si (>75wt.% SiO_2) rhyolites, offering an ideal window to investigate the genesis of the large volume, high-Si explosive eruptions. We report 154 analyses of 11 major elements in zircon-hosted melt inclusions (MIZs), together with 91 analysis of 26 trace-elements and 126 analysis of oxygen isotope compositions of their host zircons from the member B of the Huckleberry Ridge Tuff (HRT, 2450 km^3), the largest caldera-forming super-eruption at the Yellowstone Plateau Volcanic Field, and compare these data with those from member C (HRT-C) and the post-caldera Blue Creek Flow (BC) (Crisp et al., 2023, AGU; Crisp et al., 2024, Goldschmidt). MIZs from HRT-B show parallel major-element trends, but lower SiO_2 contents and higher whole-rock εNd values than those from HRT-C (HRT-B = –8.58, HRT-C = –18.51; compiled in Watts et al. (2011, J.Pet.)), consistent with variable degrees of mixing of melts from Archean crust and melts from mafic intrusions with calculated crustal contributions of ~13–20% for HRT-B and ~30–38% for HRT-C rhyolites. This is further supported by the more 'ocean island–type' zircon (Grimes et al. 2015) trace-element signatures (U/Nb(zircon)=13±8 versus 34±19 and Sc/Yb(zircon)=0.05±0.04 versus 0.09±0.07 for HRT-B and HRT-C, respectively) and correspondingly more mantle-like $\delta^{18}O$(zircon) from HRT-B (5.54±0.67‰) compared to HRT-C (6.06±0.35‰). The MIZs and zircons from BC (low $\delta^{18}O$(zircon)=1.72 ± 1.62‰) are intermediate between SiO_2 contents of the MIZs and trace-element compositions of the zircons, suggesting the total melting of hydrothermally altered pre-existing HRT-B and HRT-C rhyolites for the formation of BC rhyolites. Our results demonstrate that the formation of high-Si rhyolites in the HRT requires the partial melting of relatively high-Si Archean rock (>63wt.% SiO_2) coupled with melting/differentiation of mafic intrusions, highlighting the critical role of crustal materials in generating high-Si rhyolites within a continental intraplate setting, with important implications for silicic super-eruptions along the Snake River Plain–Yellowstone hotspot track.