Reconstructing a Snake River Plain 'super-eruption' via compositional fingerprinting and high-precision U/Pb zircon geochronology

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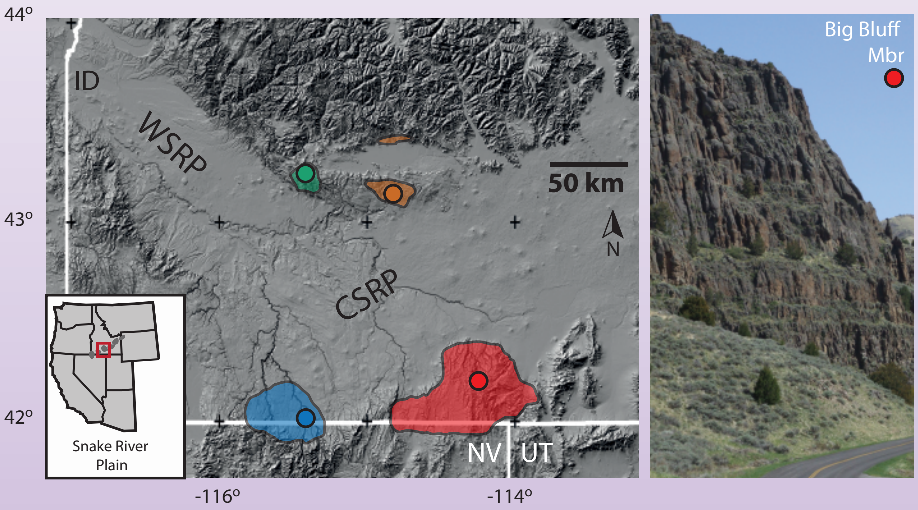
The story

Despite the potential hazards posed by the largest explosive eruptions, so called 'super-eruptions', their recurrence rate remains poorly constrained. The younger portion of the Yellowstone-Snake River Plain province is well-known for large-scale explosive volcanism; however, the older history within the Snake River Plain remains poorly-known and partially obscured by later basaltic volcanism. To address this we characterised the mineral cargo of four widely spaced rhyolitic ignimbrites from the margins of the Snake River Plain that illustrate a strong compositional similarity revealed in compositions of bulk geochemistry, major phases (e.g. pyroxene and ilmenite), and radiogenic isotopes. To test for the synchronous origin and eruption of these deposits we used a tandem in-situ and isotope dilution method for U/Pb geochronology of zircon crystals. The youngest sampling of zircons from all four samples are equivalent in age, and define a pooled weighted mean $^{238}U/^{206}Pb$ age of 11.030 ± 0.006 (MSWD = 1.44, n=24). These results reveal an event with a conservatively estimated erupted volume ~1,470 km^3, of similar magnitude to the largest explosive events from Yellowstone.

The pictures



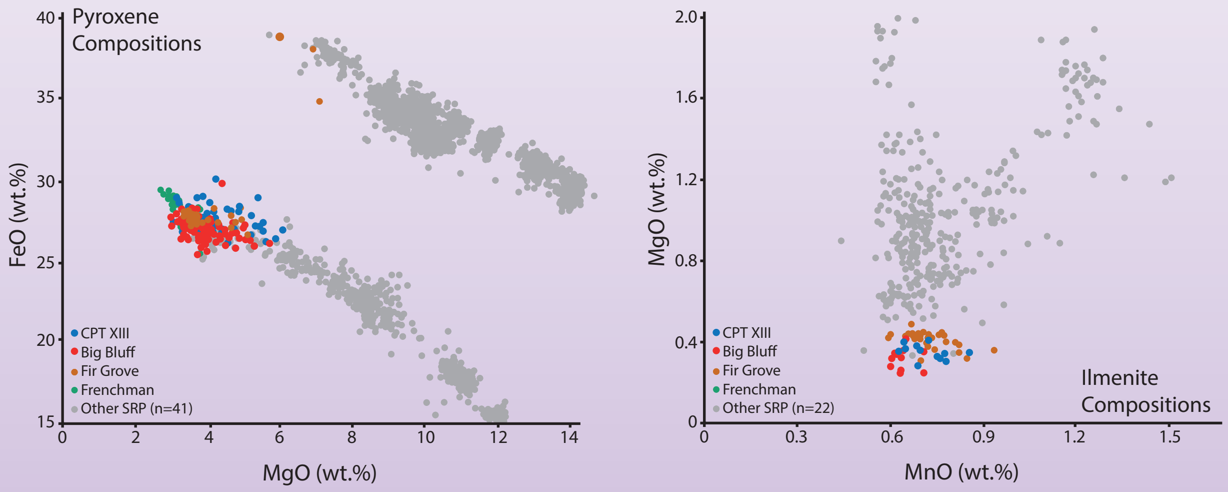


Fig. 1 (left) Location map illustrating samples used for this study. Colours used in this figure are retained for subsequent figures, Frenchman Springs (green), TFG—Tuff of Fir Grove (orange), TBB—Tuff of Big Bluff (red), and CPT XIII—Cougar Point Tuff XIII (blue). Fig. 2 (right) Mineral compositions from the four units in this study compared to other rhyolites of the central Snake River Plain.

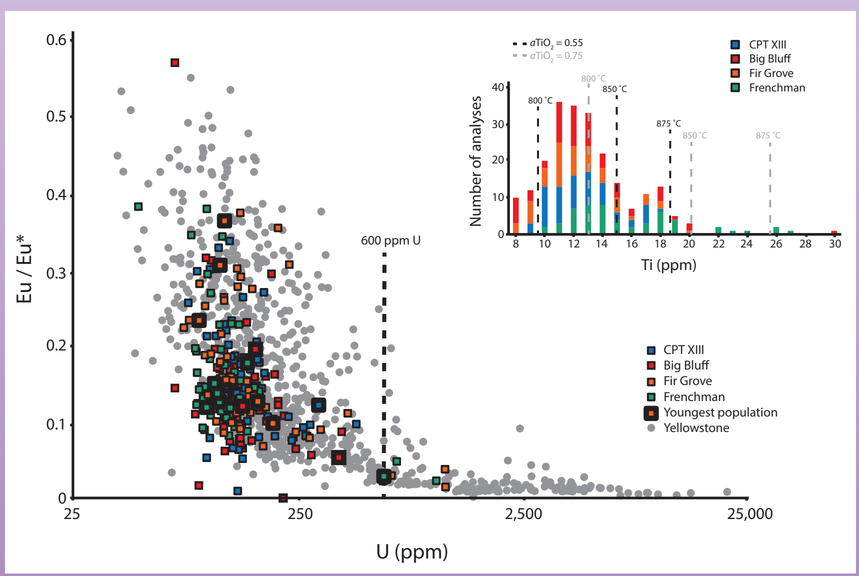


Fig. 3 (left) Zircon compositions Grey data are from Yellowstone (Rivera et al. 2014, 2016 & Wotzlaw et al. 2015). Inset shows Ti contents of zircons and temperatures inferred at different $aTiO_2$.

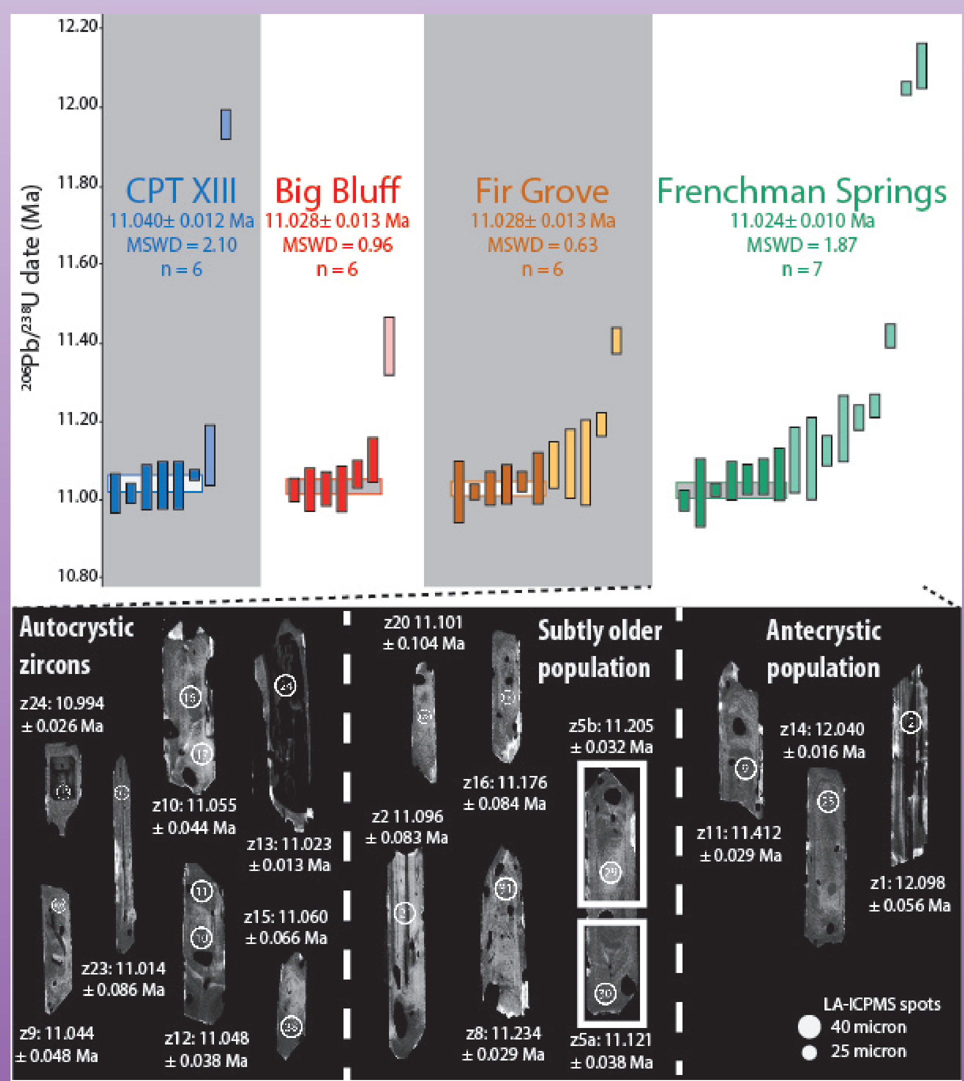


Fig. 4 (right) ID-TIMS geochronology of the 4 samples revealing identical ages from both the youngest zircons and the youngest populations.

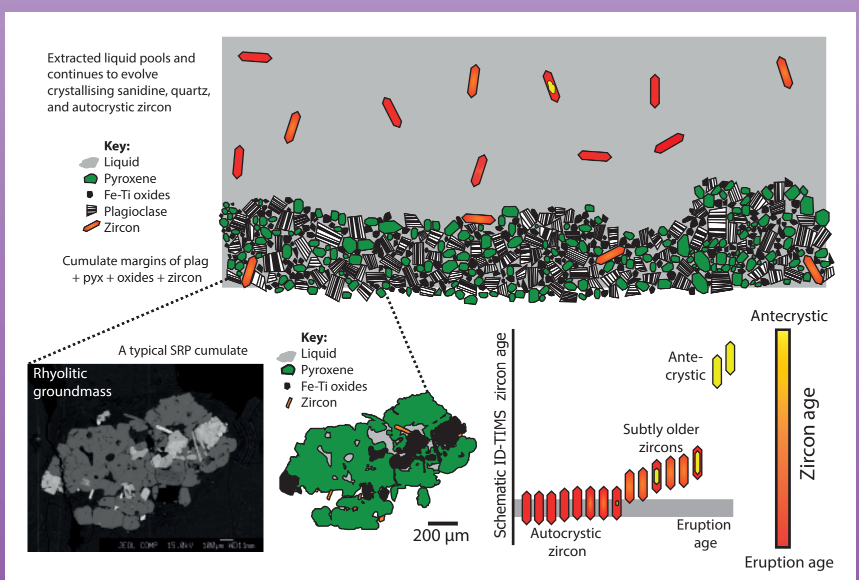


Fig. 5 Cartoon illustrating the potential locations of zircon crystallisation in the CPT XIII system and how the zircon growth environment may relate to the measured age range.

The conclusion

The most widely used compilation of large magnitude explosive eruptions (Mason et al. 2004) contains 42 eruptions with volumes > 450 km^3 from the last 36 Ma. By including more recent studies, this total more than doubles to at least 87 events within the same time window. Likely, these huge eruptions occur more frequently than is widely appreciated. Our study illustrates a suite of techniques that are a powerful method to define 'super-eruptions' that exists in the Snake River Plain and elsewhere.

For more information please see: Ellis et al. (2019) Reconstructing a Snake River Plain 'super-eruption' via compositional fingerprinting and high-precision U/Pb zircon geochronology. *Contributions to Mineralogy and Petrology 174: 101.*