Inherited, heated, enriched or recycled? Exploring causes of the extreme zircon fertility of Grenville (1.2 – 1.0 Ga) granites

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Exceptional geochemical characteristics of any group of granitoids argues for exceptional conditions for their generation. The majority of granitic magmas generated during the Grenville Orogeny (~ 1 Ga) are extremely zirconium rich (Zr contents often > 500 ppm). No other orogeny produced, on average, granitoids that are so zircon fertile. One possible mechanism that could explain high Zr concentrations is if most of the plutons contained an exceptionally high percentage of xenocrystic zircon. If the source(s) of the Grenville granitic magmas was extremely trace element enriched, then the granitic magmas would inherit that enriched signature. Alternately, if the magmas were exceptionally hot, then a high concentration of Zr could be dissolved into the magma. Observations to-date make the first mechanism unlikely – a vanishingly small percentage of zircon is demonstrably xenocrystic in the granites we have dated. The second mechanism is plausible, although not easily demonstrated. The third mechanism also appears plausible as we have obtained Ti-in-zircon temperatures that are uncommonly high for granitic magmas. These temperatures agree well with crystallization models which demonstrate zircon saturation is achieved at temperatures approaching 1000^{o}C. If additional Grenville granitoids have similar characteristics then they may represent the largest group of exceptionally high temperature granitic magmas generated during Earth history.