Shock-metamorphosed rutile and associated mineral phases in Neoarchean impact layers

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Shock-metamorphosed rutile has been identified by micro-Raman spectroscopy in four spherule layers from the Kaapvaal and Pilbara Cratons, likely formed by two impact events [1]. Three of these spherule layers, the Carrawine and Jeerinah in Australia and the Monteville in South Africa, all formed at ~2.63 Ga and have been correlated based on similarities in stratigraphic context, petrography and geochemistry. The fourth spherule layer, the Bee Gorge (found only in Australia) was formed ~2.54 Ga. Thirty-four grains from heavy mineral fractions of the four layers contain the α-PbO_2-structured polymorph of rutile (TiO_2-II), a high-pressure phase previously identified in the Ries, Chesapeake, and Xiuyan craters as well as the Australasian microtektite layer.

Scanning electron microscopy and electron microprobe analyses of the grains have provided detailed high resolution imagery and geochemical analyses that indicate a complex intergrowth of the TiO_2-II with varying abundances of clays, quartz, rutile and anatase. Phyllosilicates include chlorite-sericite, which has been observed petrographically within the spherules.

Trace element contents of the rutile and TiO_2-II were measured to provide information on provenance or protolith. Zr, Nb, V, and Cr have been used in Phanerozoic sedimentary rutiles to identify source rock and temperature history. We find significant heterogeneity in trace element content of both the TiO_2-II-bearing grains and the unshocked rutile grains from the same sections, with Cr content ranging from 54 to nearly 2000 ppm, V ranging from below detection to 1100 ppm, and Zr ranging from below detection limits to over 11,000 ppm. We have yet to detect any consistent correlation patterns between samples from different sections or between the shocked and unshocked rutiles. Planned further work will map analytical points to regions with the strongest shocked rutile signature from the Raman analysis.

[1] Smith *et al.* (2016) *Geology* **44** 775-778.