Geophysical Research Abstracts
Vol. 19, EGU2017-3914, 2017
EGU General Assembly 2017

Petrochronology in constraining early Archean Earth processes and environments: Barberton greenstone belt, South Africa

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Analytical and petrological software developments over the past decade have seen rapid innovation in high-spatial resolution petrological techniques, for example, laser-ablation ICP-MS, secondary ion microprobe (SIMS, nano-SIMS), thermodynamic modelling and electron microprobe microscale mapping techniques (e.g. XMapTools). This presentation will focus on the application of petrochronology to ca. 3.55 to 3.33 billion-year-old metavolcanic and sedimentary rocks of the Onverwacht Group, shedding light on the earliest geologic evolution of the Paleoarchean Barberton greenstone belt (BGB) of South Africa. The field, scientific drilling and petrological research conducted over the past 8 years, aims to illustrate how: (a) LA-ICP-MS and SIMS U-Pb detrital zircon geochronology has helped identify the earliest tectono-sedimentary basin and sediment sources in the BGB, as well as reconstructing geodynamic processes as early as ca. 3.432 billion-years ago; (b) in-situ SIMS multiple sulphur isotope analysis of sulphides across various early Archean rock units help to reconstruct atmospheric, surface and subsurface environments on early Archean Earth and (c) the earliest candidate textural traces for subsurface microbial life can be investigated by in-situ LA-ICP-MS U-Pb dating of titanite, micro-XANES Fe-speciation analysis and metamorphic microscale mapping. Collectively, petrochronology combined with high-resolution field mapping studies, is a powerful multi-disciplinary approach towards deciphering petrogenetic and geodynamic processes preserved in the Paleoarchean Barberton greenstone belt of South Africa, with implications for early Archean Earth evolution.