Greenstone belts as archives of early Earth processes

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The Archaean geological record is characterized by greenstone belts, i.e. curvi-linear, commonly bifurcating outcrop areas of volcano-sedimentary rocks that are wrapped around and/or intruded by different generations of granitoids. They occur in various states of preservation in Archaean cratons, but are also common in some Palaeoproterozoic granitoid-greenstone terrains.

Greenstone belts are direct evidence for non-actualistic tectonic processes on Earth, reflecting secular evolution of the Earth mantle and crust. They are characterised by submarine, predominantly mafic volcanic rocks that are interstratified or tectonically interleaved with volcaniclastic, siliciclastic and chemical sedimentary rocks of marine to terrestrial environments. Gold, nickel and iron form important ore deposits in greenstone belts, reflecting specific enrichment processes. The volcano-sedimentary successions have recorded very different physico-chemical conditions of the ancient Earth surface, and are the prime target for the study of the co-evolution of the atmosphere, hydrosphere, and biosphere.

In order to investigate a particularly well preserved archive of Palaeoarchaean surface processes, five holes were drilled in the course of 2011/2012 in the Barberton greenstone belt of South Africa, funded by the International Continental Drilling Program. One drill core (BARB3) sampled well-preserved chemical sedimentary rocks of the c. 3.4 Ga Buck Reef Chert. Abundance of organic matter, sulphides and Fe-bearing carbonates in specific intervals or associated with specific sedimentary facies of the chert succession reflect changes in the oceanic, environmental and hydrothermal conditions in a shallow marine Palaeoarchaean setting. A combination of detailed petrographic core analysis, aided by trace element and stable isotope data characterises the habitat of early life, geochemical cycles and marine/hydrothermal conditions 3.4 Ga ago.