Barberton Drilling Project – Peering into the Cradle of Life

South Africa

Goal & Scientific Objective

The aim of the project is to investigate conditions on the early Earth in which life emerged and evolved by (i) sedimentological and geochemical investigations of clastic sedimentary rocks to provide information on erosion, transport and deposition under Archean conditions, (ii) studies of tidal sequences to place constraints on the dynamics of the Earth-Moon system, (iii) petrological and chemical studies of komatiites to provide information about the temperature and geodynamic activity in the Archean mantle, (iv) geochemical and stable isotope studies of cherts and silicified volcanic and sedimentary rocks to determine the temperature and composition of Archean ocean waters, and (v) combined micropaleontology, biochemistry and biogeochemistry studies to search for and characterize traces of early life in the sedimentary and volcanic rocks.

Operational Achievements

More than 3000 m of core from 5 holes at 4 sites were recovered.

Volcanic core sites:

Tjakastad komatiite: BARB1: 420 m

Tjakastad komatiite: BARB2: 431 m

Sedimentary core sites:

Buck Reef hole: BARB3: 899 m

Mid Fig Tree hole BARB4: 538 m

Barite Valley hole BARB5: 763 m

Web & Media Resources

http://barberton.icdp-online.org/

http://www.icdp-online.org/fileadmin/icdp/projects/doc/barberton/p102-104_Harald_Strauss_1.pdf

Timeline

2008 ICDP proposal submission

2011 (July) – 2012 (May) drilling operations

Principal Investigators

Nicholas T. Arndt, Joseph Fourier University

Paul R.D. Mason, University of Utrecht

Michael Bau, Jacobs University Bremen

Allan Wilson, University of the Witwatersrand

Axel Hofmann, University of Johannesburg

Gary Byerly, Louisiana State University

Data & Sample Access

The core is stored and has been logged in facilities of the University of the Witwatersrand.

Drill rig at the Tjakastad site

Scientific Findings

Petrographic analyses in combination with stable isotope and fluid inclusion analysis of quartz veins indicate that the veins and mineral assemblages formed during metamorphism at conditions of 230 to 400 MPa and 250 to 400°C.

The high salinity of fluid inclusions from the veins may be explained by fluid circulation through evaporites.

Komatiites and tholeiites do not show the expected unfractionated sulfur pool of juvenile magmatic sulfur, best be explained by alteration of oceanic crust through interaction with ambient seawater sulfate and incorporation of photolytic sulfate sulfur: Sedimentary pyrite in black shale samples exhibit a positive Δ33S signature that clearly indicates photolytic elemental sulfur as the principal sulfur source.

The 760-m-long BARB5 core from the Barite Valley Syncline contains four Paleoarchean spherule layers. Chromium, Co, Ni, and highly siderophile element concentrations and respective interelement relations tend towards signatures comparable to compositional ranges for known chondrite groups, supporting the impact hypothesis for the formation of at least three of the four analyzed spherule layers.

The bright red bands are jasper (chert containing hematite or another form of oxidized iron), the dark maroon bands are hematite or mixtures of chert and hematite, and the white bands are pure chert.

Key Publications

Farber, K.; Dziggel, A.; Meyer, F.M.; Harris, C. (2016): Petrology, geochemistry, and fluid inclusion analysis of altered komatiites of the Mendon Formation in the BARB4 drill core, Barberton greenstone belt, South Africa. South African Journal of Geology, vol. 119.4, 639-654. doi:10.2113/gssajg.119.4.639

Fritz, J.; Tagle, R.; Ashworth, L.; Schmitt, R.T.; Hofmann, A.; Luais, B.; Harris, P.D.; Hoenel, D.; Özdemir, S.; Mohr-Westheide, T.; Reimold, W.U.; Koeberl, C. (2016): Non-destructive spectroscopic and petrochemical investigations of paleoarchean spherule layers from the ICDP drill core BARB5; Barberton Mountain Land, South Africa. Meteoritics and Planetary Science 51(12) 2441-2458. doi:10.1111/maps.12736

Montinaro, A.; Strauss, H.; Mason, P.R.D.; Roerdink, D.; Münker, C.; Schwarz-Schampera, U.; Arndt, N.T.; Farquhar, J.; Beukes, N.; Gutzmer, J.; Peters, M. (2015): Paleoarchean sulfur cycling: multiple sulfur isotope constraints from the Barberton Greenstone Belt, South Africa. Precambrian Research 267, 311-322. doi:10.1016/j.precamres.2015.06.008

Blichert-Toft, J.; Arndt, N.T.; Wilson, A.; Coetzee, G. (2015): Hf and Nd isotope systematics of early Archean komatiites from surface sampling and ICDP drilling in the Barberton Greenstone Belt, South Africa. American Mineralogist 100, 2396-2411. doi:10.2138/am-2015-5325

Arndt, N.T.; Wilson, A.; Hofmann, A.; Mason, P.; Bau, M.; Byerly, G.; Chunnett, G. (2012): Peering into the cradle of life: scientific drilling in the Barberton Greenstone Belt. Scientific Drilling 13 71. doi:10.5194/sd-13-65-2012