The Eoarchean- Palaeoarchean boundary: The current discussion

Jaana Maija Halla1, Stan Awramik2, Nik Beukes3, Flávia Callefo4, Douglas Galante5, Christopher Fedo6, Peter Haines7, Linda Hinnov8, David Huston9, Jessica Haddock10, Axel Hofmann3, Martin Homann11, Donald Lowe12, Simon Johnson7, Linda Kah6, Mathias Kuchenbecker13, Juha Köykkä14, Noah Nhleko15, Nora Noefke16, Humberto Reis17, Barry Reno18, Evelyn Sanchez13, Yogmaya Shukla19, Mark Van Zuilen20, Frances Westall21, and Martin Whitehouse22

1Helsingin yliopisto = Helsingfors universitet = University of Helsinki – Finland
2University of California – United States
3University of Johannesburg [South Africa] – South Africa
4Universidade Estadual de Campinas = University of Campinas – Brazil
5Brazilian Synchrotron Light Laboratory – Brazil
6The University of Tennessee [Knoxville] – United States
7Geological Survey of Western Australia – Australia
8George Manson University – United States
9Geoscience Australia – Australia
10Old Dominion University – United States
11University College London – United Kingdom
12Stanford University – United States
13Universidade Federal dos Vales do Jequitin e Mucuri – Brazil
14Geological Survey of Finland = Geologian tutkimuskeskus tuottaa – Finland
15Swaziland Geological Survey and Mines Department – Swaziland
16Old Dominion University [Norfolk] – United States
17Universidade Federal de Ouro Preto – Brazil
18Northern Territory Geological Survey – Australia
19Birbal Sahni Institute of Palaeobotany – India
20Institut de physique du Globe de Paris – Institut de Physique du Globe de Paris – France
21CNRS Orleans Campus Centre de Biophysique Moléculaire (CBM) – CNRS Orleans Campus Centre de Biophysique Moléculaire (CBM) – France
22Swedish Museum of Natural History – Sweden

Abstract

The ICS Subcommission on Pre-Cryogenian Stratigraphy is currently discussing the Eoarchean- Palaeoarchean boundary. During the 4.0 to 3.6 Ga Eoarchean era (by current definition), Earth had cooled down sufficiently to allow the development of increasing volumes of
continental crust. The Archean igneous lithology is characterized by tonalite-trondhjemite-granodiorite (TTG) suites and ultramafic to felsic volcanic rocks. In the Eoarchean, TTGs were formed by episodic melting within a relatively thin basaltic oceanic crust. In the Paleoarchean (3.6-3.2 Ga), crustal growth by TTG formation continued and protocratons were thickened and stabilized by intracrustal granitoid magmatism. The Archean supracrustal rock assemblages are commonly associated with fluvial conglomerates, marine sandstones, mudstones, cherts and banded iron formations metamorphosed under low- to high-grade conditions. A low level of oxygen may have been present in the CO2- and CH4-rich Archean atmosphere. The oldest putative traces of life are C-isotopes and C–H–N–(P) elemental associations in the Isua Greenstone Belt, Greenland. Cherts in the Pilbara region of West Australia and in the 3.55 to 3.22 Ga Barberton Greenstone Belt, South Africa, include exceptionally preserved carbonaceous cells of prokaryotes and microbial mat fabrics of microbenthos once colonizing ancient oceans and hydrothermal systems. In the West Australian 3.48 Ga Dresser Formation, microbial mats colonizing a clastic coastal sabkha and silica hot springs formed stromatolites and microbially induced sedimentary structures (MISS). Sulfate-reducing metabolism is recorded by S-isotopes. Associated Ni suggests methanogetic pathways, while aliphatic molecules document the presence of both Archaea and Bacteria. The already high diversity of biogenic structures and biogeochemical patterns indicates that microbial life at the end of the Eoarchean must have been complex, forming substantial microbial films and mats with similar structural and textural sedimentary expression like those on the modern Earth. The current discussion addresses the concepts and lithological, geochemical, geochronological and paleontological characteristics that might be used for a rock record-based definition of the boundary between the Eo- and the Paleoarchean eras.

**Keywords:** Precambrian, Hadean, Archean, stratigraphy, boundary