The Eoarchean- Paleoarchean boundary: The current discussion

Jaana Maija Halla*†[1], Stan Awramik[2], Nik Beukes[3], Flávia Callefo[4], Douglas Galante[5], Christopher Fedo[6], Peter Haines[7], Linda Hinnov[8], David Huston[9], Jessica Haddock[10], Axel Hofmann[3], Martin Homann[11], Donald Lowe[12], Simon Johnson[7], Linda Kah[6], Mathias Kuchenbecker[13], Juha Köykkä[14], Noah Nhleko[15], Nora Noffke[16], Humberto Reis[17], Barry Reno[18], Evelyn Sanchez[13], Yogmaya Shukla[19], Mark Van Zuilen[20], Frances Westall[21], and Martin Whitehouse[22]

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

Abstract

The ICS Subcommission on Pre-Cryogenian Stratigraphy is currently discussing the Eoarchean - Paleoarchean 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

*Speaker
†Corresponding author: jaanahalla@gmail.com

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 suprractustal 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 sabhka and silica hot springs formed stromatolites and microbially induced sedimentary structures (MISS). Sulfate-reducing metabolism is recorded by S-isotopes. Associated Ni suggests methanogenetic 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