An ancient origin of bacterial magnetic navigation and biomineralization

Subject Code: D04

With the support by the National Natural Science Foundation of China, Dr. Lin Wei (**林巍**), Prof. Pan Yongxin (**潘永信**) and co-workers from the Institute of Geology and Geophysics, Chinese Academy of Sciences and a team of international researchers have recently found that bacterial navigation through the Earth's magnetic field might have evolved during the mid-Archean (before 3 billion years ago), suggesting that bacterial magnetic navigation and microbial biomineralization (formation of minerals by microorganisms) may be more ancient than previously thought. This work was published in *PNAS* (2017, 114: 2171—2176).

A wide range of organisms sense the geomagnetic field for the purpose of navigation, a process called magnetotaxis. However, the origin of this behavior remains an enigma. Magnetotactic bacteria synthesize intracellular magnetic organelles, called magnetosomes, which are membrane-enveloped, nano-sized crystals of magnetite (Fe_3O_4) and/or greigite (Fe_3S_4), normally arranged into one or multiple linear chains to facilitate the navigation of magnetotactic bacteria using the geomagnetic field. Magnetotactic bacteria represent a model system to study the origin, evolution and mechanisms of magnetotaxis and biomineralization.

Through genomic and phylogenetic analyses of deep-branching magnetotactic bacteria, researchers have shown that the magnetosome gene clusters responsible for magnetosome biomineralization and magnetotaxis in magnetotactic bacteria originated prior to or near the Archean (a geologic eon, 4.0 to 2.5 Ga) divergence between the bacterial phyla *Nitrospirae* and *Proteobacteria* (~3.4—3.2 Ga, Figure), suggesting that magnetotactic bacteria are one of the earliest magnetic-sensing and biomineralizing organisms on Earth. The authors of this paper pointed out that magnetotaxis and microbial biomineralization likely evolved due to environmental pressures conferring an evolutionary advantage on early Earth. An ancient origin of magnetotactic bacteria, and its persistence in multiple bacterial lineages since their divergence during Archean time, implies both temporal continuity of Earth's dynamo and persistent environmental stratification.

The study was done in collaboration with J. Craig Venter Institute, University of California, San Diego, China Agricultural University, University of Nevada, Las Vegas, California Institute of Technology and Tokyo Institute of Technology.

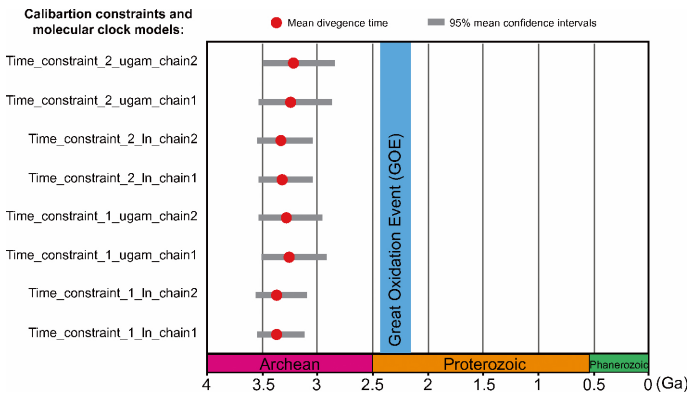

Figure Summary of mean divergence dates for the *Nitrospirae* and *Proteobacteria* phyla estimated using Bayesian relaxed molecular-clock analyses.