Biogeochemistry and geomicrobiology in extreme environments: Preface

1. Introduction

Geomicrobiology as an interdisciplinary area has achieved great progress during the past two decades (Dong and Yu, 2007). Geomicrobiology involves the study of microbes in a number of fundamental geological processes, both in the past and present (Gadd, 2010). Biogeochemistry in extreme geological environments is one of the key topics under this theme. The extreme environments include alkaline, acidic, hot, hypersaline, high pressure, dry, or anoxic (Horikoshi and Bull, 2011). Biogeochemical information from extreme geological environments is of great importance to our understanding of the early life on Earth or other planets and also to bio-prospecting of microbial resources (e.g. enzymes) (Song et al., 2010).

This special issue of Geoscience Frontiers (GSF) stems from the first international conference on geomicrobial ecotoxicology (GME) held in Wuhan, PR China in May 30–June 2, 2011. These selected papers included in this special issue cover broad topics in biogeochemistry and geomicrobiology in certain extreme environments (such as hot springs, glaciers, cold springs, and deep-sea sediments).

2. Geomicrobiology in hot springs of Yunnan Province

Hedlund et al. (2012) review the diversity of thermophilic microorganisms (bacteria, archaea, and viruses) in hot springs in the Rehai Geothermal Field in Tengchong County, Yunnan Province, China. The geothermal zone in Yunnan Province, China, is one of the most active geothermal areas in the world and is located between the Indian Plate and Eurasian Plate. The strong historic and current tectonic activities result in remarkably widespread geothermal features in this area. The Tengchong County is located in the western Yunnan geothermal zone (high-temperature), where the geothermal features are controlled by the extent of basement tectonic activities, tectonic upheaval, and depression distribution. Of the geothermal areas in and around Tengchong County, Rehai is the site of the most concentrated hydrothermal activity, highest thermal energy (Liao and Guo, 1986), and hottest subterranean reservoir (Zhang et al., 1987). The wide diversity of physical and chemical conditions that exist within Rehai provides niches for diverse microorganisms. In the last part of the review paper, Hedlund et al. (2012) also introduce the ongoing Tengchong PIRE (Partnerships for International Research and Education from the U.S. NSF) project briefly with the goal of gaining visibility among Chinese researchers. The PIRE project is to work toward a holistic and global view of biology in geothermal systems by studying the hot springs in Tengchong, Yunnan, the largest geothermal area in China, within the context of similar research in other geothermal systems such as Yellowstone National Park. The project is a collaborative effort involving eight US universities and six Chinese universities. The project is funded by a 5-year (2010–2015) grant from the NSF Partnerships in International Research and Education program with co-funding from the Biology and Geosciences Directorates (Hedlund et al., 2012).

3. Geochemistry in Tibetan hot springs

He et al. (2012) report isoprenoidal and bacterial glycerol dialkyl glycerol tetraethers (GDGTs) from the Tibetan hot springs with efforts to investigate the distribution of archaeal lipids among different hot springs in Tibet. Tibet hosts one of the most active geothermal areas in the world and possesses many hot springs with many environmental gradients (Hu et al., 2003). GDGTs are molecular biomarkers and have been used for producing biogeochemical and ecological proxies in the natural environments. As the first report that describes the distribution of GDGTs in Tibetan hot springs, this study is of great interest to researchers in similar fields.

4. Geomicrobiology in cold seep sediments of South China Sea

Zhang et al. (2012) report microbial diversity on cold seep sediments from the Northern South China Sea (SCS). Cold seep
sediments represent one of the most extreme marine conditions and offer robust opportunities to discover the interactions between macroorganisms/microbes and geochemical processes and are thought to be related to gas hydrates. The SCS is one of the marginal seas around the Pacific Ocean. Tectonically, it is a passive margin setting grading into the SCS Basin and it abuts on the accretionary wedge formed off-shore with the south-western Taiwan Island. During the past decades, a number of geophysical and geological cruises were performed in this area and showed the presence of gas hydrate in this area. Zhang et al. (2012) are the first to examine microbial community composition and its correlation with geochemical conditions in cold seep sediments in the SCS, which is of great importance for understanding the biogeochemical processes in globe cold seep ecosystems.

5. Geomicrobiology in Tibetan cold springs

Li et al. (2012) present the microbial diversity in two cold springs on the Qinghai-Tibetan Plateau. Terrestrial cold springs are also part of the extreme environments on the Earth. Although microbial communities have been sporadically studied in terrestrial cold springs at low elevation and high latitude, little is known about the geomicrobiology in Tibetan cold springs. Li et al. (2012) are the first to investigate the geomicrobiology in two cold springs on the Tibetan Plateau, and their results have implications for a better understanding of microbial diversity in cold spring ecosystem.

6. Geomicrobiology in Tibetan Glaciers

Shen et al. (2012) investigate the variation of culturable bacteria along depth in the East Rongbuk ice core, Mt. Everest. Mountain glaciers are widespread in Tibetan Plateau, and they are used for paleoclimatic reconstruction. Similar to geochemical proxies, microbial records in ice cores are also of significant to scientists who are interested in microbial response to climatic and environmental changes in glaciers.

7. Geomicrobiology near and around the Three Gorges Dam (TGD)

Wang et al. (2012) present the diversity of microbial plankton across the Three Gorges Dam of the Yangtze River, China. The TGD built in the middle reach of the Yangtze River, ~1800 km upstream from the Yangtze River estuary, is one of the largest irrigation and hydroelectric engineering projects in the world (Huang, 2001). Many previous studies have demonstrated how the TGD affects flora and macrophyte in the Yangtze River ecosystem; however, little is known about how the TGD influence microbial communities near and around the TGD in the Yangtze River. Wang et al. (2012) bridge this knowledge gap, and their results are of great significance to our understanding of microbial responses to environmental changes in river ecosystems affected by man-made dam construction.

8. Isotopic difference between ectomycorrhizal and saprophytic fungi

Ectomycorrhizal and saprophytic fungi are two important players controlling nutrition cycling in forest ecosystems (Hou et al., 2012). Hou and colleagues report the use of carbon and nitrogen isotopic compositions to distinguish between ectomycorrhizal and saprophytic fungi, which is necessary to evaluate the nutrition cycling in forest ecosystems.

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References


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