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Introduction

Frank Reith Memorial Issue

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This special issue is dedicated to the work and memory of Prof Frank Reith – The Man with the Golden Bug. Frank was dedicated to his work, where he could identify relationships that were invisible to the naked eye – between microorganisms and gold. However, these precious relationships were not the only ones that he cultivated along the way. Frank's work led him around the world, where each new collaborator quickly became a friend. Many of these collaborators join to put this memorial issue together to honour Frank as a scientist, mentor, and friend.

The first article in this series is an obituary to Frank written by Allan Pring, Joël Brugger and Jeremiah Shuster. They provide an overview of Frank's life and career, together with many action shots of geomicrobiological fieldwork and the loved ones who shared that time with Frank, including his much-loved wife, Tina. Frank's work revolved around metals in the environment, and as a tribute, the rest of the articles dedicated to him in this special issue concern many aspects of Frank's broader research interests.

The article "The formation of alluvial platinum-group minerals: present knowledge and the way ahead" was written by John Bowles and Saioa Suárez. This article discusses the controversy of alluvial platinum-group minerals (PGM) and insight into mechanisms for supergene PGM growth. The authors present very interesting photographs of PGM mining operations as well as back-scatter electron images of PGM. These images of the PGM exhibit an extraordinary range of textures, with some displaying bacterial biofilms covering the PGM.

Next, Anuhai Lu, Feifei Liu, Yuwei Liu, Huan Ye, Ziyi Zhuang, Yanzhand Li, Hongrui Ding and Changqiu Wang contributed, "The photogeochemical cycle of Mn on Earth's surface". Here, the authors review the evolution, abundance and speciation of manganese minerals on the Earth's surface, as well as an overview of the implications these minerals have on the photochemical reactions important for photooxidation processes through geological time. Figure 11 brings everything together in a great conceptual model showing Mn redox chemistry over the history of the Earth.

Erik Melchiorre, Robert Evans, Kathryn VonSydow and Bryan Seymour wrote the article, "The geochemistry of gold assayers' ingots from the *SS Central America* shipwreck: a geoarchaeological window into mid-1800s California assaying". This article sheds light on the culture of miners and assayers involved in the California Gold Rush by examining geochemical signatures in ingots collected from a shipwreck. There are beautiful photos of the recovered gold ingots as well as their geochemical analysis for lead and tin as well as copper and zinc.

The next article, "Biogeochemical formation of metalliferous laminations in surficial environments", was written by Anicia Henne, Dave Craw, Jessica Hamilton, Anat Paz, Gemma Kerr, David Paterson, Jeremiah Shuster and Gordon Southam. This article furthers our understanding of the formation of metal-rich laminated structures in the environments around economic metal deposits and how they are driven by (bio)geochemical processes. This paper showcases many beautiful cross-sections along with X-ray fluorescence (XRF) mapping of elemental distribution within laminated precipitates.

The work by Stuart Mills, Pavel Kartashov, Anthony Kampf, Mike Rumsey, Chi Ma, Chris Stanley, John Spratt, George Rossman and Margarita Novgorodova describes native tungsten derived from gold placers in Russia. Along with beautiful back-scatter electron photomicrographs of the tungsten grains, the authors present electron back-scatter diffraction patterns used to determine the tungsten structure. The authors also describe the occurrence of technogenic tungsten commonly found in precious metal placers.

Marcos Voutsinos, Jillian Banfield and John Moreau studied the phosphorus- and rare earth element (REE)-bearing minerals dissolved from weathering of granites to understand the speciation and mobility of REE and phosphorus as well as the formation of secondary REE- and P-bearing minerals in their work, "Secondary lanthanide phosphate mineralisation during biogeochemical weathering of I-, S-, and A-type granites". This article presents several beautiful scanning electron microscopy images along with in-depth energy dispersive X-ray spectroscopic analysis of the secondary lanthanide and phosphate-bearing minerals.

Jeremiah Shuster, Maria Rea, Bhanu Nidumolu and Anupama Kumar studied how the presence of various gold species in the environment could directly affect fish larvae, "Toxicity assessment of gold ions and gold nanoparticles to golden perch larvae (*Macquaria ambigua*)". They present an interesting figure showing how yolk sack morphology of perch larvae can change with varying concentrations and forms of gold in water.

"An *in situ*, micro-scale investigation of inorganically and organically driven rare-earth remobilisation during weathering" was written by Alexander Kalintsev, Joël Brugger, Barbara Etschmann and Rahul Ram. This work explores how photolith mineralogy can control the fate of REEs during weathering by studying a REE-enriched deposit undergoing rapid uplift to

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study REE liberation. This paper used brilliant XRF and X-ray absorption near edge structure maps to show the migration of REE through microfractures.

The Letter written by Maria Rea, Joël Brugger, Barbara Etschmann, Victor Okrugin, and Jeremiah Shuster, "Gold particles from Kamchatka Krai: A brief look at gold biogeochemical cycling in a unique environment", discusses the characterisation of gold particles and microbial communities associated with those particles, collected from the Yelizovsky District in Russia. They found that the gold particles had rich surface textures and were colonised by a consortia that were dominated by *Gammaproteobacteria*.

Lastly, the article by Santonu Kumar Sanyal and Jeremiah Shuster, "Gold particle geomicrobiology: Using viable bacteria as a model for understanding microbe-mineral interactions" characterises the microbiome occurring on gold grains and found an isolate that could grow at concentrations of gold up to 20 μM. There are some impressive back-scatter electron micrographs in this article of gold particles from the Prophet Mine in Australia.

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