

Life at the fringe: redox conditions around a 1.6 Ga submarine vent

PETER MCGOLDRICK^{1*}, JOSHUA GUILLIAMSE², TOBY DAWBORN³, AND DONNA SATTERTHWAIT⁴

¹CODES ARC Centre of Excellence in Ore Deposits, University of Tasmania, Hobart, Australia, p.mcgoldrick@utas.edu.au
(*presenting author)

²Geological Survey of Western Australia, Perth, Australia, Joshua.Guilliamse@dmp.wa.gov.au

³Teal Exploration & Mining, Chingola, Zambia, toby@tealming.com

⁴School of Earth Sciences, University of Tasmania, donna.satterthwait@utas.edu.au

The supergiant Century sediment-hosted Zn-Pb-Ag deposit formed in an outer shelf setting [1] from a submarine hydrothermal vent system developed on, or very near, the seafloor[2]. The mine sequence comprises variably sulfidic (mainly sphalerite) and sideritic siltstones and carbonaceous shales [1,3]. It is somewhat (~1.5x) thicker than equivalent strata observed in a drill-core (MMG788) 5km to the west, suggesting sub-basin development at the site of ore deposition [3]. Unlike other northern Australia Proterozoic sedex Zn deposits, Century is relatively low in pyrite.

Sideritic siltstones in the mine sequence are characterised by crinkly and wispy carbonaceous, bedding-parallel seams, previously interpreted as stylolites. We have re-interpreted these features as microbialites. Their diversity and abundance in the mine sequence, compared to drill-core MMG788, is consistent with locally abundant biological activity at the site of ore formation.

Major element geochemical data and iron speciation measurements from samples from the mine and MMG788 indicate anoxic (ferruginous, *not* sulfidic) conditions mostly prevailed [3]. This is despite several hundred million tons of biogenically reduced S having been sequestered into the Century deposit.

We will present new Mo, P and organic C data from the mine sequence that speak to locally high primary organic productivity. Organic matter thus produced may have been fuel for biogenic sulfate reduction sufficient to form the Century Zn sulfide orebody.

[1] Andrews *et al.* (1998) *Economic Geology* **93**, 1132-1152.

[2] Feltrin *et al.* (2009) *Computers & Geoscience* **35**, 108-133.

[3] Guilliamse (2010) *Unpub. BSc(Hons) thesis, University of Tasmania* 86pp.

Geologic Storage Mavericks: Insights and Promise from Laboratory and Field Pilot Studies in Flood Basalts

B. PETER MCGRAIL

Pacific Northwest National Laboratory, Richland, Washington, USA, pete.mcgrail@pnnl.gov

Abstract

“Maverick” according to the Merriam-Webster dictionary is defined as “One that refuses to abide by the dictates of or resists adherence to a group.” Hence, “maverick” is apropos for anyone seriously studying flood basalts for sequestration of carbon dioxide. Continental flood basalts represent one of the largest geologic structures on earth but have received comparatively little attention for geologic storage of CO₂. In fact, flood basalts have flow tops that are porous, permeable, and have enormous capacity for storage of CO₂ or other gases of interest. In appropriate geologic settings, interbedded sediment layers and dense low-permeability basalt rock flow interior sections may act as effective containment for injected gases. For CO₂ sequestration purposes, containment is critical so that sufficient residence time is established for mineralization reactions to occur. Initial laboratory experiments conducted nearly a decade ago with scCO₂ showed rapid chemical reaction of CO₂-saturated pore water with basalts to form stable carbonate minerals. However, recent discoveries in laboratory tests with water-saturated supercritical CO₂ show that mineralization reactions occur directly in this phase as well, providing a second and potentially more important mineralization pathway than was previously understood. In fact, in deep geologic settings, mineralization by water-wet scCO₂ is the dominant mineralization pathway. But, despite many years of laboratory investigation, the remarkable 10 fold variability in reactivity of different basalts remains an unresolved scientific question, defying easy correlation to mineral makeup or chemical compositional differences in the basalts.

In this paper, we will also discuss an important leveraging application of the work on CO₂ sequestration in basalts for compressed air energy storage to help manage electric grid stability in the Pacific Northwest. Here, mineralization reactions need to be avoided to prevent reservoir permeability decline over the course of many air injection and extraction cycles. Oxygen depletion through reaction with Fe(II) in the basalts also might need mitigation if the extracted air is to be used directly in a combustion turbine.

Field testing of CO₂ storage in basalts is proceeding with drilling of the world’s first supercritical CO₂ injection well in flood basalt being completed in May 2009 near the township of Wallula in Washington State and corresponding CO₂ injection permit granted by the State of Washington in March 2011. Injection is in the final planning stage. In Iceland, the CARBIFIX project has drilled an injection well and several monitoring wells and plans to test injection of groundwater saturated with a CO₂-H₂S gas mixture obtained from a geothermal power plant. If proven viable by these field tests and others that are in progress or being planned, major flood basalts in the U.S., India, and perhaps Australia would provide additional CO₂ storage capacity and regional sequestration options in these countries where conventional storage is limited, and also provide tangible benefits for future applications in energy transmission and storage.