

Metal Enrichment and Evolution of Zn-Pb-Fe Sulfides in Grieves Siding Peat, Western Tasmania, Australia

Richelle Awid-Pascual,^{1*} Vadim Kamenetsky,¹ Karsten Goemann,² Neil Allen,³
Taryn L Noble,¹ Bernd G Lottermoser,⁴ and Thomas Rodemann²

¹ARC Centre of Excellence in Ore Deposits (CODES), School of Physical Sciences,
University of Tasmania, Hobart, Tasmania 7001, Australia

²Central Science Laboratory, University of Tasmania, Hobart, Tasmania 7001
³14 Station Lane, Exton, Tasmania, Australia

⁴Camborne School of Mines, University of Exeter, Penryn Campus, Penryn,
Cornwall, TR10 9FE, UK

*E-mail, rpascual@uts.edu.au

The Grieves Siding prospect, part of the Pb-Zn metallogenic province in western Tasmania, Australia is characterized by two distinct zinc-rich profiles, the metalliferous peat overlying the Ordovician Gordon Limestone-hosted Irish-style carbonate Pb-Zn mineralization represented by sphalerite, minor galena and other zinc bearing oxides, silicates and carbonates. The mantling peat has been one of the significant exploration targets in the area owing to its exceptional Zn content estimated to form a JORC-compliant Inferred Resource of 409,000 tons at 3.9% Zn. Understanding the geochemistry and mineralogy of the Grieves Siding peat with its fluctuating redox conditions, changing pore water chemistry as well as the prevalence of organics and complex microbiology, provides a unique chance to gain insights on the occurrences, reactivity, and stability of the metals therein.

Geochemical analysis of the peat revealed Zn content reaching up to 27.20 wt. %; Pb up to 3.78 wt. %; Fe up to 2.56 wt. % and numerous trace elements. Pb isotope analysis of galena indicated that the Pb, Zn, and other metals are derived from the Cambrian volcanics and sediments, in addition to the Ordovician carbonates. Examination utilizing X-ray diffraction (XRD), scanning electron microscopy (SEM) and Raman spectroscopy identified mineral assemblages consisting of sulfides, silicates, sulfates, oxides, carbonates, and phosphates that are categorized as (i) detrital minerals supplied by the contiguous rocks, and (ii) authigenic phases that are precipitated in situ, including the predominant Zn-Pb-Fe bearing phases. Detrital minerals are characterized by weathering-related morphologies (e.g. round, smooth surfaces and angular edges and dissolution pits), whereas authigenic phases are recognized by their delicate micro-particle textures (e.g. bladed, framboidal and botryoidal textures). Zinc-bearing phases are represented by botryoidal Zn-S-O-Al-Si, sphalerite, wurtzite, baileychlore, Zn-rich aluminosilicate and Fe-Zn-Pb carbonate. Authigenic Pb- and Fe-bearing phases are also present in the peat such as galena, anglesite, plumbojarosite, magnetite and pyrite. An evolutionary pathway of authigenic sulfides has been established suggesting that the non-stoichiometric botryoidal Zn-S-O-Al-Si is a precursor to the stoichiometric mineral sphalerite. Stages of pyrite formation, where massive polycrystalline pyrite is produced via disseminated and framboidal pyrite, have also been hypothesized in this study.

Our investigation clearly demonstrates the capacity of the peat to be an effective repository for metals, in this case, in the form of biogenic and diverse authigenic assemblages that do not represent an equilibrium sequence of mineral phases. This research presents an opportunity for a peat deposit, under favorable conditions, to upgrade into a viable host to ore mineralization.