# ABSTRACT

At the Mount Torrens prospect, minor Pb-Zn-Ag mineralisation in calc-silicate rocks occurs at the base of the Talisker Calc-siltstone. The sulfides (typically pyrite, galena and sphalerite) vary from disseminated (barren) to massive (mineralised) pods comprising 50-70% pyrite, 10-25% galena, and 5-10% sphalerite. Reverse circulation and diamond drilling by CRAE Pty Ltd outlined an inferred resource of 0.7 Mt ore at 6.4% Pb, 1.6% Zn and 41 ppm Ag.

The Talisker Calc-siltstone (including the Nairne Pyrite Member) is underlain by sandstones of the Backstairs Passage Formation and overlain by metasedimentary units of the Tapanappa Formation. The Tapanappa sequences have weathered to produce ferruginous saprolite, which forms low rolling hills in the central part of the area investigated. Weathering of the sulfides has produced gossans, characterised by the occurrence of goethite, hematite, kaolinite, cerussite, barite, jarosite, plumbogummite, plumbojarosite, gorceixite, iodargyrite and native gold.

In fresh rock, the mineralised zones are anomalous in Pb, Zn, Ag, Ca, Mn, Na, As, Cd, In, Mo, Sb, Te and Tl, but are relatively depleted in Ti, REE, V and Zr. Compared to the gossans, fresh sulfides contain more Ca, Mn, Cd, S and Zn (which are strongly leached during weathering), and less Cu, Se, U and W. Ferruginous saprolite along the mineralised zone generally has greater concentrations of As, Cu, Mo, Pb and Tl than that lateral to the mineralised horizon.

Acid sulfate soils in seeps have developed in rising saline groundwater tables and are expanding in response to land clearing. Potential acid sulfate soils (PASS) consist of black sulfidic materials (pyritic, waterlogged mud) and are stable under reducing conditions. However, when they are exposed to air by drainage, they become strongly acidic ($pH<4$), liberating sulfuric acid, and are termed actual acid sulfate soils (ASS) with sulfuric horizons. The acidic solutions dissolve clay minerals and oxidise Fe sulfides to produce white (hydrated Al oxyhydroxide) and brownish orange Fe oxide (ferrihydrite, goethite and schwertmannite) precipitates, which have high sorptive capacities for trace elements (e.g., As). Bright yellow mottles with plumbojarosite have been recorded in acid sulfate soils where these overlie mineralisation. These seep materials, together with the gossans, ferruginous saprolite and saprolite, were studied to determine whether they have potential as mineral exploration sampling media for base-metal mineralisation.

The Fe- and Al-rich precipitates (gels) locally contain significant concentrations of As, Ba, Cd, P, Pb, Sn and Zn. Black sulfidic materials locally contain anomalous As, Ba, Bi, Cd, Cu, P, Pb, Sn, Tl and Zn, but it is possible that some of these elements may have accumulated through mechanical dispersion from the gossans. These sulfidic materials and associated iron oxide precipitates thus are a geochemical sampling medium for the detection of mineral deposits, particularly where mineralisation is blind.

The black sulfidic materials contain secondary framboidal pyrite. Bright yellow mottles containing plumbojarosite ($PbFe_6(SO_4)_4(OH)_{12}$) and plumbogummite ($PbAl_3(PO_4)_2(OH)_5.H_2O$) occur in the sulfuric horizons, which have developed from the oxidation of the black sulfidic materials. These minerals are absent in similar materials lateral to the mineralised zone. Plumbojarosite and plumbogummite are associated with goethite, jarosite, quartz, clays, mica and detrital monazite.

Sulfuric horizons with secondary Pb minerals are characterised by greater Bi, Cd, Cu, In, Mo, Pb, Tl and Zn concentrations than those lateral to the mineralised zone and reflect the dispersion halo around it. At the prospect scale, a geochemical dispersion halo up to 750 m in width occurs around the mineralisation and is defined by anomalous concentrations of As, Ba, Bi, Cd, Cu, P, Pb, Sn, Tl and Zn in Fe oxide gels and black sulfidic materials.

A mechanistic model, developed to explain the formation of these sulfidic materials, involves saline groundwaters enriched in sulfate (with elements such as Pb and Zn sourced from the mineralised zone) seeping up through soils, concentrating by evaporation and forming various precipitates. The combination of rising saline sulfate-rich groundwaters, anaerobic conditions associated with saturated soils and organic carbon in soils yielded pyrite-enriched or sulfidic material through anaerobic bacterial reduction of sulfate. Weak and/or incipient oxidation of the sulfidic materials has produced minerals such as jarosite and plumbojarosite in sulfuric horizons overlying mineralisation.

These sulfidic materials, sulfuric horizons and surface Fe-rich precipitates constitute a new sampling medium for mineral exploration and provide broader dispersion haloes around mineralisation than conventional sample types. In addition, sulfidic materials and sulfuric horizons in seeps may be used to locate blind mineralisation in areas of cover.