Voluminous, Submarine, Intracaldera Pumice Breccia Generated by Explosive Eruptions; the Cambrian Mount Black and Kershaw Pumice Formations, Western Tasmania

C C Gifkins (Centre for Ore Deposit Research, University of Tasmania, GPO Box 252-79, Hobart, Tasmania, Australia 7001; ph. 61 3 6226 2481; fax 61 3 6226 7662; e-mail: cgifkins@utas.edu.au); R L Allen (Volcanic Resources Limited, Guldgatan 11, S-936 32 Boliden, Sweden; ph. & fax 46 (0) 910 581122; e-mail: rodallen@pop.algonet.se)

The Middle Cambrian Mount Black and Kershaw Pumice Formations are interpreted to be an intracaldera association related to explosive eruptions in a large submarine calc-alkaline felsic volcanic complex. The complex includes widespread syn-volcanic pumice-rich facies and compositionally related lavas, domes and syn-volcanic intrusions. The presence of sparse laminated, pyritic black mudstone, abundant hyaloclastite, turbidites, other mass-flow-emplaced volcaniclastic facies and associated VHMS mineralisation are interpreted to indicate deposition of the Mount Black and Kershaw Pumice Formations in a submarine, below-wave-base environment.

The Mount Black Formation is a laterally extensive (>20 km), thick succession (>1.6 km) of mainly feldspar-phyric massive, flow-banded and autobrecciated lavas, domes, cryptodomes and syn-volcanic sills. Rare water-settled tuffaceous mudstone and mass-flow-emplaced crystal-rich sandstone are also present. Pumice-breccia units of the Kershaw Pumice Formation conformably overlie the Mount Black Formation.

The Kershaw Pumice Formation is a laterally extensive (>16 km), thick (>800 m) succession dominated by non-welded pumice breccia, pumice-rich sandstone and shard-rich siltstone, with lesser proportions of pumice-lithic clast-rich breccia and sandstone, massive, flow-banded and brecciated rhyolitic and dacitic lavas and intrusions.

The pumice breccia occurs in thick (up to 100 m) beds with sharp basal contacts. Single beds have crystal and lithic clast-rich bases that grade up through a pumice clast-rich middle section to a normally graded or stratified pumice-rich sandstone or shard-rich siltstone top. The pumice breccia facies is moderately sorted and clast-supported. It is composed of plagioclase-phyric, tube pumice clasts (70-90%, 0.1-15 cm), plagioclase crystals and crystal fragments (5-20%, 1-2 mm), bubble-wall shards (3-20%, <0.2 mm) and sparse non-vesicular volcanic lithic clasts (1-5%, <10 cm).

Pumice-rich sandstone beds (up to 2 m thick) have sharp basal contacts, are massive, graded or diffusely stratified and are texturally identical to the finely stratified tops of the beds of the pumice breccia facies. The pumice-rich sandstone facies is well sorted, clast-supported and comprises tube pumice clasts (50-60%, 0.5-3 mm), bubble-wall shards (30%, 0.2 mm), plagioclase crystal fragments (10-20%, 1 mm) and fiamme (3-5 mm) in a matrix of feldspar-quartz-sericite.

The shard-rich siltstone facies is laminated and interbedded with pumice-rich sandstone. Laminations are diffuse to distinct, planar and internally graded. Convolute folds, slumps, syn-depositional faults, cross laminae and local scours infilled by pumice-rich sandstone are common. This facies is well sorted and comprises bubble-wall and platy shards (80%, <0.5 mm), feldspar crystal fragments (10-20%, 0.1-0.3 mm) and sparse fiamme (<1 mm) in a matrix of sericite, quartz and feldspar.

The pumice-rich facies association is essentially composed of juvenile pyroclasts that were produced by an explosive felsic eruption. The thickness (>800 m) and extent (>16 by 3 km) of this association indicate a large-volume eruption or eruptions (>24 km3). The uniform composition, great thickness and lack of other intercalated facies suggest that these are proximal facies that were deposited rapidly onto the seafloor, most likely synchronous with a major pyroclastic eruption. Furthermore, the proximal facies characteristics, below wave-base environment of deposition, and lack of reworking suggest that the pumice-rich facies association was erupted from a submarine vent. The volume and thickness of the pumice-rich facies association and syn-depositional faults in the Kershaw Pumice Formation are consistent with an intracaldera setting, although the original margins of the caldera have not been located. This felsic caldera complex was initially dominated by effusive eruptions that produced a thick succession of rhyolitic and dacitic lavas and domes (Mount Black Formation). Dominantly effusive eruptions were followed by large explosive eruptions that produced thick ignimbrite-like pumice-rich units (Kershaw Pumice Formation). Eruption may have been accompanied by caldera subsidence, leading to a very thick intracaldera section. Hot pumice clasts would have initially been buoyant in the water column, however rapid quenching, ingestion of seawater and condensation of gases within the vesicles would have caused clasts to sink. Deposition may have originally been by a combination of water-settled fall and water-supported mass-flows of water logged pumice clasts. Subsequently pumice clasts and ash, which had remained buoyant, settled from suspension.

Following the caldera-forming explosive eruptions, rhyolitic and dacitic lavas, domes and syn-volcanic intrusions were emplaced at the top of the Kershaw Pumice Formation. During this stage, syn-eruptive pumice-lithic clast-rich facies derived from fault scarp collapse, resedimentation of autoclastic facies or dome-related explosions were deposited onto the caldera floor. Significant hydrothermal alteration and mineralisation are interpreted to have commenced during this final stage.