HERCULES AND SOUTH HERCULES Zn-Pb-Cu-Ag-Au DEPOSITS, WESTERN TASMANIA

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LOCATION

The Hercules and South Hercules deposits are located approximately 7 km S of Rosebery at 41°51'S, 145°31'E (Figure 1); Queenstown 1:250 000 sheet (SK 55-5).

DISCOVERY HISTORY

Following the discovery of alluvial gold in the Ring River in 1891, A. E. Conliffe, a prospector, traced the dispersion to a gossan on the flanks of Mt Hamilton (Hills, 1915). This gossan was on what is now known as the L - N lodes of the Hercules orebody (Figure 2). Base metal mineralization was discovered in 1894 by J. Will who located a 25 mm band of gossan that thickened to 0.6 m and assayed 660 g/t Au, 1.09% Ag and 60% Pb. This gossan passed into massive Pb-Ag-Au-bearing sulphides. Subsequently, other outcrops were prospected and the A, B and C lodes were identified; the largest, E lode, was discovered in 1908.

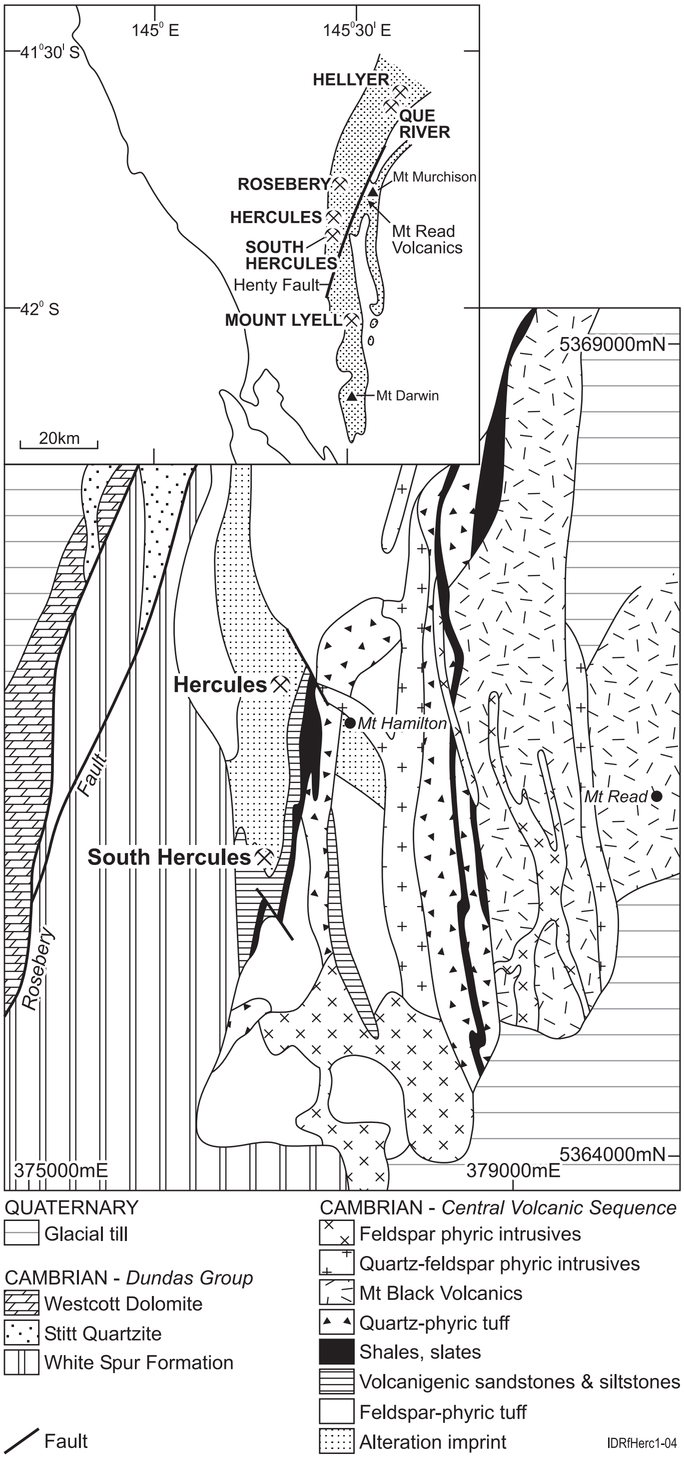

Figure 1. Location of the Hercules – South Hercules deposits in the Mt Read Volcanics, Western Tasmania (after Lees, 1987).

The South Hercules Deposit (250 m S of N lode at Hercules) was found in the 1890's. The Williams shaft contained base and precious metal mineralization. There was no further serious exploration, apart from five diamond drill holes, until 1972 when a Turair survey focused interest in the area. IP and Hg soil anomalies led to the drilling of 21 diamond drill holes in 1973. This discovered the buried South Hercules precious-metal lens. When precious metal prices increased in the 1980's the deposit was finally thoroughly explored by drilling.

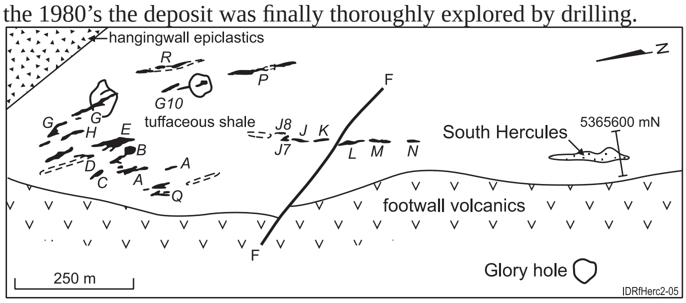

Figure 2. Hercules – South Hercules Ore Zone – 4 Level (showing location of cross section 5 365 600 mN, Figure 5). The Hercules deposit consists of ore lenses A-N.

PHYSICAL ENVIRONMENT

The area has high relief, with a plateau gently sloping westward from Mt Read (1124 m) to Mt Hamilton (1006 m; Figure 1). The Hercules deposit occurs on its western slope (Figure 3). A drainage divide also runs SW from the Hercules area (Figures 1 and 3). On the NW side of this divide, the terrain slopes precipitously into the valleys of Baker Creek and the Ring River. A moraine, just N of Williamsford, forms a low connecting divide between Mt Hamilton and Colebrook Hill. The triangular plateau to the E of Hercules and South Hercules forms the

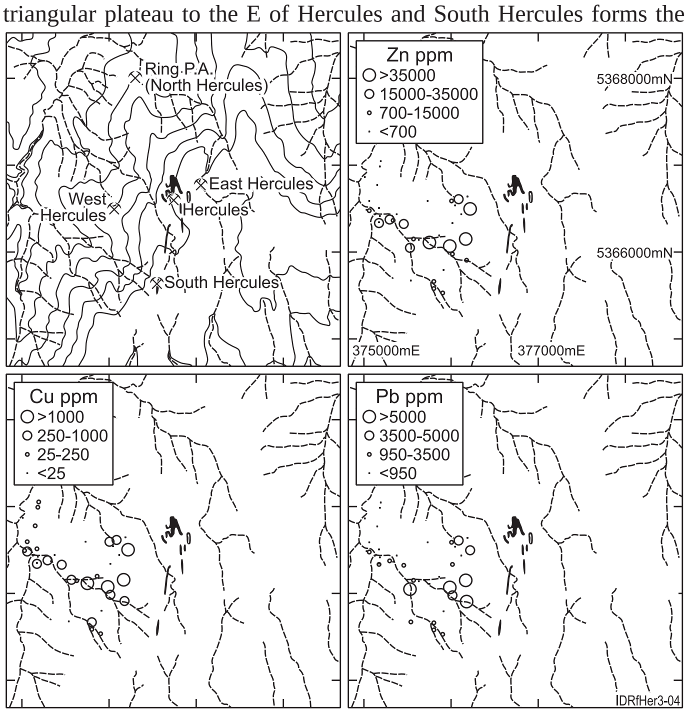

Figure 3. Drainage and mineralization with stream sediment sampling (<180 μm) for Zn, Cu and Pb.

centre of three drainage patterns – the Henty River system to the SE, the Ring River to the W and the Pieman River system to the N. The rivers and creeks of the area all flow in steep-sided valleys and gorges, falling as much as 500 m in 1000 m, and have numerous rapids and waterfalls (Figure 3).

The climate at Hercules is cool, ranging from 0°C during winter to approximately 18°C during summer and with an average annual precipitation of 3000 mm. The topography is very steep and alpine species dominate at the highest altitudes. The mine area is dominated by sub-alpine sclerophyll scrub. At lower altitudes, temperate rainforest is dominant with myrtle and sassafras common (Ackerman and Barrell, 1992). However, vegetation in the Mt Hamilton area is sparse, mainly due to logging for firewood and mining timbers. This clearing of vegetation, high rainfall and steep slopes has caused rapid erosion of the skeletal organic soils, leaving only clay or bedrock in many areas. However, there are dense patches of stunted King Billy pine, celery-top pine and pandani vegetation.

GEOLOGICAL SETTING

The Hercules and South Hercules Zn-Pb-Cu-Ag-Au deposits are S of the Rosebery Zn-Pb-Cu-Ag-Au deposit, but in the same stratigraphic setting. Together, these deposits form a Zn-rich volcanic-hosted massive sulphide (VHMS) district within the Cambrian Mt Read Volcanics on the W coast of Tasmania (Figure 1, inset). The Hercules deposit lies on the eastern limb of a N-trending anticline. It straddles the contact of a >500 m thick, regionally extensive, feldspar porphyritic unit (Rosebery – Hercules Footwall Volcaniclastics; Central Volcanic Complex), and an overlying interbedded black slate and volcanic sandstone unit up to 50 m thick (Hanging Wall Black Slate). The black slates are overlain conformably by approximately 50 m of quartz- and feldspar-rich sandstone of the White Spur Formation. The stratigraphy at South Hercules is very similar to that for Hercules, except that the hanging wall quartz-feldspar sandstone occurs higher in the hanging wall (Lees *et al*., 1990; Hunns, 1991).

REGOLITH

The Cambrian Mt Read Volcanics are overlain by shallow (<500 mm), acidic, nutrient-poor, siliceous soils. The dominant volcanic rocks weather to gravelly, yellow-brown, gradational soils, whereas dark grey soils tend to develop on mudstone and slate. These soils are overlain by a mantle of peat that develops over a variety of rock types in this cool, wet environment (Johnston, 1988). The peat, which can rapidly absorb and retain large quantities of water, is resistant to erosion. However, once the peat layer is lost, through disturbance or fire, it is not readily re-established and the underlying substrate is easily eroded. Once disturbed, localized glacial till deposits are also readily eroded.

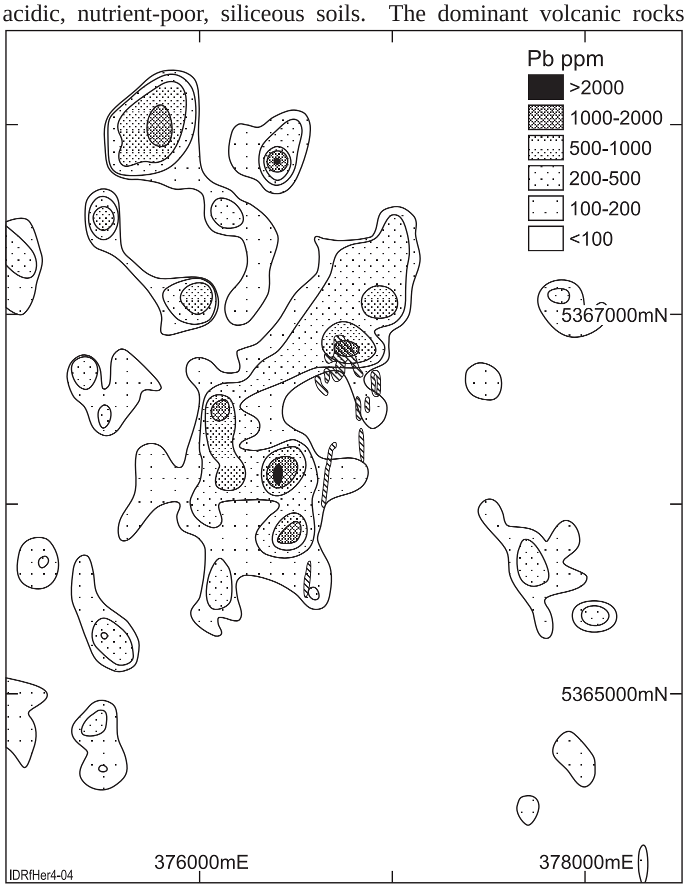

Figure 4. Hercules District, Conventional Soil Sampling (1:25 000) with Pb results on the Rosebery Mine Lease ML28M/93. The ore lenses of the Hercules deposit are shown as hatched.

MINERALIZATION

The Hercules deposit consists of a series of small E dipping (70-80°) lenses (designated A lode, B lode *etc.*), about 100 x 100 m by 5-10 m thick. Most ore lenses are zoned, with mineralization grading from sphalerite-galena-pyrite to pyrite and stringer chalcopyrite down-dip. The ore lenses are grossly stratabound, with only minor truly stratiform sulphides (Lees, 1987). The ore lenses have their long axes parallel to a strongly developed N-trending cleavage within the host and footwall rocks. Geologically, South Hercules is a continuation of the Hercules mineralization, occurring as a lenticular body 1 km along strike from the main Hercules ore lenses (Figure 2). The South Hercules ore zone is mainly sub-parallel to bedding (Allen, 1991).

The Hercules mineralization has an extensive (footwall) alteration system of chloritized and pyritized pumice (Lees *et al.*, 1990) and consists of pyrite, sphalerite, galena, electrum, tetrahedrite and chalcopyrite. Historical production and remaining reserves at Hercules total 2.57 Mt at 16.7% Zn, 5.2% Pb, 0.42% Cu, 160 g/t Ag and 2.7 g/t Au. South Hercules has a resource of 0.71 Mt at 3.5% Zn, 1.9% Pb, 0.11% Cu, 150 g/t Ag and 2.7 g/t Au. The Hercules mine closed in 1999 after operating discontinuously for a century.

REGOLITH EXPRESSION

Bedrock

Host rocks at surface contain a multi-element (Zn-Pb-Ba-As-Sb) geochemical anomaly that forms a 600 m NE-trending zone with >20 ppb Au. This encloses most of the known deposits and prospects in the Hercules area (Aung Pwa and van Moort, 1996). This zone is generally superimposed on a NE-trending geochemical halo of low Na/K and Sr/Rb ratios in the footwall and high ratios in the hanging wall (Lees, 1987). The surficial rocks of the Hercules – South Hercules area are also relatively enriched in Si, Mg, Mn, Nb, Ba and Y and depleted in Al, Ti, Fe, K, P, Si and Zr (Follington, 1991). There is a sharp decrease in Cu, Pb, Zn, Mn, Ca, Hg and CO_2 across the contact from the host rocks to the hanging wall massive pyroclastics (Fitzgerald, 1974; Lees, 1987).

Soil

The high degree of alteration in the footwall and host sequence through to the White Spur Formation is accompanied by a major A, B and C horizon soil anomaly along the strike of mineralization in Cu, Pb and Zn. There is anomalous Au, Ag and Ba over the South Hercules deposit. Mercury in the soil was investigated in the 1970s and found to be anomalous above known zones of mineralization (Throop, 1973). However, Fitzgerald (1974) found that Hg closely corresponded with Zn over the host, footwall and hanging wall rocks, indicating that Zn might be a more direct and a less expensive indicator element. Directly over the G and R lodes, Zn and Pb in soil can exceed 0.1% (Figure 4). Maxima for Zn and Pb over South Hercules are similar but there is significantly less, although anomalous, Cu (200 ppm).

Around the South Hercules deposit, the A and C soil horizons are poorly developed. Thus, Basford and Murphy (1997) sampled the 0.1-0.3 m soil interval using Regoleach and MMI digestions and compared these with total analyses (AAS/XRF) using different soil fractions. Both the MMI and total soil analyses gave a large multi-element anomaly over the South Hercules mineralization (Figure 5). The size of the anomaly from total soil analysis was significantly less than the anomaly from MMI data. The MMI data showed anomalous Zn, Pb, Cu, Au, Ag, Cd and Pd. Depletion in Ni and Co defined the host sequence at surface. However, there was no anomaly over the blind massive sulphides down-dip along the host sequence. There were no significant anomalies from Regoleach.

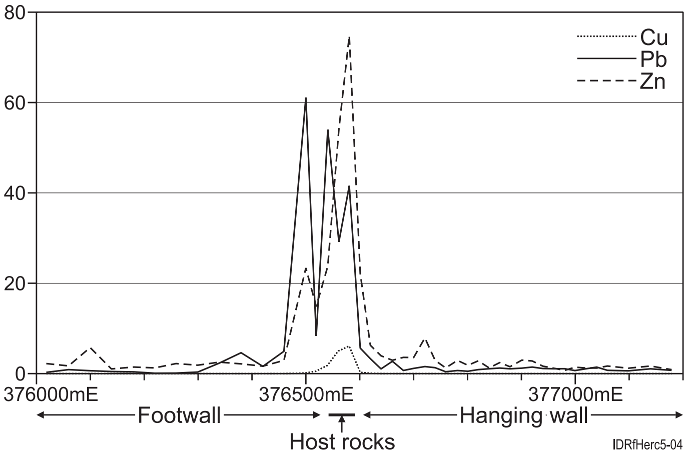

Figure 5. South Hercules MMI Soil Sampling 5 365 600 mN, showing Cu-Pb-Zn anomalies over the host sequence.

There is a prominent multi-element anomaly in soil, litter and stream sediments extending from the host sequence to an area known as West Hercules. West Hercules is located in a region where the topography slopes steeply to the WSW of Hercules, with generally westerly drainage from the host sequence to the highly altered footwall. There are two possible geochemically anomalous populations, one related to underlying footwall alteration and the other as a contamination overprint from the Hercules mine. A strongly displaced hydromorphic anomaly has formed in the soils on the steep terrains at West Hercules, by down-slope seepage of groundwater from the Hercules host rocks. Groundwater, rich in trace elements, precipitatates elements under different conditions. The main controlling factor at West Hercules appears to be precipitation of Fe oxides where clay accumulates at a break in the slope and where groundwater reaches the surface (Russell and van Moort, 1981). The clays developed on the shales have fixed this contamination from up slope. Marshall (1979) suggested that the change in soil from lithosols, on the upper slopes, to a deeper, mature, residual soil, on the lower slopes, acted as a trap for base metals travelling in solution from the Hercules mineralization. East of this zone, the thin, skeletal, stony soils were permeable. However, biogeochemical recycling has accumulated anomalous Pb and As on the upper slopes in the leaf litter. The change in gradient coincides with the start of dense myrtle and sassafras, which is reflected in a change from thin, dry tea tree leaves to thick rain forest leaf mould. There are two anomalies in the litter, i) an upslope anomaly, due to enrichment from solutions developed in the absence of a true soil profile, and ii) a downslope anomaly from biogeochemical cycling from a well-developed B-horizon soil anomaly, related to hydromorphic dispersion from the Hercules mineralization (Marshall, 1979).

Stream sediments

The West Hercules alteration zone is also indicated by a significant multi-element anomaly in the two main streams draining W of the Hercules orebody with anomalies extending up to 1.5 km downstream of the Hercules deposits (Figure 3). There are few anomalies in easterly drainages or from the South Hercules deposit in other streams draining the area.

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SAMPLE MEDIA - SUMMARY TABLE

Sample medium	Indicator elements	Analytical methods	Detection limits (ppm)	Background (ppm)	90th percentile (ppm)	Maximum anomaly (ppm)	Dispersion distance (m)
Fresh rock	Ag	AAS	0.1	1	-	4021	?<10
	As	AAS	1	4	-	203	?<10
	Au	AAS	0.001	0.008	-	103	?<10
	Ba	XRF	10	1230	-	159200	?<10
	Cu	AAS	1	40	-	10600	?<10
	Pb	AAS	3	140	-	126000	?<10
	Zn	XRF	10	280	-	167000	?<10
Saprock at surface	Ag	AAS	0.1	1.5	2.5	2750	-
	As	AAS	1	3	4.55	3650	-
	Au	AAS	0.0001	0.002	0.0025	3010	-
	Ba	XRF	50	1015	1060	53000	-
	Cu	ICP-MS	1	8	95	32100	-
	Pb	ICP-MS	1	20	260	130000	-
	Zn	ICP-MS	1	75	485	293000	-
Soil	Ag[1]	AAS	0.5 - 1	0.5	-	1.27	-
	Au[1]	AAS	?	0.001	-	1.28	-
	Ba[1]	XRF	10	320	-	3030	-
	Cu	AAS	0.5 - 5	3	25	9900	500 - 1000[3]
	Pb	AAS	1	30	161	14000	500 - 1000[3]
	Zn	AAS	0.1 - 5	20	90	7000	500 - 1000[3]
Soil	Au[2]	MMI	0.0025	0.00025	0.00	0.12	-
	Ag[2]	MMI	0.0025	0.001	0.06	2.12	-
	Cd[2]	MMI	0.002	0.03	0.00	0.24	-
	Cu[2]	MMI	0.02	0.03	1.23	6.12	30
	Pb[2]	MMI	0.02	0.6	116.31	61.10	170
	Zn[2]	MMI	0.04	1.1	124.48	74.56	100
Stream sediments	Ag	AAS	0.5	1	2	75	-
	As	AAS	2.5	15	60	400	-
	Au	AAS	0.00005	-	-	0.01	1600[3]
	Cu	AAS	1	10	360	1500	1600[3]
	Pb	AAS	10	50	2100	14000	1600[3]
	Zn	AAS	5	60	7000	170000	1600[3]

[1] South Hercules only

[2] 80 - 200 or <200 mesh (180-75 µm or <75 µm)

[3] Dispersion is predominantly to the west

AAS and ICP-MS analyses after aqua regia digest

Note: The method of analysis is not completely certain for some media.

