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# *A summary of mineral exploration in the Cygnet–Kettering area*

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## **Abstract**

*The Cygnet district produced about 100 kg (3000 oz) of gold by 1902, mostly from Quaternary placers (Twelvetrees, 1908). The gold was derived from mineralised breccias, veins and contact zones of Cretaceous alkaline intrusive rocks in the Permian sediments. Syenite-derived kaolinite has also been mined in the area (near Surges Bay), but the area has really only been explored for gold.*

*Some recent gold exploration by Cyprus Minerals has focussed on the potential for 'Carlin style' and porphyry-hosted gold deposits, (Jones, 1987a, 1988). Limited drilling and geochemistry in the Cygnet–Kettering area failed to delineate a viable gold resource, but indicated that gold and base metals are erratically enriched in shear zones. The best intersection was 17 m at 1 g/t, but grades of up to 24 g/t occur (Jones, 1987a, 1988). The exploration program was terminated before completion. There was also some limited investigation of the rare-earth potential of the intrusive rocks.*

## **GEOLOGY**

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The Cygnet area is underlain by Permo-Triassic sedimentary rocks of the Parmeener Supergroup, which range from mudstone to sandstone and tillite, and are calcareous, carbonaceous and/or pyritic in part (Leaman and Naqvi, 1967; Farmer, 1985). These rocks were intruded by Jurassic dolerite and a suite of Cretaceous alkali igneous rocks; they are gently domed around the Cretaceous epicentres (Mt Mary and Oyster Cove), and are hornfelsed near intrusive contacts (Leaman and Naqvi, 1967; Farmer, 1985). Tertiary and Quaternary sediments are relatively minor, but both probably occur in the deeper valleys.

The Cretaceous intrusive rocks crop out sporadically over an area of about 20–30 km, from near Snug south to Police Point. They are typically medium grained, felsic, quartz-poor and porphyritic, and comprise mostly monzonite and syenite, but compositions include dacite, diorite, phlogopite-pyroxenite and lamprophyre; some may have hybridised with dolerite (Edwards, 1947; Ford, 1983, 1989; Farmer, 1985; Jones, 1986, 1987a). Heterolithic xenoliths, feldspathoids, pyroxenes and garnets and other xenocrysts are locally present, and some anomalous geochemistry may have resulted from the incorporation of mineralised carbonates (Ford, 1989).

## **GEOCHEMISTRY AND GEOPHYSICS**

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The area has been reasonably well covered by regional stream-sediment surveys, regional and detailed rock-chip surveys, and some localised soil surveys (Hourdin, 1971; Croft, 1970, 1970; Wall, 1980, 1981; Jones, 1985, 1986, 1987a, 1987b, 1988). The gold content appears to be low in the stream sediments, probably due to clearing and cultivation, but still delineates anomalies. The stream-sediment sample locations are shown on Figure 1.

Geophysical surveys (regional gravity and ground magnetics) were conducted by Leaman and Naqvi (1967) and Leaman (1975); other limited geophysical surveys were reported by Wall (1980, 1981). A very prominent magnetic anomaly in the Port Cygnet inlet remains unexplained (Leaman and Naqvi, 1967; Leaman, 1975).

## **MINERALISATION**

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The only important metallic mineral produced in the area has been gold, most of which was in Quaternary alluvial sediments in relatively young gullies and valleys. Gold can still be recovered on a small scale. The area also contains significant hard-rock gold mineralisation, but the nature and genesis is not understood. Mines and prospects are shown on Figure 1.

Quartz veins are rare in the area, but Thureau (1881) described a vein of “moderately mineralised quartz” in sandstone near Lymington and another auriferous quartz vein at a porphyry contact at Little Oyster Cove. Smith (1899) also described a variably mineralised quartz vein in porphyry at the Livingstone mine. Scott (1927) noted the presence of erratically gold-bearing, ferruginous quartz veins up to several feet thick, assaying up to 5 oz/ton Au, at the Mt Mary mine. The true nature of these quartz veins is unknown; they may be silicified contact zones.

Twelvetrees (1908) described the ore zone in the Livingstone mine: “The reef here is apparently a contact development... it is the only lode found entirely in porphyry”, and noted it contained arsenopyrite, pyrite, chalcopyrite, sphalerite and galena. It was considered likely to be a favourable gold host. The reef appears to be a narrow (<1 m) zone of sheeted quartz veining.

Smith (1899) described the gold lode at Mt Mary as a fine-grained, hematitic zone in a fragmental volcanic rock or tuff. Smith (1899) and Twelvetrees (1908) noted the presence of visible gold in this red rock, and a high Au content was confirmed by Wall (1981), although the exact nature of the rock is unknown.

Wall (1981) noted that gold mineralisation is also present in the closely related alkaline igneous rocks at Mt Dromedary, NSW. The mineralisation there is present as narrow, late-stage pyrite veins, averaging 1 oz/ton Au, in quartz-diorite (Wall, 1981).

Recent drilling and costeaning in the Cygnet area indicate that the gold appears to be distributed within both the intrusive and contact rocks (Jones, 1986, 1987a). Hydrothermal alteration includes silica, K-feldspar, carbonate, epidote, clay, pyrite and hematite. Anomalous gold was found in ferruginous and fossiliferous Bundella Mudstone; ferruginous and weakly stockworked intrusive syenomonzonite, and brecciated to mylonitised mudstone. Visible gold was only seen in jarosite and limonite-rich zones in a sedimentary breccia (Jones, 1986).

The intrusive rocks contain disseminated and stringer sulphides, including pyrite, chalcopyrite, pyrrhotite, marcasite and chalcocite, with magnetite and hematite (Jones, 1986). Disseminated pyrite is present in the sedimentary rocks, and may be partly syngenetic. Pyrite is also present in rare quartz veins in the sedimentary rocks. Cinnabar was reported by Hine (1979).

Jones (1986) considered the gold mineralisation to be partly of the ‘Carlin-style’, i.e. a carbonate-hosted replacement deposit, and partly of a porphyry-hosted style.

Rare earth elements are anomalous in the intrusive rocks, but little is known regarding their distribution and mineralogy. Wohlerite ( $\text{NaCa}_4(\text{Zr,Nb})\text{Si}_4\text{O}_7(\text{O,OH,F})_2$ ) has been reported in phonolite from Tasmania (presumably the intrusive rocks at Cygnet; Vlasov, 1966) and is probably the Ca-Zr-silicate recorded as an important constituent of heavy minerals near The Neck on Bruny Island (M. Forster, unpublished data).

The nepheline-bearing syenites may have an economic potential for ceramics, etc., but relatively little is known about them in this regard.

Kaolinite of paper-filler quality has been mined from a weathered alkaline intrusive at Surges Bay (Bacon, 1992). There has been little exploration for similar deposits. The kaolinisation may be hydrothermal (P. A. Jones, pers. comm.).

## **EARLY PROSPECTING AND MINING**

Gold was discovered at Cygnet in 1877, and the district had produced about 3000 oz (100 kg) of gold by 1902 (Twelvetrees, 1902, 1908). Production was mostly from Quaternary placers, particularly at Lymington (Forsters Rivulet) and Wheatleys Bay (Riseleys Creek). Other alluvial areas included Nicholls Rivulet, Little Oyster Cove Creek, Petchey's Bay and Agnes Rivulet (Thureau, 1881; Twelvetrees, 1908).

In 1892 some ‘lode gold’ (hard-rock) mining occurred on some of the contact zones between some of the Cretaceous intrusive rocks and the hornfelsed Parmeener sequences. Gold values up to 100 g/t (5 oz/ton) in sediments and 6 g/t in the intrusive rocks were reported, with minor silver and sulphides. Quartz veins were small and uncommon. The major workings were the Mt Mary gold mine and the Livingstone mine (Tobys Hill) with other significant workings on Kings Hill, Black Jack Ridge, Little Oyster Cove and other areas (Smith, 1899; Twelvetrees, 1902, 1908; Henderson, 1936). The total value of this lode gold production is not known, but was probably small.

The Mt Mary or Cygnet gold mine was the largest operation, with ten shafts, one 64 m deep, and drives to 46 m over an area of 450 × 60 m (Scott, 1927; Jones, 1987a). Grades reported were very erratic, but were up to 100 g/t Au and 210 g/t Ag. The mine was worked intermittently from 1898 to 1927, but no production was reported.

Workings at the Livingstone mine (dating from 1898) included a shaft to 20 m and two adits, one to 120 m which apparently failed to reach the reef exposed at the shaft. Grades of 90 g/t Au were reported, but were inconsistent; some 7 tons of ore was extracted, but this only produced about 30 g of gold (Twelvetrees, 1902).

## RECENT EXPLORATION

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### *EL 23/71*

This lease was granted to Quilko Mining Pty Ltd in 1971, and covered the peninsula south and east of Cygnet. Pechiney (Australia) Exploration Pty Ltd undertook regional stream-sediment, soil and rock-chip geochemical surveys, a radiometric survey and miscellaneous geological studies (Hourdin, 1971; Croft, 1970). Weak stream-sediment copper anomalies (<115 ppm) were found near Mt Mary and Glaziers Bay (no gold or silver analyses were undertaken). The soil and rock chips were only analysed qualitatively, but results suggest some weakly anomalous Zr and possibly Ba, Mn, V, Pb, Ni and some other elements. The radiometric survey apparently produced no anomalies; the results are not available. The syenites were analysed for Al; results are not available but were in the range of 15–18% Al<sub>2</sub>O<sub>3</sub>. The heavy minerals and mineralisation of the area were studied and a regional geological map produced.

### *BHP Survey*

BHP conducted a small orientation program on the Cygnet peninsula, mostly over the Mt Mary and Livingstone mines, for porphyry-hosted gold. The surveys included soil and rock-chip sampling, analysis of Ramsay Ford's thesis samples, and petrography (Bottrill, 1995). There appeared to be an association of gold with silver, arsenic, copper, lead, zinc and possibly barium.

### *EL 8/80, ML 1059 and 1060 P/M*

The Golden Apple Mining Syndicate of Cygnet held a lease for gold over the Cygnet peninsula from 1980 to 1982, conducting minor mapping, gridding and geophysical surveys at Tobys Hill, Mt Mary and Black Jack Ridge (Wall, 1980, 1981). Some rock-chip sampling was undertaken; one sample assayed 25 g/t Au. A diamond drill hole at Mt Mary was logged and assayed by both the syndicate and Cyprus Minerals, but the results are poorly recorded, despite reporting 11 m @ 0.23 g/t Au (Bottrill, 1995). The geophysical surveys were localised around Mt Mary, and used magnetics and SP, but appear to be poorly constrained.

Two Mining Lease applications were held by the Golden Apple Mining Syndicate but were later revoked and incorporated into EL36/82. The only work recorded on these leases was some rock-chip assaying (partly on the EL).

### *EL 36/82*

This licence, covering the Cygnet Peninsula, was granted to Amoco Minerals (later Cyprus Minerals) in 1984 and was worked as a joint venture with Poseidon Minerals for three years. The area was subject to exploration for gold by Phil Jones, on behalf of Cyprus Minerals. The lease was abandoned

in 1989, although more work was proposed. The exploration targets were stratabound gold deposits of the Carlin type, and disseminated or stockwork-hosted gold in high-level porphyritic intrusive rocks. Exploration involved regional geochemical surveys, geological mapping, petrography, gridding, costeaning and drilling.

Geochemical exploration involved regional stream-sediment (143), pan concentrate (154), soil (8) and rock-chip (221) sampling surveys. All samples were analysed for gold and some for silver; rock-chip samples were also analysed for As, Cu, Pb and Zn. The regional stream-sediment and pan concentrate results were relatively low (possibly due to dilution from land clearing and cultivation), with the maximum gold values returned being 0.77 g/t in pan concentrates and 0.12 g/t in stream sediments (Jones, 1985).

Regional rock-chip surveys returned up to 24 g/t Au and some minor base metal and As anomalies. Four anomalous areas were delineated, and detailed rock-chip and soil surveys were conducted in these (Black Jack Ridge, Mount Mary, Tobys Hill and Kings Hill) areas, in conjunction with gridding, geological mapping and petrographic studies. The soil and rock-chip samples were analysed for Au, Ag, As, Cu, Pb and Zn (Jones, 1986). Extensive costeaning was undertaken in the Black Jack Ridge, Mount Mary and Tobys Hill areas to follow up soil anomalies in areas of old workings; these were mapped and assayed in detail. Significant results include 50 m @ 0.25 g/t Au (Black Jack Ridge) and 6 m @ 1.54 g/t Au (Mt Mary).

About 1000 m of drilling was undertaken in the Mt Mary (3 diamond, 14 rotary percussion holes), Kings Hill (1 rotary percussion hole) and Black Jack Ridge areas (3 diamond holes), to a maximum depth of 133 metres. These holes were logged and assayed and produced some encouraging results, including 12 m @ 1.06 g/t, 17 m @ 1.0 g/t and 3 m @ 4.1 g/t Au. The gold-bearing zones appear, however, to be erratic and discontinuous (Jones, 1987a, 1988).

The rare-earth potential of the alkaline intrusive rocks was assessed by random rock-chip sampling of some percussion and diamond drill samples in the Mt Mary area. The results are mostly above background (some 700 ppm total REE) but were not considered sufficiently encouraging to warrant additional work (Jones, 1988).

### *EL 23/83*

This licence, covering the Nicholls Rivulet–Oyster Cove–Woodbridge area, was granted to J. Harris in 1985 and later transferred to Poseidon Minerals, subject to a 50/50 joint venture with Cyprus Minerals. The area was subject to some reconnaissance exploration for gold by Phil Jones, on behalf of Cyprus Minerals, in 1986. Only one

report was produced on the work done, although more work was proposed (Jones, 1987b).

The exploration targets were stratabound gold deposits of the Carlin type, and disseminated or stockwork-hosted gold in high level porphyritic intrusive rocks.

Exploration involved regional stream-sediment and pan concentrate sampling surveys, and minor rock-chip sampling (150, 143 and 6 samples respectively). The maximum gold values obtained were 0.05 g/t in stream sediments and 0.21 g/t in pan concentrates; values >0.02 were designated as anomalous. The rock-chip samples were not anomalous. Five areas were designated as worthy of follow up: Little Oyster Cove, Victoria Creek, Constance Rivulet, Gardners Creek and Heeneys Bluff.

No follow up work was reported.

## SUMMARY

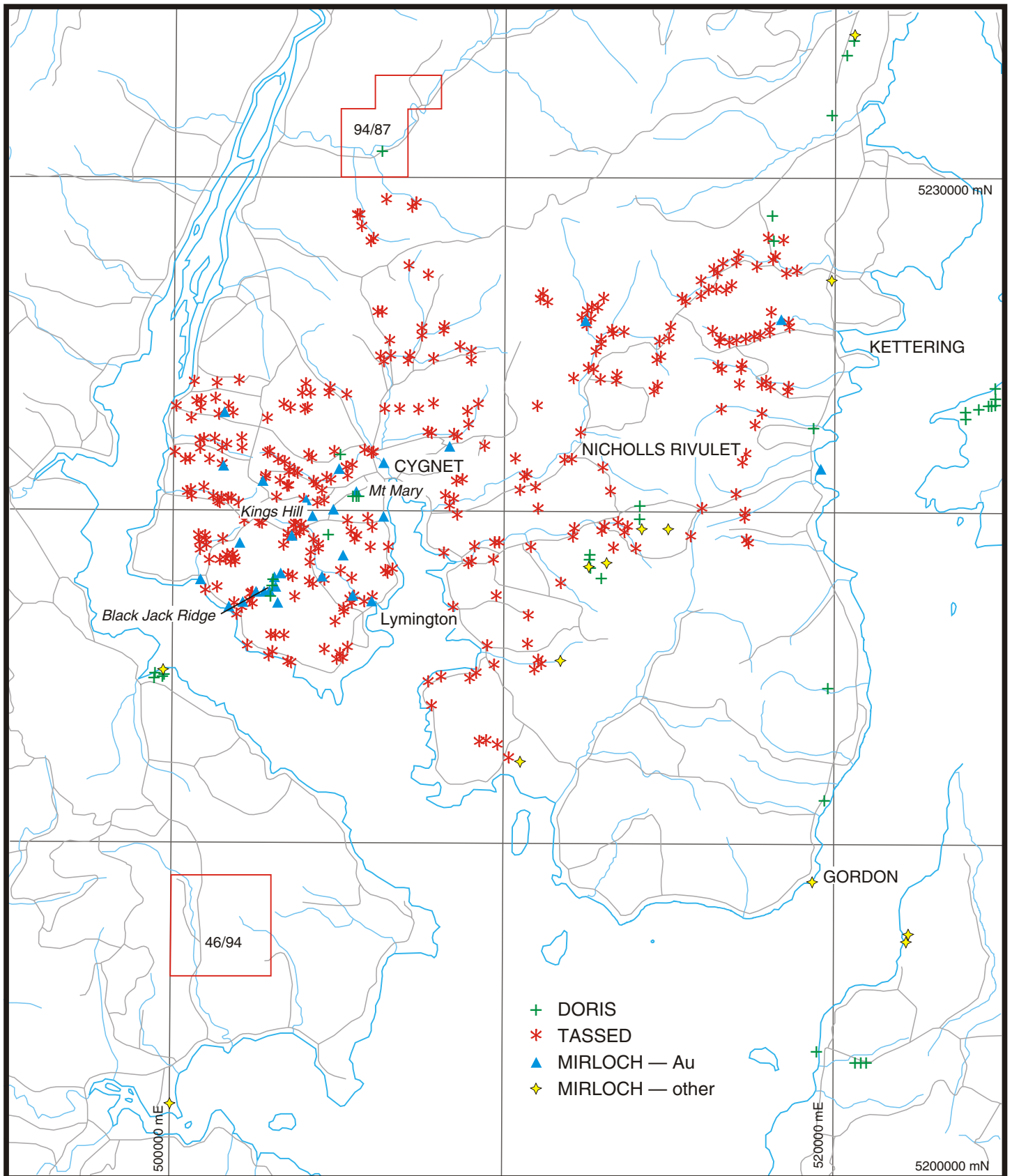
The mineral potential of the area must be considered not fully tested, as the Cyprus Minerals programs were incomplete, and most of the other exploration in the area has been very limited in scope. The best targets appear to be Carlin-style gold mineralisation, and breccia-hosted porphyry gold-copper-silver. The genesis and styles of mineralisation, however, need detailed study.

The potential for economic deposits of industrial minerals (particularly rare earths, kaolinite and nepheline syenite) is significant and is almost untested.

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**Figure 1**

*Location map of Cygnet–Kettering area, showing exploration leases and roads, streams, major prospects, and digital data plotted from Industry Safety and Mines databases DORIS (drill logs), TASSED (stream sediment analyses, exploration company data), and MIRLOCH (mine and mineral deposit locations).*