Round 5 Geophysics and Drilling Collaborations Report

Illogwa (IOCG) Project

Patrick Lyons
Mithril Resources Pty Ltd
58 King William Rd
GOODWOOD SA 5034
+61 8 8378 8200

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Introduction

Mithril Resources’ Illogwa Project area (named after Illogwa Creek) is located about 160 km east-northeast of Alice Springs, Northern Territory. It is contained within three exploration leases (ELs 25643, 25653, 28335) covering 1,692 km², held over portions of the pastoral leases of Loves Creek, Numery, and Indiana. No mineralisation has, yet, been recognised in the portion on Indiana (Figure 1).

The project area occupies a region of rugged hills and strike ridges generally rising 100 m to 200 m from wide valley floors. The valleys contain a mixture of open grassland and scrubby woodland and most parts are accessible by four-wheel drive vehicle.

From Alice Springs, access to Illogwa is via (1) Ross Highway–Numery Road–station tracks, (2) Ross Highway–Arltunga Tourist Drive–station tracks, or (3) Stuart Highway–Plenty Highway–station tracks. The Stuart and Ross Highways are all-weather roads. Advice from authorities and property owners should be sought prior to entry, especially during rainy periods or bushfire season.

Figure 1. Map showing location of Mithril Resources’ exploration leases at Illogwa and principal routes into the project area.

During the course of regional mapping in 2010, geologists from the Northern Territory Geological Survey (NTGS) found granite-hosted hematite- and fluorite-alteration on one of Mithril’s, EL 25643. The modes of occurrence suggested the possibility that there may be an iron oxide-copper-gold (IOCG) minerals system in the region (Whelan et al., 2011). To test this concept, Mithril commissioned a 400 m × 400 m gravity survey and requested that soil samples be taken at each
survey station. Field checking of the location of a sample site that returned anomalous copper led to discovery of a quartz-carbonate-hematite strike-ridge containing minor secondary copper carbonates, primary sulfides, and boxworks, about 4 km north of the hematite-fluorite alteration. A total of eight prospects and occurrences have now been identified, distributed in a belt about 50 km long. Those drilled during this program are shown in Figure 2.

However, despite follow-up mapping and IP surveys, confirmation of the existence of IOCG mineralisation could only be made by obtaining samples of primary mineralisation; thus the need to drill. Mithril successfully applied for funding available in Round 5 of NTGS Drill Collaboration to undertake a small program of diamond drilling to test IP anomalies and geological targets. Drilling confirmed the presence of IOCG mineralisation.

Figure 2. Satellite image showing location of prospects with respect to exploration leases (see Figure 1) drilled during this program: B = Bigglesworth, A = Austin, M = Mini Me. P = Powers is the NTGS discovery site.

Mithril’s activities are conducted from a well-appointed base camp providing accommodation for up to fifteen people. Facilities at the camp include satellite communications (phone and internet), secure storage, core yard, and helipad. When travel to and from base camp was not convenient, activities were conducted from a temporary camp containing powered caravans and satellite communications. This camp is now dismantled. Future programs will be based out of Numery homestead.

Water for drilling and camp-use is supplied from local bores. Drinking water is brought in from Alice Springs.

Mithril has been conducting fieldwork in the region since 2008. The company has excellent relations with pastoralists, whose permission is always sought prior to commencing field work. Pastoralists
have been very co-operative and are most willing to assist Mithril in all aspects of its exploration activities, including maintenance of roads and transporting freight.

The Aboriginal Areas Protection Authority (AAPA) and the Central Lands Council (CLC) have provided necessary heritage clearances.

Regional Context

Geology

Mithril’s Illogwa Project area is situated in part of the geologically complex Arunta Block, within the Illogwa Creek 1:250 000 series map sheet area. It lies just south of the boundary between the Cambro-Ordovician Harts Range Metamorphic Complex, of the Irindina Province in the north, and the Paleoproterozoic Aileron Province in the south (Figure 3). Units of the Neoproterozoic-Carboniferous Amadeus Basin lie above the Proterozoic basement, predominantly in the south, mainly the 850-800 Ma Heavitree Quartzite and Bitter Springs Formation and the Ediacaran–Carboniferous Julie Formation and Arumbera Sandstone.

Figure 3. Map of generalised regional geology showing the location of Illogwa Project area. It lies near the boundary between the Paleoproterozoic Aileron Province and the Cambro-Ordovician Irindina Province (after Geological Regions of the Northern Territory, 2010, published by NTGS).

The Aileron Province comprises variably metamorphosed sedimentary and igneous units preserving a long history of metamorphism and deformation spanning 1865 Ma to 1130 Ma. Sedimentation in the
Amadeus Basin, initially part of the intracratonic Centralian Superbasin, began during the Neoproterozoic, at about 850 Ma, with deposition of marine and fluvial successions, and eruption of minor volcanics. It waned during the Early Carboniferous with deposition of molasses siliciclastics. Protoliths of the Harts Range Metamorphic Complex were bi-modal volcanics, seafloor volcanics, and sedimentary units deposited in a deep pull-apart basin at about 520 Ma. Amphibolite-granulite facies metamorphism took place during the Early Ordovician Larapinta Event.

In the Illogwa Project area, basement consists of para- and ortho-gneisses of the 1770-1750 Ma Albarta Metamorphics and the 1745 Ma Atneequa Suite of granites, both unconformably overlain by abovementioned units of the Amadeus Basin. The Cainozoic Aremra Basin and Quaternary cover dominate areas lacking basement outcrop (Figure 4).

Figure 4. Outline of project area and principal prospects (as per Figure 2) shown on 1:250,000 scale geological series Illogwa Creek SF53-15, 1985. Most of the project area is covered by Cainozoic and Quaternary units and (orange and yellow); members of the Amadeus Basin (various browns) dominate in the southern parts; the Atneequa Suite (pink) is common in the west, around Bigglesworth; the Albarta Metamorphics are mostly exposed in the southeast, around Mini Me. A complete geological map, including legend, may be downloaded from https://www.ga.gov.au/products/servlet/controller?event=GEOCATDETAILS&catno=71367.
Because of its long history, the region is structurally complex. It has most likely been affected by at least three (and possibly more than five) major tectonothermal events, from the ~1780-1760 Ma Yambah Event through to the end of the Alice Springs Orogeny at ~350 Ma. Deep seismic reflection data show the region to be part of a south-verging thrust complex with floor-thrusts cutting through the whole of the crust and tapping the mantle (Korsch et al., 2011). These thrusts exerted first-order control on deformation, undergoing multiple reactivations during compressional and extensional events.

A fuller summary of the regional geology of the project area is given in Whelan et al. (2012).

Mineralisation

The eastern Arunta region is considerably underexplored but exhibits high potential for hosting large base metal deposits — as Mithril’s discovery of outcropping copper mineralisation at Basil (26.5 Mt at 0.6% Cu) demonstrates. There are three styles of base metal mineralisation recognised in the crystalline basement of Arunta region: volcanic-associated massive sulfides, replacement or skarn deposits, and possible metamorphosed IOCG deposits (Hussey et al., 2005). This classification hinges on observations from a limited number of small examples. Historically, the Illogwa Project area has been shown to be prospective for stratabound copper and lead in the Bitter Springs Formation and there are some poorly documented and poorly located historical copper occurrences. Mithril’s recent work suggests that these occurrences are part of the quartz-hematite IOCG vein systems.

Regional mapping by NTGS of the Illogwa area has shown its potential for IOCG mineralisation: the presence of fluorite-associated hematite ± iron- and copper-sulfides and potassic and hematitic alteration (including “red rock”), in granites of the Atneequa Suite (Whelan et al., 2011).

The occurrences and prospects found by Mithril Resources exhibit criteria of IOCG minerals systems, and returned up to 7.8 % Cu and 1.4 ppm Au from surface samples. At surface, the copper minerals are mostly secondary carbonates with minor to trace chalcopyrite and possible bornite. The mineralisation is hosted in quartz-hematite±calcite veins varying in width from less than a metre to over 50 m. Strike length of exposed mineralized veins exceeds 1 km in places. Some occurrences are found within a few hundred metres north of ridge-forming quartz veins which, although barren, may have formed during the same event. The host rocks are granites, felsic gneisses, and amphibolites of the Atneequa Suite and Albarta Metamorphics.

The vein-systems carrying mineralisation strike west-northwest, have strike-extents up to 4 km and dip 40° to 60° northerly, with splayds dipping to the west and northwest (Figure 5a). At Austin, the vein-systems are up to 200 m wide, with alteration and brecciation extending up to 500 m from the main veins. At Bigglesworth, one of the vein-systems forms a strike-ridge rising 150 m above the level of the plain (Figure 5b). Here, boxworks after sulfides are abundant, with pyrite and chalcopyrite commonly preserved. Away from the main veins, outcrop is sporadic-to-rare, although mapping indicates that the cover is thin; in the order of a few metres or less. On Mithril’s leases, the IOCG minerals system is about 50 km long and 5 km wide. Nearly half of the system is exposed.
Figure 5. (a) Top. View, looking east, of part of the Austin IOCG veins. The outcrop is 2 m wide. Veins in foreground are dominantly hematite-quartz. (b) Bottom. Strike ridge of quartz-hematite veins at Bigglesworth, looking west. The ridge rises about 150 m above the plain. At a distance, these large outcrops may be mistaken for Heavitree Quartzite.
Previous Exploration

Previous exploration in the Illogwa region has been sporadic. Deposit styles sought were stratabound copper and lead, orogenic gold and (interestingly) Witwatersrand-style gold, uranium, heavy minerals, and diamonds. The earliest recorded exploration was in late 1966 in the Limbla Syncline, with Australian Geophysical Pty Ltd seeking copper through IP surveys and rock chip sampling, stream sediment sampling, geological mapping, and limited percussion drilling (CR1967-0004). Summaries of previous exploration in tenements that overlapped ELs 25643, 25653, and 28335 are given in Appendix 1.

The only historical drilling within the Mithril lease areas was done in the search for uranium in the Aremra Basin, by Agip NuCleare Australia Pty Ltd in the late 1970s (CR1977-0082, CR1978-0102); Rio Tinto Exploration Pty Ltd investigating sediment-hosted copper in the Limbla Syncline (Amadeus Basin) in the late 1990s (CR1998-0565); and a 69-metre percussion program undertaken by Mr L. A. Johannsen in 1987, looking for vein-hosted gold (CR88-0296). Locations of historical drill holes are shown in Figure 6.

Figure 6. Geological map showing locations of historical drilling. Triangles, AGIP NuCleare. Diamonds, Rio Tinto. Square, Johannsen. Locations of Mithril’s diamond drilling described in this report shown by red circles.
A single instance of exploration pertaining to the currently identified IOCG mineralisation was conducted in 1970 (albeit before recognition of IOCG as a distinct type of mineralisation). A geologist from Geopeko Ltd inspected some copper occurrences in quartz-hematite veins on a prospector’s lease (CR1971-0066). He noted the presence of strong and widespread epidote alteration, boxworks with silica and hematite, disseminated chalcopyrite, “quartzose bodies” some 30 m to 60 m wide, striking northwest, and fault-controlled alteration and mineralisation. The reported location (“4 miles south of Alberta Dam”) is consistent with this being at, or near, the Bigglesworth prospect.

Exploration Concept

At Illogwa, the presence of styles of alteration, mineral assemblages, and structural settings are consistent with known shear-hosted IOCG deposits (e.g., Eloise, Queensland; Hillside, South Australia) and was compelling evidence that the project area may contain its own IOCG system. However, owing to weathering, the field evidence was not conclusive of the existence of an IOCG system. As such, the exploration concept was a fairly simple one: that potential IOCG mineralisation is hosted in northerly-dipping structures with recognizable strike. These structures required drill-testing to establish that an IOCG system exists. Only after that could the proper process of exploring for any IOCG deposit begin. To establish the existence of an IOCG system, drill core containing unequivocal IOCG mineralisation must be obtained.

To assist in defining drill targets, Mithril Resources carried out IP surveys at Austin and Powers and detected a number of anomalies. Anomalies at Austin were chosen for drill testing. One of the IP anomalies at Austin was located 200 m down dip of outcropping copper mineralisation. The IP anomalies could be due to sulfides or hematite. At Bigglesworth and Mini Me, the presence of primary sulfides (Mini Me) or relatively abundant malachite (Bigglesworth) in mapped mineralized veins presented suitable drill targets (Figure 7).

Details of Collaborative Program

Mithril Resources submitted a proposal, under Round 5 of Geophysics and Drilling Collaborations, for drill testing IP anomalies and geological targets.

Method and collar locations

Mithril contracted Ron Potts Drilling for the program. Five NQ diamond holes (with HQ precollars) were drilled using a UDR1000 rig. Drilling was done during August-September 2012. Mithril reserved the option to bring the rig back to drill more holes, but decided that the expected onset of summer rains would make this risky. The drilling program formally finished on 5 November 2012. A total of 1,001 m was drilled. Downhole surveys were done every 50 m, using a digital single shot tool, which also measured total magnetic field.

Only one drill site, APDD002, required preparation of a pad. All other sites required little or no clearing of bushes and shrubs. Due to the difficulty of digging sumps in hard, rocky ground, above ground sumps were used.
Figure 7. Outcrop of quartz-hematite veins with secondary copper minerals at Bigglesworth, looking west. This occurrence is at the foot of the strike-ridge shown in Figure 5b. These veins were drilled.

Drill hole collar locations and orientations are given in Table 1. Collar locations were established using hand-held GPS, with a nominal accuracy of ±4 m. Datum and grid are GDA94 and MGA (Zone 53), respectively.

Table 1. Collar locations (MGA94, Zone 53), azimuth, dip, estimated depths of drill holes.

<table>
<thead>
<tr>
<th>Drill hole</th>
<th>Easting (MGA Zone 53)</th>
<th>Northing (MGA Zone 53)</th>
<th>Depth (m)</th>
<th>Dip</th>
<th>Azimuth (MGA)</th>
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<td>7378755</td>
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**Logging, sampling, assay techniques**

The drill core was logged, photographed, and sampled on-site. Logging included capturing lithological observations and measuring structures, density, and magnetic susceptibility. Samples for assay were taken either as half core from selected intervals, where mineralisation and significant alteration occur, or as 10-centimetre lengths of half core sampled each metre and composited over five metres. Standards were included at regular intervals, usually every 25 metres.

Assays were done by ALS Global using conventional ICP-AES analysis. Preparation was by aqua regia digest, for all elements except gold. Samples for reading gold were prepared by fire assay. Detection limits are shown in Table 2.

<table>
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<th>Element</th>
<th>Range ppm</th>
<th>Element</th>
<th>Range ppm</th>
<th>Element</th>
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<td>Na</td>
<td>0.01-10%</td>
<td>Ti</td>
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<td>Cu</td>
<td>1-10,000</td>
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<td>Fe</td>
<td>0.01-50%</td>
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**Results and Interpretation**

The objective of the drill program was to demonstrate the existence of IOCG mineralisation. Each hole intersected alteration and brecciation indicative of an IOCG system: hematite-, magnetite-, chlorite-, and carbonate-alteration and veinlets in host rocks of the Atneequa granite (Figure 8a) and the Albarta Metamorphics and epidote alteration in the latter. Trace to minor pyrite and chalcopyrite were found in all holes except APDD003, which intersected the least altered and brecciated part of the system. Importantly, chalcopyrite in intense hematite-silica-altered granite was intersected over 3 m in APDD002 (Figure 8b), conclusively establishing the existence of an IOCG system. Fluorite and carbonate veinlets were also intersected in this hole (Figure 8c). Assays for this interval returned grades up to 0.67% Cu.

Gold is also present in the system, but in small amounts. Grab samples have returned up to 1.4 ppm Au from hematite-quartz vein float. The highest grade found in the drill core is 0.09 ppm Au from brecciated, hematite-altered granite in APDD001.
The mapped veins at Austin were intersected at predicted depths, as was the IOCG mineralisation in APDD002. However, veins mapped at surface at Mini Me and Bigglesworth do not persist down dip and predicted intersections of these veins were not realized.

The three holes at Austin, APDD001-003, were sited to test IP anomalies. The amount of hematite-magnetite drilled in APDD001 and APDD002, plus the chalcopyrite in APDD002, may be the cause of the anomalies, but this remains to be established. The anomaly drilled in APDD003, which only intersected unaltered and weakly altered granite, is unexplained. Subsequent to this drill program, Mithril conducted extensive IP surveys immediately west Austin and at Mini Me. The IP anomalies west of Austin are interpreted to be due to groundwater. The anomalies at Mini Me are interpreted to be due to mineralisation and are expected to be drilled in the first half of 2013.

Detailed logs, photographs of the core, and assay results are given in the Appendices.

Field observations provide poor constraints on the age of the mineralisation. It is younger than its youngest host unit, the 1745 Ma Atneequa Suite and probably older than 850-800 Ma Heavitree Quartzite, as the latter does not appear to host the IOCG mineralisation or alteration. The age of the IOCG system will have to be determined by isotopic methods.
At this stage, there are no plans to drill test gravity anomalies as modelling shows their sources may be several hundred metres deep. Any drilling of gravity targets will be during a later phase of exploration.

**Conclusion**

Mapping and drilling at Illogwa have established the existence of a vein-hosted IOCG mineral system in the eastern Arunta region. Prior to regional mapping by NTGS in 2010, no hint of IOCG mineralisation was known in this region. Mithril’s has shown that the IOCG mineralisation is distributed over a minimum trend-length of 50 kilometres and that its footprint is probably about 100-300 km$^2$. Any ore body in this footprint probably has an area of less than 1 km$^2$. These are typical dimensions for IOCG systems and highlight the difficulty in finding IOCG deposits. However, given that IOCG systems also typically occur in provinces several hundreds of kilometres long (e.g., Olympic Cu-Au Province, Cloncurry IOCG Province, Carajás Mineral Province), the Illogwa IOCG Belt is expected to be part of a more extensive system.

**References**


Appendices

Appendix 1  Summaries of historical exploration
Appendix 2  Drill core logs
Appendix 3  Photographs of diamond drill core
Appendix 4  Geochemical assays of drill core

Appendices are attached as separate files.