EL 28567 Running Creek

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<th>Toro Energy Ltd</th>
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<td>Toro Energy Ltd</td>
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<td><strong>Title</strong></td>
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<td><strong>Project</strong></td>
<td>McArthur</td>
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<td>EL28567 Running Creek Annual Technical Report for period 24th October 2011 to 23rd October 2012</td>
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<td>Uranium</td>
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<td>18th December 2012</td>
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<td><strong>100k Mapsheets</strong></td>
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Summary

This first Annual Technical Report for EL28567 covers work carried out during the twelve month period from 24th October 2011 to 23rd October 2012. Exploration activities during the period have involved:

- Historical data review comprising assessment of all available open file reports and data.
- Negotiation of an Option Agreement with Auminco Coal Pty Ltd for a farm-in on all commodities apart from uranium.
- Liaison with stakeholders, specifically the pastoralist who operates Wollogorang Station.
- Collection of 210 soil and lag samples (including 9 duplicates), and 5 rockchip samples throughout the tenement.
- Recognition of a weak uranium signature in the top part of some established breccia pipes at Running Creek.
- Anomalous U-Cu-As-Au-PGE signature at several sites.
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INTRODUCTION

This report outlines the work conducted within the exploration tenement EL28567 during 2012 (first year of tenure) by Toro Energy Limited (“Toro”; ticker code “TOE”). EL28567 is located in the northeastern corner of NT in the Gulf of Carpentaria, approximately 30km from the QLD border on the Robinson River 1:250,000 mapsheet (Figure 1; Figure 2). Tennant Creek lies around 500km to the southwest. Access from Alice Springs is 500 km north on the Stuart Highway to Tennant Creek, then another 25km north to Three Ways, then east on the Barkly Highway for approximately 185km, turning north at Barkly Roadhouse onto the Tablelands Highway for approximately 200 km. From this highway, turn right on the Calvert Hills Road and travel northeast for a further 220km to the Borroloola-Burketown Road (Figure 3; Figure 4; Figure 5). From this intersection, travel east 50 km to Wollogorang Homestead, then travel north along an old exploration track (rough 4WD only) that runs to the mouth of the Calvert River via EL28567, a distance of approximately 80 km. Alternative access to Wollogorang from Darwin is via the Stuart Highway to Daly Waters, then along the Carpentaria Highway to Borroloola, then east along the Borroloola-Burketown Road. Either way, these routes are a good day and half drive from Darwin or Alice Springs. Access could also be gained from Mount Isa, 500 km to the southeast, via Doomadgee (Figure 3).

Figure 1 EL28567 Location in NT
Figure 2 EL28567 Tenement location over 250k and 100k mapsheets

Figure 3 EL28567 Regional location (other Toro tenure in grey)
EL28567 lies wholly within NT pastoral lease No 1113, Wollogorang Station, and is currently used exclusively for cattle grazing (Figure 6). The homestead lies 50 km south of this licence (80 km by road). Access north of Running Creek is sporadic as the northern part of the station is not highly stocked, and this creek flows all year round. Access within the tenement is via partly rehabilitated exploration and station tracks relating to the extensive exploration carried out by CRAE in the mid 1990s.

The Gulf region (bioregion) is characterised by gently undulating coastal plains along the southern Gulf of Carpentaria with scattered rugged areas of Proterozoic sandstones. Soils are predominantly sandy red earths and shallow gravelly sands. The climate is tropical with annual rainfall between 800 and 1200mm falling mostly between December and March; cyclones are a frequent phenomenon. Eucalyptus woodlands with grassy understory dominates the region with significant areas of tidal flats mangroves and littoral grassland. The field season generally runs from May/June to October in order to avoid monsoonal activity.

Figure 4  EL28567 Location and access on 250k topographic base
Exploration over this licence will focus on determining the uranium potential of breccia pipes of the Running Creek-Stanton field, discovered by Joe Fisher in the 1980s.

Figure 5  EL28567 Proximal location and access
2 TENEMENT

EL28567 was granted on the 24th October 2011 to Toro Energy Ltd for a period of 6 years. This report refers to work carried out during the first year of grant. At the date of this report, it is entering its second year of tenure and consists of 33 blocks covering a total area of 108.52 square kilometres. Toro entered into an Option agreement with Auminco Coal Pty Ltd in which Toro retain uranium right and Auminco earn-in on all other commodities. Their principal interest is commercialisation of the Cu-Co-Ni breccia pipes within Toro’s licence, and also within the small Mining Lease No 23348 enclosed by Toro’s licence (Figure 5). The discrepancy between exploration licence and mining lease boundaries is the result of adjustments being made by the Department of Mines and Energy in relation to moving to the newer map datum.

<table>
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<tr>
<th>Tenement</th>
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Table 1 EL28567 Tenement details
3 GEOLOGICAL SETTING

EL28567 lies within the Proterozoic McArthur Basin (Figure 7; Figure 8), a 12km thick unmetamorphosed sedimentary succession containing dolostone, sandstone and shale units with minor felsic and mafic volcanics (Rawlings, 1999). The McArthur Basin unconformably overlies the Palaeoproterozoic Pine Creek Orogen to the northwest, Murphy Inlier to the southeast and Arnhem Inlier to the northeast and is host to the McArthur River ("HYC") Zn-Pb-Ag mine, the Westmoreland uranium deposit and is spatially associated with the uranium deposits of the Alligator Rivers region, including Ranger and Jabiluka. The basin also hosts numerous other occurrences of base metals, iron ore, manganese and uranium. Bauxite is mined at Gove and manganese is mined on Groote Eylandt from World-class Cenozoic deposits.

The local surface geology of EL28567 is dominated by the Gold Creek Volcanics ("Ptg" in Figure 9; Figure 10). This formation is a series of basaltic lavas and shallow intrusives, interlayered with thin ‘oxidised’ sandstone, carbonate and siltstone units (Rawlings, 2006). It is conformably underlain by ‘reduced’ sedimentary facies of the Wollogorang Formation, which includes dolostones, sandstones...
and carbonaceous shales. A regional dolerite sill, the Settlement Creek Dolerite, was emplaced synchronous with effusion of the Gold Creek Volcanics. The Wollogorang Formation and Settlement Creek Dolerite do not outcrop on EL28567, but are intersected in a number of drill holes on the tenement. In the district, the Gold Creek Volcanics is disconformably overlain by a felsic volcanic package that includes a rhyolitic rheoignimbrite sheet (Hobblechain Rhyolite), proximal epiclastics (Pungalina Member) and distal reworked clastics (Echo Sandstone). Within EL28567, the rhyolite is absent and a ~30 m interval of Pungalina Member conglomerate and siltstone ("Ptcu" in Figure 9) rests on the Gold Creek Volcanics. A mesa of coarse lithic sandstone is the only remnant of the Echo Sandstone ("Ptc" in Figure 9) in the tenement. Deformation of the Gold Creek Volcanics and Wollogorang Formation is thought to have been related in part to emplacement of the Hobblechain Rhyolite and it's subvolcanic feeder, the Packsaddle Microgranite (the yellow and red units, respectively, in Figure 8).

Figure 8  EL28567 on NTGS Lithology interpretation and faults
Figure 9  EL28567  Local 250k NTGS geology and mineral occurrences/prospects (base from Rawlings, 2006)
Figure 10  Stratigraphic column for Robinson River area, including EL28567 (Rawlings, 2002).
The Running Creek tenement incorporates a number of documented historic breccia pipes that host Cu, Co and Ni. These pipes are described in detail below. Based on a deposit research study by Toro Energy, the area of this application also has potential for “Arizona Strip” style uranium and base metal deposits (Pool and Ross, 2007). The Arizona Strip in western USA is where uranium has been mined from multi-commodity breccia pipes for over 50 years. The individual deposits of the Arizona Strip, whilst relatively small tonnage at less than 10 Mlb U3O8, are high grade (>0.5% U3O8) and occur in a dense cluster that is able to support sustainable mining operations.

Toro believes there is a high-probability of similar targets in the McArthur Basin because breccia pipe clusters are already well known in the region (e.g., Redbank, Running Creek and Stanton pipe sets; Figure 11) and have supported copper mining over the last 20 years. The geological and geochemical commonalities with the Arizona Strip are remarkable. Toro also believes there is a close connection between the Running Creek breccia pipes and the nearby Selby P-U-REE prospect.

Figure 11 Running Creek-Karns project area on regional radiometrics, showing mineral occurrences and planned soil traverses for 2012.
4 PREVIOUS EXPLORATION AND DEPOSIT MODEL

Exploration within the area encompassing EL28567 was largely in an effort to discover an economic-sized base metals deposit of the Redbank breccia pipe style. A summary table and spatial index of previous exploration can be found in the Appendix. The following summary has been extracted verbatim from Rawlings (2006) – Robinson River Explanatory Notes – which is a good overview of the breccia pipes. References herein can be traced to that report.

Reports of historical mine workings near Running Creek were first made by Battey (1958). Malachite and azurite ore had been removed from a 10 m-deep shaft and a 3 m-deep open pit by unknown prospectors. At present, the open pit is still visible near 795500mE 8148900mN, but the shaft has been covered. Subsequent mapping and exploration in the Running Creek area by Fisher (1977, 1980, 1989, 1991a, b) identified eight anomalous circular topographic and aerial photofeatures, which were shown to represent breccia pipes like those at Redbank in CALVERT HILLS (Ahmad and Wygralak 1989). The pipes are small (20–100 m diameter), physiographically distinct, circular or elliptical zones of increased brecciation, stratigraphic offset and copper mineralisation. They taper downward as a cone and mysteriously terminate over a few hundred metres.

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<td>Cu</td>
<td>chalcopyrite, Muscovite, detrital flow breccia</td>
<td>Rawlings et al (1996), this report</td>
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Table 2 Summary of mineral occurrences and prospects on EL28567, including those within the excision of ML23348.

Limited, but anomalous geochemical data and auger drilling encouraged CRAE to farm-in during 1990 and establish a joint venture agreement in 1994. Substantial ground and airborne geophysics, soil and lag geochemistry and geological mapping were conducted in the Running Creek EL to identify targets (Palmer 1991a, 1992, 1993a–c, 1994, Palmer et al 1995). Seven discrete prospects and a number of anomalous zones were identified (Table 2; Figure 12). A total of 210 reverse circulation holes (aggregate 15,400 m) and 48 diamond holes (aggregate 6,100 m) were drilled to test breccia bodies, geochemical and geophysical anomalies, refine local geology and concepts, conduct metallurgical testing, and close out mineralisation at a number of prospects. Best drill results at Stanton prospect...
were 22 m @ 0.3% Co, 0.17% Ni, 0.14% Cu, 10 ppb Pd and 10 ppb Pt (Palmer 1993a) and 22.3 m @ 0.33% Co and 0.19% Ni (Palmer 1993c), and at Running Creek, 13.4 m @ 1.2% Cu (Palmer et al 1995). Stanton also has rare anomalous intersections of gold, including 6 m @ 0.2 g/t (Palmer 1992). Based on CRAE drilling, the total indicated resource at Stanton is 800 000 tonnes at 0.15% Co, 0.08% Ni and 0.15% Cu (Hydromet Corporation 2001). Detailed data pertaining to the economic assessment of this prospect by Chemmet Pty Ltd and Hydromet Corporation Ltd remain confidential.

Figure 12 Map of principal prospects and critical drill holes at Running Creek
Host lithology

Mineralisation in the Running Creek EL is stratabound, mostly constrained within the ‘target unit’ of the upper Gold Creek Volcanics, comprising 15–20 m of red oxidised, ferruginous, mildly dolomitic mudstone and fine sandstone (heterolithic ‘redbeds’). This lithofacies is characterised by ubiquitous dewatering structures, which were probably partly responsible for facilitating cross-stratal fluid flow, a crucial element in the generation of sediment-hosted copper deposits (Lustwerk and Wasserman 1989). Some mineralisation is also present in the interlayered basalt, peperite and dolarenite/sandstone units above and below the ‘target unit’, to depths of about 100 m.

Mineralisation

Ore minerals are mainly siegenite [(Co,Ni)3S4] and chalcopyrite below the current groundwater table (>15 m depth), and malachite, azurite, chalcocite, native copper and asbilite (a manganese-base metal oxide) in the oxidised zone. Primary sulfides occur as disseminated 1–5 mm sized euhedral (cuboid) crystals in coherent and brecciated mudstone and sandstone within the breccia pipes, and in quartz-dolomite veins within altered basalt and dolarenite units adjacent to the pipes. Local additional gangue minerals include chlorite, K-feldspar, bitumen, celadonite, pyrite, haematite and siderite. Bitumen infilling porosity is locally common in sandstone, and live oil shows and bleeds have also been recorded.

Structure and brecciation

Breccia pipes at Stanton, Running Creek and other nearby prospects are circular, trapezoidal or elliptical in plan and have a diameter of less than 100 m. They often exhibit a surface expression of anomalously steep radial dips and stratigraphic juxtapositions that imply faulting and downward movement of the pipe interior (Fisher 1980). However, some pipes are obscured by younger deposits or their associated faults are difficult to recognise in the field, and are therefore essentially blind. Drilling indicates that the pipes are characterised by various breccias and fault blocks displaying chaotic to predictable stratigraphic juxtapositions.

Breccia ranges from monomict to polymict, and comprises clasts of sandstone, mudstone and basalt in a mud-sand matrix (Rawlings et al 1996). The degree of preservation of the stratigraphy through the breccia pipes varies. Breccia textures range from monomict stratigraphy-preserving to polymict clast-rotated, reflecting the degree of stratigraphic disturbance. Sedimentary clast-matrix relationships show both ductile and brittle deformation features, including angular sandstone clasts with an early carbonate cement in a matrix of disrupted, unconsolidated mudstone, and angular mudstone clasts in a disrupted sand matrix. This indicates that brecciation occurred while the sandstone and mudstone were only partially consolidated (i.e in late Tawallah Group time). Some faults and fault zones clearly truncate earlier-formed breccias, and appear to have been active while the sediments were more or less consolidated. As expected, basalt units show only brittle features.
Figure 13 Cross section through Stanton breccia pipe (from Rawlings, 2006)
In section (Figure 13; Rawlings et al 1996), the focus of major brecciation and stratigraphic offset at Stanton is a pipe- shaped body, tapering and plunging downward at 40° to the northwest. Drilling data indicate that the overall Gold Creek Volcanics stratigraphy within the pipe lies lower than the adjacent succession (i.e. it has ‘dropped down’). Drilling has thus not yet reached the terminating structure where stratigraphy reverts to the undisturbed state. It appears likely that the breccia body continues down-plunge, perhaps into the underlying Wollogorang Formation. Within the breccia body, the stratigraphy has clearly been modified by structural repetitions and truncations along faults dipping at about 35° to the northwest. Segments of the ‘target unit’ have been repeated, perhaps as many as four times, in the core of the breccia zone. Rafts of the adjacent basalt and arenite units have been incorporated into the breccia, but overall, stratigraphy within each fault repetition has been maintained. The breccia pipe is interpreted to be bounded to the southeast by a large subvertical fault, and by a shallowly plunging fault to the northwest, both faults accommodating the net stratigraphic juxtaposition (Figure 13).

Breccia at Stanton also occurs outside the main body, along discrete horizons at the level of ‘arenite 1’, ‘arenite 2’ and the ‘basal sandstone marker’ (Figure 13; Rawlings et al 1996). This brecciation is associated with green, soft- sediment deformed, muddy lithic sandstone, sandwiched between early-cemented evaporitic dolarenite and adjacent basalt units. Brecciation also accompanies substantial thinning of the dolarenite units. There is good evidence that this stratiform breccia and ‘lithic sandstone’ formed due to destructive alteration (dedolomitisation) of dolarenite and consequent volume loss and differential compaction.

**Breccia pipe formation**

The structural event that formed breccia pipes in the Running Creek EL is thought to be contemporaneous with folding of the Gold Creek Volcanics, development of a disconformity at the base of the Pungalina Member, and emplacement of the Hobblechain Rhyolite and Packsaddle Microgranite (Rawlings et al 1996, Rawlings 2002). The reasoning is that:

- the Pungalina Member is essentially undeformed and contains no breccia pipes or ‘Jura-style’ folds in this area
- the Pungalina disconformity truncates folds in the Gold Creek Volcanics
- the Pungalina Member infills palaeotopographic features in the top of the Gold Creek Volcanics that resemble the plan shape and dimensions of breccia pipes
- immature, locally derived rhyolite detritus is prolific in the basal Pungalina Member.

Based on timing and characteristics, two alternative models are suggested for the formation of the Stanton breccia pipe. These models are also applicable to other pipes in the region, including those at Redbank. Brecciation was localised either within a transtensional jog associated with a north-northeast-trending, steeply northwest-dipping strike-slip (wrench) fault, or within a dilatational boundary between two gravity-driven slide blocks. Both alternatives are consistent with peripheral deformation associated with the emplacement of shallow intrusions (Merle and Vendevelle 1995, Rawlings and Page 1999). In their model, Rawlings and Page (1999) interpreted Jura-style folding and
radial deformation in the correlative upper Katherine River Group in MOUNT MARUMBA to be the 
result of lateral gravity sliding of a semiconsolidated sediment-basalt package outward from the 
intruding Jimbu Microgranite. Similarly, in ROBINSON RIVER deformation can be attributed to 
emplacement of the Packsaddle Microgranite and unexposed equivalents (Rawlings 1997). The strike-
slip fault jog alternative is preferred in the case of Stanton because there is no significant vertical 
displacement on local fault systems; structural cross-sections through the breccia pipe (e.g., Figure 
13) are impossible to balance; and subhorizontal, curved to flat fault striae have been recognised at 
Stanton and Sandy Flat (Redbank) during reconnaissance studies (Rawlings 2002).

Although a macro-scale orthogonal geometric relationship has been noticed in the Redbank 
prospects (Orridge and Mason 1975, Wall and Heinrich 1990), more detailed studies are required to 
ascertain the structural controls on mineralisation.

Importantly, the structural model proposed by Rawlings et al (1996) contrasts with earlier 
hypotheses that breccia pipes on the Wearyan Shelf formed by hydrothermal and magmatic 
explosion associated with emplacement of postulated deep-seated carbonatite magma bodies 

**Alteration and fluid types**

At least eight distinct alteration types have been recognised in the Running Creek EL (Morris et al 
1996, Rawlings et al 1996). Basalt units are affected by two early low-temperature diagenetic 
alteration events:

- regional pervasive, texture-preserving, incipient to moderately strong chlorite alteration
- localised pervasive, texture-destructive, moderate to intense potassic alteration.

Sedimentary rocks are likewise affected by two early diagenetic alteration events:

- regional pervasive haematite alteration
- regional patchy, buff-cream dolomite alteration.

Additionally, three types of syn-mineralisation alteration are recognised in the sedimentary rocks:

- localised pervasive, fault- and breccia-controlled, green to black chlorite ± bitumen alteration 
in mudstone and breccia
- localised stratiform, green to black chlorite ± bitumen
- alteration associated with carbonate destruction and compactional brecciation in dolarenite 
units
- localised pervasive, fault- and breccia-controlled, dark brown alteration.

A further, genetically late, buff to orange porous alteration occurs in the upper 20–30 m of drillholes 
in the area and is probably a weathering feature related to downward percolation of oxygenated 
groundwater along faults and fractures. Primary mineralisation has been remobilised during this 
alteration event (cf McLaughlin et al 2000).
Potassic and haematitic alteration in the Running Creek EL are interpreted to have resulted from the passage of oxidised alkaline brines through evaporitic 'redbeds' and fractured and vesicular basalt of the Gold Creek Volcanics and Wollogorang Formation. Fluid inclusion studies (Morris et al 1996, Rawlings unpublished data) have shown that brines were relatively low temperature (110–120°C) and highly saline (>20 wt% NaCl equivalent).

Oxidised fluids were essential to leach and transport Cu, Co, Ni and possibly sulfate at the observed low temperatures (Pietsch et al 1991a, Haines et al 1993, Cooke et al 1998), and were probably the ambient pore waters residing in the ‘redbeds’ prior to faulting and folding. The sporadic distribution of potassic alteration in basalt indicates that only partial leaching of metals occurred from the coherent basalt. Leaching was much more effective from basalt detritus in the overlying juvenile ‘redbeds’. This is consistent with contemporary models for the formation of redbed-associated sediment-hosted copper deposits (Walker 1989). Local uplift associated with the generation of folds and faults may have increased hydraulic head and enabled base metal concentrations in the oxidised brines to approach saturation levels.

The fluids responsible for chlorite alteration and the deposition of bitumen in veins and pods are interpreted to have been reduced, hydrocarbon bearing and carbonate destructive (acidic), derived from carbonaceous rocks in the underlying Wollogorang Formation (Rawlings et al 1996). These fluids were relatively hot, as the organic source rock would have needed to be in the oil window to allow liquid hydrocarbon generation and migration. This would be consistent with an excellent source rock that has passed through the oil window, but is still in the zone of oil preservation. In drillhole DD95RC128, there is an erratic, but overall downward increase in Ro from 0.9% to 1.1% over 100 m depth. This suggests an elevated, but heterogeneous palaeogeothermal gradient, rather than a simple burial curve as proposed by Morris et al (1996). A ‘tail’ of elevated homogenisation temperatures (120–350°C; Morris et al 1996) and the presence of liquid oil in fluid inclusions (Rawlings unpublished data) also favour the existence of a hot hydrocarbon-bearing fluid.

A strong interrelationship between base metal precipitation and mobile hydrocarbons at Stanton is supported by the presence of microscopic Cu, Co and Ni sulfide phases in bitumen pods; the absence of mineralisation in primary oxidised ‘redbeds’; and the obvious spatial distribution of chlorite alteration with Cu-Co-Ni mineralisation. However, it is also clear from the occurrence of altered, but unmineralised zones that metals and reductants were unlikely to have coexisted in a single ore-forming fluid. Thermodynamic and chemical principles also favour two separate fluids (Wall and Heinrich 1990, Rawlings et al 1996, Cooke et al 1998).

At Stanton, high-grade Co-Ni mineralisation is closely associated with dark brown or lesser dark green altered mudstone of the ‘target unit’, which was altered synchronously with mineralisation through either overprinting of chlorite-altered rock by late oxidised fluids, or as a consequence of mixing of reduced hydrocarbon-bearing and oxidised metalliferous fluids. Rock-scale relationships cannot distinguish these two possibilities.
Mineralisation model

The structural development of Stanton and other prospects in the Running Creek EL was clearly important for the isolation of mineralisation. Brecciated rock has provided permeability for the introduction of fluids responsible for mineralisation and the development of potassic, haematitic, chloritic and dark brown alteration types. Brecciated rock is a common host of Cu-Co-Ni mineralisation, but there are many examples of mineralised coherent rock. Consequently, brecciation is apparently not necessary on a small (metre) scale to host mineralisation, but is clearly necessary on a deposit (hectometre) scale.

As outlined above, geological and geochemical relationships favour the involvement of two fluids in the mineralising process: an oxidised saline brine and a reduced hydrocarbon-bearing fluid. Rawlings et al (1996) favoured a fluid mixing model not unlike the ‘Redbank’ model of Wall and Heinrich (1990) and the ‘mobile reductant’ model for sediment-hosted copper deposits of Kazakhstan (Gabлина 1981). This mixing model is summarised below.

Uplift, folding and faulting in late Tawallah Group time created breccia pipes and allowed cross-stratal fluid flow of reduced hydrocarbon-bearing fluids from carbonaceous rocks of the Wollogorang Formation into overlying oxidised Gold Creek Volcanics. What prompted the maturation and expulsion of hydrocarbons is unknown. Rawlings et al (1996) suggested that carbonaceous rocks underwent ‘early’ thermochemical degradation in the presence of hot hydrothermal fluids related to emplacement of a nearby felsic intrusion (Packsaddle Microgranite) or due to conductive heating by an underlying mafic intrusion (Settlement Creek Dolerite). This hypothesis is somewhat supported by the organic maturation and fluid inclusion data (see above). In addition, deep drilling at Stanton has identified an unusually high-level dolerite intrusion immediately below the breccia pipe. Rawlings (2002) has also noted that regionally, there is a close spatial and temporal association between intrusive apophyses, breccia bodies, alteration and emplacement of the Settlement Creek Dolerite (e.g. Eagle Hawk Neck). In contrast, Morris et al (1996) favoured a model of regional burial maturation, where hydrocarbons were only generated after deposition of the overlying 2–3 km-thick cover, some 50–100 my or more after generation of the breccia pipes. Their model cannot account for the absence of alteration and mineralisation in the Pungalina Member.

Upward passage of reduced fluids did not significantly affect basaltic intervals in the Gold Creek Volcanics, but partially altered the ‘redbeds’ of the ‘target unit’ to a reduced chloritic assemblage. Simultaneously, ambient oxidised metalliferous fluids derived from the volcanic rocks were drawn laterally and perhaps downward by hydraulic head associated with the uplift event. Fluid mixing occurred in the top of the main dilatation zone, as the upwelling reduced fluids displaced the ambient and laterally migrating oxidised brine. Reduction of the oxidised waters resulted in siegenite and chalcopyrite deposition in the sedimentary matrix and in fractures in the basalt. Oil in the reduced fluid was trapped as liquid inclusions in quartz and carbonate, or was degraded to solid bitumen.
The distribution of metals at Stanton is consistent with a mixing model for mineralisation. Cu-Co-Ni mineralisation is focused around the upper part of the main breccia zone and in the ‘target unit’ immediately above (Figure 13). There, the volume of oxidised fluid was sufficient to dilute the reduced fluid close to the major upflow zone and cause sulfide precipitation. Concentration of grades in the ‘target unit’ may also be a function of the lower permeability of the reduced fluid in the mudstone. In contrast, the main breccia body is almost devoid of sulfides because reduced fluids dominated over oxidised fluids and prevented sulfide precipitation. For similar reasons, the grade of lateral mineralised intervals within dolarenite units adjacent to the breccia pipe (‘sandstones 2 and 4’) are highest 50–100 m outboard of the breccia zone.

Other, less appealing alternatives for ore genesis include:

- a two-stage fluid model: initial ground preparation by a reduced fluid followed by introduction of metals in a later, oxidised brine
- a single-fluid model: metal transport in a reduced brine
- a more complicated mixing model in which the oxidised and reduced fluids are both derived from the underlying stratigraphy, but ascend along the fault conduits at different flow rates, with a mixing zone coincident with the zone of brecciation.

As mentioned above, Toro is interested in the potential for uranium to have been part of the hydrothermal system described by Rawlings (2006). The reason it appears to be absent at Stanton/Running Creek is twofold:

- CRAE seldom analysed for this element, but did sporadically run gamma logs, and may have missed any uranium present.
- Uranium as part of a zoned redox system is expected to be separate from base metals and might lie stratigraphically above or below the target that was being explored by CRAE and others. Applying the Arizona Strip model (Pool and Ross, 2007), uranium might occur 10s to 100s of metres higher or lower in the pipe structure. Given this tenement lies at a roughly uniform stratigraphic level of the Gold Creek Volcanics, uraniferous intervals are therefore likely to be absent near the surface.

Accepting this premise, exploration for uranium in the area would require either deeper drilling below the base metal-dominant part of the system, or it might be present to the west in the Pungalina Member/Echo Sandstone. EL28567 represents a test of the former, i.e., that the redox system is “upside” down relative to the Arizona Strip and uranium occurs deeper in the system. The alternative scenario will be tested by Toro on adjacent tenements, including the Selby prospects.
5 EXPLORATION CARRIED OUT

As a first-pass test of the exploration model, Toro undertook the following in September 2012:

- orientation soil/lag sampling over the existing coverage of CRAE’s lag grid from 1995, in which uranium was not analysed for. This survey also extends north to the edge of the tenement where higher stratigraphic levels might be exposed (Figure 14).
- rockchip sampling around the periphery of existing known pipes and other radiometrically anomalous outcrops to determine if there are anomalous levels of uranium present in the tenement at or about the level of the upper parts of the pipes (Figure 14).

Soil/lag sampling

Toro collected coincident -5mm, -80# and -5mm+2mm (lag) sieved samples at 70 locations, as shown in Figure 14. Three of these “locations” comprise 9 duplicates; therefore, only 201 analyses are presented in Appendix. These samples were processed by ALS Laboratories in the following manner:

- -5mm samples were partly digested using a typical laboratory “exploration style” leach and analysed for a large multielement suite including Au and Pb isotopes.
- -80# samples were fully digested in 4 acid solution and analysed for a large multi-element suite, including gold and PGEs.
- -5mm+2mm (lag) samples, which CRAE showed to be the most suitable for base metals at Running Creek, were digested as per the -80# samples.

Results of the various methods were compared to determine which has the most sensitivity and best matched the lag grid generated by CRAE (Figure 14). The -5mm partial digest, while generating relative values only, showed greatest sensitivity over a number of elements. The full digest method suffered from a number of important trace metals reporting close to the detection limits, including uranium, and is therefore less useful for uranium exploration in the area. Uranium in partial digest, by comparison, showed three orders of magnitude variation and excellent repeatability of duplicates at different concentrations (Figure 15). Notably, uranium was not a significant presence at some breccia pipes, but was at others. Interesting coincident Cu-U-Au-As and Pb isotope anomalies were also identified near Felix, suggesting that area might be suitable for follow up work (Figure 16). Stout has elevated Ag to match it’s known Cu-Mn anomalism.

Rockchip sampling

Toro collected 5 rock chip samples within EL28567, which were analysed at ALS Laboratories for a large multielement suite including Au and PGEs. The highest uranium value is 39 ppm, and Cu-Mo-Au-PGE are also anomalous at several localities (Figure 16). Phosphate also appear to be higher than expected in all the samples. These features suggest a genetic connection with the U-P-REE Selby prospects.

Stakeholder liaison

During the soil sampling program, Toro liaised with the pastoralist at Wollogorang Station and assessed access into the tenement for future works.
Figure 14 EL28567 Toro 2012 soil/lag and rockchip samples, on CRAE Cu lag geochemical grid.
Figure 15 EL28567 Toro -5mm partial digest Uranium grid
Figure 16  EL28567 Toro -5mm partial digest Gold grid and rockchip geochemistry summary (magenta triangles)
6 EXPLORATION EXPENDITURE

Expenditure incurred during the second year of term for EL28567 was approximately $116,029 (see associated Expenditure Report).

7 EXPLORATION PROPOSED

The exploration programme for the upcoming reporting period within EL28567 will include the following:

- Ground traversing of anomalies presented in geochemistry and follow up anomalous copper and uranium from rockchip samples. This is likely to include soil sampling and rock chip sampling.
- Broadening of existing soil sampling grid.
- Compile GIS of geological and topographic data.
- Plan future drilling target in consultation with Auminco, assuming they exercise their Option to joint venture in February 2013.

8 APPENDICIES

A – Surface Geochemical data.

B – Historic data summary.

9 REFERENCES


All other references cited in Previous Exploration can be found in Rawlings, 2006.