SUMMARY

Thirteen blocks (43.58 sq km or 10.4% of the granted tenement area) in the eastern most portion of Exploration Licence (EL) 23462 have been proposed for relinquishment. Cameco Australia was granted a partial *Waiver of Relinquishment*. This report describes exploration work undertaken on the relinquished area during the past five years of tenure, between 2002 and 2007. The tenement is located in Northwest Arnhem Land and is operated by Cameco Australia Pty Ltd. EL23462 was granted on 25 July 2002.

The objective is to discover economic ‘unconformity-style’ uranium mineralisation within a geological setting similar to the known deposits of the Alligator Rivers Region, Northern Territory, and the concealed high-grade deposits of the Athabasca Region, Saskatchewan, Canada.

Exploration began on the entire tenement in the 1970’s; however, work was limited to an airborne radiometric and magnetic survey over the project area due to a moratorium imposed by the federal government in 1973. The moratorium banned ground exploration until the issue of Aboriginal Land Rights was resolved and groundwork was allowed to continue in 1987.

Exploration activities in the relinquished area comprised field reconnaissance, outcrop sampling of anomalies, ground proofing of previous geological mapping and prospects, and airborne magnetic, radiometric, digital terrain and hyperspectral surveys.
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INTRODUCTION

Kukalak is a uranium exploration project consisting of Exploration Licence (EL) 23462 (Figure 1). Thirteen blocks of the tenement, totalling 47.58km², are proposed for relinquishment (Figure 2). The project is operated by Cameco Australia Pty Ltd (Cameco). This report details exploration work completed by Cameco throughout the five years of tenure, from 2002 to 2007.

The objective is to discover economic ‘unconformity style’ uranium mineralisation within a geological environment similar to the known deposits of the Alligator Rivers Region, Northern Territory, and the concealed high-grade deposits of the Athabasca Region, Saskatchewan, Canada.

The project area is underlain by a variety of basement units, including the favourable Lower Cahill Formation that hosts the significant uranium deposits of the Alligator Rivers Region. The Kombolgie Subgroup sandstone and volcanic units outcrop extensively throughout the area. Favourable structures and alteration occur in the region. Several uranium occurrences have been identified in the project area; an indication of a favourable mineralising and alteration event.

Exploration work was undertaken according to the terms of a grant specified by the Division of Mines and Energy in the Department of Primary Industry, Fisheries and Mines (DPIFM; formerly DBIRD) on 25th July 2002.

Contractors and consultants utilised during all of the exploration programs are:

- Pontifex & Associates Pty Ltd, South Australia, for preparation of thin sections and petrographical analysis of samples;
- Northern Territory Environmental Laboratory, Darwin, for geochemical assaying and analysis of all samples;
- Jayrow Helicopters Pty Ltd, for air charter services;
- Northern Territory Geological Survey, Darwin, for conducting regional gravity surveys and geological mapping;
- Northern Australian Laboratories Pty Ltd (NAL), Pine Creek, for the preparation of the fire assay discs as part of the geochemical analysis of all samples;
- UTS Geophysics Pty Ltd, Perth for conducting a joint magnetic, radiometric and DTM survey;
- Genalysis, Perth, for the preparation of the fire assay discs as part of the geochemical analysis of all samples, as NTEL became dissatisfied with the turn-over of assays and results from NAL;
- DEMED and NLC representatives (Traditional Owners), for undertaking reconnaissance surveys and walks with Cameco staff during the reported period;
- Earthsea Archaeological Consultants, for conducting archaeological surveys and studies throughout Cameco’s tenements in the northwestern part of Arnhem Land.

Location and Access

EL23462 is located in Western Arnhem Land, Northern Territory (Figure 1), on the Alligator River (SD-5301) and Millingimbi (SD-5302) 1:250,000 topographic maps and the Oenpelli (5573), Goomadeer (5673), Howship (5572) and Liverpool (5672)
1:100,000 topographic maps. The area is also covered by relatively new 1:50,000 topographic maps – Dalabon, Gagudju and Spencer Range.

**Figure 1 Location Map for EL23462**

The Kukalak tenement is centred approximately 60 km east of Jabiru (Figure 1). The rugged nature of the sandstone, which overlies most of the licence, means that access is only possible by helicopter and then by foot. Previous exploration programs on the Kukalak licence have utilised tracks to the Devil’s Elbow and Dog Leg prospects; however, these tracks have not been used or maintained since exploration ceased during the early 1990s. In 2004, helicopter access was based from a semi-permanent field camp located on Tin Camp Creek, named ‘Myra Camp’, which was previously operated by AFMEX. Road access to Myra Camp is via the Arnhem Highway to Jabiru and bitumen road to Cahill’s Crossing, then by dirt road via Oenpelli and Nabarlek.

**Tenure**

The Kukalak project Exploration Licence (EL23462) is located on Aboriginal Land (Arnhem Land) and covers an area of 419 km$^2$, comprising 125 blocks. The area of proposed relinquishment comprises 13 blocks and covers an area of 43.58 km$^2$ (Figure 2). The exploration licence was granted on 25 July 2002 by the Division of Mines and Energy (DME; now Minerals and Energy Branch) in the Department of Primary Industry, Fisheries and Mines (DPIFM; formerly DBIRD).

**Figure 2 Location map for the area of proposed relinquishment in EL23462**

The original exploration licence application was not granted by DME in 2001 due to the Attorney General’s decision that the process had contravened sections of the NT Aboriginal Land Rights Act (1976) in spite of both deemed and actual consent from the NLC representing the Traditional Owners and the ATSIC Minister. Under advice from NTDME and NLC, the exploration licence application was relinquished and re-applied for in December 2001. As the exploration agreement and work proposal had been negotiated, the exploration licence was facilitated by the NLC and DBIRD.

The Kukalak licence contains two classes of area that are sensitive or have cultural and/or social significance to the Traditional Owners. The most important of these classes is the ‘No Go Areas’, which are absolutely excluded from exploration access. The other class is ‘Restricted Access Areas’, where permission from the Traditional Owners must be sought before conducting exploration within the designated areas.

Grant of title was for a period of six years (this expires on 24$^{th}$ July 2008), however data collected from surveys and samples from the eastern most portion of the tenement (Figure 2) have not yielded any promising results to date, therefore this area will be relinquished.
TENEMENT GEOLOGY

The Kukalak project area is located on the eastern margin of the Pine Creek Inlier (PCI), roughly on the boundary of the so-called East Alligator and Nimbuwah structural domains (Figure 3). The following text relates largely to this region. Reconnaissance mapping of the PCI has been done by the Bureau of Mineral Resources (BMR) since 1946, with more detailed work in the 1950’s and 60’s following the discovery of uranium at Rum Jungle. The Alligator Rivers region was systematically mapped by the BMR during the period 1972 to 1983, resulting in the publication of two 1:250 000 scale geological and metallogenic maps (Needham, 1990; Needham et al., 1983) and a detailed report (Needham, 1988). Cobourg Peninsula was also mapped at this time (Hughes, 1973). 1:100,000 scale compilation maps were published in colour and/or black & white format. Related publications are numerous and include: (Hughes, 1978; Needham et al., 1980; Needham and Stuart-Smith, 1985; Stuart-Smith and Ferguson, 1978; Stuart-Smith and Needham, 1982; Stuart-Smith and Needham, 1984; Warren and Kamprad, 1990). In more recent years, the Northern Territory Geological Survey (NTGS) has remapped the central parts of the PCI and the Milingimbi sheet (Ahmad, 1998; Carson et al., 1999; Ferenczi and Sweet, 2004). In collaboration with Geoscience Australia (GA), it has also begun focused geochronological studies aimed at developing a better stratigraphic framework (Worden et al., 2004).

Figure 3 Regional Geology of the Alligator Rivers Region

Regional and deposit scale metallogenic research, including uranium, has also been carried out in the PCI by a number of organisations, including the BMR (and subsequently AGSO and GA), Queens University, Johns Hopkins University, Bas-Becking Laboratory, Australian National University, CSIRO, USGS and NTGS (Ahmad, 1998; Browne, 1990; Carville et al., 1990; Crick, 1981; Crick et al., 1980; Dunn et al., 1990; Ewers et al., 1985; Ferguson et al., 1980; Ferguson and Goleby, 1980; Fraser, 1980; Garven and Raffensperger, 1996; Hancock et al., 1990; Hork et al., 2003; Johnston, 1984; Maas and McCulloch, 1988; Mernagh, 1992; Needham, 1985; Needham and De Ross, 1990; Needham and Roarty, 1980; Needham and Stuart-Smith, 1980; Raffensperger and Garven, 1995a; Raffensperger and Garven, 1995b; Rossiter and Ferguson, 1980; Snelling, 1990; Solomon and Groves, 1994; Stuart-Smith et al., 1993; Stuart-Smith et al., 1980; Sweet, 2001; Tucker et al., 1980; Wilde et al., 1989; Wilde and Noakes, 1990; Wyborn, 1990).

The oldest rocks (Figure 3) exposed in the Alligator Rivers region, belonging to the 2500 Ma (late Archaean) Nanambu Complex, outcrop sparsely in Kakadu National Park and include paragneiss, orthogneiss, migmatite, granite and schist (Needham, 1988). The Archaean complexes form structural domes that are unconformably overlain by metasediments and minor metavolcanics of the Palaeoproterozoic Pine Creek Succession or Supergroup (PCS), which constitutes the Pine Creek Orogen tectonic unit (formerly the Pine Creek Geosyncline). In the Alligator Rivers region, the PCS initiates with meta-psammitic and quartzose rocks of the Mount Howship Gneiss and Kudjumarndi Quartzite (both Kakadu Group). These are interpreted to be laterally equivalent to the Mount Basedow Gneiss and Munmarlary Quartzite respectively (Ferenczi et al., 2005). This Group appears to onlap the Archaean basement highs, but gneissic variants are also reported to be transitional into paragneiss of the Nanambu Complex (Needham, 1988).
The Cahill Formation and Masson Formation of the Namoona Group (Ferenczi et al., 2005) conformably overlie the Munmarlary Quartzite, the Cahill Formation being informally mapped as two subunits or members (Needham, 1988). The Lower Cahill Formation hosts the main uranium (Figure 3) ore bodies in the region (e.g. Nabarlek, Ranger and Jabiluka) and consists of a basal calcareous marble and calc-silicate gneiss unit that is overlain by pyritic, garnetiferous and carbonaceous schist (meta-pelite), quartz-feldspar-mica gneiss (meta-arkose) and minor amphibolite. The Upper Cahill Formation is more psammitic, comprising feldspar-quartz schist (meta-arkose) and quartzite, lesser mica-feldspar-quartz-magnetite schist (meta-pelite), and minor conglomerate and amphibolite. It also contains the mafic to intermediate Stag Creek Volcanics, which has a SHRIMP U-Pb age of 2048±13 (Ferenczi et al., 2005). The Cahill Formation is notably magnetic, in particular the base of the upper psammitic unit (also known as ‘hanging-wall sequence’ at Ranger), due to the presence of mafic sills and/or magnetite, providing a means of spatially distinguishing it from underlying and overlying less magnetic formations (Kendall, 1990). The Masson Formation is generally considered to be the lower grade metamorphic equivalent of the Cahill Formation.

The unconformably overlying Nourlangie Schist is a monotonous succession of argillaceous to quartzose phyllite and quartz-mica schist that locally contains garnet and staurolite. Nourlangie Schist is interpreted to be the eastern temporal correlative of the combined interval – Mundogie Sandstone and Wildman Siltstone (Mount Partridge Group), and Koolpin Formation, Gerowie Tuff and Mount Bonnie Formation (all South Alligator Group) (Needham, 1988). Some authors argue that temporal equivalents of the Mundogie Sandstone are absent east of the South Alligator River (Ferenczi et al., 2005), but it may not be possible to distinguish facies variants at the Cahill Formation-Nourlangie Schist level. Wildman Siltstone is characteristically composed of silty carbonaceous phyllite, sandy ferruginous siltstone and shale, consistent with a Nourlangie Schist ‘protolith’.

Early stratigraphic columns also included the Kapalga Formation as a lateral equivalent of the Nourlangie Schist (Needham et al., 1983), however, outcrops formerly mapped as this unit in the Mount Evelyn sheet are now re-assigned to South Alligator Group (Ferenczi and Sweet, 2004). As a result, the name Kapalga Formation will probably be abandoned and various outcrops throughout the eastern PCI re-assigned to other units. Lithological descriptions of the Kapalga Formation (Needham et al., 1983) – ferruginous, pyritic and carbonaceous chert-banded metasiltstone (slate/phyllite) or biotite schist, garnetiferous schist and quartzite – are consistent with the lower metamorphic grade Koolpin Formation, which hosts a number of gold prospects and deposits in the central PCI (Ahmad, 1998). However, calcareous and dolomitic lithologies (including stromatolites) and banded iron formation that are also common in the Koolpin Formation are not documented in the Kapalga Formation. The overlying Gerowie Tuff and Mount Bonnie Formation in the central PCI comprise variously interbedded massive silicic-potassic tuffaceous chert, carbonaceous clayey siltstone, coarse ‘greywacke’ and lithic sandstone. Metamorphosed equivalents of these lithologies have not yet been recognised in the Nourlangie Schist, suggesting either facies variation, onlap/pinchout, erosional removal or a lack of definitive exposure in the east.

The age of the Nourlangie Schist is only constrained by its inferred correlatives. The Wildman Siltstone is about 2025 Ma and the Gerowie Tuff is 1863±2 Ma, based on SHRIMP U-Pb zircon dating (Worden et al., 2004). Large time breaks are obviously present in the succession.
Mafic sills and dykes including the Goodparla and Zamu Dolerites intrude the PCS, with the former common in the upper Cahill Formation and the latter prolific in the South Alligator Group (Warren and Kamprad, 1990). Lower metamorphic grade rocks have typical dolerite textures, but in the Alligator Rivers region, they are generally amphibolite sensu stricto. Regardless, these dykes impart a magnetic signature to their respective hosts where they contain residual magnetic phases.

The sedimentary and igneous rocks of the PCS are structurally complex, having undergone at least three recognisable phases of deformation (Thomas, 2002) related to Top End Orogeny (1880 to 1780 Ma). They have also undergone high-temperature/low-pressure prograde metamorphism, including local migmatisation and remobilisation, during the ~1850-1860 Ma Nimbuwah Event of the Barramundi Orogeny (Page and Williams, 1988). The intensity of metamorphism and deformation varies across the region, with the western and eastern margins of the Pine Creek Inlier (Litchfield Province and Nimbuwah Domain respectively) showing the most pronounced effects. In the Nimbuwah Domain or Alligator Rivers region, there is a broad trend of increasing grade from southwest to northeast. This gradient clearly reflects synchronous emplacement of the 1865 Ma Nimbuwah Complex granitoids in that area. Distinctions based on metamorphic grade and protolith type have been made on regional maps (Needham, 1988) and are summarised below.

Greenschist to amphibolite facies metasedimentary rocks in the southwest can generally be distinguished stratigraphically and are assigned to specific formations and groups.

1. Amphibolite to granulite facies metasedimentary rocks that lie between the Nimbuwah Complex in the northeast and the areas of better-defined stratigraphy in the southwest are mapped as Myra Falls Metamorphics. They incorporate outcrop that cannot be distinguished from the Zamu Dolerite and Kakadu, Mount Partridge, Namoona or South Alligator Groups, but where a sedimentary precursor can be demonstrated (Needham, 1988). Rocks with a likely felsic igneous protolith are assigned to the Nimbuwah Complex (see below).

2. Magmatic rocks (mostly I type granodiorite) and felsic to intermediate migmatite and granulite in the northeast are distinguished as the Nimbuwah Complex. These rocks have a relatively simple isotopic character (Page and Williams, 1988) that suggests an entirely igneous protolith. However, there is some doubt about this distinction, as much of the mapped Nimbuwah Complex around King River appears to have a sedimentary protolith (e.g. lit par lit zones).

Metamorphic, igneous and sedimentary rocks of the PCS have been intruded (Figure 3) by later Palaeoproterozoic ‘post-orogenic’ granites of the Cullen Batholith, including the Jim Jim and Mount Bundey Granites (Jagodzinski and Wyborn, 1997).

The PCS and Cullen Batholith are locally overlain by felsic volcanic rocks belonging to the Edith River and El Sherana Groups, which are comagmatic with the Cullen Batholith (Jagodzinski, 1992). These units are thickest in the south in the South Alligator Fault Zone and are generally absent in the Alligator River region due to Palaeoproterozoic erosion.

The various basement units are unconformably overlain by the Kombolgie Subgroup, the basal unit of the late Palaeoproterozoic Katherine River Group, McArthur Basin (Sweet et al., 1999a; Sweet et al., 1999b) (Figure 3). This subgroup consists of a series of sandstone
formations (Mamadawerre, Gumarrirnbang and Marlgowa Sandstones), which are divided by thin basaltic units (Nungbalgarri and Gilruth Volcanics). The minimum age of the Mamadawerre Sandstone is 1725 Ma based on geochronology of the Oenpelli Dolerite (see below). Detrital zircon SHRIMP data from the GA OZCHRON database constrain the maximum age as ~1810 Ma. The true age is probably close to 1800 Ma (Rawlings, 2002). The sandstones form a flat-lying or shallow southeast-dipping strongly-jointed platform, called the Arnhem Land Plateau. The eroded edge of the Mamadawerre Sandstone forms the characteristic Arnhem Land escarpment and the isolated sandstone mesas and ranges on the coastal plain. The middle to upper part of the Katherine River Group is exposed ~50 km further to the southeast near Mount Marumba (Sweet et al., 1999b).

The Oenpelli Dolerite is the most pervasive mafic intrusive suite to affect the Alligator Rivers region and is the youngest Precambrian rock unit exposed. It intrudes various levels of the stratigraphy, including the PCS and Kombolgie Subgroup (Figure 3), forming highly magnetic sills, dykes, lopoliths and laccoliths. Intrusions can be either concordant or discordant with Palaeoproterozoic stratigraphy. This unit is currently constrained by a SHRIMP baddeleyite date of 1723±6 Ma (Ferencki et al., 2005), however, geochemical and geophysical data suggest several phases of intrusion throughout the region. At least one phase correlates with emplacement of the Nungbalgarri Volcanics at about 1780 Ma (Rawlings, 2002). These intrusive events had a pronounced thermal effect within the Kombolgie Subgroup, with the promotion of fluid flow and aquifer/aquitard modification. Localised effects in the sandstone include silicification, desilicification and introduction of chlorite, muscovite and pyrophyllite in active aquifer systems. A characteristic mineral assemblage of prehnite-pumpellyite-epidote has formed in the quartzofeldspathic basement rocks adjacent to the intrusions.

Field relationships between the Tin Camp Creek Granite and Kombolgie Subgroup are locally ambiguous. Although some outcrops show the Tin Camp Granite unconformably overlain by Mamadawerre Sandstone, locally pervasive silicification and up-doming of the sandstone above this granite is more consistent with emplacement as a sill at the basement-sandstone unconformity and subsequent thermal metamorphism of the sandstone. These observations may be explained by long-lasting radiogenic-driven fluid flow and silicification above the granites and vertical structural displacement of the granite (i.e. isostatic uplift or solid state diapirism).

Deformation since deposition of the Katherine River Group includes transpressional movement along steep regional-scale strike-slip faults and possibly some shallow thrusting. These regional faults follow a pattern of predominantly north, northwest, north-northwest and northeast strikes, giving rise to the characteristic linearly dissected landform pattern of the Kombolgie plateau (Figure 3). Another significant set trends east-west and includes both the Ranger and Beatrice Faults. The Bulman Fault Zone is a principal regional feature and is considered to represent a long-lived deep crustal structure, with a large lateral component in rocks of the PCS. However, it is clear that post-Kombolgie displacements along this and other faults have not been great because the Arnhem Land Plateau is essentially coherent and offsets along lineaments are generally minor. Field investigations of many interpreted ‘faults’, including those with a marked geomorphic expression, show no displacement, and are best described as joints or lineaments (Thomas, 2002).
Erosional remnants of flat-lying Palaeozoic Arafura Basin and Cretaceous Carpentaria Basin are present as a veneer throughout the coastal zone of the Top End. Various regolith components are also recognised in the region.

**Local Geology of Kukalak**

Kukalak lies at the eastern extremity of the Myra Falls Inlier and at the north eastern extremity of the Caramal Inlier. Lower Kombolgie Subgroup rocks overlie the majority of the tenement, with minor exposed basement rocks where the Caramal Inlier and Myra Falls Inlier encroach onto the tenement. The most visibly obvious structure in the tenement is a deeply incised curvilinear feature, herein informally termed the Kukalak Valley. This feature has previously been inferred to be a shallow southwest-dipping reverse fault, the ‘Goomadeer Thrust’ (Otto et al., 2003; Rippert, 1992; Taylor, 1999; Thomas, 2002). It is overall northwest to southeast oriented, and in part traces the Goomadeer River. It is now thought to represent the margin of an uplifted block of sandstone above a dolerite sill or laccolith.

The Caramal and Myra Falls Inliers are the only locations of exposed basement rocks on the Kukalak tenement. Mapping within the Caramal East Re-entrant identified porphyroblastic quartzofeldspathic gneiss assigned to the Nimbuwah Complex. Mica rich, biotite rich and quartz rich feldspar gneiss and schist are assigned to the Myra Falls Metamorphics. The lack of clear marker horizons, such as the Kudjumarndi Quartzite, makes correlations difficult, but on the basis of comparison, the lithologies appear consistent with Cahill Formation and Mount Howship lithologies seen on the nearby Myra and Tin Camp exploration licences. Minor contained mafic amphibolite is correlated to the Zamu Dolerite. Uranerz mapped one small area of porphyroblastic gneiss in the Caramel Re-entrant that they believed is Archaean in age, but this has not been confirmed by Cameco. Basement rocks are in turn intruded by thick sills of the Oenpelli Dolerite. Tin Camp Creek Granite is best exposed immediately to the west of the property boundary within the Caramal Inlier, and is exposed to the north in Myra Falls Inlier. Cameco mapping suggests it is more widespread in the northern half of the tenement, including in the Dog Leg area and along the Quarry Fault. Diamond drilling data indicate that Nimbuwah Complex dominates the subsurface basement geology in the southern and western portions of the tenement. The eastern area has not been drilled and basement lithology is unknown.

The Palaeoproterozoic sedimentary and volcanic Kombolgie Subgroup of the McArthur Basin overlies basement in the Kukalak tenement. The Mamadawerre Sandstone, the oldest formation of the Kombolgie Subgroup, occupies most of the western portion of the tenement, where it forms the deeply dissected plateau surface. This area is composed largely of bare rock with sparse areas of shallow sandy soil supporting Spinifex and scrub. Plateau escarpments are developed surrounding the Caramal and Myra basement inliers.

Mamadawerre Sandstone is unconformably overlain by Nungbalgarri Volcanics. The unconformable contact is expressed locally as 100-500 m diameter subcircular depressions (‘dome and basins’), with the upper sandstone surface interpreted to represent the palaeotopographic surface of giant lunate current ripples or aeolian sand dunes with the volcanics draped over the top (Nott and Ryan, 1996). It may also represent large dewatering structures formed as a result of hot volcanic rocks draped...
over water-saturated sediments, which were deposited in estuarine conditions (Needham, 1978). The Nungbalgarri Volcanics consist of multiple vesicular and amygdaloidal basaltic flows 100-200 m thick.

The Gumarrirnbang Sandstone disconformably overlies Nungbalgarri Volcanics. The sandstone comprises fine to coarse-grained quartz arenite with scattered pebbly units. Sedimentary structures include planar and trough cross-stratification, ripples and horizontal planar stratification, suggesting a proximal to distal fluvial braided stream and estuarine depositional environment.

Oenpelli Dolerite intrudes the Kombolgie Subgroup as sills and dykes. Significant exposure of dolerite occurs as a curvilinear intrusive, which may be partly fault controlled, along the Kukalak Valley.

Undifferentiated Cretaceous rocks have been mapped in the south of the tenement on the Milingimbi 1:250,000 map sheet (Carson et al., 1999). The rocks are exposed as weathered outcrops of lateritised sandstone and siltstone forming resistant mesa-like ridges.

EXPLORATION TARGET

The focus of the Cameco exploration strategy is the discovery of unconformity style uranium deposits. The nearby economic deposits at Ranger, Jabiluka, Koongarra and Nabarlek serve as exploration models. There is also potential for gold, palladium and platinum Coronation Hill (South Alligator Valley) style deposits in the region.

Given that there are local variations in geological setting (structure, host rock, element association), the deposits appear to have a common position relative to the base of the Kombolgie Subgroup i.e. the Palaeoproterozoic unconformity, or to its erosional margin. In several examples, down-faulted blocks of Kombolgie Sandstone (reverse faulting) are juxtaposed adjacent to the mineralisation, as at Ranger No. 3 orebody and the Hades Flat Prospect between Ranger and Jabiluka. These and other recognised features are considered to be indicative of a favourable setting for the concentration of mineralising fluids within a structurally disrupted unconformity setting.

Whilst the mineralisation discovered to date at Kukalak is low grade and small size, the area is considered prospective for unconformity related uranium-gold-PGE mineralisation based upon the following:
- proximity to the unconformity between metasedimentary packages and overlying Kombolgie Sandstone
- favourable lithologies
- association of chloritic and haematitic breccias in the vicinity of fault structures

The deposits of the South Alligator Valley (SAV) and the Rum Jungle-Waterhouse region also exhibit a spatial relationship to Palaeoproterozoic unconformities. The SAV deposits are ‘capped’ by the Kombolgie Subgroup sandstone and have an igneous affiliation (sub-volcanic intrusive). They tend to be more gold enriched and are characterised by the presence of palladium and platinum selenides. The Sargeants and Kylie styles of mineralisation, located south of Rum Jungle on the fringe of the Archaean Waterhouse Complex, have some
similarities to the SAV with Au-PGE enrichments in association with uranium. The Depot Creek Sandstone, the basal unit of the Tolmer Group, unconformably overlies these deposits, which are hosted in a carbonate-carbonaceous schist sequence.

EXPLORATION PROGRAM

Exploration throughout EL23462: 1970 - 2007

Exploration began in the Kukalak tenement after the discovery of the Ranger and Nabarlek ore-bodies, in the Alligator Rivers Region, in 1969 and 1970 respectively. Esso Minerals (Esso) and Queensland Mines Pty Ltd (QMPL) carried out exploration work over the tenement in the early 1970s until exploration was banned in the Alligator Rivers area in early 1973 by a federal government imposed moratorium on exploration, pending a resolution on the issue of Aboriginal Land Rights. QMPL conducted an airborne radiometric and magnetic survey over the Kukalak area during 1972. No exploration work was conducted from 1973 until Uranerz Australia Pty Ltd (Uranerz) negotiated rights to explore the Kukalak tenement and undertook exploration (Table 1) between 1987 and 1994 (Barrett, 1988a; Barrett, 1988b; Barrett, 1990; Barrett and Becker, 1989; Bruneton, 1993; Coles, 1988; Paterson, 1989; Rich and Bruneton, 1992; Rich and Fraris, 1988; Rippert, 1992; Swayze et al., 1992).

Table 1 Summary of Work Carried Out by Uranerz

Activities in the entire tenement between the late 1970’s and 2007 comprised: reconnaissance and anomaly-directed outcrop sampling; ground-proofing of previous geological mapping and prospects; further geological mapping of various prospects; airborne magnetic, radiometric, Hyperspectral and TEMPEST surveys, and helicopter-assisted diamond drilling.

Exploration fieldwork in the area of relinquishment: 2002 - 2007

Two hyperspectral survey lines just below the northern boundary. Airborne magnetic and radiometric anomalies, and four outcrop samples collected between 2002 and 2006 are within the relinquished area.

Procedures for outcrop sampling, sample preparation and geochemical analysis, and geophysical survey techniques are provided as Appendices to this report.

Table 2 Exploration Summary for proposed relinquished area of EL23462
Geophysics

Hyperspectral Survey

The survey data was collected over EL 8568 (Myra) and EL 9029 (Kukalak) of the Myra Kukalak project between July 9 and July 11, 2000. The scanner was operated by M. Hornibrook (Spectral Geology Pty. Ltd.) flown aboard Kevron Aviation’s Cessna 404 (VH-AZU). Sixteen alternating north-south and south-north flight lines of data were collected at a ground speed of 140 knots from an altitude of approximately 2800 m, providing a ground resolution of approximately 5.6 m. Relatively constant solar illumination was maintained by collecting the data near midday (between 10:06 AM. and 3:03 PM local time) with cloud cover less than or equal to 1/8.

The De Beers HYMAP Mark I instrument was built by Integrated Spectronics Pty. Ltd (ISPL) in 1996 and is a similar system to the Probe-1 and a later version of the ISPL HYMAP scanner. It is a 96-channel, 3-spectrometer, whiskbroom scanner with a signal to noise ratio greater than 800:1. The scanner measures reflectance from the ground surface, with each spectrometer consisting of 32 channels with an approximate 15 nm spectral resolution; VNIR from 500 to 1000 nm, SWIR1 from 1400 to 1900 nm, and SWIR2 from 2000 to 2450 nm. While most of the geological information is detected by SWIR2 (clays, carbonates, sulphates, etc), the VNIR range can map Fe-oxides and hydroxides, vegetation, and general land cover. Although the most diagnostic spectral features are contained within specific windows or wavelength regions, full VNIR to SWIR spectral sampling is advantageous for properly correcting the data for atmospheric effects.

A DVD containing all available data from the Hyperspectral survey, in the proposed area for relinquishment, has been provided with this report.

Airborne magnetic-radiometric-DTM Survey

In 2001 and 2005, UTS Geophysics Pty Ltd of Perth conducted a detailed airborne magnetic and radiometric survey over the Kukalak tenement. Both surveys were flown at a line spacing of 50m and a flying height of 30m (the 2001 survey totalled 548 line kilometres, while the 2005 survey totalled 976 line kilometres). The survey was designed to specifically target the Dog Leg, Devil’s Elbow, Ferricrete and China Block prospects. The proposed relinquishment areas were not covered by this survey. The radiometric anomalies identified in (Figure 4) are from public domain radiometric/magnetic data collected by Uranerz.

Figure 4 Location of radiometric and magnetic anomalies
Outcrop Sampling

The various outcrop sampling programs conducted throughout the tenement were designed to:

- provide a semi-regional lithogeochemical and clay mineralogy dataset as a basis for the definition of alteration systems and anomalous areas believed to be associated with unconformity-style uranium mineralisation;
- follow-up airborne magnetic, Hyperspectral and radiometric anomalies from surveys conducted during the five years of tenure;

Uranerz conducted extensive regional scale sampling and detailed sampling of the Kombolgie Subgroup sandstone cover sequence during their term of exploration. The level of sampling coverage should have discovered any obvious U mineralisation on the project. The Uranerz geochemical detection limits, by today’s modern standards are high, and subtle geochemical anomalies, if they exist, may have been missed or were below the level of detection.

Cameco selected areas of investigation based on a model that any mineralisation requires a post-Kombolgie structural element in order to focus and provide a pathway for basinal fluids to interact with basement fluids and form a deposit. Therefore sampling was concentrated within and proximal to identified lineaments from remote sensing imagery, as it was believed that these areas might have been the surficial expression of structural elements, where alteration fluids may have interacted with the wall rocks.

Four samples (KL010080C1, KL010081C1, KL010082C1, KL010083C1) are on the area of relinquishment. Refer to Figure 5 for their locations and Table 3 and Table 4 for assay results and their physical properties including geochemical alteration, lithological descriptions, gamma responses and magnetic susceptibilities.

Appendices 1 to 7 provide the procedures used for outcrop sampling, processing and sample preparation.

CONCLUSIONS
The hyperspectral survey identified a couple of anomalies in the relinquishment area that are most likely associated with the Nungbulgarri Volcanics. The survey did not provide any useful information for future exploration in the region. Uranerz radiometric/magnetic data was used to define several anomalies in the relinquished areas. The northern-most anomaly in the northern-most relinquished area was sampled, but the assay results did not yield any significant data; the highest uranium assay result was 51.8 ppm (Sample KL040080C1) in coarse-grained Gumarrirnbang Sandstone (Figure 5).


