Cameco Australia Pty Ltd

EL 23700

NAMARRKON PROJECT
NORTHERN TERRITORY

RELINQUISHMENT REPORT

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DRDPIFR - Minerals and Energy (1)
Northern Land Council (1)
SUMMARY

The Namarrkon Project consists of a single Exploration Licence, EL23700. The license is located in western Arnhem Land in the Alligator Rivers uranium field approximately 250 km east of Darwin and approximately 75 km northeast of Jabiru.

EL23700 was granted on 31st May 2005 to Cameco Australia Pty Ltd (Cameco) for an initial period of six years. The project is operated and managed by Cameco in joint venture with Uranium Equities Limited (UEL) who currently hold 40% interest in the tenement.

On 31st May 2010, the anniversary of the fifth year of tenure, Cameco relinquished 17 blocks for 56.8 km². This report details exploration work conducted during the period of tenure.

Cameco reprocessed Tempest electromagnetic data collected by Afmex in 2001; commissioned a HyMap survey over the project; and collected 23 outcrop samples and one water sample.

The result from this work is disappointing and no further work on the relinquished area was deemed to be warranted.
# TABLE OF CONTENTS

Summary .................................................................................................................................... 1  
Introduction ................................................................................................................................ 1  
Location and Access .................................................................................................................. 1  
Tenure ........................................................................................................................................ 1  
Regional Geology ...................................................................................................................... 2  
  Local Geology .......................................................................................................................... 4  
Previous Exploration .................................................................................................................. 5  
  EL3589 – Afmex, Namarrkon Joint Venture: 1996-2002 ........................................................... 5  
Exploration During Period of Tenure 2005 – 2010 ................................................................... 6  
  Regional Outcrop Sampling and Reconnaissance .................................................................. 6  
  Geophysical Surveys ............................................................................................................... 7  
  TEMPEST ............................................................................................................................... 7  
  HYMap ................................................................................................................................. 8  
Conclusions ................................................................................................................................ 8  
References .................................................................................................................................. 9  

# LIST OF FIGURES

Figure1: Project Location Map .................................................................................................. 1  
Figure 2: Location of Relinquished Blocks ............................................................................... 1  
Figure 3: Simplified geology of the Pine Creek Orogen showing the location of selected mineral deposits ................................................................................................................. 2  
Figure 4: AGSO Pine Creek Orogen 1:500,000 Geology .......................................................... 2  
Figure 5: Namarrkon Project - Local Geology ......................................................................... 4  
Figure 6: Location of Diamond Drill Holes (Afmex 1998 - 2000) .......................................... 6  
Figure 7: Location of Sample Sites .......................................................................................... 6  

# LIST OF TABLES

Table 1: Location of Samples Sites ........................................................................................... 6  
Table 2: Sample Descriptions and Properties ............................................................................ 7  
Table 3: Outcrop Sample Structure Measurements ................................................................... 7  
Table 4: Outcrop Sample Alteration ......................................................................................... 7  
Table 5: Outcrop Sample TSA Clay Minerals ........................................................................... 7  
Table 6: Outcrop Sample Geochemistry Results ..................................................................... 7  
Table 7: Water Sample Analytical Results ................................................................................ 7  

# LIST OF APPENDICES

Appendix 1: Cameco Standard Outcrop Sampling and Processing Procedures ...................... 7  
Appendix 2: HyMap Survey Logistics Report .............................................................................. 8
INTRODUCTION

Namarrkon Project is a uranium project solely comprised of Exploration Licence 23700 (EL23700). The licence was granted to Cameco Australia Pty Ltd (Cameco) on 30th May 2005.

EL23700 is located within the Arnhem Land Aboriginal Reserve and is subject to a Consent Deed with the Northern Land Council (NLC) and the Traditional Owners.

On 31st May 2010, Cameco relinquished 17 blocks from the original 30 blocks.

This report details exploration covering the relinquished portion of the Exploration Licence.

LOCATION AND ACCESS

The Namarrkon Project is located in West Arnhem Land, entirely within Aboriginal Land (Figure 1). The project is approximately 50km east north east of Jabiru and 15km south east of the rehabilitated Nabarlek mine site. Darwin lies approximately 250 kilometres to the west.

Figure 1: Project Location Map

The project is covered by the 1:250000 Alligator Rivers (SD-5301) and the 1:100000 Oenpelli (5573) map sheets.

Rugged sandstone plateau almost entirely covers EL23700. Access is mainly by helicopter. Limited vehicle access is possible to small areas in the west and northern parts of the project area.

The exploration licence is located on Aboriginal land with all work programs carried out under the terms of consent documentation agreed with the Northern Land Council and the Traditional Owners, pursuant to the Aboriginal Land Rights Act 1973 (Northern Territory).

TENURE

Application for EL23700 was lodged on 27th March 2003 and grant of title was given to Cameco on 31st May 2005. The original area of the licence was 30 blocks for an area of 100.6 km². Approximately 3.1 km² of EL23700 was designated as ‘no-go’ and various other archaeological sites are excluded from exploration access.

EL23700 is subject to a Joint Venture agreement between Cameco and Uranium Equities Limited (UEL) who currently hold 40% interest in the project. Cameco is manager and operator of the project.

On 30th May 2010, Cameco relinquished 17 blocks for 56.8 km² in the eastern and western portions of the licence. The location of the relinquished area of EL 23700 is shown Figure 2.

Figure 2: Location of Relinquished Blocks
REGIONAL GEOLOGY

The regional geology of Arnhem Land has been systematically and intensely studied and described in detail since 1946, comprising work from the Bureau of Mineral Resources (BMR) (1972-1988), the Northern Territory Geological Survey (late 1990’s to 2008), Geoscience Australia (2004) and many previous reports for Cameco Exploration Licences in the western Arnhem Land area. Studies included geological mapping and reconnaissance, as well as regional-scale and deposit-scale metallogenic research. Only a brief summary and overview of the geology will be provided here. This section is largely based on the work by (Needham, Crick et al. 1980; Needham, Smart et al. 1983; Needham and De Ross 1990). Information that is not based on these references is indicated below.

The Namarrkon project area is located within the eastern margin of the Neoarchaean and Palaeoproterozoic Pine Creek Orogen, and is in a region that has been subdivided into the Nimbuwah Domain of the Alligator Rivers region (refer Figure 3 (Piranjo and Bagas 2008)).

Figure 3: Simplified geology of the Pine Creek Orogen showing the location of selected mineral deposits

Figure 4: AGSO Pine Creek Orogen 1:500,000 Geology

The Bureau of Mineral Resources (now Geoscience Australia) completed 1:250,000-scale geological maps of the Pine Creek Orogen between the 1940s and 1960s following the discovery of uranium at Rum Jungle near Batchelor. The Alligator Rivers region was systematically mapped by the BMR and the Northern Territory Geological Survey between 1972 and 1983. This later work produced 1:100,000-scale geological maps and reports for the region from Darwin to Katherine to the Alligator Rivers region (Refer Figure 4).

The oldest exposed rocks in the Alligator Rivers region are included in the Neoarchaean (ca. 2500 Ma) Nanambu Complex. The complex consists of paragneiss, orthogneiss, migmatite, and schist forming domical structures that are unconformably overlain by Palaeoproterozoic metasedimentary and metavolcanic rocks, which were formerly included in the Pine Creek Geosyncline. Recent collaborative research work by the NTGS and Geoscience Australia indicates that SHRIMP U-Pb age dating of an area of previously mapped Myra Falls Metamorphics outcropping within the Myra Inlier is Neoarchean in age and these quartzofeldspathic gneisses are named the ‘Kukalak Gneiss’ (Hollis, Carson et al. 2009a; Hollis, Carson et al. 2009b). Palaeoproterozoic rocks in the Alligator Rivers region are amphibolite-facies psammites assigned in the Mount Howship Gneiss and the Kudjumarndi Quartzite. These formations are included in the Kakadu Group and are probably correlatives of the Mount Basedow Gneiss and Munmarlary Quartzite, respectively (Ferenczi et al., 2005). The group appears to on-lap Neoarchaean basement highs, but gneissic variants are also thought pass transitional into paragneiss of the Nanambu Complex.

The Cahill Formation of the Namoona Group conformably overlies the Kudjumarndi Quartzite. The lower part of the Cahill Formation (informally referred to as the Lower Cahill Formation) hosts the Nabarlek, Ranger and Jabiluka uranium deposits. The Lower Cahill Formation consists of a structurally lower calcareous marble and calc-silicate gneiss, which is overlain by pyritic, garnetiferous and carbonaceous schist, quartz-feldspar-mica gneiss, and minor proportions of amphibolite.
The informally named Upper Cahill Formation is psammitic and consists of feldspar-quartz schist, quartzite, lesser proportions of mica-feldspar-quartz-magnetite schist, and minor proportions of metaconglomerate and amphibolite. The Upper Cahill Formation is magnetic and significantly so at the base of psammitic unit in what is informally known as ‘hangingwall sequence’. The magnetic characteristic of this unit is due to the presence of mafic sills or magnetite and it is a useful characteristic used to distinguishing the Cahill Formation from surrounding less magnetic rocks (Kendall 1990). Mafic sills and dykes assigned to the Goodparla and Zamu Dolerites intruded the Cahill Formation prior to metamorphism.

The Nourlangie Schist overlies the Cahill Formation and consists of argillaceous to quartzose phyllite and quartz-mica schist that locally contain garnet and staurolite.

The supercrustal rocks of the region are structurally complex, having been affected by at least three deformation event before deposition of the late Palaeo- to Mesoproterozoic Kombolgie Subgroup (Thomas 2002). The rocks have also been subject to local migmatisation during the ca. 1847-30 Ma Nimbuwah Event. In addition, there is a broad trend of increasing grade from southwest to northeast in the Nimbuwah Domain. This gradient is thought to reflect the synchronous emplacement of ca. 1865 Ma granites in the Nimbuwah Complex.

The Kombolgie Subgroup is the basal unit of the late Palaeo- to Mesoproterozoic Katherine River Group of the McArthur Basin (Sweet, Brakel et al. 1999; Sweet, Brakel et al. 1999). The subgroup consists of sandstone units called the Mamadawerre Sandstone, Gumarrimbang Sandstone, and Marlgowa Sandstone, which are divided by thin basaltic units called the Nungbalgarri Volcanics, and Gilruth Volcanics. The Mamadawerre Sandstone has a minimum age of ca. 1700 Ma, which is the minimum age of the intrusive Oenpelli Dolerite. Detrital zircon SHRIMP data from the GA OZCRON database constrain the maximum age of the sandstone at ca. 1810 Ma.

The Oenpelli Dolerite is the most pervasive mafic intrusive suite to affect the Alligator Rivers region and is the youngest Proterozoic rock unit exposed. It intrudes various units Neoarchaean and Palaeoproterozoic units, and the Kombolgie Subgroup, forming magnetic sills, dykes, lopoliths, and laccoliths. The Oenpelli Dolerite has a SHRIMP U-Pb baddeleyite date of 1723 ± 6 Ma (Ferenczi, Sweet et al. 2005), however, geochemical and geophysical data suggest several phases of intrusion throughout the region. These intrusive events had a pronounced thermal effect within the Kombolgie Subgroup, with the promotion of fluid flow and aquifer or aquitard modification. Localised effects in the sandstone include silicification, desilicification, chloritisation, sericitisation, and pyrophyllite alteration. A characteristic mineral assemblage of prehnite-pumpellyite-epidote has formed in the quartzofeldspathic basement rocks adjacent to the intrusions.

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. 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
appears 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 ubiquitous as cover throughout much of the region.

**Local Geology**

EL23700 is almost completely covered by Palaeoproterozoic sedimentary and volcanic Kombolgie Subgroup. Basement rocks are present in the far northeastern corner of the tenement at the base of the Stevens fault-bound Mamadawerre Sandstone escarpment, although these are largely obscured by Quaternary cover. Figure 5 displays the local project geology of the Namarrkon project.

**Figure 5: Namarrkon Project - Local Geology**

The Mamadawerre Sandstone, the oldest formation of the Kombolgie Subgroup, occupies most of the tenement, where it forms a 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 to the north of the tenement along the Stevens Fault.

Mamadawerre Sandstone is unconformably overlain by the Nungbalgarri Volcanics. The unconformable contact is expressed locally as 100 – 500m diameter circular 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 dome and basin structures dominate airborne imagery of the southern-central part of the tenement with its’ unique dimpled pattern.

The Nungbalgarri Volcanics itself consists of multiple vesicular and amygdaloidal basaltic flows approximately 100 – 200m thick. Following airborne radiometric surveys by BMR in 1971-72 (Horsfall and Wilkes 1975) it was noted that ferricrete developed downslope of the outcropping Nungbalgarri Volcanics displays elevated U/Th ratios and forms prominent radiometric anomalies (Needham 1988).

The Gumarrirnbang Sandstone disconformably overlies the Nungbalgarri Volcanics forming restricted outcrop occurrences in EL23700. 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 Mamadawerre Sandstone as sills and outcrops at several localities, most notably along the arcuate Spencer Thrust extending from the centre to the west of the tenement. Oenpelli Dolerite is also present along the Stevens Fault in the north east of the tenement.

Previous explorers (AFMEX), with later modifications by Cameco, have developed a detailed stratigraphy correlating metasedimentary rocks of the Myra Falls Metamorphics with the lower-grade Cahill Formation. In Western Arnhem Land the AFMEX stratigraphy correlates the Upper Cahill formation with the ‘Upper Arkosic Unit,’ which consists of alternating meta-arkose (quartz–biotite–muscovite gneiss) and biotite–muscovite–quartz schists.

The Lower Cahill formation correlates with three units, the upper ‘Amphibolitic Unit,’ the middle ‘Lower Arkosic Unit’ and the basal ‘Calc-silicate Unit.’ The ‘Amphibolitic Unit’ is characterized by para- and ortho-amphibolites (~40%) interbedded with biotite-muscovite schists. The ‘Lower Arkosic Unit’ consists of biotite-muscovite schists, some with garnet and/or sillimanite and rare graphite alternating with fine-grained meta-arkose and occasional amphibolite beds. The ‘Calc-silicate Unit’ contains amphibolites, garnet-mica schists, calc-silicate gneisses marbles and cherts.

A number of large structures pass through the tenement. The Spencer thrust runs west – northwest through the central part of the tenement and exhibits a north-side-up movement ((Kastellorizos, Moreau et al. 1999)). The Quarry fault runs north – south through the tenement, passing through Kukalak Valley to the south of Namarrkon and disappears under cover to the north. To the north of the Spencer thrust, the Quarry fault has a surface expression of silicified sandstone breccias.

The Stevens fault in the northeast of the tenement strikes east – west through Namarrkon and the adjacent Cadell project (ERL 25896) to the east. Two well-defined faults, the Lightning and Thunder faults run west-north-westerly through the northern half of the tenement and continue into the adjacent Nabarlek (EL10176) and Cadell projects. Oenpelli Dolerite has intruded along these faults.

The Namarrkon lineament is a regional lineament originating near the northeast corner of Namarrkon and striking west-southwest for over 50km. The extent of movement, if any, on this feature is not known.

PREVIOUS EXPLORATION

Exploration in the Alligator Rivers region of the Northern Territory can be divided into two phases. The first phase of exploration commenced in 1970 and continued until September 1973 when a Federal Government moratorium on mineral exploration on Aboriginal Land halted exploration activity. Exploration in West Arnhem Land recommenced in 1986 and on the Namarrkon Project area in 1996.

EL3589 – Afmex, Namarrkon Joint Venture: 1996-2002

Details of exploration conducted by AFMEX on EL3589 can be found in the respective annual reports (Kastellorizos 1998; Kastellorizos, Moreau et al. 1999; Fabray 2000; Wollenberg 2001; Fabray 2002). A brief summary of this activity follows.
Afmex conducted various airborne geophysical surveys including radiometrics, magnetics, electromagnetics (DIGHEM and TEMPEST), and helicopter supported gravity; small ground geophysical surveys including electromagnetics (NanoTem), induced polarisation (IP) and radiometrics; ground radiometric follow-up and outcrop sampling, and stream sediment sampling; and helicopter-supported diamond drilling of 12 holes (NAM-001 to NAM-012) for 3,691.2 m.

The diamond drilling was conducted over two years from 1998 to 2000. Eight holes (NAM-001 to NAM-008R) were planned to determine the geology of the basement rocks and determine alteration and/or mineralisation prospectivity of the targeted areas. Four holes (NAM-009 to NAM-012) drilled to follow up alteration and structural disruption intersected in NAM-002. Results from the drilling were disappointing with the highest result of 2.8 ppm U₃O₈.

Of these holes that we drilled, nine of them lie within the area of relinquishment; NAM-001, NAM-002, NAM-005, NAM-006, NAM-007, NAM-009, NAM-010, NAM-011 and NAM-012 (Figure 6).

Figure 6: Location of Diamond Drill Holes (Afmex 1998 - 2000)

EL3589 was relinquished on 26th July 2002.

EXPLORATION DURING PERIOD OF TENURE 2005 – 2010

Cameco was granted EL23700 on 31st May 2005 covering the same area as the former EL3589. The original area of the license was 30 blocks for an area of 100.6 km². On 31st May 2010, the anniversary of fifth year of tenure, Cameco relinquished 17 blocks for 56.8 km² in the eastern and western portions of the licence. No previous relinquishments of the license area have been made.

Cameco has conducted various exploration programs over the relinquished portion of EL23700. Exploration within the area of relinquishment has consisted of reprocessing of the Tempest electromagnetic survey data collected by Afmex in 2001; a HYMap survey in 2006; and sampling, reconnaissance and mapping.

Regional Outcrop Sampling and Reconnaissance

During the period of tenure, helicopter-supported and ground-based outcrop sampling, mapping and reconnaissance, follow-up investigations have been conducted within the area of relinquishment. A total of 24 sites were recorded, with 23 outcrop samples and one water sample collected. Refer to Figure 7 for the location of the sample sites and a summary of the locations and lithologies is given in Table 1.

Figure 7: Location of Sample Sites

Table 1: Location of Samples Sites

The outcrop sampling and processing was performed using Cameco standard methodology, as outlined in Appendix 1. This appendix details methodology used for reflectance spectroscopy, laboratory techniques and methods, and analysed elements.
All samples were submitted to Northern Territory Environmental Laboratories (NTEL) in Darwin for geochemical analysis. The laboratory sample preparation, analytical methods and techniques and analysed elements can also be found within Appendix 1.

Appendix 1: Cameco Standard Outcrop Sampling and Processing Procedures

The following tables details the data and results from samples collected during the program.

Table 2: Sample Descriptions and Properties

Table 3: Outcrop Sample Structure Measurements

Table 4: Outcrop Sample Alteration

Table 5: Outcrop Sample TSA Clay Minerals

Table 6: Outcrop Sample Geochemistry Results

Table 7: Water Sample Analytical Results

The results from the sampling indicate that elevated uranium results are coincident with a high Fe$_2$O$_3$ content. These rocks are strongly hematite altered; however the hematite and uranium content is related to surficial weathering processes rather than a hydrothermal mineralising event. In all cases, mafic rocks of the Nungbalgarri Volcanics or Oenpelli Dolerite outcrop in close proximity to the samples, with Fe$_2$O$_3$ sourced and liberated by the weathering process of the mafic igneous rocks.

Geophysical Surveys

TEMPEST

In 2001, AFMEX flew a 200 m line spaced TEMPEST electromagnetic survey over the project area. The TEMPEST survey was a relatively early application of the technology to the Arnhem Land environment, and Afmex raised concerns about the quality of the data.

Cameco contracted Fugro to reprocess the data in 2005. The reprocessing did not use HPRG (height, pitch, roll and geometry) correction as this introduces topographic effects in the data. Fugro also calculated time-constant grids, which were not part of the original processing. After the reprocessing, the data appeared to be of better quality than what had been suggested by Afmex.

The Tempest survey showed a number of deep conductors in the western portion of the relinquished area, however these were not deemed to be high priority targets, and have not been followed up with further exploration.
HYMap

HyVista Corporation was contracted by Cameco to acquire HyMap airborne hyperspectral scanner imagery over EL23700, with the survey flown on 19th August 2006 (refer Appendix 2). Cameco subsequently commissioned HyVista to process the strip images from the survey to produce various image maps that highlight mineralogical and geological variations.

Appendix 2: HyMap Survey Logistics Report

No anomalies of potential hydrothermal origin that could be attributed to a mineralising event were identified within the survey.

Raw data from the HyVista HyMap airborne survey is provided on 2 DVD’s and accompanies this report.

CONCLUSIONS

The exploration work that has been conducted on the relinquished portions of EL23700 suggests that there is little indication of uranium mineralising processes within the area of focus. The elevated uranium reported from the outcrop sampling is interpreted to be the result of surficial weathering processes rather than unconformity related uranium mineralising processes. The HYMap survey did not identify any potential alteration that can be attributed to a mineralising event within the project. The reprocessed Tempest electromagnetic data identified deep conductive targets in the west of the licence area, but further work on these targets was not considered to be warranted.
REFERENCES


