

## WELLINGTON RANGE PROJECT

# EL 5893

# ANNUAL REPORT

# CONFIDENTIAL

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## SUMMARY

This report describes exploration work undertaken on the Wellington Range Project during the first year of tenure. The tenement was granted on 5 May 2004 for an initial period of six years.

Field activities during the reporting period consisted of four days of helicopter assisted sampling, radiometric anomaly follow-up, reconnaissance and familiarisation of project geology. Airborne magnetic and radiometric surveys and a hyperspectral survey have been flown over the project area, with the latter conducted only over the sandstone covered portion of tenement.

Radiometric anomaly follow-up of the thirteen anomalies identified on the project were found to be mainly pebble and conglomeratic beds within the basal portion of the Mamadawerre Sandstone, and from geochemical analysis most of the sampled anomalies are due to thorium enrichment.

Regional base-line sampling has been completed over the outcropping sandstone on the tenement with a sampling density of approximately one sample per one square kilometre.

Future work would consist of an evaluation of targets generated from the hyperspectral clay interpretation, and an airborne TEMPEST electromagnetic survey.

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## **INTRODUCTION**

This report describes exploration activities carried out from 5 March 2004 to the anniversary date on EL 5893 known as the Wellington Range Project. The Exploration Licence is located on Aboriginal Land and the exploration program was carried out under the terms of consent documentation agreed with the NLC pursuant to the Aboriginal Land Rights (Northern Territory) Act 1976.

The field program for the first year consisted of airborne geophysical surveys, and ground based field activities.

### **Location and Access**

The tenement is located in western Arnhem Land immediately to the north-east of the Aboriginal settlement of Gunbalanya and is wholly within Aboriginal Land. The Ranger uranium mine is situated approximately 100 km to the south-west and the rehabilitated Nabarlek site is to the south-east of the project area. Access from Darwin is via the Arnhem Highway to Jabiru then north to Gunbalanya, continuing on to the turn off to Gurig National Park, Coburg Peninsula. The Gurig National Park road traverses immediately to the east of the licence area. One pre-existing track provides access to the Sandy Creek telecommunications tower and services remote outstations further to the west of the licence area.

The country is variable, ranging from flat lying woodland, river estuary, coastal mangroves and swamps to heavily dissected sandstone plateau. Where flat lying, the country may be traversed by four-wheel drive vehicle. Access to the sandstone plateau would only be by helicopter.

## Location Plan

## Tenure

EL5893 was granted on 5 May 2004 for an initial period of six years. On granting, the total area under licence was 856.4 square kilometres of which 378.8 square kilometres (44%) was excluded from exploration by the wishes of the Traditional Owners and the Sacred Site Authority. The current area available for exploration is 477.6 square kilometres.

## Physiography

The tenement contains some remnant areas of dissected sandstone plateau, which form the eastern extension of the Wellington Range. The remainder consists predominantly of gently undulating plains covered by savannah woodland. The principal drainage systems within the region are the Angularli creek draining to the east, Murgenella Creek draining to the west, and Cooper Creek draining to the south of the project.

## **Tenement Geology**

Paleoproterozoic rocks, which have been intersected in drill holes along the Aurari Fault zone to the east of the project area, have been equated with the Myra Falls Metamorphics (MFM). The MFM are considered to be the higher metamorphic grade equivalents of the Cahill Formation (the host rocks to the Alligator Rivers uranium deposits) and consist broadly of quartzofeldspathic gneiss, sometimes with garnet,

quartz-mica-amphibole-garnet schist and amphibolite. No carbonates have as yet been identified but possible calc-silicate lithotypes are present as amphibole-rich schists and? para-amphibolite.

The Myra Falls Metamorphics abut the granulite facies Nimbuwah Complex, which consist of gneiss and migmatite and various granitic intrusives. The most recent age determinations place the Nimbuwah within 1870-1850 Ma. The 'Nimbuwah Complex' has an I-type granite origin and is considered to be, in part, intrusive into the paleoproterozoic metasediments (Carson and others 1999). An anomalously magnetic unit marks the inferred contact with the MFM. It is a finely banded, fine-grained quartz feldspar rock containing magnetite and almandine garnet and may be a transitional (contact) phase between the MFM and the Nimbuwah Complex. There appears to be a rapid regional progression of metamorphic grade increasing from west to east. Outcrop tends to be slightly more extensive in comparison to the MFM. Good exposures of both gneissic rocks and the intrusive granitic variants occur throughout.

The basement rocks are overlain by rocks of the Kombolgie Subgroup (formerly Kombolgie Formation), which form the base of the early Proterozoic Katherine River Group. The Mamadawerre Sandstone, the fluviatile basal unit of the Kombolgie, outcrops as the characteristic escarpment country of the west Arnhem Land plateau. The sandstone outcrops as a series of outliers throughout the western part of the tenement, and forms heavily dissected low relief plateaux. The age of the Mamadawerre has been constrained between 1822 and 1720 Ma and is probably closer to 1800 Ma (Sweet and others 1999).

The Oenpelli dolerite is present throughout the tenement as an extensive network of mostly east-west trending bodies that intrude the basement rocks and Kombolgie Subgroup sandstone. There is an apparent relationship between the dolerite orientation and the sandstone outcrop pattern. Drill hole intersections of dolerite, from the neighbouring King River Project, show that they have exerted little effect on the intruded rocks apart from localized silicification and some chloritisation of the sandstone. Contacts tend to be sharp where preserved and have variable orientations. Chilled margins are generally only centimetres wide with much of the remaining dolerite having a homogeneous grain size. Several intersections, considered to approximate true width, show thicknesses ranging up to 250 metres. The Oenpelli Dolerite has been dated to approximately 1720 Ma and constrains the youngest date of the Kombolgie Subgroup sediments (Sweet and others 1999).

Remnants of the Cretaceous outcrop in various parts of the tenement are usually along the erosional fringes of lateritised tablelands. Outcrops of more resistant siltstone and sandstone are present in the central portion of the tenement, in areas to the east of the tenement and form spectacular cliff outcrops along the coastline near Brogden Point. The Cretaceous overlies and obscures both the MFM and Nimbuwah Complex rocks.

Recent cover comprising sands and clay, gravel and cemented ferruginous deposits infill most valleys and also obscure any outcrop.

## Regional Geology and Structures

### **Structure and Geological History**

The early Proterozoic rocks of the region have been affected by the Top End orogeny (1880 to 1780 Ma), which includes the initial Nimbuwah Event, or Barramundi Orogeny at about 1870 Ma. This produced a prograde metamorphic effect with associated tight folding and faulting. The various 'domains' exhibited a variability of deformation and metamorphic grade with the western and eastern margins of the Pine Creek Inlier (Litchfield Province and Nimbuwah domain respectively) exhibiting the most pronounced effects.

Major regional faults, which affect the early Proterozoic, have north-west (Bulman), north-north-west (Aurari) and northerly (Anuru, Goomadeer) strikes. Another significant set trends to the east and includes both the Ranger and Beatrice faults. The Bulman Fault Zone is the principle regional feature and is considered to represent a long-lived deep crustal structure, which has exerted a large lateral component in rocks of the Pine Creek Inlier.

A more intense concentration of structures traverse the mid-Proterozoic and younger rocks and include north-west, east, north-east and northerly trends. Both faulting and jointing with displacements ranging from a few metres up to 100 metres locally heavily dissect the Kombolgie.

The Wellington Range area occupies the north-western extension of the Arnhem Shelf in the northern McArthur Basin. Deposition of the Mamadawerre Sandstone took place in an environment of extension and local basin formation with probable fault-controlled sedimentation. Rapid thickening and thinning of the sequence imply this.

The widespread Oenpelli Dolerite intrusive event took place at about 1720 Ma. Localised effects in the sandstone include silicification, the introduction of magnesiumrich to intermediate chlorite and the formation of muscovite-illite. A characteristic mineral assemblage of prehnite-pumpellyite-epidote has formed in quartzofeldspathic Nimbuwah gneiss and migmatite adjacent to the intrusions.

## **Tenement Geology**

#### **Exploration Target**

The focus of the exploration strategy is the discovery of unconformity-related uranium deposits. The nearby economic deposits at Ranger, Jabiluka, Koongarra and the now depleted Nabarlek Mine serve as models for this strategy. The presence of gold, palladium and platinum in these deposits plus the economic gold-platinum resource at Coronation Hill in the South Alligator Valley, indicates an additional potential for this deposit style.

## **Previous Exploration**

Historically, the tenement has had no known exploration. Other exploration activities have been conducted in the surrounding areas to the east and the south. Union Carbide Exploration Corporation, during 1970–1972 undertook substantial exploration, principally for uranium, in the King River area, now held by Cameco. This work comprised airborne magnetics and radiometrics with follow-up geochemical surveys and geological mapping, with shallow and deep auger drilling.

Union Carbide's exploration work, as was all exploration work on Aboriginal ground, was curtailed in early 1973 by a Federal Government imposed moratorium on exploration pending a resolution on the issue of Aboriginal Land Rights.

## **EXPLORATION PROGRAM**

The 2004 exploration program consisted of an airborne radiometric / magnetic survey and an airborne hyperspectral survey, ground investigations of airborne radiometric anomalies identified from the geophysics, and regional grid based outcrop sampling. The sampling program was conducted over four days from 26 August to 29 August 2004. Field operations were based out of the Cameco King River Camp with personnel ferrying daily to and from the exploration licence area by helicopter.

## Work Summary

## **Outcrop Sampling**

In total, 99 samples were collected from 103 stations; the outstanding stations being mapping locations. The aim of the 2004 program was to explore the tenement in a regional sense; this was achieved firstly by identifying regional baseline rock properties and geochemical signatures from all rock types within the tenement, by collecting samples on a regional basis in a grid pattern across the exposed rocks on the tenement. The regional outcrop samples were based on nominal one kilometre spaced stations on one kilometre spaced lines resulting in an on overall coverage of approximately one sample per square kilometre of rock exposure. Small exposures of Nimbuwah Complex were found scattered throughout the low lying areas of the tenement as small knolls or tors and as low rounded benches poking through the sand cover, and were sampled where available.

The bulk of the samples were collected from the Mamadawerre Sandstone, the basal formation of the Kombolgie Subgroup. Nimbuwah Complex lit-par-lit and crystalline granitoids, and undifferentiated Cretaceous sandstones comprise the remainder of the samples, with mapping locations at sites of un-sampled Cainozoic ferricrete. 87 samples were collected from the Mamadawerre Sandstone, 10 samples from Nimbuwah Complex and 2 samples from Cretaceous sediments, making up the total 99 samples.

The second objective of the outcrop-sampling program was to ground truth the airborne anomalies identified from radiometric processing of the survey data. A total of 13 radiometric anomalies were identified from the radiometric survey within the open exploration area. These anomalies are tabulated in the following Airborne Radiometric Anomaly Table and the locations shown in the following Airborne Radiometric Anomaly Location Map. All ARAD anomalies were investigated, however the locations of some of the anomalies were coincidental with water logged swamps with no available close helicopter landing sites, and as such were not inspected from the ground.

Airborne Radiometric Anomaly Table

## ARAD Anomaly Locations with Geology

## ARAD Anomaly Locations with Landsat

The outcrop sampling and processing were performed using Cameco standard methodology. This methodology is shown is the Cameco Outcrop Standard Procedures.

### Cameco Standard Outcrop Sampling and Processing Procedures

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

Sample Locations Sample Descriptions Outcrop Lithology and Physical Properties Outcrop Alteration and Structural Measurements ARAD Anomalies Checked - Summary

Sample Location Map - Geology

Sample Location Map - Landsat

All samples were analysed at NTEL in Darwin using techniques outlined in Cameco Standard Outcrop Sampling and Processing Procedures.

#### Outcrop G400 Geochemistry

All outcrop samples were processed using PIMA and TSG, with results in the following tables and figures.

#### Outcrop Samples TSA Analysis (Identified Mineral Species)

#### Outcrop PIMA TSA Clay Distribution Map

Six samples were submitted to Pontifiex and Associates for thin section preparation with detailed petrographic descriptions written by Alan Purvis. The report received has been altered to remove references to samples from other projects.

#### Pontifex Petrographic Report

#### **Outcrop Sampling Discussion**

The follow-up of the radiometric anomalies was generally disappointing with a maximum of 4.68 ppm U recorded from sample WR04C10239, sampled at anomaly WRR003. The majority of the radiometric anomalies in the sandstone were associated with reddish hematite-altered pebble bands up to 0.5m thick with scintillometer responses varying between 200 and 1000cps (Urtec). Other anomalies consisted of ferricrete in sand covered terrain and waterlogged black soil swampy areas. From mapping in other areas of Arnhem Land, where pebbly horizons are prevalent in the sandstone, the radiometric data shows an increase in intensity that is associated with a marked increase in Th in the sample geochemistry.

Anomalies WRR004, 5, 10 and 11 were not ground truthed due to lack of helicopter access. The nearby WRR003 was observed spatially associated with radiometrically anomalous pebbly bands in the sandstone, and given the proximity of WRR004, it would be reasonably expected to be of similar character. Anomalies WRR005, 10 and 11 appear, from the air, to be associated with ferricrete or pisolites on flat

timbered sandy terrain, but will be evaluated from the ground in the coming 2005 field program. WRR009 was observed from the helicopter to be coincident with a waterlogged black soil swampy area, and would not require any further work. Reconnaissance and sampling of WRR007 found thin siliceous-hematitic fractured and drusy quartz veined Kombolgie outcrop up to 220cps (Urtec) adjacent to overlying Cretaceous sandstone (120cps Urtec) and a prominent ferricrete ridge.

The sandstone appears, from the radiometrics, to have responses in the K and Th channels, with anomalies identified from an increase in the U channel with respect to the Th channel. The airborne radiometric responses appear to be inconsistent with the results obtained from the chemical analysis of the samples. The areas are radiometrically anomalous, validated by the responses of the scintillometer. The geochemistry results would indicate that the radiometric anomalies checked within the sandstone are associated with Th rich pebble and cobble horizons, with slightly above background values of U, an affect which has been demonstrated in other areas of Arnhem Land. It may be possible that further processing of the radiometric data may result in anomalies that may have been concealed in the less obvious low order range of the data.

## Uranium - Thorium Map

The Mamadawerre Sandstone in the area represents the basal portion of the formation. Nimbuwah Complex basement rocks are exposed in close spatial proximity to the sandstone; however, no unconformity surfaces were observed within the licence area during the field program.

The Pima clay mineralogy, derived from The Spectral Geologist, and the hyperspectral clay interpretation show reasonable correlation. As expected from other project surveys, the correlation between the Hymap clay interpretation and the results derived from the surface sampling PIMA interpretation is quite good. Some differences may be attributed to the fact that PIMA clays may be more biased to specific samples that cannot be resolved in the six metre pixel resolution of the Hymap, and the Hyperspectral collects data in 10nm wavelength resolution versus the PIMA 2nm wavelength.

The results from the hyperspectral survey were not available prior to the field program, and as such, no ground validation of the results, apart from those realised from the radiometric follow-up, and regional sampling program.

## PIMA TSA and Hyperspectral Clay Interpretation Map

From the hyperspectral survey G Zaluski has interpreted that the dominant clay mineralogy of the basal portion of the sandstone is made up of illitic group clays of illite and possibly muscovite or phengite although they have been classified as long wavelength and very long wavelength illite. This basal illitic sandstone stratigraphy is then overlain by a dickite dominant zone and then dickite and illite mixed clay sandstone. The areas of mixed dickite and illite have not been identified in the outcrop samples; the PIMA clay minerals from those areas of mixed dickite and illite are interpreted as almost pure dickite, with only a few samples in the more peripheral areas showing very minor illite group clays. Pyrophyllite is noted in close spatial proximity to the mapped dolerite intrusions, and as observed in other

areas in Arnhem Land is interpreted to be a thermal product of the intrusion. The areas of pyrophyllite were not sampled or observed in any of the outcrop samples.

In the hyperspectral interpretation report, G Zaluski has identified a number of areas that display clay signatures that deviate from the dominantly observed stratigraphic patterns and may represent hydrothermal alteration overprint. These targets, detailed in his report, will be evaluated in the forthcoming year in context with other exploration data.

### Geophysics

### Airborne Magnetics, Radiometrics and DTM (Digital Terrain Model)

UTS Geophysics Pty Ltd of Perth conducted a magnetic/radiometric/DTM survey over the project area, totalling 3021 line km. The survey was oriented west-east with a line spacing of 200 m and a flying height of 60 m.

The primary aim of the airborne radiometric survey was to locate surface uranium enrichment. Consequently, several anomalies were followed up during 2004, and further follow-up of the lower priority anomalies is planned for 2005. It should be noted that the outcropping sandstone is related to both potassium and thorium responses. However, the majority of the project has a variable low response due to surface Quaternary and Cretaceous cover.

The airborne magnetic response can be utilized to map the Oenpelli Dolerite, which is reversely polarized and has a complex response typical of sill-like bodies. In the southern part of the project a broad magnetic response is likely to be due to magnetite-bearing Nimbuwah Complex; Nimbuwah Complex rocks sub-crop in the area. The northern part of the project has virtually no outcrop, however, a magnetic response can be traced regionally towards the south-west and is similar in character to magnetic portions of the Cahill Formation, such as the lower part of the Upper Cahill Formation. This is a positive indication that prospective basement rocks may be present. The airborne magnetics may be further utilized to refine the project geology interpretation as required.

Airborne Geophysics Logistics Report by UTS – 2004

Airborne Magnetics – Reduction To Pole (RTP) with 1st Vertical Derivative (1VD)

Airborne Radiometrics – Total Counts (TC)

Airborne Radiometrics – Potassium (K)

Airborne Radiometrics – Uranium (U)

Airborne Radiometrics – Thorium (Th)

Airborne Radiometrics – RGB=U,Th,K

Airborne DTM – Height with NE Sun Angle

## <u>Hyperspectral – HyMap Mk1</u>

In 2004, a hyperspectral survey was flown over the eastern portion of the project known to contain outcropping Kombolgie Subgroup Sandstone. The survey was conducted by De Beers utilising their HyMap MkI system, an airborne multi-spectral

scanning instrument designed to map minerals and identify alteration. Cameco is utilising the instrument as an aid in locating alteration patterns associated with unconformity-style uranium deposits. It is hoped that the system will identify and map variations in clay types in the sandstone such as kaolinite, illite, dickite, halloysite and iron and magnesium chlorites as well as silicification.

## Airborne Hyperspectral Logistics Report by De Beers - 2004

Gerard Zaluski of Cameco Corporation completed the interpretation report of the hyperspectral data collected from the De Beers survey. His interpretation has identified that similar clay patterns exist within the sandstone units of the Wellington Range project as occur on other Cameco operated projects in the Arnhem Land region. A regional illite group clay signature appears to be prevalent at the base of the Mamadawerre Sandstone and is interpreted to be a regional diagenetic effect resulting from the interaction of basinal and basement fluids, rather than a stratigraphic phenomenon.

## Processing and Interpretation of De Beers Hyperspectral Scanner Data for EL 5893 Hyperspectral Clay Interpretation Class Display

A number of targets were identified based on the hyperspectral results in conjunction with interpreted basement lithology, magnetics and apparent structural deformation. The targets are listed within the report. The hyperspectral results from which the targets were selected focussed on the regional clay signatures for the various stratigraphic units and identified those areas that are apparently overprinted or crosscut by clay patterns of interpreted hydrothermal origin.

## CONCLUSIONS AND RECOMMENDATIONS

The results derived from the airborne radiometric follow-up work are somewhat disappointing with less than 5ppm U maximum returned from the outcrop sampling. The Mamadawerre Sandstone in the Wellington Range area represents the basal portion of the formation and is comprised of coarse grained to granular sandstone with common pebbly and conglomeratic horizons. As observed in other areas, these pebbly horizons are often anomalous in Th.

The lack of outcrop and blanketing of the basement rocks by Cretaceous sediments in the northern portion of the tenement makes the area difficult to explore. To outline areas of further study the region will be flown with airborne TEMPEST electromagnetic in an attempt to identify any conductors and structures within the basement rocks.

Further work may be aimed at reconnaissance and sampling of the zones of structural disruption within the sandstone, and would be conducted after the planned TEMPEST airborne electromagnetic survey planned for the 2005 field season. A ground validation and investigation of the targets identified from the interpretation of the hyperspectral survey would be carried out in conjunction with other planned outcrop sampling and reconnaissance programs. The hyperspectral clay interpretation outlines a number of broad possible alteration features that cross-cuts the stratigraphic clay pattern. The TEMPEST survey may provide details of structures that compliment the results of the hyperspectral clay interpretation.

## EXPENDITURE

A summary of the expenditure for the reporting period is given in the following table. The total reportable expenditure for EL 9452 is \$94,829.66

## Summary of Expenditure EL 5893

As the proposed expenditure covenant at the time of application was \$150,000, Cameco Australia has filed a Waiver of Expenditure with DBIRD-DME as required by statutory obligations.

## WORK PROGRAM

A summary of the proposed exploration activities, timing and contractors under consideration for Year 2 of the project is tabulated below.

- Airborne TEMPEST electromagnetic survey over entire licence area.
- Follow up of anomalies not checked during 2004 sampling.

The budget to complete the program as planned is expected to be \$150,000.

Activity	Duration of Activity	Timing	Amount	Approximate Location
Follow - up Investigations	3-4 days	June	5 anomalies remain unchecked, hyperspectral target areas	Regionally based
TEMPEST survey	2-3 days	Dependant on contractor	200m lines	Regional coverage

### Location and Scheduling of Activities

#### Listing of On-Site Personnel Requirements

Activity	Equipment	Personnel	Potential Contractor
Airborne Geophysics	Fixed wing aircraft	2	Fugro
Sampling investigations		3-4	1-2 Cameco personnel, 1 Traditional Owner and helicopter pilot
Transportation to Project area	Bell Jetranger helicopter	1 pilot	Jayrow Darwin

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