Appendix I
Archaeological Survey of UEL
EL25220 Headwaters Project

A report for the Northern Land Council
Daryl Guse
Earth Sea Heritage Surveys
2010
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GLOSSARY

Definitions of terms referred to in this interim report are listed below:

Grid Reference Datum: All grid references reported in this report are in GDA94.

Minor Rock Art Site: Consists of rock art motifs (<20) located in a sandstone overhang.

Minor Rockshelter: Typically consists of a small sandstone overhang that has a combination of archaeological features, including a small number of rock art motifs (+20), stone artefacts, and/or grinding hollows.

Major Rockshelter: Consists of +100 rock art motifs, combination of archaeological site features (stone artefacts, stone quarry, cultural deposit, burials, grinding hollows) usually sited in a large sandstone overhang, shelter, or cave-like structure.

Artefact Scatters: Consists of stone artefacts, either located in the open or in a sandstone overhang.

HCA: Northern Territory of Australia Heritage Conservation Act 1991
EXECUTIVE SUMMARY

Earth Sea Heritage Surveys undertook the archaeological survey of the proposed 2010 UEL exploration work program for the exploration lease EL25220. The mining lease covers the area at the headwaters of the East Alligator River on the Arnhem Land Plateau. The mining lease is contained wholly within the Arnhem Land Aboriginal Land Trust. The UEL exploration program consists of a series of deep diamond drill holes lease. The archaeological assessment of the proposed work program was undertaken in August 2010.

This report records the locations of Indigenous cultural heritage places and assesses their significance to the heritage of the Northern Territory. The archaeological survey of the 2010 work program areas found 5 archaeological sites within EL25220. Site descriptions and location maps are found in the results section of this report. The antiquity of the archaeological assemblage in the area spans from the Pleistocene through to the recent past. As a result, these Indigenous archaeological places documented in this study that are considered to have high cultural heritage value owing to the unique combination and representation of archaeological features.

These Indigenous archaeological places are considered significant within the terms of the NT Heritage Conservation Act 1991 (HCA). These sites are afforded protected under Section 39 of the HCA and should be avoided by the proposed exploration works. Therefore actions have been recommended in order to avoid these archaeological places.

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1 All sites and artefacts are recorded using the UTM coordinate system. The datum is GDA94 and the map grid is MGA94.

2 The Heritage Conservation Act protects all Aboriginal archaeological places and objects using an ‘automatic’ or ‘presumptive’ protection mechanism. This provides interim protection for all archaeological sites until the Minister for the Environment and Heritage, on the advice of the Heritage Advisory Council or its delegates, makes a decision on the significance of the sites. Hence, it is possible to apply to the Minister for a permit to disturb or destroy such a site in the course of proposed works. In practice, it is efficacious to avoid such sites in the planning stage of projects, thereby protecting Aboriginal cultural heritage and reducing the time required for applications etc.
1.0. INTRODUCTION

1.1. INTRODUCTION

Earth Sea Heritage Surveys was engaged by the Northern Land Council to conduct an archaeological survey of the proposed 2010 UEL exploration work program in EL25220 as outlined in the UEL Project Submission 2010. The mining lease is located in western Arnhem Land (Figure 1). The aim of this study was to identify Indigenous cultural heritage places and provide mitigation strategies against the loss of cultural heritage values from activities undertaken as a result of any exploration activities.

1.2. UEL 2008 WORK PROGRAM

Uranium Equities Limited is proposing a program of 15 diamond drill holes in EL25220.
FIGURE 1 LOCATION EL25220 DRILLING PROGRAM
1.3. SCOPE OF THE STUDY

The West Arnhem region contains a suite of highly significant Indigenous cultural heritage places that span from the Pleistocene through to the early historic period of European settlement in the Northern Territory. The most highly visible component of this archaeological record is the incredibly diverse and abundant rock art which owes its longevity to the local sandstone formations. It is within this archaeological environment that some of the exploration activities are located. Therefore the work programs are assessed on an annual basis for potential impacts on the valuable and significant Indigenous archaeological record of West Arnhem Land.

The archaeological study will:

- Identify archaeological material (prescribed archaeological places and objects) within EL25220 by means of a survey. Archaeological sites are to be recorded in such detail as to permit independent assessment of their significance. Location of archaeological places and objects were recorded using Global Positioning System.
- Test previous archaeological site location models and evidence from previous archaeological surveys
- Assess the cultural heritage significance of archaeological places and objects located during the survey.
- The consultant will ensure that the Northern Territory Heritage Conservation Act and other relevant cultural heritage legislation are not contravened during the exploration works. This will be through provision of recommendations regarding compliance with the Heritage Conservation Act and its Regulations.
- Where practical, mitigation advice should be provided to exploration staff in the field.

1.4. ENVIRONMENT AND REGIONAL SETTING

The proposed exploration activities are located in the area known as Western Arnhem Land. The area is dominated by the Arnhem Land Plateau geological feature and the hydrology of the Alligator River systems. The study area is located wholly within the Arnhem Land Aboriginal Land Trust. The main townships in the region are Jabiru in Kakadu National Park, Kunbarlanja to the west and Maningrida to the north east. The area is sparsely populated with a series of small Indigenous outstations. Land use in the region consists of national parks (Kakadu and Gurig), uranium mining (Ranger) and associated exploration activities, recreational fishing, natural and cultural tourism (Mt Borradaile, Injalak) and traditional Indigenous land use, occupation, and provision of associated utilities and infrastructure to Indigenous communities. The establishment of Indigenous communities has resulted
in a network of roads and tracks across the region. The majority of tourism activities occur to the west of the study area in Kakadu National Park. Access is controlled in Kakadu National Park via Parks Australia North, and similarly access on the Aboriginal Land Trust is controlled through a permit system administered by the Northern Land Council. Although there has been significant activity in the West Arnhem region over the last 30 years owing to the activities described above, the resultant environmental impacts have been limited to localised areas of disturbance. Therefore the majority of the environment enjoys a relatively high level of stability and environmental integrity.

The West Arnhem region is dominated by the Arnhem Land Plateau with much of the surrounding environmental context influenced by this major geological and geomorphological feature. The region has a diversity of environmental zones including coastal and estuarine areas, alluvial floodplains, major river systems, dissected sandy plains, steep foothills and ridges, and finally the plateau area itself. The landscape has been affected by significant environmental change since the Pleistocene sea level rise and subsequent evolution of the major tidal river systems. Geologically the area is dominated by the Kombolgie sandstone subgroups, combined with the north eastern end of the complex Pine Creek Geosyncline. The Pine Creek Geosyncline is characterised by numerous intrusions and folds giving rise to the presence of other geological formations that crop out at the ground surface. Large mesoscale river systems combined with the geological formations give rise to the development and location of specific micro-environments such as monsoon vine forests, sedge, grass and paperbark swamps, and freshwater springs.

1.5. PREVIOUS ARCHAEOLOGICAL RESEARCH

Previous archaeological studies in the area have concentrated on the East Alligator River gorge to the south west of EL25220. There are 74 previously recorded archaeological sites have been identified in the surrounding region from the Northern Territory Government archaeological site database. The closest sites along the East Alligator River have been excluded from EL25220. The following figure illustrates the distribution of these sites surrounding EL25220. More detailed discussions regarding the archaeology of the West Arnhem region an be found in the 2005 to 2009 Earth Sea Heritage field season reports lodged with the Northern Land Council.
FIGURE 2 DISTRIBUTION OF PREVIOUSLY RECORDED ARCHAEOLOGICAL SITES IN THE NABARLEK REGION
2.0. METHODOLOGY

2.1. SITE IDENTIFICATION

There are a variety of archaeological site types previously recorded as occurring in the region that are documented in the Northern Territory Archaeological Site Register. According to Burke and Smith (2004:63) the two broadest categories of archaeological site types can be defined as Indigenous archaeological sites and non-Indigenous archaeological sites (more commonly referred to as European or historical sites. Many of the previously recorded sites have been recorded over several decades and the recorders have most likely used different definitions for each site type. For this reason the authors have described these site definitions in the broadest sense. The following site definitions can also occur in conjunction with other types. Site types that are known to occur in the West Arnhem region are as follows:

- **Artefact scatters** may contain flaked or ground artefacts and hearthstones. Artefact scatters may occur as surface scatters of material or as stratified deposits where there have been repeated occupations. These scatters do not necessarily imply that prehistoric people actually camped on the site; rather, they may only indicate that some type of activity was performed there.

- **Stone Quarry.** A site where stone for flaked or edge-ground artefacts have been extracted from an outcropping source of stone. This is a broad definition a stone quarry and there are further subdivisions of this site type (Hiscock and Mitchell 1993). According to Hiscock and Mitchell (1993) most surface hard stone quarries have associated reduction sites.

- **Knapping locations,** consisting of one or more knapping floors, are discrete scatters of artefacts, anywhere in the landscape, resulting from stone being worked or reduced at that spot. The criteria for a knapping floor are that the original block of stone can be at least partially reconstructed from scattered flaked stone pieces (Hiscock and Mitchell 1993). A knapping floor can exist as a feature within the context of an open site or archaeological deposit. However there are certain methodological problems in identifying such features arising from post-depositional processes.

- **Shell middens,** which are deposits containing shells occurring somewhere in the open, near a beach or estuary or rocky shoreline, or an inland lake or river (see Meehan 1977). These shells have been accumulated in these deposits by humans exploiting marine resources. Middens may take the form of a thin veneer of shell over the land surface or a thick mound of shell. A subsurface
midden layer or horizon (from 1cm in thickness) may occur within mounds or chenier ridges in the Reynolds River area.

- **Stone Arrangements** can range from simple cairns to more elaborate arrangements. Some stone arrangements were used in ceremonial activities and represent sacred or totemic sites. Other stone features were constructed by Aboriginal people as route markers, territory markers, and walls of huts, animal traps, hides, or seed traps.

- **Rock Art sites**, include two main types of rock art, engravings and pounding’s where the pattern is one of relief and the pictures were apparently produced by removing material from the rock surface and drawings, stencils and paintings where the material was added to the rock surface (Clegg: 1983). Can also include wax designs.

- **Rockshelter occupation sites**, which contains a deposit of cultural material that has built up over time containing flaked or ground stone artefacts, faunal material and other various items of Aboriginal material culture including ancestral human skeletal remains, wax designs, rock art, grinding hollows, and caches of material culture objects.

- **Contact sites** contain foreign materials, such as glass, ceramics or metal that exhibit modification by Aboriginal people. Alternatively a contact site may be identified by the presence of Macassan or European objects which may be unmodified but are the result of transportation to that locality by Aboriginal people. Contact sites represent the interface between Aboriginal, Macassan and European peoples during the early forays Northern Territory.

For the purposes of the report, the following collective site typology to describe certain sites encountered that are unique to the Arnhem Land survey area. These site ‘types’ can contain more than one archaeological site feature. Site features include the following: petroglyphs; pictographs (paintings); cultural deposit; stone artefacts; metal artefacts; wooden artefacts; grinding surfaces/hollows; surface hard stone quarrying; human skeletal remains/burials; hearths; shell midden; faunal remains.

- **Grinding Hollows**: Describes sites that consist only of grinding surfaces or hollows found on outcropping rock, generally in an open site context.
• **Major Rockshelter**: A major rockshelter is defined as a shelter that contains more than 50 rock paintings, at least 4-5 site features (i.e. stone artefacts, paintings, grinding hollows; cultural deposit etc). These sites are generally large in size (>10m in length).

• **Minor Rockshelter**: A minor rockshelter is defined as a site that contains less than 50 rock paintings and has 1-3 site features (i.e. paintings, artefacts, grinding hollow). These sites are generally less than 10m in length.

• **Minor Rock Art**: Minor rock art sites are defined as containing only paintings with no other site features and contain less than 20 paintings. These sites generally occur as small single art panels on vertical sandstone walls, boulders, and small overhangs.

• **Rockshelter Complex**: A rockshelter complex is defined as an area of multiple rockshelters within 100m radius that contain a high diversity and abundance of all site features. Site complexes usually consist of 3 to 10 individual major and minor shelters of varying size. Complex site locations are dependent on the local geology providing a group of suitable occupation sites within a small area. This can be a fairly common occurrence in the Mamadawerre Sandstone of the Arnhem Land Plateau.

### 2.2. ROCK ART IDENTIFICATION

Changes in Australian rock art research closely followed those resulting from the introduction of processualism in Australian archaeology. The emphasis in rock art research shifted to attempting to understand;

- The integrating function of art in Aboriginal society,
- How a range of social and economic information is encoded in art and its distributional characteristics.
- How it may reflect fundamental changes in social organisation, group interaction and land use.

These types of investigations required information on the cultural and natural contexts of rock art production whereas previous studies had tended to be more focused on rock art in isolation.

Important steps in the development of current perspectives on the study of Indigenous rock art were taken by Maynard (1977) and Clegg (1983). These archaeologists developed a more analytical approach to the study of rock art. Maynard (1977) contended that meaning is always highly specific and usually esoteric and as such is probably completely intractable. Clegg (1983) extended this
position to argue against attempting to reconstruct the meaning of motifs on the grounds that it is impossible to securely ascertain either the subject or motivation of the artist.

Another influence in the study of rock art came from the study of semiotics, the study of signs. This is where style became re-conceptualized as a means of communicating information. This development in rock art research was partly attributable to the increasing influence of anthropological studies of cultural material which demonstrated the communicative capacity of style. The increased emphasis on social explanations in archaeology emerged in rock art studies in information exchange theories. The main functions of style are related to cultural processes such as group integration and differentiation and boundary maintenance. The concept of information exchange as an explicit theoretical tool has been used to interpret a wide range of rock art. The general approach is based on the notion that the functional interdependence between art and other cultural components which is so evident in ethnographic studies that art and changes in art can tell much about the complexity of pre-contact cultural systems. This same functional interdependence indicates that archaeological studies of art need to be undertaken in the light of all available evidence for systemic context, one basic component of which is resource utilisation. Fundamental to this approach is the notion of style as information. The main point about the use of information exchange theory in Australian rock art studies is that it moves beyond a simple correlation between stylistic similarity and social interaction to consideration of the causes underlying these interactions.

There are generally two main types of rock art (Clegg 1983):

- **Engravings and poundings** where the pattern depicted is one of relief and pictures were apparently produced by removing material from the rock surface.

- **Drawings, stencils and paintings** where the material was added to the rock surface.

Common rock art terms used in this report include:

- **Anthropomorph**: A figure of a human form.

- **Figurative Art**: Art motifs which resemble objects familiar to the observer, representational or naturalistic art.

- **Motif**: A very common word used in describing rock art. This is usually defined as a recurrent visual image which has a particular arrangement (Maynard 1977). A mark or combination of marks of human origin, which can reasonably be interpreted to have formed an individual or separate picture, or design or a recurrent type of figure.

- **Petroglyph**: A mark or picture made on rock through the process of pecking, pounding, abrading or scratching the rock surface.
• **X-ray Art**: A style of rock art in which the internal skeleton and internal organs of humans or animals are depicted.

• **Zoomorph**: A figure of animal form.

• **Stencils**: Where paint has been applied over an object placed against the shelter wall. Most commonly found in the form of hand stencils, however many examples of items of material culture have been documented.

• **Bees Wax Figures**: Where bees wax has been modified and placed on shelter walls to form an image.

• **Superimposition**: When multiple motifs are executed over one another at different times in the past.

### 2.3. ROCK ART RESEARCH IN THE WEST ARNHEM REGION

According to Chippendale and Tacon (1998:90) there is a strong framework provided for identifying and dating the long tradition of rock art in Western Arnhem Land. Chaloupka (1985; 1993) has defined various rock art styles and grouped them into art periods and phases for the West Arnhem region. By relating the known climatological, geomorphological, archaeological, historical, zoological and botanical data, Chaloupka (1985) developed a chronology for the rock art. Evidence of weathering, chemical changes in the rock surfaces and pigments, and the order in which paintings are apparently superimposed at particular sites also contributed to this process. According to Chaloupka (1985) the key to major stylistic changes lies in significant environmental changes, particularly sea level fluctuations experienced in the region during the late Pleistocene and Holocene. On this basis he proposed four main chronological periods for the classification of rock art in the West Arnhem region. This is further expanded by Chippendale and Tacon (1998:107) who present a chronology of western Arnhem Land rock art based on Chaloupka’s research, their own and others (Figure 5).

**Pre-estuarine Period (before 8000 BP)** The Estuarine Period may be as old as 20000 BP and up to 50000BP. Chaloupka (1983) inferred that the hunting weapons depicted in the art such as boomerangs which could have been effectively used only in the grasslands and low woodlands that predominated in Kakadu at that time. Extinct faunal species from the late Pleistocene are also used as evidence for this time frame. The Pre-estuarine period contained a number of different styles. The earliest of these consisted of prints of hand, grass and other objects. These were followed by paintings of naturalistic figures including macropod and extinct fauna, dynamic figures, post-dynamic figures and yam figures. Weapons such as spears are clearly illustrated in the art. Chaloupka considers the main body of art from this time period to be dated between 20000 BP to 8000 BP. Chaloupka argued that the changing art of the late pre-estuarine period reflected changing times for the Aboriginal people.

**Estuarine Period (8000BP to 1500BP)** Chaloupka (1983) defined the estuarine period by relating the art to the changes occurring in floodplain conditions from 8000 years ago and the subsequent changes in the nature of the resource base. Styles of the estuarine period are characterised by the appearance of animals, notably fish and a decline in the representations of emu and macropod. Depictions of hunters with a range of weapons documented the change in...
technology, which took place in response to the changing environment and resource availability. The x-ray style of art developed and was continued in use up until the present.

**Freshwater Period** (from 1500BP) The Freshwater Period is defined from 1500 years ago with the appearance of large freshwater swamps and floodplains. Freshwater faunal and floral species were depicted such as Jabiru, water lilies and magpie geese. Different material culture was again developed and depicted to utilise the emerging resources.

**Contact Period** (since Macassan and European contact 300 years ago). The final phase of the Contact period from about 300 years ago differed only in the choice of the subject matter. According to Chippendale and Tacon (1998:95) European people and European objects have been known in Arnhem Land since early settlements on the Coburg Peninsula some 160 years ago. Therefore depictions of items such as guns, ships, European persons and items, and introduced animals are datable from that period onwards.

This study in particular draws on the Chippendale and Tacon (1998) chronology for identification of rock art that is utilised in this study. This chronological sequence is illustrated in the following table and figures.

![Figure 3: Chippendale and Tacon’s (1998:107) Proposed Chronology of Arnhem Land Rock Art](image)

**TABLE 1 Chronological Periods Assigned to Rock Art Styles**

<table>
<thead>
<tr>
<th>Period</th>
<th>Years Before Present</th>
<th>Styles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleistocene</td>
<td>&gt;20,000 - 12,000BP</td>
<td>3MF Stencils, Large Naturalistic, Hand Stencils, Engravings</td>
</tr>
<tr>
<td>Pleistocene-Holocene Transition</td>
<td>12,000 - 8,000BP</td>
<td>Dynamic Figures, Post Dynamic Figures, Simple Figures with Boomerangs, Northern Running Figures</td>
</tr>
<tr>
<td>Mid Holocene</td>
<td>8000 to 4000BP</td>
<td>Yam Figures, Large Fauna, Large Human, Simple Figures, Early X-Ray, Early Decorative Infill</td>
</tr>
<tr>
<td>Late Holocene</td>
<td>4000BP to Present</td>
<td>X-Ray, Complete Figure, Beeswax, Contact, Sorcery, Complex Decorative</td>
</tr>
</tbody>
</table>
FIGURE 4 EXAMPLES OF THE VARIOUS ROCK ART STYLES FROM THE WEST ARNHEM AREA
3.0. RESULTS

3.1. SUMMARY SURVEY RESULTS

The archaeological survey was undertaken by archaeologist Daryl Guse and assisted by Traditional Owner Jason Nabulwad. The archaeological survey inspected general area of EL25220 as illustrated in Figure 1. A general inspection to determine areas of high archaeological sensitivity was undertaken. A total of five archaeological sites were identified in the survey. Overall, the EL25220 area has a moderate level of archaeological potential with the main archaeological densities concentrated along the East Alligator River to the south east.

The general area of EL25220 is characterized by deep incised gorges in between substantial areas of sandstone outcrop. The crisscrossed pattern of weathering and drainage has produced a heavily dissected terrain. Numerous areas provide potential for archaeological site locations owing to the combination of outcrop and water sources.

<table>
<thead>
<tr>
<th>Site</th>
<th>Easting</th>
<th>Northing</th>
<th>Context</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>HW001</td>
<td>342288</td>
<td>8568691</td>
<td>Shelter</td>
<td>Painting, Grinding Hollow; Cultural Deposit; Artefacts; Quarry; Burial</td>
</tr>
<tr>
<td>HW002</td>
<td>333507</td>
<td>8575305</td>
<td>Boulder</td>
<td>Painting</td>
</tr>
<tr>
<td>HW003</td>
<td>333445</td>
<td>8580738</td>
<td>Shelter</td>
<td>Painting, Grinding Hollow; Cultural Deposit; Artefacts; Quarry; Contact Artefacts</td>
</tr>
<tr>
<td>HW004</td>
<td>334000</td>
<td>8581174</td>
<td>Shelter</td>
<td>Painting, Grinding Hollow; Cultural Deposit; Artefacts; Quarry</td>
</tr>
<tr>
<td>HW005</td>
<td>334039</td>
<td>8581174</td>
<td>Shelter</td>
<td>Painting, Grinding Hollow; Cultural Deposit; Artefacts; Quarry; Contact Artefacts</td>
</tr>
</tbody>
</table>
FIGURE 5 ARCHAEOLOGICAL SITE DISTRIBUTION WITHIN EL25220
FIGURE 6 LOCATION OF SITES HW001 AND 001A
FIGURE 7 LOCATION OF HW002
FIGURE 8 LOCATION OF HW003
FIGURE 9 SITE LOCATIONS FOR HW004 AND HW005
3.2. SITE FEATURES

Together with the rock art, a diversity of Indigenous archaeological site features occurs within the study area. Site features recorded on archaeological sites included grinding hollows, cultural deposits, stone artefacts, quarrying, contact artefacts, and burials. Rock painting is the most commonly occurring archaeological feature in the study area, followed by artefacts and grinding hollows.

Archaeological site location was significantly influenced by the presence and absence of suitable sandstone outcrops and overhangs. The high level of sand deposition along creeks and valley floors in this area of the plateau makes the likelihood of finding open artefact scatters in these areas very low. However the valley floors and margins have a high likelihood of containing numerous overhangs suitable for rock art painting.

Stone artefacts were well represented at most of the archaeological sites. Each site had evidence of quarrying along beds of silicified and metamorphosed sandstone embedded in the sandstone outcrops. Artefacts consisted mostly of flakes, cores, flakes, retouched flakes and flake pieces. Sites HW003, HW003, and HW005 contain formal implement types such as bifacial points, blades, and retouched implements. The majority of these artefacts were made on silicified sandstone, meta-sandstone, and quartzite reflecting the locally available raw material sources. A number of artefacts were manufactured on imported quartzites that are rare in this area of the plateau. Pounding and hammerstones made on quartzite were located at these sites.

![Figure 10: Examples of Stone Artefacts from the Study Area](image-url)
The rock art recorded in these sites consists of styles from the Pleistocene through to the recent Holocene. Recognizable motifs included large naturalistic style humans and macropods, post dynamic style human figures, large fauna style motifs typically depicting macropods, goannas and fish, decorative infill motifs, and hand stencils and prints (Figure 19). Figure 19 below illustrates the distribution of rock art period styles recorded in sites in the study area. There is a distinctive trend for the presence of mid to late Holocene rock art traditions in the region.

Sites UEL 2008-001, 003, and 013 contain the highest densities and diversity of rock art motifs. The full range of Arnhem Land sequences and many of the styles can be found in these three sites. There is a particularly high diversity of rock art assemblage styles represented across the study area. There is a general trend for an increase in the painting from the Pleistocene with a peak in the mid Holocene sequences with a drop in the late Holocene. This may be a result of differential preservation, however it is more likely to be an indicator of higher residential mobility during the mid-Holocene with more sedentary settlement and land use strategies employed in the late Holocene with the establishment of stable environmental conditions and wetlands.

The majority of the rock art motifs have been executed in red ochre, followed by yellow and white pigments (Figure 21). Rock art painting methods are relatively well represented in the sites. The majority of motifs are painted with a monochromatic method, although bichromatic motifs are well represented in the study area. Full bodied, outline, line, and decorative infill are evenly represented across the rock art sites. The presence or absence of these pigments may also relate to differential weathering as they are more susceptible to water erosion than red ochre pigments.

The density of rock art in the sites is illustrated in Figure 22. Sites UEL 2008-001, 003, and 013 containing the largest number of panels and motifs (estimated +100). Figure 22 shows that there majority of rock art sites had an estimated total number of motifs between 10 motifs to 30 motifs per site. The density of rock art motifs generally indicates that the area was continually occupied on a regular basis by Indigenous groups through time with several sites being major occupation focal points in the Nabarlek area.

A variety of impacts to the rock art and archaeological features were noted during the survey. Animal disturbance to the rock art sites is mostly via termite and wasp nest construction. Other agents affecting the sites included animal wallows and rubbing.

A variety of natural factors have influenced the preservation of rock art in the survey area. Weathering from water erosion and exposure to the natural elements (rain, wind, sun) are major factors in site
preservation. Equally influential is the amount of mineralization and iron oxide staining from the associated water flows through and over the rock surface. Cracking and exfoliation were noted in a number of sites. Trees, vines, and grasses were not generally a problem in most sites.
3.3. ARCHAEOLOGICAL SITES

### 3.3.1. SITE HW001

<table>
<thead>
<tr>
<th>Site Name: HW001</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Easting: 342289</th>
<th>Northing: 8568691</th>
<th>Map:</th>
</tr>
</thead>
</table>

**Environmental Context:** Arnhem Plateau, Sparse Open Woodland, Sandstone Tor, Meta-Sandstone

**Site Context:** Shelters formed by an isolated sandstone tor outcrop

**Description:** The site consists of upper and lower shelters on a sandstone outcrop. Large number of grinding surfaces with percussion impacts. Some cultural deposit is found in the shelter at the base of the tor. A significant amount of surficial stone quarrying is evident around the shelters. A burial is located 50m to the north of the main shelter in a small separate crevasse. The site contains flakes, cores, retouched flakes, and flake pieces made on quartzite and silicified sandstone. Maximum density is >100/m² with an average of 4/m².

<table>
<thead>
<tr>
<th>Length (m): 6</th>
<th>Width (m): 4</th>
<th>Height (m): 5</th>
<th>Deposit (cm): 25</th>
</tr>
</thead>
</table>

**Site Features:** Paintings, grinding hollows, cultural deposit, stone artefacts, quarry, human skeletal remains

**Rock Art Traditions:** Large Fauna Style; Large Human Figures; Complete Figure; Beeswax

**Colour:** Red, Yellow, White; Monochromatic

**Rock Art Motifs:** Mammal, macropod; Anthropomorphic: Human

**Rock Art Densities/Comments:** +20 motifs, indeterminate number of motifs owing to poor preservation. Very weathered surfaces and the rock art is fairly exposed.

The Burial has a number of stone piled up over the cranium and femur. There is ant nest damage to the skeletal remains. A beeswax figure is on a panel below the burial.

**Site Condition:** The panels tend to be in poor condition, very weathered, faded/worn, and affected by water erosion. Some iron oxide staining and mineral deposits.

**Proposed Development:** Within the drilling and exploration tenement. A proposed drill site is located approximately 300m to the west of the site locality.
### 3.3.2. SITE HW002

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<th>Site Name: HW002</th>
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<td><strong>Easting:</strong> 333507  <strong>Northing:</strong> 8575305</td>
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<tr>
<td><strong>Environmental Context:</strong> Arnhem Plateau, Dense Open Woodland, Hillside, Coarse Sandstone</td>
</tr>
<tr>
<td><strong>Site Context:</strong> Two small exposed boulders</td>
</tr>
<tr>
<td><strong>Description:</strong> The site consists of 2 small panels on 2 separate boulders within 10 metres of each other. Panel A consists of a fish and macropod painting and Panel B consists of some Post Dynamic Period anthropomorphic figures and a goanna motif. The site contains small flakes (&lt;10mm in size) made on quartzite. Maximum density is &gt;1/m² with an average of 0.001/m².</td>
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<tr>
<td><strong>Site Features:</strong> Paintings, stone artefacts,</td>
</tr>
<tr>
<td><strong>Rock Art Traditions:</strong> Post Dynamic Figures</td>
</tr>
<tr>
<td><strong>Colour:</strong> Red; Monochromatic</td>
</tr>
<tr>
<td><strong>Rock Art Motifs:</strong> Mammal, macropod; Anthropomorphic: Human; Reptile: Goanna</td>
</tr>
<tr>
<td><strong>Rock Art Densities/Comments:</strong> Between 5-10 motifs in total, indeterminate number of motifs owing to poor preservation. Very weathered surfaces and the rock art is fairly exposed.</td>
</tr>
<tr>
<td><strong>Site Condition:</strong> The panels tend to be in poor condition, very weathered, faded/worn, and affected by water erosion. Some iron oxide staining and mineral deposits.</td>
</tr>
<tr>
<td><strong>Proposed Development:</strong> Within the drilling and exploration tenement. A proposed drill site is located within 200m of the site locality.</td>
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</table>
3.3.3. SITE HW003

**Site Name:** HW003

**Easting:** 333445  **Northing:** 8580738

**Environmental Context:** Arnhem Plateau, Sparse Open Woodland, Spinifex, Sandstone Tor, Meta-Sandstone

**Site Context:** A complex of shelters formed by a large isolated sandstone tor outcrop

**Description:** This site consists of a complex of shelters and art panels. It is estimated that there are >20 panels of art in 4 separate shelters. The site is rich in cultural materials including grinding surfaces with percussion impacts, remains of hearths, cut wood fragments, beeswax and spinifex resin balls. A significant amount of surficial stone quarrying is evident around the shelters. The site contains flakes, cores, retouched flakes, grinding stones, hammerstones, bifacial points and flake pieces made on quartzite, sandstone and silicified sandstone.

<table>
<thead>
<tr>
<th>Length (m): 6</th>
<th>Width (m): 4</th>
<th>Height (m): 5</th>
<th>Deposit (cm): 25</th>
</tr>
</thead>
</table>

**Site Features:** Paintings, grinding hollows, cultural deposit, stone artefacts, quarry, wood implements, hearth

**Rock Art Traditions:** 3MF Stencils, Large Naturalistic, Dynamic, Hand Stencils, Post Dynamic, Large Fauna Style, Large Human Figures, Simple Figures, Early Decorative Infill, X-Ray, Complete Figure, Beeswax, Complex Decorative

**Colour:** Red, Yellow, White; Monochromatic, Bichromatic

**Rock Art Motifs:** Mammal: macropod; Reptile: snake; Fish: Barramundi, Saratoga; Anthropomorphic: Human, Male, Female, Sorcery, Head Dress, Hook Bi-serial spear, Simple Spear

**Rock Art Densities/Comments:** >100 motifs. This is a major art site gallery. The site contains a large diversity of old and recent rock art styles. The site contains good examples of Dynamic Figures. There is an exceptional painting of a large recent X-Ray kangaroo and barramundi.

**Stone Artefact Densities:** Maximum density is >50/m^2 with an average of 4/m^2.

**Site Condition:** The panels tend to be in poor condition, very weathered, faded/worn, and affected by water erosion. Some iron oxide staining and mineral deposits. Animal disturbance includes mud wasp nests, termite nests, ant nests, and some animal rubbing.

**Proposed Development:** Within the drilling and exploration tenement.
### 3.3.4. SITE HW004

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<td><strong>Northing:</strong></td>
<td>8581174</td>
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<tr>
<td><strong>Environmental Context:</strong></td>
<td>Arnhem Plateau, Sparse Open Woodland, Spinifex, Sandstone Tor, Meta-Sandstone</td>
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<tr>
<td><strong>Site Context:</strong></td>
<td>A complex of shelters formed by a several isolated sandstone outcrops within 100m radius</td>
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<tr>
<td><strong>Description:</strong></td>
<td>This site consists of a group of shelters with some art panels. It is estimated that there are approximatelu &gt;5 panels of art in the 3 separate shelters. Shelter A limited painting but extensive quarrying; Shelter B some paintings from mid-Holocene period, a Thylacine motif, and quarrying; Shelter C late Holocene paintings, catfish white &amp; red pigment. The sandstone is particularly iron oxide rich and silicified/metamorphosed. The site contains flakes, cores, retouched flakes, blades and flake pieces made on quartzite and meta-sandstone.</td>
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<td><strong>Width (m):</strong></td>
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<td><strong>Deposit (cm):</strong></td>
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<td><strong>Site Features:</strong></td>
<td>Paintings, grinding hollows, stone artefacts, quarry</td>
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<tr>
<td><strong>Rock Art Traditions:</strong></td>
<td>Large Naturalistic, Dynamic, Post Dynamic, Large Fauna Style, Large Human Figures, Simple Figures, Complete Figure, Complex Decorative</td>
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<tr>
<td><strong>Colour:</strong></td>
<td>Red, Yellow, White; Monochromatic, Bichromatic</td>
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<tr>
<td><strong>Rock Art Motifs:</strong></td>
<td>Mammal: macropod; Fish: Eeltail Catfish; Anthropomorphic: Human, Male, Simple Spear</td>
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<td><strong>Rock Art Densities/Comments:</strong></td>
<td>20-30 motifs. The site contains mostly older rock art styles with recent motifs concentrated in Shelter C. Partial Dynamic figures and a Thylacine are found in Shelter B.</td>
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<td><strong>Stone Artefact Densities:</strong></td>
<td>Maximum density is &gt;100/m² with an average of 0.25/m². A high density of meta-sandstone flaking material is located between the sandstone boulders with numerous quarried edges.</td>
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<td><strong>Site Condition:</strong></td>
<td>The panels tend to be in poor condition, very weathered, faded/worn, and affected by water erosion. The sandstone contains high levels of iron oxide/haematite. Mineral deposits occur in some places. Animal disturbance includes mud wasp nests, termite nests, ant nests, and some animal rubbing.</td>
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<td><strong>Proposed Development:</strong></td>
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### 3.3.5. SITE HW005

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<tr>
<td><strong>Environmental Context:</strong></td>
<td>Arnhem Plateau, Sparse Open Woodland, Spinifex, Sandstone Tor, Meta-Sandstone</td>
</tr>
<tr>
<td><strong>Site Context:</strong></td>
<td>A major shelter formed by a large isolated sandstone outcrop</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>This site consists of a large low shelter formed under a tor. It is estimated that there are &gt;10 panels of art in this shelter. The site is rich in cultural materials including a very significant panel of cupule petroglyphs, axe grinding surfaces, anvil percussion impact, and remains of hearths. A significant amount of surficial stone quarrying is evident in this shelter. The site contains flakes, cores, retouched flakes, hammerstones, blades and flake pieces made on quartzite and silicified sandstone.</td>
</tr>
<tr>
<td><strong>Length (m):</strong></td>
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<td><strong>Deposit (cm):</strong></td>
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<td><strong>Site Features:</strong></td>
<td>Paintings, cupules, grinding hollows, axe grinding, cultural deposit, stone artefacts, quarry, hearth</td>
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<td><strong>Rock Art Traditions:</strong></td>
<td>Post Dynamic, Large Fauna Style, Simple Figures, Complete Figure, Complex Decorative</td>
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<td><strong>Colour:</strong></td>
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</tr>
<tr>
<td><strong>Rock Art Motifs:</strong></td>
<td>Mammal: macropod; Reptile: snake; freshwater crocodile, long necked turtle; Anthropomorphic: Human, Male, Female; Hook Bi-serial, Uniserial, Simple, Multi-barbed Spears; Fighting Pick, Stone Axe</td>
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<tr>
<td><strong>Rock Art Densities/Comments:</strong></td>
<td>&gt;50 motifs. The site contains a mostly recent rock art styles. It contains an excellent scene of a male figure painted with an array of weapons.</td>
</tr>
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<td><strong>Stone Artefact Densities:</strong></td>
<td>Maximum density is &gt;25/m² with an average of 0.25/m².</td>
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<td><strong>Site Condition:</strong></td>
<td>The panels tend to be in fair condition protected under the low overhang. Some paintings are weathered, faded/worn, and affected by water erosion. Some iron oxide staining and mineral deposits. Animal disturbance includes mud wasp nests, termite nests, ant nests, and some animal rubbing.</td>
</tr>
<tr>
<td><strong>Proposed Development:</strong></td>
<td>Within the drilling and exploration tenement.</td>
</tr>
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</table>
5.0. RECOMMENDATIONS

The results of this archaeological investigation located 5 archaeological sites within the UEL exploration lease EL25220. These sites have been recorded and assessed as having high levels of cultural heritage significance. Figure 11 below illustrates the areas of high and moderate archaeological sensitivity in EL25220. The Red Zones should be excluded from exploration drilling. The Green Zones denote areas of moderate archaeological sensitivity. In these areas, low impact activities, such as accessing water sources in these areas are an acceptable activity with very low risk to archaeological sites. The physical terrain in the vicinity of HW003, 004, 005 is likely to contain many more archaeological sites.

Recommendations in this section generally apply to the proposed exploration activities in the area. The archaeological sites documented in this report have a high cultural significance to local Bininj and are archaeologically significant to the Northern Territory and Australia. Sites are considered significant...
within the terms of the NT *Heritage Conservation Act* 1991 (HCA). These sites are protected under Section 39 of the HCA and should be avoided by the proposed works.

### 5.1. ARCHAEOLOGICAL SITE RECOMMENDATIONS

1. **Implement a 100 meter no-go conservation buffer zone around all archaeological sites documented in this survey and undertake no disturbance works within the 100 meter buffer zone.**

   The buffer zone is based on several factors. The sandstone margins are highly archaeologically sensitive regions in Arnhem Land and are generally also very culturally significant area for Traditional Owners. There may be a high likelihood of encountering sub-surface archaeological materials in this zone that could not be detected on the ground surface. A conservation zone will provide an appropriate buffer during any ground disturbance works. It will also direct attention to the contractors and staff working in this area that the area has a high archaeological risk. UEL should ensure that there are no off-site impacts from exacerbating erosion from water run-off from access tracks as several of the sites are prone to wet season inundation.

2. **Appropriate mention is made of the existence of archaeological sites and the conservation zone in the Environmental Management Plan and site induction.**

   Inclusion of cultural heritage constraints in site inductions for work within EL25220 should be undertaken by UEL. It is UEL’s responsibility to ensure that all contractors and site visitors are made aware that archaeological sites are protected and any damage and destruction may result in prosecution by the Northern Territory Government. Any unauthorised entry into the conservation zones must be reported to a project geologist and/or environmental officer. Works should cease in the area if unauthorised entry occurs. Any damage to archaeological sites must be reported to the Northern Land Council.

3. **A program of annual site inspections should be undertaken to assess whether there are any new impacts to the archaeological sites. Archaeological sites should not be visited by personnel unless accompanied by UEL Environmental Officer and is recommended that local Traditional Owners should be present.**

   Owing to the level of disturbance from previous mining activities, it is important that access to the archaeological sites is kept to a minimum. Given that the area is easily accessible, it is possible that non UEL persons may visits sites in the area. The sites in this area have a great deal of cultural heritage significance and it is recommended that UEL should monitor archaeological site conditions at
the end of each exploration season to ensure that there have been no impacts. The Northern Land
Council should be notified immediately of any signs of deterioration or unwarranted impacts.


Collis, A. 2004 Archaeology survey King River Project. An unpublished report to the Northern Land Council by ERM.


Appendix II
<table>
<thead>
<tr>
<th>Core Size</th>
<th>Total Depth</th>
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<th>Rig</th>
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<th>RF</th>
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**Survey and Orientation:**
- Orientation: Good (No significant movements)
- Survey: Good (No significant movements)
## GEOTECHNICAL LOG

**Project:** Headwaters

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<th>Depth To (m)</th>
<th>Interval (m)</th>
<th>Core Recovery</th>
<th>R.Q.D.</th>
<th>Fractures per Interval</th>
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<th>Rock Type</th>
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**Date:** 1/10/2010  

Volcanics  
SA(u) - Upper sandstone  
(Marlgowa)  
SA(L) - Lower sandstone  
(Sammarb)  
(mafic basalt)
# GEOTECHNICAL LOG

**Project:** Headquarters

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<th>Depth To (m)</th>
<th>Interval (m)</th>
<th>Core Recovery</th>
<th>R.Q.D.</th>
<th>Fractures per Interval</th>
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Hole No.: HC0002
Logged by: FB, JS
Recorded by:
Date: 1/10/2020

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**Uranium Log**

*Interpreted: Light Silted Layer*

*Interpreted: Light Silted Layer with non-sorted non-value clays*

*Interpreted: Light Silted Layer with non-sorted non-value clays along with non-sorted clay clasts agglomerated to bedding plane 94 24 - 94 25*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 10 - 95 11m 95 12 - 95 13m and non-sorted clay clasts throughout*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 94 24 - 94 25m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 94 25 - 94 26m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 10 - 95 11m and non-sorted clay clasts agglomerated to bedding plane 95 11 - 95 12m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 12 - 95 13m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 13 - 95 14m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 14 - 95 15m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 15 - 95 16m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 16 - 95 17m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 17 - 95 18m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 18 - 95 19m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 19 - 95 20m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 20 - 95 21m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 21 - 95 22m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 22 - 95 23m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 23 - 95 24m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 24 - 95 25m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 25 - 95 26m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 26 - 95 27m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 27 - 95 28m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 28 - 95 29m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 29 - 95 30m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 30 - 95 31m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 31 - 95 32m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 32 - 95 33m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 33 - 95 34m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 34 - 95 35m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 35 - 95 36m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 36 - 95 37m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 37 - 95 38m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 38 - 95 39m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 39 - 95 40m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 40 - 95 41m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 41 - 95 42m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 42 - 95 43m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 43 - 95 44m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 44 - 95 45m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 45 - 95 46m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 46 - 95 47m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 47 - 95 48m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 48 - 95 49m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 49 - 95 50m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 50 - 95 51m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 51 - 95 52m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 52 - 95 53m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 53 - 95 54m*

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*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 60 - 95 61m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 61 - 95 62m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 62 - 95 63m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 63 - 95 64m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 64 - 95 65m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 65 - 95 66m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 66 - 95 67m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 67 - 95 68m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 68 - 95 69m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 69 - 95 70m*

*Interpreted: Mixed Silt and Clay (Hydrothermal) Layer 95 70 - 95 71m and non-sorted clay along with non-sorted clay clasts agglomerated to bedding plane 95 71 - 95 72m*
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**DIAMOND DRILLHOLE LOG**
## GEOTECHNICAL LOG

**Project:**

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**Legend:**
- Row 1: Additional notes or instructions.
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Assumed core loss at toe of hole.

Driller error: Core ID 17 when should be 013.

Driller error: Core ID 33-1 should be 38-4.
### GEOTECHNICAL LOG

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UEQ Geotechnical Log Sheet
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Logged during end of dec/Jan 2011 (after transport to Uranium)
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DRILL LOG

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JERONIUM MINING CO.
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**Notes:**
- Drilling was conducted using a hydraulic drill rig.
- The borehole was inclined at 5°.
- Samples were collected at 0.5m intervals.
- Water table was observed at 2.0m depth.

**Sample Analysis:**
- No significant mineralogical or chemical variations were observed.
- Sediments were primarily clay and silt with minor sand and gravel.
- No evidence of groundwater flow was observed.
# Structure

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- **Depth:** 0 m
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- **Finished:** 0
- **Comment:**

**Additional Notes:**
- **Logging Method:**
- **Survey Method:**
- **Drilling Company:**

**Additional Details:**
- **Logging:** Drilling along bedding plane.
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<td>5</td>
<td>30</td>
<td>brown</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>2</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**Notes:**
- 10-15 m clay layer. Interbedded cream/purple (humidite) layers with dark purple humicite laminations.
- 15-20 m Interbedded clay/purple (humidite) layers with dark purple humicite laminations.
- 20-25 m Interbedded clay/purple (humidite) layers with dark purple humicite laminations.
- 25-30 m Interbedded clay/purple (humidite) layers with dark purple humicite laminations.
- 30-35 m Interbedded clay/purple (humidite) layers with dark purple humicite laminations.

**Drill Log**

- Increase in jointing angles.
- Increase in humidite content.
<table>
<thead>
<tr>
<th>HOLE ID</th>
<th>DEPTH (m)</th>
<th>GRID ID</th>
<th>STARTED</th>
<th>FINISHED</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOLE TYPE</td>
<td>RL</td>
<td>COLOR SURVEY METHOD</td>
<td>DIRECTION</td>
<td>TENEMENT</td>
</tr>
<tr>
<td>SHEET 15 OF 19</td>
<td>NS</td>
<td>DEPENDS</td>
<td>DIRECTION</td>
<td>ENDING CO</td>
</tr>
</tbody>
</table>

**DRILL LOG**

- **Structure:**
  - Interbedded coal/loam (locally brecciated) layers with hematitic partings (conglomerate, coal).
  - Reduction fracture core 250-300m, hosted fracture with clay infill.
  - Interbedded coal/loam layers with hematitic partings (local angular variably).
  - Reduction, but jointing all occurring 55-60° to CA.

- **Notes:**
  - Hematite content increased, amount of jointing increasing joint angle, variable for wear away for tool during drilling.
  - Reduction, hematite content, interbedded coal/loam layers with dark red/purple hematitic laminae.
  - Reduction, hematite content variable.
  - Reduction, joint angle variable.
  - Reduction, hematite content variable.

- Remarks:
  - Occasional hematite nodules (locally core 250-300m South (mainly)).
  - Clay infill, reduction fracture, locally associated with rounded rubble.
  - Activity from stratigraphic breakage, reduced depth, 75° dipping.
  - Higher up some hematite laminae, leading along 55° to CA, not along bedding plane.
<table>
<thead>
<tr>
<th>HOLE ID</th>
<th>DEPTH (m)</th>
<th>GRID ID</th>
<th>BORE STATION</th>
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<tbody>
<tr>
<td></td>
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<table>
<thead>
<tr>
<th>HOLE TYPE</th>
<th>METHOD</th>
<th>SHEET</th>
<th>DRAWING</th>
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<tbody>
<tr>
<td>RL</td>
<td>Collar survey method</td>
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<table>
<thead>
<tr>
<th>SURVEY</th>
<th>DECLINATION</th>
<th>TENEMENT</th>
<th>LOGGED BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DRILL LOG**

- **Hole ID**: H001X
- **Depth (m)**: 0
- **Grid ID**: (Blank)
- **Bore Station**: (Blank)

**Hole Details**

- **Hole 1**: Depth 0, Grid 0.
- **Hole 2**: Depth 0, Grid 0.

**Notes**

- **Hole 1 Notes**: General notes on drilling conditions, logging details, and sample collection.
- **Hole 2 Notes**: Similar notes as Hole 1, with specific details on sampling and orientation.

**Additional Details**

- **Sample Numbers**: Sample 001, 002, etc.
- **Orientation and Geology**: Specific orientations and geological notes.

---

**Image Context**: Detail of a drilling log indicating various depths and borehole conditions.
<table>
<thead>
<tr>
<th>Type</th>
<th>Width</th>
<th>Grain Size</th>
<th>Colour</th>
<th>Intensity</th>
<th>Type</th>
<th>Utility</th>
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</thead>
<tbody>
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<td>Rock</td>
<td>sand</td>
<td>fine</td>
<td>grey</td>
<td>5</td>
<td>type</td>
<td>unknown</td>
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<tr>
<td>Mine</td>
<td>gravel</td>
<td>medium</td>
<td>brown</td>
<td>3</td>
<td>type</td>
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</tr>
<tr>
<td>Quarry</td>
<td>gravel</td>
<td>coarse</td>
<td>white</td>
<td>1</td>
<td>type</td>
<td>unknown</td>
</tr>
</tbody>
</table>

**Measurements**

- Width: sand, gravel, coarse
- Grain Size: fine, medium, coarse
- Colour: grey, brown, white
- Intensity: 1, 3, 5
- Type: type
- Utility: unknown

**Additional Notes**

- Rock
  - Sand: fine, grey, 5, type, unknown
- Mine
  - Gravel: medium, brown, 3, type, unknown
- Quarry
  - Gravel: coarse, white, 1, type, unknown

**Charts and Diagrams**

- Chart for Width vs. Grain Size
- Chart for Colour vs. Intensity
- Diagram illustrating the distribution of types across utilities

**Drill Log**

- Faults: X-Y-Z

**Drill Results**

- Samples: 1-2-3-4-5-6-7-8-9-10-11
- Analysis: 10-9-8-7-6-5-4-3-2-1
- Comments: Note significant variations in sample analysis.
<table>
<thead>
<tr>
<th>HOLE ID</th>
<th>DEPTH (m)</th>
<th>ORIG ID</th>
<th>STARTED</th>
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<th>DRILLING CO</th>
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<tr>
<td>HED003</td>
<td>47.2</td>
<td>RL</td>
<td>12/7/65</td>
<td>12/14/65</td>
<td>J R A N I U M</td>
<td></td>
</tr>
</tbody>
</table>

**STRUCTURE**

- **Structural Notes:**
  - 51 grade granite.
  - Cored to show granite and overburden.
  - Overburden consists of 2-3 m of shale.
  - Granite is moderately foliated with 1-2 m of foliation.
  - Drill core samples show foliation.

- **Drill Core Samples:**
  - Samples show foliation with 1-2 m of foliation.
  - Drill core samples show foliation.
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Appendix III
HED001
TRAY 8 25.3-28.9 m WET

26

27

28
HED 001
TRAY 22  79.65 - 85.88 m  WET

START

80

81

82

83

84

85
HED002
TRAY 6  19.51 - 23.32m  WET

START

20

21

22

23
HED002
TRAY 16  55.0-56.8m  WET
HED003
TRAY 29  149.7 - 155.9m WET

START

150
151
152
153
154
155
HED003
TRAY 31 162.09-168.44 m WET
HED003
TRAY 41 224.95-231.03m WET

START

225

226

227

228

229

230

231
HED003
TRAY 56 317.9-324.09m WET
START

TRAY 59

335.29 - 34140m

WET
HED003
TRAY 74  428.7 - 434.8 m WET
HED003
TRAY 76 440.93-443.8m WET
HED003
TRAY 9 26.90-33.21m WET

START
27
28
29
30
31
32
33
Appendix VI
MINERALOGICAL REPORT No. 9853
by Alan C. Purvis, PhD

February 21st, 2011

TO:

Grant Williamson
Geology Manager – Exploration
Uranium Equities Ltd
Level 4, 29 King William Rd
ADELAIDE SA 5000

YOUR REFERENCE:

Order No. 447
Your letter 12/01/11

MATERIAL:

Nine core samples, Headwaters Project area, NT
of Uranium Equities Ltd, Drill Hole Nos HED001 to HED003

IDENTIFICATION:

WORK REQUESTED:

Thin section preparation, description and report
with comments as specified.

SAMPLES & SECTIONS:

Returned to you with hard copy of this report.

DIGITAL COPY:

Emailed 21/2/11 to:
<grantwilliamson@uel.com.au>

[Signature]

PONTIFEX & ASSOCIATES PTY. LTD.
SUMMARY COMMENTS

The nine core samples described in this report from normal thin sections are from three drillholes into sandstone, basalt and dolerite in the Headwaters project area of Uranium Equities Limited in the Northern Territory. Four samples are from drillhole HED001, one from HED002 and four from HED003.

The samples from HED001 and 2 include four core segments of sandstone or conglomerate and one of altered basalt, indicated in your covering notes as representing Gilruth Volcanics, a unit interlayered with Kombolgie Subgroup sediments. The samples from HED003 are all mafic petrographically identified as altered basalts and dolerites. A summary of the sandstones and of the basalts follows.

The sandstone samples are typical of Kombolgie Subgroup sandstones and conglomerates, single crystal and polycrystalline detrital quartz grains and granules commonly with optically continuous overgrowths, or with interstitial sericite/illite ± hematite ± quartz. Sample HED002, 54.1m has sparse patches of interstitial kaolinite/dickite as well as optically the continuous quartz overgrowths.

Notes accompanying the samples question the presence of basaltic or volcanic detritus, such as ash or rip-up clasts, but there is no evidence of volcanic ash. Rip-up clasts in conglomerate HED001, 50.3m differ from the sample of Gilruth Volcanics in lacking leucoxene and, except for a small clast with poor textural preservation, there is no evidence of volcanic/basaltic textures. One rip-up clast with little or no hematite is clearly derived-sedimentary, and other hematite-rich clasts also seem to represent fine-grained sediments.

Hematite-rich fragments in several samples have quartz grains impressed into their margins, suggesting soft sediments. Any volcanic component would need to have been altered to clay and hematite, and therefore softened, to allow quartz to be impressed into the fragments. None of the other sandstone thin sections have identifiable volcanic material.
Headers of the individual sandstone descriptions are listed as follows:

HED001, 50.3m: Granule-bearing conglomerate with single crystal and polycrystalline quartz grains and large platy clasts variously rich in sercite and hematite, locally with quartz. Microtextures within these clasts are poorly preserved but seem to represent shale and sandy shale i.e. derived from sediments.

HED001, 58.9m: Irregularly laminated very fine to coarse-grained sandstone with interstitial sercite/illite and hematite but no evidence of volcanic ash components.

HED001, 60.05m: Mostly medium-grained sandstone with single crystal quartz grains rimmed by limonite, commonly with optically continuous quartz overgrowths. Minor irregular lenses of interstitial sercite or illite + quartz + hematite. Other scattered hematite may represent deformed clasts, with irregular porosity partly ex-hematite. Accessory detrital tourmaline, leucoxene, zircon and anatase.

HED002, 54.1: Well-bedded sandstone with layers of fine to very coarse-grained sandstone mostly with hematite-rimmed cores and optically continuous quartz overgrowths. Local interstitial kaolinite or dickite ± illite or with interstitial films of illite. No obvious volcanic ash.

The basalt in drillhole HED001 has hematite-clay-leucoxene alteration, whereas finer-grained mafic samples from drillhole HED003 have various combinations of sercite, carbonate, chlorite, albite, hematite, quartz and leucoxene. A single coarse-grained dolerite at 372.85m has fresh plagioclase with cores of calcic labradorite and more sodic rims as well as carbonate-clay-altered pyroxene and interstitial albite/granophyre + late magmatic quartz + apatite or carbonate + clay.

Headers of the individual mafic descriptions are listed as follows:

HED001, 52.7m: Basalt altered to hematite-clay-leucoxene basalt with clay-filled fractures.

HED003, 251.4m: Basalt or dolerite altered to sercite-chlorite-carbonate-leucoxene-albite, includes altered plagioclase and pyroxene phenocrysts and veinlets of carbonate ± quartz.
HED003, 372.85m: Probable quartz-bearing dolerite, with carbonate-clay-altered pyroxene, interstitial carbonate-clay patches, as well as granophyre and late magmatic quartz containing microcrystals of apatite.

HED003, 422.45m: Basalt altered to albite-chlorite-hematite-quartz, with amygdales containing quartz and chlorite.

HED003, 443.65m: Basalt altered to albite-chlorite-hematite, with amoeboid patches of chlorite and colourless possible clay ± quartz.
INDIVIDUAL DESCRIPTIONS

| HED001, 50.3m | Granule-bearing conglomerate with single crystal and polycrystalline quartz grains and large platy clasts variously rich in sericite and hematite, locally with quartz. Microtextures within these clasts are poorly preserved but seem to represent shale and sandy shale i.e. derived from sediments. |

Field Note:  *Pebble conglomerate: coarse-grained sandstone with subrounded quartz pebbles and irregular red-brown rip-up clasts from underlying Gilruth Volcanic Member mafics*

Hand Specimen

Quartz pebble or granules are visible in this core segment, with platy red-brown possible rip-up clasts or intraclasts in irregularly pale and slightly reddish probable sandstone.

Thin Section

The thin section has abundant unsorted but largely subrounded or rounded single crystal and polycrystalline quartz grains from 0.4mm to nearly 4mm in diameter (medium sand to granules). The polycrystalline grains range from very fine-grained to coarse-grained and include variously granular of columnar quartz. Sparse fragments of microcrystalline quartz or decussate amphibolite also occur. Most of the single crystal quartz grains, and some of the coarser polycrystalline grains, have narrow optically continuous overgrowths, but there are also interstitial areas containing sericite/illite ± quartz and/or hematite in various proportions.

Unsorted, partly platy clasts consist of hematite and sericite in various proportions and may be as much as 25mm long and 4mm wide, possibly defining bedding. One small clast has poorly defined possible feldspar shapes and may have been basalt, but others contain fine-grained quartz.
and/or hematite-rich and sericite-rich lamellae, suggesting former shale squeezed between sand grains and granules. One sample has abundant crystalline (grey) hematite, but the others have red earthy hematite. One clast has little or no hematite but has sand-sized quartz grains in laminated and foliated sericite. Most of the platy fragments may be intraclasts of sericite or clay-hematite-rich shale and sandy shale.
HED001, 52.7m | Basalt altered to hematite-clay-leucoxene basalt with clay-filled fractures.

Field Note:  *Gilmour Volcanics: fine-grained red-brown hematitic basaltic ash*

Hand Specimen

This sample is red-brown with a bluish tint in some areas and is laminated at 90° to the core axis.

Thin Section

There are abundant sericite/fililite-clay-altered feldspar shapes in this thin section, to 1.5mm long, separated by lenses and lamellae of earthy hematite accompanied by minor leucoxene. Formerly feldspar-rich lamellae to 2mm wide are rich in interstitial leucoxene and poor in hematite. The lack of hematite may make any leucoxene more visible than in hematite-rich areas, however. There are also narrow clay-filled fractures roughly parallel to the layering.

This sample seems to represent coherent basalt rather than volcanic ash, but has been altered and flattened.
| HED001, 58.9m | Irregularly laminated very fine to coarse-grained sandstone with interstitial sercite/illite and hematite but no evidence of volcanic ash components. |

Field Note: *Interbedded fine-grained sandstone and hematitic volcanic ash.*

Hand Specimen

Planar and lenticular millimetre to centimetre scale bedding laminations are evident in this core segment and are at about 90° to the core axis, with dark and pale reddish lamellae and lenses.

Thin Section

Most of the thin section has abundant very fine to medium sand, from 0.05mm to 0.5mm in grainsize, with angular and subrounded single crystal quartz grains set in sercite/illite and earthy hematite. On one side of the thin section there are lamellae and lenses with medium to coarse-grained sand-sized quartz, 0.3mm to 1mm in diameter, disseminated or in narrow laminations. In other areas there are weakly anastomosing possible veins of fractures filled with pale green possibly phengitic sercite and hematite. There is minor tourmaline in the fine-grained areas, as well as leucoxene, hematite and zircons to 0.15mm long. Minor porosity is disseminated.

There is no obvious ash in this thin section.
HED001, 60.05m

Mostly medium-grained sandstone with single crystal quartz grains rimmed by limonite, commonly with optically continuous quartz overgrowths. Minor irregular lenses of interstitial sericite or illite ± quartz ± hematite. Other scattered hematite may represent deformed clasts, with irregular porosity partly ex-hematite. Accessory detrital tourmaline, leucoxene, zircon and anatase.

Field Note:  *Interbedded fine-grained sandstone and hematitic volcanic ash.*

Hand Specimen

Pinkish sandstone in this core segment contains an irregular cream lamination and blocky dark red-brown zones in sharp contact, across possible fractures, with paler reddish-brown zones.

Thin Section

Abundant subrounded or subangular single crystal quartz grains in this thin section are mostly less than 0.5mm in diameter, suggesting medium-grained sandstone, with detrital cores rimmed by limonite. Narrow optically continuous overgrowths are abundant but there is also common interstitial sericite/illite, mostly intergrown with quartz, and patches of microcrystalline or earthy hematite. Some of the larger hematite masses, to 2mm long, may represent clasts deformed between quartz grains. However, areas of interstitial sericite/illite without optically continuous overgrowths are also common and there are examples of stylolitic grain boundaries. Accessory heavy minerals include tourmaline, leucoxene and zircon, with zircon to 0.2mm in diameter and a grain replaced by anatase. Porosity is irregularly disseminated, to 6mm long, but mostly smaller, and may partly represent leached hematite-rich zones.
HED002, 54.1  Well-bedded sandstone with layers of fine to very coarse-grained sandstone mostly with hematite-rimmed cores and optically continuous quartz overgrowths. Local interstitial kaolinite or dickite ± illite or with interstitial films of illite. No obvious volcanic ash.

Field Note:  *Laminated fine-grained hematitic sandstone ± some fine ash component*

Hand Specimen

This sample is mostly pinkish sandstone with planar bedding laminaions at 90° to the core axis.

Thin Section

The thin section has bedding laminaions from 3mm to 6mm thick with layers as listed.

1. Poorly sorted medium to very coarse-grained sandstone with single crystal quartz grains to 1.5mm in grainsize showing subrounded or subangular cores, rimmed by hematite, abundant optically continuous overgrowths, interstitial fine sand and rare interstitial kaolinite or dickite ± illite.

2. A layer 4-5mm wide with abundant fine sand (to 0.25mm in grainsize) and less abundant partly elongate grains to 1mm long (medium to coarse sand), with abundant optically continuous overgrowths and hematite-rimmed cores.

3. A layer 5-6mm wide with rounded and subrounded single crystal quartz grains to 2mm long (very coarse-grained sandstone) with optically continuous overgrowths, hematite-rimmed cores and sparse patches of interstitial kaolinite or dickite ± illite. Fine sand-sized grains, to 0.25mm in diameter, occur locally between the larger grains.

4. A lenticular layer of fine-grained sandstone 2-4mm wide has coarse sand from the adjacent layer #3 impressed into it. This layer has quartz grains with optically continuous overgrowths. Where it is thin it passes into a coarsening layer with grains reaching 1.5mm long in the coarsest zone, but where it is thicker the contact with coarser
sandstone is sharper. The coarser layer is 5-6mm thick and again has rounded single crystal quartz grains with optically continuous overgrowths and hematite-rimmed cores. A lens of fine to medium-grained sandstone occurs within this layer.

5. The final layer is fine-grained sandstone with grains 0.05mm to 0.25mm in diameter and interstitial films of sericite or illite.
HED003, 251.4m | Basalt or dolerite altered to sericite-chlorite-carbonate-leucoxene-albite, includes altered plagioclase and pyroxene phenocrysts and veinlets of carbonate ± quartz.

Field Note:  *Fine-grained dolerite dyke with calcite veining*

**Hand Specimen**

This sample is dark green with possible carbonate veins at a high angle to the core axis ans a possibly later vein at a low angle to the core axis.

**Thin Section**

This sample has abundant altered plagioclase phenocrysts and microphenocrysts to 1mm long, with carbonate-albite-sericite alteration, occurring singly or in small aggregates, and less abundant pyroxene phenocrysts and microphenocrysts to 1mm long with chlorite-carbonate-leucoxene alteration suggesting some titanium in the pyroxene. Some of the pyroxene is composite with plagioclase but some is separate. There are also disseminated microphenocrysts of magnetite and a crescent-shaped patch og carbonate of uncertain origin. The groundmass is rich in unoriented sericitised plagioclase microlites with interstitial possible chlorite as well as opaque oxide and abundant leucoxene. Rare microcrystalline quartz is disseminated. There are sparse fractures filled with carbonate ± quartz, as seen in hand specimen.
| **HED003, 372.85m** | Probable quartz-bearing dolerite, with carbonate-clay-altered pyroxene, interstitial carbonate-clay patches, as well as granophyre and late magmatic quartz containing microcrystals of apatite. |

**Field Note:** *Medium-grained microdiorite*

**Hand Specimen**

This sample is visibly granular in hand specimen with abundant plagioclase and dark olive-green altered mafic grains. A carbonate vein parallel to the core axis is not present in the thin section.

**Thin Section**

There is abundant (~60%) plagioclase in this thin section, as laths to 6mm long. Cores may be as calcic as An_{66-68} (calcic labradorite) with narrow strongly zoned rims. Abundant (~30%) former pyroxene to 2mm in grain size has been altered to carbonate and brown clay, possibly smectite. There is also possibly 3-5% disseminated interstitial material including albittised feldspar and granophyre and patches of late magmatic quartz. These areas contain prisms of apatite, but there are also interstitial patches of carbonate ± fibrous clay. Granular and skeletal opaque oxides are disseminated (~5%) and as much as 2mm in diameter, possibly including ilmenite as well as magnetite.

This sample is probably altered quartz-bearing dolerite such as Oenpelli Dolerite rather than microdiorite, based on the presence of calcic plagioclase, former pyroxene and largely skeletal opaque oxides.
HED003, 422.45m | Basalt altered to albite-chlorite-hematite-quartz, with amygdales containing quartz and chlorite.

Field Note: *Amygdaloidal basalt*

Hand Specimen

This dark grey-green altered basalt has abundant irregularly zoned circular or elliptical amygdales to 6 or 7mm in maxim diameter.

Thin Section

The basalt in this thin section has disseminated plagioclase phenocrysts and microphenocrysts, to 1.5mm long, altered to hematite-stained albite ± chlorite. Smaller, less abundant grains of probable pyroxene have been altered to chlorite and there are small silicified grains that may have been olivine. The groundmass is rich in albitised plagioclase microlites as well as irregularly translucent or opaque interstitial material possibly rich in chlorite and opaque oxide.

Amygdales in the thin section vary from 0.4mm to 6mm in diameter, with granular to prismatic quartz in the smaller amygdales. The larger amygdales have irregular zones of mostly isotropic probable chlorite and mostly prismatic quartz. There is no uniform pattern to the chlorite and quartz zones in these amygdales.
| HED003, 443.65m | Basalt altered to albite-chlorite-hematite, with amoeboid patches of chlorite and colourless possible clay ± quartz. |

Field Note:  *Fine-grained basalt lava*

Hand Specimen

This sample is fine-grained and dark greenish grey.

Thin Section

There are abundant weakly hematite-stained albitised plagioclase laths in this thin section, mostly less than 0.8mm long. Patches of bluish green chlorite to 1mm long may represent minor pyroxene and commonly contain minor carbonate. There are also patches of isotropic possible chlorite or clay with limonite-filled fractures. These patches may represent former olivine but this is uncertain. Minor fine-grained opaque oxide is disseminated. Some of the interstitial material contains pale orange-pink albite or dull green chlorite, but there are also abundant amoeboid patches or amygdales with zones of chlorite and inner zones of colourless possible clay ± microcrystalline quartz. Some of the colourless material occurs as small circular grains apparently less than 10μm in diameter, but there is also very fine-grained granular quartz in some areas.