52.4

ANNUAL REPORT OF

EXPLORATION ACTIVITIES ON

EXPLORATION LICENCE 5071

TENNANT CREEK, N.T.

FOR PERIOD

29.01.87 to 28.01.88

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SUMMARY

Exploration Licence 5071, with an area of 19 square kilometres in the vicinity of Tennant Creek in the Northern Territory, was granted to Australian Development Limited on 29 January, 1987.

To date, work has comprised review of existing geological and geophysical data to determine the most appropriate exploration methods. The prime exploration target is considered to be oxidised haematite-hosted gold mineralisation (eg. Nobles Nob and Rising Sun mines).

A reconnaissance gravimetric surveys has been designed over the northern and south-western portion of the licence area. This will commence on completion of the gridding which is currently in progress, on another lease area.

1.0 INTRODUCTION

1.1 Location, Climate, History

The township of Tennant Creek is located on the Stuart Highway approximately 500 kilometres north of Alice Springs and 1,000 kilometres south of Darwin in the Northern Territory. Exploration Licence 5071, held by Australian Development Limited, lies within the Tennant Creek 1:250,000 sheet bounded by latitudes 19° 35' S and 19° 37' S and longitudes 133° 55' E and 133° 59' E. (Figure 1)

The main centre of population is Tennant Creek (population approximately 3,500), however smaller settlements are located at Warrego and Nobles Nob mines, the Threeways Roadhouse and the two pastoral properties of "Phillip Creek" and "Tennant Creek".

The climate is hot in summer (mean daily temperature ranges from 24° C to 37°C) and mild in winter (11°C to 24° C). Temperatures into the mid-forties are common during summer. The yearly average rainfall is 365 mm, confined mainly to the summer months.

The semi-arid country supports semi-desert vegetation comprising porcupine bush, spinifex, turpentine bush, small eucalypts and mulga.

Gold was first recognised in the area probably around 1870, but it was not until 1932 that the first significant deposit was discovered. The field subsequently developed into a major producer of gold and copper. Four mines are in production at the present time: Warrego and Argo (Peko-Wallsend Operations Limited), TC 8 (Cuprex Limited), and the recently discovered and developed White Devil mine (Australian Development Limited). Milling operations are still conducted at Nobles Nob (Australian Development Limited). Peko-Wallsend's Gecko mine is currently under evaluation for re-opening. Details relevant to the geology and mineralisation of mines in the Tennant Creek field are presented by White (1962), Crohn (1965, 1975), Crohn and Oldershaw (1965), White (1965), Dunnet and Harding (1967), Large (1975), Goulevitch (1975) and Nguyen et al (in prep.).

Australian Development Limited is currently involved in continued exploration in the Tennant Creek field searching primarily for gold. This follows a particularly successful programme undertaken since 1985 which resulted in the discovery and successful exploitation of New Hope and Rising Sun West underground mines, open pit mining of Northern Star mine (in joint venture with Australian Consolidated Minerals Limited) and the high grade White Devil mine. The White Devil mine was discovered and brought on-stream in 14 months; the first gold pour being achieved during August, 1987. Reserves amount to 280,000 tonnes at 22 grams per tonne gold.

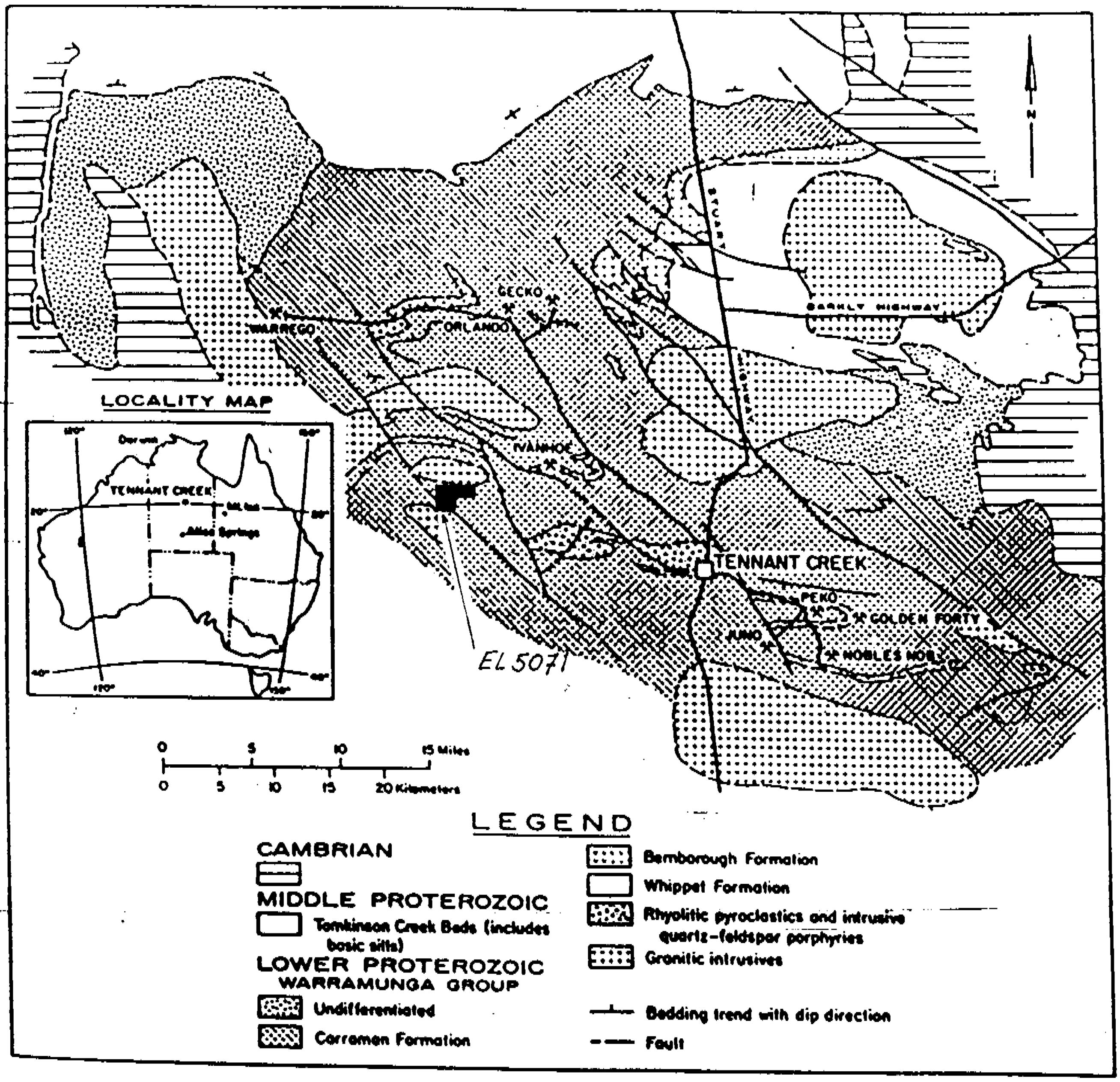

Fig 1: Geology of the Tennant Creek mineral field (from Large, 1975).

1.2 Land Title

Exploration Licence 5071 was granted to Australian Development Limited on 29 January 1987. The licence area is 19 square kilometres. Expirary date for the licence is 29 January 1991.

1.3 Previous Exploration

The first geological report on the Tennant Creek goldfield was compiled in 1936 by Woolnough. Ivanac carried out a comprehensive study of the regional geology and mineral deposits of the area in 1954. The geology of the Tennant Creek one-mile sheet was described by Crohn and Oldershaw (1965) and this was followed in 1967 by Dunnet and Harding's report on the adjoining Mount Woodcock one-mile sheet area. Numerous unpublished geological and geophysical reports have been prepared by both government and private bodies (in particular the B.M.R., Geopeko Limited, and Australian Development Limited. The most recent geological survey was undertaken in 1970-71 (Dodson and Gardener).

2.0 REGIONAL GEOLOGY, STRUCTURAL AND METAMORPHIC HISTORY

2.1 Regional Geology

Comprehensive reviews of the regional geology have been given by Crohn (1965), Large (1975) and Black (1977). The generalised geology is shown in Figure 1.

The Lower Proterozoic Warramunga Group forms a large proportion of the Tennant Creek Block and consists predominantly of tuffaceous greywackes, greywackes and shales with major intercalations of acid volcanics and associated pyroclastics. Estimates of the thickness of the Group range from approximately 3,000 metres (Mendum and Tonkin, 1979; Black, 1984) up to 10,000 metres (Ivanac, 1954; Dunnet and Harding, 1967).

The stratigraphic succession of the Warramunga Group comprises three formations: the Whippet Formation, the Bernborough Formation and the Carraman Formation in order of decreasing age. The Carraman Formation hosts the known Au (Cu,Bi) deposits in the Tennant Creek field with the possible exception of the Last Hope mine in the northwest of the field.

The Whippet Formation underlies the eastern part of the Tennant Creek area and consists of shallow water sandstone with subordinate amounts of greywacke and shale.

The Bernborough Formation consists of acid volcanic rocks, tuff and tuffaceous greywacke that are interbedded with subordinate amounts of red shale and siltstone. The lower geological contact is gradational with the sedimentary rocks of the Whippet Formation, whilst the upper contact may represent a disconformity. Apart from areas occupied by resistant bedded chert, no marker horizon has been recognised throughout the volcanic sequence.

The Carraman Formation forms approximately 50 percent of the outcrops in the area, and consists mainly of argillite, shale, siltstone and tuffaceous greywacke that form units with features indicative of deposition by turbidity currents. Isolated occurrences of dolomite have been reported at several localities (Dunnet and Harding, 1967), as have haematitic shales, ironstones, cherts and conglomerates.

Felsic volcanism is present throughout the formation and forms lenses that have been variously named Warrego, Orlando and Gecko Volcanics on the previous geological maps (scales 1:63,360 and 1:250,000). In the field these volcanic rocks are indistinguishable from the Bernborough Volcanics, supporting an interpretation of a pulsating volcanism during the development evolution of the Tennant Creek basin with peak periods of volcanic activity co-inciding with the Bernborough Formation and the main lenses of Orlando-Warrego Volcanics. Volcanic rocks of a fissure type are indicated to the north of Tennant Creek, where they transgress several units.

Vent areas have not been recognised with certainty and to which extent the vents are filled with outcrops of porphyry remains a matter of speculation. Areas near the Tennant Creek airport and south of the Bernborough mine contain ignimbrites that could qualify as pipe fillings (Crohn, 1965).

Sills and dykes of diorite and, less commonly, dolerite, intrude the upper parts of the Warramunga Group and lower part of the Tomkinson Creek Beds. Small lamprophyre dykes and sills intrude Warramunga Group sediments, particularly in the vicinity of the granite bodies.

The Warramunga Group is overlain inconformably by sediments of shallower water facies, namely the Hatches Creek Group in the south and the Tomkinson Creek Beds in the north. The Warramunga Group was intruded by granitic plutons, deformed and metamorphosed prior to the deposition of both the abovementioned Groups.

The Hatches Creek Group (maximum thickness 7,000 metres) consists of sandstone, greywacke and shale with basalt and porphyritic rhyolite present in the lower parts of the sequence (Smith et al, 1961). It has been intruded by gabbroic to doleritic dykes and sills and also by granitic plutons (e.g. the Elkedra Granite). The Tomkinson Creek Group (maximum thickness 17,000 metres) consists of quartz-rich greywacke, sandstone and minor limestone, dolomite and chert. Ivanac (1954) reports rare rhyolitic porphyries and basalt. The Group is cut by basic dykes and sills, but is not intruded by granitic rocks.

The Proterozoic rocks are overlain by flat lying Cambrian rocks, and Mesozoic and Cainozoic sediments.

2.2 Structural History

The structural history of the Tennant Creek region is poorly understood. The so-called "main (east-west) folding " of Dunnet and Harding (1967) has been adopted by most workers, with the terms "east-west folding" and "main folding" being synonomous and occurring in much of the literature which has been published subsequent to Dunnet and Harding's report. Most workers regard this period of folding as the first deformational event that occurred in the region. Dunnet and Harding suggested that this main period of folding was a consequence of a second deformation and that earlier (D1) fold structures had been folded during this event. Their evidence for D1 was, however, limited and their discussion of that event was therefore brief. Mendum and Tonkin (1979) contend that the earlier phase of folding (D1) proposed by Dunnet and Harding did not take place.

Examination of photo-geological map sheets of the Tennant Creek region indicate the Warramunga Group sediments have been tightly to isoclinally folded (D1) and subsequently folded (D2) into a major open anticlinal structure. It is this open style of folding ("main east-west folding") that is considered by many workers (e.g. Black, 1977) to be the first deformational event. As most workers have not recognised this early event, one should treat with caution any estimates relating to the thickness of the Warramunga Group.

The main folding event, D2, produced a fracture cleavage (S2) in the more massive greywacke units and a crenulation cleavage (S2) in the finer grained, more micaceous siltstones and shales. Partial or complete transposition of the earlier So (bedding) and S1 surfaces has been reported by Dunnet and Harding (1967) in intensely deformed areas (e.g. near the Quartz Hill Fault). The low temperatures that prevailed during this period of deformation have aided in the development of the fracture cleavage and also the numerous shear zones that are broadly axial planar to the large D2 fold.

A later event (D3) with open folds and flexures that plunge NNW has been suggested (e.g. Dunnet and Harding, 1967). This event has caused minor flexuring of some D1 folds and has probably been the cause of the synclinal basins and anticlinal domes that can be observed in the northern areas of the field.

The structural position of the Tomkinson Creek and Hatches Creek Groups is also a point of contention amongst geologists working in the Tennant Creek region. Some authors (e.g. Dunnet and Harding, 1967; Mendum and Tonkin, 1979) consider the Tomkinson Creek Group, and by inference the Hatches Creek Group, to predate the main folding (D2).

Other workers, however, suggest that the Hatches Creek and Tomkinson Creek Groups postdate D2. The Tomkinson Creek Group rests unconformably on both the Tennant Creek Ganite Complex and the Warramunga Group. There is no evidence to suggest that the Tomkinson Creek Group was folded during the first period of deformation, D1. It has, however, been folded during D2.

2.3 Metamorphic History

The metamorphic history of the region is also poorly understood. Some workers ascribe greenschist facies conditions (e.g. Dunnet and Harding, 1967; Rao, 1977), whilst other workers consider the rocks to be virtually unmetamorphosed (e.g. Wyborn, in Black, 1977; Coupard, 1978). According to Duncan (1970), the composition and low structural state of K-feldspars in the porphyroidal rocks, the decalcification of andesine in the granites and the formation of chlorite and white mica in these rocks was accomplished in response to greenschist facies metamorphism. One opinion is that these conditions were attained during the first phase of deformation.

Contact metamorphic effects caused by the emplacement of the Tennant Creek Granite Complex have been mentioned by only a few workers (Crohn and Oldershaw, 1965; Dunnet and Harding, 1967). The observations made by these authors are extremely important, however, when considering the time of emplacement of this granitic complex. It is obvious that the pluton was intruded after the deposition of the Warramunga Group as it has contact metamorphosed rocks of this Group. The Tomkinson Creek Group, however, rest unconformably on the pluton, indicating that emplacement occurred prior to the deposition of the Group of sediments.

The structural and metamorphic events in the Tennant Creek area can be summarised as follows:-

(i) The Warramunga Group was intruded by the Tennant Creek Granite Complex and then tightly to isoclinally folded during D1. Parallel S1 surfaces in the sediments and the granite confirm this. Metamorphism accompanying this deformation was of low grade greenschist facies.

(ii) Uplift and erosion occurred. The Tomkinson Creek Group was deposited unconformably over the Warramunga Group and the Tennant Creek Granite Complex.

(iii) During a second deformation event (D2), the Warramunga Group and Tomkinson Creek Group were folded into broad, open anticlinal and synclinal structures.

(iv) A third, weak deformational event (D3) affected the region causing flexuring of pre-existing folds; and

(v) Cambrian strata laid down unconformably on all Proterozoic rock types.

3.0 MINERALISATION

Comprehensive details of the geology, structure and mineralisation are described in White (1962), Crohn (1965, 1975), Crohn and Oldershaw (1965), Dunnet and Harding (1967), Large (1975) and Goulevitch (1975).

Mineralisation in the Warramunga Group is widespread and consists of gold deposits associated with haematite-quartz ironstone and magnetite-chlorite-quartz ironstone, and copper-gold-bismuth orebodies associated with quartz-haematite and quartz-magnetite lodes and chloritic alteration.

According to Large (1977), all known economic gold, bismuth and copper mineralisation in the field occurs in the Carraman Formation which forms more than 50 percent of the outcrops in the district. Large divides the Carraman Formation into three members based on the content and type of syngenetic iron oxides.

The basal sediments of the formation, termed the magnetite facies by Large, are predominantly fine laminated siltstones and tuffaceous greywackes; the siltstones carry 2 to 15 weight percent magnetite. Turbidites predominate in the upper portion, and there is sufficient volcanic material in many of the beds to warrant the term "tuffaceous greywacke". The middle section of the Carraman Formation contains a greater proportion of haematite than magnetite and is termed the haematite facies by Large. The unit comprises felsic turbidites, tuffaceous greywackes, argillaceous iron formations, rhyolitic pyroclastics, ash flow and interbedded quartz-feldspar porphyry of volcanic origin. The uppermost sediments, termed the iron-free facies by Large, are predominantly greywackes and lithic wackes, with minor shales. There is a general lack of syngenetic iron oxides, and no felsic volcanics or intrusive porphyries in this unit.

According to Large, economic gold-bismuth-copper mineralisation within the Tennant Creek field invariably occurs within lenticular, ellipsoidal or pipe-like bodies rich in magnetite and/or haematite.

Seven to eight hundred ironstone bodies of various sizes occur within the Warramunga Group, but only carry economic concentrations of ore minerals when located within the haematite facies of the Carraman Formation. In this subdivision there have been approximately 250 ironstones indentified. Within this environment, mineralised magnetite-haematite bodies are commonly found close to thin beds of argillaceous banded iron formation and haematite rich shales (e.g. Nobles Nob, Juno and Eldorado Mines), which Large interprets as representing "normal shales which received contributions from iron-rich submarine volcanic exhalations during their period of deposition".

Other associations listed by Large include the occurrence of orebodies within sediments adjacent to contacts of rhyolitic porphyries (e.g. Peko Mine); within soft sediment slump structures such as mudflow conglomerates or breccia conglomerates (e.g. Gecko, Orlando, Kia Ora and Northern Star Mines). A small proportion of mineralised ironstones, especially those with a sheet-like form, are located within faults or shear zones (e.g. Ivanhoe Mine and White Devil Main Zone).

Mineralogy and wallrock alteration of the major mines are notably similar. Massive magnetite with minor chlorite and/or quartz is commonly concentrated at the centre of the ironstone body. Zones composed of quartz-magnetite, magnetite-haematite, quartz-haematite, talc-magnetite, dolomite-jasper, dolomite-talc-chlorite, and chlorite-haematite may surround the central body (Large, 1977).

According to Black (1977), geochronological studies indicate that "the concordance of muscovite ages (at 1810 Ma) is strong evidence for a common age, and by inference, common origin for the ore deposits of at least Warrego, Juno, Golden Forty and Nobles Nob mines". Recent geochronological studies (Black, 1984), indicate that granite emplacement occurred both before and after the main 1810 Ma tectonothermal event and accompanying mineralisation.

Economic ore minerals found comprise gold, chalcopyrite, native bismuth and bismuthinite. Sellenium and, in the case of Juno Mine, silver have been significant by-products. Accessory minerals comprise pyrite, pyrrhotite, galena. Uraninite has been recorded as submicroscopic grains with values of over 80 ppm in the Juno deposit (Large, 1975), and monazite is present at Warrego (Gouvelitch, 1975) with uranium values up to 500 ppm. Uraninite has also been reported from the Northern Star mine (Edwards, 1987).

In addition, trace amounts of sphalerite, wolframite and cassiterite have been recorded in the field.

4.0 WORK UNDERTAKEN

4.1 GEOLOGY

EL 5071 is one of a group of exploration licences granted to Australian Development Limited in the Red Bluff area of the Tennant Creek Field. The other licences are EL 5069, 5070, 5074, 5132, 5135. These licences have since been the subject of a joint venture agreement between Australian Development Limited and Newmont Australia Limited.

The geology of EL 5071 can be broadly divided into two zones. The northern area consists essentially of granite of the Tennant Creek Granite Complex. On-lapping the granite to the south are sediments of the Carraman formation. Within the licence area these consist of magnetite and haematite bearing shales, siltstones and tuffaceous greywacke.

An initial assessment of the licence area was undertaken during the first year of tenancy. This assessment was delayed until a decision was made with regard to joint venture of a number of exploration licences held by Australian Development Limited. This issue was resolved in November 1987. Since that time work undertaken has been directed towards developing a comprehensive exploration programme designed to evaluate the southern portion of licence area for classical Tennant Creek style Au (Cu,Bi) mineralisation and in the north, the contact between the Carraman Formation and the Tennant Creek Granite Complex. This latter region will be assessed for contact metamorphic style mineralisation.

4.2 GEOPHYSICS

No production has been recorded from the licence area, however its prospectivity has not been properly evaluated. Within the southern area of the licence the sequence is magnetically disturbed due to the presence of magnetite bearing sediments and shear zones. Three weak magnetic anomalies are evident within the southern area. Geophysical assessment has been made from the results of an aeromagnetic survey conducted in June-July, 1984 on behalf of Geopeko Ltd. This data was made available to Australian Development Limited. Assessment of the magnetic data was undertaken by consultant geophysical, L. Farrar.

A geophysical grid has been designed over the aeromagnetic ridge and associated magnetic anomalies in the south of the licence area. This grid will be set with a line spacing of 320 metres and station spacing of 40 metres. A gravimetric survey will be undertaken to identify broad zones of interest with the interest being shallow haematite hosted Au mineralisation (e.g Nobles Nob). Follow-up surveys at 80 metre and 40 metre line spacings will be undertaken to define drill targets.

Infill gridding will be undertaken over the three weak magnetics anomalies to provide a ground magnetics survey to define drill targets.

Gridding of EL 5071 has been let to Exsurv Pty Ltd (Adelaide) and will be undertaken on completion of a similar programme on EL5075 (in progress).

5.0 EXPENDITURE

expenditure to date on EL 5071 has been minimal. The contract surveying crew will move on site on completion of their current programme on EL 5075. This will substantially increase the level of expenditure on the licence. The licence has a first year covenant of $16,000. The proposed work programme for Year Two involves a committed expenditure of $29,000.

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