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G E O - F L I T E

GEO-FLITE RESEARCH PTY. LTD.

E 53/70

FRACTURE AND MINERALIZATION STUDY

MT LIVINGSTONE AREA

TASMANIA

AUSTRALIA

COPY

FOR

MACLEOD MINING AND EXPLORATION PTY. LTD.

PERTH

WESTERN AUSTRALIA

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INTRODUCTION

The Mt Livingstone Area is located 20 km north west of the lead-zinc mining town of Zeehan in north west Tasmania. The area supports many active mines for lead, zinc, copper, gold, iron and tin, and the latter is mined at Renison Bell, some 15km to the south east. The area of interest lies on the approx 10km by 20km exploration licence E.L. 53/70, which includes Mt Livingstone itself. The terrain is rugged, with the Stanley River and its tributaries draining south to the Pieman River in a series of deeply incised valleys.

Several potentially economic minerals have been sought in the past by C.R.A. LIMITED-MCD and many other consulting and exploration groups. Attention was focused on tin exploration around some gossanous outcrops which were drilled and explored for a possible extension of the Renison Bell type deposit, to the south east. In addition to tin, the area has been explored for lead, zinc, copper and gold using geochemical stream sampling. Some significant results were obtained by drilling, trenching and geochemical sampling and airborne magnetics were also flown. There is also a report of diamonds in the area and the possibility of volcanic pipes or diatremes has been considered. There have been several recorded occurrences of monazite and rare earths associated with placers and possibly pegmatite veins and bodies in the area. Also several circular structures have been described as possible carbonatite or kimberlite plugs.

A considerable volume of data and results from previous work is currently available to the company for this area. Since this material dates from the early 1970's to the present, it is considered appropriate later in this report to briefly review the current theories of mineralization relating to this area. Also the present exploration direction will be considered in view of current world mineral prices and the present demand for commodities which have changed considerably since 1970.

The exploration problem for the company is to locate any possible extensions of the known gossans and other deposits and to determine the most efficient means of testing such deposits and reserves in the area. GEO-FLITE RESEARCH Pty. Ltd. has applied its new Low Altitude Multispectral Scanner system for fracture and mineralization analysis. The aim is to find extensions of mineralization on similar structural style and fracture patterns and spectral analysis of the rocks and minerals.

GEOLOGY AND BACKGROUND

The area lies in the extreme southern end of the Tasman Geosynclinal Belt, comprising the eastern one third of the Australian continent. This region had a complex history from Paleozoic to Tertiary time with sedimentary, igneous and volcanic sequences and multiple tectonic phases of folding, faulting and associated mineralization.

The oldest rocks in the area are the Oonah series of quartzites and slates which are believed to be of Pre Cambrian age with a variable structural relationship to the overlying Cambrian rocks. In areas adjacent to the licences these rocks are both conformable and nonconformable, but the rugged terrain and cover in this area makes determination difficult.

The next youngest rocks comprise the Cambrian age Crimson Creek formation which is a sedimentary sequence of graywackes with minor volcanics and shales. There are also some carbonate units in the sequence and the most notable is the Stanley Reward Dolomite. This unit is mineralized and has a complex relationshp to the Cambrian and pre Cambrian sequences and to the later Devonian age Meredith granite intrusion.

The Meredith Granite is an intrusion of some 400 square kilometres in area and may be a multiple phase intrusion. The granite is thought to be Devonian in age and is associated with many important mining and mineralization areas. The known tin mineralization in the present area is close to the granite contact, as is the case at the Mt

Lindsay mine to the east, and the important Renison Bell tin and mineral area to the south east. The Mt Bischoff mine to the north has been a good producer and there are many others in the same general province and region such as Zeehan, Read-Roseberry, Queen Hill, Cleveland and Razorback. Most of the mineralized areas closest to the current license tract appear to be hydrothermal contact areas between the granite and the Crimson Creek formation with some carbonates present in skarn type alteration. This also appears to be the most acceptable interpretation of the Livingstone Creek and Stanley Reward areas in the present licence area. The granite has a considerable metamorphic aureole and the relationship to the possible mineralization will be discussed later.

The present project did not involve regional geology, except to establish ground truth for the spectral reflectance values of the rocks are related to the imagery. To this end, it was important to take into consideration the latest ideas of company geologists in regard to structure, mineralization and alteration of the known ore bodies.

KNOWN MINERALIZATION

Previous exploration of the area by other companies was directed at the obvious tin gossans and alluvial deposits in the area of the granite contact, to locate a possible economic ore body of the Renison Bell type. Later work has indicated several other possible types of mineralization such as gold, diamonds and rare earths. With the exception of the diamonds, the other potential mineralization appears to be related to one or more phases of granitic intrusion, hydrothermal alteration or later remobilization of mineralizing fluids.

I. CURRENT GEO-FLITE APPROACH

The main theme of the Geo-Flite Low Altitude Multispectral Scanning Method is to determine the fracture pattern of an area and then relate this to the mineralization and alteration patterns. The method of fracture analysis is new and unique, and has not previously been attempted in this area. It is therefore appropriate at this point to discuss the method first and then relate it to exploration targets for the various types of mineralization. The location of such targets in the past has obviously been made very difficult by the rugged terrain and limited ground access. Both of these problems are minimized by the Geo-Flite system.

METHOD

Geo-Flite uses a new multispectral scanning system developed for use with light aircraft at low altitude. The system detects detailed fractures, faults and lineaments in surface outcrop or through soil and vegetation cover. The method also differentiates mineralized zones associated with these fractures, by spectral analysis of the associated rock, soil and vegetation. The system was developed by Professor Bruce Moore at the University of Kentucky in the United States, where the imagery is processed. It has been very successful for the detection of all types of mineralization and also oil and gas structures and seeps.

A basic postulate of the method is the fact that fracturing in the upper bittle zones of the earth's crust is the main controlling factor in the emplacement of hydrothermal and other mineralization. The method first delineates the controlling fracture system by high resolution computer enhanced imagery, and then compares the multispectral response of known mineralized zones to unknown areas to find new deposits.

PROCEDURES

The region of maximum interest was designated by company personnel as the area of the exploration licence E.L. 53/70. After processing the entire area particular emphasis was placed on:

1. The Stanley Reward and Livingstone Creek area.

2. The possible source areas for gold.

3. The delineation of any diatremes or valcanic pipe structures favourable for diamonds or carbonatites.

4. The possible target areas for rare earths.

no comments on when flown and weather!

The multispectral scanning equipment was flown in light aircraft and the imagery processed in the United States. The imagery was processed first for structure and lineament enhancement to delineate the fracture systems. Close attention was paid to the existing mineralized area which shows appreciably more faulting than was currently known from outcrop mapping and drilling. The spectral curves and spectral response of the rock types previously mapped and recorded from the area were used to establish ground truth and to calibrate the imagery.

II. BRIEF REVIEW OF APPLICABLE MINERALIZATION THEORY

MINERALIZATION

The main control of the mineralization throughout the entire area appears to be the Meredith granitic instrusion coupled with strong regional fracturing, faulting and possible shearing. The granite body has a large metamorphic aureole and specialized contact zones, particularly in the vicinity of the Stanley Reward dolomite, which appears to have contributed to specialized skarn type mineralization.

There appear to be several stages of mineralization, with the contact tin skarn zone at Stanley Reward being a relatively early high temperature phase. This was possibly followed by later stage pegmatitic, aplitic hydrothermal activity and related shearing, producing gold, rare earths and possibly more tin. There is also the possibility of disseminated tin in the granite body, due to multiple phases of intrusion.

Each particular type of potential mineralization will be described and discussed here, together with the possible environments of formation.

GENERAL DISCUSSION OF MINERALIZED PLUTONIC BODIES

Several reports of previous work by many companies, consultants and individuals are in the files for the current licence area. A number of different mineralization environments have been suggested including skarn alteration, hydrothermal tin and gold mineralization, possibly aplite and pegmatite phases, possible carbonatites and diatremes, and the presence of rare earth minerals. It is considered appropriate here to present a brief update of the current status of knowledge on these specialized topics. This will provide the basis for exploration target selection and planning using the results of this present work.

The main plutonic body of the Meredith granite and its contact zones are a very important part of the known mineralization and this is supported by the current fracture and spectral analysis. The phases of intrusion of the granite body and its contact zones should be re-examined in the light of the current state of knowledge of ore bodies related to granitic intrusions, which will be briefly reviewed here.

The Meredith granite appears to be an S type granitoid as opposed to an I, M or A type. The S type usually carries garnet, monazite, magnetite, zircon and apatite as accessory minerals, all of which are reported from this area. The S type occurs in orogenic belts and the rocks are believed due to partial melting of continental crust or sediment. They commonly contain molybdenum, berylium niobium, bismuth, uranium rare earths, with tin and tungsten. Most of these have been reported from this region. Other notable occurrences of S type granitoids are in Malaya, Cornwall, France, the Bushveldt Complex in South Africa, and importantly, the Blue Teir tin region of eastern Tasmania. Hence this area is a very favourable location for further exploration for the above minerals.

An aplite and possibly pegmatite phase has previously been reported in the company files adjacent to the granite margin along Livingstone Creek, and in the vicinity of the ferruginous tin gossans, see map enlargement 1:10,000. Other potential pegmatites appear possible from the multispectral analysis of other portions of the granite body, which may have several multiple phases of intrusion.

Pegmatites result from crystallization of the final water rich melts of intermediate to silicic igneous rocks. They are usually form as an early magmatic phase or a late stage hydrothermal phase. They are usually a source of beryllium, lithium, cesium, rubidium, tantallum, niobium, uranium, thorium and the rare earths, in addition to tin, tungsten, beryl, topaz, garnet and tourmaline. Most of these minerals and elements have been reported in company records, either in placers or rocks adjacent to the contact areas.

Carbonatites have been suggested as occurring in the area and the Stanley Reward mineralized dolomite has been mentioned as a possible carbonatite. While this is not indicated by this study, the possibility should be examined in follow up ground work. Carbonatites are also a potential source of rare earth minerals and the

Stanley Reward area and the circular, diatreme-like structures should be re-examined.

There is still considerable debate on the origin of carbonatites and they appear in a variety of geologic settings and are often difficult to detect. Most workers in the field agree that they are a mafic rock closely related to kimberlites but not necessarily of the same kinship. They are of igneous origin and calcite, dolomite and siderite rich. Several different varieties are magnetite rich, rare earth rich, fluorite and barite rich and apatite rich. They occur in a wide range of structural settings such as:

1. With alkali ring complexes.

2. With non ring alkalic complexes such as Mountain Pass.

3. Not associated with alkalic rocks.

4. As ash flows or pyroclastics.

5. They do not have to be associated with mafic igneous rocks.

Hence Carbonatites can occur in a wide variety of structural settings and in many different geologic environments. They usually contain the rare earths, niobium-tantallum, and other exotic elements and minerals. Carbonatites range in age from pre Cambrian to Recent. They are thought to be due to upper mantle processes involving carbonatitic liquid separation and injection or some other form of mantle degassing.

The presence of possible carbonatite features in this area will be discussed in the results.

III RESULTS

GENERAL

The results are summarized on a series of maps and overlays. The main map of the area presents findings on a scale of 1:25,000 for the area of the study, centred on E.L.53/70. The fracture analysis is presented on the map at this scale with fractures, joints and faults marked in red. An enlargement of the Livingstone Creek-Stanley Reward area shows the fracture and mineralization relationship in greater detail at 1:10,000. Two detailed study areas A and B are outlined in orange on the 1:25,000 map and are presented as transparent overlays. These indicate the fracture related target areas showing alteration and potential mineralization, taken from the multispectral computer enhancement. The overlays should be regarded as the most accurate locations for drill site selection and further testing and sampling.

In addition a few representative examples of enhanced imagery have been taken from the computer to illustrate some of the stages involved in the processing. The computer processes several hundred of these images by statistical correlation, ratioing and other enhancement techniques to produce the final results for each target area. Two image examples are included to illustrate one stage of the lineament enhancement and one stage of the spectral analysis for each of the subscenes marked in green on the map. They illustrate how the structural fabric emerges from the analysis and the use of spectral response in colour enhancement to identify rock and mineral types.

Where?

FRACTURE ANALYSIS

Examination of the general fracture pattern from the imagery indicates that there is a distinct change in the style of the fracture pattern at the contacts of the Meredith granite with the bedrock, see 1:25,000 base map. The intersection of these shear zones has undoubtedly provided the fracture porosity controlling the mineralization. The mineralized zone at the granite contact shows a prominent set of shear zones parallel to the contact and trending north west to south east through the Stanley Reward area. A second prominent main shear runs from south west to north east across the entire area. The second set show some hydrothermal alteration which may be a late intrusion stage or even reactivation after the granite was emplaced. This fracture set is labelled the Livingstone shear and passes approx 1 km south of Mt Livingstone. The targets marked along the fracture zones show hydrothermal alteration and possible pegmatite development where the fractures cut the granite. This is parallelled by other fractures and all appear related to the potential source of the stream gold values.

The contact of the granite appears to be related to skarn type alteration with south east trending shears along Livingstone Creek parallel to the gossan outcrops. The presence or absence of the suggested carbonatite in the same area will have to be the subject of a field evaluation and petrographic analysis and is very important to future exploration.

There have been some aplitic and possibly pegamatitic rocks mapped as a border phase to the contact, see enlargement map 1:10,000. This region has a very high density of fractures and therefore the highest fracture porosity, which is typical of a mineralized zone. It has apparently been considerably altered and erodes easily, so the actual contact is largely buried beneath placer material, which makes evaluation difficult. The largest placer (P1) is located here and the position of it is related to fractures and faults producing a temporary base level of erosion on Livingstone Creek above the junction with the Stanley River. There are two other placers to the north of this on the Stanley River and one of its small tributaries which appear fracture related and mineralized.

For simplicity, the results will be grouped according to the most critical areas and the particular types of mineralization. The suggested and recommended sequence of testing these target areas will be presented at the end of the results section.

1. THE STANLEY REWARD-LIVINGSTONE CREEK AREA

This area is unique in the area studied since it has strong shear patterns parallel to the granite contact, which do not appear elsewhere. It is also the site of the only ferruginous tin gossans in the area and the site of major placer area. I believe that all these factors are related and that the high density of fractures has produced mineralization and contact hydrothermal alteration together at this location. The alteration zone is less resistant and has weathered rapidly producing a low relief area in the Livingstone Creek valley for the formation of the placer.

On the basis of the present information and the occurrence of marbleized dolomites, tin gossans, with tourmaline, monazite garnets and magnetite in the dolomite, I would consider this the exoskarn region of a skarn contact. The endoskarn or internal part of the contact may still be unexposed and untested and contain disseminated tin, tungsten and base metal sulphides on the granite side of the contact at depth. There may be carbonatites associated but there is no structural indication of this from the imagery and more field work and petrographic work would be needed to establish this fact. The same petrographic work could determine whether the dolomites and carbonates have any of the mineralogical characteristics of a carbonatite which would be very important as a source of rare earths and the monazite already recorded from the area.

The three apparent placer deposits indicated on the spectral analysis include P1, which has already been tested in part on Livingstone Creek for tin. It is important to re-evaluate this placer for gold, monazite and rare earths. The size and location of the deposit indicates that tin and any other minerals may also be coming from disseminated portions of the granite other than the contacts, or from the Livingstone shear. Presence of tin and monazite in placer P2 on the Stanley River could be an important indication of other sources of these minerals in the granite, since it drains an area away from the contact. The apparent placer P3 has not been mentioned in any previous reports but has the same spectral response as the other two and should be closely tested. Hydrothermal alteration adjacent to the area is also indicated.

I believe that the testing of these placers for rare earths and gold has the highest priority for this area, followed by consideration of a new drilling program to test the skarn contact in depth. Some drilling has previously been completed but this was undertaken when little was known of the nature or potential of the granite contact.

2. <u>SOURCE AREAS FOR GOLD</u>

The company had reported results of a stream geochemical survey for gold and this was reviewed in the form of a base map produced by C.S.R. Limited. This showed many anomalous samples distributed throughout the area, ranging from less than 5 ppb to over 50 ppb. These have been colour coded and appear on the current 1:25,000 base map.

The main problem with the stream sediment samples for gold is that none of them are very high and one minute speck of gold can skew the sample badly. The other is that the regional distribution of the best samples is very wide and it is difficult to determine a background for the area, and hence which values are truly anomalous.

Another factor to consider in a tectonic belt such as this, is that the area has been subjected to several periods of uplift and stream rejuvenation. All the gold may have come from the one source originally and been deposited in several high level placers which have since been resorted and the gold widely distributed away from the original source.

The approach here was to plot the fractures and scan for areas of hydrothermal alteration, possibly producing gold. The strongest of these would be the target areas 4 and 5 along the Livingstone Shear, and to a lesser degree the targets 6,7,8 and 9, all on overlay A. Gold has been found at the large placer P1 at target 1, and should be checked at placers P2 and P3. Likewise there are other similar fracture/alteration zones on Area B at targets 10 through 15.

These gold target areas would possibly have quartz stockworks and veins at the locations shown. They should also show hydrothermal alteration and should be tested geochemically for gold, silver, copper, lead, zinc, mercury, antimony and arsenic.

4. RARE EARTH MINERALS AND PEGMATITES

Rare earth minerals were identified by Valley Exploration Pty Ltd in a report and map now in company files. Several localities showed monazite and rare earth minerals in excess of 10,000 ppm with analyses for Thoriun, Niobium and other elements. Monazite in the placers may be concentrated from the granite but is also reported at the contact zone at Stanley Reward and may be associated with the aplite-pegmatite phase mapped here. There are also some spectral signatures for pegmatites indicated at target areas 4 and 5 along the Livingstone shear which should be examined as a rare earth source.

5. CARBONATITES, DIATREMES, DIAMONDS

Mention is made in several company reports of the possible occurrence of carbonatites along the contact zone at Stanley Reward in discussing the origin of the marbleized dolomite. It is therefore a high priority to re-evaluate these rocks mineralogically and geochemically to see if the apparent skarn alteration identified here spectrally, is in fact carbonatite or has this association or it is present as a separate event.

Several circular structures have been marked on previus maps and the more prominent are marked on the 1:25,000 map here. While they appear circular in shape they do

Given no great prominence in follow up

not have any associated fracturing or radial structure displayed by diatremes and they do not have the low relief often associated with these structures when they are weathered. From the imagery analysis, and without ground checking, these would appear to be a weathering forms rather than vents or diatremes. Hence no source for the 17 reported diamond specimens previously identified in the area is apparent from a structural analysis at this time.

6. DISSEMINATED TIN

In addition to the tin previously recorded at the Stanley Reward and Livingstone Creek gossans there may be considerable tin reserves in the placers P2 and P3. This would indicate a possible source of tin elsewhere in the granite and possibly disseminated through it in other locations. The possible placer area P2 lies outside the current licence area and hence it should be rapidly evaluated and possibly acquired.

Cyprus

RECOMMENDATIONS

Current mineral prices and future potential would indicate at this time that priority for exploration be placed on gold and the rare earth minerals, closely followed by the upgrading of the known tin reserves.

The present fracture analysis and mineralization study clearly defines the Livingstone Creek-Stanley Reward area as the prime target for additional tin, tungsten, tantallum, pegmatites and the principal placer deposits in the area. The delineation of the Livingstone shear zone in this study and the associated alteration and potential mineralized zones, indicates a source for the gold in stream sediment samples. There are also several fractures which intersect the Stanley Reward area, trending south west to north east and should be prime drill targets in exploring this zone at depth.

Recommendation Priority

1. Re-evaluate the placers P1, P2, P3, for gold and monazite in addition to tin and consider acquiring P2. If results are positive, then consideration should be given to acquiring more land in the Stanley drainage.

2. Rapidly evaluate the gold mineralization areas along the shears by helicopter sampling and geochemistry. The granite body should be examined for pegamatites at the same time.

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3. Completely re-evaluate the petrology and geochemistry of the Stanley Reward-Livingstone Creek contact as a skarn with possible pegmatite and carbonatites.

4. At a later date, test the most prominent circular structures for rock types and geochemistry.

Bruce R. Moore

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21st Oct '87

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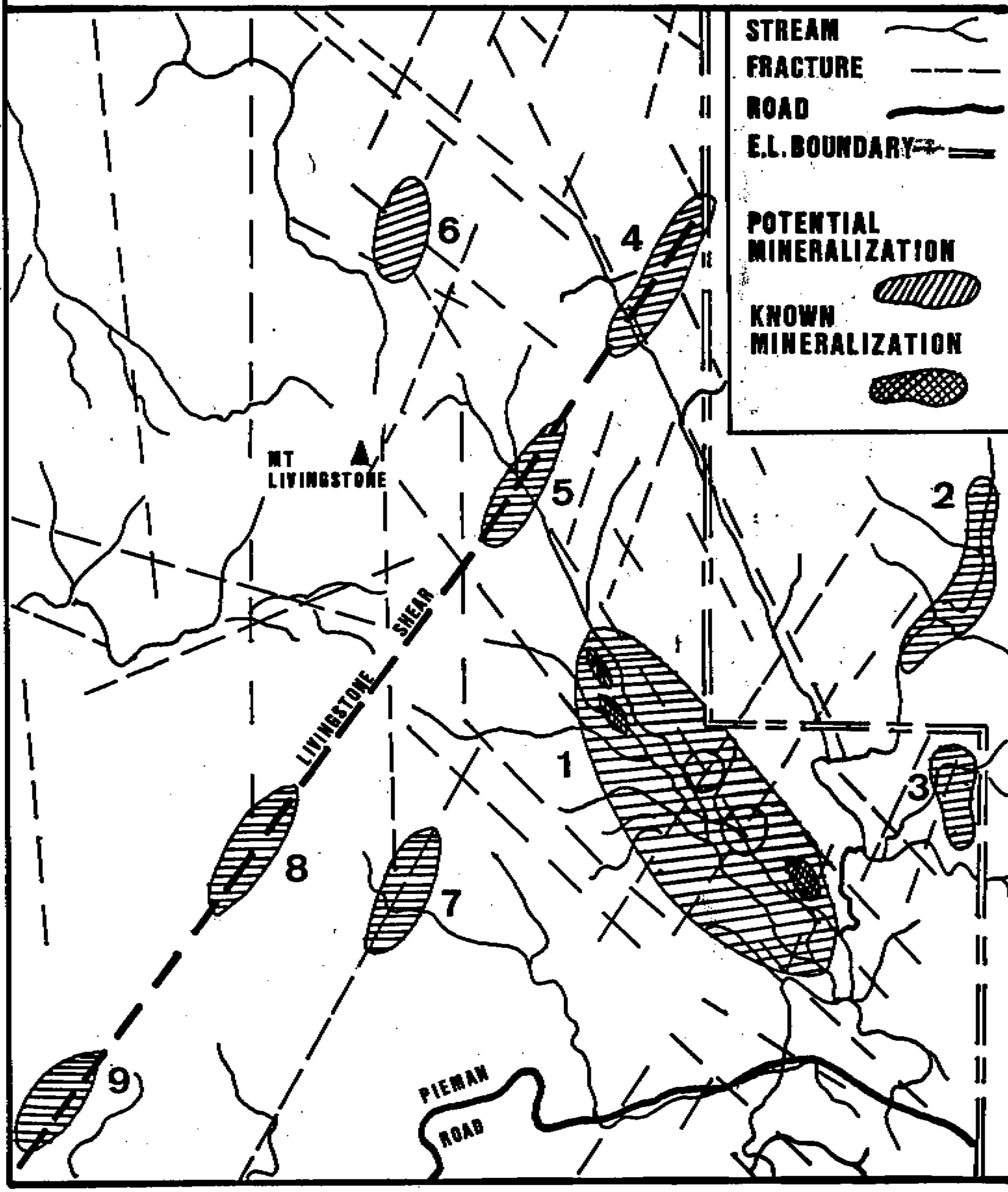
FRACTURE AND MINERALIZATION MAP
MT. LIVINGSTONE AREA NW TASMANIA AREA A
SCALE 1:25,000



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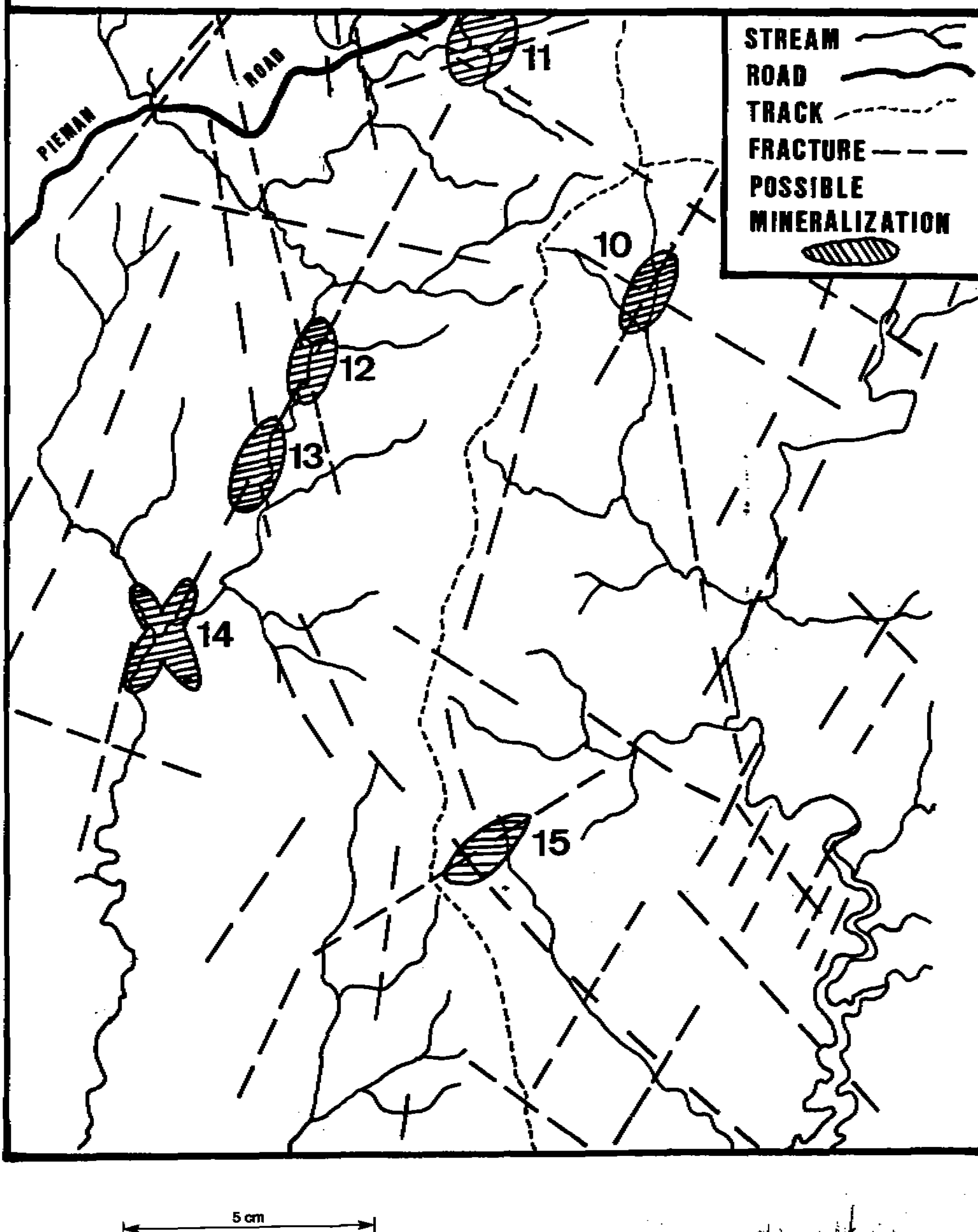
FRACTURE AND MINERALIZATION MAP

MT.LIVINGSTONE NW TASMANIA AREA B

NORTH



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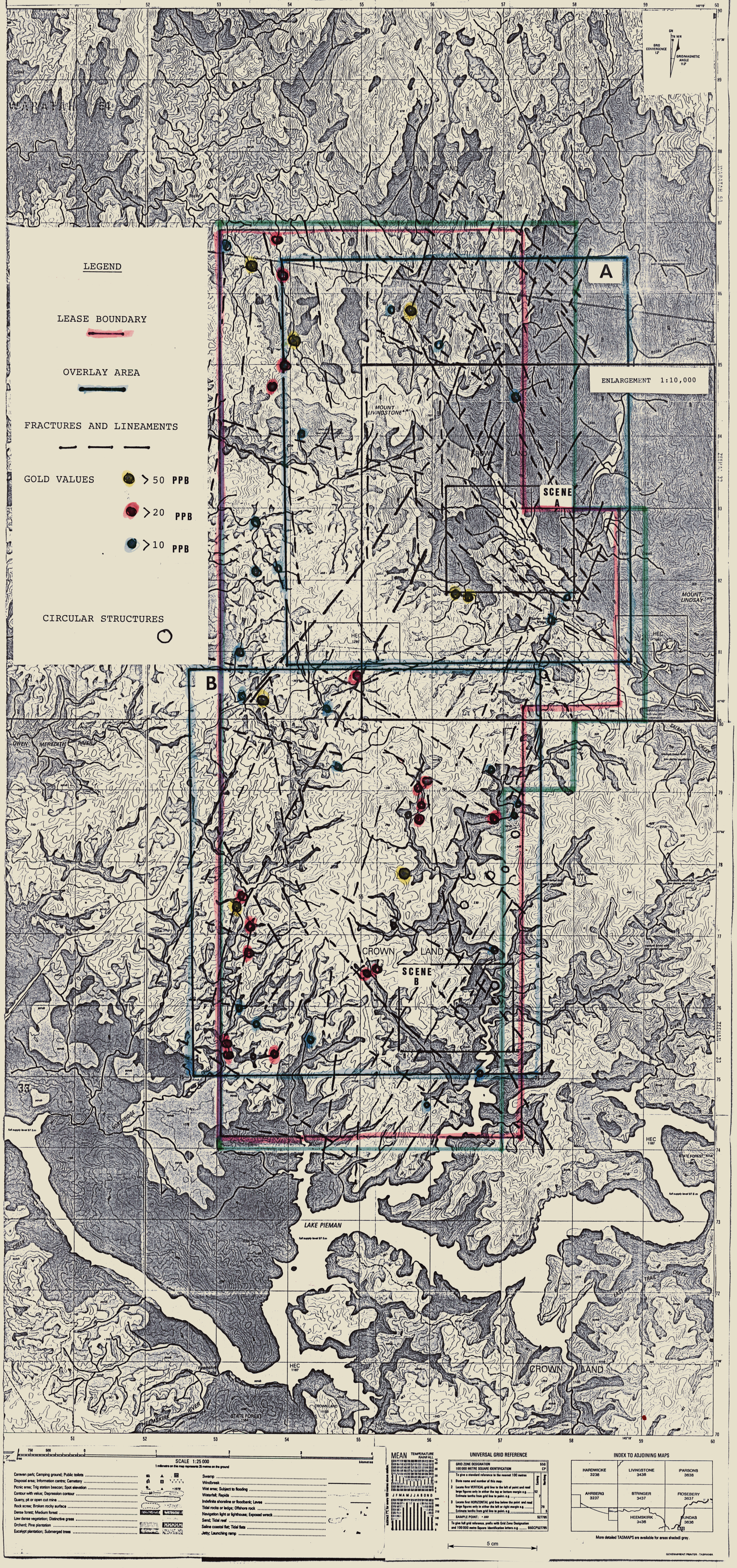

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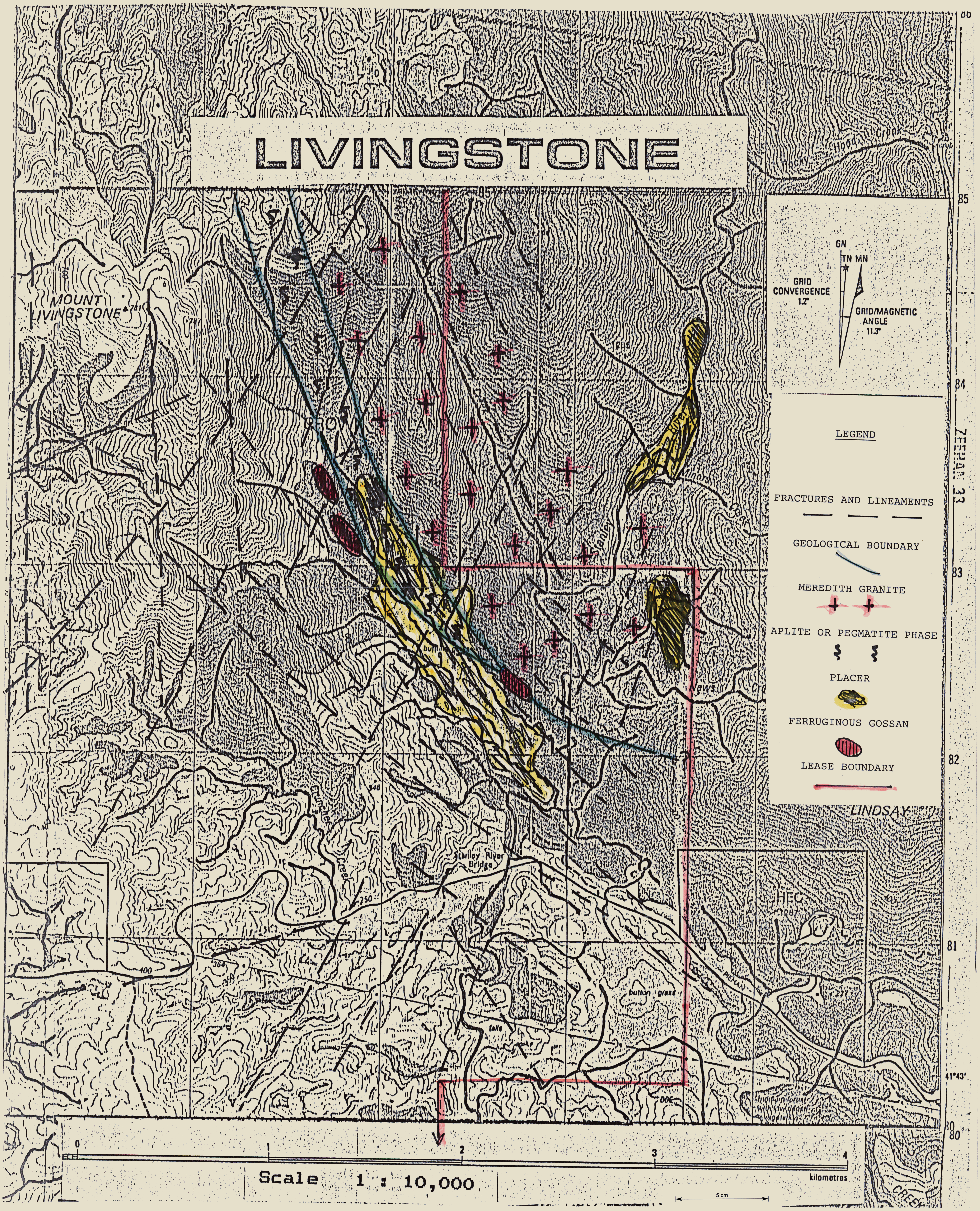

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