# THE NATURE AND DISTRIBUTION OF THE TANTALUM MINERALS IN THE TANCO (CHEMALLOY) MINE PEGMATITE AT BERNIC LAKE, MANITOBA.

A Thesis
Submitted to
The Faculty of Graduate Studies
University of Manitoba

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
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1970

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# ABSTRACT

Wodginite $(Ta,Nb,Mn,Fe,Sn,Ti)_2O_4$, manganotantalite $(Mn,Fe)(Ta,Nb,Ti,Sn)_2O_6$ and pseudo-ixiolite $(Ta,Nb,Mn,Fe,Sn,Ti)_2O_4$ are the three major Ta-oxides occurring in the Tanco pegmatite at Bernic Lake, Manitoba, wodginite being by far the most abundant. Microlite $Ca_2Ta_2O_6(O,OH,F)$ and tapiolite $(Fe,Mn)(Ta,Nb)_2O_6$ occur in minor amounts.

A detailed crystallographic study was carried out on the three major Ta-oxides which are closely related crystallographically. Orthorhombic pseudo-ixiolite has the simplest cell ( a=4.76, b=5.75, c=5.16Å). Upon heating to 1000°C for several hours over a range of oxygen fugacities, the pseudo-ixiolites are converted to orthorhombic tantalites with the a-period three times that of pseudo-ixiolite and with a small increase in comparative <u>a</u>-dimension, with <u>b</u> remaining constant and <u>c</u> decreasing slightly. This change from pseudo-ixiolite to tantalite is considered to result from disordering-ordering of the cations but x-ray photographs show that the two phases are not completely disordered or ordered. The monoclinic wodginites have a marked subcell similar to that of ixiolite but a few weak reflections indicate that the <u>a</u> and <u>b</u> cell dimensions are doubled. The small monoclinic distortion of wodginite from the orthorhombic

ixiolite cell is expressed by a variation in $\beta$ from 90°56′ to 91°6′ in the Tanco pegmatite specimens studied. All available published data were used to determine the variation of $\beta$ with the separation of one pair of the major peaks, and a linear equation derived.

The wodginites generally have lower Mn and higher Fe,Sn and Ti contents, and higher Ta/Nb ratios than either tantalite or pseudo-ixiolite. The chemical distinctions between tantalites and pseudo-ixiolites are less marked. Both have low Fe and high Mn, and five out of six tantalites have lower Sn and Ti contents and higher Ta/Nb ratios than the pseudo-ixiolites.

The Ta-minerals occur in distinct zones within the pegmatite. The pseudo-ixiolite occurs in the quartz-plagioclase-K-feldspar-spodumene-muscovite- zone and wodginite occurs in the K-feldspar-muscovite-plagioclase-quartz-beryl zone just inside the pseudo-ixiolite bearing zone. The albitic aplite contains both tantalite and wodginite. The zoning of these Ta-minerals within the pegmatite is discussed in relation to the paragenesis of the body.

## ACKNOWLEDGEMENTS

The author is very grateful to Dr. R.B.Ferguson, Professor of Mineralogy at the University of Manitoba, for the suggestion of this project and continued guidance throughout the research.

Mr. C.T.Williams, Mine Manager and Mr. R.A.Crouse, Geologist of the Tanco Mine at Bernic Lake, Manitoba, were very helpful in making specimen collection within the mine possible.

The electron micro-probe at the Whiteshell Nuclear Research Establishment in Pinawa, Manitoba was made available through the generosity of Dr. A.Sawatzky of the Material Sciences Branch. A special thanks to Mr. S.Jones, the probe operator at Pinawa for his time spent on the analyses in this thesis. Dr. J.C.Rucklidge and Miss E. Gasparrini, Geology Department, University of Toronto were kind enough to provide two electron probe analyses.

Two computer programs were used in this project: Dr. D.B.Stewart of the United States Geological Survey, Washington, D.C. provided a copy of Appleman, Handwerker and Evans'program for the least squares refinement of unit cell dimensions from powder diffraction data; and Dr.J.C. Rucklidge provided a copy of the program written by himself and Miss E. Gasparrini for reduction of electron probe data.

Members of the Earth Sciences staff at the

University of Manitoba whom the author would like to thank are Dr. P.Cerny for valuable advice and discussions, Dr. A.C. Turnock for assistance with heating experiments, Miss I. Berta for the preparation of polished and thin sections, and Mr. R. Pryhitko for photographs.

Financial assistance was provided in part through Dr. R.B.Ferguson by means of research grants from the Geological Survey of Canada and the National Research Council, and in part by a University of Manitoba Summer Stipend.

# CHAPTER I. INTRODUCTION

## (a) General Introduction

The Tanco (Chemalloy) Li-Cs-Ta-Be pegmatite is located on the western part of Bernic Lake approximately 100 miles northeast of Winnipeg. This body is part of the southeastern Manitoba pegmatite district.

The property was first staked in 1929 by Jack Nutt Tin Mines Limited for a cassiterite occurrence. In 1954 Montgary Explorations Limited, now Chemalloy Minerals Limited, took over the property. Chemalloy marketed small tonnages of quartz, and stockpiled various minerals. In 1962 the mine was abandoned and allowed to flood. In 1967 Tantalum Minimg Corporation reopened the mine and set up equipment for mining and concentrating tantalum-oxide ore.

From previous work it was known that tantalite, wodginite and minor amounts of microlite and tapiolite were preseht in the mine. Due to the current interest in the Tanco pegmatite as a tantalum mine, it appeared that it would be valuable to fully define the Ta-minerals there and to do a detailed chemical and crystallographic study of these minerals in relation to their position in the pegmatite.

Concurrent studies in the Mineralogical Laboratory at the University of Manitoba on other minerals in this pegmatite are: petalite, spodumene, and feldspars by Postdoctoral Fellow Dr.P.Černý; amblygonite-montebrasite by M.Sc. candidate Mrs. Iva Černá; and Li-Rb-Cs micas by M.Sc. candidate Mr. Romano Rinaldi. The accumulated information from these and the author's studies should give evidence of the pegmatite paragenesis at Bernic Lake.

## (b) General Geology of the Tanco Pegmatite

The Tanco pegmatite was first described in detail by Hutchinson (1959) and later by Wright (1963) under the name Montgary pegmatite. It is essentially Wright's work which is being used in this general description.

The pegmatite body has the shape of a flat-lying, elongate disc. The north-south axis is about 1,500 feet long, the east-west dimension is at least one-half mile long, and the thickness reaches a maximum of 280 feet. It dips north at 10°-15°. The body is enclosed in Precambrian amphibolite with large neighbouring bodies of granite to the south and west.

The Tanco pegmatite is complexly zoned. Wright (1963) proposed six zones: (1) a quartz-albite border zone; (2) a perthite-quartz-plagioclase-muscovite wall zone; (3) a spodumene-perthite-plagioclase-quartz intermediate zone; (4) a spodumene-quartz intermediate zone with minor perthite; (5) a microcline-quartz intermediate zone, and (6) a quartz core. In addition to these six zones is an aplitic albite, a fine-grained lepidolite and a pollucite which Wright suggests are late-stage replacement bodies. Jahns and Burnham (1969) on the other hand have suggested that aplitic albite in pegmatites of this type is a primary magmatic phase formed early in the pegmatite's history.

The Ta-minerals occur in Wright's zones 3,4 and 5 and in the aplitic albite and the lepidolite bodies which are also regarded as zones in this thesis. Also in this thesis Wright's zones 3 and 4 are combined and called the quartz-plagioclase-spodumene-K-feldspar-muscovite zone; and Wright's zone 5 is termed the K-feldspar-muscovite-plagioclase-quartz-beryl zone.

## (c) Previous Work on the Ta Minerals

Although considerable mineralogical work has been done on wodginite, tantalite, pseudo-ixiolite, tapiolite and microlite from various localities throughout the world only a limited amount of mineralogical research has been published on the Ta minerals at Bernic Lake. Bernic Lake wodginite was one of the first wodginites reported (Nickel et al.,1963a). Nickel et al. (1963b) also described the crystallographic relationships between wodginite, tantalite and pseudo-ixiolite. The Tanco Company have done considerable drilling and analyzing to determine the grade and extent of their Ta ore but no data as of yet has been published.

## (d) Present Study

The Tanco (Chemalloy) pegmatite is a single body from which mutually-occurring wodginite,tantalite and pseudo-ixiolite could all be collected and studied. Tapiolite, microlite, cassiterite and ilmenite also occur in this pegmatite in small amounts, and minor observations were made on these minerals.

Sixty-five oxide-bearing rock specimens were collected in the mine, and an additional five specimens were contributed to this study by Dr. P.Černý. Table 1 gives a complete listing of the specimens and Fig.1 gives their location in the mine. Table 1 also outlines the study made on each specimen. Initially the oxides from each specimen were run on the x-ray powder diffractometer (column 4) to try and identify as many phases as possible. Eighteen thin-sections (column 9) and forty-three polished sections (column 10) were made of specimens throughout the mine. Several wodginites, tantalites and pseudo-ixiolites were examined by single-crystal x-ray diffraction (column 7), and accurate cell dimensions were determined on all but one of these by x-ray powder diffraction (column 8). These specimens and some others were analyzed by electron probe (column 6). The specimens for which a detailed study was

## Table 1. Specimen Details

**NOTE: 1. Abbreviations used:**

| Silicate Minerals | | Oxide Minerals | |
|---|---|---|---|
| Ab | Albite | C | Cassiterite |
| Ap | Aplitic albite | M | Microlite |
| Bl | Beryl | PI | Pseudo-ixiolite |
| Cl | Cleavlandite | T | Tantalite |
| KF | K-feldspar | Tp | Tapiolite |
| Ms | Muscovite | W | Wodginite |
| Q | Quartz | | |
| Sp | Spodumene | | |

**NOTE: 2. Zone numbers:**

1 Quartz - plagioclase-spodumene-K-feldspar-muscovite.

2 K-feldspar-muscovite-plagioclase-quartz-beryl.

3 Aplitic albite.

Table 1. - continued

| 1 Specimen No. | 2 Matrix Minerals | 3 Zone | 4 X-ray Powder Ident. | 5 Ident. by probe(*) or optics | 6 Analyzed by probe | 7 X-ray Precession | 8 Cell Dimensions | 9 Thin Section | 10 Polished Section | 11 Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| G69-1 | KF,Ms,Q,Bl | 2 | W | M | | | | 3 | 2 | Sphene |
| -2 | KF,Ms,Q | 2 | W | | X | X | X | | | |
| -3 | KF,Q,Ms | 2 | W | | | | | | | |
| -4 | KF,Ms | 2 | W | | | | | | | |
| -5 | KF,Ms | 2 | W | | | | | | | |
| -6 | KF,Ms | 2 | W | | | | | | | Found adjacent to zone 3,pattern like reduced W |
| -7 | Ap,Ms | 3 | W,T | | | | | | 3 | X-ray pattern like reduced W |
| -8 | KF-Ap | 2/3 | T | W | X | | | | 2 | |
| -9 | KF | 2 | C,W | | | | | | | Lepidolite |
| -10 | KF,Ms,Q,Sp | 2 | - | C | | | | | 1 | |
| -11 | KF,Q,Ms,Ab | 2 | W | M | | | | 1 | 1 | Contact zone 2 and Q core |
| -12 | KF,Ms,Q | 2 | W | | | | | | | |
| -13 | KF,Ms,Q | 2 | W,T | | X | X | X | | | Apatite |
| -14 | KF,Ms,Q | 2 | W | | | | | | | |
| -15 | KF,Ms,Ab | 2 | W | | | | | | | |
| -16 | Ap,Q,Ms | 3 | W,T | | | | | | | |
| -17 | KF,Q | 2 | W | | X | X | X | | 1 | |
| -18 | KF,Ms | 2 | W | | | | | | | |
| -19 | KF,Ms,Bl,Q | 2 | W | M | X | | | 1 | 2 | |
| -20 | KF,Ms,Q | 2 | W | | | | | | 1 | |
| -21 | KF,Ms,Q | 2 | W,T | M | X | | | 1 | 2 | |

Table 1. - continued

| 1 Specimen No. | 2 Matrix Minerals | 3 Zone | 4 X-ray Powder Ident. | 5 Ident. by probe (*) or optics | 6 Analyzed by probe | 7 X-ray Precession | 8 Cell Dimensions | 9 Thin Section | 10 Polished Section | 11 Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| G69-22 | KF,Ms,Q | 2 | W | | | | | | 1 | |
| -23 | KF,Q,Ms | 2 | W | | | | | | | |
| -24 | KF,Ms,Q | 2 | W | | | | | 2 | 3 | |
| -25 | KF,Bl,Q | 2 | W | | | | | | | |
| -26 | Q,KF,Ms | 2 | C | | | | | | | C in streaks |
| -27 | KF | 2 | C,W | | | | | | | |
| -28 | KF | 2 | W | | | | | | | Near bluish Ap |
| -29a | Ap-Q | 3 | T | | | | | | | |
| -29b | Ap-Q | 3 | T | | X | X | X | 1 | 5 | |
| -30 | Q,Cl,Ms | 1 | PI | M* | X | | | | 1 | Apatite |
| -31 | Q,Cl,Ms | 1 | PI,M | M* | X | | X | | 1 | |
| -32 | Ap,KF,Q | 3 | W,C,T | C | | | | | 1 | |
| -33 | Ms,KF,Q | 2 | W | | | | | | | |
| -34 | KF,Q,Ms | 2 | W | | | | | | | |
| -35 | KF,Ms | 2 | W | | | | | | | |
| -36 | KF,Ms | 2 | W | | | | | | | |
| -37 | KF,Ms | 2 | W | | | | | | 1 | |
| -38 | KF,Ms,Q/Ap | 2/3 | W,T | | | | | | | |
| -39 | Kf,Ms | 2 | W | | X | X | X | | 1 | |
| -40 | Q,KF | 1 | - | | | | | | | Tourmaline, Apatite |
| -41 | Ms,KF,Q | 2 | W | | | | | | | |

Table 1. - continued

| 1 Specimen No. | 2 Matrix Minerals | 3 Zone | 4 X-ray Powder Ident. | 5 Ident. by probe(*) or optics | 6 Analyzed by probe | 7 X-ray Precession | 8 Cell Dimensions | 9 Thin Section | 10 Polished Section | 11 Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| G69-42 | KF,Ms,Bl,Q | 2 | W | | | | | | | |
| -43a | Ap,Q | 3 | W,M | M | | | | 1 | 3 | |
| -43b | KF,Ms | 2 | Tp,W,M | M,Tp | | | | 2 | 2 | |
| -44 | KF,Ms,Q,Bl | 2 | W | | X | | | 2 | 2 | |
| -45 | KF,Ms,Q | 2 | W | | | | | | | |
| -46a | KF,Ms,Bl,Q | 2 | W | | X | | | 1 | 2 | |
| -46b | KF,Ms | 2 | W | | X | | | | 1 | |
| -47 | Ap,Ms,Q | 3 | W,T | | | | | | | |
| -48 | KF,Ms,Q | 2 | W | | | | | | | |
| -49 | KF,Ms | 2 | W | | | | | | | |
| -50 | KF,Ms,Q | 2 | W | | | | | | | |
| -51 | KF,Ms | 2 | W | | | | | | | |
| -52 | KF,Ms,Q | 2 | T,W,Tp | M | X | | | 2 | 3 | |
| -53 | Ap,Q | 3 | T | | X | X | X | | | |
| -54 | Q,Cl | 1 | PI | | | | | | | |
| -55 | Cl,Q,Ms | 1 | PI | | X | X | X | | | |
| -56 | Q,Sp,Ab | 1 | PI | | | | | | | |
| -57 | Ap,Q | 3 | W | | | | | | | |
| -58 | Q,Ms,Ab | 1 | T/PI | | X | X | X | | | Adjacent to zone 3 |
| -59 | Cl,Q,Sp,Ms | 1 | PI,C | | X | | | 1 | 1 | |

Table 1. - continued

| 1 Specimen No. | 2 Matrix Minerals | 3 Zone | 4 X-ray Powder Ident. | 5 Ident. by probe (*) or optics | 6 Analyzed by probe | 7 X-ray Precession | 8 Cell Dimensions | 9 Thin Section | 10 Polished Section | 11 Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| G69-60 | Q,Cl | 1 | PI | | X | X | X | | | |
| -61 | Q,Cl | 1 | PI | | X | X | X | | | |
| G70-I | Q,Ab,Ms | 1 | PI | | | | | | | |
| -II | Ap/KF,Q | 3/2 | W,T | | | | | | | |
| -III | Q,Cl | 1 | PI | | | | | | | |
| -IV | Ap/Q,Cl | 3/1 | PI | | | | | | | |
| BLM-1A | KF,Q,Ms | 2 | W | | X | X | X | | | - near G69-14 |
| BLM-16A | Q,KF | 1 | PI | | | | | | | - west drift |
| BLM-16C | Ms,Q | 2 | W,M | | | | | | | - main drift: crystal morphology |
| BLM-71 | Ap,Q | 3 | C | | | | | | | - near G69-8 |
| BLM-77 | Q,KF | 1 | C | | | | | | | - near G69-40 |

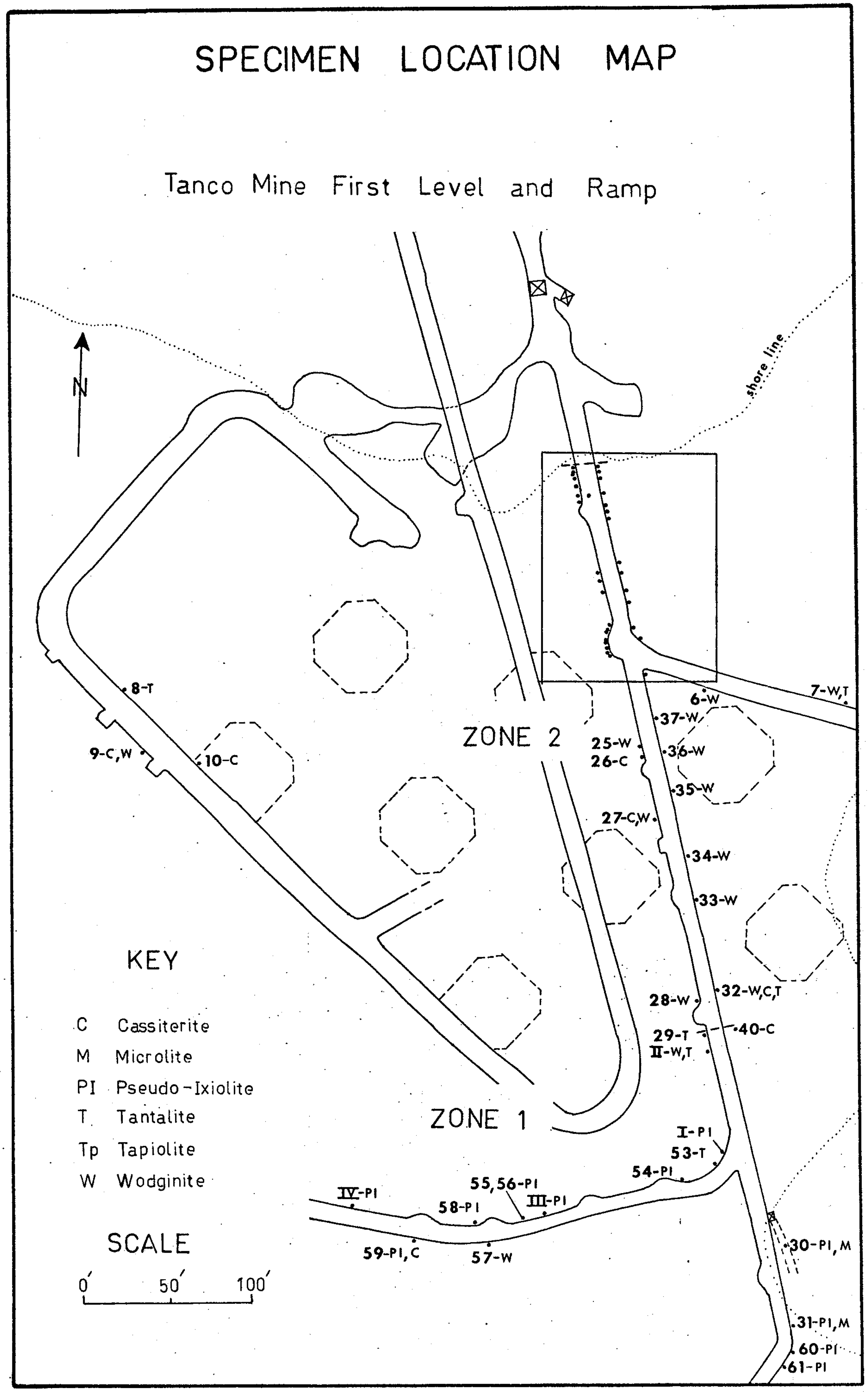
SPECIMEN LOCATION MAP
Tanco Mine First Level and Ramp
N
shore line
ZONE 2
ZONE 1
8-T
9-C,W
10-C
7-W,T
6-W
37-W
25-W
26-C
36-W
35-W
27-C,W
34-W
33-W
28-W
32-W,C,T
29-T
40-C
II-W,T
I-PI
53-T
54-PI
55,56-PI
III-PI
IV-PI
58-PI
59-PI,C
57-W
30-PI,M
31-PI,M
60-PI
61-PI
KEY
C Cassiterite
M Microlite
PI Pseudo-Ixiolite
T Tantalite
Tp Tapiolite
W Wodginite
SCALE
0' 50' 100'

Fig. 1. - continued