



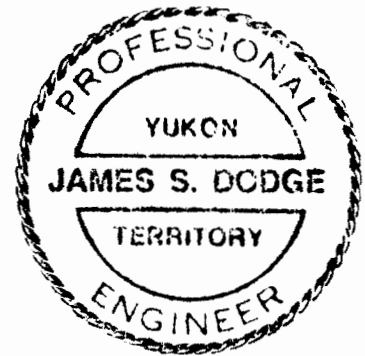
EVALUATION REPORT
LANCER QUARTZ CLAIMS
CLAIM SHEET 105-F-08
WATSON LAKE MINING DISTRICT
YUKON, CANADA
20 June, 1996

093472

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Prepared By
James S. Dodge, P.Eng.
President, DODGEX LTD.



This report has been examined by
the Geological Evaluation Unit
under Section 53 (4) Yukon Quartz
Mining Act and is allowed as
representation work in the amount
of \$ 4000 .

M. Burke

for Regional Manager, Exploration and
Geological Services for Commissioner,
of Yukon Territory.

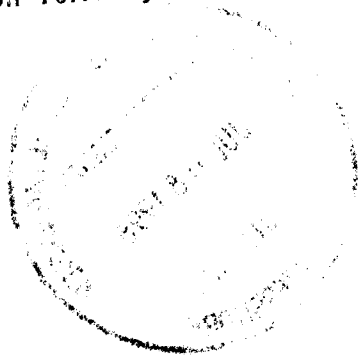


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APPENDICES

(Following Text)

RICHARD MOZLEY MULTI-GRAVITY SEPARATOR
LAKEFIELD RESEARCH - BENCH-SCALE PROPOSAL
ABT ENTERPRISES - NIOBIUM MARKET
RHONE-POULENC - RARE EARTHS
U.S. BUREAU OF MINES - U.S. IMPORT RELIANCES
RARE EARTH TRENDS - NORTHERN MINER

(Separate Packet)

RESULTS OF PROSPECTING; JULY, 1991
RE-EVALUATION OF LANCER PROPERTY; JUNE, 1993
TRENCHING/SAMPLING RESULTS; MAY, 1994
MINERALOGY OF LANCER SAMPLE - CANMET; SEPTEMBER, 1995

EXECUTIVE SUMMARY

PROPERTY EVALUATION

- 1.0 Location/Access
- 2.0 Tonnage Potential
- 3.0 Grade/Gross Assets
- 4.0 Beneficiation/Concentrates
- 5.0 Markets
- 6.0 Work Plan/Strategies

1.0 Location/Access

The LANCER mineral claims are situated in the Pelly Mountains of southeastern Yukon, Canada near the headwaters of the Ketza River at altitudes 1500-2050 meters. Access is by 10 km of 4x4 vehicle track off the all-weather road serving the Ketza Mines gold mine 90 km southeast of the town of Ross River.

Significance: The LANCER deposit is conveniently vehicle-accessible, in contrast to other known potential rare earths/niobium deposits in Canada, e.g. Strange Lake and Red Wine, Labrador and Thor, Northwest Territories. The LANCER is only 18 km by road from a modern (1990) 350tpd mill in stand-by condition.

2.0 Tonnage Potential

Extensive outcrops of the LANCER main vein have been trenched and sampled over an unbroken horizontal distance of 650 meters, and over an indicated vertical interval of 245 meters. The width of the steeply dipping vein averages 4.0 meters. The estimated inferred geologic resource, including footwall mineralization, is at least 3Mt in an underground mineable deposit.

Significance: The resource tonnage is adequate to support a medium-sized (350-450 tpd) mine/mill over a 20 year life on a year round and environmentally responsible operating conditions.

3.0 Grade/Gross Assets

Grade estimates of the LANCER vein are based on analyses of bulk samples from six bedrock trenches and intervening outcrops along with a 200 Kg composite sample (for CANMET) from eight sites. The estimated 3Mt resource averages:

0.15% Y₂O₃ Yttrium 0.66% Nb₂O₅ Niobium
1.37% REO Rare Earths 1.11% ZrO₂ Zirconium

Combined in-place market assets of contained metal oxides is a minimum of US\$300 per tonne. Losses in concentrate production, and the soft market for zirconium, may lower this estimate to US\$250 per tonne.

Significance: Sample results forecast a uniform grade for the 3Mt deposit with a conservative total in-place asset in the range of US\$750M.

4.0 Beneficiation/Concentrates

Detailed mineralogical studies in the laboratories of the Canadian Centre for Mineral and Energy Technology (CANMET) have identified the LANCER ore minerals and their liberation sizes. The high density ore minerals are fine grained indicating that specialized mechanical milling equipment will be required, e.g. Mozley Multi-Gravity Separator. Supplemental flotation, acid leaching and roasting may be required to enhance beneficiation of the ore to produce separate concentrates of yttrium, light rare earths, and niobium.

Significance: Identification of common rare earth minerals (bastnaesite, monazite, parisite) and the association of yttrium- and niobium-bearing heavy minerals support the probability that bench-scale laboratory tests will devise a metallurgical process for production of saleable concentrates.

5.0 Markets

Dodge Ltd. has received a written offer from an American company for the purchase of niobium concentrates on a monthly basis year round for a prolonged period. This opportunity is important because the single niobium mine in North America (Niobec, Quebec) no longer sells niobium concentrates; instead, produces ferroniobium. The United States is 100% dependent upon imports of niobium. Along with neodymium among the light rare earths of the LANCER deposit, yttrium spearheads the high-tech growth market with applications in advanced ceramics, permanent magnets, and nickel-hydride batteries.

5.0 Markets (Continued)

Significance:

- A. A marketing offer has been received from an American company prepared to purchase niobium concentrates from the LANCER deposit.
- B. The large chemical company Rhone-Poulenc of France, a major producer of high purity rare earths, is now studying the mineralogy and analyses of the LANCER deposit to determine if the concentrates would balance their rare earth requirements. Two American rare earth marketing firms are also reviewing the data.

6.0 Work Plan/Strategies

- 6.1 Undertake bench-scale laboratory testing of bulk samples from the LANCER deposit to devise metallurgical process(es) for production of saleable concentrates.
 - 6.11 Select laboratory for testing (Lakefield Research; Centre de Recherches Minerales; CANMET).
 - 6.12 Raise financing for bench-scale testing from companies which buy niobium and rare earth concentrates. The niobium concentrate purchaser in the United States has offered to pay for its share of the laboratory costs.
- 6.2 If tests indicate a viable concentrate production process, carry out core drilling of the LANCER vein to prove sufficient ore reserves for preparation of a mine production feasibility study.
- 6.3 Concurrently, conduct baseline studies for the environmental review process toward application for a water-use licence and mine permitting.

1.0 INTRODUCTION

This Evaluation Report accompanies the detailed 1995 mineralogical study prepared by the Canadian Centre for Mineral and Energy Technology (CANMET) the cost of which was submitted toward the required assessment work on the LANCER 1-8 quartz claims.

The Evaluation Report serves as a 1995-1996 overview of exploration and development on the LANCER claims since their staking in 1991 by James S. Dodge under the Yukon Mining Incentives Program. References are made herein to the following reports copies of which are to be found in this evaluation as Appendices:

- a) Results of Prospecting; July, 1991
- b) Re-Evaluation of Lancer Property; June, 1993
- c) Trenching/Sampling Results; May, 1994
- d) Mineralogy of Lancer Sample; September, 1995

Geological mapping and sampling of extensive outcrops have been undertaken; a \$20,000 detailed mineralogical study has been completed by CANMET; proposals for bench-scale beneficiation tests have been received and are being reviewed; marketing commitment for purchase of niobium concentrates has been received; discussions continue with rare-earths marketing service companies; and acquisition of baseline environmental review data are being planned.

Details of these studies and related correspondence are to be found in the above-mentioned Appendices to this Report.

2.0 LOCATION/ACCESS

The LANCER 1-8 quartz claims are situated above timberline in the Pelly Mountains of southcentral Yukon, Canada near the headwaters of the north-flowing Kitzu River at altitudes ranging 1500-2050 meters above sea level.

Summertime access to the eastern boundary of the claims is by 10 km of 4x4 vehicle track which, at an abandoned airstrip, branches off the all-weather road serving the mothballed (1990) 350 tonne per day Ketzu Mines gold property formerly operated by Canamax. The Ketzu Mines road begins at the Robert Campbell highway at a point 50 km southeast of the town of Ross River where lodging, general supplies, and chartered helicopters are available.

The road distance from the LANCER claims at $61^{\circ}29'$ north latitude and $132^{\circ}11'$ west longitude to Ross River is approximately 90 km, and to the Ketzu Mine mill only 18 km.

3.0 TONNAGE POTENTIAL

In 1993 hand trenching of bedrock at six locations was carried out where the southeasterly extension of the main vein had been partially concealed by 0.5-1.0 meters of scree. Anomalous high radiometric readings detected by a spectrometer were used in selecting trenching sites, inasmuch as monazite is one of the principal minerals in the vein and radiometrically readily detectable because of its thorium content.

Anomalously high radiometric readings were obtained at the ends of the trenches beyond the exposed footwall and hangingwall boundaries of the vein. Accordingly, chip sampling across the strike of the vein was also extended roughly 0.5 meters beyond the vein into the hornfels host rocks. Dilution of the vein portion of each sample resulted in lower grades of yttrium, light rare-earths, and niobium compared to those from previous outcrop sampling at the ridge and outcrops farther southeast of the trenched area. The anomalously high radiometric readings in the hornfels can now be shown to have originated from overburden vein-derived scree from up-slope buried vein bedrock.

As shown by CANMET's assays of the 200 kg sample in 1994 - one-quarter of which was collected from trenches #1-93 and #2-93 - the average grade of vein material from the trenches and outcrops closely parallels that of the earlier analyses of the ridge top samples.

The inferred resource of 3Mt is estimated from geological mapping, surface and trench sampling of the steeply dipping 3- to 5-meter wide vein, and the 1- to 3-meter wide footwall zone traceable for 650 meters horizontally and 245 meters vertically. Continuous outcrop exposure and closely uniform grade from sample analyses support the decision to defer diamond core drilling until bench-scale tests indicate the feasibility of beneficiation to produce saleable concentrates.

Based on the market quotes submitted in the 1993 Re-evaluation report, the LANCER deposit has an estimated combined metal in-place gross asset of US\$300 per tonne. Milling losses in concentrate production, and the soft market for zirconium, may lower that estimate to US\$250 per tonne.

4.0 ORE BENEFICIATION/CONCENTRATES

Results from the CANMET mineralogical study have enhanced the potential economic viability of the LANCER Y+REE+Nb+Zr high-technology materials deposit inasmuch as:

- 4.1 Analyses of the 200 kg representative sample collected from 4 bedrock outcrops and 2 trenches, closely replicates the average values previously obtained by the author over several years of sampling of the extensive outcrops. Thus, laboratory results by CANMET are meaningful in the deposit-scale context.
- 4.2 The identification of minerals containing the targeted yttrium, light rare-earths, niobium and zirconium values revealed that a sharp specific gravity difference exists between the collective high-tech minerals and the dominantly low-gravity gangue minerals - mostly quartz. Thus, the potential for simple gravity methods of mechanical mineral beneficiation is indicated.
- 4.3 Although the grain size of the high-tech minerals is quite fine, at multi-staged optimum ("practical") grinds of the ore, it is estimated that 75%-80% of the high-tech minerals could be liberated by gravity ore dressing methods. Additional recoveries of targeted minerals will require subsequent finer re-grinds and probable chemical leaching treatment.

- 4.4 Although the optimum liberation grain size of the high-tech minerals is finer than most gravity separation devices can successfully treat, CANMET pointed out that the Bartles-Mozley shaking table has been used to treat effectively material in the 100 micrometer size range.
- 4.5 Following the CANMET recommendation, Dodgex contacted Richard Mozley Limited in the United Kingdom and received information regarding their newly developed centrifugal multi-gravity separation machine. This represents a marked improvement over their earlier shaking table with respect to installed capital cost and to higher recoveries of very fine particles (25 micrometers).
- 4.6 In the 1993 Re-Evaluation report by Dodgex it was stated that, "... simple chemical methods...at an Australian (Brockman) rare earth deposit, holds considerable promise for the successful, cost-effective production of chemical concentrates from the LANCER deposit." After reviewing the CANMET report, Mr. Philip Gray, U.K. metallurgist formerly consultant on the Brockman project, recommended that ore dressing studies at the LANCER focus on fine particle separation rather than the chemical route which at Brockman proved elaborate and expensive.
- 4.7 Lakefield Research Limited of Lakefield, Ontario, a commercial laboratory with considerable experience in bench-scale beneficiation testing of rare-earth minerals, was contacted and requested to make a proposal for testing LANCER samples - based on their review of the CANMET report.

Their proposal, including cost estimates is attached. In addition to mechanical gravity concentration tests on finely ground samples, chemical leaching tests would be under taken before and after the gravity recovery tests.

The results will permit computer factored analysis of optimization of various operating parameters in mine production, milling capacity, thorium-bearing mineral disposition, project and infrastructure costs, concentrate grades and market sales schedules.

5.0 MARKETS

Rare-earth elements (REE) and niobium, contrasted with base and precious metals, are not commonly quoted on the London Metal Exchange and, therefore, are among the commodities for which only spot prices are available.

5.1 Rare-earth Elements

Worldwide, there are only two large integrated sources of light rare-earths: Bayan Obo, China and Mountain Pass, California, U.S.A. Both have very large ore resources of the mineral bastnaesite which they concentrate and refine in the production of high-purity rare-earth elements required by end users in the electronics and permanent magnet industries. The large French chemical company, Rhone-Poulenc, produces high purity rare-earths, including yttrium, from concentrates purchased from a variety of independent sources.

Reportedly, there is a trend in the industry requiring ultra-pure REE, and this market is being targeted by a growing number of small specialized firms in Japan and southeastern Asia countries as competitors to the Chinese producers.

Dodgex Ltd. is optimistic about entering this latter market niche for its planned production of concentrates containing yttrium and neodymium, two elements now in the forefront of the growth market in rare-earths. Yttrium concentrates are not produced from either the Bayan Obo or Mountain Pass deposits and,

consequently, is sought after by the less integrated independent concentrate purchasers. It is this market that holds the most promise for sale of the LANCER concentrates. Discussions are continuing with Rhone-Poulenc and two U.S.-based marketing firms.

As reported in the May, 1996 issue of Mining Engineering, the United States is now 100% dependent upon the importation of yttrium. Furthermore, as stated by the U.S. Bureau of Mines in its review for 1994, "The long term outlook is for increase in competitive and diverse group of rare-earth suppliers.

5.2 Niobium

"The high degree of import reliance for columbium (niobium) and tantalum is the principal strategic problem faced by the United States." - from the U.S. Bureau of Mines Annual Review for 1994. It is with this situation, and the elimination of Canada as the former main supplier of niobium raw materials feedstock (concentrates) for the United States, that brought on the enquiry to Dodgex Ltd. by ABT Enterprises of Edgewood, Maryland, USA in its search for a replacement source of niobium concentrates for its ferroniobium plant.

The Niobec mine in Quebec, operated by Teck/Cambior, is the only North American producer of Niobium, but no longer sells concentrates; instead, produces value-added ferroniobium. Likewise, the only other

source of niobium is Brazil where the availability of concentrates is being phased out in favor of ferroniobium production. Thus, ABT Enterprises considers the LANCER deposit's development to be of prime importance.

In January, 1996, ABT Enterprises submitted a written offer to Dodgex for the purchase of 20 to 40 tons of niobium concentrates each month on a long term basis. A further offer was made to finance a proportionate share of the bench-scale ore beneficiation tests proposed by Dodgex for 1996.

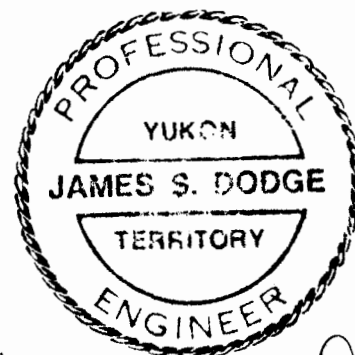
Meanwhile, Dodgex has proposed to the large French chemical company, Rhone-Poulenc, that they finance the balance of the bench-scale testing costs in order to earn the right of first refusal on the purchase of rare-earth concentrates; discussions are continuing at this writing.

6.0 CONCLUSIONS

Evaluation of the LANCER 1-8 claims indicates that:

- 6.1 The deposit containing yttrium+light rare-earths+niobium+zirconium, all in current economic concentrations, at an accessible site in southern Yukon, is unique in the Western Hemisphere.
- 6.2 The detailed CANMET mineralogical study has identified the host minerals and estimated their liberation characteristics at various comminution levels.
- 6.3 Review of this mineralogical study by Richard Mozley Limited and Lakefield Research Limited has led to the conclusion that bench-scale laboratory testing will be effective in determining the efficacy of combined selective multi-gravity mechanical beneficiation, and perhaps subsequent chemical extraction, in producing saleable concentrates.
- 6.4 The steeply dipping, 3- to 5-meter wide vein has been geologically mapped and sampled at outcrops and in trenches over a length of 650 meters and down dip for 245 meters. Given the continuity of the vein, together with a recently identified footwall zone 1- to 3-meters wide, an inferred resource of 3Mt is estimated.

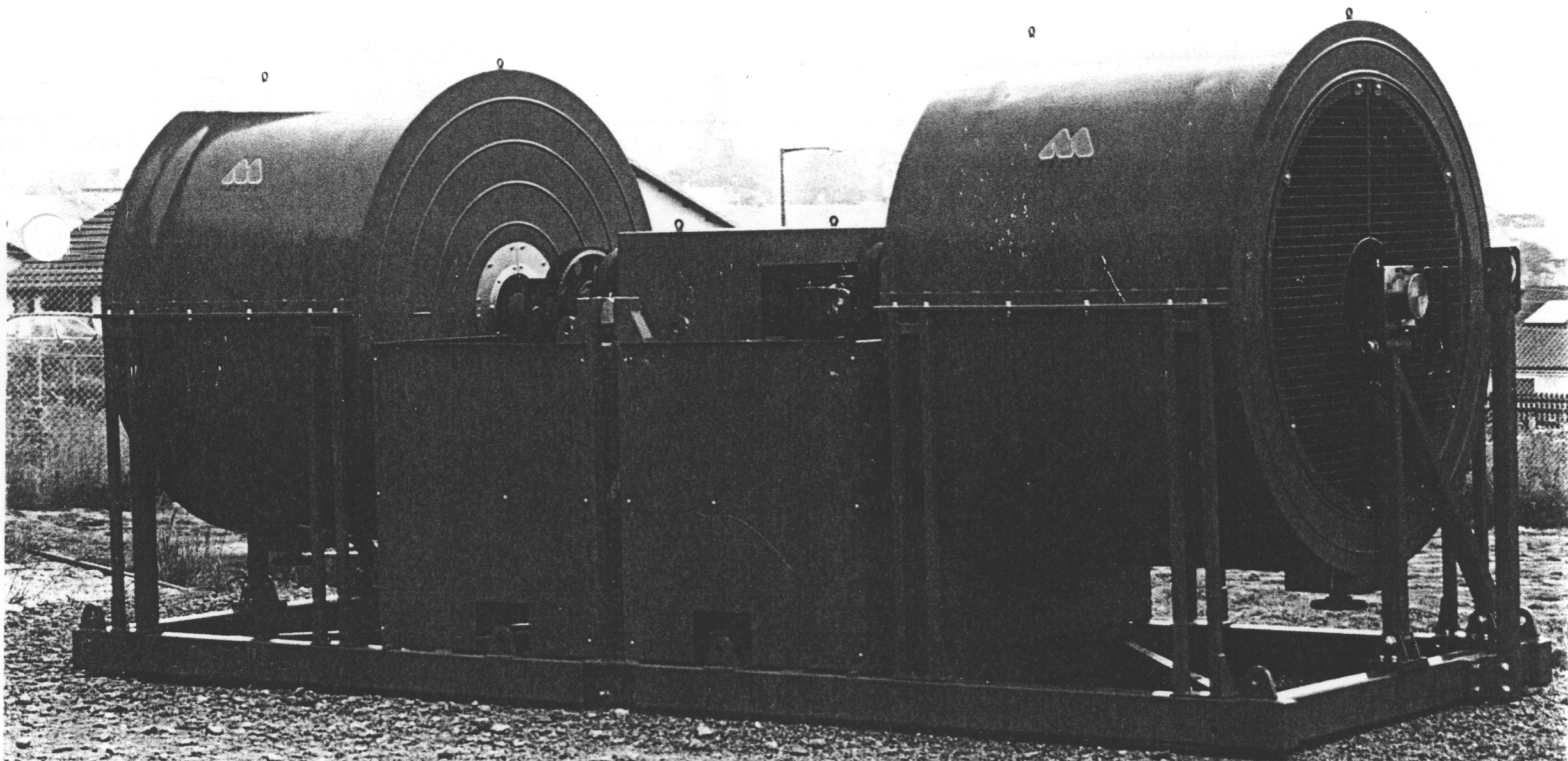
- 6.5 Underground, rather than open pit, extraction is unquestionably the mining method dictated by the steeply dipping vein, particularly because: a low level adit entry is feasible; waste rock dilution would likely be minimal; dewatered mill tailings could be returned underground to fill open stopes; and underground mining presents very little surface disturbance in this environmentally sensitive area.
- 6.6 Marketing of concentrates will be formalized once that beneficiation tests of the ore indicate that economically recoverable grades of the contained elements is feasible. An American company has written to offer the purchase of niobium concentrates and to finance a proportionate (niobium) share of the cost of bench-scale testing.



James A. Dodge



THE MOZLEY DOUBLE DRUM MULTI-GRAVITY SEPARATOR ...



... REPRESENTS THE LATEST DEVELOPMENT IN FINE MINERAL SEPARATION TECHNOLOGY. IT CAN RECOVER ALL THOSE ELUSIVE FINE AND ULTRA-FINE VALUABLE MINERALS — GOLD, PLATINUM AND THE REST — IT CAN ALSO REDUCE ASH AND SULPHUR LEVELS IN FINE COAL.

HOW DOES THE MGS WORK?

– by wrapping the horizontal concentrating surface of a conventional shaking table into a drum, then rotating it. By this means a force many times greater than the normal gravitational pull can be exerted on the particles in the film flowing across the surface, thus greatly enhancing the separation process.

WHAT ARE ITS APPLICATIONS?

– recovering PRECIOUS METALS such as gold and platinum; upgrading METAL OXIDES AND SULPHIDES such as chromite, iron ore etc.; recovering ALLUVIAL MINERALS such as monazite, ilmenite etc.; upgrading INDUSTRIAL MINERALS such as coal, kaolin, celestite etc. ENVIRONMENTAL applications include coal desulphurisation and harbour silt clean-up.

HOW DOES THE MGS COMPARE WITH OTHER CONCENTRATING EQUIPMENT?

– one MGS is equivalent to an average of TWELVE full size shaking tables. For example during trials at a tin mine it was shown that one DOUBLE DRUM MGS treating a fine cassiterite ore sizing 83% finer than 75 microns assaying 0.9% tin was able to produce a 40% tin concentrate to which 70% of the tin was recovered. Feed rate was 2.30t/h. Simultaneous trials with a shaking table showed that to achieve the same results a feed rate of 0.19t/h could not be exceeded.

HOW CAN YOU TAKE ADVANTAGE OF THESE BENEFITS?


1. Let Richard Mozley Limited evaluate your application via laboratory testing with the 0.2t/h Pilot Scale MGS. Alternatively you may wish to hire or purchase a Pilot Scale MGS for on-site trials with the assistance of our commissioning engineer.

If test results are promising...

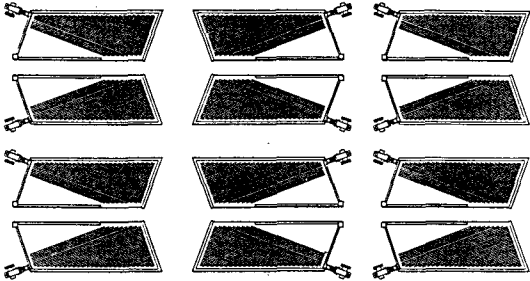
2. Carry out mine scale confirmatory trials with the Double Drum MGS and the assistance of our commissioning engineer. If these are successful..

3. Richard Mozley Limited will design and supply an installation specific to your needs at a fraction of the cost of conventional fine gravity circuits.

COMPARISON BETWEEN DOUBLE DRUM MGS AND SHAKING TABLES

THIS DOUBLE DRUM MGS : 

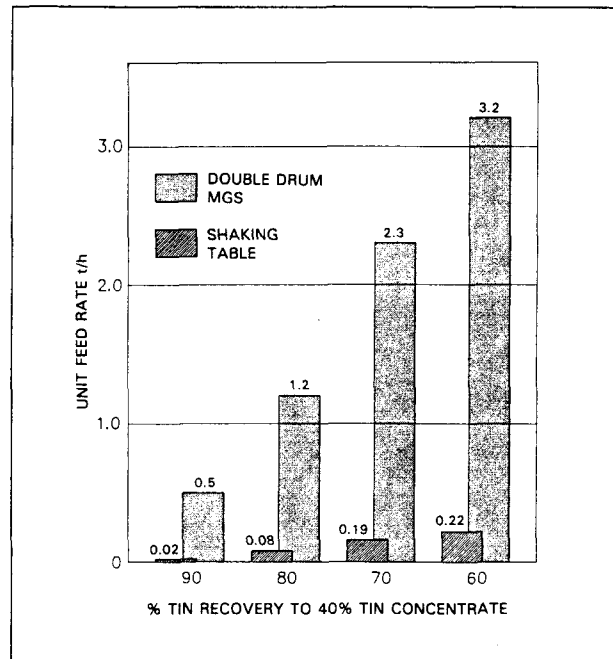
CAN DO THE SAME JOB AS THESE TWELVE SHAKING TABLES :



FEED : 2.3t/h, 83% - 75 micron, 0.9% Tin
 CONC. : 40% Tin
 TIN RECOVERY TO CONC. : 70%

| | MGS | 12 TABLES |
|--------------------------------------|-----|-----------|
| FLOOR AREA REQUIRED m ² : | 7 | 195 |
| POWER CONSUMPTION kW : | 2.2 | 6.7 |

THE INSTALLED COST OF THE MGS IS LESS THAN HALF THE INSTALLED COST OF THE TWELVE SHAKING TABLES



SPECIFICATIONS

Length : 4.50m
 Width : 1.55m
 Height : 1.85m
 Weight : 2.5 tonnes (approx)
 Motors : 6.6kW, 380 - 415V/50/3
 Capacity : 2 - 4 t/h (solids)
 Feed Pulp : 30 - 50% solids w/w
 Washwater : 10m³/h maximum

The information presented here is offered as a guide only. No warranty or guarantee express or implied is made regarding the capacity, performance or suitability of any product.



Richard Mozley Limited
 Cardrew · Redruth
 Cornwall · TR15 1SS · England
 Telephone (0209) 211081
 Fax (0209) 211068
 Telex 45735 MOZLEY G



Richard Mozley Limited,
Tel: (01209) 211081

Cardrew, Redruth,
Fax: (01209) 211068

Comwall TR15 1SS U.K.

Mr James S. Dodge
DODGEX Ltd.
14 MacDonald Road
Whitehorse,
Yukon
Y1A 4L2
Canada

Ref : 6.02/078

23/04/96

Dear Mr Dodge.

Thank you for your recent letter dated 18th April en route to Whitehorse.

You should have by now received my letter dated 16th March 1996. I hope that you found it useful.

I am not sure of the laboratory techniques employed by Lakefield. I would envisage that they will undertake either a simple 2-product separation to construct a grade-recovery curve or undertake a gravimetric release analysis in order to assess the economic liberation size with respect to the grade-recovery relationship of the ore. I have enclosed a copy my paper on Release Analysis which may or may not be useful to you. This method, if carefully undertaken (especially on materials below 15um) on well fractionated samples, will give a very clear indication of ultimate gravity grade/recovery in a near perfect system.

However, as the C900 Laboratory M.G.S will give similar performance the full scale plant machine, it is useful to ascertain the potential grade-recovery from the device. The enhanced gravity separation of the M.G.S will not only yield unparalleled grade-recovery on feeds finer than 45 microns but also offer higher capacities per square foot of occupied space. Its selection is therefore recommended where gravimetric recovery and upgrading of fines is required together with low installation costs.

I trust this answers you enquiry and if there is any way that I may further assist, please do not hesitate to contact me.

Yours sincerely

Guy Cordingley
Applications Engineer - Minerals Division.



Richard Mozley Limited,
Tel: (01209) 211081

Cardrew, Redruth,
Fax: (01209) 211068

Cornwall TR15 1SS U.K.

Mr James S. Dodge
DODGEX Ltd.
14 MacDonald Road
Whitehorse,
Yukon
Y1A 4L2
Canada

Ref : 6.02/078

16/04/96

Dear Mr Dodge.

Thank you for your recent letter and mineralogical report.

At the time of writing, Mr Billy Chan, your contact in Mozley is away on business. In his absence I would like to advise that I am unaware that Lakefield Resources Ltd possess a C900 as we have not directly sold them one. However, I would like to recommend CRM (Centre de Recherches Minerales) as a test centre for the C900. We have had excellent mineralogical service from them in our past dealings.

You may contact Dr Arthur Plumpton at CRM:-

2700 Rue Einstein
Sainte Foy
Quebec
G1P 3W8

Tel. 001 418 643 4540
Fax. 001 418 643 6706

The C900 is a laboratory scale M.G.S and is capable of treating up to 150kg/hr of feed solids material. The machine is fully adjustable for evaluation of different parameters and generally yields the same metallurgical performance as the C902 Double drum machine but at approximately 1/20th of the capacity.

The C902 Double drum machine can treat up to 4.00mt/hr of solids depending up on feed %Solids. In general terms account for 10.00mt/hr of pulp slurry per machine.

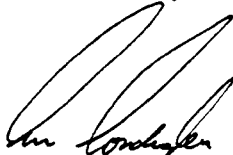
I would advise that the M.G.S will be able to recover and upgrade your value minerals (Y-REE-Nb-Zr) provided that there is a density differential between these values and the gangue (silicates, carbonates etc.). I am aware that we have had considerable success in treating both Nb and Zr minerals with the M.G.S.

I have studied the CANMET report and although I am no mineralogist, the deposit appears to be quite complex. The report indicates that liberation occurs in the sub 150 micron range. I would envisage that any future processing could possibly entail much finer liberation to produce an economically saleable concentrate(s). The M.G.S. has been specifically designed to treat ultra-fine minerals and can effectively treat classified feeds from 500um down to 2um.

I hope that the information I have supplied is useful and that you maintain your interest in the M.G.S. and its unique ability to separate fine minerals by gravity.

In the meantime if there is any way that I may further assist, please do not hesitate to contact me.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Guy Cordingley', written in a cursive style.

Guy Cordingley
Applications Engineer - Minerals Division.

**p.s. We do not appear to have any record of your telephone or facsimile numbers.
Please could you forward them for the completion of our records**



**LAKEFIELD
RESEARCH
LIMITED**

185 Concession Street, Postal Bag 4300
Lakefield, Ontario, Canada K0L 2H0
Tel. (705) 652-2024 Fax (705) 652-1918

H Y D R O M E T A L L U R G Y

To: Mr. J. Dodge **Company:** Dodgex Ltd.
From: Dr. C.J. Ferron **Fax No:** 970-563-4504
Date: March 28/96 **Project No:**

This transmission consists of 3 pages including this one.

RE: Proposal/Cost Estimate for a scoping testwork program for the rare earth Lancer deposit

Greg Davison, our Senior Mineralogist, passed me the Canmet reports on your Lancer deposit. From their reports, it appears that:

- ◆ both ore types are very fine grained, the footwall sample being the finest. The main vein sample appears to be more amenable to upgrading by conventional methods.
- ◆ monazite and bastnaesite are liberated at a relatively coarse grind (minimum grind ~60-90 microns K₈₀). At that grind, liberation of most of the other valuable elements is not good. Zirconium in particular requires very fine grind, and an acceptable recovery would likely require a chemical attack on the untreated ore (if it is economic).

Based on these mineralogical results, we could recommend a two-phase approach to treat this ore: direct chemical attack of the untreated ore, and upgrading of the rare earth minerals (monazite, bastnaesite) followed by chemical treatment.

1. Upgrading of the rare earth minerals. It would significantly reduce processing costs of the chemical treatment, but metal recoveries would be lower. The first options to be tested should be gravity and possibly magnetic separation, since no chemicals are involved. If those options are not successful, we could suggest as a second phase to test physico-chemical methods, such as flotation or selective flocculation.
2. Chemical attack of the untreated ore. Due to the large amounts of silica, we would recommend sulphuric acid baking, followed by water leach.

Attached is a proposal/cost estimate for a scoping testwork program on the Main Vein ore sample.

If you have any further questions, do not hesitate to contact us.

Best regards



C. J. Ferron, Ph.D.
Manager - Hydrometallurgy

CJF/cp
cc-Greg Davison

**COST ESTIMATE - SCOPING TESTS - PHASE I
MAIN VEIN ORE**

| | <i>Cdn \$</i> |
|---|------------------------|
| 1. Sample preparation (50-100 kg) | |
| • Crushing to minus 10 mesh | |
| • Cutting a sample for head assays (Ce, La, Nb, Zr, Whole Rock Analyses) | |
| • Cutting test charges | |
| • Grindability curve | \$ 1,500 |
| 2. Chemical attack on untreated ore | |
| Fine grind | \$ 150 |
| Acid baking tests, with Ce, La, Zr, Nb assays (effect of acid addition, temperature) | |
| Allow 5 tests | \$ 3,500 |
| 3. Upgrading tests - Physical methods only | |
| Grind, desliming, screening | \$ 500 |
| Gravity tests (Mozley Table), 3 fractions | \$ 1,200 |
| Magnetic separation tests (Carpco), 3 fractions | <u>\$ 1,200</u> |
| | \$ 8,050 |
| 4. Project Management, Supervision | |
| Add 20% | \$ 1,610 |
| 5. Report preparation | |
| Add 10% | \$ 805 |
| 6. Miscellaneous (Fax, Phone, Courier, Consumables) | |
| Add 5% | \$ 403 |
| Overall Total | <u>\$10,868</u> |
| (GST not included) | |



ABT Enterprises
706 Rainbow Ct.
Edgewood, MD 21040
USA

TEL: 410-676-6617
FAX: 410-676-6604

May 13, 1996

James S. Dodge, President
DODGEX LTD.
14 MacDonald Road
Whitehorse, Yukon
Y1A 4L2 Canada

Dear Mr. Dodge:

Once again, thank you for your letter 16 February 1996 proposing possible investment for prospective purchasers of concentrates from Yukon deposit. Most likely our earlier reply to your letter got lost in the mail since we did not receive any answer back (you were also changing your address during that period from Colorado to Canada).

We are only interested in Niobium concentrates (not in Rare Earth materials) and our needs will be one to two container loads (about 20 to 40 Tonnes) per month on a long term basis.

Most likely the above tonnage requirement will be a very small percentage in comparison to your total production of Niobium concentrates.

We welcome this proposal of up front investment for bench scale test for prospective buyers.

However we would like to know the approximate amount we might have to invest as our share for these lab test for Niobium Ore considering the small amount of tonnage we will be buying.

We have also passed on these information to one of our business contacts who might be interested in your project including Rare Earth.

As stated earlier, we wish to maintain contacts with your firm for future transactions.

We look forward to hearing from you.

Sincerely

Ms. Tonya Craft, President
ABT Enterprises, Inc.

**ABT** Enterprises706 Rainbow Ct.
Edgewood, MD 21040
USATEL: 410-676-6617
FAX: 410-676-6604

January 29, 1996

TO: Mr. James S. Dodge
President
Dodgex Ltd.

Dear Mr. Dodge,

It was a pleasure receiving your fax in response to our inquiry concerning Niobium ore or pyrochlore ore.

We intend to purchase Niobium concentrate/Ore or Columbite ore or Pyrochlore Ore with Nb2O5/Cb2O5 content anywhere from 40% to 70% range, preferably 50 to 60% content. With favorable terms and depending on availability, we need approximately 20 gross ton per month (one container load) round the year on a long term basis. Even we could purchase 40 ton per month if material is available on a regular basis.

Specs: Nb2O5 - 40% to 70 % - preferably 50% to 60% range
SiO2 - 3.5% max P2O5 - 0.2 % max H2O - 0.1 %
TiO2 - 4.5% max Ta2O5 - 1% - All others as per standard.
Slight variation in specs acceptable.

Although we prefer very low content on Ta2O5, ore might be having higher percentage of tantalum and we could accept around 5% range on Ta2O5.

Although Ta2O5 is a valuable item in ores, we consider it as an impurity in our production of Ferro Niobium. Therefore we prefer very low on Ta2O5 if available.

We will be very much interested in maintaining contact with you over the coming year for this ore purchase.

However until then, if you could help us in procuring this ore from any source, we will purchase it through your company or any arrangement you offer.

We hope for the best and wishing you a great success in your upcoming mining operation.

Once again thank you very much for your reply to our inquiry.

Best regards,

Sincerely

Ms. Tonya Craft
President, ABT Enterprises, Inc.



RARE EARTHS & GALLIUM

ONE CORPORATE DRIVE, BOX 881
SHELTON, CT 06484

TEL: (203) 925-3300
FAX: (203) 925-8182

January 24, 1996

**Mr. James S. Dodge
Dodge Ltd.
14 MacDonald Road
Whitehorse, Yukon
Canada Y1A 4I2**

Dear Mr. Dodge:

Your letter and mineralogical studies addressed to John Forti arrived last week. I have replaced John as the Director of Rare Earths for Rhone-Poulenc in North America. Your study looks interesting and we are always looking for new sources of ore to balance our rare earth requirements. I have forwarded your study to our materials procurement group in Paris. If we decide that we would like to analyze the samples you offer, I will contact you.

In the meantime, if you have any questions, please do not hesitate to call. Thank you for your interest.

Sincerely,


Paul W. Bacon
Business Director

DODGEX-"C"
PB/

ANNUAL REVIEW 1995

Mining Overview Exploration Overview Coal Overview State Summaries

United States 1995

D. WASHINGTON, US Geological Survey

The US economy and the demand for nonfuel minerals grew at lower rates in 1995 than in 1994. Demand for major metals, such as aluminum, copper and steel, was mixed but relatively stable. The building industry, including highway construction, helped to support modest overall growth in demand for industrial minerals.

The value of processed materials of nonfuel mineral origin produced in the United States during 1995 was estimated to be \$395 billion, an increase of almost 10% compared with 1994 (Fig. 1). The estimated value of US raw nonfuel minerals production during 1995 was \$38 billion, about 7% more than in 1994. The value of US minerals production has increased in 30 of the last 35 years.

The United States was a net importer of raw and processed materials of mineral origin during 1995. Total US trade in those materials was valued at \$77 billion. Im-

ports of processed mineral materials were valued at an estimated \$49 billion, while exports were valued at about \$23 billion. Imports of metal ores and concentrates increased almost 10% to \$1.4 billion, while imports of raw industrial minerals rose 7% to \$900 million. Raw minerals exports showed greater variance. Metal ores and concentrates jumped 53% to \$1.6 billion, while raw industrial minerals exports increased by a more moderate 8% to \$1.3 billion. Table below shows US net import reliance for selected nonfuel minerals during 1995.

Significant events

The Uruguay Round of the General Agreements on Tariffs and Trade (GATT) became effective Jan. 1, 1995. GATT rules that address market access affected by tariff and nontariff market barriers are significant to US minerals producers. For example, GATT Uruguay Round agreements eliminate tariffs (during a 10-year

Fig. 1. Net import reliance for selected nonfuel mineral materials.

| Commodity | % | Major Sources (1991-1994) |
|---------------------------------|-----|---|
| Arsenic | 100 | China, Chile, Mexico |
| Columbium (Niobium) | 100 | Brazil, Canada, Germany |
| Graphite (natural) | 100 | Mexico, Canada, China, Madagascar, Brazil |
| Manganese | 100 | South Africa, Gabon, France, Brazil |
| Mica, sheet (natural) | 100 | India, Brazil, Finland, China |
| Strontium (celestite) | 100 | Mexico, Germany |
| Thallium | 100 | Belgium, Canada, United Kingdom |
| Yttrium | 100 | China, United Kingdom, Hong Kong, Japan, France |
| Bauxite and Alumina | 99 | Australia, Jamaica, Guinea, Brazil |
| Gemstones | 98 | Israel, India, Belgium, United Kingdom |
| Fluorspar | 92 | China, South Africa, Mexico |
| Tungsten | 87 | China, Germany, Bolivia, Peru |
| Tin | 84 | Brazil, Bolivia, Indonesia, China |
| Cobalt | 82 | Zambia, Norway, Canada, Zaire, Finland |
| Tantalum | 80 | Australia, Germany, Canada, Thailand |
| Chromium | 78 | South Africa, Turkey, Zimbabwe, Russia, Finland |
| Potash | 74 | Canada, Belarus, Germany, Israel, Russia |
| Barite | 65 | China, India, Mexico |
| Iodine | 62 | Japan, Chile |
| Nickel | 61 | Canada, Norway, Australia, Dominican Republic |
| Antimony | 60 | China, Mexico, South Africa, Hong Kong |
| Stone (dimension) | 57 | Italy, Spain, India, Canada |
| Peat | 55 | Canada |
| Magnesium compounds | 50 | China, Canada, Mexico, Greece, Austria |
| Asbestos | 46 | Canada |
| Zinc | 41 | Canada, Mexico, Peru, Spain |
| Diamond (dust, grit and powder) | 36 | Ireland, China, Russia |
| Selenium | 33 | Canada, Philippines, Japan, Belgium, United Kingdom |
| Silicon | 33 | Norway, Brazil, Canada, Russia |
| Gypsum | 30 | Canada, Mexico, Spain |
| Pumice | 29 | Greece, Zaire, Turkey, Ecuador |
| Aluminum | 25 | Canada, Russia, Venezuela, Brazil |
| Cadmium | 21 | Canada, Mexico, Belgium, Germany |
| Iron and Steel | 21 | European Union, Canada, Japan, Brazil, South Korea |
| Nitrogen (fixed), Ammonia | 20 | Trinidad and Tobago, Canada, Russia, Mexico |
| Iron ore | 18 | Canada, Brazil, Venezuela, Australia, Mauritania |
| Sulfur | 18 | Canada, Mexico |
| Cement | 17 | Canada, Spain, Greece, Venezuela, Mexico |
| Lead | 15 | Canada, Mexico, Peru, Australia |
| Salt | 15 | Canada, Mexico, Bahamas, Chile |
| Sodium sulfate | 15 | Canada, Mexico |
| Vermiculite | 15 | South Africa |
| Mica, scrap and flake (natural) | 10 | Canada, India |
| Perlite | 8 | Greece |
| Copper | 6 | Canada, Chile, Mexico |
| Rare Earths | 2 | Australia |
| Lime | 1 | Canada, Mexico |

Additional commodities for which there is some import dependency include:

- Bismuth: Mexico, Belgium, China, Peru.
- Gallium: France, Germany, Russia, United Kingdom, Hungary.
- Germanium: United Kingdom, Belgium, Germany, China.
- Ilmenite: South Africa, Australia, Canada.
- Indium: Canada, France, Italy, Belgium, Russia.
- Iron and steel slag: Canada, Japan.
- Kyanite: South Africa, France.
- Mercury: Canada, Russia, Germany.
- Platinum: South Africa, United Kingdom, Belgium, Germany.
- Rhenium: Chile, Germany, United Kingdom, Russia, Kazakhstan.
- Rutile: Australia, Sierra Leone, South Africa.
- Silver: Mexico, Canada, Peru, Chile.
- Thorium: Australia.
- Titanium (sponge): Russia, Japan, China.
- Vanadium: Russia, South Africa, Canada, Mexico.
- Zirconium: Australia, South Africa.

High-purity rare earths grow in demand

High-purity rare earths products represent an important and fast-growing market, says market analyst Roskill. Its report, *The economics of rare earths 1994*, states that separated rare earths claim around 75% of the value of the world rare earths market and that this proportion is set to increase.

With prices of some separated rare earths reaching up to one thousand times those of mixed rare earths compounds, high-purity rare earths products represent an important and fast-growing market.

Although separated rare earths are estimated to account for no more than 25% of the world market for rare earths by volume, they claim around 75% of the estimated US\$400 million per annum world market by value. According to the

report, this share is increasing as end-users such as permanent magnets, phosphors and advanced ceramics continue to expand their markets, while demand is relatively static in the industries which consume high-volume, low-purity rare earths such as petroleum cracking catalysts.

The main area of short-term growth in demand for rare earths lies in the use of neodymium oxide in permanent magnets. Neodymium-iron-boron magnets are the highest-strength magnets currently produced, with markets in industrial motors, medical imaging body scanners, automobile starter motors and voice coil motors.

Roskill says that magnets are forecast to achieve average annual growth rates of 13.7-21.2% throughout the 1990s, accounting for 6,000-10,000 tonnes rare earths oxides by 2000. Samarium-cobalt magnets are also still in demand for high-temperature, corrosion-resistant uses.

A second important growth market is nickel-hydride batteries, currently replacing nickel-cadmium rechargeable batteries in many applications.

According to the report, demand for rare earths in the production of fluid-cracking catalysts, which appears to have leveled off, could fall later in the decade because of the development of alternative raw materials such as ultra-stable zeolites.

Meanwhile, as environmental awareness continues to increase, the demand for cerium in autocatalysts to reduce exhaust emissions is expected to grow. The main area of growth for cerium oxide lies in the European Union, where catalytic converters have been added to all new cars since 1992. As a re-

sult, Rhone-Poulenc, the largest European rare earths producer, has cut production of cerium abrasives and is concentrating on the supply of cerium oxide for autocatalysts.

The importance of high-purity value-added rare earths products is reflected in the co-operation between major producers Santoku and Rhone-Poulenc. In order to try and improve both companies' profitability, they are concentrating their joint efforts on achieving a fully integrated rare earths operation. Such co-operation agreements are likely to occur increasingly in the industry.

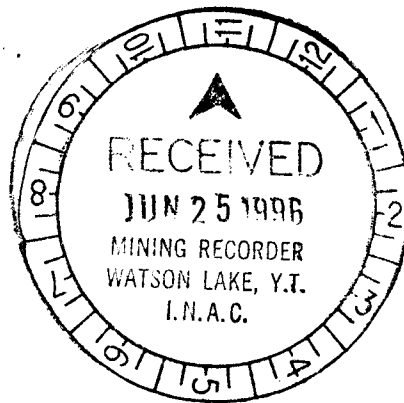
Other processors have been forced into closures. Chinese rare earths producers are attempting to end their price war and stop the undercutting which has made rare earths production barely profitable, by forming a cartel which adopted uniform prices starting Jan. 1, 1994.

However, the move comes too late for some processing companies, especially in Japan where they have suffered from the combined effects of falling rare earths prices and the appreciation of the Yen.

The report says that the supply of processed rare earths is expected to become increasingly internationalized as the CIS and southeast Asian producers join Japan, Europe, China and the U.S. as sources of rare earths before the beginning of the next century.

It is likely that Japan will remain a leading authority in rare earths research and development, while output of less highly processed products will move to China and southeast Asia.

For more information about the report, write Roskill Information Services Ltd., 2 Clapham Road, London SW9 0JA, England.



RESULTS OF PROSPECTING
LANCER 1-24 CLAIMS

CLAIM SHEETS 105-F-08/09
61 29'N 132 11'W

JAMES S. DODGE, P.ENG.
18-30 JULY 1991





LANCER CLAIMS

No. 1 Posts for Lancer 7/8 and No. 2 Posts for Lancer 5/6

Posts are standing on 3-meter wide
rare earths+yttrium+zirconium vein

Rusty knob in mid-distance
is intrusive syenite plug

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INTRODUCTION

James S. Dodge chose the search for rare earth elements (REE) in the Yukon as a major emphasis for prospecting under the 1991 Yukon Mining Incentives Program. This decision followed a detailed library search of the geologic literature (winter 1990-91) on peralkalic rock hosts of rare earth deposits and a useful brief field examination of the bastnaesite REE mine at Mountain Pass, California.

Thereupon, Dodge's review of the 1980 assessment report on the former Nokluit claims, prepared under the supervision of A. R. Archer, suggested that a careful field reassessment was warranted on the basis of the level of REE values previously obtained at several sites, and because of the current high degree of interest in, and anticipated future growth for, rare earth elements including, especially, yttrium.

Previous work had identified sites of anomalously high radioactivity with associated promising REE values, albeit in relatively small, isolated bedrock and talus sources. Several geologic notations by earlier workers led this author to question the skarn hosted nature of the REE mineralization.

Noting that the area was open for staking and, moreover, that a road for 4x4 vehicles would provide limited but important access to the property once the area was free of late-melting snow, the staking of the first eight Lancer claims was undertaken on 30 May, 1991 using a chartered helicopter based in the settlement of Ross River 60km to the north.

Ground access to the claims during the period 18-30, July provided the opportunity to prospect and reevaluate several of the sites previously reported to contain REE concentrations. A further sixteen Lancer claims were staked toward the end of the field season.

PROPERTY AND LOCATION

The contiguous group of 24 Lancer mining claims are recorded in the Watson Lake (Yukon) Mining District recorder's office as follows:

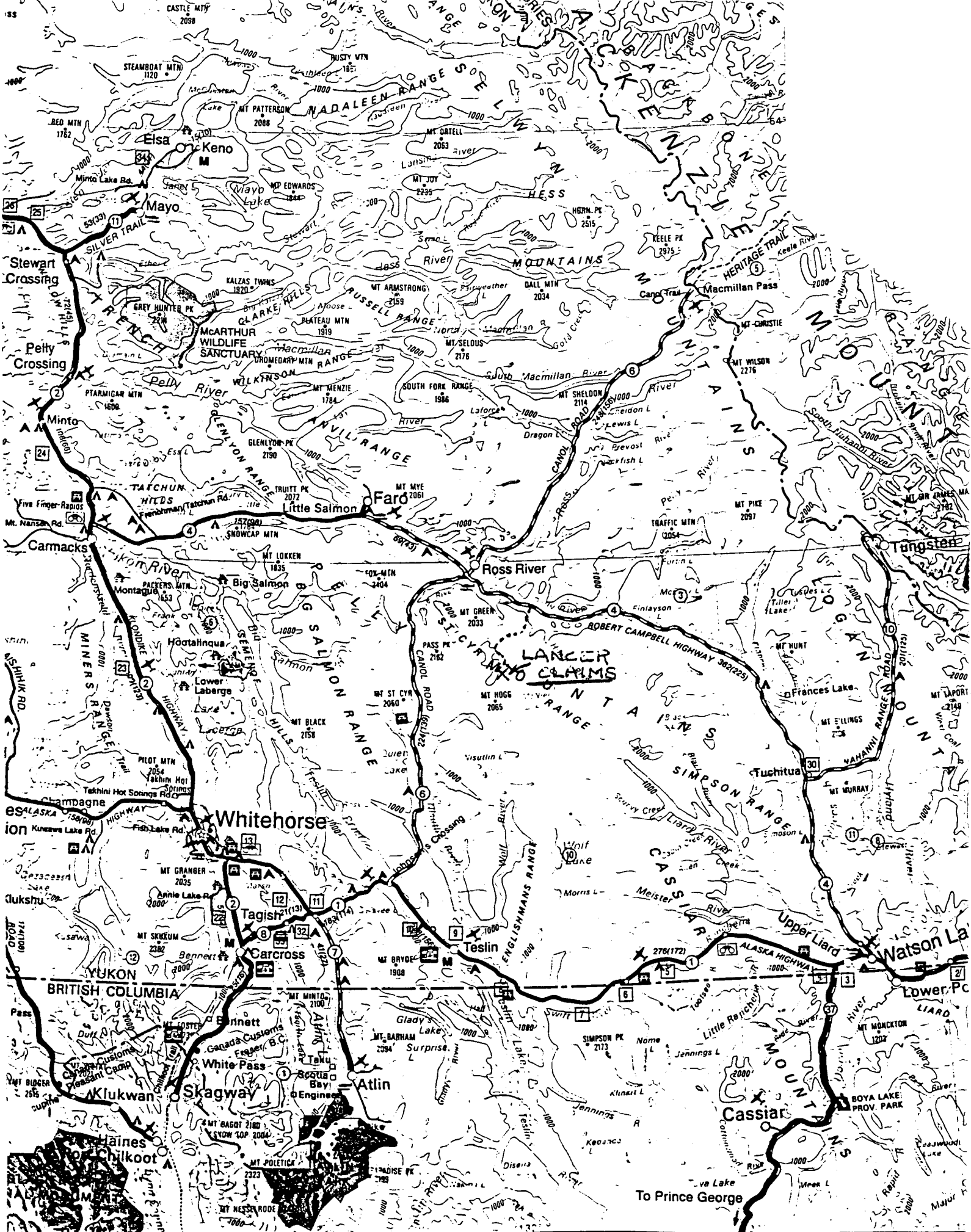
| <u>Name</u> | <u>Grant Number</u> | <u>Date of Record</u> |
|-------------|---------------------|-----------------------|
| LANCER 1-8 | YB33962-YB33969 | 05 June, 1991 |
| LANCER 9-24 | YB34264-YB34279 | 24 September, 1991 |

Ownership of all the claims is held by DODGEX LTD., a private Yukon corporation controlled by James S. Dodge of Whitehorse, Yukon, Canada.

The claims are situated at approximately 61°29' north latitude and 132°11' west longitude on NTS Map Sheets 105-F-08 and 105-F-09 near the headwaters of the Ketzka River in the Pelly Mountains of southcentral Yukon.

Altitudes on the claims range from 1500 meters along the Ketzka River to 2050 meters along the headwall of a composite cirque.

A 10km 4x4 vehicle road connects the eastern boundary of the claims to the all-weather Ketzka Mine road at a point 30.5km southeast of the turnoff on the Campbell Highway. (Map I and II)



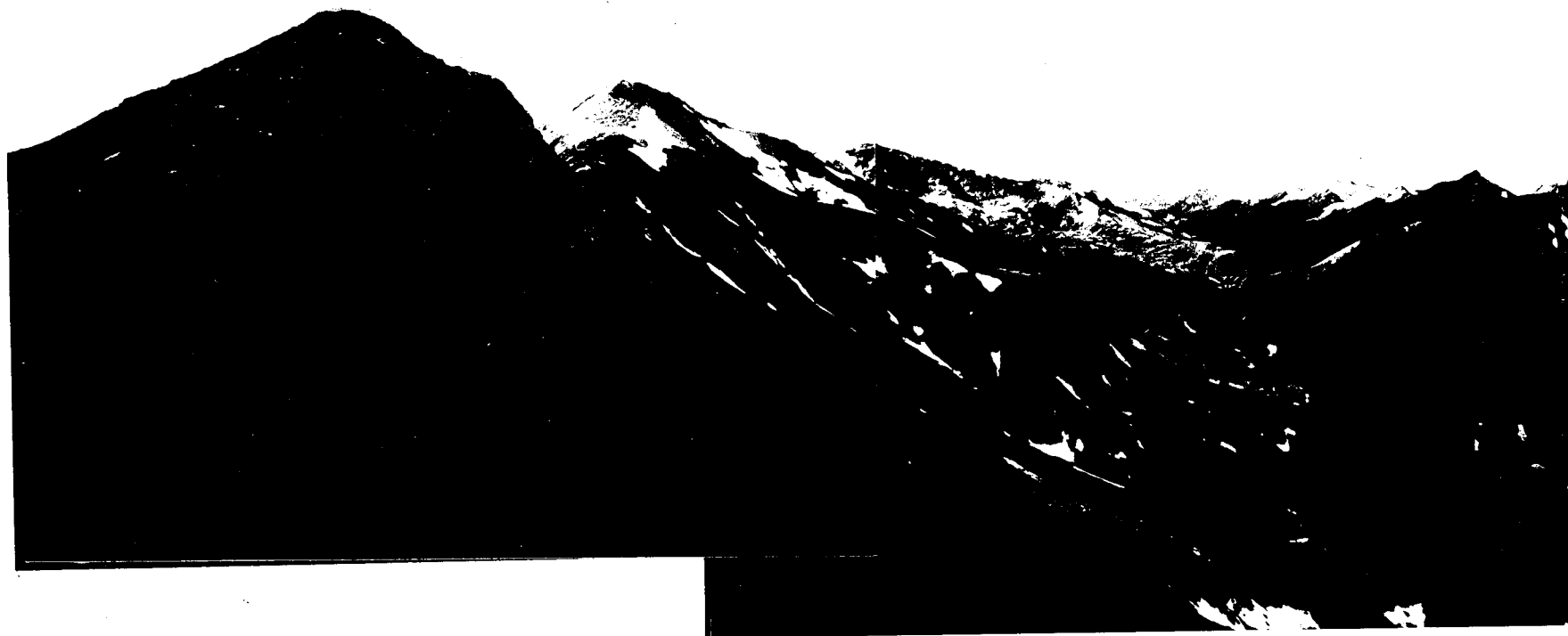


PHOTO 1

Overview of Lancer claims looking 240° A into the headwaters valley of the Ketzka River which flows to the lower right. Dark reddish brown knob in right center is the intrusive syenite plug.

Left foreground cliff and partially concealed ridge leading to snow-patchy peak comprise skarn and hornfels as part of the thermal metamorphic aureole generated in a southeasterly direction from that part of the syenite intrusion now exhumed by erosion.

LANCER CLAIMS
RESULTS OF INVESTIGATIONS

Activity under this prospecting phase of the 1991 Yukon Mining Incentives Program entailed a (1) field review of data provided in the 1980 Assessment Report #090577 on the former Nokluit claims prepared under the supervision of A. R. Archer and (2) thereupon, reassessment of these data following prospecting, ground radiometric scanning, laboratory analyses, petrological descriptions, and the determination of source-significance of numerous talus trains in the main cirque.

Geologic Terrane Reconnaissance

Prospecting traverses crisscrossed the Lancer group of 24 claims and confirmed the presence of a bimodal alkaline syenite intrusive plug with a southeasterly trending thermal metamorphic aureol expanding outward from skarn then to hornfels. This aureol has been developed prominently in both high level vesicular trachyte and in older phyllite and black shale.

The younger, layered tuffaceous syenite units commonly exhibit only weakly developed schistosity. Areas of dolomitic rocks adjacent to the west/northwest periphery of the syenite plug will require further study to determine their field relations.

Numerous narrow, parallel, steeply dipping fissure-filling siliceous pyritic zones lace the aureol in 100°-120°A trends.

Confirmatory Radiometric Scanning

Predicated on earlier reports of radiometric anomalies associated with REE concentrations in the cirque, a hand held Scintrex GIS integrating gamma ray spectrometer was used to assist in relocating sites of anomalous uranium/thorium concentrations. Field results which indicated that values for thorium were greater than those for uranium were later confirmed by analytical results.

Only very low level total radioactive response was obtained from large talus boulders below the syenite plug in which localized, but high, concentrations of macroscopic brown zircon were evident.

Prospecting Vein Outcrops (Photo 2)

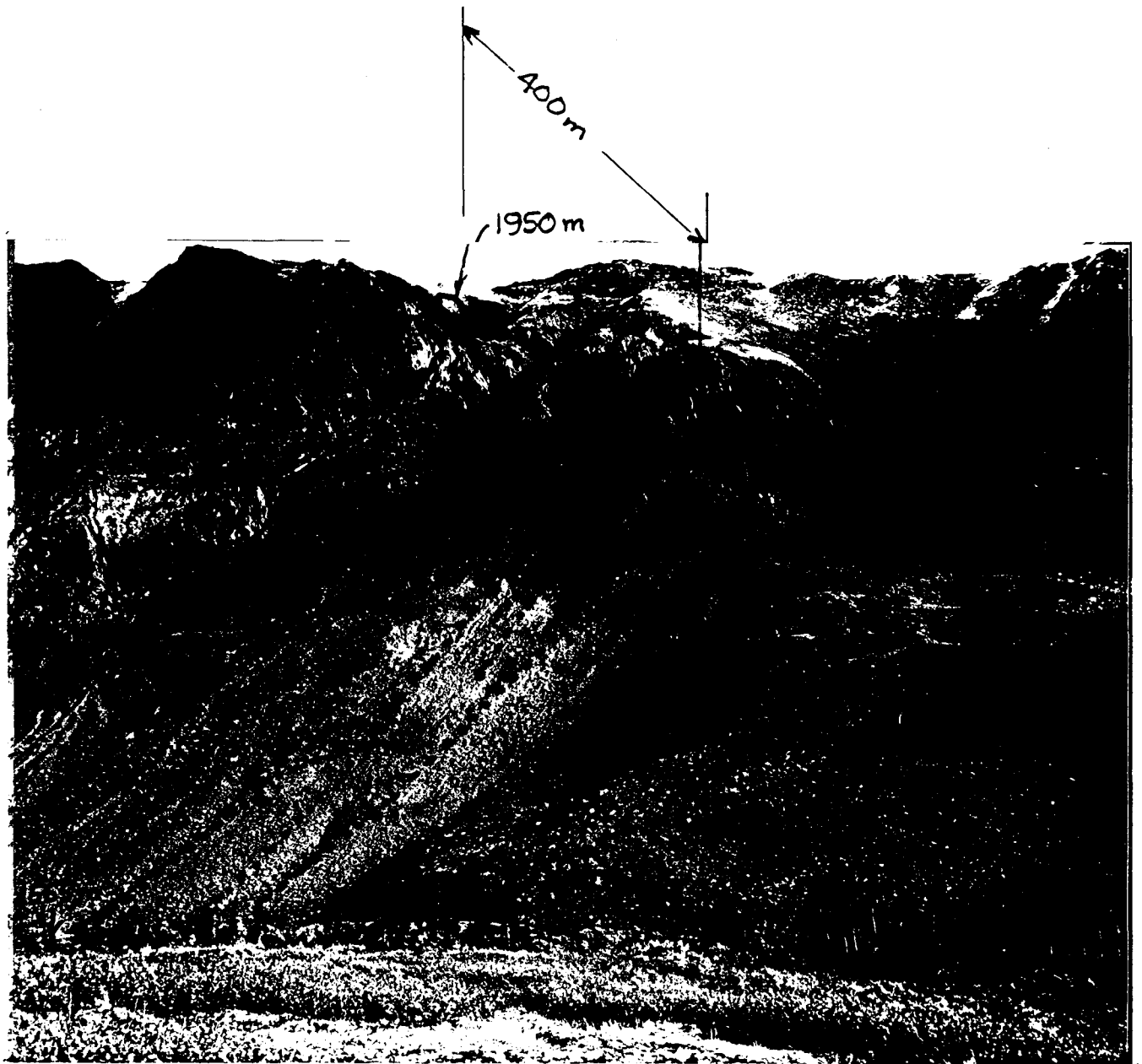
Prospecting along the headwall ridge of the main cirque relocated the 3-meter (10 feet) wide zone of anomalous radioactivity described as a dike in the 1980 report (Photo 3). The fine grained groundmass appeared to be unmetamorphosed. The hematitic feldspar, together with the fabric of closely spaced, narrow quartz and carbonate stringers and patches, suggested a late stage hydrothermal, possibly metasomatic, event rather than a true dike emplacement.

The several narrow, siliceous pyritic fissure filling veins along the ridge exhibited generally 120° A trends which matched closely that of the reported REE-bearing radioactive zone. Thus, further evidence was provided to indicate that the radioactive zone was most likely a vein emplaced in a similar fissure zone.

Solo prospecting northwesterly following the outcrop of the vein from the ridge was restricted by the very steep slopes leading down into the cirque. Accordingly, attention was redirected to the examination of several radioactive REE-bearing bedrock areas reported to outcrop at the head of talus slides some 240 meters (800 feet) lower altitude and an estimated 400 meters (1400 feet) slope distance to the northwest.

Location of the lower area was confirmed by the discovery of two adjacent vein outcrops (Photo 4) with lithology quite similar to the vein exposed at the ridge outcrop. Moreover, the 120° A strike and near-vertical inclination in both of these lower, 8-meter (25 feet) wide, in-line outcrops suggested a genetic commonality with outcrops of the same vein as on the ridge.

Skarn is confined to the wall rocks at all vein outcrops. This implies that the REE-bearing vein material is younger than the thermal metamorphic event and was emplaced from a magmatically differentiated solution arising from an underlying syenite intrusive which had probably overall cooled significantly by that time.



Looking south into main cirque covered by LANCER 5/6/7/8 claims. Solid red lines outline ridge (1950m altitude) and cliff (1710m) outcrop areas examined in 1991.

Dotted red lines indicate trend of distinct talus trains containing boulders of REE-bearing, radioactive vein material lithologically similar to that in vein outcrops examined in 1991.

Dashed red line predicts trend of bedrock vein on-line between ridge and lower outcrop sites as sources of vein material in talus.



PHOTO 3

Outcrop of 3-meter wide REE-bearing vein (1940m altitude) situated 50m down south flank of ridge above cirque.

Note white streaks, veinlets and patches of late metasomatic quartz and carbonate minerals. Site of sample #420727.



PHOTO 4

Looking 210° A across one of several lower cirque outcrops of 8-meter wide REE-bearing vein (1710m altitude). Site of sample #420725. Cream colored terrane behind vein is skarnized trachyte.

Interpretation of Talus Components

As seen in Photo 2, a group of talus trains, with a combined width of over 150 meters (500 feet), descend from cliffs and rock chutes, therewith provide a sampling of the various lithologic units within the cirque. All of the trains contain varying concentrations of phyllitic hornfels, trachytic hornfels and skarn, siliceous pyritic veins, and radioactive REE-bearing vein boulders (Photos 5 and 6).

REE-bearing vein material in the various talus trains displays remarkably similar lithology with the exception that fluorite is more commonly seen in the two westernmost talus trains. Thus, the higher fluorite content noted in the lower outcrop sites is clearly reflected in the talus.

The ubiquitous REE-bearing vein presence in all talus appears significant with regard to relating this to the location of probable bedrock sites as sources of the talus. On this evidence it would seem likely that the vein extends, more or less continuously, from the ridge outcrop down through the craggy terrain of the cirque to the lower outcrops.



PHOTO 5

Large (1m^3) boulders in talus train below cirque outcrops of REE-bearing vein.

The dun color and narrow white stringers of quartz and ankerite are characteristic.

Scintillometer is reading 2684 counts per second of total gamma radiation.



PHOTO 6

Dark purple fluorite stringers in REE-bearing vein material (upper right) in westernmost talus train.

Off-white boulder next to pack is typical skarnized trachyte.

Familiarization Sampling

Four rock samples were selected for analysis by Chemex Labs in Toronto to provide information which could confirm the reported presence of interesting values in rare earths and associated elements in vein material. Results were provided on Certificate of Analysis #A911456. One representative chip sample was taken from each of the ridge (#420727) and lower bedrock (#420725) outcrops; also, one from each of two adjacent, easterly, talus trains (#420726 and #420728) as grab chips from approximately 8-10 boulders.

Analyses were carried out for 14 REE elements, thorium-uranium, yttrium, and zirconium. These revealed important values in yttrium and zirconium as well as anomalously high values in lanthanum, cerium and neodymium. Thorium values consistently exceeded those of uranium.

A fifth sample was taken from a talus boulder beneath the north-facing buttress of the syenite plug. Visible in the fine grained melasyenite specimen was a 5cm (2-inch) wide band of compact, medium grained, mostly euhedral brown zircon. Although the very high (27.8%) zirconium content was anticipated, the high (#420730) value for yttrium was unexpected.

Petrographic Descriptions

Four rock samples were submitted for petrographic descriptions to Vancouver Petrographics in Fort Langely, British Columbia (Appendix A). Samples 1 to 3 were of vein material and the fourth was of the zircon-rich zone in the syenite boulder.

From the descriptions it is concluded that the early matrix of the vein material was principally high-sodic feldspar which was metasomatized upon the introduction of late stage quartz and carbonate bearing hydrothermal solutions. No discrete yttrium, zirconium or REE minerals were identified, although hematite particles could now contain these and the radioactive elements.

Based on the relationship of high yttrium and lower REE values in the syenite boulder sample, a 2-stage genesis is proposed for the "main" vein: that the zirconium-rich syenitic vein filling was followed by metasomatizing radioactive hydrothermal solutions rich in REE. Metasomatism may also have produced metamict phase of zircon by altering the original zircon which could have served as a carrier for yttrium in the first stage of vein genesis.

Conditions Favoring Project Development

1. Yukon and Federal Canadian mining development departments offer generous financial incentives programs for project development and for access road construction.
2. Very short review time is typical for permitting on proposals for realignment of the existing 9km (6 mile) 4x4 access road leading to the Lancer claims.
3. Total distance from the Lancer claims to the settlement of Ross River is 80km (50 miles) of which 71km (44 miles) is all-weather gravel road.
4. Ross River, with a population of about 350, provides all basic services including hotel, two cafes, stores, fuel, nursing station, and year-round helicopter charters. Thrice weekly scheduled air and bus-freight services are offered to Whitehorse.
5. Underground mining would have advantages of gravity feed of ore to a main haulage level. Adequate water in Ketz River for all mine/mill uses.
6. One ore milling possibility which could be considered is the leasing and modification(?) of the Canamax Ltd.'s gold mill under standby maintenance since 1990. The mill is located 18km (11 miles) by road from the Lancer claims.

Estimated Potential Resource

A conservative geologic projection indicates the potential resource of the vein may be at least 1,000,000 tonnes grading 0.14% Y_2O_3 , 0.98% ZrO_2 , and 1.17% total REE. This estimate is based on:

1. Vein continuity for at least 400 meters (1300 feet) horizontally between the lower cliff outcrops and 50 meters (160 feet) southeast of the ridge outcrop.
2. Vertical interval of the vein no less than 245 meters (800 feet) between the lower cliff outcrops and the ridge outcrops. A further 60 meters (200 feet) of depth inferred below the lower cliff outcrops.
3. Average width of the vein of 5.5 meters (18 feet) as the numerical average of a 3.0 meter (10 feet) width on the ridge and an 8.0 meter (25 feet) width at the lower cliff outcrops.
4. Dilution in mining to be negligible, owing to vertical attitude of the vein and its sharp contact with firm skarn and hornfels wallrocks.
5. Grade presumed to be no less than the numerical average of the four familiarization sample analyses (#420725-420728) which represented not only bedrock outcrops both on the ridge and on the lower cliff sites, but also of vein boulders in parallel talus trains issuing from slots in the cirque wall between these two similar bedrock outcrops.

CONCLUSIONS

Prospecting of the Lancer property during 1991 has shown that:

1. Yttrium and zirconium, as well as several rare earth elements, occur in anomalously high percentages in two widely separated vein-type outcrops which are lithologically and structurally quite similar.
2. The occurrence of concentrations of all of these elements in a single epigenetic vein-type setting is uncommon.
3. The high incidence of vein material occurring as boulders in all of the numerous parallel talus trains, including those that appear to have been derived from bedrock sites in line between the two widely separated vein-type outcrops, undoubtedly point to the presence of exposures of the through-going vein between these outcrops.
4. Field confirmation of the apparent continuity of the REE-bearing vein through the cirque would indicate a potential resource of at least one million tonnes grading 0.14% Y_2O_3 , 0.98% ZrO_2 , plus 1.17% total REE including 0.55% cerium, 0.36% lanthanum, and 0.13% neodymium.
5. The highly anomalous values of yttrium, zirconium, and hafnium detected in talus boulders proximal to the syenite intrusive offer a second exploration target.
6. Future reconnaissance rock geochemical sampling of the Lancer claims should focus on yttrium and zirconium not only as economic targets in themselves but also as the pathfinder elements for REE concentrations. Laboratory analyses for just these two elements are inexpensive and have rapid laboratory turnaround time.
7. Lateral and depth continuity of the elevated values of yttrium, zirconium, and REE in the vein-type setting can initially be determined from one or more shallow geologic core drill holes.

RECOMMENDATIONS

A follow-up program of "Target Evaluation" of the LANCER claims is recommended for the 1992 field season.

The conclusions reached from the results of the 1991 investigations indicate the need for detailed sampling of the vein-type deposit in conjunction with geological mapping and site-specific rock geochemical sampling of the 24-claim block.

The estimated CDN\$30,000 cost of a recommended 4-weeks program includes mobilization, salaries of 2 geologists, field supplies, laboratory analyses, and rentals of camp, EDM survey equipment, scintillometer, and transceiver radios.

A proposed budget for the 1992 Target Evaluation of the LANCER claims follows:

PROPOSED BUDGET 1992 PROGRAM

| | <u>Canadian \$</u> | |
|--|--------------------|---------|
| <u>Mobilization</u> | | |
| Fixed wing (Cessna) over-flight to verify sufficient snow melt prior to mobilization | \$ 250 | |
| Helicopter (206) based in Ross River 60km to north. Two round-trips @ \$750 each | 1,500 | |
| Pickup 4x4 Whitehorse to Lancer claims round-trip; camp resupply and shipment of rock samples from Ross River 2000km @ 38.5¢/km (Yukon gov't rate) | 770 | |
| Air fare for one geologist round-trip Vancouver-Whitehorse and accomodations 2 nights Whitehorse | <u>850</u> | |
| | | 3,370 |
| <u>Rentals</u> | | |
| Camp | | |
| Tents, kitchen, single sideband radio, rifle | 700 | |
| Equipment | | |
| Electronic distance measuring (EDM) survey equipment | 600 | |
| Transceiver field radios (2) | 350 | |
| Scintillometer | 400 | |
| Ultraviolet mineralite | 250 | |
| JKS-10 Sampler core drill | <u>600</u> | |
| | | 2,900 |
| Page total | | (6,270) |

PROPOSED 1992 BUDGET (Cont'd.)

(Page total brought forward \$ 6,270)

Camp Supplies

| | |
|--|-------|
| Food, fuel, incidentals for 2 persons @ \$52/day/person (Yukon gov't rate) 30 days | 3,120 |
|--|-------|

Field Supplies

| | |
|---|-----|
| Sample bags, survey discs, flagging, hip chain filament, maps, photo film, note books, felt markers, ammo | 400 |
|---|-----|

Laboratory Analyses

| | | |
|---|--------------|--|
| Vein rock samples Y,Zr,REE 25 @ \$85 each | 2,125 | |
| Geochem rock samples Y,Zr 100 @ \$8.50 ea | 850 | |
| Petrographic reports 8 @ \$100 each | 800 | |
| Freight for samples to laboratories | 200 | |
| | <u>3,975</u> | |

Salaries (one month)

| | | |
|---|---------------|--|
| Senior geologist (J.S.Dodge, Yukon Registered Professional Engineer) | 9,000 | |
| Geologist | 5,000 | |
| | <u>14,000</u> | |

Overhead

| | | |
|--|------------------|--|
| Telephone, photo processing, report preparation, secretarial, xerox | 650 | |
| | <u>\$ 28,415</u> | |

| | | |
|-------------------------------------|--------------|--|
| <u>Contingency Allowance ca. 5%</u> | <u>1,585</u> | |
|-------------------------------------|--------------|--|

| | | |
|----------------------------------|-----------|----|
| TOTAL PROPOSED 1992 BUDGET . . . | \$ 30,000 | ** |
|----------------------------------|-----------|----|

** The estimated total cost of this Target Evaluation proposal will be eligible for 50% funding by the Yukon government under its Mining Incentives Program (see attached M.I.P. information packet).

STATEMENT OF QUALIFICATIONS

I, James S. Dodge, of 14 MacDonald Road, Whitehorse, Yukon, Canada submit the following information which establishes some of my qualifications bearing on the necessary level of competence required to carry out the field work and preparation of this preliminary report on the LANCER 1-24 mining claims in the Yukon.

Education

Missouri School of Mines, B.S. Mining Engineering 1941
Princeton University, Field Geology, 1940
Stanford University, M.S. Economic Geology 1951
Albert Ludwigs Universitaet (Germany), Economic Geology 1952

Experience

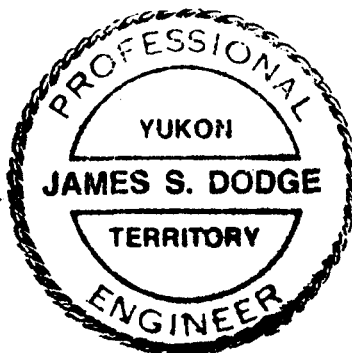
Active in mineral industry since 1941 (including U.S.Army engineers) in North and South America, Asia and Africa as prospector, company geologist, mining engineer, mine operator, and consultant in ferrous and non-ferrous metals and in industrial minerals. Among the many organizations which I have been associated as an employee and consultant:

Anaconda, Esso, Mitsui, USAEC, Ventures, DIAND, SCAP-Japan, Atlas, Glidden, Spartan/Nuspar, Hirst-Chichagof, Floyd Odlum, Yukon Barite and numerous small mining ventures.

Specifically applicable field experience includes (USAEC) examinations of numerous vein-type uranium and thorium deposits in western United States and central France. Briefly visited the bastnaesite REE mine at Mountain Pass, California. Over two years with Anaconda Mining Company in Butte, Montana as vein-type underground mine geologist.

Professional Affiliations

Registered Professional Engineer (No. 311) by Association of Professional Engineers of the Yukon Territory
Fellow of the Society of Economic Geologists
Senior Member of Society of Mining, Metallurgy and Exploration



James S. Dodge
James S. Dodge, P.Eng.

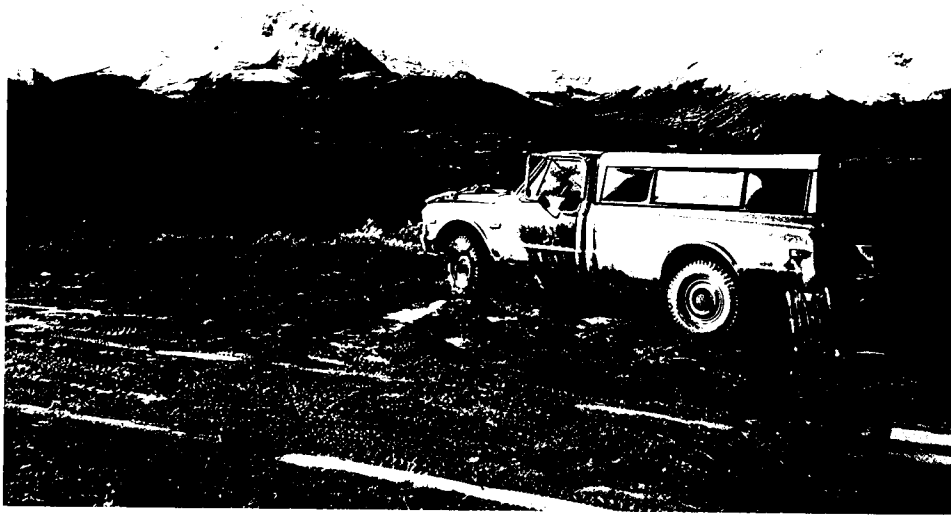


PHOTO 7

Lancer claims 1-24 cover both snow covered mountains in mid-distance. Headwaters of Ketzá River lies between them.

Access road for 4x4 vehicles leads to base of the mountain on the left.



Vancouver Petrographics Ltd.

JAMES VINNELL, Manager
JOHN G. PAYNE, Ph.D. Geologist
CRAIG LEITCH, Ph.D. Geologist
JEFF HARRIS, Ph.D. Geologist
KEN E. NORTHCOTE, Ph.D. Geologist

P.O. BOX 39
8080 GLOVER ROAD,
FORT LANGLEY, B.C.
VOX 1J0
PHONE (604) 888-1323
FAX. (604) 888-3642

Report for: James Dodge,
14 MacDonald Road,
WHITEHORSE,
Yukon, Y1A 4L2

Job 217

September 19th, 1991

SAMPLES:

4 samples of possible Zr and REE-bearing rock, for sectioning and petrographic examination.

The samples are numbered Dodge 1-91 through 4-91.

SUMMARY:

Sample 1 is a mafic-free syenite of intrusive aspect, composed essentially of fresh K-feldspar. It is intergranularly and veniformly pervaded by carbonate and quartz.

Sample 2 is a silica-carbonate rock of metasomatic origin, apparently representing the wholesale alteration of an intrusive protolith - possibly an albitite dyke.

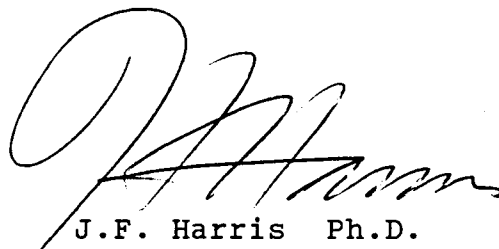
Sample 3 is a sodic porphyry of specialized composition, consisting of a groundmass of fresh, equigranular albite and abundant phenocrysts of aegiritic pyroxene. It is cut by veniform alteration zones rich in carbonate, fluorite, phlogopite and hematite.

Sample 4 is another specialized rock, probably representing a pegmatitic differentiate of the syenite complex. It is composed predominantly of zircon, as individual, subhedral grains abundantly scattered through a matrix of albite with minor intergrown quartz and carbonate. The zircon shows partial alteration to a dusty sub-opaque form (cyrtolite).

The source of rare earth elements in these samples is not immediately apparent from the petrographic study (except for the zircon, which is almost certainly a carrier in Sample 4). Rare earths may be concentrated in diffuse ferruginous products or hematite, and in possible traces of bastnaesite associated with carbonate.

More or less extensive checks by scanning electron microprobe analysis would be required to pursue this question.

Individual petrographic descriptions are attached.

A handwritten signature in cursive script, appearing to read 'J.F. Harris', is positioned above the printed name.

J.F. Harris Ph.D.

((604) 929-5867)

Estimated mode

| | |
|-------------|-------|
| K-feldspar | 60 |
| Plagioclase | 10 |
| Rutile | trace |
| Quartz | 10 |
| Carbonate | 16 |
| Limonite | 4 |

This sample is a syenite, composed predominantly of fresh, perthitic K-feldspar.

It shows a wide grain size range, from microgranular material on the scale 0.02 - 0.1mm, up to coarse, blocky aggregates of 1 - 2mm. Grain shapes are anhedral, and grain boundaries are commonly crenulate.

Minor plagioclase occurs intimately intergrown with the perthite.

The rock appears to be devoid of mafic silicates. Sparse traces of rutile and/or Fe-Ti oxides occur as fine-grained disseminations.

Carbonate and quartz are major accessories, probably representing late-stage deuteric or hydrothermal introductions. Carbonate constitutes a pervasive phase of intergranular pockets and networks throughout the feldspar aggregate, locally expanding to sizeable, ragged patches which show included remnants of feldspar, and apparently involve partial replacement of the syenite matrix.

The sectioned portion includes a pair of prominent veinlets (2 - 4mm thick) of sparry carbonate and clumpily intergrown, coarse quartz. The quartz extends laterally into the syenite as irregular, pockety networks. The rock is also cut by a few discrete, sub-parallel, hairline veinlets of quartz and carbonate.

The carbonate is unreactive to dilute HCl, and locally shows flecks and cleavage-controlled networks of limonitic staining - suggesting that it is a ferruginous variety (ankerite or siderite). Limonite impregnation is particularly strong in the two principal carbonate veinlets, which appear dark brown in the off-cut.

The dispersed carbonate often includes tiny euhedra and/or spheroids of a darker carbonate in a predominant, colourless, lower relief host, suggesting that two (or more) varieties of carbonate may be present. There is also a possibility that this material could be bastnaesite.

Estimated mode

| | |
|-------------|-------|
| Quartz | 53 |
| Carbonate | 36 |
| Sericite | 1 |
| Plagioclase | 8 |
| Limonite | 2 |
| Pyrite | trace |

This is a compact, structureless rock which appears, in thin section, to represent a product of intense metasomatic alteration (silicification/carbonatization) of an original intrusive rock.

It now consists essentially of a vari-granular intergrowth of quartz and carbonate.

Quartz is the dominant component, forming an aggregate of strained, anhedral grains, in the size range 0.1 - 2.0mm. Carbonate is developed rather evenly throughout this matrix as individual, tiny euhedra and aggregates thereof, forming irregular pockets and semi-continuous networks, intergranular to, and within, the quartz grains.

Tiny flecks of sericite are a minor associate of the carbonate.

The rock exhibits a rather well-developed relict texture of randomly oriented, slender laths. These clearly originated as plagioclase and, in part, survive as such. Others are partially and wholly pseudomorphed by carbonate, or are recognizable as ghosts, delineated by dusty limonite in the quartz matrix.

The remaining constituents are sub-opaque/limonitic material, as diffuse dust and small granules, mainly associated with the carbonate; and sparsely disseminated pyrite, as individual pyritohedral grains 50 - 200 microns in size.

This rock probably represents an advanced stage of the quartz-carbonate alteration process exemplified in Sample 1.

Estimated mode

| | |
|------------|-------|
| Albite | 53 |
| K-feldspar | trace |
| Aegirine | 28 |
| Phlogopite | 2 |
| Carbonate | 7 |
| Fluorite | 4 |
| Quartz | 1 |
| Hematite | 5 |

This is a texturally heterogenous rock (see etched off-cut), showing streaky, crypto-fragmental variations in grain size and mineral proportions.

In thin section the dominant assemblage is found to consist of a matrix of varigranular, stumpy, subhedral-anhedral plagioclase (grain size 0.03 - 0.8mm), studded with abundant, elongate, prismatic grains of euhedral pyroxene. These range from 0.1 - 2.0mm in length.

The plagioclase is strikingly fresh, and sharply twinned. It shows twinning extinction angles and refractive index indicative of albite.

The pyroxene is also mainly fresh. It is pleochroic from green to yellow-green, and has the almost straight extinction and elongate habit characteristic of aegirine. It commonly shows skeletal/fragmented form, with the albite matrix intergrown as inclusions, cleavage lamellae, and apparent fracture fillings.

Locally the pyroxene appears to be partially replaced by carbonate - typically showing limonite staining, and apparently a ferruginous variety, as in the other rocks of the suite.

The sectioned area includes linear zones of alteration, probably related to shearing. These contain high concentrations of carbonate, and include oriented flakes of phlogopite - possibly an alteration of the pyroxene.

A prominent accessory in these zones (intimately intergrown, as irregular pockets and networks, with the carbonate and remnant albite) is fluorite, showing typical colourless - purple zonation. Fluorite is also occasionally seen in the fresh albite-aegirine assemblage, but is rare.

The remaining accessory is hematite, of fine-grained acicular form, occurring as sporadic, irregular clumps and meshwork clusters. This is notably concentrated in the carbonate-phlogopite-fluorite alteration zones (partially pseudomorphing original pyroxene?), and is also abundant in an isolated patch near the centre of the sectioned area. Here it forms a meshwork of flakes within a matrix

Sample Dodge 91-3 cont.

of albite. Aegirine is virtually absent in this patch, apparently being replaced by the hematite. This area merges gradationally to the normal feldspar-pyroxene assemblage.

No obvious source of REE values is recognizable. If these exist in this material they are most likely associated with the hematite and/or diffuse limonitic phases.

Estimated mode

| | |
|-------------|-------|
| Zircon | 60 |
| Plagioclase | 22 |
| Sericite | trace |
| Quartz | 12 |
| Carbonate | 6 |
| Pyrite) | trace |
| Limonite) | |

This is a homogenous, equigranular rock of unusual composition.

The major constituent is zircon, as individual euhedral-subhedral crystals, 0.02 - 2.0mm in size, densely disseminated through a matrix of fresh, anhedral plagioclase with sporadically intergrown quartz and carbonate. The plagioclase seldom shows distinct twinning, but its low refractive index suggests that it is probably albite.

Some of the zircon grains are of composite/skeletal form, and incorporate small inclusions of the matrix components.

At each end of the sectioned area the abundance of zircon shows a marked fall-off, and the rock becomes predominantly an aggregate of feldspar, mildly flecked and dusted with sericite.

Opagues consist of very rare, tiny specks of pyrite, partially altered to limonite. The carbonate component also tends to show diffuse limonitization along cleavages and grain boundaries.

Many of the zircon crystals have a more or less dusty appearance, and sometimes show development of diffuse networks of sub-opaque to opaque material. Rarely, the original crystal structure is destroyed and converted to a fibrous/radiate form. This phenomenon represents partial alteration of the zircon to cyrtolite. Rare earth elements are typically concentrated in this sub-opaque breakdown product.

The origin of this rock is indeterminate from the petrography. It is most likely a late-magmatic/pegmatitic differentiate of the syenite, in the form of a dyke or vein.



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: DODGE, JAMES S.
14 MACDONALD RD.
WHITEHORSE, YUKON
Y1A 4L2

Page Number : 1
Total Pages : 1
Certificate Date: 24-SEP-93
Invoice No. : I9321054
P.O. Number :
Account : BKY

Project :
Comments:

CERTIFICATE OF ANALYSIS

A9321054

| SAMPLE | PREP | | Ce | NAA Dy | NAA Er | NAA Eu | NAA Gd | NAA Ho | NAA La | NAA Lu | NAA Nd | NAA Pr | NAA Sm | NAA Tb | NAA Th | NAA Tm | NAA U | NAA Yb | NAA | Nb | Y | Zr |
|---------|------|-----|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|------|-----|------|-----|
| | CODE | | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm |
| 578267H | 208 | 274 | 3984 | 70 | 20 | 13.00 | 150 | 17 | 3046 | 6.10 | 345 | 645 | 152.00 | 12.60 | 985 | < 1 | 129.0 | 37.40 | 1520 | 760 | 5760 | |
| 578268H | 208 | 274 | 2260 | 56 | 20 | 20.00 | < 50 | 11 | 1375.0 | 4.30 | 240 | 305 | 122.00 | 13.20 | 506 | < 1 | 77.0 | 31.90 | 2080 | 530 | 3850 | |
| 578269H | 208 | 274 | 4732 | 70 | 40 | 17.00 | 50 | 19 | 3041 | 7.00 | 370 | 420 | 223.0 | 14.80 | 1402 | < 1 | 95.0 | 47.40 | 5840 | 910 | 3040 | |

CERTIFICATION

Adriana Alexandre



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
 212 Brooksbank Ave., North Vancouver
 British Columbia, Canada V7J 2C1
 PHONE: 604-984-0221

To: DODGE, JAMES S.

14 MACDONALD RD.
 WHITEHORSE, YUKON
 Y1A 4L2

Page Number :1
 Total Pages :1
 Certificate Date: 05-SEP-91
 Invoice No. :I9119456
 P.O. Number :

Project :
 Comments: ATTN:JAMES DODGE

CERTIFICATE OF ANALYSIS

A9119456

| SAMPLE DESCRIPTION | PREP CODE | | Ce | NAA Dy | NAA Er | NAA Eu | NAA Gd | NAA Ho | NAA La | NAA Lu | NAA Nd | NAA Pr | NAA Sm | NAA Tb | NAA Th | NAA Tm | NAA U | NAA Yb | Y | Zr |
|--------------------|-----------|-----|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|------|--------|
| | | | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm |
| 420725H | 205 | 294 | 6506 | 93 | 40 | 23.50 | 350 | 18 | 5057 | 7.60 | 1285 | 675 | 230.2 | 17.50 | 981.2 | 44 | 140.0 | 48.50 | 1100 | 6990 |
| 420726H | 205 | 294 | 3914 | 75 | 40 | 14.50 | < 50 | 13 | 2376 | 5.70 | 1085 | 410 | 208.5 | 16.10 | 1403.5 | 8 | 83.0 | 39.70 | 780 | 3350 |
| 420727H | 205 | 294 | 5832 | 139 | 120 | 18.50 | 300 | 20 | 3844 | 11.30 | 1405 | 670 | 286.7 | 20.60 | 2735 | 4 | 214.0 | 56.50 | 1420 | 11200 |
| 420728H | 205 | 294 | 5650 | 114 | 40 | 19.50 | 200 | 24 | 2980 | 8.50 | 1455 | 470 | 257.0 | 21.60 | 1242.5 | 13 | 144.0 | 58.10 | 1120 | 7620 |
| 420730H | 205 | 294 | 2614 | 238 | 340 | 38.50 | 250 | 56 | 1279.0 | 66.50 | 505 | 220 | 157.10 | 33.80 | 2199 | 40 | 320.0 | 370.7 | 2200 | 278000 |

Cerium

Lanthanum

Neodymium

Thorium

Uranium

Yttrium

Zirconium

Alicia Alexandre
 CERTIFICATION:

REVIEW - STATUS
LANCER CLAIMS
RARE EARTHS - SPECIALTY METALS

105-F-08
WATSON LAKE MINING DISTRICT
YUKON

DODGEX LTD.
01 JUNE, 1993

Prepared By
James S. Dodge, P.Eng.



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P R E F A C E

The reader of this report on the LANCER claims is advised that, owing to inadequate financing, detailed analyses for all of the rare-earths and specialty-metals have not been carried out on all samples.

Also, whole rock analyses and additional petrologic/mineralogic studies are required, since the results from electron microscopic scanning of only one sample (1992) were inconclusive.

Integrated data from the above mentioned laboratory work are prerequisites for initiation of a bench-scale metallurgical investigation to determine efficacy of a chemical concentration process for beneficiation of ore (ref. CANMET letter 16 July, 1992).

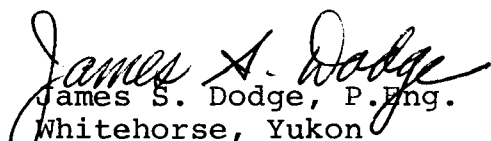
The LANCER specialty-metals and rare-earths resource is exposed as a wide and extensive epithermal vein in the Mississippian age syenite volcanics at the headwaters of the Ketzka River in south-central Yukon, Canada. The geological re-evaluation conducted under the Yukon government's Mining Incentives Program, together with trenching, assaying of large outcrop samples, and initial petrographic studies, has defined a major resource (2,500,000 tonnes) with high combined grades of yttrium, niobium, zirconium, and several of the light rare earth elements.

The lithologic host is a metasomatically altered syenite dike which intruded a thick succession of volcanic tuff and flows of syenite composition. A syenite intrusive plug nearby had metamorphosed the volcanics and underlying carbonate rocks producing a hornfels and skarn aureol in areas subsequently cut by the dike.

Earlier geological mapping (1978-79) led to the conclusion that specialty-metals and rare-earth mineralization was confined to isolated areas within the skarn. Re-evaluation by detailed geologic mapping, and representative sampling of outcrops and trenches by Dodgex Ltd., revealed that the calcite-quartz-fluorite bearing metasomatized dike, now properly termed a vein, is continuous for over 650 meters horizontally and up to 250 meters vertically. The high average combined grade/value of yttrium, niobium, zirconium, and the light rare earths (lanthanum, cerium, neodymium) has proven, with few exceptions, to be relatively uniform throughout the outcrops of the vein. The minerals containing these specialty-metals and rare-earths are very fine grained, and additional electron microscopic scanning will be required to identify all the host minerals for these elements.

There appears to be little expectation that significant metal recoveries can be obtained through physical separation techniques. However, a laboratory beneficiation process, which obtained high recoveries of these same elements by simple chemical methods from fine grained syenitic host rocks at an Australian deposit, holds considerable promise for the successful, cost-effective, production of chemical concentrates from the LANCER deposit.

Development of a second mineralized vein is planned on this easily accessible and promising resource property of specialty-metals and rare-earths both of which have a projected strong annual growth markets for applications in engineering ceramics, phosphors, superconductors, electronics, glass, optical devices, hard-wearing materials, and alloys.


James S. Dodge, P.Eng.
Whitehorse, Yukon
01 June, 1993

INTRODUCTION

James S. Dodge chose the search for rare-earth elements (REE) in the Yukon as a major emphasis for prospecting under the 1991 Yukon Mining Incentives Program. This decision followed a detailed library search of the geologic literature (winter 1990-91) on peralkalic rock hosts for rare-earth deposits, and a useful brief field examination of the bastnaesite (REE) mine of MolyCorp at Mountain Pass, California.

Thereupon, Dodge's review of the 1980 assessment report on the former NOKLUIT claims, prepared under the supervision of A. R. Archer, suggested that a careful field assessment of the area was warranted on the basis of the level of REE values previously obtained at several sites, and because of the current high degree of world-wide interest in, and anticipated future growth for, rare-earth elements, especially for yttrium.

Previous work had identified sites of anomalously high radioactivity with associated promising REE values, albeit in relatively small, isolated bedrock and talus sources. Several geologic notations by earlier workers led Dodge to question the skarn hosted nature of the REE mineralization.

Noting that the area was open for staking and, moreover, that a road for 4x4 vehicles would provide limited but important access to the property once the area was free of late-melting snow, the staking of the LANCER 1-8 claims was undertaken on 30 May, 1991 using a chartered helicopter based at the settlement of Ross River some 60 km to the north.

PROPERTY AND LOCATION

The contiguous group of 8 LANCER mining claims are recorded in the Watson Lake (Yukon) Mining District recorder's office as follows:

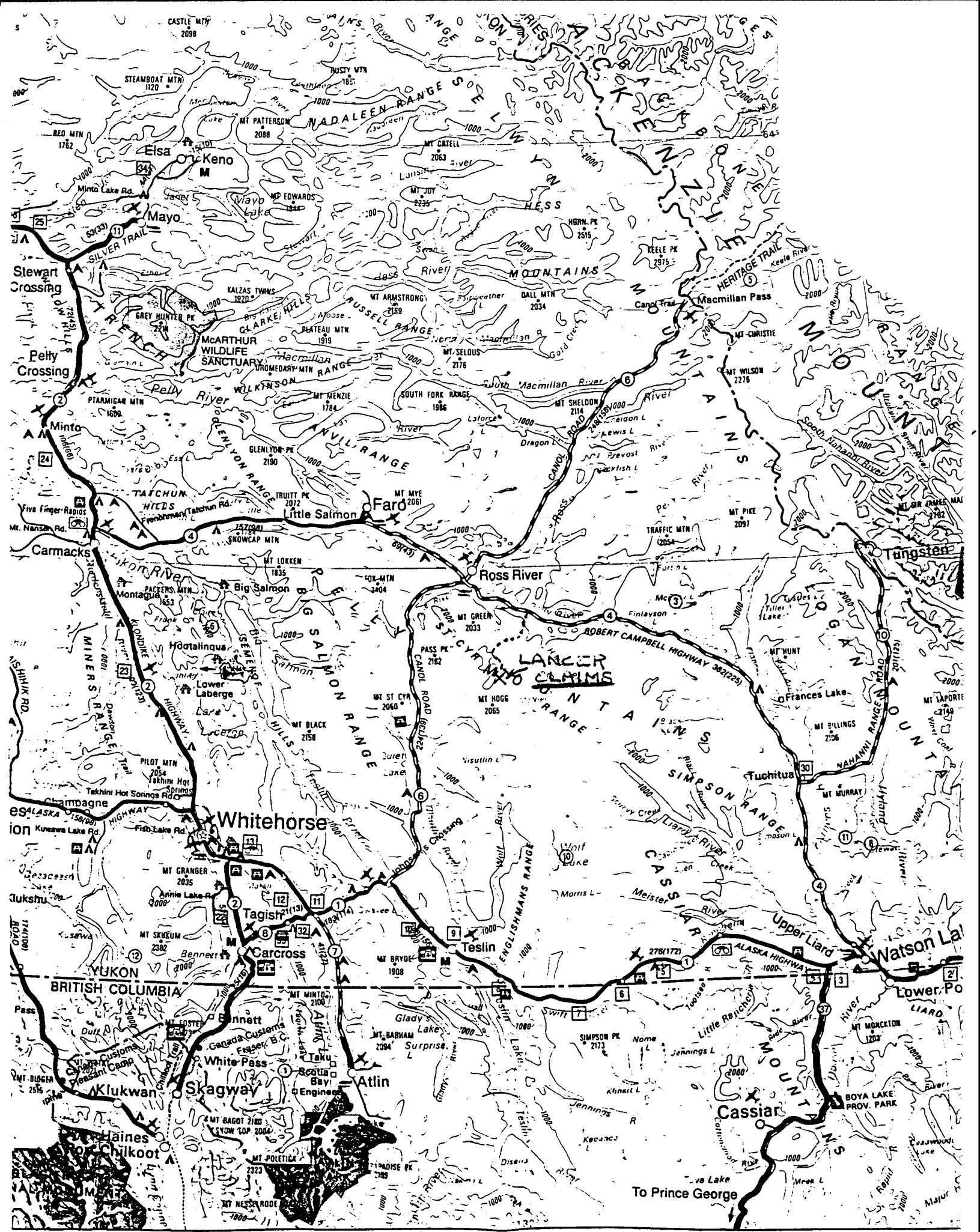
| <u>Name</u> | <u>Grant Numbers</u> | <u>Date of Record/Expiry</u> |
|-------------|----------------------|------------------------------|
| LANCER 1-8 | YB33962-YB33969 | 05 June, 1991 / 1994 |

Ownership of all the claims is held by DODGEX Ltd., a private registered Yukon corporation co-owned by James S. and Elizabeth K. Dodge of Whitehorse, Yukon.

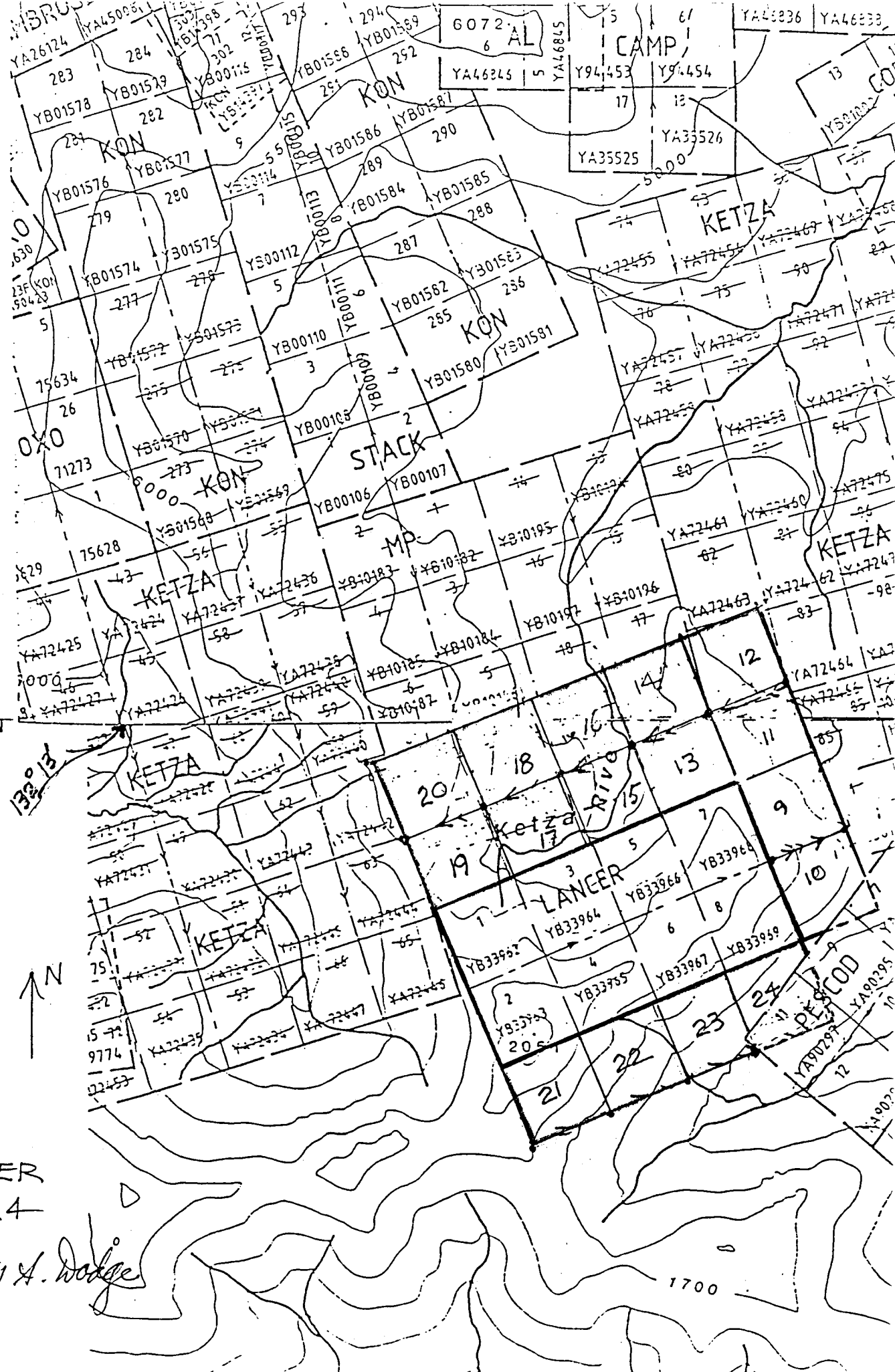
The claims are situated at approximately 61° 29' north latitude and 132° 11' west longitude on NTS Map Sheets 105-F-08 and 105-F-09 near the headwaters of the Ketz River in the Pelly Mountains of south-central Yukon.

Altitudes on the claims range from 1500 meters along the Ketz River to 2050 meters along the headwall ridge of a composite cirque.

A 10 kilometer 4x4 vehicle road connects the eastern boundary of the claims to the all-weather Ketz Mine road at a point 30.5 kilometers southeast of the turnoff on the Campbell Highway. (Maps I and II)



60 km



105-F-09

105-F-08

61° 30'

N

LANCER
9-24

James A. Dodge

6072
6 AL

CAMP

KON

KETZA

STACK

MP

LANCER

KETZA

PESCOD

1700

LANCER CLAIMS
RESULTS OF INVESTIGATIONS

Activity under the prospecting phase of the 1991 Yukon Mining Incentives Program on the LANCER claims entailed a (1) field review of data provided in the 1980 Assessment Report #090577 on the former Nokluit claims prepared under the supervision of A. R. Archer, and (2) thereupon, re-evaluation of these data following prospecting, ground radiometric scanning, laboratory analyses, petrographic descriptions, and the determination of source-significance of the numerous talus trains in the main cirque.

Geologic Terrane Reconnaissance

Prospecting traverses crisscrossed the LANCER group of 8 claims and confirmed the presence of a bimodal alkaline syenite intrusive plug with a southeasterly trending thermal metamorphic aureol expanding outward from skarn then to hornfels. This aureol has been developed in both high level vesicular trachyte and in older phyllite and black shale.

The younger, layered tuffaceous syenite units commonly exhibit only weakly developed schistosity. Areas of dolomitic rocks adjacent to the west/northwest periphery of the syenite plug will require further study to determine their field relations.

Numerous narrow, parallel, steeply dipping fissure-filling siliceous pyritic zones lace the aureol in 100°-120°A trends.

Confirmatory Radiometric Scanning

Predicated on earlier reports of radiometric anomalies associated with REE concentrations in the cirque, a hand held Scintrex GIS integrating gamma ray spectrometer was used to assist in relocating sites of anomalous thorium/uranium concentrations. Field results which indicated that values for thorium were greater than those for uranium were later confirmed by analytical results.

Only verylow-level radioactive response was obtained from large talus boulders below the syenite plug in which localized, but high, concentrations of macroscopic brown zircon were evident.

Prospecting Vein Outcrops (Photo 2)

Prospecting along the headwall ridge of the main cirque relocated the 3.5-meter (11.5 feet) wide zone of anomalous radioactivity described as a dike in the 1980 report of assessment work (Photo 3). The fine grained groundmass appeared to be unmetamorphosed. The hematitic feldspar, together with the fabric of closely spaced, narrow quartz and carbonate stringers and patches, suggested a late stage epithermal vein; possibly a metasomatized syenite dike.

The several narrow, siliceous pyritic fissure filling veins along the ridge exhibited generally 120° trends which matched closely that of the reported REE-bearing radioactive zone. Thus, further evidence was provided to indicate that the radioactive zone was most likely a vein emplaced in a parallel fissure zone.

Solo prospecting northwesterly following the outcrop of the vein from the ridge was restricted by the very steep slopes leading down into the cirque. Accordingly, attention was redirected to the examination of several radioactive REE-bearing bedrock areas reported to outcrop at the head of the talus slides some 245 meters (800 feet) lower altitude and an estimated 400 meters (1300 feet) slope distance to the northwest.

Location of the lower area was confirmed in 1991 by the discovery of two outcrops (Photo 4) of a wide vein with lithology quite similar to the vein exposed at the ridge outcrop. Moreover, the 120° strike and near-vertical inclination in both of these lower, 8-meter (25 feet) wide, in-line outcrops suggested a genetic commonality with outcrops of the same vein as on the ridge.

Detailed prospecting in 1993 located a 325-meter (1070 feet) long, well-defined, southeasterly extension of the 'main' vein which is partially covered by talus near the earlier 'ridge' outcrop area. Width of the vein averages 3.5 meters (11.5 feet) with an apparent steep westerly dip. Purple fluorite accompanies the swarm of quartz/calcite stringers which generally parallel the strike of the vein (Photo 9). The radiometrically anomalous readings matched closely those from the vein where outcrop samples on the ridge and in the cirque carried high values in specialty-metals and rare-earth.

Interpretation of Talus Components

As seen in Photo 2, a group of talus trains, with a combined width of over 150 meters (500 feet), descend from cliffs and rock chutes, therewith providing a sampling of the various lithologic units within the cirque. All of the trains contain varying concentrations of phyllitic hornfels, trachytic hornfels and skarn, siliceous pyritic veins, and REE-bearing vein boulders (Photos 5 and 6).

REE-bearing vein material in the various talus trains displays remarkably similar lithology with the exception that fluorite is more commonly seen in the two westernmost talus trains. Thus, the higher fluorite content noted in the lower outcrop sites is clearly reflected in the talus.

The ubiquitous REE-bearing vein presence in all talus appears significant with regard to relating this to the location of probable bedrock sites as sources of the talus. On this evidence it would seem likely that the vein extends, more or less continuously, from the 'ridge' outcrop down through the craggy terrain of the cirque to the lower outcrops.

Plans are made in 1993 for a roped descent through the cirque to sample vein outcrops.



LANCER CLAIMS

Claim posts are standing on 3.5-meter wide,
northwesterly trending vein which carries
high values in yttrium+niobium+zirconium+
light rare earth elements

Rounded knob in mid-distance to the west is a
centrally situated mela-syenite intrusive plug

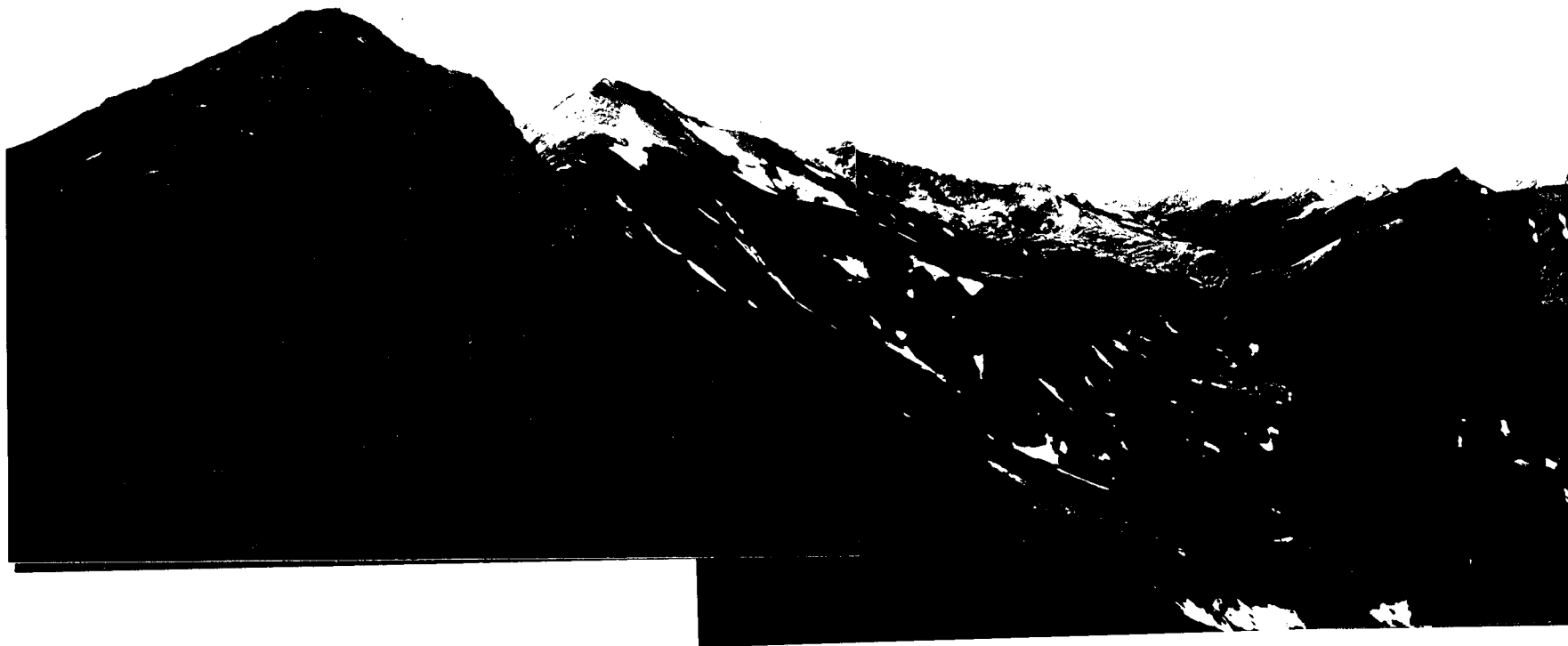
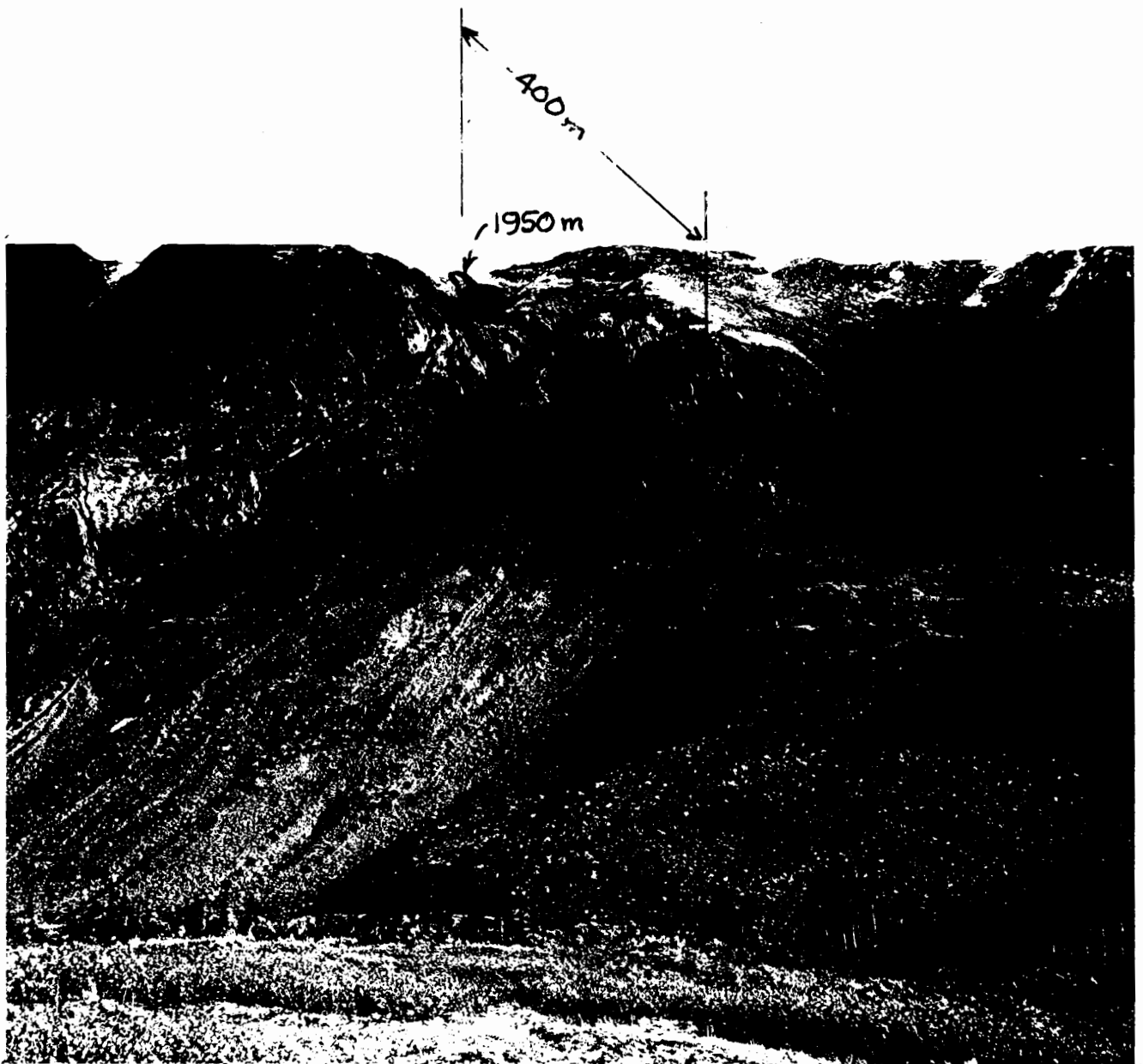


PHOTO 1

Overview of Lancer claims looking 240° A into the headwaters valley of the Ketzka River which flows to the lower right. Dark reddish brown knob in right center is the intrusive syenite plug.

Left foreground cliff and partially concealed ridge leading to snow-patchy peak comprise skarn and hornfels as part of the thermal metamorphic aureole generated in a southeasterly direction from that part of the syenite intrusion now exhumed by erosion.



Looking south into main cirque covered by LANCER 5/6/7/8 claims. Solid red lines outline ridge (1950m altitude) and cliff (1710m) outcrop areas examined in 1991.

Dotted red lines indicate trend of distinct talus trains containing boulders of REE-bearing, radioactive vein material lithologically similar to that in vein outcrops examined in 1991.

Dashed red line predicts trend of bedrock vein on-line between ridge and lower outcrop sites as sources of vein material in talus.



PHOTO 3

Outcrop of 3-meter wide REE-bearing vein (1940m altitude) situated 50m down south flank of ridge above cirque.

Note white streaks, veinlets and patches of late metasomatic quartz and carbonate minerals. Site of sample #420727.



PHOTO 4

Looking 210° A across one of several lower cirque outcrops of 8-meter wide REE-bearing vein (1710m altitude). Site of sample #420725. Cream colored terrane behind vein is skarnized trachyte.



PHOTO 5

Large ($1m^3$) boulders in talus train below cirque outcrops of REE-bearing vein.

The dun color and narrow white stringers of quartz and ankerite are characteristic.

Scintillometer is reading 2684 counts per second of total gamma radiation.



PHOTO 6

Dark purple fluorite stringers in REE-bearing vein material (upper right) in westernmost talus train.

Off-white boulder next to pack is typical skarnized trachyte.

Familiarization Sampling

Four rock samples were selected in 1991 for analysis by Chemex Labs in North Vancouver and Toronto to provide information which could confirm the reported presence of interesting grades in rare earths and associated elements in vein material. Results were provided on Certificate of Analysis #911456. One representative chip sample was taken from each of the ridge (#420727) and lower bedrock (#420725) cliff outcrops; also, one from each of the two adjacent, easterly talus trains (#420726 and #420728) as grab chips from approximately 10 boulders.

Analyses were carried out for 14 REE plus thorium and uranium, plus yttrium and zirconium. These revealed important values in yttrium and zirconium as well as anomalously high values in cerium, lanthanum, and neodymium. Thorium values consistently exceeded those of uranium.

A fifth sample in 1991 was taken from a talus boulder beneath the north-facing buttress of the syenite plug. Visible in the fine grained, melasyenite specimen was a 5cm (2-inch) wide band of compact, medium grained, mostly euhedral brown zircon. Although the very high (27.8%) zirconium content was anticipated, the high (0.22%) yttrium grade was unexpected.

In 1992 four 15-kilogram representative rock samples from the newly discovered southeasterly extension of the 'main' vein were analyzed for yttrium, niobium, and zirconium (Chemex Certificate #A9221321). The average grade of each sample was slightly higher than the four samples taken in 1991 in the cirque. The additional cost of analyzing these samples for the rare earth elements, as well as for tantalum, scandium, hafnium, and gallium, would have exceeded the available prospecting budget.

A second radioactive, epithermal fluorite-bearing vein, approximately 2-meters (6.5 feet) wide, was located outcropping on the ridge south of the syenite plug and approximately 300 meters (1000 feet) west of the 'main' vein. This showing may be a mineralized structure continuous between sites 'S' and 'M' in the earlier reports. Blizzard conditions and snow cover in mid-September precluded prospecting and properly sampling the lateral extensions of this outcrop.



PHOTO 7

Access road for 4x4 vehicles leads to
base of mountain on the left covered
by LANCER 1-8 claims

Headwaters of Ketzka River lies between
the two snow covered mid-distant peaks
looking west





PHOTO 8

Outcrop of vein SE Extension Sample #420788
100 meters south of 'ridge' at skyline saddle



PHOTO 9

Outcrop of vein SE Extension Sample #420789
170 meters south of 'ridge' site

Petrographic Descriptions

In 1991 four rock samples were submitted for petrographic descriptions to Vancouver Petrographics in Fort Langley, British Columbia (Appendix). Samples 1 to 3 were of vein material and the fourth was of the zircon-rich zone in the syenite boulder near the plug.

From the descriptions it is concluded that the early matrix of the vein material was principally high-sodic feldspar which was metasomatized upon the introduction of late-stage quartz and carbonate bearing hydrothermal solutions. No discrete yttrium, zirconium or REE minerals were identified, although hematite particles could these as well as the radioactive elements.

In 1992 Vancouver Petrographics conducted further petrographic and electron microscopic scanning of one sample which had already been submitted in 1991 for petrographic description. The yttrium-bearing mineral was not identified - although it was not zircon - and further work is recommended on samples taken most handily from the outcrops of the new southeasterly vein extension.

Environmental Impact

Although sulfide-free mine/mill tailings will present no source of surficial acid generation, it will be prudent to undertake water samples from the headwaters of the Ketzka and McNeil Rivers to identify natural geochemical signatures around the unmined deposit on the LANCER claims. These data will provide a baseline for assessing any unanticipated environmental impacts during both mining and post-mining reclamation cleanup.

Minor thorium/uranium content of the tailings may dictate locating the concentrating mill near the deposit where tailings would be classified by hydrocyclones for use as underground backfill. Canadian/U.S. experience has shown that the addition of barium salts decontaminates radium and thorium in mill discharge effluents. Thus, negative environmental impacts associated with handling and storage of the low-level radioactive materials will be acceptably limited.

Demonstrated Resource

Only the so-called 'main' vein is considered in this evaluation of resources. A generalized geologic projection, based on well-exposed outcrops and uniform preliminary assay results, designates a demonstrated resource of over 2,500,000 tonnes grading:

| | | |
|-------|-----------|---------------|
| 0.15% | Y_2O_3 | (yttrium) |
| 0.66% | Nb_2O_5 | (niobium) |
| 1.11% | ZrO_2 | (zirconium) |
| 0.02% | HfO_2 | (hafnium) |
| 1.37% | REO | (rare-earths) |

Basis for this resource definition follows:

1. Vein continuity for 650 meters (2100 feet) horizontally between lower cliff outcrops in cirque and the southeasterly extension outcrops discovered in 1992.
2. Vertical interval of the vein no less than 245 meters (800 feet) between lower cliff outcrops in the cirque and the 'ridge'/vein extension outcrops.
3. Vein width of 5.6 meters (18 feet), calculated as the numerical average of a 3.5-meter (11.5 feet) width on the 'ridge'/vein extension outcrops, and the 8-meter (25 feet) width at the lower cirque outcrops.
4. Numerical average grade as assembled from the various assay certificates from Chemex Labs (Table I).

All Elements in Parts Per Million

| SAMPLE Number | Niobium (Nb) | Yttrium (Y) | Zirconium (Zr) | Hafnium (Hf) | Thorium (Th) | Uranium (U) | Cerium (Ce) | Lanthanum (La) | Neodymium (Nd) |
|------------------------------------|---|-------------------------------|-------------------|------------------|-----------------|----------------|---------------------------------|---|---|
| 420725 | 2390 ^(a) | 1100 | 6990 | 98 | 981 | 140 | 6506 | 5057 | 1285 |
| 420726 | 4260 | 780 | 3350 | 106 | 1404 | 83 | 3914 | 2376 | 1085 |
| 420727 | 5290 | 1420 | 11200 | 320 | 2735 | 214 | 5832 | 3844 | 1405 |
| 420728 | 4240 | 1120 | 7620 | 242 | 1243 | 144 | 5650 | 2980 | 1455 |
| 420787 | 4410 | 1310 | >10000 | n | n | n | n | n | n |
| 420788 | 4170 | 1300 | 9860 | n | n | n | n | n | n |
| 420789 | 5300 | 1030 | 9320 | n | n | n | n | n | n |
| 420790 | <u>4590</u> | <u>1100</u> | <u>7120</u> | <u>n</u> | <u>n</u> | <u>n</u> | <u>n</u> | <u>n</u> | <u>n</u> |
| | 32260/8 | 9160/8 | 65460/8 | 766/4 | 6363/4 | 581/4 | 21902/4 | 14257/4 | 5230/4 |
| Average | 4033 | 1145 | 8183 | 192 | 1591 | 145 | 5476 | 3564 | 1308 |
| Factor (element to oxide) | x1.43 | x1.27 | x1.35 | x1.18 | | | x1.23 | x1.17 | x1.17 |
| Average Grade (% wgt.) Oxide | 0.5767 | 0.1454 | 1.1050 | 0.0226 | | | 0.6735 | 0.4170 | 0.1530 |
| | Nb ₂ O ₅ (0.6590) ^(b) | Y ₂ O ₃ | ZrO ₂ | HfO ₂ | | | CeO ₂ ^(c) | La ₂ O ₃ ^(c) | Nd ₂ O ₃ ^(c) |

(a) Anomalously low

(b) Average of 7 samples after rejecting (a)

(c) Sum of LREO = 1.24%; other REO = 0.13%

n Not analysed

PRELIMINARY RESOURCE VALUATION - LANCER CLAIMS

| <u>Metal Oxides</u> | <u>%</u> | <u>Kg/t</u> | <u>US\$/kg</u> ^(a) | <u>Gross Value/t</u> | <u>Total</u> ^(b) <u>Resource</u> <u>(Tonnes)</u> |
|--------------------------|----------|-------------|-------------------------------|----------------------|---|
| Yttrium | 0.15 | 1.5 | 30.00 | 45.00 | 3,750 |
| Niobium | 0.66 | 6.6 | 7.60 | 50.16 | 16,500 |
| Zirconium ^(c) | 1.11 | 11.1 | 0.90 | 10.00 | 27,750 |
| Hafnium | 0.02 | 0.2 | 80.00 | 16.00 | 500 |
| Cerium | 0.67 | 6.7 | 21.00 | 140.70 | 16,750 |
| Lanthanum | 0.42 | 4.2 | 13.75 | 57.75 | 10,500 |
| Neodymium | 0.15 | 1.5 | 11.00 | 16.50 | 3,750 |
| | | | | US\$336.11 | (d) |

(a) Open market prices quoted by U.S. Bureau of Mines 1990-1992; ELEMENTS Concord Trading, September, 1992. Long term concentrate contracts for time/volume with price negotiated every 3 months.

(b) Demonstrated resource at 2,500,000 tonnes - 1992:

(c) As Zircon.

(d) Losses from dilution of ore grade in mining and through unrecovered values in mill concentrating may reduce this figure by up to 20%.

CONCLUSIONS

1. Preliminary LANCER resource valuation of gross in-place US\$840,000,000 is derived from the combined average grade/market-quotes of US\$336 per tonne for yttrium, niobium, zirconium, hafnium, and light rare earths in the 2,500,000-tonne demonstrated resource projected from well-exposed outcrops.
2. Geological reconnaissance of the claims indicates a reasonably high potential for the delineation of additional resources in other similar mineralized structures.
3. Existing vehicular accessibility to the property is of prime advantage in development of this resource. Other Canadian specialty-metal/rare-earth deposits (e.g. Strange Lake, Red Wine, Thor Lake) are sub-economic in part by being extremely disadvantaged from the very high costs to be borne in providing ground access and infrastructure.
4. Markets for these specialty-metals and rare-earths, especially for yttrium, are forecasted to demonstrate substantial growth during the next decade. Services of a specialized marketing consultant will contribute significantly to success of the project.
5. The development of a bench-scale, cost-efficient metallurgical process for production of chemical concentrates from LANCER appears optimistic, based on the generally uniform grade of outcrop samples and the success of laboratory tests on similar host rocks in Australia.
6. Thus, overall development of the LANCER deposit will best be undertaken in the following sequence:
 - a) Definitive mineralogical investigation of outcrop samples to identify the host minerals for the above elements together with their distribution and grain size.
 - b) Undertake bench-scale laboratory ore-beneficiation tests on large outcrop samples. Selection of the laboratory for this work is crucial to ensure cost-effective results. The successful work accomplished on the syenite-similar Brockman Project in Western Australia by Mr. Philip Gray, UK consulting metallurgist and the Australian Metallurgical and Mineral Testing Consultants' laboratory serves to recommend use of their expertise in the bench-scale process metallurgical testing.
 - c) Successful results from laboratory tests will lead to development of ore reserve delineation by core drilling and, subsequently, to bulk sampling for a pilot concentrating facility.

STATEMENT OF QUALIFICATIONS

I, James S. Dodge, of 14 MacDonald Road, Whitehorse, Yukon, Canada submit the following information which establishes some of my qualifications bearing on the necessary level of competence required to carry out the field work and preparation of this preliminary report on the LANCER 1-8 mining claims in the Yukon.

Education

Missouri School of Mines, B.S. Mining Engineering 1941
Princeton University, Field Geology, 1940
Stanford University, M.S. Economic Geology 1951
Albert Ludwigs Universitaet (Germany), Economic Geology 1952

Experience

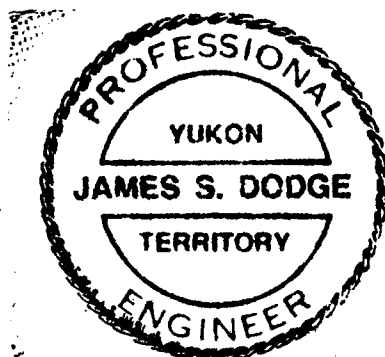
Active in mineral industry since 1941 (including U.S. Army engineers) in North and South America, Asia and Africa as prospector, company geologist, mining engineer, mine operator, and consultant in ferrous and non-ferrous metals and in industrial minerals. Among the many organizations which I have been associated as an employee and consultant:

Anaconda, Esso, Mitsui, USAEC, Ventures, DIAND, SCAP-Japan, Atlas, Glidden, Spartan/Nuspar, Hirst-Chichagof, Floyd Odlum, Yukon Barite and numerous small mining ventures.

Specifically applicable field experience includes (USAEC) examinations of numerous vein-type uranium and thorium deposits in western United States and central France. Briefly visited the bastnaesite REE mine at Mountain Pass, California. Over two years with Anaconda Mining Company in Butte, Montana as vein-type underground mine geologist.

Professional Affiliations

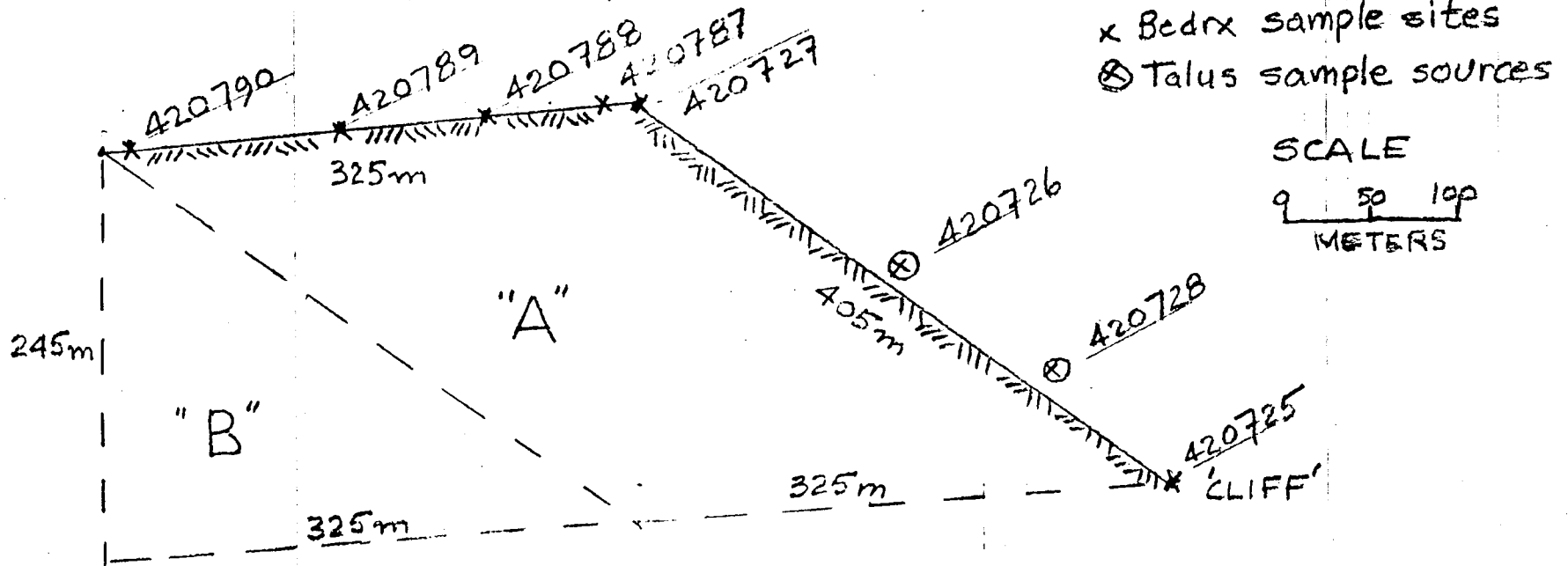
Registered Professional Engineer (No. 311) by Association of Professional Engineers of the Yukon Territory
Fellow of the Society of Economic Geologists
Senior Member of Society of Mining, Metallurgy and Exploration



James S. Dodge
James S. Dodge, P. Eng.

LANCER VEIN
LONGITUDINAL SECTION

'RIDGE' (LOOKING SW)



x Bedrock sample sites
⊗ Talus sample sources

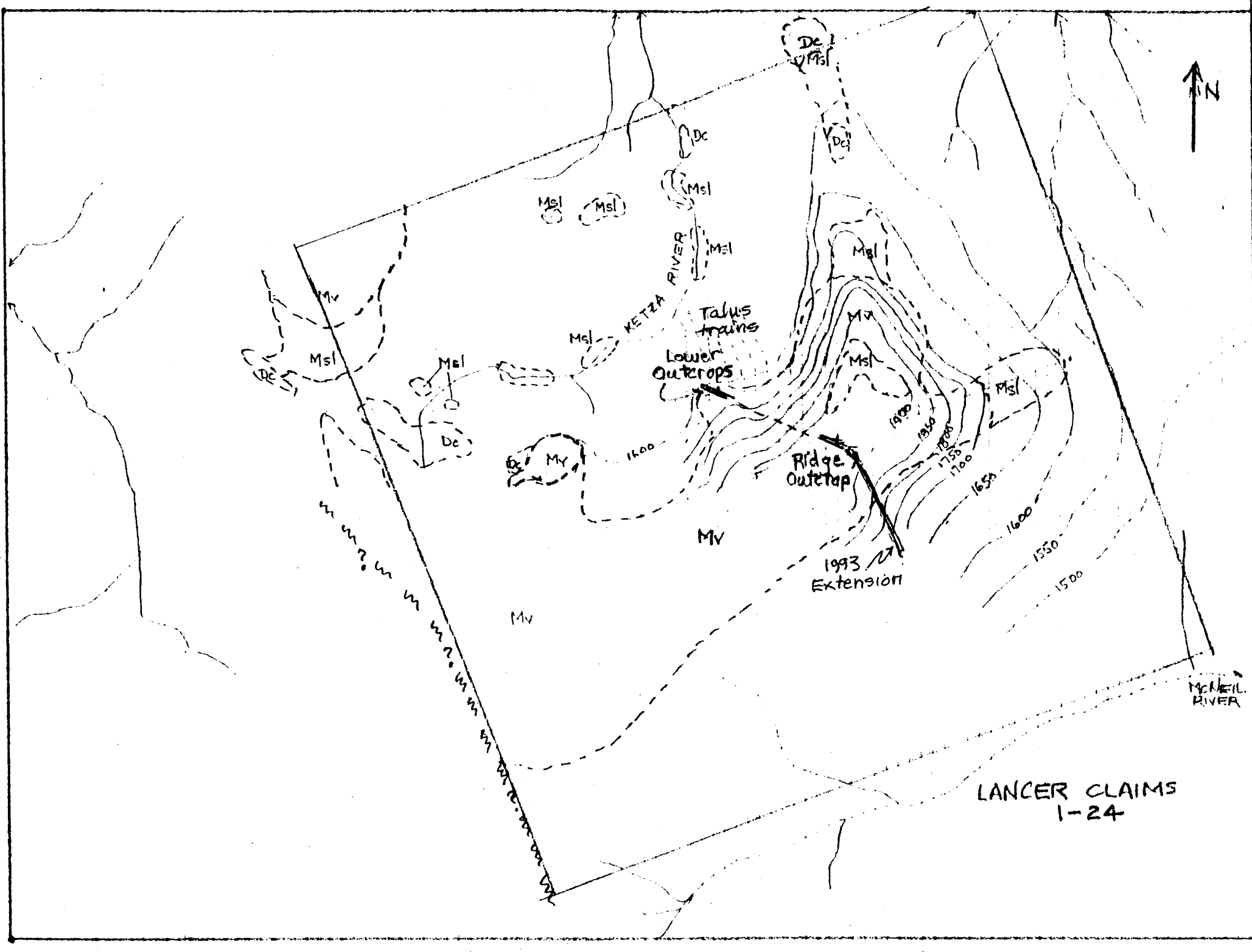
SCALE
0 50 100
METERS

BLOCK 'A' $405\text{m} \times 325\text{m} \times 5.6\text{m} \times 2.65\text{sp.gr.} = 1,953,315\text{t}$

BLOCK 'B' $\frac{245\text{m} \times 325\text{m}}{2} \times 5.6\text{m} \times 2.65\text{sp.gr.} = \underline{590,818}$

TOTAL DEMONSTRATED RESOURCE: 2,544,133t

Sketch by J. Dodge 1953



LANCER CLAIMS
1-24

KETZA RIVER AREA
YUKON, CANADA

LEGEND

- MISSISSIPPIAN
- [My] SYENITE
 - [Mv] Thin bedded syenitic flows
 - [Msl] Black/brown phyllite/shale/slate
- MIDDLE DEVONIAN
- [D] Silty dolomite

CONTOURS 50 METERS

SCALE: 1:10,000

100 0 100 200 300 400 METERS

NTS 105-F-08/09

NOTE: Prospecting Field Sketch, Summer 1991 J.S. Dodge
In part after Assessment Report #090577



Vancouver Petrographics Ltd.

JAMES VINNELL, Manager

JOHN G. PAYNE, Ph.D. Geologist

CRAIG LEITCH, Ph.D. Geologist

JEFF HARRIS, Ph.D. Geologist

KEN E. NORTHCOTE, Ph.D. Geologist

P.O. BOX 39

8080 GLOVER ROAD,

FORT LANGLEY, B.C.

VOX 1J0

PHONE (604) 888-1323

FAX. (604) 888-3642

Report for: James Dodge,
14 MacDonald Road,
WHITEHORSE,
Yukon, Y1A 4L2

Job 217

September 19th, 1991

SAMPLES:

4 samples of possible Zr and REE-bearing rock, for sectioning and petrographic examination.

The samples are numbered Dodge 1-91 through 4-91.

SUMMARY:

Sample 1 is a mafic-free syenite of intrusive aspect, composed essentially of fresh K-feldspar. It is intergranularly and veniformly pervaded by carbonate and quartz.

Sample 2 is a silica-carbonate rock of metasomatic origin, apparently representing the wholesale alteration of an intrusive protolith - possibly an albitite dyke.

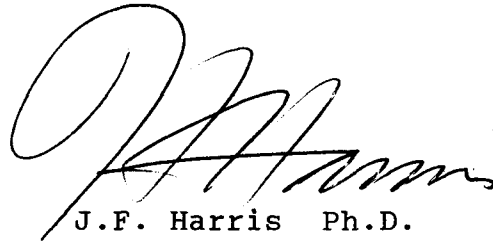
Sample 3 is a sodic porphyry of specialized composition, consisting of a groundmass of fresh, equigranular albite and abundant phenocrysts of aegiritic pyroxene. It is cut by veniform alteration zones rich in carbonate, fluorite, phlogopite and hematite.

Sample 4 is another specialized rock, probably representing a pegmatitic differentiate of the syenite complex. It is composed predominantly of zircon, as individual, subhedral grains abundantly scattered through a matrix of albite with minor intergrown quartz and carbonate. The zircon shows partial alteration to a dusty sub-opaque form (cyrtolite).

The source of rare earth elements in these samples is not immediately apparent from the petrographic study (except for the zircon, which is almost certainly a carrier in Sample 4). Rare earths may be concentrated in diffuse ferruginous products or hematite, and in possible traces of bastnaesite associated with carbonate.

More or less extensive checks by scanning electron microprobe analysis would be required to pursue this question.

Individual petrographic descriptions are attached.

A handwritten signature in cursive script, appearing to read 'J.F. Harris', is positioned above the printed name.

J.F. Harris Ph.D.

((604) 929-5867)

SAMPLE: DODGE 91-1

SYENITE

Estimated mode

| | |
|-------------|-------|
| K-feldspar | 60 |
| Plagioclase | 10 |
| Rutile | trace |
| Quartz | 10 |
| Carbonate | 16 |
| Limonite | 4 |

This sample is a syenite, composed predominantly of fresh, perthitic K-feldspar.

It shows a wide grain size range, from microgranular material on the scale 0.02 - 0.1mm, up to coarse, blocky aggregates of 1 - 2mm. Grain shapes are anhedral, and grain boundaries are commonly crenulate.

Minor plagioclase occurs intimately intergrown with the perthite.

The rock appears to be devoid of mafic silicates. Sparse traces of rutile and/or Fe-Ti oxides occur as fine-grained disseminations.

Carbonate and quartz are major accessories, probably representing late-stage deuteric or hydrothermal introductions. Carbonate constitutes a pervasive phase of intergranular pockets and networks throughout the feldspar aggregate, locally expanding to sizeable, ragged patches which show included remnants of feldspar, and apparently involve partial replacement of the syenite matrix.

The sectioned portion includes a pair of prominent veinlets (2 - 4mm thick) of sparry carbonate and clumpily intergrown, coarse quartz. The quartz extends laterally into the syenite as irregular, pockety networks. The rock is also cut by a few discrete, sub-parallel, hairline veinlets of quartz and carbonate.

The carbonate is unreactive to dilute HCl, and locally shows flecks and cleavage-controlled networks of limonitic staining - suggesting that it is a ferruginous variety (ankerite or siderite). Limonite impregnation is particularly strong in the two principal carbonate veinlets, which appear dark brown in the off-cut.

The dispersed carbonate often includes tiny euhedra and/or spheroids of a darker carbonate in a predominant, colourless, lower relief host, suggesting that two (or more) varieties of carbonate may be present. There is also a possibility that this material could be bastnaesite.

Estimated mode

| | |
|-------------|-------|
| Quartz | 53 |
| Carbonate | 36 |
| Sericite | 1 |
| Plagioclase | 8 |
| Limonite | 2 |
| Pyrite | trace |

This is a compact, structureless rock which appears, in thin section, to represent a product of intense metasomatic alteration (silicification/carbonatization) of an original intrusive rock.

It now consists essentially of a vari-granular intergrowth of quartz and carbonate.

Quartz is the dominant component, forming an aggregate of strained, anhedral grains, in the size range 0.1 - 2.0mm. Carbonate is developed rather evenly throughout this matrix as individual, tiny euhedra and aggregates thereof, forming irregular pockets and semi-continuous networks, intergranular to, and within, the quartz grains.

Tiny flecks of sericite are a minor associate of the carbonate.

The rock exhibits a rather well-developed relict texture of randomly oriented, slender laths. These clearly originated as plagioclase and, in part, survive as such. Others are partially and wholly pseudomorphed by carbonate, or are recognizable as ghosts, delineated by dusty limonite in the quartz matrix.

The remaining constituents are sub-opaque/limonitic material, as diffuse dust and small granules, mainly associated with the carbonate; and sparsely disseminated pyrite, as individual pyritohedral grains 50 - 200 microns in size.

This rock probably represents an advanced stage of the quartz-carbonate alteration process exemplified in Sample 1.

Estimated mode

| | |
|------------|-------|
| Albite | 53 |
| K-feldspar | trace |
| Aegirine | 28 |
| Phlogopite | 2 |
| Carbonate | 7 |
| Fluorite | 4 |
| Quartz | 1 |
| Hematite | 5 |

This is a texturally heterogenous rock (see etched off-cut), showing streaky, crypto-fragmental variations in grain size and mineral proportions.

In thin section the dominant assemblage is found to consist of a matrix of varigranular, stumpy, subhedral-anhedral plagioclase (grain size 0.03 - 0.8mm), studded with abundant, elongate, prismatic grains of euhedral pyroxene. These range from 0.1 - 2.0mm in length.

The plagioclase is strikingly fresh, and sharply twinned. It shows twinning extinction angles and refractive index indicative of albite.

The pyroxene is also mainly fresh. It is pleochroic from green to yellow-green, and has the almost straight extinction and elongate habit characteristic of aegirine. It commonly shows skeletal/fragmented form, with the albite matrix intergrown as inclusions, cleavage lamellae, and apparent fracture fillings.

Locally the pyroxene appears to be partially replaced by carbonate - typically showing limonite staining, and apparently a ferruginous variety, as in the other rocks of the suite.

The sectioned area includes linear zones of alteration, probably related to shearing. These contain high concentrations of carbonate, and include oriented flakes of phlogopite - possibly an alteration of the pyroxene.

A prominent accessory in these zones (intimately intergrown, as irregular pockets and networks, with the carbonate and remnant albite) is fluorite, showing typical colourless - purple zonation. Fluorite is also occasionally seen in the fresh albite-aegirine assemblage, but is rare.

The remaining accessory is hematite, of fine-grained acicular form, occurring as sporadic, irregular clumps and meshwork clusters. This is notably concentrated in the carbonate-phlogopite-fluorite alteration zones (partially pseudomorphing original pyroxene?), and is also abundant in an isolated patch near the centre of the sectioned area. Here it forms a meshwork of flakes within a matrix

Sample Dodge 91-3 cont.

of albite. Aegirine is virtually absent in this patch, apparently being replaced by the hematite. This area merges gradationally to the normal feldspar-pyroxene assemblage.

No obvious source of REE values is recognizable. If these exist in this material they are most likely associated with the hematite and/or diffuse limonitic phases.

Estimated mode

| | |
|-------------|-------|
| Zircon | 60 |
| Plagioclase | 22 |
| Sericite | trace |
| Quartz | 12 |
| Carbonate | 6 |
| Pyrite) | trace |
| Limonite) | |

This is a homogenous, equigranular rock of unusual composition.

The major constituent is zircon, as individual euhedral-subhedral crystals, 0.02 - 2.0mm in size, densely disseminated through a matrix of fresh, anhedral plagioclase with sporadically intergrown quartz and carbonate. The plagioclase seldom shows distinct twinning, but its low refractive index suggests that it is probably albite.

Some of the zircon grains are of composite/skeletal form, and incorporate small inclusions of the matrix components.

At each end of the sectioned area the abundance of zircon shows a marked fall-off, and the rock becomes predominantly an aggregate of feldspar, mildly flecked and dusted with sericite.

Opaques consist of very rare, tiny specks of pyrite, partially altered to limonite. The carbonate component also tends to show diffuse limonitization along cleavages and grain boundaries.

Many of the zircon crystals have a more or less dusty appearance, and sometimes show development of diffuse networks of sub-opaque to opaque material. Rarely, the original crystal structure is destroyed and converted to a fibrous/radiate form. This phenomenon represents partial alteration of the zircon to cyrtolite. Rare earth elements are typically concentrated in this sub-opaque breakdown product.

The origin of this rock is indeterminate from the petrography. It is most likely a late-magmatic/pegmatitic differentiate of the syenite, in the form of a dyke or vein.



Vancouver Petrographics Ltd.

JAMES VINNELL, Manager
 JOHN G. PAYNE, Ph.D. Geologist
 CRAIG LEITCH, Ph.D. Geologist
 JEFF HARRIS, Ph.D. Geologist
 KEN E. NORTHCOTE, Ph.D. Geologist

PO. BOX 39
 8080 GLOVER ROAD,
 FORT LANGLEY, B.C.
 VOX 1J0
 PHONE (604) 888-1323
 FAX. (604) 888-3642

Report for: James S. Dodge,
 14 MacDonal Rd.,
 Whitehorse, Yukon,
 Y1A 4L2

Job 50

August 28th, 1992

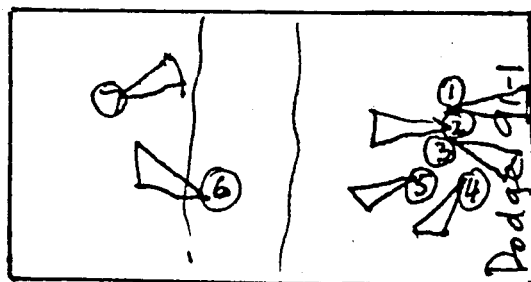
MINERALOGY OF Zr/REE-BEARING SYENITE

As requested, the polished thin section Dodge 92-1 (originally 91-1 in Report 217 of September 1991) was re-examined, with a view to obtaining additional information on the mineralogy and mode of occurrence of rare earths and related elements in this material.

An assay of the sample, of which the thin section represents a specific piece, gave the following results:

| Element | ppm |
|---------|-------|
| Zr | 11200 |
| Nb | 5390 |
| Ce | 5832 |
| La | 3844 |
| Nd | 1405 |
| Th | 2735 |
| Y | 1420 |

Several different areas exemplifying various optically unidentifiable minor phases were marked for SEM microanalysis. The following diagram shows their locations on the slide:



Descriptions of these areas, and results of the SEM work follow. Illustrative photomicrographs are provided.

Area 1 Photomicrograph 264-6: Scale 1cm = 85 microns.

Equant and atoll-shaped grains, 5 - 70 microns in size, of brown, translucent, high-relief mineral (circled on photo) in patch of carbonate.

SEM analysis yields peaks of Zr, Si and minor Fe. Indicated mineralogy is zircon, somewhat altered and ferruginous.

Area 2 Photomicrograph 264-7: Scale 1cm = 42 microns.

Irregular grains, 10 - 100 microns in size, of a weakly to moderately reflective phase (A), showing translucent brown colour and acicular prismatic form under high magnification; and non-reflective, brownish, translucent/sub-opaque material (B), both associated with pockets of carbonate in the K-spar aggregate.

SEM analysis yields peaks as follows:

A: Nb, Ti, Fe, Si. Mineralogy uncertain. Presumably a niobate-titanate of Fe etc. It does not fit with the optical properties/crystallography of the main groups of Nb-bearing minerals (e.g. pyrochlore, fergusonite, columbite, samarskite), nor has it quite the right indicated elemental composition for any of these.

B: Zr, Ca, Fe, Ce, La and Th (Al, Si). Indicated mineralogy is intimate, fine-grained intergrowth of altered zircon and unidentified REE and Th minerals in feldspar matrix. Some points within the circled area are Ce/La-rich, others are Th-rich.

Area 3: Photomicrograph 264-8: Scale 1cm = 85 microns.

Patches 25 - 250 microns in size of a sub-opaque material (A), and small clusters (20 - 60 microns) of a low - moderately reflective hematite-like phase (B). In fine-grained feldspar at contact with a patch of carbonate.

SEM analysis yields peaks as follows:

A: Zr and Si. Indicated mineralogy is zircon.

B. Ce, La and P - suggesting monazite. This does not fit the optical properties. An adjacent point gave peaks of Si Ca and Th - suggesting thorite. Location of a specific small grain in the SEM is often difficult, especially in intimate fine-grained intergrowths like this, and it seems likely that the oxide-like phase was not actually analyzed.

Areas 4 and 7: Photomicrographs 264-10 (reflected light), 264-11 (cross-polarized transmitted light. Scale 1cm = 85 microns.

Equant grains, 100 - 200 microns in size, of colourless, transparent, high relief, moderate to high birefringent mineral (circled on photos) in the K-spar aggregate or carbonate patches.

SEM gives peaks of Ce and La. Indicated mineralogy is bastnaesite. This is consistent with the optical properties.

Area 5:

Confirms the matrix composition as perthitic K-feldspar, with scattered, small (50 - 200 microns), irregular inclusions of quartz.

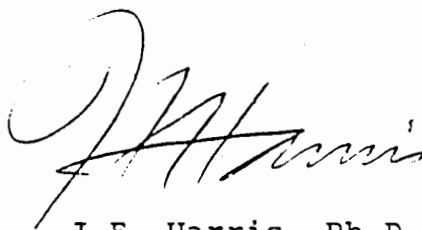
Area 6: Photomicrographs 264-12, 13. Plane-polarized and cross-polarized transmitted light. Scale 1cm = 170 microns.

The composition of the diffuse, patchy carbonate pervading the feldspar marginal to the discrete central carbonate veinlet is indicated as ankerite, Ca Fe (Mn) carbonate. The rare earth/Zr mineralization appears often to be associated with this component.

The composition of the central, limonite-stained veinlet is confirmed as Fe carbonate (siderite).

No peaks of Y or Nd were obtained in any of the areas analyzed, and the form of these constituents remains unknown. The study suggests that the bulk of the Y is not in the zircon.

Additional work on more Y-rich sample material and/or heavy mineral concentrates is recommended.



J.F. Harris Ph.D.

(929-5867)



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

o: DODGE, JAMES S.

14 MACDONALD RD.
WHITEHORSE, YUKON
Y1A 4L2

Page Number : 1
Total Pages : 1
Certificate Date: 21-SEP-92
Invoice No. : 19221321
P.O. Number :
Account : BKY

Project :
Comments:

CERTIFICATE OF ANALYSIS

A9221321

| SAMPLE | PREP CODE | Nb ppm | Y ppm | Zr ppm | | | | | | | |
|--------|-----------|--------|-------|--------|--|--|--|--|--|--|--|
| 420787 | 205 274 | 4410 | 1310 | >10000 | | | | | | | |
| 420788 | 205 274 | 4170 | 1300 | 9860 | | | | | | | |
| 420789 | 205 274 | 5300 | 1030 | 9320 | | | | | | | |
| 420790 | 205 274 | 4590 | 1100 | 7120 | | | | | | | |

CERTIFICATION:

James S. Dodge



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
 212 Brooksbank Ave., North Vancouver
 British Columbia, Canada V7J 2C1
 PHONE: 604-984-0221

DODGE, JAMES S.

14 MACDONALD RD.
 WHITEHORSE, YUKON
 Y1A 4L2

Page Number : 1
 Total Pages : 1
 Certificate Date: 05-SEP-91
 Invoice No. : 19119456
 P.O. Number :

Project :
 Comments: ATTN:JAMES DODGE

CERTIFICATE OF ANALYSIS A9119456

| SAMPLE DESCRIPTION | PREP CODE | | Ce | NAA Dy | NAA Er | NAA Eu | NAA Gd | NAA Ho | NAA La | NAA Lu | NAA Nd | NAA Pr | NAA Sm | NAA Tb | NAA Th | NAA Tm | NAA U | NAA Yb | NAA Y | Zr |
|--------------------|-----------|-----|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|-------|--------|
| | | | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm |
| 420725H | 205 | 294 | 6506 | 93 | 40 | 23.50 | 350 | 18 | 5057 | 7.60 | 1285 | 675 | 230.2 | 17.50 | 981.2 | 44 | 140.0 | 48.50 | 1100 | 6990 |
| 420726H | 205 | 294 | 3914 | 75 | 40 | 14.50 | < 50 | 13 | 2376 | 5.70 | 1085 | 410 | 208.5 | 16.10 | 1403.5 | 8 | 83.0 | 39.70 | 780 | 3350 |
| 420727H | 205 | 294 | 5832 | 139 | 120 | 18.50 | 300 | 20 | 3844 | 11.30 | 1405 | 670 | 286.7 | 20.60 | 2735 | 4 | 214.0 | 56.50 | 1420 | 11200 |
| 420728H | 205 | 294 | 5650 | 114 | 40 | 19.50 | 200 | 24 | 2980 | 8.50 | 1455 | 470 | 257.0 | 21.60 | 1242.5 | 13 | 144.0 | 58.10 | 1120 | 7620 |
| 420730H | 205 | 294 | 2614 | 238 | 340 | 38.50 | 250 | 56 | 1279.0 | 66.50 | 505 | 220 | 157.10 | 33.80 | 2199 | 40 | 320.0 | 370.7 | 2200 | 278000 |

Cerium

Lanthanum

Neodymium

Thorium

Uranium

Yttrium

Zirconium

Adriana Rosemarie
 CERTIFICATION



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

Client: DODGE, JAMES S.

14 MACDONALD RD.
WHITEHORSE, YUKON
Y1A 4L2

Project:
Comments:

Page number : 1
Total Pages : 1
Certificate Date: 16-JUN-92
Invoice No. : 19215793
P.O. Number :
Account : BKY

CERTIFICATE OF ANALYSIS

A9215793

| SAMPLE | PREP CODE | Be ppm | Nb ppm | | | | | | | | |
|---------|-----------|--------|--------|--|--|--|--|--|--|--|--|
| 420725H | 244 232 | 76.0 | 2390 | } re-assays of 1971 samples - for Moberly not from Lancer Strains from syenite pegmatite | | | | | | | |
| 420726H | 244 232 | 29.0 | 4260 | | | | | | | | |
| 420727H | 244 232 | 100.0 | 5390 | | | | | | | | |
| 420728H | 244 232 | 41.0 | 4240 | | | | | | | | |
| 420729H | 244 232 | 1.4 | 40 | | | | | | | | |
| 420730H | 244 232 | 3.7 | 1710 | | | | | | | | |

Supplemental
Analyses
16-06-92

CERTIFICATION:

Yhai D Ma

CERTIFICATE OF WORK

No.: QA 20441

FORM "5" SECTIONS 54 & 59
YUKON QUARTZ MINING ACT

FEE PAID \$ 80.00

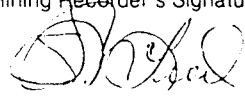
| | |
|------------------------------------|------------------------------|
| Mineral claim(s) LANCER 1-8 | |
| Grant number(s) YB33962-YB33969 | |
| Mining District WATSON LAKE | Date recorded 2 June 1992 |

This is to certify that an affidavit setting out a detailed statement of the work done on the above claim(s) since the 1 day of

Jul 19 91 has this day been filed in my office and in pursuance of the provisions of the YUKON QUARTZ MINING ACT I do now

issue this certificate of work in respect of the above claim(s) to James S. Dodge

is entitled to continue in possession of the said claim(s) until 5 June 19 1994

| | | |
|-------------------------------|----------------------------|--|
| General Receipt No. C51524 | Date Applied 8 Oct 1992 | Mining Recorder's Signature  P. L. McLeod |
| Group No. WA05512 | Claim File No. | |

802 4 (7 88)

White Copy ► OWNER

Pink Copy ► MINING RECORDER

Yellow Copy ► CENTRAL MINING RECORDS

Canada



**GROUPING CERTIFICATE
FORM 6 (SEC. 52)
YUKON QUARTZ MINING ACT**

► Certificate that annual expenditure may, after recording claims, be made on any one of not more than sixteen claims grouped together for the performance of work.

Mining District **WATSON LAKE**

Claim Sheet **105-F-08**

Certificate No. **WA05512**

This is to certify that in accordance with the provisions of section 52 of the YUKON QUARTZ MINING ACT the registered owner(s) or agent(s) of such of the following mineral claims have filed a notice of his (their) intention to group such claims together for the performance of work:

| Claim Names | Grant Numbers |
|-------------|---------------|
| LANCER 1 | YB33962 |
| LANCER 2 | YB33963 |
| LANCER 3 | YB33964 |
| LANCER 4 | YB33965 |
| LANCER 5 | YB33966 |
| LANCER 6 | YB33967 |
| LANCER 7 | YB33968 |
| LANCER 8 | YB33969 |

WATSON LAKE

Dated at _____, in the Yukon Territory.

2 June 92

this _____ day of _____

P. L. McLeod

Mining Recorder

General Receipt **CS1524**

\$ **5.00**

Date Applied

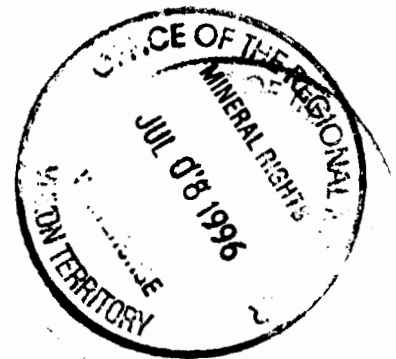
October 8, 1992

Issued to

James S. Dodge

ASSESSMENT REPORT
PHYSICAL REPRESENTATION REPORT
LANCER QUARTZ CLAIMS
CLAIM SHEET 105-F-08
WATSON LAKE MINING DISTRICT
YUKON CANADA

31 MAY, 1994



Prepared by

James S. Dodge, P.Eng.
Whitehorse, Yukon

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1.0 INTRODUCTION

During the three-day period 21-23 August, 1993, Mr. James S. Dodge, Professional Engineer Yukon, of 14 MacDonald Road, Whitehorse carried out assessment representation work on the LANCER quartz claims at the headwaters of the Ketzra River on Claim Sheet 105-F-08 in the Watson Lake Mining District.

This report summarizes the representation work.

2.0 PROPERTY, LOCATION, ACCESS

2.1 The LANCER property is centered at approximately $61^{\circ}29'30''$ north latitude and $132^{\circ}09'50''$ west longitude on Claim Sheet 105-F-08 of the Watson Lake Mining District at the headwaters of the Ketzra River.

The property comprises a block of eight LANCER 1-8 contiguous quartz claims which are grouped under certificate WA05512 dated 02 June, 1992 for the performance of work.

2.2 Location

Altitudes on the LANCER property range from a low of 1500 meters in the Ketzra River valley up to the highest point on LANCER 2 claim of 2051 meters on the main ENE-trending cirque headwall. Most of the southern half of the property is grass covered (see Photo 1), while nearly inaccessible, cliffy, cirque terrane dominates the northern half of the claims.

1993 Vein Trenching
Along Dashed Line



LANCER 8 CLAIM
Viewed Toward West
August 1993

2.3 Access

Summer access is by way of a 9 kilometers of unimproved 4x4 vehicle road which extends southerly from the Ketzá Mine road at Kilometer 30.5 and up to within 500 meters of the ENE end of LANCER 7 claim. The LANCER turn-off at the airstrip on the Ketzá Mine road is 30.5 kilometers from its junction with the Campbell Highway at approximately Kilometer 322 from Watson Lake.

3.0 REPRESENTATION WORK

3.1 Mobilization

Mr. Dodge provided a 4x4 pickup in Whitehorse which was driven to the end of the access road near the LANCER claims at an altitude of 1550 meters. Hand tools and scintillometer were carried up to the trenching sites on the projection of the main vein at 1880 meters altitude over a distance of approximately 1.5 kilometers. The truck served a campsite each night.

3.2 Qualifying Representation Work

Purpose of the work was to confirm the lateral continuity of the main vein, its width and inclination, and to obtain samples of the heretofore overburden-covered intervals. Use of a scintillometer was advantageous in defining the width of vein mineralization which exhibits anomalous gamma radiation owing to presence of thorium-bearing minerals.

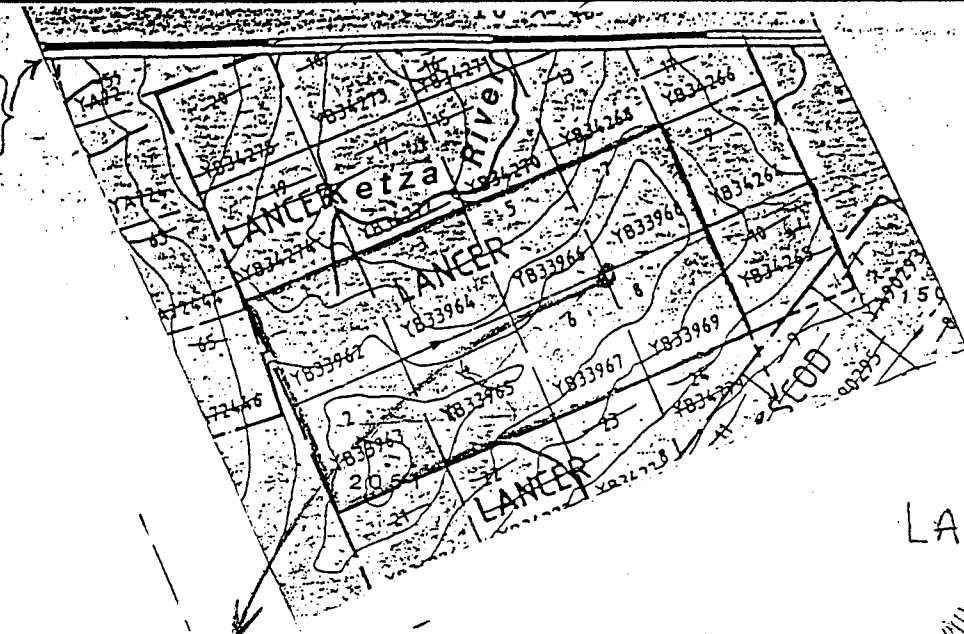
Six hand dug trench sites were chosen along the projected southeasterly strike of the main vein outcropping on the ridge at Posts No. 1 of LANCER 7&8.

A hip chain line was run commencing at Post No. 1 of LANCER 8 claim at the ridge outcrop of the main vein and extended over vein outcrops SE of the claim post and on to the next outcrops at a distance of 150 meters. Six trenching sites were chosen at intermediate distances between the outcrop areas, namely at 63-, 76-, 85-, 95-, 110-, and 126-meters numbered 1-6 respectively. Although vein float was noted in the talus/overburden, trenching was deemed necessary to expose bedrock clearly enough to map and sample the vein.

The vein was well exposed in all trenches. The scintillometer, Precision Model 111B, was used to scan the level of gamma radiation which reflects the presence of thorium - a general gage of concentration of accompanying targeted minerals containing yttrium, niobium, rare earth elements, titanium, and zirconium.

Chip rock sample (8-12 kg each) of the full vein width plus 0.5 meters into the hanging and footwalls of the vein, were collected from each trench. Samples from Trenches 5 and 6 were combined and analyzed under CHEMEX No. 578267H; samples from Trenches 3 and 4 were combined and analyzed under CHEMEX No. 578268H; and samples from Trenches 1 and 2 were combined and analyzed under CHEMEX No. 57829H. Results were reported out by CHEMEX in Certificate of Analysis #A9321054 (attached).


61°30'
132°12'

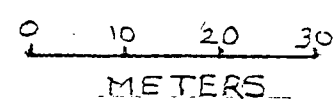
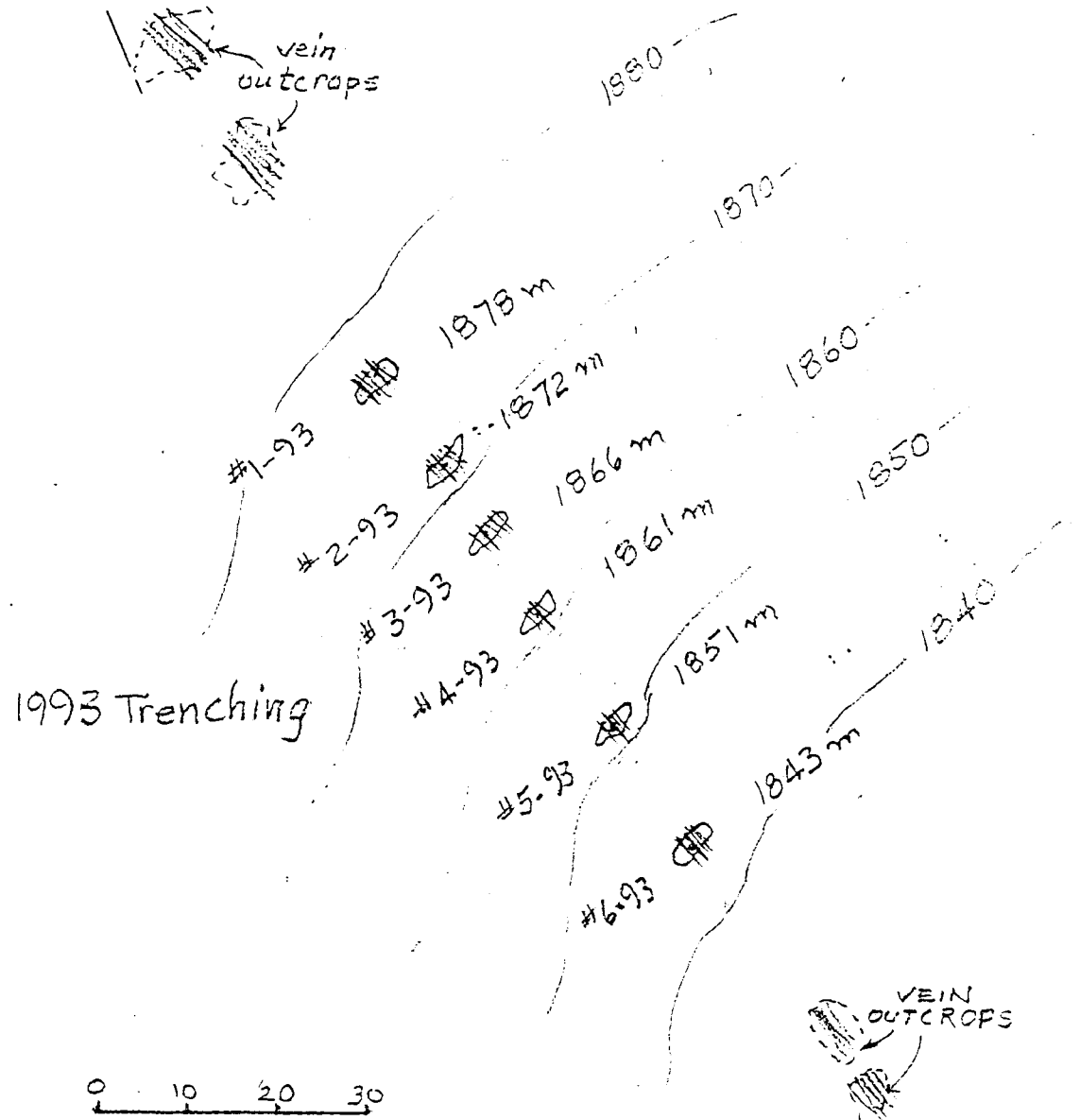
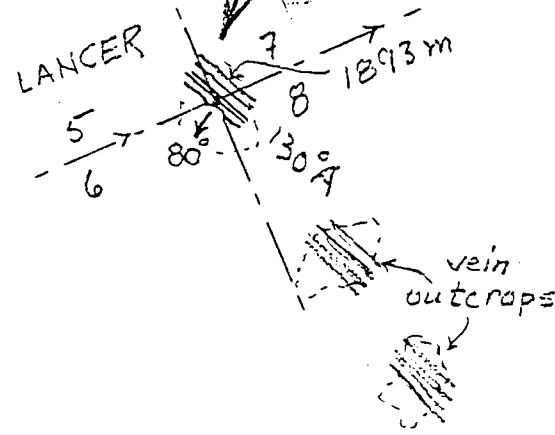


MAP SHEET
105.F.08



LANCER CLAIMS

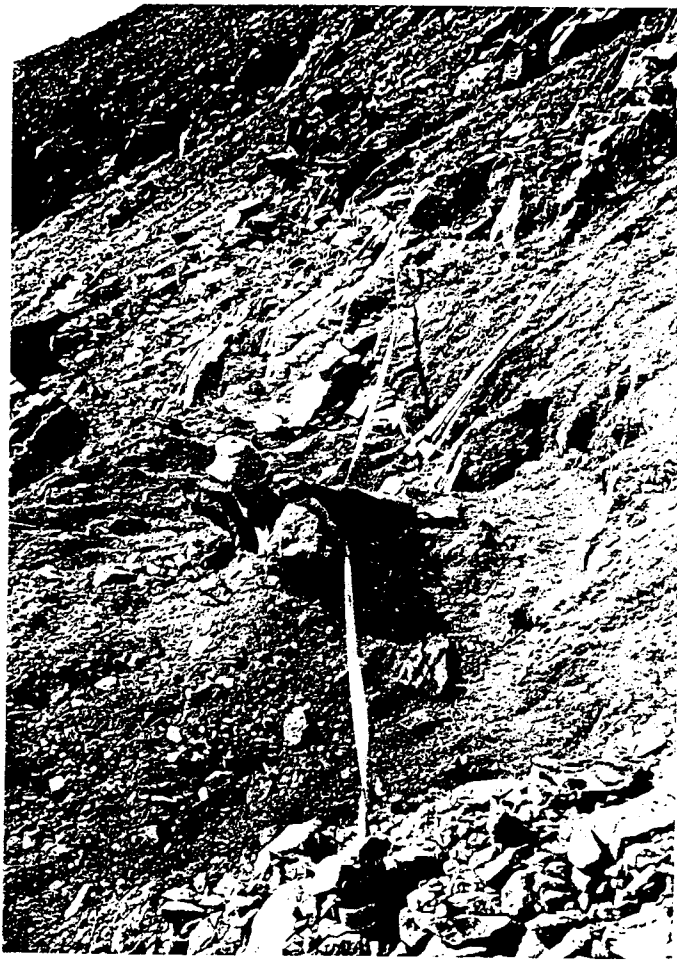
 = VEIN
Y+Nb+REE+Zr



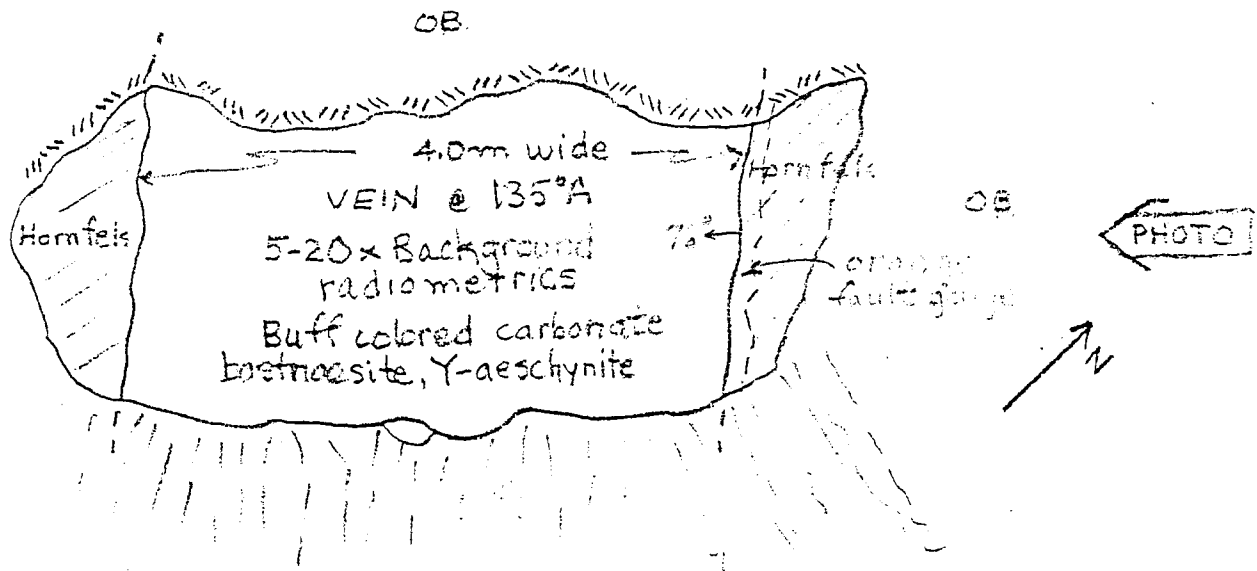
Altitudes in Meters

FIGURE 1

BEST AVAILABLE IMAGE



TRENCH #1-93



TRENCH #1-93
63m SE of Post No 1 LANCER 8

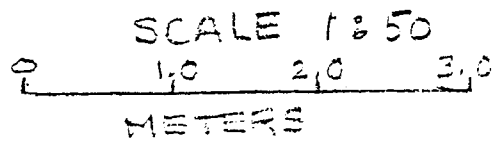
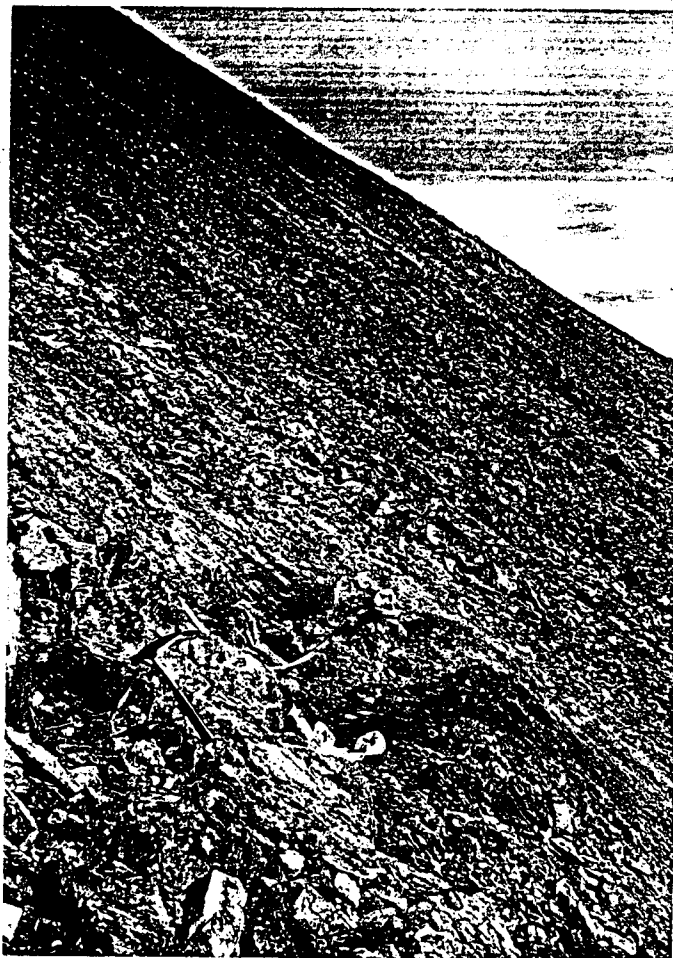
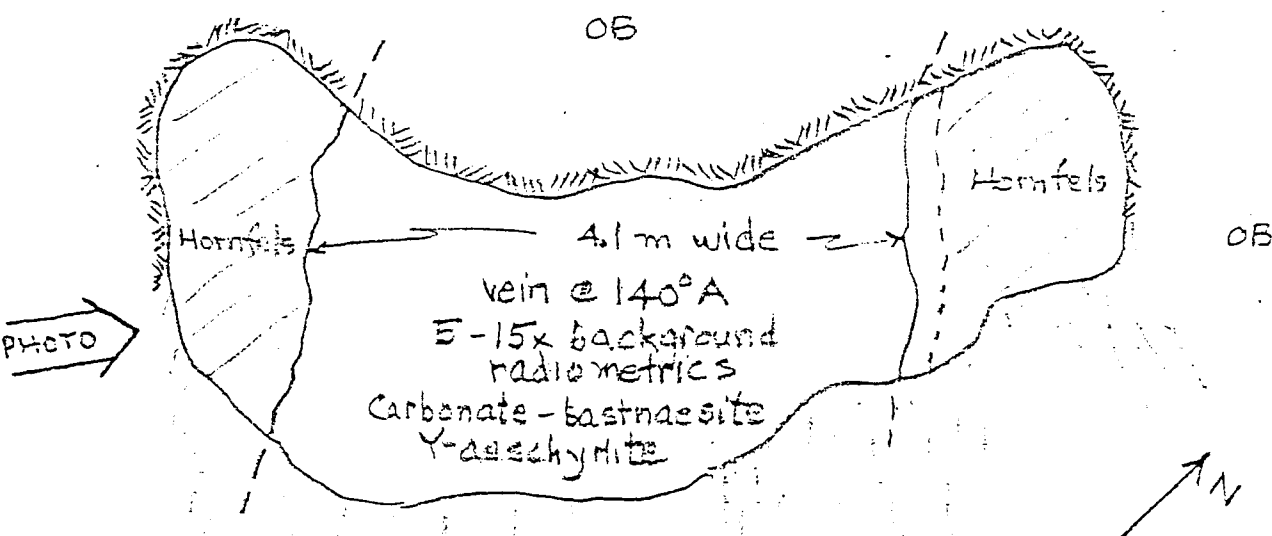


FIGURE 1



TRENCH
#2-93



TRENCH #2-93
76m SE of Post Nat LANCER 8

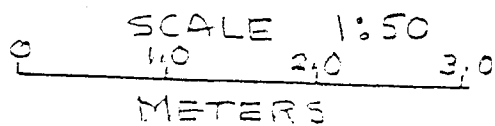
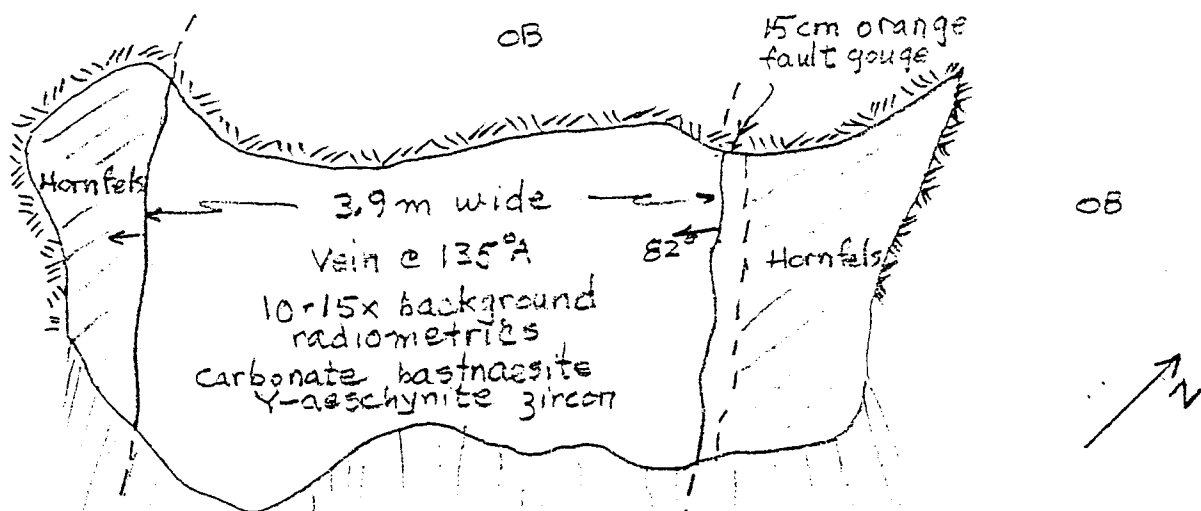


FIGURE 3

(NO PHOTO-SHOWING)



TRENCH #3-93
85m SE of Post No.1 LANCER 8

SCALE 1:50

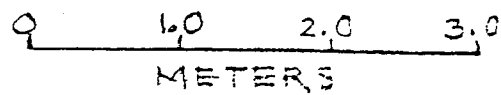
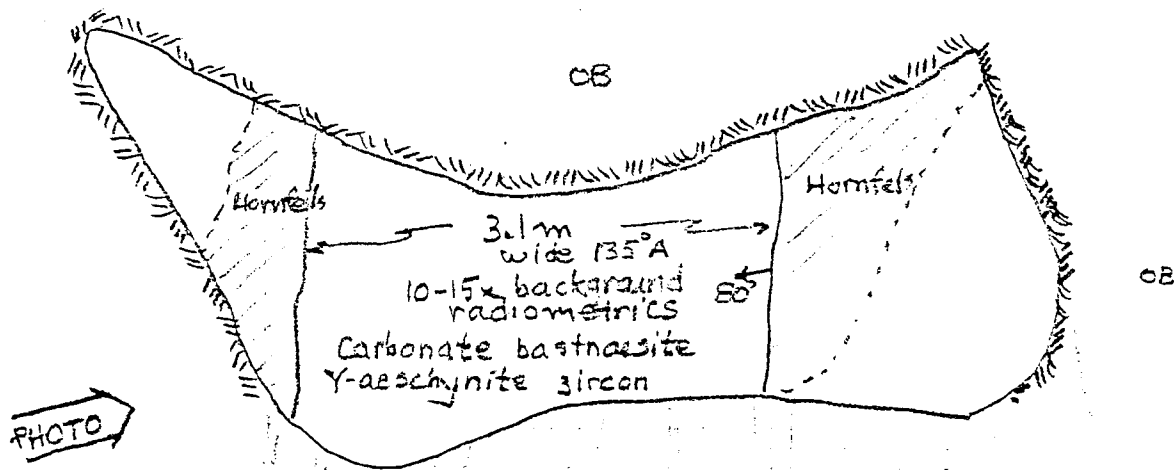


FIGURE 4



TRENCH
#4-93



TRENCH #4-93
95m SE of Post No. 1 LANCER 8

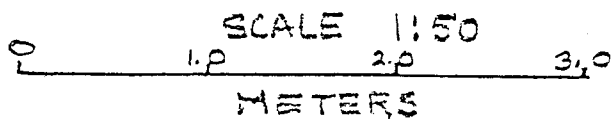
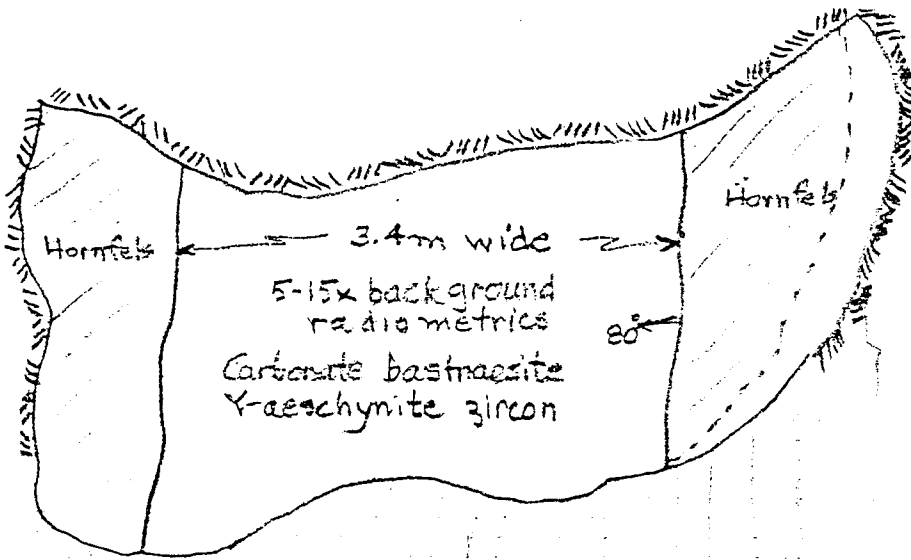


FIGURE 5



TRENCH
#5-93

OB



OB

TRENCH #5-93
110m SE of POST No 1 LANCER 8

SCALE 1:50

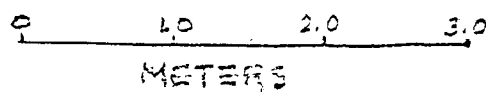
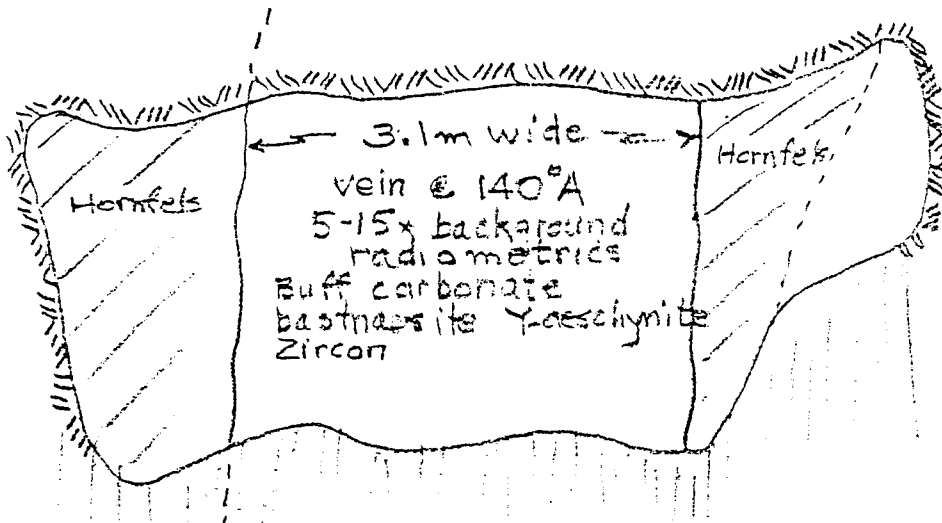


FIGURE 6

(NO PHOTO)

OB.



OB

TRENCH #6-93
126m SE of POST No 1 LANCER 8

SCALE 1:50

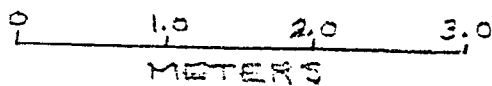
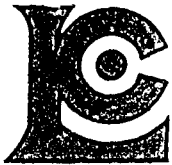


FIGURE 7



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: DODGE, JAMES S.
14 MACDONALD RD.
WHITEHORSE, YUKON
Y1A 4L2

Page Number : 1
Total Pages : 1
Certificate Date: 24-SEP-93
Invoice No. : 19321054
P.O. Number :
Account : BKY

Project :
Comments:

CERTIFICATE OF ANALYSIS A9321054

| SAMPLE | PREP CODE | | Ce | NAA Dy | NAA Er | NAA Eu | NAA Gd | NAA Ho | NAA La | NAA Lu | NAA Nd | NAA Pr | NAA Sm | NAA Tb | NAA Th | NAA Tm | NAA U | NAA Yb | NAA Nb | Y | Zr |
|---------|-----------|-----|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|--------|--------|-----|------|
| | | | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm | ppm |
| 578267H | 208 | 274 | 3984 | 70 | 20 | 13.00 | 150 | 17 | 3046 | 6.10 | 345 | 645 | 152.00 | 12.60 | 985 | < 1 | 129.0 | 37.40 | 1520 | 760 | 5760 |
| 578268H | 208 | 274 | 2260 | 56 | 20 | 20.00 | < 50 | 11 | 1375.0 | 4.30 | 240 | 305 | 122.00 | 13.20 | 506 | < 1 | 77.0 | 31.90 | 2080 | 530 | 3850 |
| 578269H | 208 | 274 | 4732 | 70 | 40 | 17.00 | 50 | 19 | 3041 | 7.00 | 370 | 420 | 223.0 | 14.80 | 1402 | < 1 | 95.0 | 47.40 | 5840 | 910 | 3040 |

Alexandra Alexander
CERTIFICATION:

4.0 CONCLUSIONS

4.1 Trenching confirmed that the main vein is continuous and not offset by faulting, that its width ranges from roughly 3- to 4-meters, and its inclination varies only about 5° from 80° to 75° westerly.

4.2 Scanning of bedrock with handheld scintillometer indicated that the vein exhibited highest radiometric readings. However, up to 5x background readings were obtained from up to 1.0 meter widths in both the hanging- and footwall hornfels bedrock.

Accordingly, chip sampling was extended approximately 0.5 meters beyond the carbonate vein into both hanging and footwalls.

4.3 Assay results of the three combined samples indicated values for yttrium, niobium, rare-earth elements, and zirconium well below the 1992 bedrock sampling of strictly vein material at both the ridge outcrops and the outcrops at 150 and 160 meters SE of the ridge.

4.4 Anomalous radiation detected on bedrock hornfels bordering the vein are spurious. Perhaps slabs of vein talus in proximity to the hornfels accounts for the anomalous readings. In the future, sampling should be confined to the vein.

4.5 Trenching in 1993, supplementing previous sampling of a series of outcrops, confirms the continuity of a ~~1200-meter~~^{365m} southeasterly extension of the main vein from the ridge at Post No. 1 of LANCER 8.

CERTIFICATE

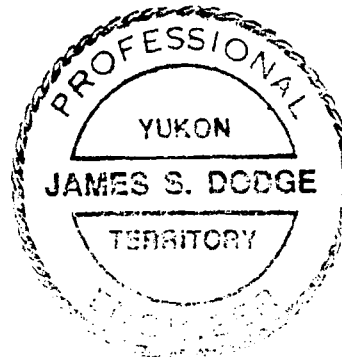
I, James S. Dodge, consulting economic geologist located at 14 MacDonald Road, Whitehorse, Yukon, Canada do hereby certify that:

1. I am a graduate of the Missouri School of Mines (1941), Rolla, Missouri, receiving a degree as a Mining Engineer, that I am a graduate of Leland Stanford University (1951), Palo Alto, California, receiving a master of science degree in economic geology. Training also included summer geological mapping (1940) with Princeton University in Montana, and studies in exploration geochemistry and ore deposits at Albert Ludwigs Universitaet (1952), Freiburg, Germany.
2. I am a Registered Professional Engineer in the Yukon Territory, Canada under Certificate Number 311.
3. I have practiced the professions of mining engineering and economic geology since 1941, with the exception during service in the U.S.Army (1944-1946).
4. I have personally carried out the hand trenching on the LANCER 8 claim on Claim Sheet 105-F-08 in the Watson Lake Mining District during 21-23 August, 1993.

Dated at Whitehorse, Yukon this 31 May, 1994 A.D.

Respectfully submitted,

James A. Dodge
James S. Dodge
Professional Engineer, Yukon
14 MacDonald Road
Whitehorse, Yukon Y1A 4L2



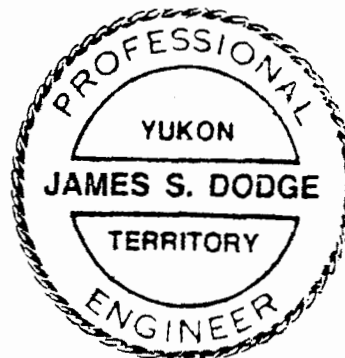
STATEMENT OF LABOR AND EXPENDITURES
LANCER 1-8 CLAIMS

During the period 21-23 August, 1993, Mr. James S. Dodge carried out hand trenching on the LANCER 8 quartz claim in Claim Sheet 105-F-08 of the Watson Lake Mining District.

The following is a summation of labor and expenditures associated with the work program:

| | | |
|-------------------------------------|-------------|---------------|
| Transportation (mob. and de-mob.) | | |
| 4x4 pickup Whitehorse-Lancer | | |
| claims (return) | | |
| 950 km @ 15¢/km 20/24 August 1993 | | \$142.50 |
| Assays | | |
| Samples analyzed by CHEMEX for | | |
| Rare-earth elements, Niobium, | | |
| Yttrium, and Zirconium | | |
| 3 samples @ \$82.15 +GST | | 263.70 |
| Camp Supplies | | |
| Food 3 days @ \$20/day | 60.00 | |
| Flagging 2 rolls @ \$3 ea | 6.00 | |
| Photography | <u>6.50</u> | 72.50 |
| Equipment Use | | |
| Dodge's personal Model 111B | | |
| Precision scintillometer | | |
| nominally operated during | | |
| three-day period @ \$10/day | | 30.00 |
| Labor | | |
| Dodge hand-dug six trenches, | | |
| radiometrically scanned, mapped | | |
| widths, sampled, photographed, | | |
| backpacked tools and samples (55kg) | | |
| during 30 hours 21-23 August, 1993 | | |
| for 30 hours @ \$12/hour | | <u>360.00</u> |
| TOTAL ASSESSMENT WORK VALUE | | \$868.70 |

James S. Dodge
James S. Dodge, P.Eng.
14 MacDonald Road
Whitehorse, Yukon Y1A 4L2
31 May, 1994





Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: DODGE, JAMES S. *

14 MACDONALD RD.
WHITEHORSE, YUKON
Y1A 4L2

INVOICE NUMBER

I 9 3 2 1 0 5 4

BILLING INFORMATION

Date: 27-SEP-93

Project:

P.O. No.:

Account: BKY

Comments:

Billing: For analysis performed on
Certificate A9321054

Terms: Payment due on receipt of invoice
1.25% per month (15% per annum)
charged on overdue accounts

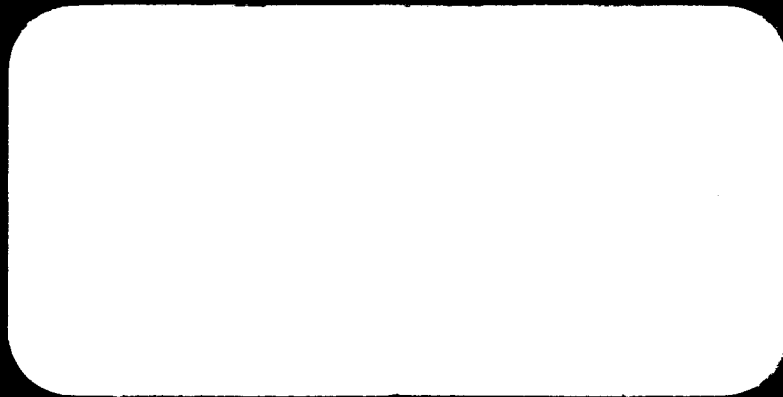
Please Remit Payments to:

CHEMEX LABS LTD.
212 Brooksbank Ave.,
North Vancouver, B.C.
Canada V7J 2C1

| # OF SAMPLES | ANALYSED FOR CODE - DESCRIPTION | UNIT PRICE | SAMPLE PRICE | AMOUNT |
|--------------|-------------------------------------|------------|--------------|--------------------------------------|
| 3 | 208 - Assay ring to approx 150 mesh | 2.10 | | |
| | 274 - 0-15 lb crush and split | 3.05 | | |
| | RE-16 Extend. rare earth | 65.00 | | |
| | 191 - Nb ppm | 2.00 | | |
| | 801 - Y ppm | 2.00 | | |
| | 914 - Zr ppm | 2.00 | | |
| | 297 - Meta-borate fusion charge | 6.00 | 82.15 | 246.45 |
| | | | | Total Cost \$ 246.45 |
| | | | | (Reg# R100938885) GST \$ 17.25 |
| | | | | TOTAL PAYABLE (CDN) \$ 263.70 |



CANMET



**Canada Centre for
Mineral and Energy Technology**



**Centre Canadien de la technologie
des minéraux et de l'énergie**

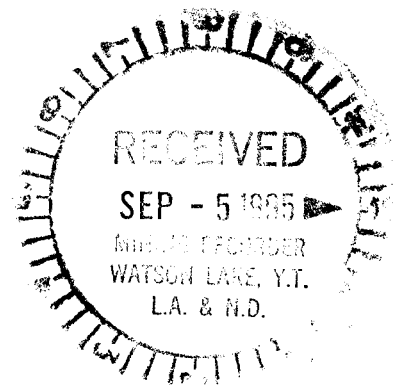
MINERALOGICAL ANALYSIS OF
ORE SPECIMENS FROM THE RARE
EARTH DEPOSIT OF DODGEX LTD.

PART 1:
MINERAL IDENTITIES, COMPOSITIONS
AND MODES OF OCCURRENCE

APRIL 1995

MINERAL SCIENCES LABORATORIES
R. Lastra and D. Owens

Work performed for:
J.S. Dodge
Dodgex Ltd.
Whitehorse, Yukon



Job No. 51075

CONFIDENTIAL

MINERAL SCIENCES LABORATORIES
DIVISION REPORT MSL 95-025 (CR)

EXECUTIVE SUMMARY

A mineralogical study was conducted on a niobium-bearing rare earth ore from the Lancer deposit in Yukon by the Applied Mineralogy Group as a cost recovery project for Mr. Dodge, President Dodgex Ltd., 14 MacDonald Road, Whitehorse, Yukon. The study was conducted in two parts. One part is to identify the minerals and to determine the compositions and modes of occurrence of the rare earth minerals, and the second part is to determine the relative quantities of the rare earth minerals and to determine their liberation characteristics. The purpose of the study is to provide guidance in processing the ore. This report is on Part 1 of the study (e.g. mineral identification, compositions and occurrence). Two samples labelled "mainvein" and "footwall" were analyzed. It was found that both are mineralogically and chemically similar. They contain, in weight %, 0.9 Zr, 0.4 to 0.7 Nb, 0.1 Y, and 1.36 rare earth elements (0.6 Ce, 0.4 La, 0.2 Nd, small quantities of Pr, Sm, Gd and Dy, and trace amounts of Eu, Tb, Ho, Er, Tm, Yb and Lu).

The Zr occurs as a major constituent of a very fine-grained, poorly crystallized spongy zircon (ZrSiO_4). The zircon is present as minute inclusions in silicates, bastnaesite/parisite and columbite.

The Nb occurs as the major constituent of a variety of minerals grouped under the "generic" term niobates, with ferrocolumbite ($\text{Fe}^{+2}\text{Nb}_2\text{O}_6$) and manganocolumbite ($\text{Mn}^{+2}\text{Nb}_2\text{O}_6$) being the main niobium minerals. The niobates are very fine-grained, and occur as inclusions in silicates, carbonates and bastnaesite/parisite.

The main rare earth mineral is monazite $((\text{Ce},\text{La},\text{Nd},\text{Th})\text{PO}_4)$, and the secondary rare earth minerals are bastnaesite $((\text{Ce},\text{La})(\text{CO}_3)\text{F})$ and parisite $(\text{Ca}(\text{Ce},\text{La})_2(\text{CO}_3)_3\text{F}_2)$. The monazite is a rare earth phosphate that contains Ce, La and some Nd. It occurs as discrete grains and as small aggregates up to $150\ \mu\text{m}$ in size. The bastnaesite/parisite are also Ce, La and minerals, but they contain some Nd and small amounts of Sm and Gd. They occur as small irregular grains and aggregates, up to $150\ \mu\text{m}$ in size.

A trace of thorium silicate, probably thorite (ThSiO_4) was found in the ore, and some of the minor niobates contain minor amounts of uranium.

An image analysis evaluation, which is performed as Part 2 of this study, will provide a sound base for predicting a grind size to liberate the RE minerals (monazite and bastnaesite/parisite), the niobates and zircon.

Keywords: rare earth, monazite, bastnaesite, parisite

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INTRODUCTION

A mineralogical and image analysis study of a rare earth ore from the Lancer deposit in Yukon was undertaken by the Applied Mineralogy Group as a cost recovery project. The deposit is owned by Dodgex Limited, and an MDA grant was contributed by the Yukon Department of Natural Resources for a mineralogical characterization which would provide guidance in processing the ore. A contract was drawn-up between CANMET (CANMET/MSL Project 51075) and Mr. Dodge, President Dodgex Ltd., 14 MacDonald Road, Whitehorse, Yukon on February 3, 1995. Two 100 kilogram samples of the ore were received by CANMET on February 17, 1995 from Mr. Dodge. The samples consisted of rock fragments averaging about 30 cm in size, and were labelled "mainvein" and "footwall".

The mineralogical and image analysis study is performed in two parts. One part is to identify the rare earth minerals and to determine their compositions and modes of occurrence, and the second part is to determine the relative quantities of the rare earth minerals and to determine their liberation characteristic.

This report is on the first part of the study (i.e. identification, compositions and occurrence of the rare-earth bearing minerals).

METHOD OF INVESTIGATION

The rock fragments from the two samples were crushed to -4.7 mm (-4 mesh) and split into 50 Kg sub-samples. One sub-sample of each type was crushed to -1.7 mm (10 mesh). A 2 Kg sample was then split from the "mainvein" and "footwall" sub-samples and ground -295 μm (-48 mesh). Representative portions of the minus 48 mesh samples were removed and pulverized. One portion of the pulverized sample was submitted for chemical analysis to identify and quantify the rare earth elements and another portion submitted for X-ray diffractometer analysis (XRD) to identify the principal rock-forming minerals.

Polished sections were prepared from representative -295 +208 μm (-48+65 mesh) fractions of the two samples. In addition, -147 +45 μm (-100+325 mesh) fractions were separated into sink and float sub-fractions using a heavy liquid with a specific gravity of 3.30. The two sink fractions, in which the heavier ore minerals were concentrated, were also mounted in polished sections.

The polished sections were studied by optical microscopy, scanning electron microscopy (SEM) with qualitative energy dispersive analysis (EDS), and powder X-ray diffraction analysis (XRD). Electron microprobe analyses (EPMA) were conducted on the major rare earth and niobium minerals to confirm their identities and to determine the quantities of rare earth elements and niobium in the minerals. Qualitative EDS spectra of the rare earth minerals are provided to illustrate their complex compositions. Backscattered electron photomicrographs of the significant rare earth minerals observed in the polished sections are included to illustrate their occurrence and associations.

RESULTS

The quantity of ore minerals (rare earth minerals) in the ore as received is extremely sparse. Therefore, characterization of the rare earth minerals is based essentially on mineralogical analyses of the polished sections prepared from the sink fractions.

The results of the chemical and XRD analyses, given in Tables 1 and 2 respectively, suggest that the "mainvein" and "footwall" samples are analogous.

The minerals identified in the ore samples are recorded in Table 3. The order in which they are listed does not necessarily correspond to their order of abundance. The formulae listed are stoichiometric and, because of elemental substitution, may not represent the compositions of the minerals in the ore.

Table 1 - Results of chemical analyses to determine the rare earth contents of the "mainvein" and "footwall" *

| | <u>MAINVEIN</u> | <u>FOOTWALL</u> |
|-----------------|-----------------|-----------------|
| Element | ppm | ppm |
| Rb ⁺ | 73 | 32 |
| Sr ⁺ | 31 | 58 |
| Y | 1049 | 1094 |
| Zr ⁺ | 8636 | 9380 |
| Nb ⁺ | 4089 | 6888 |
| Ba ⁺ | 317 | 209 |
| La | 3903 | 3695 |
| Ce | 6297 | 6520 |
| Pr | 608 | 643 |
| Nd | 1886 | 1997 |
| Sm | 266 | 284 |
| Eu | 22 | 23 |
| Gd | 209 | 226 |
| Tb | 30 | 32 |
| Dy | 168 | 186 |
| Ho | 30 | 33 |
| Er | 86 | 93 |
| Tm | 12 | 13 |
| Yb | 78 | 79 |
| Lu | 11 | 10 |

* Batch No. B95-1323

+ Not rare earth elements (Levison, 1966).

Table 2 - X-ray diffractometer analyses of the "mainvein" and "footwall"

| | <u>MAJOR</u> | <u>MINOR</u> | <u>TRACE</u> |
|----------|--------------|--------------------|----------------------|
| Mainvein | quartz | dolomite | muscovite calcite |
| Footwall | quartz | albite ankerite | muscovite |

Table 3 - Minerals identified in the "mainvein" and "footwall"

| <u>MINERAL</u> | <u>FORMULA</u> |
|---------------------|--|
| RE phosphates | |
| monazite-(Ce) | (Ce,La,Nd,Th)PO ₄ |
| RE fluorocarbonates | |
| bastnaesite-(Ce) | (Ce,La)(CO ₃)F |
| parisite-(Ce) | Ca(Ce,La) ₂ (CO ₃) ₃ F ₂ |
| Niobates | |
| ferrocolumbite | Fe ⁺² Nb ₂ O ₆ |
| manganocolumbite | Mn ⁺² Nb ₂ O ₆ |
| fergusonite-(Y) | YNbO ₄ |
| niobates-(Ti,Ce, Y) | Undetermined |
| zircon | ZrSiO ₄ |
| huttonite/thorite | ThSiO ₄ |
| Sulphides | |
| pyrite | FeS ₂ |
| sphalerite | (Zn,Fe)S |
| chalcopyrite | CuFeS ₂ |
| arsenopyrite | FeAsS |
| Oxides | |
| goethite | Fe ⁺³ O(OH) |
| magnetite | Fe ₃ O ₄ |
| Silicates | |
| quartz | SiO ₂ |
| albite | NaAlSi ₃ O ₈ |
| pyroxene | NaFe ⁺³ Si ₂ O ₆ |
| muscovite | KAl ₂ (Si ₃ Al)O ₁₀ (OH,F) ₂ |
| Carbonates | |
| ankerite | Ca(Fe ⁺² ,Mg,Mn)(CO ₃) ₂ |
| dolomite | CaMg(CO ₃) ₂ |
| siderite | Fe ₊₂ CO ₃ |
| calcite | CaCO ₃ |
| rhodochrosite | Mn ⁺² CO ₃ |

OCCURRENCE OF RARE EARTH ELEMENTS AND NIOBIUM

The rare earth elements in the "mainvein" and "footwall" samples are essentially the light lanthanides (La, Ce, Pr, Nd, Pm, Sm, Eu and Gd) and yttrium. Only trace amounts of the heavy lanthanides (Tb, Dy, Ho, Er, Tm, Yb and Lu) were sporadically observed.

The light lanthanides are dominated by cerium (Ce) and lanthanum (La), with small amounts of neodymium (Nd), and trace amounts of samarium (Sm) and gadolinium (Gd). The Ce and La occur largely as constituents of the mineral monazite and less commonly as bastnaesite and parisite. Minor to trace amounts are also present in some ferrocolumbite and manganocolumbite grains.

Neodymium occurs as a constituent of monazite, and small amounts are present in the bastnaesite and parisite. Trace amounts of Nd were also detected in the ferrocolumbite, manganocolumbite and fergusonite-(Y).

Trace quantities of samarium and gadolinium are present in the bastnaesite, parisite and fergusonite-(Y).

No host mineral was found for the significant amount of praseodymium reported by assay (Table 1).

The only indication of the heavy lanthanides was trace amounts of dysprosium detected by qualitative EDS analysis of several columbite grains.

The yttrium content in the ore samples is much less than that of the light lanthanides (Table 1), but its occurrence is as widespread. It is most prevalent as a minor to trace element in zircon and in some of the ferrocolumbite and manganocolumbite grains. Yttrium also constitutes a major element in fergusonite-(Y), yttrrocolumbite and a titanium-niobate tentatively identified as aeschynite-(Y).

Niobium occurs in a wide variety of minerals grouped under the generic name of niobates, and is generally a major constituent of the minerals. The niobium minerals include ferrocolumbite, manganocolumbite, ytrocolumbite, fergusonite-(Y), aeschynite-(Y) and pyrochlore. The identification of some of these minerals is tentative, as it is based solely upon qualitative EDS spectra.

GENERAL MINERALOGY OF THE "MAINVEIN" AND "FOOTWALL"

Since very little difference was noted between the "mainvein" and "footwall" samples they are treated and described as samples from one ore.

The RE, niobium and metallic minerals identified in the samples from the Lancer deposit include pyrite, monazite, bastnaesite, zircon, ferrocolumbite, manganocolumbite, ytrocolumbite, fergusonite-(Y), complex niobates, thorium silicate, goethite, magnetite, chalcopyrite, sphalerite and arsenopyrite. The latter four minerals were observed only in trace amounts in the polished sections prepared from the sink products, and are of little or no significance in this ore. They will not be discussed further in this report.

The rock-forming minerals identified in the "mainvein" include major quartz, minor dolomite and traces of muscovite, acmite, calcite, siderite and rhodochrosite (?). The rock-forming minerals in the "footwall" include major quartz, minor ankerite and albite, and trace amounts of muscovite, acmite, siderite and rhodochrosite (?).

DETAILED MINERALOGY OF THE RARE EARTH AND RE-BEARING MINERALS

The rare earth and RE-bearing minerals identified in the ore include monazite, bastnaesite, parisite, zircon, ferrocolumbite, manganocolumbite, niobates and fergusonite-(Y).

MONAZITE

Monazite is a rare-earth phosphate of the light lanthanides. EMPA have shown that Ce is generally the dominant RE element followed by La. Neodymium is present in small but significant amounts (Table 4). A qualitative EDS spectrum which illustrates the composition of monazite is shown in Figure 13.

The monazite occurs essentially as inclusions (grains and small aggregates) in matrixes of silicates and/or carbonates (Fig. 1). These inclusions are between 5 and 120 μm in size. Discrete, crystals with a maximum dimension of 150 μm (Fig. 2) were also observed in the 100 to 325 mesh fraction of the "footwall" sample. Direct association of monazite with the other rare-earth bearing minerals is sporadic; in such instances it is associated with a yttrium-bearing zircon (Fig. 1). Inclusions in monazite are infrequent, but if present, are usually silicates.

BASTNAESITE/PARISITE

Bastnaesite and parisite are both members of the bastnaesite group of minerals and are fluorocarbonates of the light lanthanides. Quantitative EMPA have shown that Ce is the dominant RE element, with major La, minor Nd, and sporadically trace amounts of both Sm and Gd (Table 5). Qualitative EDS spectra which illustrate the compositions of bastnaesite and parisite are shown in Figures 14 and 15 respectively.

Bastnaesite was observed largely as inclusions in silicates, as small aggregates and occasionally as discrete grains (Figs. 2, 3 & 4) in the 100 to 325 mesh fraction. Grain size ranges between 1 and 20 micrometers although aggregates of 150 micrometres were observed. Inclusions are infrequent and usually are formed of zircon, columbite or silicates (Figs. 3 & 4). Parisite was observed only as an intimate intergrowth with bastnaesite (Figs. 5 & 5a).

ZIRCON

The occurrence of zircon is markedly diverse. It occurs almost entirely as inclusions in either silicates, bastnaesite or columbite or, in intergrowths with

Table 4 - Electron microprobe analysis of Monazite*

| <u>MAINVEIN</u> | | | | | | |
|-----------------|------|---------|------|---------|--------------------------------|--|
| Element | #1 | | #2 | | oxide | |
| | wt% | ox. wt% | wt% | ox. wt% | | |
| La | 26.0 | 30.5 | 24.9 | 29.2 | La ₂ O ₃ | |
| Ce | 26.0 | 30.5 | 27.0 | 31.6 | Ce ₂ O ₃ | |
| Nd | 3.5 | 4.1 | 3.9 | 4.6 | Nd ₂ O ₃ | |
| P | 12.7 | 29.1 | 12.6 | 28.9 | P ₂ O ₅ | |
| Totals | 68.2 | 94.2 | 68.4 | 94.3 | | |

| Element | #3 | | #4 | | oxide |
|---------|------|---------|------|---------|--------------------------------|
| | wt% | ox. wt% | wt% | ox. wt% | |
| La | 25.3 | 29.7 | 25.3 | 29.7 | La ₂ O ₃ |
| Ce | 26.1 | 30.6 | 26.1 | 30.6 | Ce ₂ O ₃ |
| Nd | 3.7 | 4.3 | 3.9 | 4.5 | Nd ₂ O ₃ |
| P | 12.9 | 29.6 | 12.8 | 29.3 | P ₂ O ₅ |
| Totals | 68.0 | 94.2 | 68.1 | 94.1 | |

* All monazites analyzed for Sm, Gd, Dy, Ca & Y; none were detected.

Table 4 - Electron microprobe analysis of Monazite* (cont'd)

| <u>FOOTWALL</u> | | | | | |
|-----------------|------|---------|------|---------|--------------------------------|
| Element | #5 | | #6 | | oxide |
| | wt% | ox. wt% | wt% | ox. wt% | |
| La | 22.6 | 26.5 | 25.4 | 29.8 | La ₂ O ₃ |
| Ce | 26.9 | 31.5 | 26.2 | 30.7 | Ce ₂ O ₃ |
| Nd | 4.4 | 5.1 | 3.7 | 4.3 | Nd ₂ O ₃ |
| P | 12.9 | 29.6 | 12.8 | 29.3 | P ₂ O ₅ |
| Totals | 67.0 | 92.7 | 68.2 | 94.1 | |

| Element | #7 | | #8 | | oxide |
|---------|------|---------|------|---------|--------------------------------|
| | wt% | ox. wt% | wt% | ox. wt% | |
| La | 19.4 | 22.8 | 23.5 | 27.6 | La ₂ O ₃ |
| Ce | 27.6 | 32.4 | 26.7 | 31.3 | Ce ₂ O ₃ |
| Nd | 6.4 | 7.5 | 4.5 | 5.2 | Nd ₂ O ₃ |
| P | 12.8 | 29.3 | 12.8 | 29.3 | P ₂ O ₅ |
| Totals | 66.5 | 92.0 | 67.5 | 93.4 | |

| AVERAGE | | | |
|---------|------|---------|--------------------------------|
| Element | wt% | ox. wt% | oxide |
| La | 24.0 | 28.2 | La ₂ O ₃ |
| Ce | 26.6 | 31.1 | Ce ₂ O ₃ |
| Nd | 4.2 | 5.0 | Nd ₂ O ₃ |
| P | 12.8 | 29.3 | P ₂ O ₅ |
| Totals | 67.8 | 93.6 | |

* All monazites analyzed for Sm, Gd, Dy, Ca & Y; none were detected.

Table 5 - Electron microprobe analysis of Bastnaesite and Parisite*

| <u>MAINVEIN</u> | | | | | |
|-----------------|---------------------------|---------|------------------------|---------|--------------------------------|
| Element | <u>#1 Bastnaesite</u> | | <u>#1 Parisite</u> | | |
| | wt% | ox. wt% | wt% | ox. wt% | oxide |
| La | 13.8 | 16.2 | 11.2 | 13.1 | La ₂ O ₃ |
| Ce | 31.9 | 37.4 | 30.4 | 35.6 | Ce ₂ O ₃ |
| Nd | 8.8 | 10.3 | 8.4 | 9.8 | Nd ₂ O ₃ |
| Sm | 0.4 | 0.5 | 0.5 | 0.6 | Sm ₂ O ₃ |
| Gd** | 0.4 | 0.5 | 0.0 | 0.0 | Gd ₂ O ₃ |
| Ca | 0.7 | 1.0 | 7.1 | 9.9 | CaO |
| F | 9.3 | 9.3 | 8.1 | 8.1 | F |
| Totals | 65.3 | 75.2 | 65.7 | 77.1 | |

| Element | <u>#2 Bastnaesite</u> | | <u>#2 Parisite</u> | | |
|---------|---------------------------|---------|------------------------|---------|--------------------------------|
| | wt% | ox. wt% | wt% | ox. wt% | oxide |
| La | 11.6 | 13.6 | 12.8 | 15.0 | La ₂ O ₃ |
| Ce | 33.0 | 38.7 | 28.6 | 33.5 | Ce ₂ O ₃ |
| Nd | 11.3 | 13.2 | 7.6 | 8.9 | Nd ₂ O ₃ |
| Sm | 0.9 | 1.0 | 0.5 | 0.6 | Sm ₂ O ₅ |
| Gd** | 0.4 | 0.5 | 0.2 | 0.2 | Gd ₂ O ₃ |
| Ca | 0.2 | 0.3 | 6.4 | 9.0 | CaO |
| F | 8.9 | 8.9 | 7.3 | 7.3 | F |
| Totals | 66.3 | 76.2 | 63.4 | 74.5 | |

Table 5 - Electron microprobe analysis of Bastnaesite and Parisite* (cont'd)

| Element | <u>FOOTWALL</u> | | wt% | ox. wt% | oxide |
|---------|---------------------------------|---------------------------------|------|---------|--------------------------------|
| | <u>#3</u> <u>Bastnaesite</u> | <u>#4</u> <u>Bastnaesite</u> | | | |
| La | 13.6 | 16.0 | 18.2 | 21.3 | La ₂ O ₃ |
| Ce | 31.7 | 37.1 | 29.3 | 34.3 | Ce ₂ O ₃ |
| Nd | 10.0 | 11.7 | 7.5 | 8.7 | Nd ₂ O ₃ |
| Sm | 0.8 | 0.9 | 0.5 | 0.6 | Sm ₂ O ₃ |
| Gd** | 0.5 | 0.6 | 0.8 | 0.9 | Gd ₂ O ₃ |
| Ca | 0.4 | 0.6 | 0.3 | 0.4 | CaO |
| F | 9.2 | 9.2 | 10.1 | 10.1 | F |
| Totals | 66.2 | 76.1 | 66.7 | 76.3 | |

* CO₂ not determined

** Values for Gd corrected for enhancement by Ce, La and Nd.

columbite, bastnaesite and silicates (Figs. 1, 3, 7, 8, 9, 10, 11 & 13). It is significant, from the point of view of a RE-bearing mineral, because of its yttrium content. Much of the zircon is spongy, minute and poorly crystallized and therefore, unsuitable for quantitative EMPA. However, sufficient data was obtained by EMPA to confirm that the zircon was yttrium-bearing. The analyses also showed that the yttrium content of the zircon in the "footwall" (mean 3.4 wt% Y; range 1.4 to 6.9 wt% Y) is greater than that of the zircon in the "mainvein" (mean 1.3 wt% Y; range 0.9 to 1.6 wt% Y). A qualitative EDS spectrum which illustrates the composition of zircon is shown in Figure 16.

NIOBATES

A wide variety of minerals grouped under the "generic" term of niobates was found. These minerals are fine-grained, occur intermittently and, are commonly associated with other more dominant rare earth minerals (Figs. 6, 7, and 10). Nearly all are niobium-rich, but titanium occasionally is dominant (mol percent); tantalum is minor and sporadic. Cations in the niobates are diverse and include yttrium, iron, manganese, cerium, thorium, uranium, neodymium, calcium and gadolinium, with one added occurrence of tin and possibly dysprosium. The identities of some niobates were confirmed by EPMA and XRD, whereas the identities of the other niobates were inferred from their EDS spectra. The niobates with confirmed identities are ferrocolumbite and manganocolumbite, and the niobates with inferred identities are yttrrocolumbite, fergusonite-(Y), aeschynite-(Y) and pyrochlore.

Columbite: At least three compositionally unique members of the columbite group of minerals are present in the ore. Ferrocolumbite and manganocolumbite were the most frequently encountered niobates, with yttrrocolumbite a distant third. Quantitative EMPA (Table 6) in conjunction with qualitative EDS analyses have shown that, in addition to being a major carrier of niobium, the columbite commonly contains small and varying amounts of Ta and Ti, with intermittent small to trace amounts of Y, Ca, Th and U. Yttrrocolumbite was appraised solely by qualitative EDS. Qualitative EDS spectra which illustrate the compositions of ferrocolumbite, manganocolumbite and yttrrocolumbite are shown in Figures 17, 18 and 19 respectively. Figure 20 shows an

Table 6 - Electron microprobe analysis of columbites/niobates

| <u>MAINVEIN</u> | | | | | |
|-----------------|------------------------------|---------|--------------------------------|---------|--------------------------------|
| Element | <u>#1 Ferrocolumbite</u> | | <u>#1 Manganocolumbite</u> | | |
| | wt% | ox. wt% | wt% | ox. wt% | oxide |
| Fe | 14.0 | 18.0 | 4.1 | 5.3 | FeO |
| Mn | 1.7 | 2.2 | 11.6 | 15.0 | MnO |
| Ca | 0.0 | 0.0 | 0.7 | 1.0 | CaO |
| Y | 0.4 | 0.5 | 0.8 | 1.0 | Y ₂ O ₃ |
| Nb | 50.6 | 72.4 | 51.0 | 73.0 | Nb ₂ O ₅ |
| Ti | 2.1 | 3.5 | 0.7 | 1.2 | TiO ₂ |
| Ta | 0.5 | 0.6 | 0.5 | 0.6 | Ta ₂ O ₅ |
| Totals | 65.3 | 97.2 | 69.4 | 97.1 | |

| Element | <u>#2 Manganocolumbite</u> | | <u>#2 Ferrocolumbite</u> | | |
|---------|--------------------------------|---------|------------------------------|---------|--------------------------------|
| | wt% | ox. wt% | wt% | ox. wt% | oxide |
| Fe | 5.3 | 6.8 | 9.3 | 12.0 | FeO |
| Mn | 10.4 | 13.4 | 5.4 | 7.0 | MnO |
| Ca | 0.3 | 0.4 | 0.5 | 0.7 | CaO |
| Y | 0.8 | 1.0 | 0.4 | 0.5 | Y ₂ O ₃ |
| Nb | 50.8 | 72.7 | 50.8 | 72.7 | Nb ₂ O ₅ |
| Ti | 0.8 | 1.3 | 0.5 | 0.8 | TiO ₂ |
| Ta | 0.7 | 0.9 | 0.6 | 0.7 | Ta ₂ O ₅ |
| Totals | 69.1 | 96.5 | 67.5 | 94.4 | |

EDS spectrum of uranium-bearing niobate, Figure 21 of yttrobetafite and Figure 22 of aeschynite.

Like zircon, the occurrence of columbite is diverse and complex. It is present as inclusions in bastnaesite, silicates, silicate/carbonate complexes; it occurs as intergrowths with zircon and bastnaesite; and, it is a host to minute grains of zircon, thorium silicate and other common silicates (Figs. 4, 6, 7, 7a, 8, 9 and 11). The columbite group minerals are very fine-grained and rarely exceed 25 μm in size.

Fergusonite-(Y): A grain of yttrium niobate was found as a small (10 μm) inclusion in carbonate (Fig. 12). Based on its EDS spectra (Fig. 23), which illustrates the composition of the mineral, the grain was identified as either beta-fergusonite or fergusonite-(Y).

OTHER ORE MINERALS

PYRITE

Pyrite occurs as discrete grains and as inclusions in the silicate/carbonate rock. Although some unaltered pyrite was observed in the ore, the vast majority of it has been replaced to some extent by an iron hydroxide (confirmed by XRD as goethite).

THORIUM SILICATE

Minute amounts of a thorium silicate, defined by EDS spectra (Fig. 24) as being either huttonite or thorite was observed in the ore. The mineral occurs as small to minute inclusions in bastnaesite, columbite and zircon (Figs. 4, 11 & 11a).

CONCLUSIONS

The "mainvein" and "footwall" samples from the Lancer deposit in Yukon are mineralogically and chemically similar. They contain, in weight %, 0.9 Zr, 0.4 to 0.7 Nb, 0.1 Y, and 1.36 rare earth elements (0.6 Ce, 0.4 La, 0.2 Nd, small quantities of Pr, Sm, Gd and Dy).

The Zr occurs as a major constituent of a very fine-grained, poorly crystallized spongy zircon (ZrSiO_4). The zircon is present as minute inclusions in silicates, bastnaesite/parisite and columbite.

The Nb occurs as the major constituent of a variety of minerals grouped under a "generic" term niobates, with ferrocolumbite ($\text{Fe}^{+2}\text{Nb}_2\text{O}_6$) and manganocolumbite ($\text{Mn}^{+2}\text{Nb}_2\text{O}_6$) being the main niobium minerals. The niobates are very fine-grained, and occur as inclusions in silicates, carbonates and bastnaesite/parisite.

The main rare earth mineral is monazite ($(\text{Ce},\text{La},\text{Nd},\text{Th})\text{PO}_4$), and secondary rare earth minerals are bastnaesite ($(\text{Ce},\text{La})(\text{CO}_3)\text{F}$) and parisite ($\text{Ca}(\text{Ce},\text{La})_2(\text{CO}_3)_3\text{F}_2$). The monazite is a rare earth phosphate that contains Ce, La and some Nd. It occurs as discrete grains and as small aggregates up to $150\ \mu\text{m}$ in size. The bastnaesite/parisite are also Ce, La and minerals, but they contain some Nd and small amounts of Sm and Gd. They occur as small irregular grains and aggregates, up to $150\ \mu\text{m}$ in size.

A trace of thorium silicate, probably thorite (ThSiO_4) was found in the ore, and some of the minor niobates contain minor amounts of uranium.

It is qualitatively interpreted that grinding to relatively fine grain sizes will be required to liberate enough of the RE minerals (monazite and bastnaesite/parisite) for a reasonable recovery in a moderate grade RE concentrate. The niobates and zircon are finer-grained than the RE minerals and grinding to even finer grain sizes would be required to liberate and recover them.

An image analysis study is needed to determine the grind size for liberating the minerals.

Metallurgical tests will need to be designed on the basis of the image analysis prediction, and will need to be conducted to determine grades and recoveries that can be obtained with existing metallurgical technologies.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to M. Beaulne for preparation of the concentrates and polished sections of the ore samples; to P. Carrière for the X-ray diffractometer analyses of the ore samples and X-ray powder diffraction analyses of selected minerals; and to personnel in the Chemical assay laboratory for the assays.

REFERENCE

Levison, A.A., (1966) Amer. Min. Vol. 51, 152.

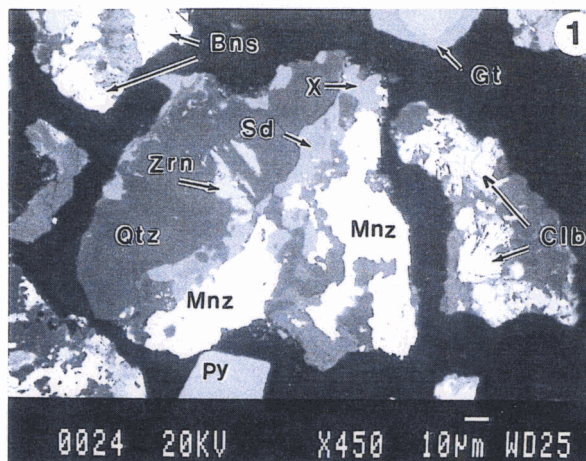


Fig. 1 Backscattered electron (BE) photomicrograph of the polished section (p.s.) prepared from the sink product of the "footwall" showing monazite (Mnz), zircon (Zrn), siderite (Sd), and an unidentified silicate (X) in quartz (Qtz). Bastnaesite (Bns) and manganocolumbite (Clb) are also shown as inclusions in quartz. Pyrite grains (Py), one rimmed by goethite (Gt) are also present in the field.

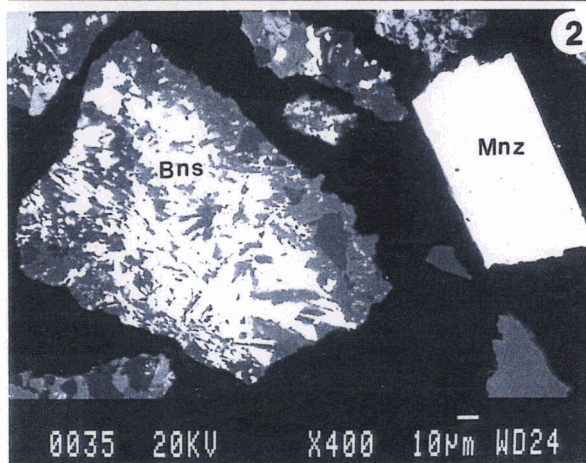


Fig. 2 BE photomicrograph of the p.s. prepared from the sink product of the "footwall" showing a discrete grain of monazite (mnz) and numerous grains of bastnaesite (Bns) in a matrix of albite and ankerite (dark grey).

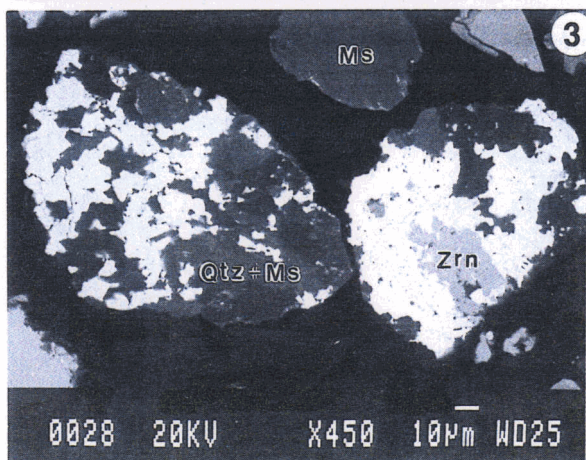


Fig. 3 BE photomicrograph of the p.s. prepared from the sink product of the "footwall" showing bastnaesite disseminated in a silicate matrix of quartz and muscovite (Qtz+Ms) and bastnaesite enclosing zircon (Zrn). Discrete muscovite (Ms) is also visible.

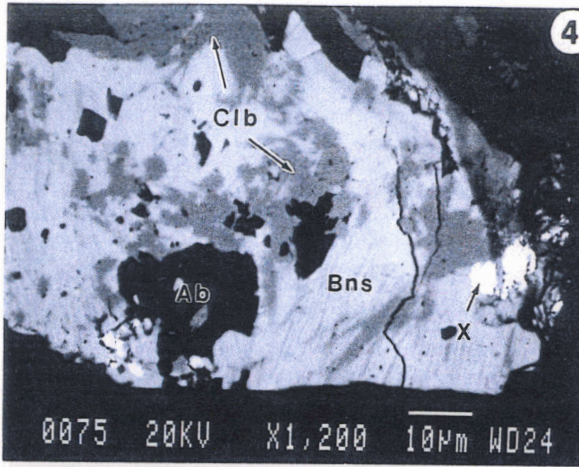


Fig. 4 BE photomicrograph of the p.s. prepared from the sink product of the "footwall" showing ferrocolumbite (Clb), thorium silicate (X) and albite (Ab) locked in bastnaesite (Bns).

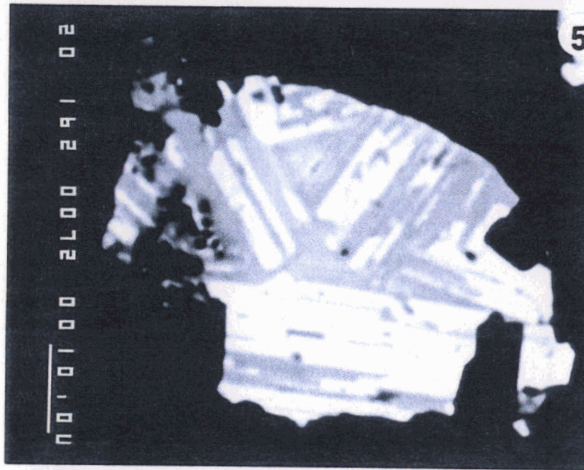


Fig. 5 BE photomicrograph of the p.s. prepared from the sink product of the main-vein showing an intergrowth of bastnaesite (white) and parisite (grey).

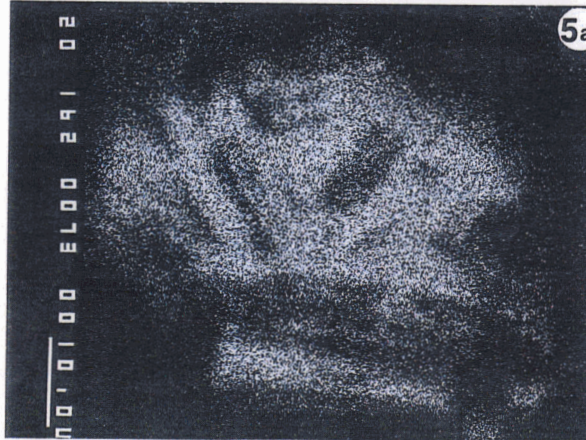


Fig. 5a X-ray photomicrograph for CaKα of the area shown in Fig. 5. The concentrated white dots delineate the calcium-bearing parisite from the bastnaesite.

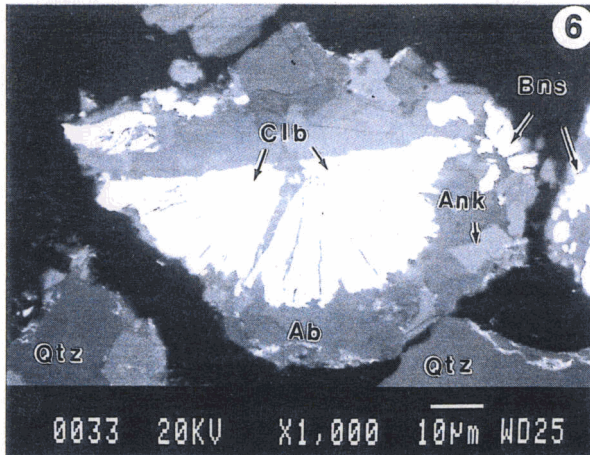


Fig. 6 BE photomicrograph of the p.s. prepared from the sink product of the "footwall" showing a fan of manganocolumbite (Clb) and small grains of bastnaesite (Bns) enclosed in combined quartz (Qtz), albite (Ab) and ankerite (Ank).

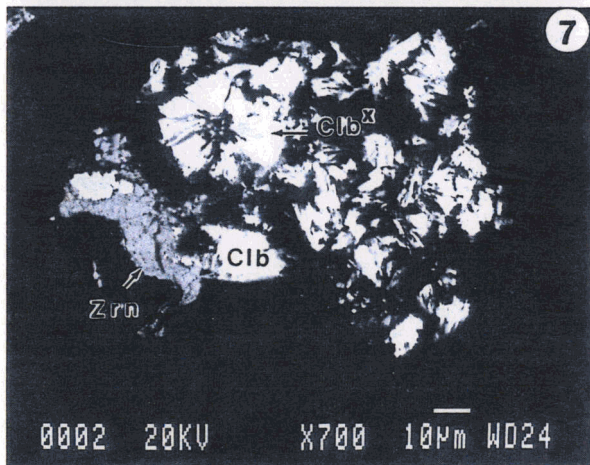


Fig. 7 BE photomicrograph of the p.s. prepared from the sink product of the main-vein showing zircon (Zrn), ferrocolumbite (Clb) and a mixture of ferro-columbite and aeschynite (Clb*) in ankerite (black).

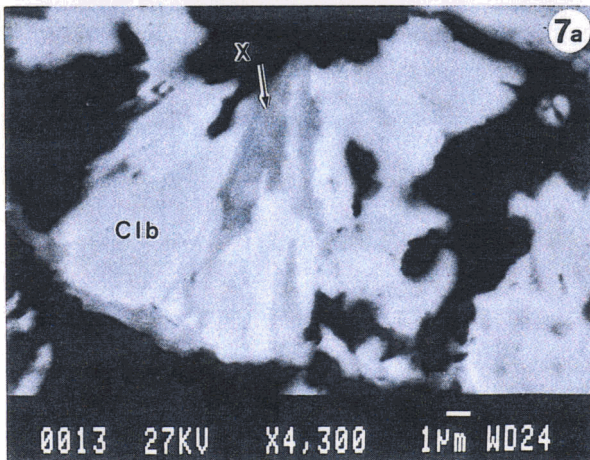


Fig. 7a BE photomicrograph of the area designated Clb* in Fig. 7 taken at a higher magnification. The dark mineral (X) penetrating and coating the ferro-columbite (Clb) is what has been tentatively identified as aeschynite. The ferrocolumbite exhibits some faint compositional zoning.

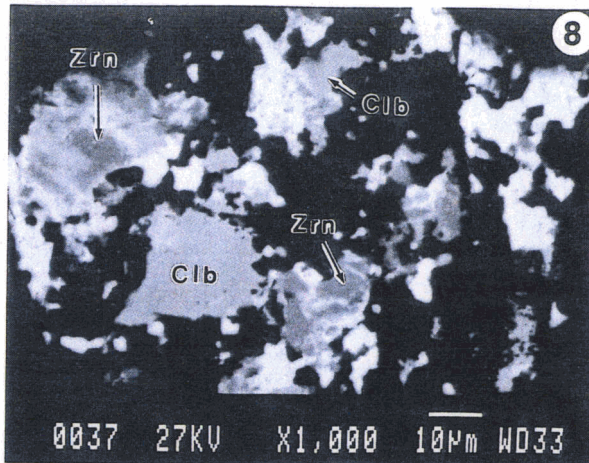


Fig. 8 BE photomicrograph of the p.s. prepared from the sink product of the "footwall" showing combined grains of bastnaesite (white), manganocolumbite (Clb) and zircon (Zrn) in quartz (black).

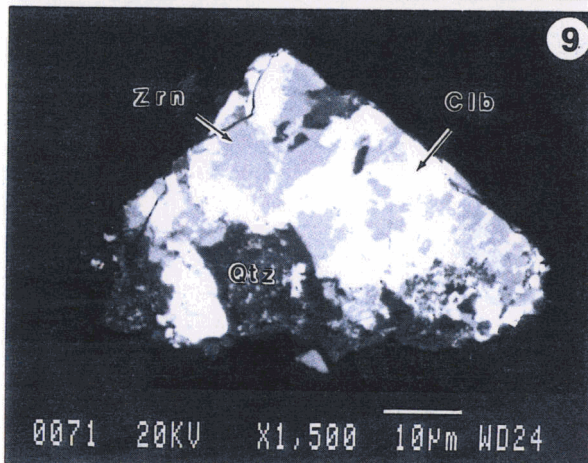


Fig. 9 BE photomicrograph of the p.s. prepared from the sink product of the "footwall" showing yttracolumbite (Clb) combined with quartz (Qtz) and enclosing minute inclusions of zircon (Zrn).

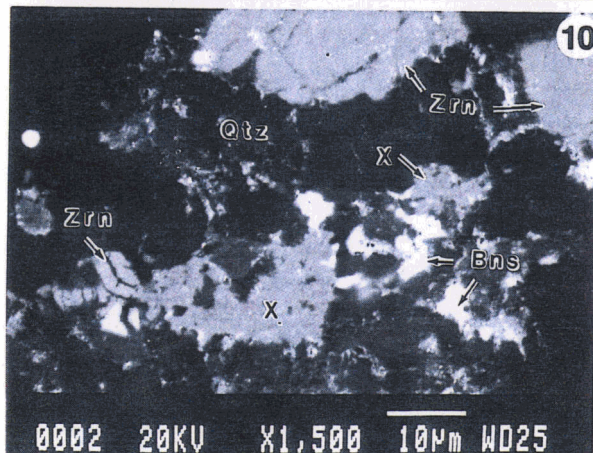


Fig. 10 BE photomicrograph of the p.s. prepared from the -48+65 mesh fraction of the "footwall" sample showing zircon (Zrn), minute bastnaesite (Bns) and a mineral (X) tentatively identified as aeschynite-(Y) as inclusions in quartz (Qtz).

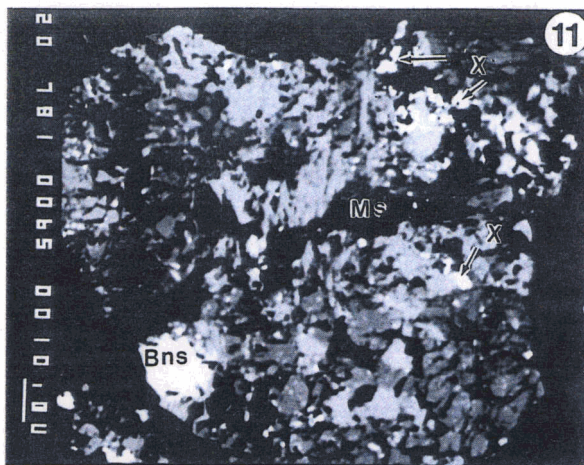


Fig. 11 BE photomicrograph of the p.s. prepared from the sink product of the main-vein showing an intimate intergrowth of fine-grained zircon (dark grey) and ferrocolumbite (light grey) in muscovite (Ms). A number of minute grains of thorium silicate (X) and a larger bastnaesite grain are locked in the complex.

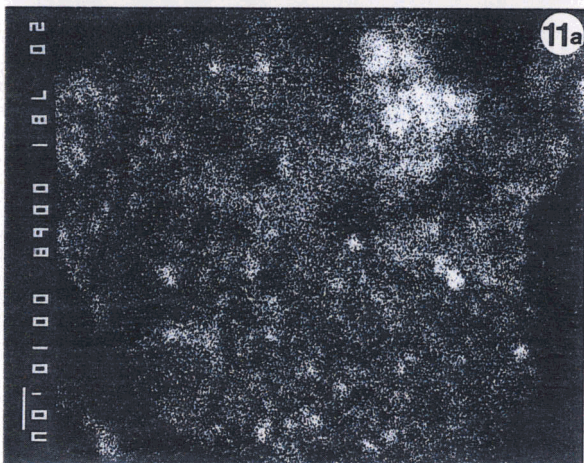


Fig. 11a X-ray photomicrograph for ThLa of the area shown in Fig. 11. The concentrated white dots delineate the inclusions of thorium silicate. The dispersed pattern of dots show that some, but not all of the ferrocolumbite contains minor amounts of thorium.

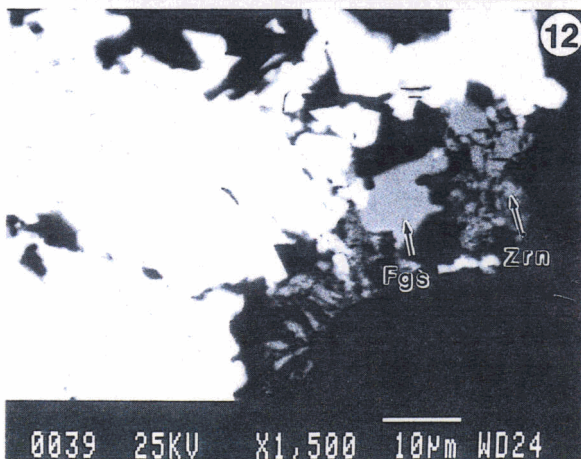


Fig. 12 BE photomicrograph of the p.s. prepared from the sink product of the main-vein showing a small grain of fergusonite-(Y) (Fgs) with zircon (Zrn) and bastnaesite (white) in carbonate (black).

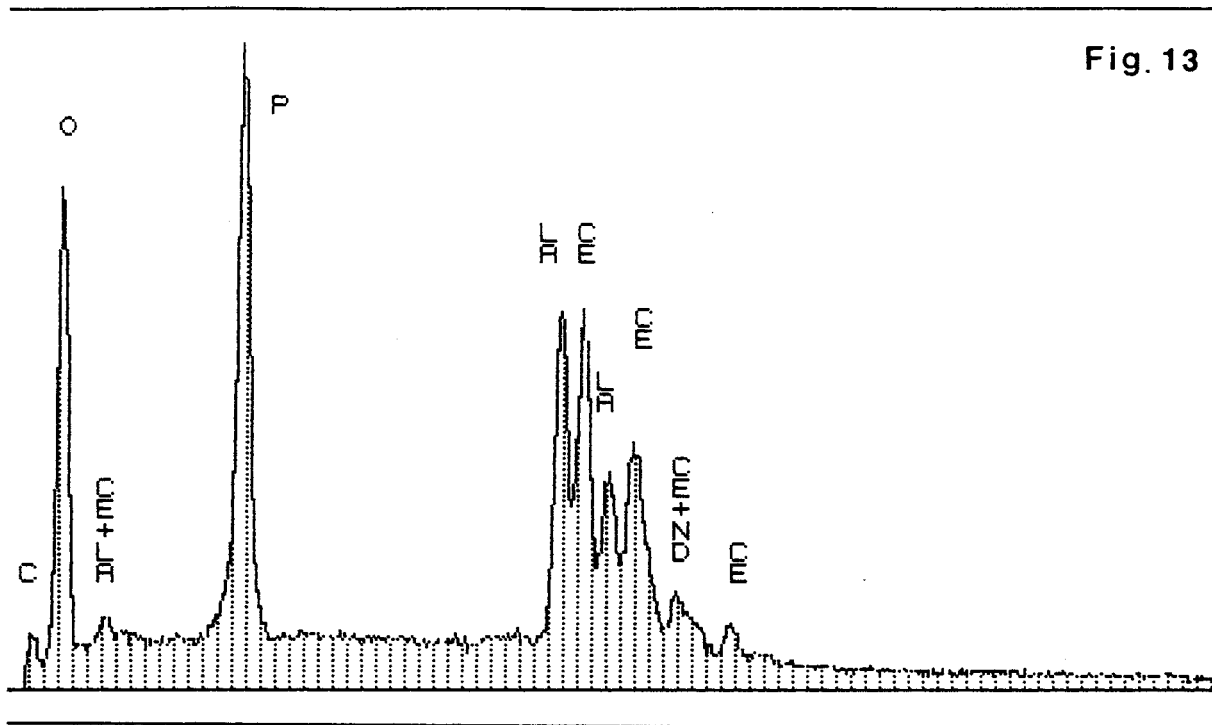


Fig. 13

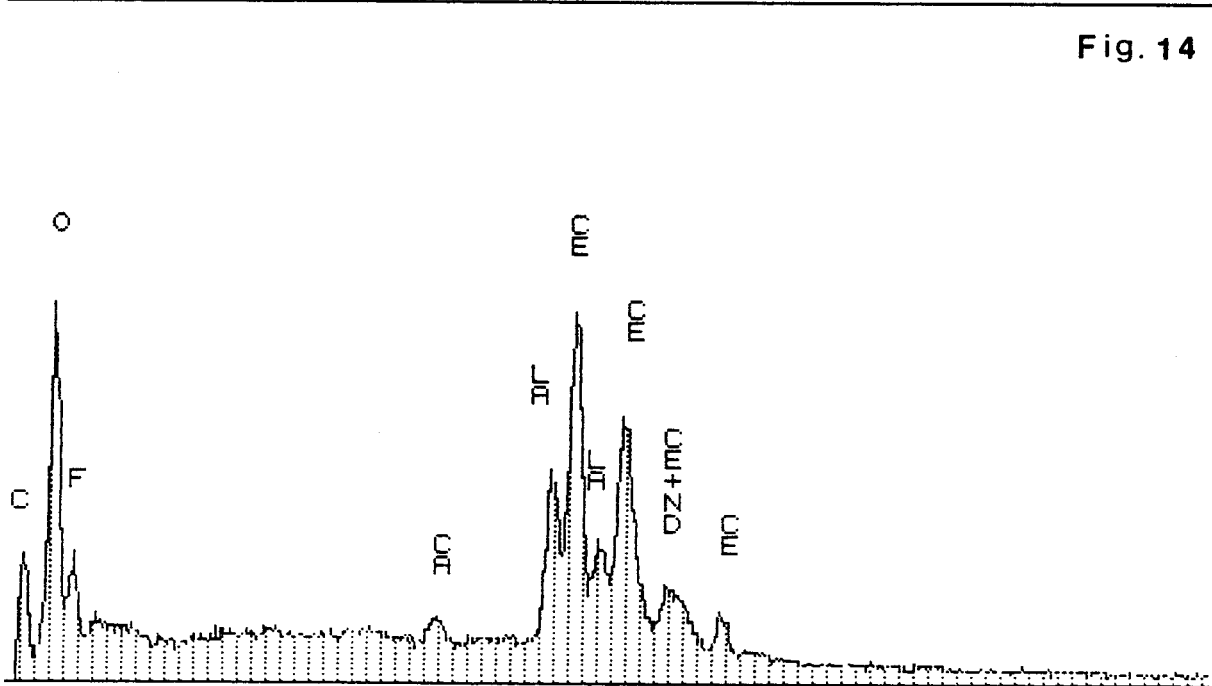


Fig. 14

Fig. 13 EDS spectra of monazite.

Fig. 14 EDS spectra of bastnaesite.

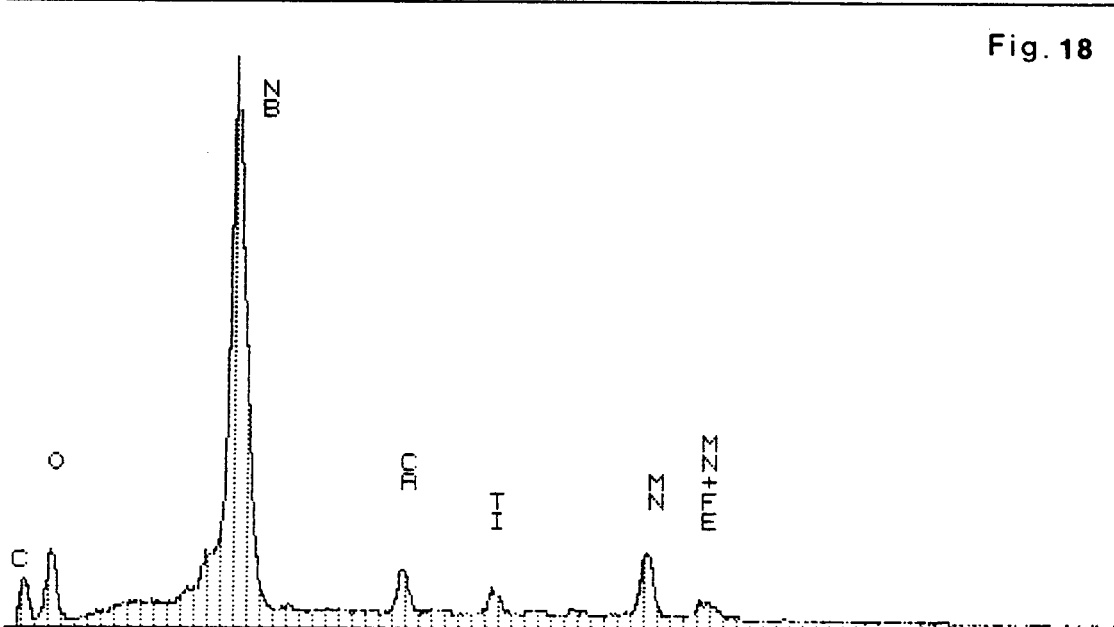
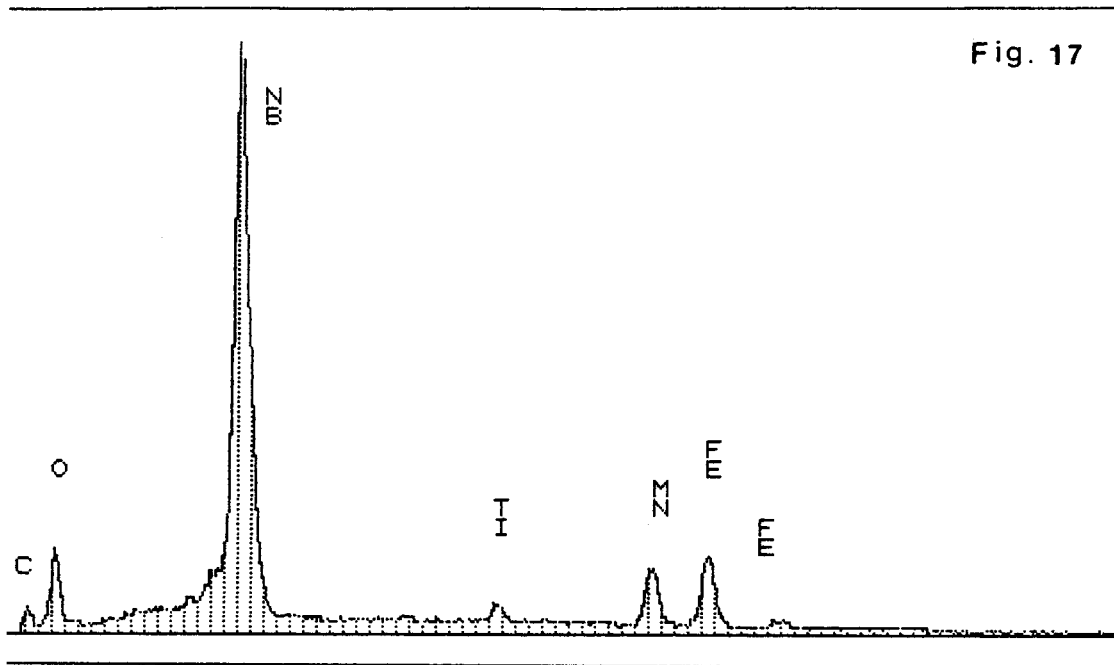


Fig. 17 EDS spectra of ferrocolumbite.

Fig. 18 EDS spectra of manganocolumbite.

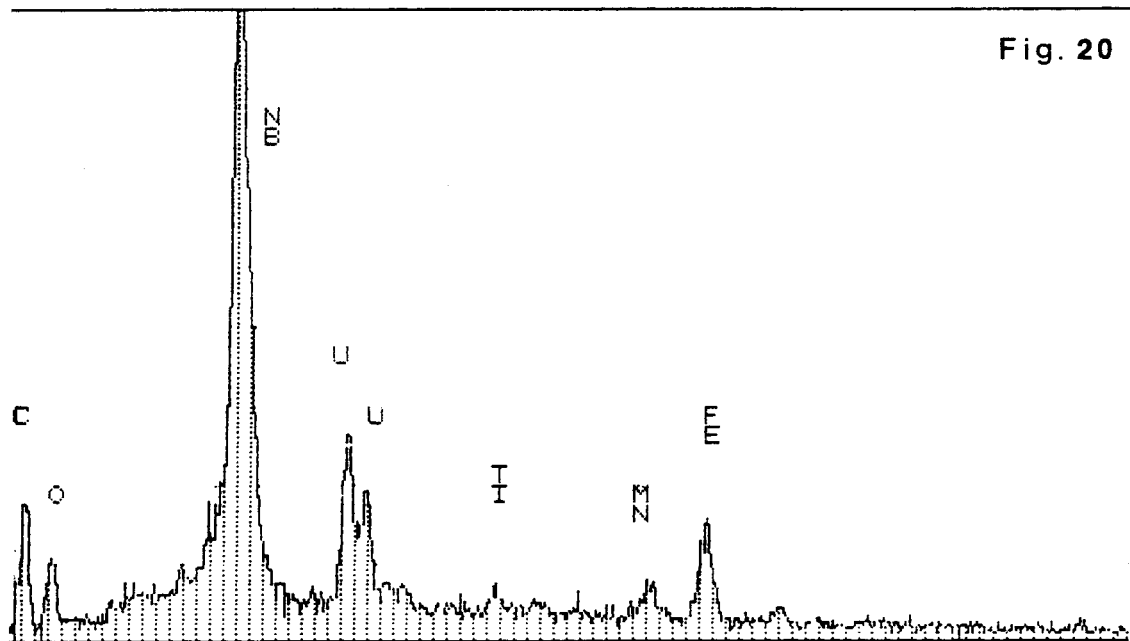
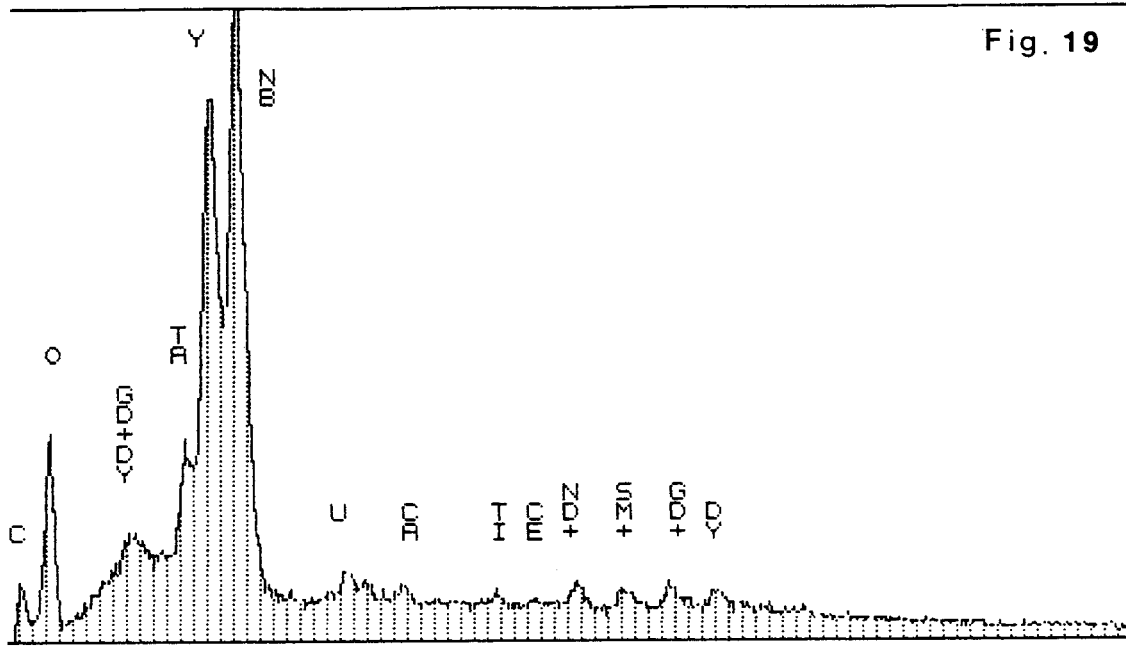


Fig. 19 EDS spectra of yttrium columbite.

Fig. 20 EDS spectra of uranium-bearing niobate.

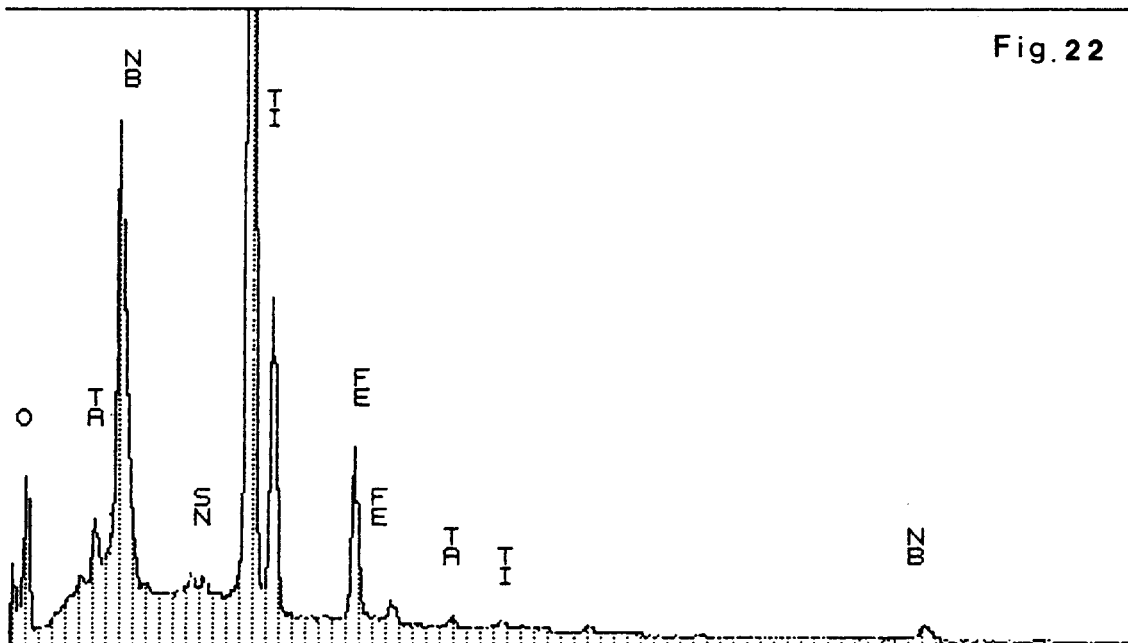
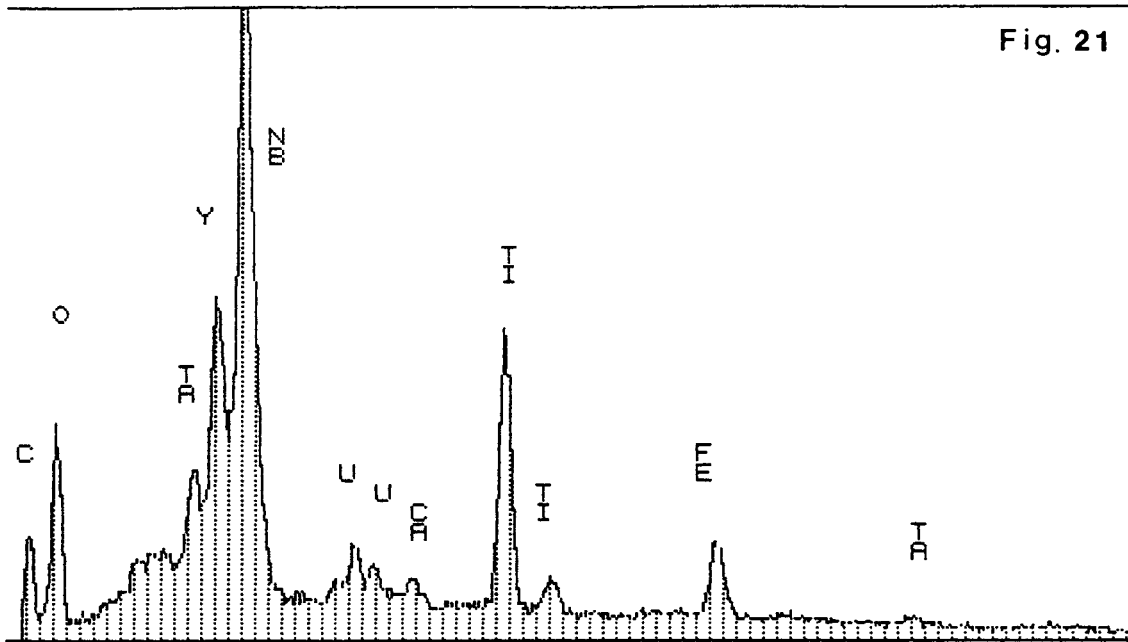


Fig. 21 EDS spectra of ytrobetafite?

Fig. 22 EDS spectra of aeschynite?

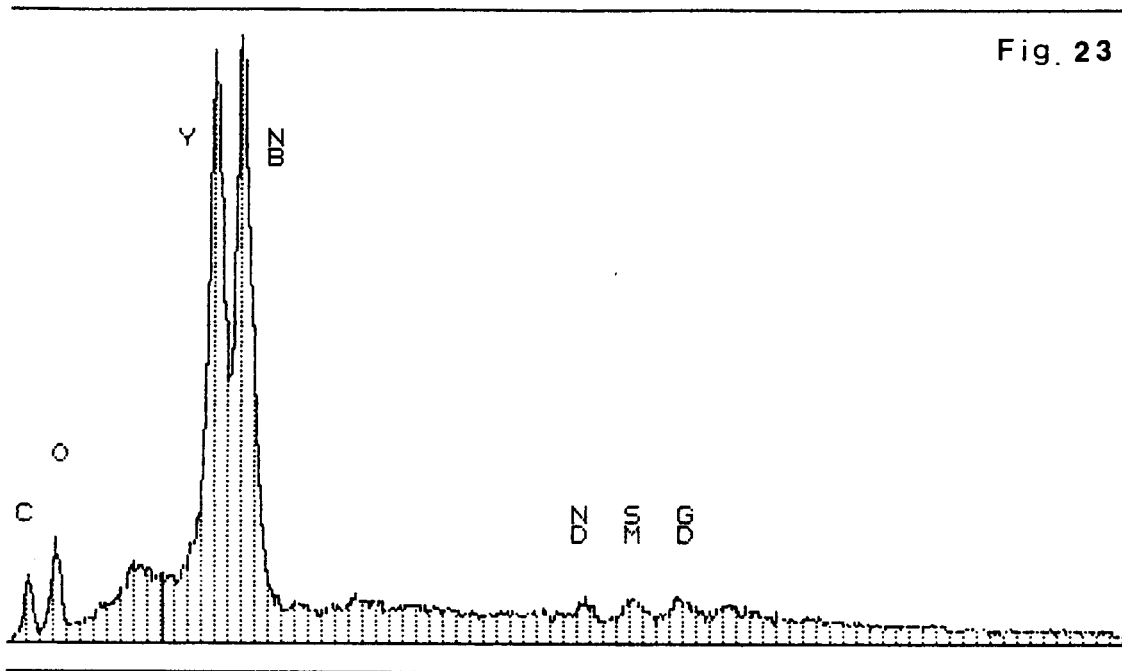


Fig. 24

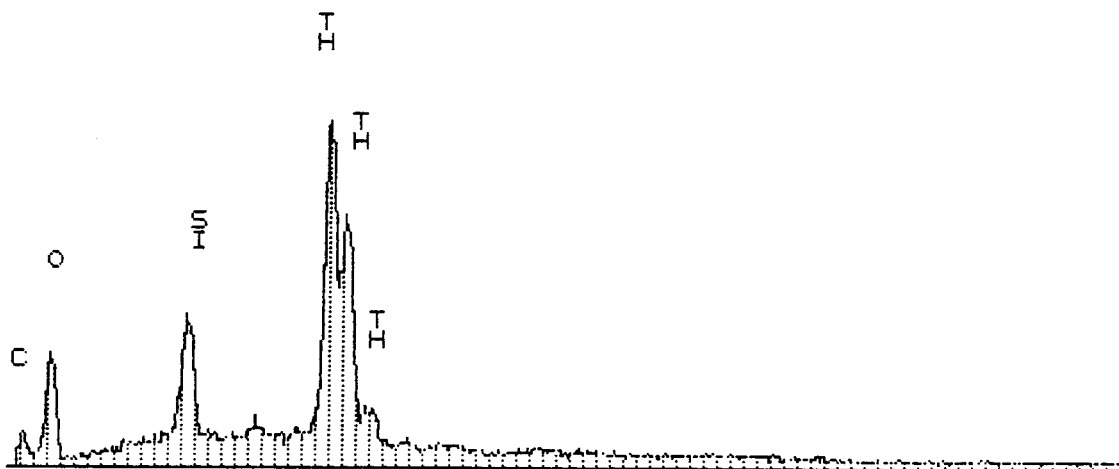


Fig. 23 EDS spectra of fergusonite-(Y).

Fig. 24 EDS spectra of thorium silicate.

MINERALOGICAL ANALYSIS OF
ORE SPECIMENS FROM THE RARE
EARTH DEPOSIT OF DODGEX LTD.

PART II
QUANTITIES OF RARE EARTH MINERALS
AND THEIR LIBERATION CHARACTERISTICS

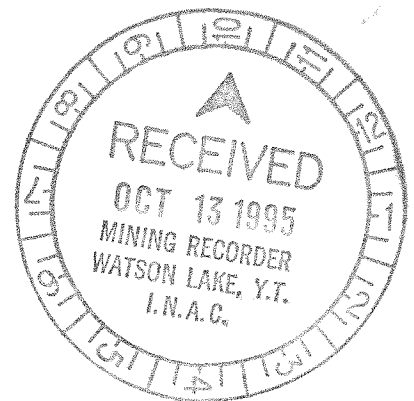
SEPTEMBER 1995

MINERAL SCIENCES LABORATORIES
R. Lastra and D. Owens

Work performed for:
J.S. Dodge
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Whitehorse, Yukon

Job No. 51075

MINERAL SCIENCES LABORATORIES
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EXECUTIVE SUMMARY

A mineralogical study was conducted on rare earth-bearing samples from the Lancer deposit in Yukon, at Dodgex Ltd. Two samples, labelled “mainvein” and “footwall” were analysed. The purpose of the study is to provide guidance for designing processing tests aimed at concentrating the rare earth minerals.

It was found that the mainvein ore contains 8636 ppm Zr, 4089 ppm Nb, 1049 ppm Y, 6297 ppm Ce, 3903 ppm La, and 1886 ppm Nd. The footwall ore contains 9380 ppm Zr, 6888 ppm Nb, 1094 ppm Y, 6520 ppm Ce, 3695 ppm La, and 1997 ppm Nd. The samples also contain small quantities of Pr, Sm, Gd, and Dy, and trace amounts of Eu, Tb, Ho, Er, Tm, Yb and Lu.

The main rare earth mineral is monazite ((Ce,La,Nd,Th)PO₄). For the mainvein ore, a grind to 80% -170 mesh (80% -250 mesh for footwall ore) will liberate 50 to 60% of the monazite, whereas a grind to 80% -250 mesh (80% -400 mesh for footwall ore) will liberate 65 to 75% of the monazite.

The second major rare earth mineral is bastnaesite ((Ce,La)(CO₃)F). For the mainvein ore, a grind to 80% -250 mesh (80% -270 mesh for footwall ore) will liberate 50 to 60% of the bastnaesite, whereas a grind to 80% -325 mesh (80% -400 mesh for footwall ore) will liberate 65 to 75% of the bastnaesite.

The Zr occurs as the major constituent of a poorly-crystallized spongy zircon (ZrSiO₄). The zircon is present as minute inclusions in silicates, bastnaesite/parisite and columbite. For the mainvein ore a grind to 80% -800 mesh (80% -1400 mesh for footwall ore) will liberate 65 to 75% of the zircon.

The Nb occurs as the major constituent of a variety of minerals grouped under the generic term “niobates,” with ferrocolumbite (Fe⁺²Nb₂O₆) and manganocolumbite (Mn⁺²Nb₂O₆) being the main niobium minerals. For the mainvein ore a grind to 80%

-325 mesh (80% -500 mesh for footwall ore) will liberate 65 to 75% of the ferrocolumbite. For the mainvein ore a grind to 80% -270 mesh (80% -500 mesh for footwall ore) will liberate 65 to 75% of the manganocolumbite.

The required grinds to liberate the rare earth minerals are finer for the footwall ore than for the mainvein ore. This is due to the smaller mineral grain sizes found in the footwall ore. Relatively coarser grinds are required to liberate monazite and bastnaesite which are the major rare earth minerals. However, the required grinds to liberate most of the other rare earth minerals are very fine and un-practical for effective mineral processing. Therefore, it is recommended to design the mineral processing tests to concentrate monazite and bastnaesite and accept whatever recovery is obtained for the other less abundant, rare earth minerals. Fifty to sixty percent of the monazite in the mainvein ore would be in particles with at least 70% of monazite by grinding the ore to 80% -170 mesh. At this grind a pre-concentration operation could be performed. Then a re-grind to 80% -400 mesh could be performed followed by other concentration steps. Also leaching tests on the un-ground and re-grinded pre-concentrate should be considered.

It is suggested that gravity separation devices be considered for pre-concentration tests of the ore ground to 80% -170 mesh (80% -90 μm). Many gravity separation devices do not successfully treat material in the 100 μm range. However, devices like the shaking table and the Bartles-Mozley table have been used to effectively treat material in the 100 μm range. It is also suggested that the mainvein ore be treated separately from the footwall ore in the mineral processing tests, at least in the pre-concentration step.

Keywords: rare earth minerals, monazite, bastnaesite, estimation of liberation grinds

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INTRODUCTION

A mineralogical and image analysis study of rare earth-bearing samples from the Lancer deposit in Yukon was undertaken by the Applied Mineralogy Group as a cost recovery project. The deposit is owned by Dodgex Limited, and a MDA grant was contributed by the Yukon Department of Natural Resources for a mineralogical characterization which would provide guidance in processing the ore. A contract was drawn-up between CANMET (CANMET/MSL Project 51075) and Mr. Dodge, President, Dodgex Ltd., 14 MacDonald Road, Whitehorse, Yukon on February 3, 1995. Two 100 kilogram samples of the ore were received by CANMET on February 17, 1995 from Mr. Dodge. The samples consisted of rock fragments averaging ≈ 30 cm in size, and were labelled "mainvein" and "footwall".

The mineralogical and image analysis study was performed in two parts. The first part, to identify the rare earth minerals and to determine their compositions and mode of occurrence has already been submitted to Dodgex Ltd. This report is Part II and deals with the relative quantities of rare earth minerals and their liberation characteristics.

METHOD OF INVESTIGATION

The same sample preparation procedure was followed for Part I and for Part II of the investigation. The rock fragments from the two samples were crushed to -4.7 mm (-4 mesh) and split into 50 kg subsamples. One sub-sample of each type was crushed to -1.7 mm (-10 mesh). A 2 kg sample was then split from the "mainvein" and "footwall" sub-samples and ground to $-295 \mu\text{m}$ (-48 mesh). Size fractionation was performed on the -48 mesh product and, in addition, the $-147+45 \mu\text{m}$ (-100+325 mesh) fractions were separated into sink and float sub-fractions using a heavy liquid with a specific gravity of 3.30. The two sink fractions, in which the rare earth ore minerals were concentrated were mounted in polished sections. This procedure already suggests that the rare earth minerals are amenable to gravity concentration.

The polished sections were studied with a KONTRON-IBAS image analyser coupled with a JEOL -733 electron microprobe and an energy dispersive system. An image analysis program of more than 1200 lines was specifically developed for this part of the study. The program was designed in basis of the general mineralogy findings given in PART I of the report (Lastra and Owens, April 1995). The image analysis was executed using backscattered electron (BSE) images to discriminate the gangue minerals (quartz, albite, pyroxene, muscovite, ankerite, dolomite, siderite, calcite and rhodochrosite), the iron oxides (goethite and magnetite), pyrite, and zircon. The rare earth minerals were segmented into three image-groups at the higher end of the BSE grey level. These groups included, chalcopyrite, sphalerite and metallic iron (contamination from grinding). The discrimination between the minerals in the rare-earth groups was done by an energy dispersive scan on each mineral grain to determine the X-ray counts for sixteen elements: La, Ce, P, Ca, Si, Y, Zr, Nb, U, Fe, Mn, Ti, Th, Cu, Zn and S. The X-ray counts for each mineral grain were normalized and used in a classification algorithm to discriminate between the minerals in the three groups. The following rare earth minerals were thus discriminated: monazite, bastnaesite, parisite, ferrocolumbite, manganocolumbite, uranium-niobate, fergusonite-(Y), yttracolumbite, yttrobetafite, aeschynite, thorite, and zircon. Chalcopyrite, sphalerite and metallic iron were left in one group, since discrimination between these minerals is not important for the present study. A meander of 10x10 contiguous frames was done at a magnification of 100 times. Therefore a total of one hundred BSE images was analysed. The image analysis program written for this job was set up to determine the mineral quantities and to measure the grain size distribution of each of the discriminated rare earth minerals to estimate their liberation grinds. Approximately 4000 particles were analysed in the meander for each polished section.

RESULTS

SAMPLE FRACTIONATION

Data for the size fractionation performed on the ground samples to -48 mesh are given in Table 1. Size fractions -100+200 and -200+325 were joined to form the

-100+325 mesh fraction which was separated into sink and float sub-fractions using a heavy liquid with a specific gravity of 3.30. Table 2 gives the proportions of sink and float products. Approximately 2.7 wt% of the -100+325 mesh fraction reports to the heavy mineral concentrate.

RELATIVE MINERAL QUANTITIES

The mineral quantities measured by image analysis in the heavy mineral concentrate fraction are given in Table 3. It should be noted that yttröbetafite was reported in Part I to contain Nb, Y, Ti, Ta, and Fe. At the time of setting the image analysis program it was found that yttröbetafite also contained Rb, U, and Th.

Table 3 shows that monazite is the most abundant rare earth mineral, followed by bastnaesite, ferrocolumbite and zircon. The microprobe analysis of the rare earth minerals (Part I) reported no significant difference between them in the mainvein sample and in the footwall sample, the chemical assays also showed that the two samples are similar and the quantity of heavy mineral concentrate from both samples is similar. Table 3 shows that the mainvein ore is apparently richer in rare earth minerals than the footwall ore. The heavy mineral concentrate from the mainvein has 25 wt% monazite whereas the concentrate from the footwall has ≈ 10 wt% monazite. However, the higher concentration of rare earth minerals in the concentrate of the mainvein is due to a higher liberation of these minerals in the -100+325 size fraction of the mainvein ore.

Polished sections prepared from the un-concentrated -48+65 size fraction were also studied with a scanning electron microscope. However, it was very difficult to locate rare earth mineral grains. Therefore the strategy of using a heavy liquid to produce a heavy mineral concentrate proved very useful in the characterization of the rare earth minerals. Table 3 also gives an estimate of the quantity of rare earth mineral in the original un-concentrated sample. This estimate was calculated from the amount of heavy mineral concentrate and the measured quantities of rare earth minerals in it. The estimated quantities of rare earth mineral in the original samples are not accurate, and are solely given to provide order of magnitude amounts. These very low amounts

prevent reliable determination of the quantities directly from polished sections of the original un-concentrated samples. Therefore chemical assays for the rare earth elements in the original samples (Table 1 in Part I) should be used to estimate the reserves of the ore.

ESTIMATED LIBERATION GRIND

As described in Part I, the grain size of the rare earth minerals is quite fine. Due to this fact, it is possible to estimate the required grinds for liberation from grain size measurements in the heavy mineral concentrate from the -100+325 size fraction. This fraction still preserves the grain size distribution found in the un-ground ore. The heavy mineral concentrates also provide a large grain population of the major rare earth minerals thus allowing a better estimation of the required grind for liberation. The measured populations for monazite, bastnaesite, zircon and ferrocolumbite was approximately 3,300, 2,500, 1,500 and 1,000 grains respectively. Thus, the estimated liberation for these minerals is more reliable.

The results of the measured grain size are plotted to give the cumulative grain size distribution (Figures 1 to 6). The X-axis of these figures gives the size (μm) of the mineral grains; the Y-axis gives the cumulative weight percent of the mineral in grains finer than the given size. For example, Fig. 1 shows that 70% of the monazite in the heavy mineral concentrate of the mainvein sample is finer grained than $75 \mu\text{m}$ ($\equiv 200$ mesh).

Figure 1 gives the cumulative grain size distribution, in the mainvein sample, for monazite (mona), bastnaesite (basn), zircon (zir), and ferrocolumbite (Fe-cmb). Figure 2 gives the cumulative grain size distribution for parisite (paris), yttröbetafite (Y-beta), uranium niobate (U-nb) and yttröcolumbite (Y-cmb). The grain size distribution curves for parisite and uranium niobate are average trends. This was done because of the small number of parisite and uranium-niobate grains in the sample. The average for each point was calculated from the measured data at the point and the measured data at the two adjacent points. Figure 3 gives the cumulative grain size distribution for

manganocolumbite (Mn-cmb), thorite (thor), aeschynite (aschy), and fergusonite-(Y) (Y-ferg). Again, curves for manganocolumbite and aeschynite are average trends. Similarly, Figures 4 to 6 give the grain size distributions in the footwall sample.

These figures can be used to estimate the required grinds to achieve liberation of the minerals. According to Petruk (1986), the grain size distribution of a mineral is the basis for predicting a minimum, an optimum and a practical grind for liberating the mineral.

Minimum grind is considered to be equal to the size distribution of the mineral in the unbroken ore. When the ore is ground to this size, liberation of the mineral is expected to be around 50 to 60%. That is, 50 to 60% of the mineral in the ore will be in particles with at least 70% of that mineral.

Optimum grind is defined as the size below which liberation does not improve significantly. This occurs when there is a significant change of slope going from finer sizes to coarser sizes. In practice there is a compromise between the values for minimum grind and optimum grind. Such grind is referred to as the practical grind.

The minimum grind is indicated in Figures 1 to 6 by the arrow at 80% in the Y-axis, the practical grind is indicated by an arrow at 50%. The estimated minimum grind, practical grind, and the optimum grind obtained from Figures 1 to 6 are summarised in Tables 4 and 5. Table 4 gives the grind sizes in micrometres and Table 5 in “mesh” units. The data in brackets are for the “footwall” sample, those not in brackets are for the “mainvein” sample. The predicted liberation in the tables is given considering the percentage of the mineral of interest that would be in particles with at least 70% of that mineral.

RECOMMENDATIONS

The data in Table 4 (or Table 5) shows that the footwall ore needs to be ground finer than the mainvein ore to achieve a given liberation. This is due to the smaller mineral grain sizes found in the footwall ore. Relatively coarser grinds are required to liberate monazite and bastnaesite, which are the major rare earth minerals. However, very fine grinds are required to liberate most of the other rare earth minerals. Therefore it is recommended that the mineral processing tests be designed to concentrate the monazite and the bastnaesite and accept whatever recovery is achieved of the other, less abundant rare earth minerals. Table 5 shows that 50 to 60% of monazite in the mainvein ore would be in particles with at least 70% of monazite by grinding the ore to 80% -170 mesh. At this grind a pre-concentration operation could be performed. Then re-grind to 80% -400 mesh and perform other concentration steps. Even though a grind to 80% -500 is too fine for many mineral processing concentration operations, some re-grind tests to that point should be considered, because the liberation data indicates a high liberation for monazite at that grind. Also leaching tests on the un-ground and re-grounded pre-concentrate should be considered.

It is also suggested that gravity separation devices be considered for pre-concentration tests of the ore ground to 80% -170 mesh (80% -90 μm). Many gravity separation devices do not successfully treat material in the 100 μm range. However, devices like the shaking table and the Bartles-Mozley table have been used to treat effectively material in the 100 μm range.

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Table 1 - Size fractionation of the -48 mesh ground samples

| Size fraction | | Weight % | |
|-------------------|----------|----------|----------|
| [μm] | [mesh] | mainvein | footwall |
| -295+208 | -48+65 | 15.7 | 18.6 |
| -208+147 | -65+100 | 12.6 | 12.1 |
| -147+74 | -100+200 | 23.6 | 19.8 |
| -74+45 | -200+325 | 14.9 | 14.1 |
| -45 | -325 | 33.2 | 35.5 |

Table 2 - Heavy mineral concentration using a liquid with a specific gravity of 3.3

| PRODUCT | Weight % | |
|---------|----------|----------|
| | mainvein | footwall |
| Float | 97.1 | 97.4 |
| Sink | 2.9 | 2.6 |

Table 3 - Mineral quantities as determined by image analysis in the heavy mineral concentrate of samples from "mainvein" and "footwall"

| MINERAL OR MINERAL GROUP | QUANTITY OF MINERAL wt % | | | |
|--|---------------------------------|-----------------------------------|---------------------------------|-----------------------------------|
| | MAINVEIN | | FOOTWALL | |
| | Heavy mineral concentrate | Original sample (estimated) | Heavy mineral concentrate | Original sample (estimated) |
| gangue | 29.8 | | 57.5 | |
| iron oxides | 10.3 | | 3.26 | |
| pyrite | 22.5 | | 15.7 | |
| zircon | 1.2 | 0.03 | 1.3 | 0.03 |
| ferrocolumbite | 3.3 | 0.1 | 1.8 | 0.05 |
| manganocolumbite | 0.1 | 0.003 | 1.6 | 0.04 |
| uranium niobate | 0.02 | 0.0006 | 0.05 | 0.001 |
| fergusonite-(Y) | 0.002 | 0.00006 | 0.0004 | 0.00001 |
| ytrocolumbite | 0.2 | 0.006 | 0.02 | 0.0005 |
| ytrobetafite | 0.2 | 0.006 | 0.1 | 0.003 |
| aeschnite | 0.004 | 0.0001 | 0.005 | 0.0001 |
| monazite | 25.2 | 0.7 | 9.7 | 0.2 |
| parisite | 0.3 | 0.01 | 0.4 | 0.01 |
| bastnaesite | 6.9 | 0.2 | 8.5 | 0.22 |
| thorite | 0.03 | 0.001 | 0.002 | 0.00005 |
| chalcopyrite, sphalerite and metallic iron | 0.04 | | 0.05 | |

Table 4 - Estimated minimum, practical and optimum grind for liberation, all values in micrometres.
Data inside brackets are for the minerals in the "footwall" sample, those not in brackets are for the minerals in the "mainvein" sample.

| | Minimum grind, 80% passing (predicted liberation 50 to 60%) | Practical grind, 80% passing (predicted liberation 65 to 75%) | Optimum grind, 80% passing (predicted liberation 85 to 95%) |
|------------------|--|--|--|
| monazite | 90 (63) μm | 63 (37) μm | 26 (13) μm |
| bastnaesite | 63 (52) μm | 45 (37) μm | 18 (13) μm |
| ferrocolumbite | 63 (37) μm | 45 (\approx 26) μm | 18 (9.4) μm |
| zircon | \approx 37 (\approx 26) μm | \approx 18 (\approx 13) μm | 9.4 (6.6) μm |
| parisite | 147 (45) μm | 52 (18) μm | 13 (6.6) μm |
| yttröbetafite | \approx 26 (26) μm | \approx 18 (18) μm | 9.4 (6.6) μm |
| uranium niobate | 90 (45) μm | 52 (26) μm | 9.4 (9.4) μm |
| yttröcolumbite | 74 (18) μm | 45 (13) μm | 18 (4.6) μm |
| manganocolumbite | 90 (45) μm | 52 (26) μm | 9.4 (9.4) μm |
| thorite | \approx 26 (4.6) μm | \approx 18 (3.3) μm | 9.4 (\leq 3.3) μm |
| aeschnite | \approx 37 (\approx 18) μm | \approx 18 (\approx 9.4) μm | 6.6 (4.6) μm |
| fergusonite-(Y) | \approx 9.4 (\leq 4.6) μm | 6.6 (3.3) μm | 4.6 (\leq 3.3) μm |

Table 5 - Estimated minimum, practical and optimum grind for liberation, all values in mesh units.
Data inside brackets are for the minerals in the "footwall" sample, those not in brackets are for the minerals in the "mainvein" sample.

| | Minimum grind, 80% passing (predicted liberation 50 to 60%) | Practical grind, 80% passing (predicted liberation 65 to 75%) | Optimum grind, 80% passing (predicted liberation 85 to 95%) |
|------------------|--|--|--|
| monazite | 170 (250) mesh | 250 (400) mesh | 500 (1400) mesh |
| bastnaesite | 250 (270) mesh | 325 (400) mesh | 800 (1400) mesh |
| ferrocolumbite | 250 (400) mesh | 325 (\approx 500) mesh | 800 (1600) mesh |
| zircon | \approx 400 (\approx 500) mesh | \approx 800 (\approx 1400) mesh | 1600 (2400) mesh |
| parisite | 100 (325) mesh | 270 (800) mesh | 1400 (2400) mesh |
| yttröbetafite | 500 (500) mesh | \approx 800 (800) mesh | 1600 (2400) mesh |
| uranium niobate | 170 (325) mesh | 270 (500) mesh | 1600 (1600) mesh |
| yttröcolumbite | 200 (800) mesh | 325 (1400) mesh | 800 (3200) mesh |
| manganocolumbite | 170 (325) mesh | 270 (500) mesh | 1600 (1600) mesh |
| thorite | \approx 500 (3200) mesh | \approx 800 (\leq 3200) mesh | 1600 (\leq 3200) mesh |
| aeschnite | \approx 400 (\approx 800) mesh | \approx 800 (\approx 1600) mesh | 2400 (3200) mesh |
| fergusonite-(Y) | \approx 1600 (\leq 3200) mesh | 2400 (\leq 3200) mesh | 3200 (\leq 3200) mesh |

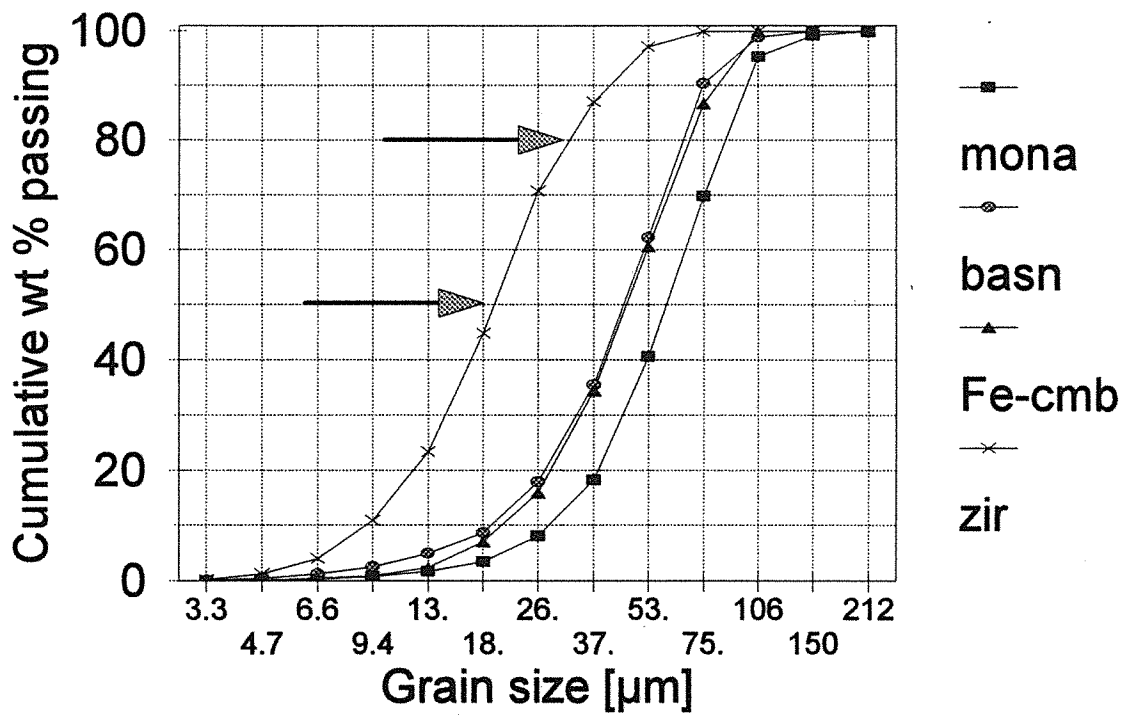


Fig. 1 - Cumulative grain size distribution for monazite (mona), bastnaesite (basn), zircon (zir), and ferrocolumbite (Fe-cmb) in the mainvein ore.

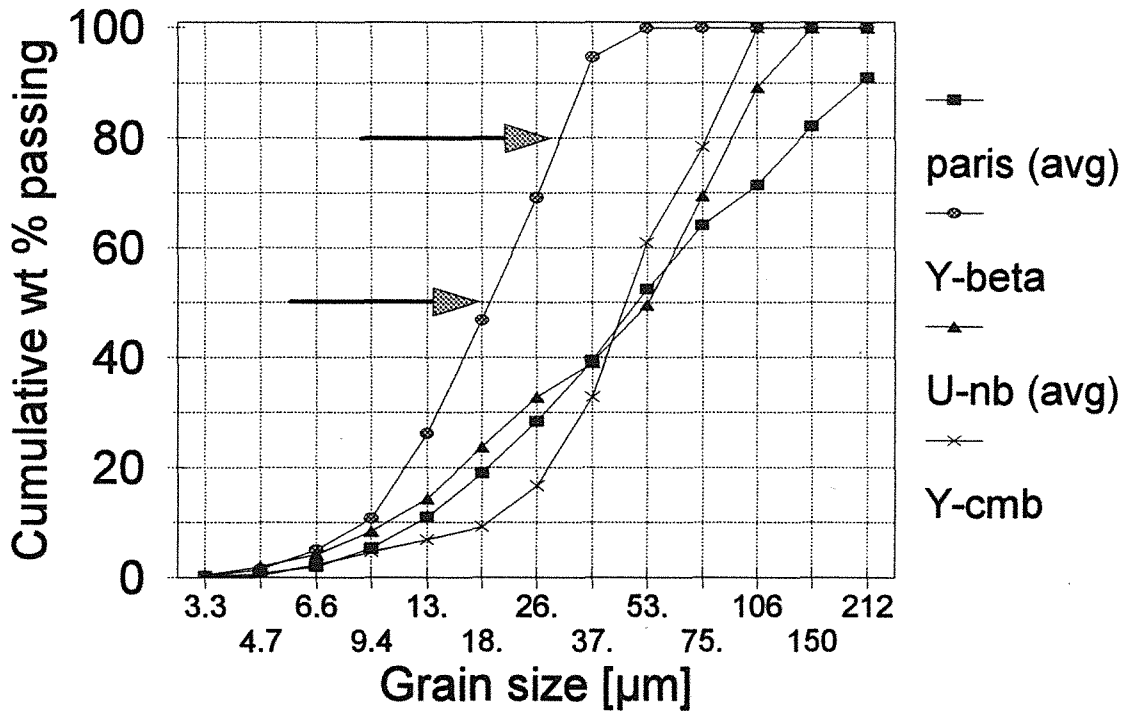


Fig. 2 - Cumulative grain size distribution for parisite (paris), yttrbetafite (Y-beta), uranium niobate (U-nb) and Yttrocolumbite (Y-cmb) in the mainvein ore. The grain size distribution curves for parisite and uranium niobate are average trends.

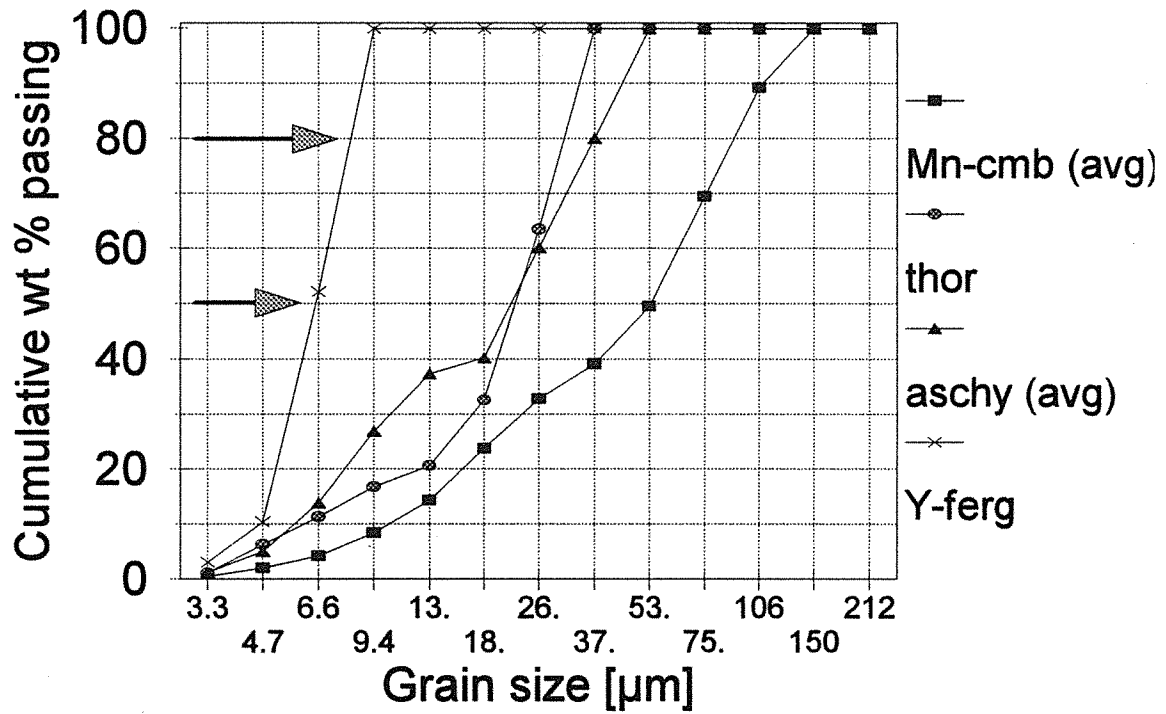


Fig. 3 - Cumulative grain size distribution for manganocolumbite (Mn-cmb), thorite (thor), aeschynite (aschy), and fergusonite-(Y) (Y-ferg) in the **mainvein ore**. Curves for manganocolumbite and aeschynite are average trends.

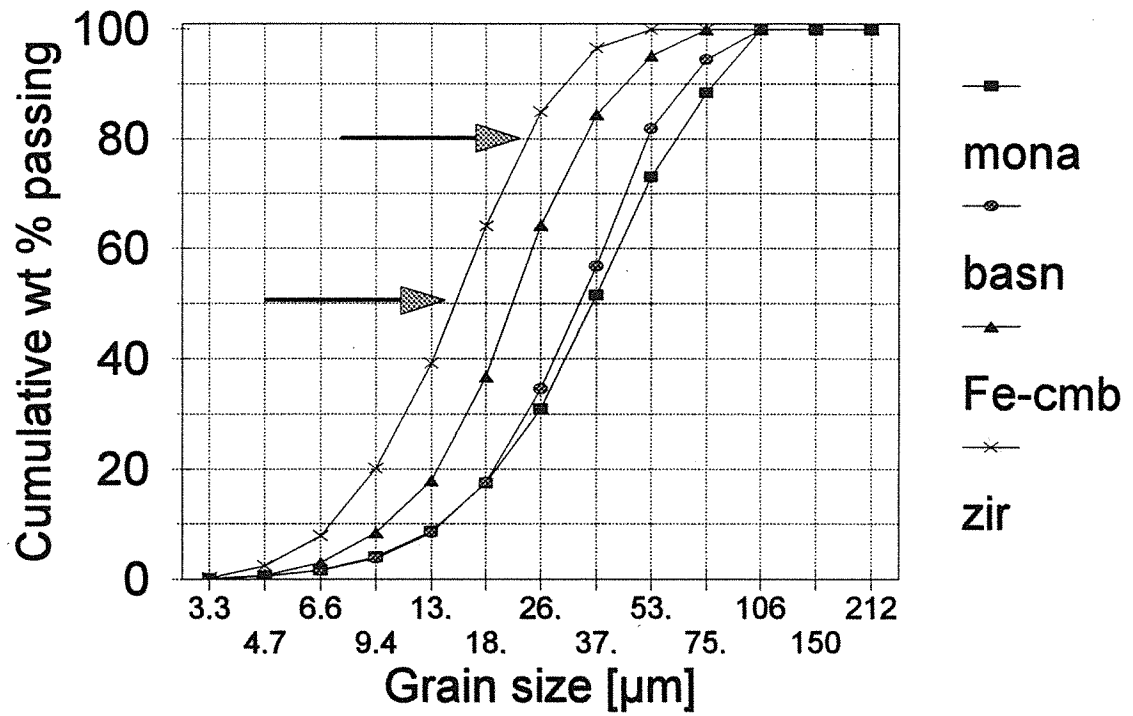


Fig. 4 - Cumulative grain size distribution for monazite (mona), bastnaesite (basn), zircon (zir), and ferrocolumbite (Fe-cmb) in the footwall ore.

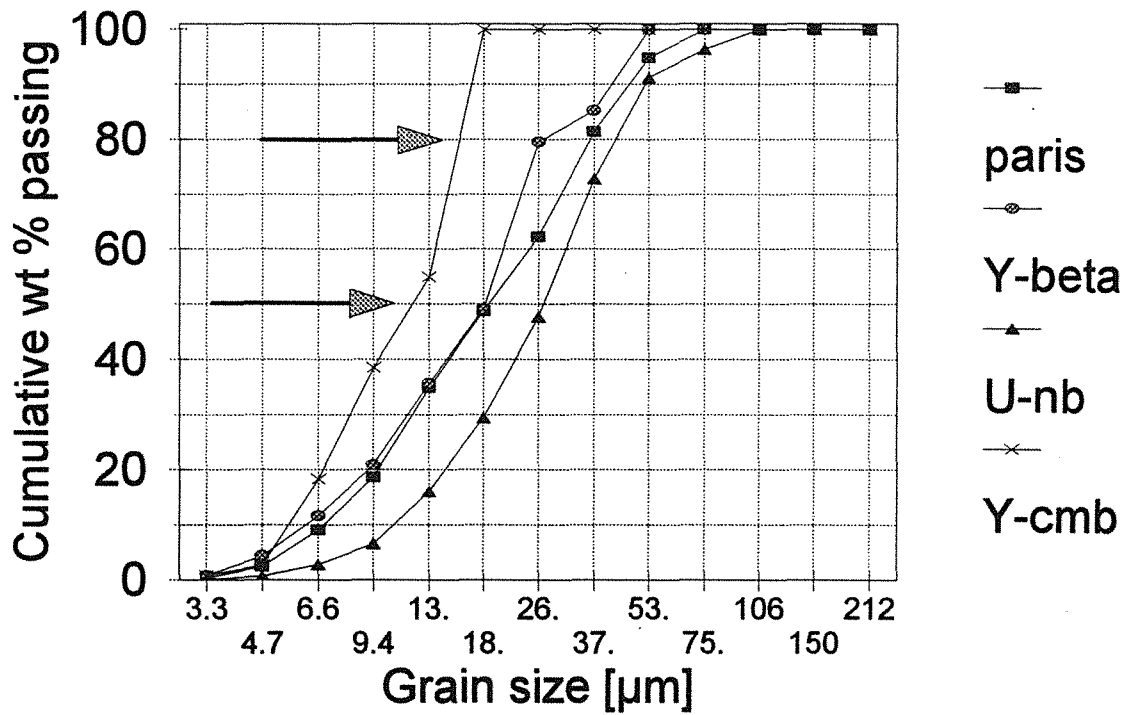


Fig. 5 - Cumulative grain size distribution for parisite (paris), yttrobetafite (Y-beta), uranium niobate (U-nb) and Yttrocolumbite (Y-cmb) in the footwall ore.

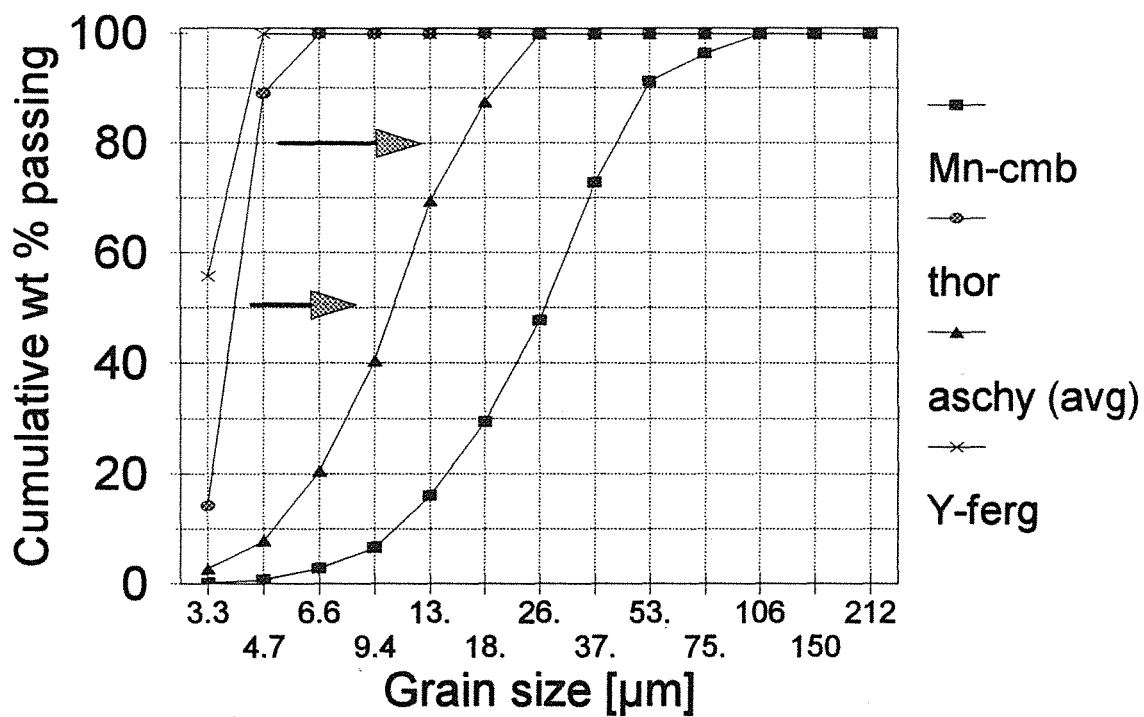


Fig. 6 - Cumulative grain size distribution for manganocolumbite (Mn-cmb), thorite (thor), aeschynite (aschy), and fergusonite-(Y) (Y-ferg) in the footwall ore. Curve for aeschynite is an average trend.