GEOLOGICAL AND GEOCHEMICAL REPORT ON THE TOM-1 MINERAL CLAIM HOMAN LAKE, B.C.

ATLIN MINING DIVISION

LATITUDE 59° 55' NORTH LONGITUDE 135° 10' WEST

N.T.S. MAP SHEET 104-M/14E

For

E & B Explorations Ltd.

By

R.R. Culbert, PhD., P.Eng.

D.G. Leighton & Associates Ltd.

28 February 1979

7385

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TOM PROPERTY
HOMAN LAKE, B.C.

INTRODUCTION

This report describes the results of geochemical sampling and geological prospecting for uranium on the TOM property. Work was completed between July 21st and 27th by three men working out of a tent camp. This work was follow-up to geochemical anomalies derived from a regional survey.

The conclusions and recommendations set forth here are based on the work cited above.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1. The TOM property is comprised of one unsurveyed mineral claim (20 units) located immediately south of Tom Thumb Mountain, 37 kilometres southwest of Carcross, Yukon Territory.

2. The property is underlain by five phases of intrusive rock varying from granodiorite to quartz monzonite in composition, and three units of volcanic rock consisting of rhyodacite, andesite and diatreme breccia.

3. Many minor showings of molybdenite and chalcopyrite were found in one area of the claim, but rocks are unaltered and overall grade is negligible.

4. Two zones anomalous in uranium were indicated from analysis of stream sediment samples. The first is co-extensive with the area of base metal showings, but the second is not associated with surface indications of base metals nor radioactivity.

5. Considering the correlation between uranium anomalies and organic areas, and with the absence of geological features indicative of worthwhile mineralization, it is recommended that no additional work be done on these claims at this time. The claims should be kept in good standing, however, pending results from our other properties and the Atlin camp.

Respectfully submitted,

R.R. Culbert, PhD., P.Eng.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
R. R. CULBERT

28 February 1979

GENERAL DESCRIPTIONS

Location and Access

Latitude 59° 55' North; longitude 135° 10' West. Located 2.5 kilometres northeast of Homan Lake and immediately south of Tom Thumb Mountain, 37 kilometres southwest of Carcross, Yukon Territory, and 11 kilometres west of Bennett, B.C. The property is accessible by helicopter from Whitehorse or Atlin.

Claims

The TOM property consists of:

Claim	Units	Record No.	Record Date	Expiry
TOM-1	20	319	1 May 1978	1979

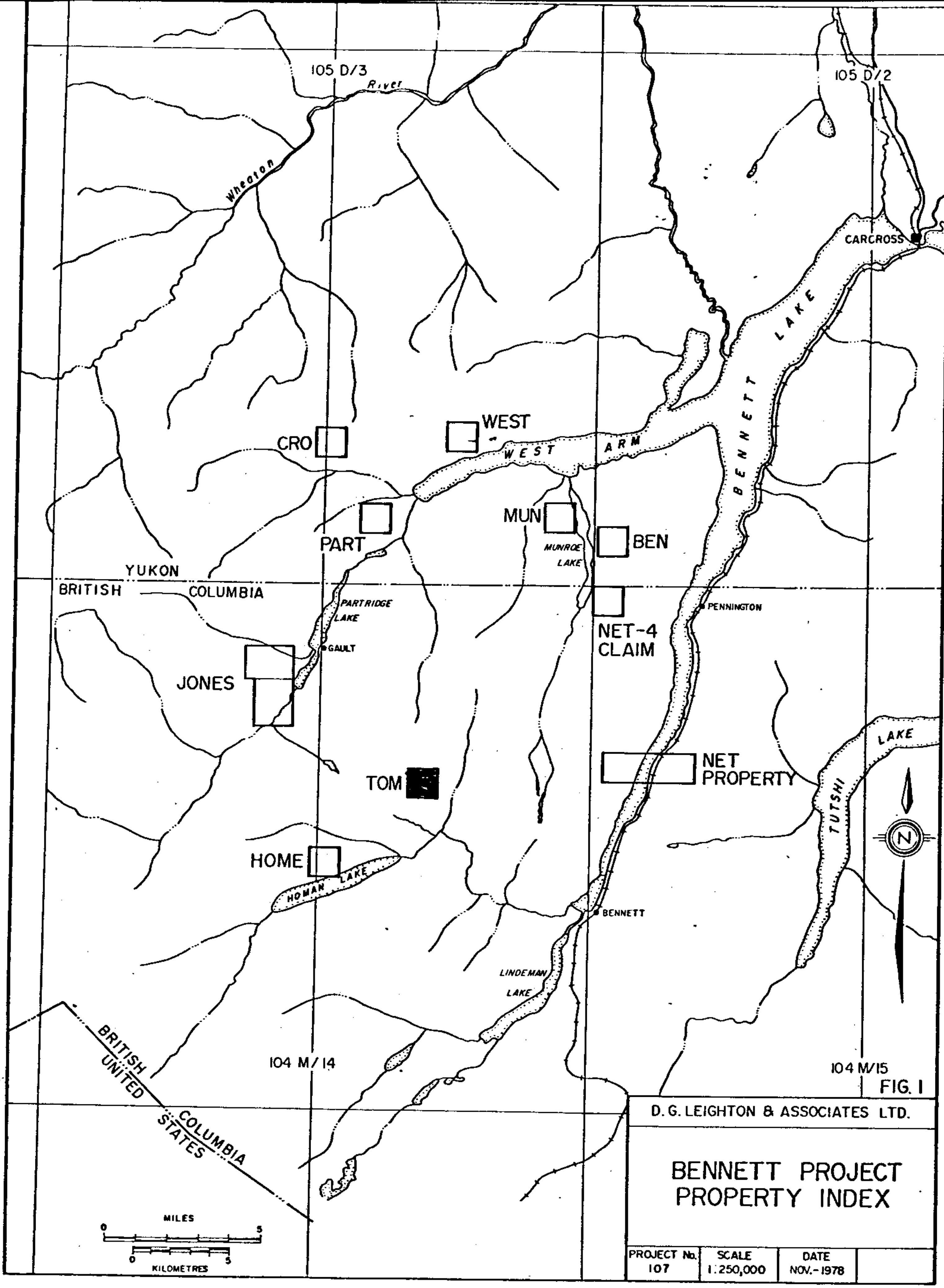

FIG. 1

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BENNETT PROJECT
PROPERTY INDEX

PROJECT No.	SCALE	DATE
107	1:250,000	NOV.-1978

GEOLOGY

Most of the property lies above tree line between 4,000 and 7,000 feet asl. Pleistocene and Recent glaciation has produced rugged topography in the form of steep-sided cirques, aretes and steep hillsides above broad U-shaped drift-filled valleys. Consequently rock exposure is excellent, except on valley bottoms.

Eight rock types have been mapped. Volcanic rocks consist of thick sills of grey weathering massive rhyodacite and green feldspar porphyry andesite, and an interesting multilithic volcanic breccia containing fragments of rhyolite, dacite and granodiorite in a comminuted matrix of the same rock types. Nature of the breccia, its association with many dikes of widely varying lithologies, and its location on top of Tom Thumb Mountain suggest it is a diatreme. Unfortunately, radioactivity of all volcanic rocks, including the breccia, does not exceed 100 cps.

Intrusive rocks consist of five phases of granodiorite and quartz monzonite, varying in radioactivity as follows:

Rock Unit	Radioactivity (cps)
Hornblende-biotite quartz monzonite	150
Foliated hornblende granodiorite	100
Fine-grained biotite quartz monzonite	140 - 150
Grey coarse-grained granodiorite	120
Fine-grained granodiorite	140

Rare aplite and pegmatite segregations occur as narrow dikes in the hornblende-biotite quartz monzonite phase and average 250 cps radioactivity. Most intrusive rocks are unaltered and exhibit only a moderate fracture density.

MINERALIZATION

Numerous small showings of molybdenite and chalcopyrite were found near the northeast corner of the claim block. Molybdenite occurs characteristically as fine streaks and blebs with pyrite and/or chalcopyrite in narrow silicified zones (1-2 m) in weakly propylitized hornblende biotite quartz monzonite. Quartz stringers are rare and mineralized zones are only of local extent, with grade being less than 0.01% MoS_2.

Two gossan zones measuring 150 x 300 m occur on the east side of the claim block. The northern gossan consists of a silicified, pyritized zone in biotite quartz monzonite. It is bracketed on the east by pyrrhotitiferous, feldspar porphyry andesite, and on the west by a fine-grained quartz monzonite dike. Strong leaching has obliterated original rock textures, and no sign of copper or molybdenum was observed. The southerly gossan, on the east side of Tom Creek, occurs as a result of 1% disseminated and fracture pyrite in chloritized hornblende-biotite granodiorite. Traces of chalcopyrite are visible (0.01% Cu). Neither gossan zone is considered to have economic potential.

GEOCHEMISTRY

Analysis of 74 stream sediment samples has indicated two anomalous zones. Many samples on steep sidehills were collected from creeks active only during break-up. Samples from the broad U-shaped Tom Creek valley are often rich in organic material.

The first anomalous area is co-extensive with the zone containing molybdenum showings, two samples showing values of 362 and 280 ppm uranium. However, both are isolated highs, surrounded by many other values of background intensity. Moreover, the association of these high values with organic material suggests the anomaly is due to scavenging of uranium by organic matter.

The second anomalous zone is of a wider and better developed nature, occurring in the southern area of the claims. Stream sediment values up to 400 ppm were generated. However, the area is marked by nearly 100% outcrop, and in three traverses with scintillometers over the area, no anomalous radioactivity was encountered, nor was unusual geology observed, such as alteration zones, fracture zones or vein systems.

A multi-element analysis of samples collected from the southern anomalous zone indicates a strong molybdenum-uranium association but no anomalies in other elements tested. The high molybdenum values are surprising in view of the absence of surface indications of molybdenum in the nearly 100% outcrop area and fresh nature of rock. However, geochemical results are not of sufficient interest alone to warrant a follow-up program at this time. The claims should be kept in good standing, and further work should be done only if a uranium-molybdenum association becomes significant in other work in the Atlin-Bennett area.

Geological and geochemical data from the TOM property are shown on Figure 2 (in pocket).

BREAKDOWN OF COSTS (for assessment purposes)

Wages and salaries	$1,750.00	
Benefits at 12%	205.00	$1,955.00
Meals and accommodation		735.00
Transportation - mainly helicopter		1,200.00
Assay costs		480.00
Miscellaneous; includes, report preparation, etc.		650.00
TOTAL		$5,020.00

The following were directly involved with field work on the TOM Property:

R.J. Beaty, Geologist	2770 Point Grey Road, Vancouver, B.C. V6R 1A6
L.O. Allen, Prospector	670 Vancouver Avenue, Penticton, B.C. V2A 1A6
R.J. Bilquist, Prospector	670 Vancouver Avenue, Penticton, B.C. V2A 1A6

PAY ROLL RECORD

Project(s)	Code	Client(s)
1 Bennett Project	107	E&B Explorations Ltd.
2		
3		
4		
5		

TOM PROPERTY

July 1978

PA

Name/Project	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Time Total	Rate	Amount
R. J. Beatty																				X	X	X	X							X	X		100.00	
																				G	G	G	M							C	C			
R. J. Bilquist																				X	X	X	X										85.00	
																				P	P	P	M											
D. Thompson																				X	X	X	X										60.00	
																				H	H	H	M											
L. O. Allen																				X	X	X	X										60.00	
R. R. Gilbert																					—											2 D	175.00	

CLASSIFICATIONS

A Airphoto Work
B Budget
C Compilation/Drafting
D Drill Supervision
E Expediting
F Line Cutting/Surveys
G Geological (Mapping)
H Geochemical (Sampling)
I Geophysical (Surveys)
J Trenching
K Cooking/Camp
L Logging Core
M Mobilization/Demobilization
N General Supervision
O Data Analysis
P Prospecting
Q Consultation
R Research
S Staking
T Travel
U Underground Surveys
V Property Examination
W Legal
X Accounting
Y Secretarial/Office
Z ....

TOTALS

BENEFITS: includes; W.C., U.I.C. & Insurance 12 **% Salary T**

REMARKS;

PREPARED BY: D. M. Leighton

APPROV

CERTIFICATION

I, R.R. Culbert, do hereby certify that:

1. I am a practicing Professional Geological Engineer with offices at 3155 West 12th Avenue, Vancouver, B.C.

2. I am a graduate of the University of British Columbia, BASc. (1964), PhD. (1971).

3. I have practiced mining exploration for fifteen years, most of which were based in British Columbia.

4. I am a member in good standing of the Association of Professional Engineers of the Province of British Columbia.

5. I have personally visited the TOM property and supervised exploration work carried out there.

Respectfully submitted,

R.R. Culbert, PhD., P.Eng.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
R. R. CULBERT

28 February 1979

TABLE I

TOM PROPERTY GEOCHEMICAL DATA

EXPLANATION OF HEADINGS
*********** ** ********

SM-- A ONE LETTER CODE DENOTING WHO TOOK THE SAMPLE

SAMP NUMB-- FIELD NUMBER ASSIGNED TO SAMPLE. A '*' FOLLOWING NUMBER INDICATES THAT MULTI-METAL ANALYSIS WAS MADE. SEE APPENDIX I.

TYP-- TYPE OF SAMPLE TAKEN, AS FOLLOWS:
- STRM- STREAM SILT OR WATERCOURSE.
- LAKE- LAKE OR POND SEDIMENT.
- SPRG- SEDIMENT FROM SPRING OR SEEP.
- LINS- LINEAMENT OR GULLY SOIL SAMPLE.
- GRID- SOIL TAKEN BY GRID OR LINE SPACING.
- AUGR- AUGER SAMPLE OF SOIL OR BOG.
- ROCK- ROCK SAMPLE.

SPEC GRAV-- SPECIFIC GRAVITY OF SAMPLE IN GMS/CC. GOOD SILT OR POWDERED ROCKS ARE ROUGHLY 1 GM/CC, WHILE ORGANIC SAMPLES RANGE MUCH LOWER.

URANIUM PPM-- PARTS PER MILLION URANIUM, WITH STANDARD ERROR FOR THE DETERMINATION IN BRACKETS.

PB-214-- LEAD-214, A URANIUM DAUGHTER PRODUCT WHICH FOLLOWS THE RADON ESCAPE POINT IN DECAY SERIES. GIVEN IN EQUIVALENT PPM URANIUM.

RADM 226-- RADIUM 226, A URANIUM DAUGHTER PRODUCT WHICH FOLLOWS THE MAJOR DISEQUILIBRIUM POINT IN THE DECAY SERIES, BUT OCCURS BEFORE RADON. GIVEN IN EQUIVALENT PPM URANIUM.

TH PPM-- PARTS PER MILLION THORIUM.

EQU LIB-- PERCENTAGE EQUILIBRIUM BETWEEN URANIUM AND ITS DAUGHTER RADIUM. VALUES OVER 100 INDICATE DAUGHTER EXCESS AND ARE TYPICAL OF CERTAIN TYPES OF LEACHING. LOW VALUES INDICATE MOBILIZED URANIUM (WATER TRANSPORT ANOMALY) IN SEDIMENTS AND SOILS, OR RELATIVE LEACHING OF RADIUM FROM ROCKS. BLANKS DELETE CASES OF URANIUM WITHIN TWO STANDARD ERRORS OF ZERO-- (IE.-- POOR STATISTICS FOR RATIOS).

RAD ESC-- RADON ESCAPE COEFFICIENT, GIVING DISEQUILIBRIUM DUE TO RADON ESCAPE FROM RADIUM. HIGH VALUES INDICATE LOOSELY HELD RADIUM, TYPICAL OF SPRING OR SEEPAGE ACCUMULATIONS.

FIELD COMMENTS-- ARE NOTES MADE BY SAMPLER TO FACILITATE RECOGNITION OF THE SAMPLE CASE.

D.G. LEIGHTON AND ASSOC. LTD.
NOVEMBER 2, 1978.

BENNETT PROJECT - 1978 GEOCHEMICAL DATA

**** TCM PROPERTY-- TOM THUMB MTN. AREA, B.C.

S M	SAMP NUMB	TYP	SPEC GRAV	URANIUM PPM	PB-214 PPM EQV	RADM 226	TH PPM	EQU LIB	RAD ESC	FIELD COMMENTS
A	TO 1*	SPRG	C.77	280 (14)	6 (2)	35	27	12		TCM GROUND SEEP
A	TO 2	SPRG	0.62	126 (14)	9 (2)	24	17	19		TOM SPRING SMAL
A	TO 3	SPRG	0.57	42 (13)	10 (3)	17	18	40		TOM SPRING MED
A	TO 4	SPRG	0.73	58 (11)	5 (2)	11	21	19		TCM SPRING MED
A	TO 5	SPRG	0.61	58 (12)	2 (2)	14	22	24		TOM SPRING FLAT
A	TO 6	SPRG	0.61	35 (11)	10 (2)	19	3	54		TCM SPRING MED
A	TO 7	SPRG	0.88	42 (9)	5 (2)		30			TCM SPRING LGE
A	TO 8	SPRG	0.74	29 (10)	6 (2)	7	14	25		TOM SPRING MED
A	TO 9	SPRG	1.15	(6)	6 (1)	11	16		42	TCM SPRING LGE
A	TO 10	STRM	0.87	18 (8)	7 (2)	18	16	100		TOM CREEK 1FT
A	TO 11	STRM	0.51	60 (14)	9 (3)	20	17	33		TOM CREEK 1FT
A	TO 12	SPRG	0.72	53 (11)	6 (2)	11	22	22		TOM SPRING MED
A	TO 13	SPRG	0.62	113 (13)	6 (2)	27	13	23		TOM SPRING MED
A	TO 14	SPRG	0.97	41 (9)	6 (1)	4	35	11		TCM GROUND SEEP
A	TO 15	SPRG	0.68	103 (13)	7 (2)	24	30	24		TCM SPRING MED
A	TO 16*	SPRG	0.71	105 (12)	8 (2)	33	32	32		TOM SPRING MED
A	TO 17	SPRG	0.75	36 (10)	9 (2)	20	16	55		TCM SPRING SMAL
A	TO 18	SPRG	0.76	42 (11)	6 (2)	17	31	42		TOM CREEK 2FT
A	TO 19*	SPRG	0.59	400 (19)	6 (3)	79	31	19		TOM SPRING MED
A	TO 20	SPRG	0.55	10 (13)	12 (3)		24			TOM SPRING FLAT
A	TO 21	SPRG	0.59	27 (12)	10 (2)	28	14	105		TOM SPRING FLAT
A	TO 22	STRM	0.63	11 (11)	7 (2)	15	25			TCM CREEK 2FT
A	TO 23	SPRG	0.46	(15)	11 (3)	16	18			TCM SPRING MED
A	TO 24	STRM	0.85	(8)	7 (2)	13	16			
A	TO 25	STRM	C.79	5 (9)	6 (2)	2	30			
A	TO 26	STRM	0.63	38 (12)	14 (2)	17	23	46	18	
A	TO 27	STRM	0.68	42 (11)	5 (2)	7	26	17		
B	TO 1	STRM	0.64	(10)	13 (2)	32	20		58	S ROCK GLACIER
B	TO 2	STRM	1.09	(6)	5 (1)	16	30			2ND SLIDE AREA
B	TO 3	STRM	0.94	(6)	5 (1)	13	20			STH 2ND SLIDE
B	TO 4	STRM	0.95	(7)	6 (1)	15	18			STH 2ND SLIDE
B	TO 5	STRM	0.84	(7)	5 (2)	15	27			STH 2ND SLIDE
B	TO 6	STRM	0.97	(7)	5 (1)	13	31			LGE CK S RK GLAC
B	TO 7	STRM	0.97	(7)	7 (1)	26	33			LGE CK S RK GLAC
B	TO 8	STRM	1.00	(6)	8 (1)	16	8		52	MAIN CK NR LCP
B	TC 9	STRM	0.97	(6)	2 (1)	4	20			E OF MAIN CK
B	TO 10	STRM	0.97	(6)	2 (1)	15	17			E OF MAIN CK
B	TO 11	STRM	0.S7	17 (7)	4 (1)	8	7	51		E OF MAIN CK
B	TO 12	STRM	0.73	43 (10)	11 (2)	7	3	16		E OF MAIN CK
B	TO 13	STRM	C.98	45 (8)	6 (1)	4	12	9		MAIN CK
B	TO 14	STRM	1.00	43 (7)	5 (1)	12	9	29		E OF MAIN CK
B	TO 15	STRM	0.76	47 (10)	5 (2)	2	8	5		E OF MAIN CK
B	TO 16	STRM	C.75	35 (10)	4 (2)	4	27	12		E OF MAIN CK
B	TO 17	STRM	0.68	40 (10)	2 (2)	3	14	9		E OF MAIN CK
B	TO 18	STRM	0.85	9 (8)	4 (1)	3	11			S RK GLAC
B	TO 19	STRM	1.03	2 (7)	5 (1)	7	18			N SIDE CIRQ
B	TC 20	STRM	0.81	26 (9)	7 (2)	14	20	55		NW CAMP BASE MTN
B	TO 21*	STRM	0.51	115 (16)	13 (3)	31	9	26	55	NW CAMP BASE MTN
B	TO 22	STRM	1.01	16 (7)	8 (1)	8	1	52		CIRC N CAMP
B	TO 23	STRM	0.95	51 (9)	5 (1)	7	23	14		CAMP CK
B	TO 24	STRM	0.91	42 (9)	7 (2)	19	28	45		W SIDE CAMP CK
B	TO 25	STRM	0.56	28 (12)	2 (2)		21	1		HEAD CAMP CK
B	TO 26	STRM	0.91	33 (8)	7 (1)	10	18	31		N END VALLEY

**** TCM PROPERTY-- TCM THUMB MTN. AREA, B.C.

S M	SAMP NUMB	TYP	SPEC GRAV	URANIUM PPM	PB-214 PPM EQV	RADM 226	TH PPM	EQU LIB	RAD ESC	FIELD COMMENTS
B	TO 27	STRM	0.89	35 (9)	10 (2)	5	22	15		DR FROM E SIDE
B	TO 28	STRM	0.78	7 (9)	7 (2)	17	20			DR FROM E SIDE
B	TO 29*	STRM	0.77	218 (14)	13 (2)	36	29	16	63	N NO 1 HOT CK
B	TO 30*	STRM	0.76	183 (13)	15 (2)	53	27	29	71	S NO 1 HOT CK
B	TO 31*	LINS	0.80	236 (14)	14 (2)	62	28	26	77	HOT SOIL HD 2 HC
B	TO 32	STRM	0.84	42 (10)	7 (2)	12	30	29		W FRK NO 2 HOT
B	TO 33	STRM	0.93	27 (8)	8 (1)	8	20	32		N NO 1 HOT CK
B	TO 34	STRM	0.88	42 (9)	8 (2)	16	17	38	45	200 W LCP
B	TO 35	STRM	0.76	56 (11)	3 (2)	6	32	11		100 M W LCP
B	TO 36	STRM	0.79	37 (9)	6 (2)	8	10	21		DR E SIDE LCP AR
B	TO 37	STRM	0.70	23 (10)	7 (2)	8	6	35		DR E SIDE
T	TO 1	SPRG	0.84	26 (9)	6 (2)	7	11	29		SMALL SPRING
T	TO 2	SPRG	0.48	43 (15)	14 (3)	8	13	19		SILT SNDORG SEEP
T	TO 3	SPRG	0.54	26 (14)	16 (3)	7	33			SILT SNDORG SEEP
T	TO 4	SPRG	0.67	95 (13)	9 (2)	25	42	27		SEEP NEAR CR
T	TO 5	STRM	0.72	16 (10)	8 (2)	1	24			SND&SILTSMALL CR
T	TO 6	SPRG	0.79	27 (10)	4 (2)	8	38	32		SND&SILTFRMSEEP
T	TO 7*	STRM	0.44	358 (23)	16 (4)	41	29	11		SML TRIB SND&ORG
T	TO 8	STRM	1.01	10 (7)	7 (1)	5	15			SML TRIB SND&ORG
T	TO 9	STRM	0.62	13 (10)	1 (2)	1	7			SMALL STREAM
T	TO 10	STRM	0.56	129 (15)	9 (3)	24	27	18		ORG&SND FRM SEEP
T	TO 11	STRM	0.70	96 (11)	(2)	12	25	12		SND FRM SEEP
T	TO 12	STRM	0.80	20 (9)	8 (2)	15	11	78	42	SND MORRAINE
T	TO 13	STRM	0.57	155 (16)	7 (3)	37	21	18		FRK OF LRG CR
T	TO 14*	STRM	0.42	362 (23)	4 (3)	61	23	16		SILT&SND
T	TO 15	STRM	1.18	(6)	2 (1)	3	20			SILT MORRAINE
X	217 3	ROCK	0.70	10 (6)	9 (1)	11	28		18	TOM-HB GRDI.RITE

APPENDIX "A"

ANALYTICAL PROCEDURE

LEGS - LOW ENERGY GAMMA SPECTROMETRY

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LEGS - LOW ENERGY GAMMA SPECTROMETRY

INTRODUCTION

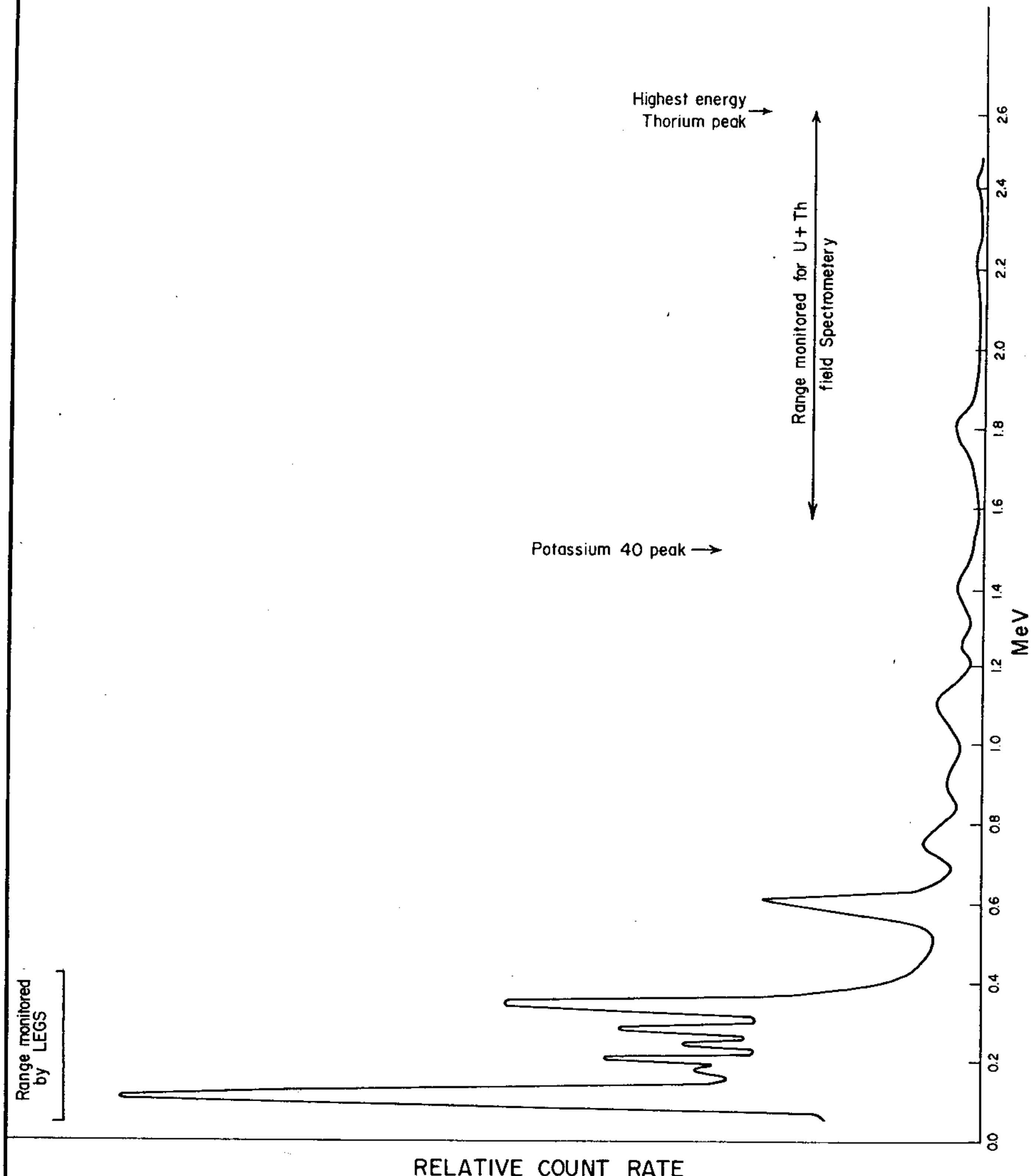
Low energy gamma spectrometry (LEGS) provides a method of determining uranium, thorium and U^{238} daughter products Pb^{214} and radium in geological samples, and has unique advantages when compared with other techniques. The system described here was developed by D.G. Leighton & Associates Ltd. with two objectives in mind. One was to provide an accurate assay facility which could be used in the field, giving field personnel rapid feedback which is particularly valuable on regional type programs. The second objective was to tackle the problem of radioactive disequilibrium. It was felt that routinely monitoring equilibrium would be useful in interpreting mobilizing mechanisms involved in uranium transport and tracking anomalies back to their source. The technique has proven to be reliable and highly cost effective in a variety of exploration programs.

METHOD

General

Conventional gamma spectrometry in geological exploration is severely limited for two reasons. First, because very high background gamma flux occurs at low energy levels (below 1 MeV), conventional systems are constrained to measure only the highest portion of the natural gamma energy range (above 1 MeV) and so cannot measure uranium directly (requiring measurements below 0.1 MeV) determining instead potassium, thorium and Bi^{214}. Unfortunately, if the geological system is in disequilibrium, considerable error will result in the value for uranium (from reliance on these measures as an indicator of uranium). In natural systems, especially in sediments and weathered rock, disequilibrium is the rule rather than the exception, due to the varying half lives and chemistries of uranium daughter products. The second limit in conventional systems is that, because only measurements at high energy levels are made, large statistical errors are introduced since at these energy levels, very low count rates occur (see Figure 1).

The LEGS system avoids both of these limitations. Measurement of the gamma spectrum at low energy levels (between 0.05 and 0.4 MeV) is achieved by ringing a 7 cm radius lead shield around both the sample and a "center-well" scintillating crystal to screen out background radiation. Since high count rates are measured at these low energy levels, a much lower statistical error exists. Moreover, uranium can be measured directly, together with two of its daughter products, so that the degree of disequilibrium in the system can be determined.



AN ORDINARY ROCK GAMMA SPECTRUM

FIGURE 1

The LEGS system, then, is a laboratory or field base method, involving a lead shielded scintillating crystal and a pulse height analyzer capable of integrating counts across preset segments of the gamma spectrum. A weighted 8.7 cc sample of the material to be analyzed is placed in a plastic vial and inserted into the scintillating crystal. Pulse counts are monitored by the pulse height analyzer and the .05 - .4 MeV gamma spectrum is broken into four segments and measured. Resultant numbers are entered into a programable desk calculator to obtain uranium and thorium content in ppm and, Ra^{226} and Pb^{214} content in percent equilibrium or ppm uranium equivalents. Background radiation corrections are involved for samples of low radioactivity and self absorption corrections for those rich in uranium or thorium.

The technique is calibrated using Geological Survey of Canada Radioactive Rock Standards, and chemical standards from Min-En Laboratories and the B.C. Department of Mines. Figure 2 shows the standardization results for uranium. These samples were counted for at least 4,000 seconds each, however, and in the usual 400 - 1,000 second geochemical analysis runs it is the counting statistic uncertainty which almost entirely controls the accuracy.

Components Measured

Although the decay sequence of uranium is very complex it may spectrographically be broken into three components (Table 1), within which the half-lives of the daughters are sufficiently short that there is unlikely to be noticeable separation of the members by natural chemical processes. The first component includes the uranium isotopes and their short lived daughter Th^{234}.

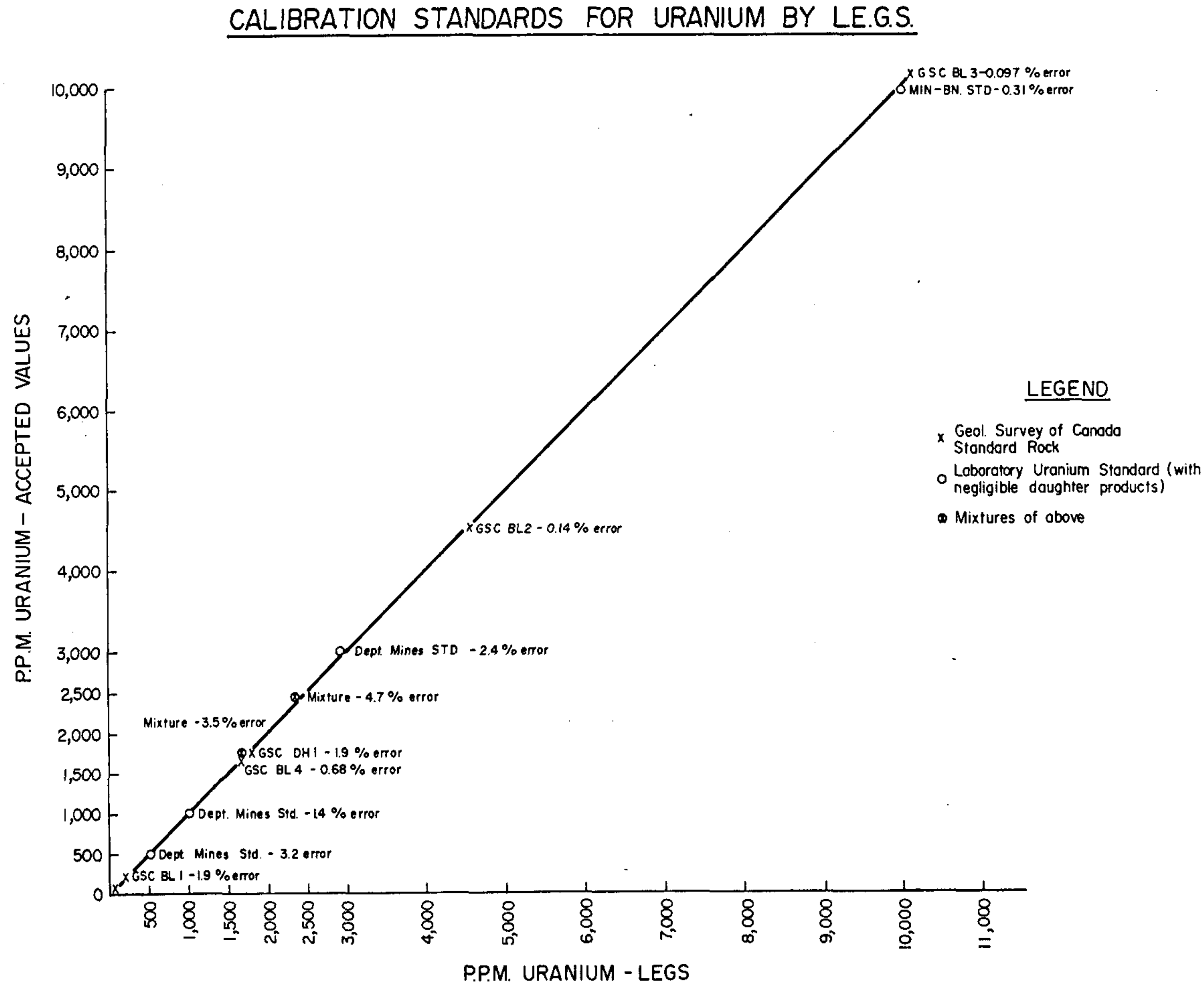

CALIBRATION STANDARDS FOR URANIUM BY L.E.G.S.
X GSC BL 3-0.097 % error
O MIN-BN. STD-0.31 % error
X GSC BL2 - 0.14 % error
O Dept. Mines STD - 2.4 % error
Mixture - 4.7 % error
Mixture - 3.5 % error
X GSC DH1 - 1.9 % error
GSC BL 4 - 0.68 % error
O Dept. Mines Std. - 1.4 % error
O Dept. Mines Std. - 3.2 error
X GSC BL 1 - 1.9 % error
P.P.M. URANIUM - ACCEPTED VALUES
P.P.M. URANIUM - LEGS
LEGEND
x Geol. Survey of Canada Standard Rock
o Laboratory Uranium Standard (with negligible daughter products)
Mixtures of above

FIG. 2

TABLE 1

DISEQUILIBRIUM COMPONENTS IN U^{238} DECAY SEQUENCE (SIMPLIFIED)

	Isotope	Half Life	Importance In LEGS	Channel (Fig. 3)	Remarks
1st Component	U^{238}	4.51 x 109 yr.			
	Th^{234}	24.1 days	Major	A	Peaks at 93 and 64 KEV
	P_q^{234}	6.75 hr.			
	U^{234}	2.47 x 105 yr.	*U-Minor*	A	
2nd Component	Th^{230}	8.0 x 104 yr.	U-Minor	A	Major disequilibrium point
	Ra^{226}	1602 yr.	Major	B	Peak at 186 KEV
3rd Component	Rn^{222}	3.82 days			Disequilibrium due to mobility of radon gas
	Po^{218}	3.05 min.			
	Pb^{214}	26.8 min.	Major	C & D	Peaks at 242, 295 and 352 KEV
				A	Conversion x-rays at 80 KEV
	B_i^{214}	19.7 min.			Higher energy gamma emission
	Po^{214}	1.6 x 10.4 sec.			
	Pb^{210}	22.0 yr.			
	B_i^{210}	5.0 days			
	Po^{210}	138.4 days			
	Pb^{206}	Stable			

Most radiation from the U^{235} decay series may be included in this component. The 80,000 year half-life of Th^{230} provides the first break in the uranium decay series and in view of the differing chemistry of U and Th, this is a major point of disequilibrium. Th^{230} itself produces negligible gamma radiation, and so may be grouped with its daughter product, radium. Ra^{226} has a 1,602 year half-life and a chemistry similar to the alkaline earths. Its immediate daughter Radon forms the second disequilibrium break in the decay chain, for although it has a short half-life, its gaseous state gives it mobility (especially during grinding or preparation of geochemical samples). Radon itself is not a gamma emmitter, but its daughter Pb^{214} has three important low energy wave lengths, and the subsequent Bi^{214} has a variety of high energy emmissions.

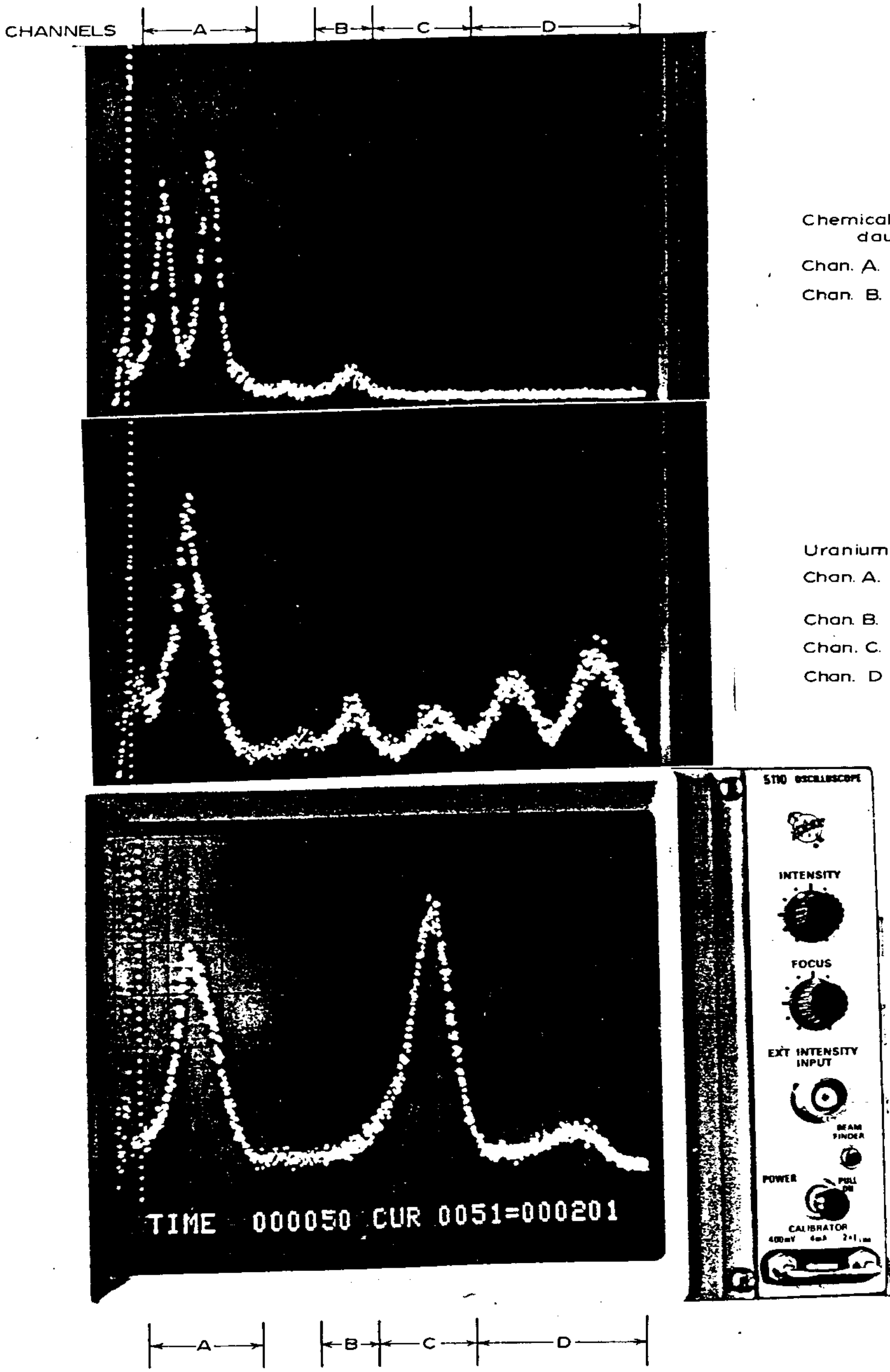
Two other radioactive components must be considered. The first of these is thorium, which is generally considered to have a fixed radiation signature in view of the short half-lives of its daughters and the especially close grouping of its major gamma emmitters. The second additional component is due to the one step decay of potassium, which does not significantly effect the technique.

Figure 3 shows the spectra of the three components of uranium radiation and thorium as viewed on the pulse height analyser. It also demonstrates how the spectrum is broken into four channels across which the counts are automatically integrated.

Precision

Both uranium and thorium are difficult elements in quantitative analysis, and the level of precision in geochemical determinations tends to be low. Figure 4 shows the results from splits

COMPARISON OF GAMMA ENERGY DISTRIBUTIONS IN THE 50–400 KEV RANGE



Chemical uranium, separated from daughter products

Chan. A. U^{238} (Via $Th.^{234}$)

Chan. B. U^{235} (Via $Th.^{231}$)

Uranium ore – approx. equilibrium

Chan. A. U^{238} and X-Rays from Pb^{214} decay

Chan. B. U^{235} and Ra^{226}

Chan. C. $Pb.^{214}$

Chan. D Pb^{214}

Thorium sample showing full cathode ray screen for pulse height analyser

FIG. 3.

Comparison of duplicate analyses for uranium between two Laboratories

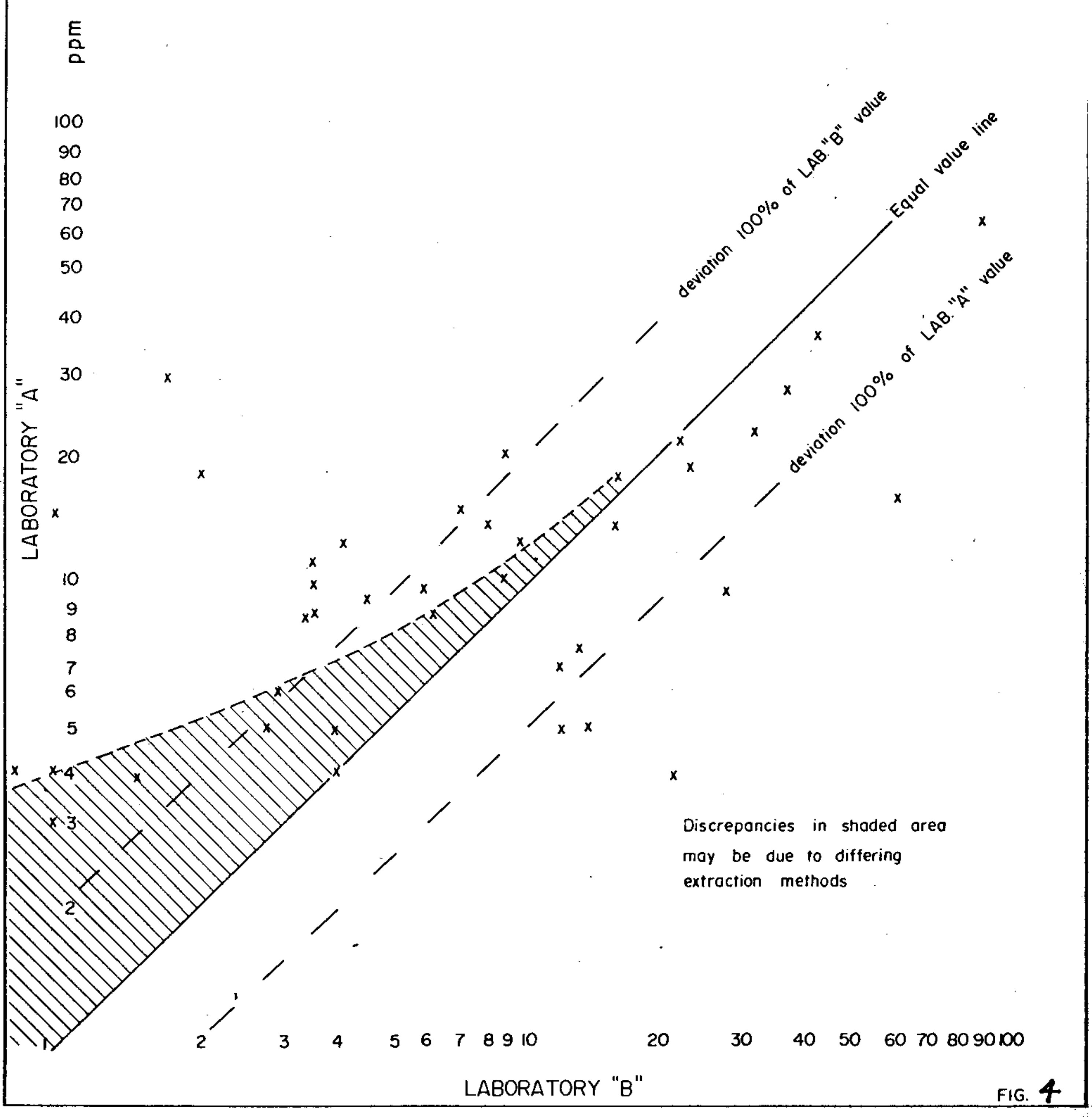


FIG. 4

of a group of -80 mesh silt samples sent to two different laboratories, and Figure 5 gives a similar example of a laboratory fluorimetric analysis (with unusually strong acid extraction) compared to neutron activation. The results show clearly that ordinary uranium geochemical determinations are really only semi-quantitative. "Assay-mode" delayed activation neutron analysis is as good as is rountinely available, in our opinion.

In statistical theory, the standard error (expected standard deviation) of a number produced by counting events is very close to the square root of that number. In practice, this is the controlling factor in precision for routine analysis by the LEGS technique, with other factors such as sample reloading differences and long term drift having little additional influence. This has the practical result of allowing quite accurate calculation of a standard error for each analysis, given the count on each of the spectrum channels monitored. Standard error curves for uranium and Pb^{214} in a variety of circumstances are shown in Figures 6 and 7 assuming a typical background radiation level and a sample density of 1 gm/cc.

Limitations

1. The main limitation of the LEGS technique in exploration geochemistry (at least with the present small crystal size) depends on the definition of "anomaly". If a few ppm is considered significant and Pb^{214} cannot substitute for uranium, then the lengthy counting times involved make another approach more applicable. Figure 6 shows the relationship of counting time to precision.

N. A. Vs. LAB. URANIUM P.P.M.

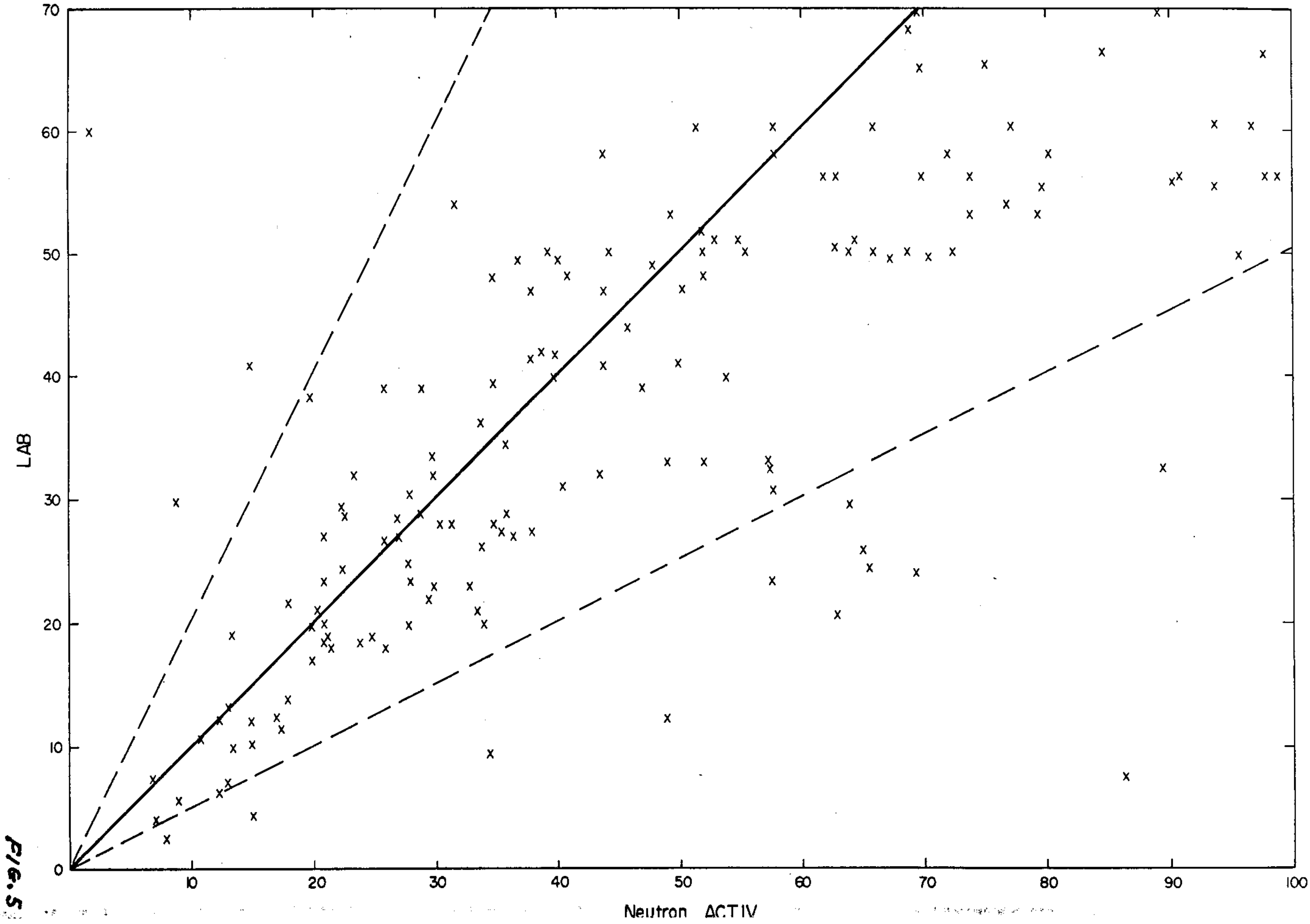


FIG. 5

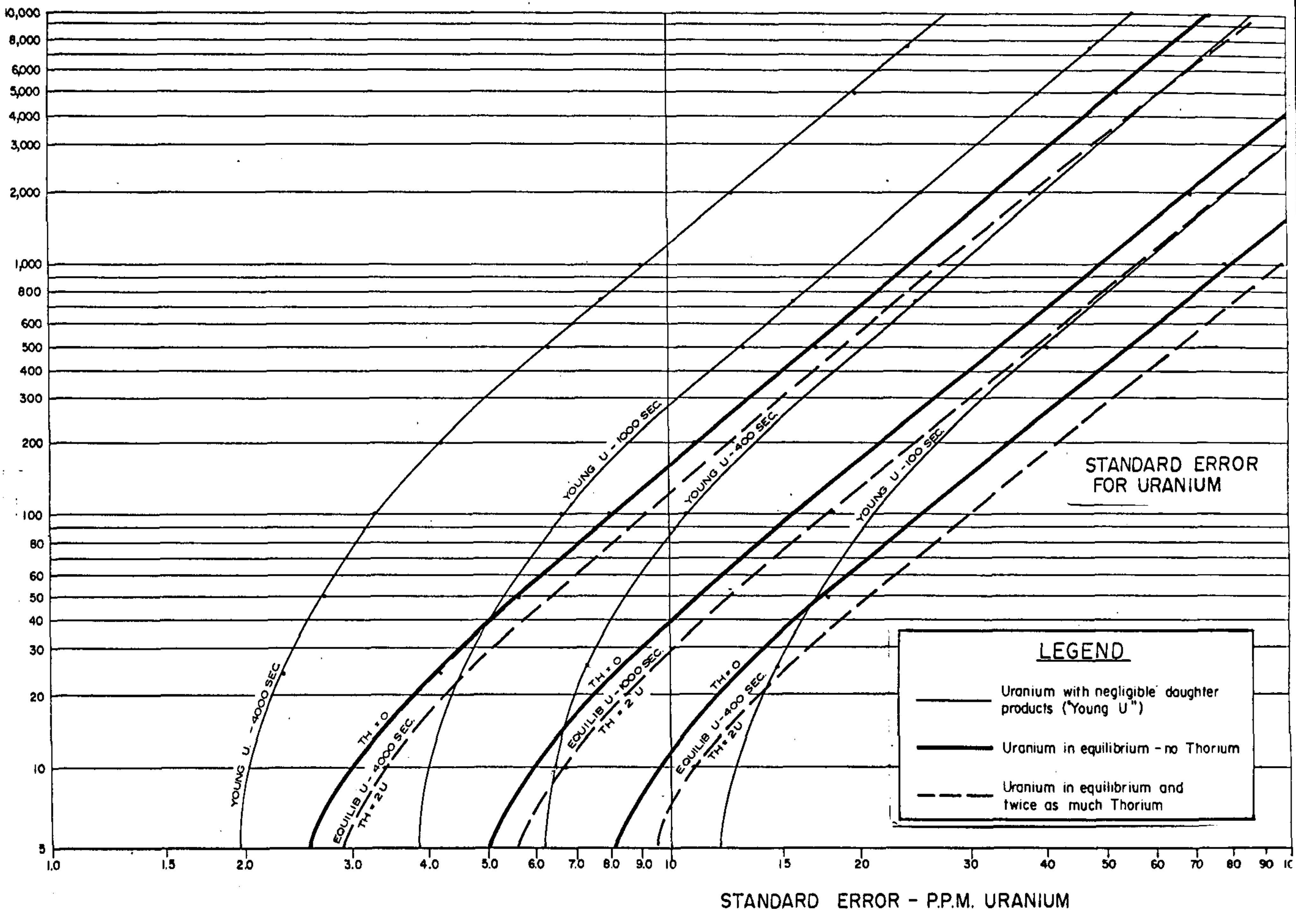
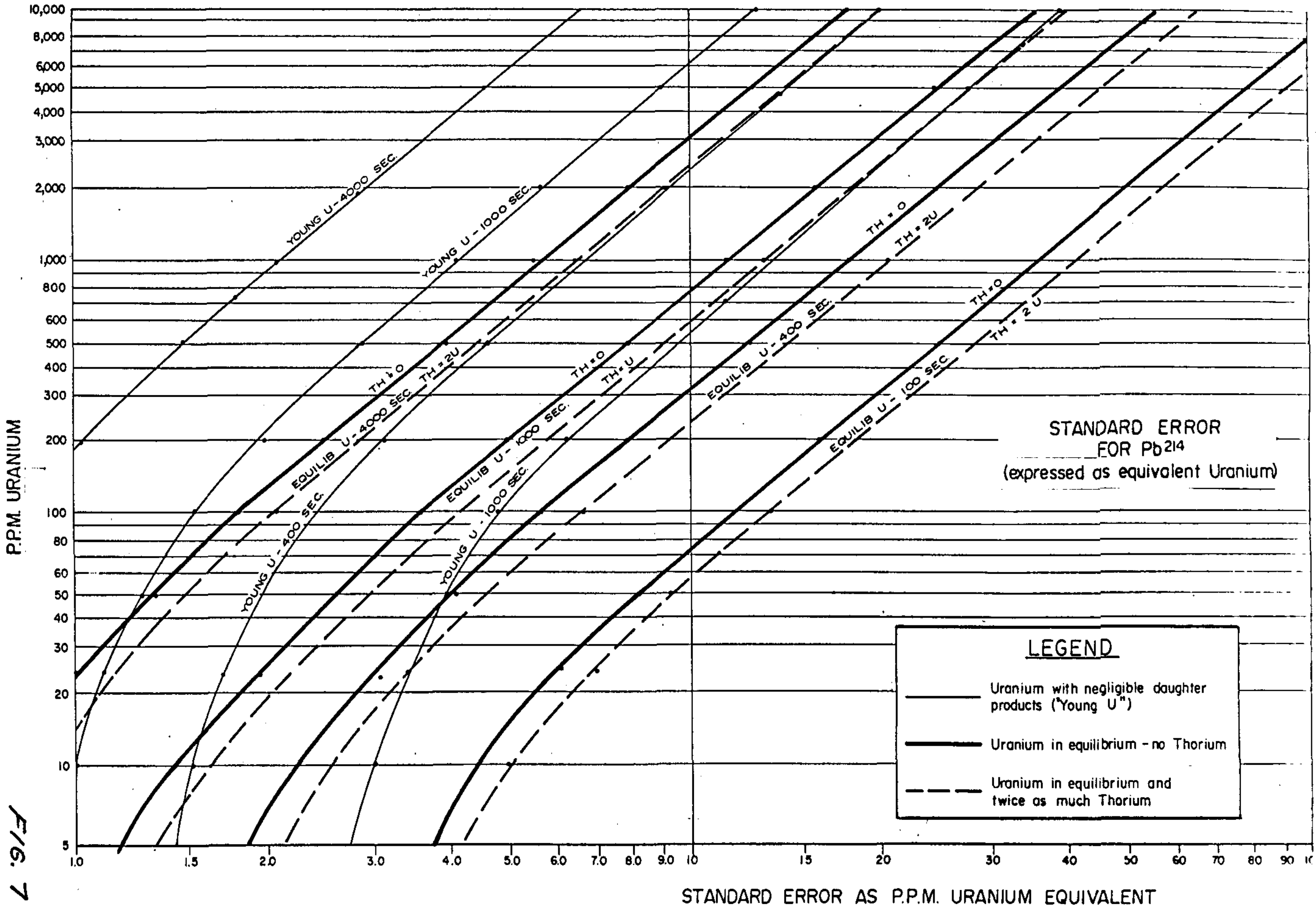

STANDARD ERROR FOR URANIUM
P.P.M. URANIUM
STANDARD ERROR - P.P.M. URANIUM
10,000
8,000
6000
5,000
4,000
3,000
2,000
1,000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
5
1.0
1.5
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10
15
20
30
40
50
60
70
80
90
YOUNG U. - 4000 SEC.
YOUNG U - 1000 SEC.
YOUNG U - 400 SEC.
YOUNG U - 100 SEC.
TH = O
EQUILIB U - 4000 SEC.
TH = 2U
TH = O
EQUILIB U - 1000 SEC.
TH = 2 U
TH = O
EQUILIB U - 400 SEC.
TH = 2U
LEGEND
Uranium with negligible daughter products ("Young U")
Uranium in equilibrium - no Thorium
Uranium in equilibrium and twice as much Thorium

FIG. 6


STANDARD ERROR
FOR Pb^{214}
(expressed as equivalent Uranium)
LEGEND
Uranium with negligible daughter products ("Young U")
Uranium in equilibrium - no Thorium
Uranium in equilibrium and twice as much Thorium
YOUNG U - 4000 SEC.
YOUNG U - 1000 SEC.
YOUNG U - 400 SEC.
YOUNG U - 1000 SEC.
EQUILIB U - 4000 SEC.
EQUILIB U - 1000 SEC.
EQUILIB U - 400 SEC.
EQUILIB U - 100 SEC.
TH = 0
TH = 2U
TH = U
P.P.M. URANIUM
10,000
8,000
6000
5,000
4,000
3,000
2,000
1,000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
5
1.0
1.5
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10
15
20
30
40
50
60
70
80
90
STANDARD ERROR AS P.P.M. URANIUM EQUIVALENT
FIG. 7

2. The very heavy elements tend to absorb radiation in the lowest energy channel. Where high uranium or thorium contents are involved, an interval correction for this effect is easily made. The only element likely to be a problem, therefore, is lead, with which 1,000 ppm gives roughly a 0.5% reduction in counts for that channel. This is likely to be a limitation only in working with certain ores.

3. Although thorium should, in theory, remain fairly close to equilibrium throughout its short decay sequence, cases of apparent thorium disequilibrium have been observed. This may cause problems in weathered, thorium-rich rocks, and is under investigation.

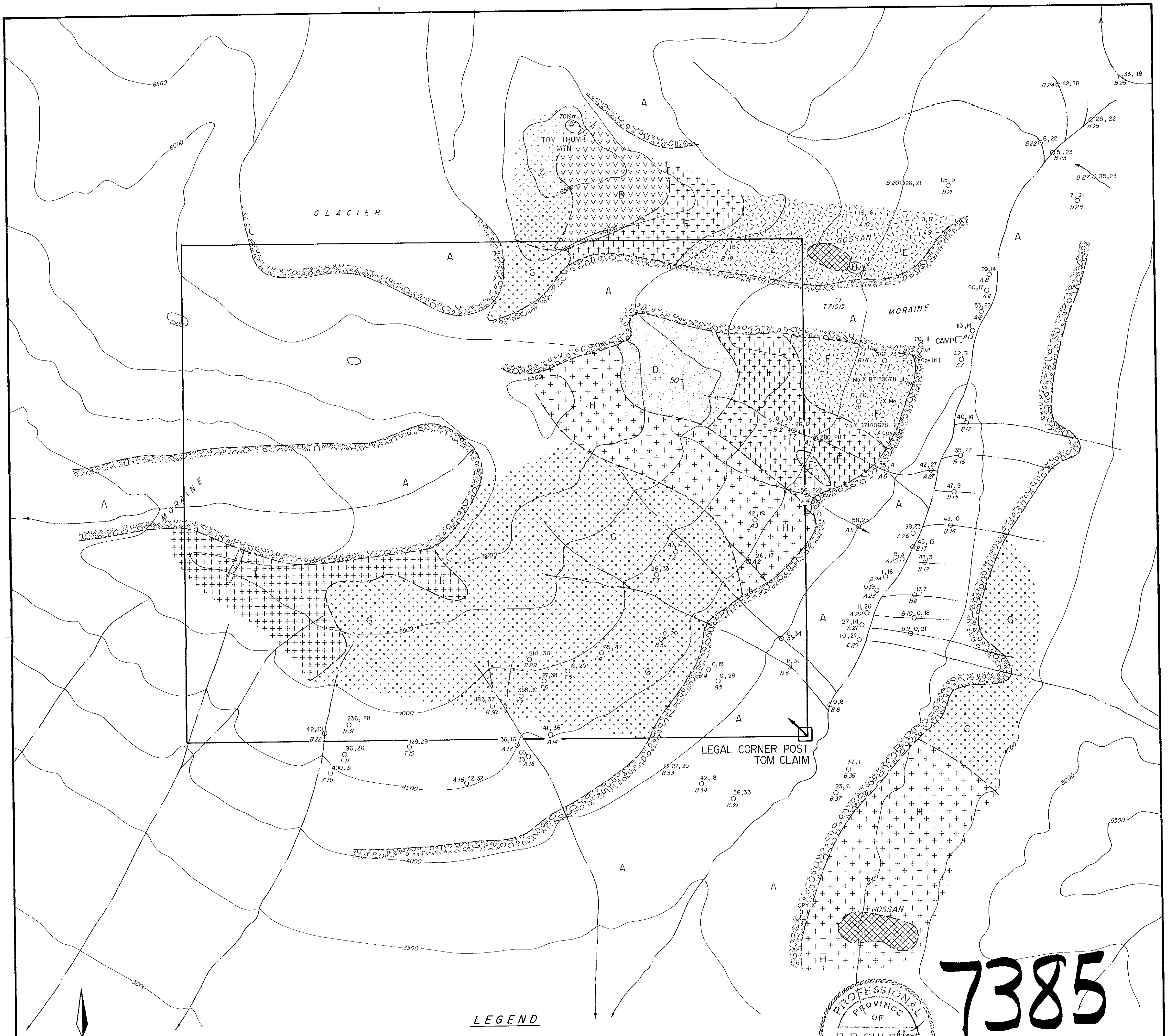


FIG. 2

LEGEND

- A — Alluvium, colluvium, snow, ice, moraine
- B — Feldspar porphyry andesite
- C — Volcanic breccia (diatreme)
- D — Rhyodacite
- E — Hornblende – biotite quartz monzonite (to granodiorite)
- F — Foliated hornblende granodiorite
- G — Fine grained brown biotite quartz monzonite
- H — Grey coarse grained hornblende – biotite granodiorite
- I — Fine grained granodiorite

- Geological boundary, observed
- Geological boundary, assumed
- x Mo — Mineral occurrence (Mo = Molybdenite; cpy = chalcopyrite ; fl = float)
- T10 — Silt sample location, sample number
- 129, 29 — Uranium p.p.m., Thorium p.p.m.
- Claim perimeter; TOM I

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