MAR 19690014: NORTHEASTERN ALBERTA

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GAMMA RAY SPECTROMETER SURVEY

QUARTZ MINERAL PERMIT NO. 60

NORTHEASTERN ALBERTA

FOR

SOUVENIR MINES LTD.

by

JOHN T. COOK, P. GEOL.

ROVING EXPLORATION SERVICES LTD.

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INTRODUCTION:

An helicopter borne radiometric survey was conducted over Quartz mineral Permit No. 60 located in Northeastern Alberta. The survey was flown on July 12th, 1969 by Roving Exploration Services Ltd. of Calgary.

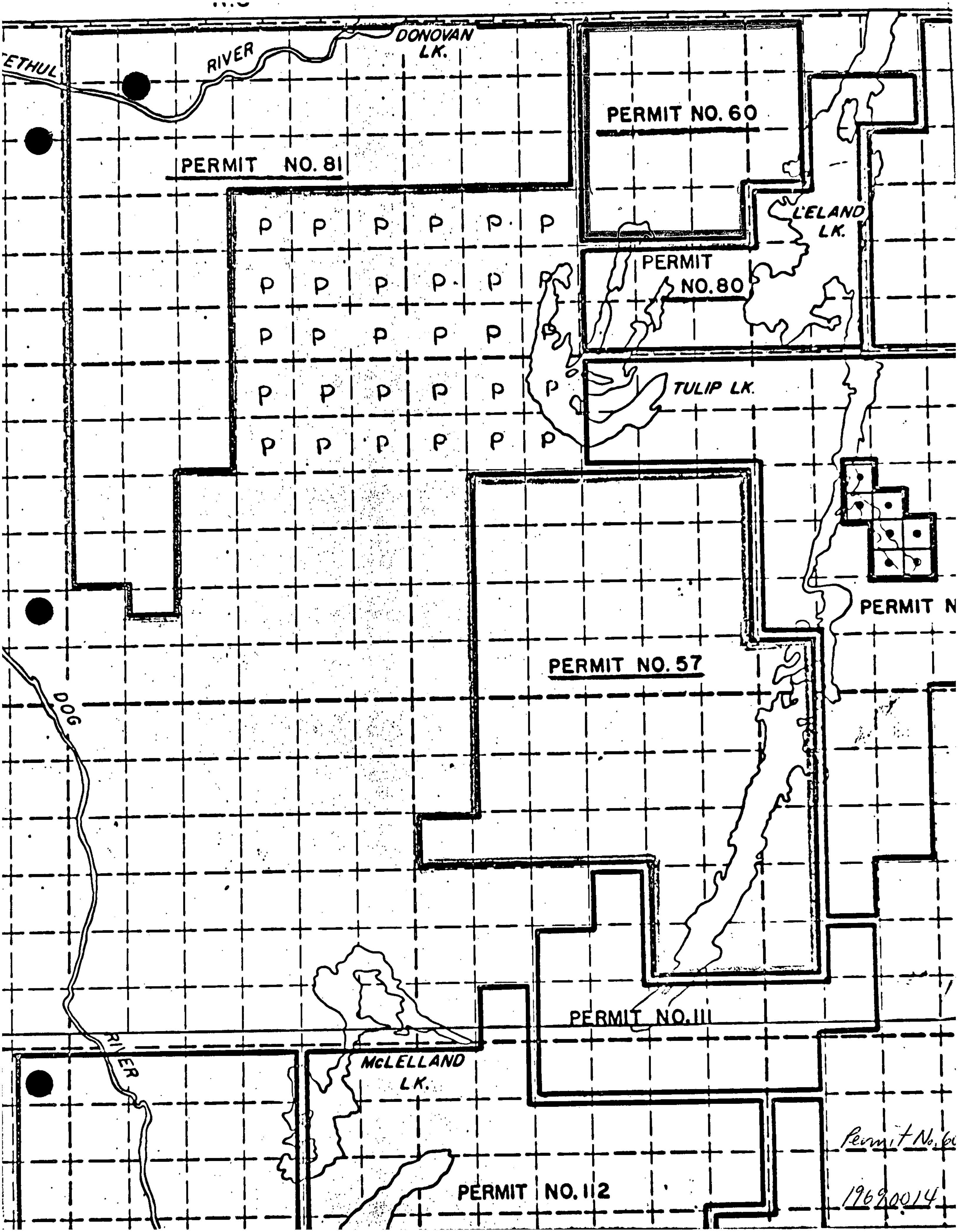
PROPERTY:

Quartz Mineral Permit No. 60 is located in Township 126, Ranges 6 and 7 in Northeastern Alberta adjacent to the Northwest Territories boundary. It is comprised of a total of 9,600 acres. The permit was taken out in the name of K.S. Newborn on July 12th, 1968. No previous exploration work has been done on the property by the permit holders to the writer's knowledge.

PERSONNEL:

The field crew was comprised of the following men:

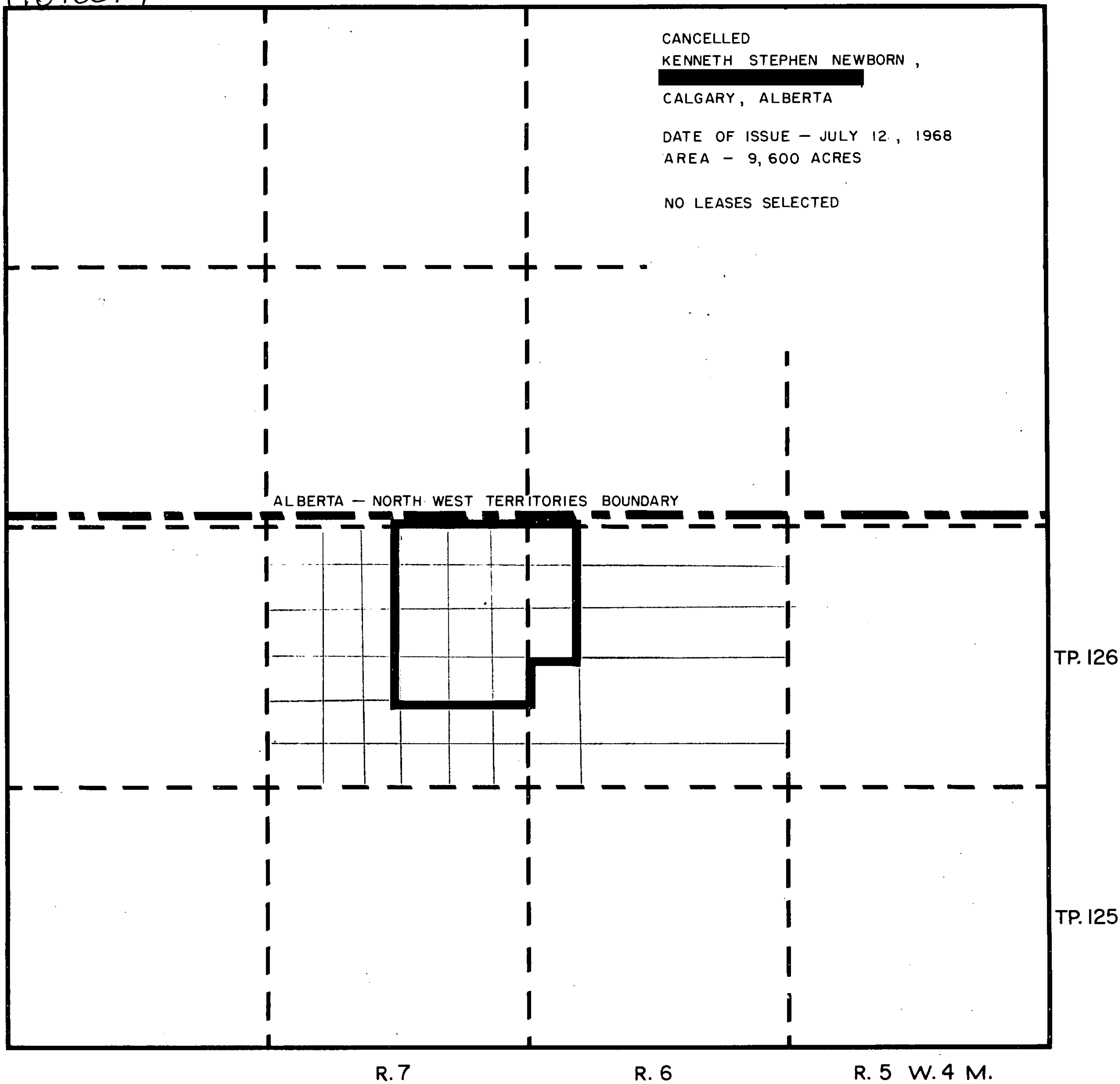
Glen M. DuPre	Party Manager
Howard Stevens	Instrument Technician
Donald Buchanan	Helicopter Pilot



ETHUL
RIVER
DONOVAN LK.
PERMIT NO. 60
PERMIT NO. 81
LELAND LK.
PERMIT NO. 80
TULIP LK.
PERMIT N
PERMIT NO. 57
DOG
RIVER
PERMIT NO. 111
McLELLAND LK.
PERMIT NO. 112
Permit No. 6
19690014

QUARTZ MINERAL EXPLORATION PERMIT No. 60

19690014



GENERAL GEOLOGY:

The permit is situated near the western margin of the Precambrian Shield. The prevailing rock types are a complex of igneous and metamorphic rocks being mainly granitic gneisses. The nearest detailed geological survey report is Bayonet, Ashton, Potts and Charles Lakes District report (Research Council of Alberta Preliminary Report 65-6) by John D. Godfrey about 25 miles to the east. The general geology of the permit area would be essentially similar to that depicted in this report.

A report "Aerial Photographic Interpretation at Precambrian Structures North at Lake Athabaska" by J.D. Godfrey at the Alberta Research Council (Geological Division, Bulletin No. 1, 1958) covers the permit area. A complex of faults and fractures is interpreted traversing the permit. The predominating fault trend is northeast-southwest.

THE SURVEY:

The permit was flown at 1/6th mile flight line spacing. The lines were oriented north-south. Flying was conducted at 175 feet elevation above ground level and at air speed of 50 to 60 miles per hour. Control of flight lines was maintained by visual navigation with the assistance of air photo mosaics. Fiducial points were recorded in flight on the spectrometer chart with a mechanical marking device. Flight lines were plotted on the 2" per mile scale mosaic "blow-ups" and transposed to 2" to 1 mile scale enlargements of the government planimeter 1 mile maps. A total of 101 miles of line was flown.

Pre-flight checks were made with pure samples of Potassium 40 and Thorium to verify the instrumentation was functioning properly.

EQUIPMENT & INSTRUMENTATION:

The Model DGRS -1000 differential Gamma Ray Spectrometer has been developed to provide the mining and survey industry with a system to obtain precise radioactive quantative analysis from aircraft and ground vehicles.

The system has a maximum capacity of four channels. The four channels are: (1) potassium -40, (2) bismuth -214, (3) thallium -208, (4) total count or integral. Spectral interaction has been eliminated by using specially developed techniques, which result in 100% discrimination between the three radioactive elements in case of secular radioactive equilibrium.

The pulse height at the output of the detector is maintained constant as function of temperature by using spectrum stabilization techniques. As a reference element, the radioactive isotope Cesium -137 is used. The system conforms to the USAEC recommended standard instrument module and bin design as covered by TID - 20893.

Integrated circuits have been used throughout the system, which resulted in an unique and small package and also provides maximum reliability. All analogue and pulse processing circuitry has been temperature compensated by using the latest integrated circuits. Plug-in modular construction allows system building from one to four channels. Temperature compensated analogue computer circuits are used to eliminate spectral interaction resulting in 100% discrimination. The system has been designed, incorporating nuclear instrumentation techniques, with an extended operating temperature range.

THE DETECTOR:

Exploranium Corporation of Canada Limited contracts the Harshaw Chemical Company for the manufacturing of thallium activated sodium-iodide crystals measuring 8" x 4", coupled to three photo-multiplier tubes and having guaranteed resolutions of 8.3% or better at .662 Mev at 1000 volt. The crystal is housed in a low background stainless steel housing and the PM tubes have high flux magnetic shields. The complete detector is mounted in a protective enclosure. This enclosure is necessary to protect the crystal from thermal shocks. Smaller crystals, in general, do not require any protection against sudden temperature changes but crystals with sizes of 8" x 4" and larger are extremely fragile. The larger crystal may be permanently destroyed if not properly protected. In general, it can be said that a 8" x 4" crystal may not experience a temperature deviation of more than 10° C per hour. The enclosure is lined with six inches of polyurethane foam. It has been calculated that 6" will provide enough temperature reduction to prevent the 10° C limitation being exceeded providing the unit does not experience more than the 100° F change per hour.

THEORY:

Radioactive Equilibrium

Uranium and Thorium are determined indirectly by gamma spectrometry. The direct determination of the actual parents such as Uranium -238 is impossible in air-borne applications because Uranium -238 and Thorium - 232 are alpha emitters.

The determination is accomplished by measuring the daughter products of both series.

One must assume therefore, secular radioactive equilibrium. Bismuth -214 is the only daughter product from the Uranium -238 series with major characteristic gamma emissions above the 1 Mev line. In air-borne applications, gamma emissions below the 1 Mev line are very difficult to resolve, due to the contributions of scatter, compton, pair production and a much higher air attenuation coefficient. If radioactive equilibrium is not considered then the determination of Thorium and Uranium may give possible uncertainties, because Uranium -238 is determined by measuring a post radon -222 daughter, bismuth -214.

Uranium and to some extent radium, have a tendency to migrate out of the upper layers of the soil during the soil forming and weathering processes, whereas potassium and thorium are more resistant to leaching.

The production of the gaseous daughter radon -222 and is subsequent emanation into the soil, air and migration into the atmosphere or deeper into the ground before decay, provides another mode of removal of the gamma emitting daughters of radium -226 from the upper layers of the soil.

A very similar process takes place in the thorium series with the production of radon -220, but is short half life (52 seconds) reduces the effect of its movement within the soil to small proportions. In general it can be said that appreciable precipitation, freezing or snow cover, will tend to seal the ground, causing a build-up of the radon concentration in the important uppermost layer, which results in an increase in gamma ray source strength in the ground. A reduction of the gamma emitting field at the surface may take place with heavy precipitation, because some of the radon will be washed down to deeper layers and the water will increase the effective gamma ray absorption coefficient in the ground.

Radio-Active Element Spectral Interaction

To obtain 100% discrimination between thorium, uranium and potassium is impossible without introducing special techniques to eliminate the spectral interaction of the thorium 232 series gamma spectrum into the bismuth -214 and potassium -40 spectrum and bismuth -214 into the potassium -40 spectrum.

In other words, if no correction is applied, when one would analyse a thorium sample, the thallium -208 series will contribute counts in the bismuth -214, 1.76 Mev channel, and the potassium -40, 1.47 Mev channel.

If one would only analyse Bismuth -214 or potassium -40, no counts are contributed in the thallium -208 channel, 2.62 Mev and Bismuth -214 has its highest gamma emission at 2.43 Mev.

Since the spectra of the three elements are overlapping, certain proportions of each detected element has to be subtracted from the element which is being analysed.

In general, the determination of the exact amount for subtraction is compex and many variables are involved.

Gamma Ray Spectrometer for Aerial Surveys of Terrestrial Gamma Radiation Selection of Gamma Lines

Aerial quantative determinations of Uranium and Thorium, except potassium are obtained by indirect gamma spectrometry.

Potassium has a single gamma line at 1.47 Mev and a quantative measurement can be made direct.

The 1.76 Mev gamma line of Bismuth -214 has been selected because it is the only gamma line with the highest peak - valley ratio of the Bismuth -214 series.

The 2.62 Mev gamma line of Thallium -208 has been selected because this gamma line is high than the highest gamma line of Bismuth -214, the 2.43 Mev line.

Therefore, Bismuth -214 and Potassium -40 will cause minimum interference.

Detection of Gamma Rays

To detect gamma rays alpha or beta particles, a phosphor is required. When the gamma ray is absorbed by a phosphor, the result will be a light emission.

The intensity of this light emission is directly proportional to the energy in Mev or Kev of the incident gamma ray.

The phosphor is then coupled to a photo sensitive cathode of a photomultiplier which converts the light emission to an electrical pulse. Again, here the amplitude of the electrical pulse is proportional to the incident gamma ray. As phosphor, an inorganic material such as thallium activated sodium iodide Nal(Tl) has been chosen. A very important parameter of the crystal is the stopping power. Only Nal(Tl) has this high stopping power because of the high density, 3.67 gm/CC^3. It also has a relatively high light output or pulse height. As explained, the amplitude of the electrical pulse at the output of the photomultiplier is proportional to the incident gamma ray, which will enable us to differentiate between two different gamma rays. The differential between two gamma rays is notiinfinite. The detector, however, has a specific resolution which determines the detail in a gamma ray spectrum, or is the ability to record a specific energy interaction with a minimum spread of pulse height. The resolution, in per cent, is a very important parameter in gamma ray spectrometers. The resolution of most crystals is determined by using a Cesium -137 radioactive source. Cesium -137 has a single gamma line of .662 Mev and is therefore mono-energetic.

Another important parameter is the detection efficiency which is determined by the geometry of the crystal. When the source is far away from the crystal, in case of air-borne surveys, the path of the gamma rays is more or less perpendicular to the surface of the crystal. When the distance is constant, but the thickness of the crystal is varied, the efficiency of the detector is about exponential. To obtain a sensitive system, it will be necessary to have a large volume crystal. In general, the prospector is interested in Uranium, Thorium as well as Potassium. This interest results in a wide range of energy to be used.

Since Thorium has the highest gamma line, the crystal must have a certain thickness which will ensure almost total absorption at 2.62 Mev. In general, a 4" thick crystal will absorb at 2.62 Mev only 75% of the gamma rays intersecting the crystal. While the thickness determines the absorption coefficient for a specific gamma line, the diameter determines the overall sensitivity. If the crystal diameter is increased twice, the crystal becomes 4 x more sensitive.

The instrumentation was flown in a <u>Hughes 269A Helicopter</u>.

A <u>Bonzer Altimiter</u> (radar divice) was used to control flight elevation above ground level--which was maintained at 175 feet.

INTERPRETATION:

All systems of the spectrometer were functioning effectively throughout the survey.

The Potassium K-40 background level ranges from 40 to 80 C.P.S. indicative of acid igneous, granitic or granite gneiss country rock.

The U_3O_8 (Bi 214) and Thorium (Th 208) curves are remarkably flat. Neither curve exceeds 10 C.P.S. above background in any instance.

It was noted by the air crew in flying the survey that a large portion of the ground is low and swampy which would eliminate effective detection of Gamma Ray sources.

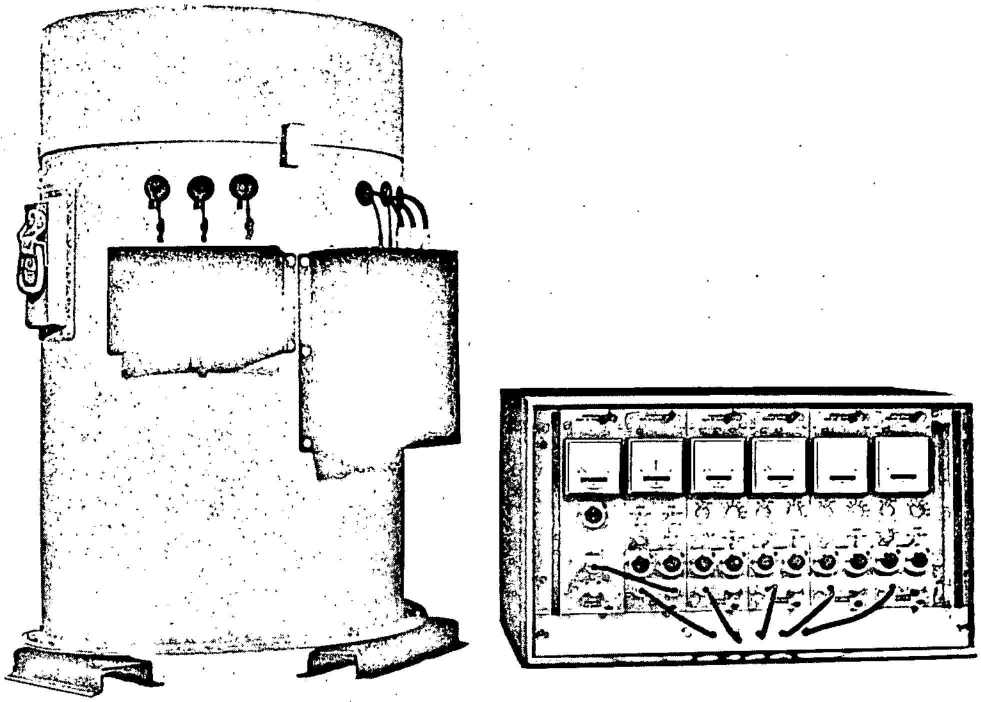
ROVING EXPLORATION SERVICES LTD.

John T. Cook, P. Geol.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF ALBERTA
PERMIT NUMBER
P322
ROVING EXPLORATION SERVICES LTD.

FOUR CHANNEL DIFFERENTIAL GAMMA RAY SPECTROMETER

Model DGRS - 1000



DESCRIPTION

The Model DGRS-1000, four channel differential gamma ray spectrometer has been developed to provide the survey and mining industry with a system to obtain precise radioactive quantative analysis from aircraft, and ground vehicles.

The system may be used for bore hole logging with a special detector, in laboratories, or at base camps.

The four channels are: 1. potassium −40 2. bismuth −214 3. thallium −208 4. total count or integral.

Spectral interaction has been eliminated by using specially developed techniques. which results in 100% discrimination between the three radioactive elements.

A large volume detector, 8" x 4" NaI (Tl) coupled to three matched photomultiplier tubes is used to obtain high sensitivity. The pulse height at the output of the detector is maintained constant as function of temperature by using spectrum stabilization techniques. As a reference element, the radioactive isotope Cesium −137 is used. The system conforms to the USAEC recommended standard instrument module and bin design as covered by TID-20893.

FEATURES

Integrated circuits have been used throughout the system, which resulted in a unique and small package and also provides maximum reliability. All analogue and pulse processing circuitry has been temperature compensated by using the latest integrated circuits. Each channel may be used for spectrum analysis by using spectrum scanning techniques. Plug-in modular construction allows system building, from one to four channels.

Temperature compensated analogue computer circuits are used, to provide spectral interaction elimination, resulting in 100% discrimination.

The system has been designed, incorporating nuclear instrumentation techniques, with an extended operating temperature range.

ROVING EXPLORATION SERVICES LTD.
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CALGARY, ALBERTA

NUCLEAR INSTRUMENT DIVISION

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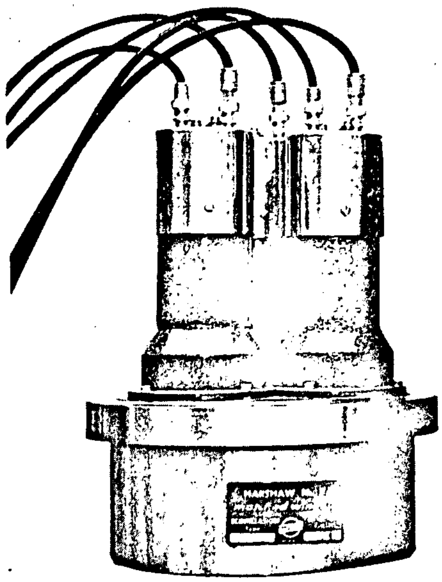
TELEPHONE: 248-6463 (AREA CODE 416)

JANUARY, 1969

DETECTOR



The Harshaw Chemical Company selects specially for Exploranium Corporation sodium iodide thallium activated crystals with unique resolutions of 8.3% or better at .662 Mev at 1,000 volts. The diameter is 8" and the thickness is 4". Larger or smaller crystals to special order. The crystal is coupled to three selected photomultiplier tubes. The gain and focus of each photomultiplier tube can be varied individually. The crystal is mounted in a low background stainless steel case with a thin entrance window. The three photomultiplier tubes are magnetically shielded and are mounted with stainless steel tube bases. The crystal assembly is mounted in a protective enclosure, which is lined with 6" of polyurathene foam to protect the crystal from thermal shocks. An ambient temperature change of 75°C per hour will cause a change of temperature inside the enclosure of not more than 10°C per hour. The crystal is suspended in 6" of semi-hard foam.

Pre-Amplifier – Main pulse amplifier

The pre-amplifier is a low noise, low gain m.o.s. amplifier. The outputs of the photomultiplier tubes are summed at the input of the pre-amplifier. To prevent loading of the photomultiplier tubes, a very high input impedance is required. The pulse shape appearing at the output is R-C shaped, with a decay constant of about 30 μs. The main pulse amplifier consists of an amplifying section of which the gain can be selected, a pulse current limiter, a delay line pulse shaping network and a low impedance output buffer. The output pulse is gaussian shaped with a pulse width of about 1 μs. The maximum output is 10 volts. Both amplifiers are mounted on the detector enclosure.

PRE-AMPLIFIER SPECIFICATIONS

Input impedance: 1 M Ohms – negative going pulses.
Input capacity: 5 pf
Gain: X1.
Input pulse time constant: 30 μs.

SYSTEM SPECIFICATIONS

Power Requirement: 110 V.A.C. or 12 V.D.C., or 28 V.D.C. at 75 Watts.
Instrument Weight: 55 lbs.
Detector Weight: 8" x 4" crystal housing—75 lbs.

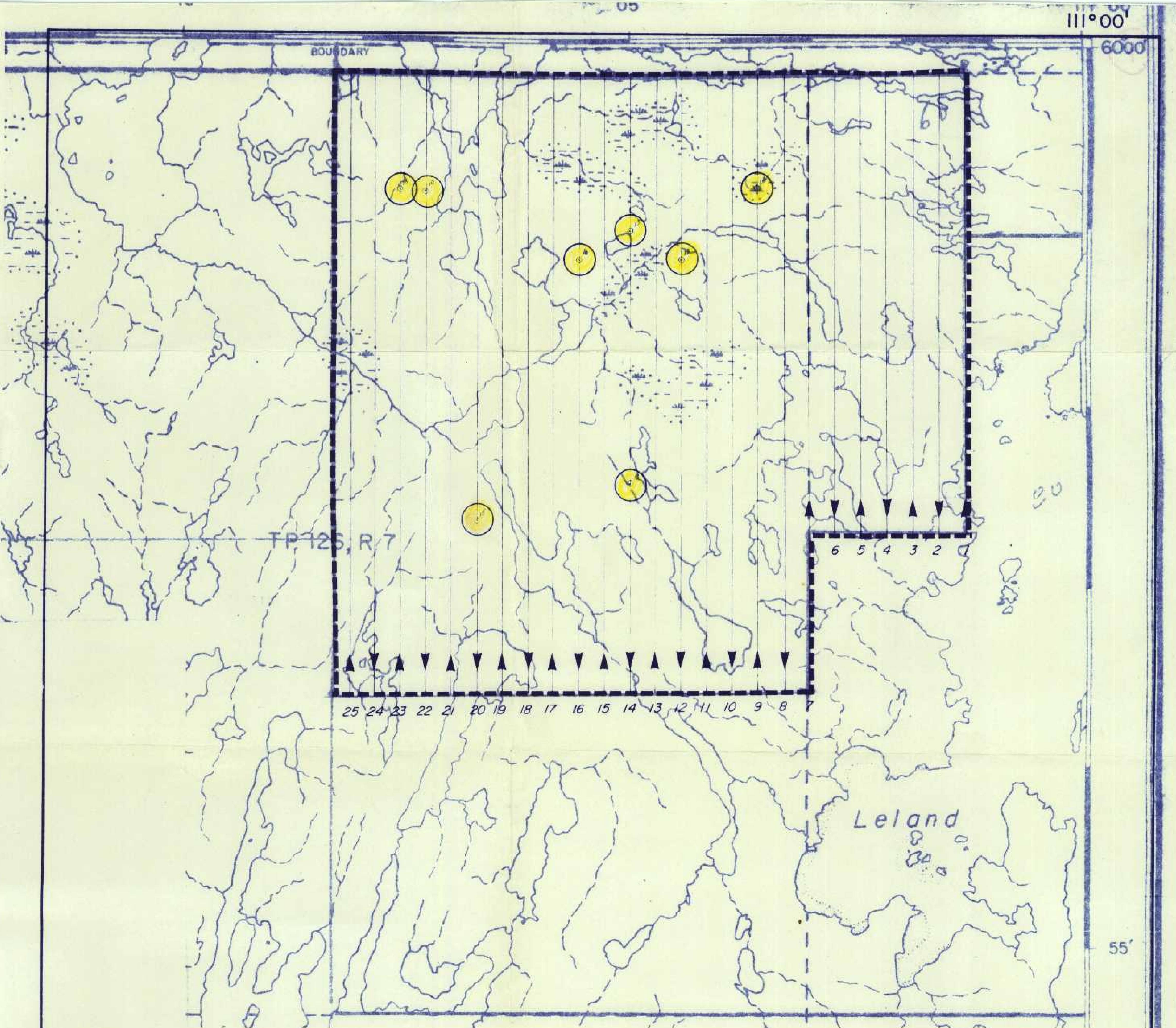
MAIN AMPLIFIER SPECIFICATIONS

Gain: 1 – 2 – 4 – 8 – 10.
Overload recovery: for 250 x overload about 20 μs.
Pulse shape: Gaussian – pulse width 1 μs.
Output: 0 to 10 volt maximum – positive going.
Maximum output load: 50 Ohms.
Stability: .1%/°C.
Differential linearity: ± 1%
Output impedence: .5 Ohms.

WARRANTY

The instrument is warranted free from material defects and poor workmanship for a period of one year from the date of shipment and defective material will be replaced free of charge during this period unless the equipment has been modified, adjusted and/or changed as a result of misuse, in which case this warranty is void.

Should repairs outside the warranty be required, then repairs will be made at our standard service rates.



N

Flight Line

17

Anomaly - counts per second

U_3O_8 - Gamma radiation

SOUVENIR MINES LTD.

Helicopter Borne GAMMA RAY SPECTROMETER SURVEY

Exploranium DGRS 1000

QUARTZ MINERAL PERMIT NO 60, N.E. ALBERTA

June 1969

SCALE · 2" = 1 mile

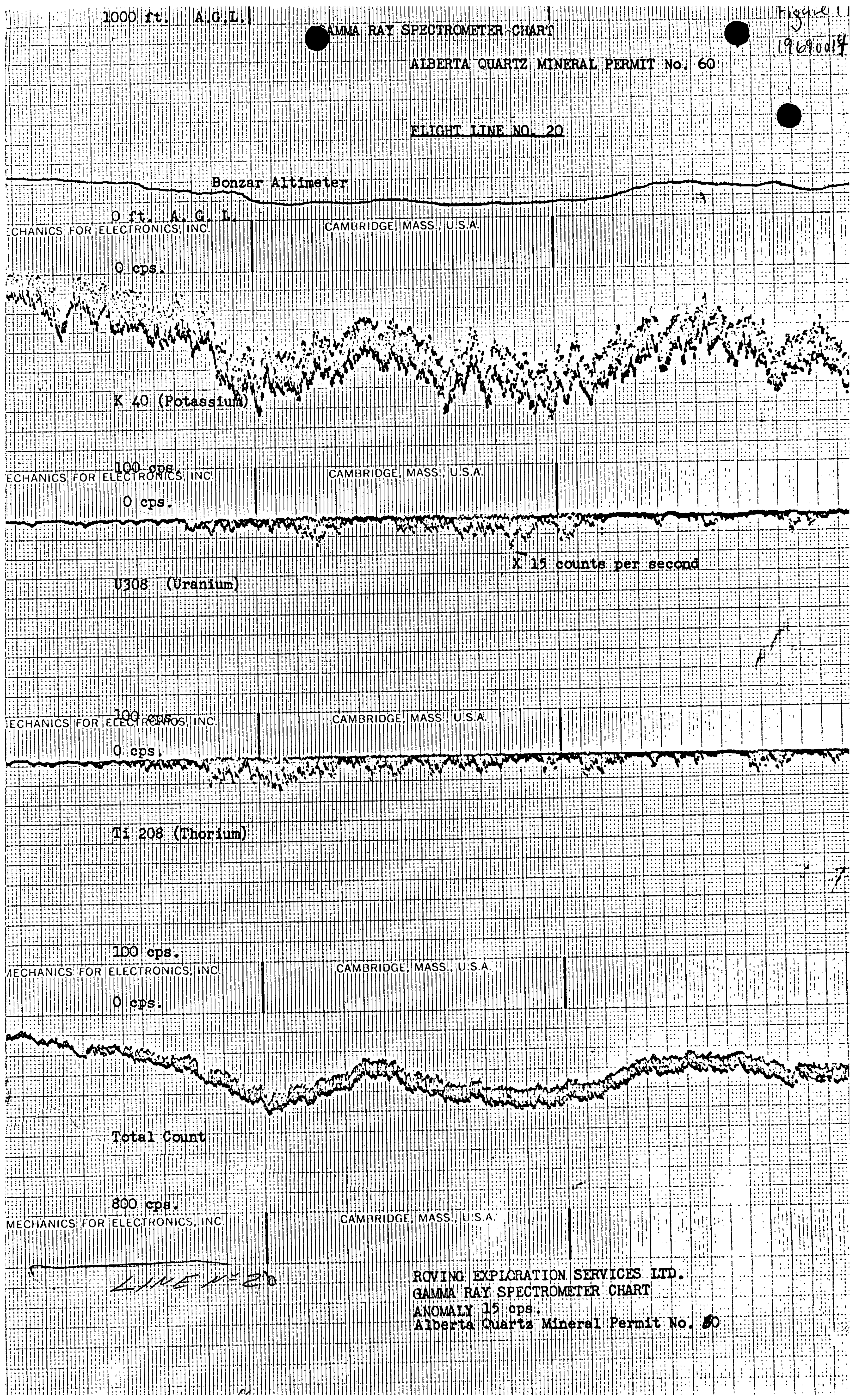
PARTY CHIEF · G.M. Dupre

APPROVED · J.T. Cook P.Geol.

ROVING EXPLORATION SERVICES LTD.

19690014

Map No. 1


1000 ft. A.G.L.
GAMMA RAY SPECTROMETER CHART
ALBERTA QUARTZ MINERAL PERMIT No. 60
FLIGHT LINE NO. 20
Bonzar Altimeter
0 ft. A.G.L.
ECHANICS FOR ELECTRONICS, INC.
CAMBRIDGE, MASS., U.S.A.
0 cps.
K 40 (Potassium)
100 cps.
ECHANICS FOR ELECTRONICS, INC.
CAMBRIDGE, MASS., U.S.A.
0 cps.
X 15 counts per second
U308 (Uranium)
100 cps.
ECHANICS FOR ELECTRONICS, INC.
CAMBRIDGE, MASS., U.S.A.
0 cps.
Ti 208 (Thorium)
100 cps.
MECHANICS FOR ELECTRONICS, INC.
CAMBRIDGE, MASS., U.S.A.
0 cps.
Total Count
800 cps.
MECHANICS FOR ELECTRONICS, INC.
CAMBRIDGE, MASS., U.S.A.
ROVING EXPLORATION SERVICES LTD.
GAMMA RAY SPECTROMETER CHART
ANOMALY 15 cps.
Alberta Quartz Mineral Permit No. 60