MAR 19690027: ALBERTA

Received date: Dec 31, 1969

Public release date: Jan 01, 1971

19690027

GEOPHYSICAL REPORT

on an

AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY

over

Permits 87 and 88 Alberta

Situated

Approximately 150 miles SW from Uranium City

Saskatchewan

On behalf of

McINTYRE PORCUPINE MINES

by

GEO-X SURVEYS LTD.
Vancouver, B.C.

Instrument Operators:

J. Pasche

N. Wilson

Report by:

D. Sutton

J. Cerne

N. Dowds

604-685-0312
TELEX 04-50404

GEO-X SURVEYS LTD. 627 HORNBY STREET, VANCOUVER 1, B. C.

<u>TABLE OF CONTENTS</u>

SUMMARY

During the month of August, 1969 an Airborne Radiometric and Magnetic Survey was conducted by Geo-X Surveys of Vancouver, B.C. on behalf of McIntyre Porcupine Mines Limited. The survey was flown in an Excaliber 800 aircraft containing a Varian V4937A proton precession magnetometer, Exploranium DiGRS - 2000, 4-channel gamma ray spectrometer, and 35mm photographic positioning systems. The data were recorded digitally on punched paper tape using Varian SDV 4991 recorders.

Data processing was conducted by Geo-X Surveys' personnel in Vancouver. IBM computers were used with Varian, IBM, and other programs. The accompanying maps were plotted on a Calcomp 665 plotter unit, and show:

(1) Total gamma ray count plotted at a contour interval of 4 cps (figure 2).

(2) Total magnetic field intensity plotted at a gamma contour interval (figure 3).

This report outlines the field procedure and data processing, specifications of the equipment used may be found in Appendix IV.

INTRODUCTION TO AEROMAGNETOMETRY

The earth has a magnetic field which is basically that of a magnetic dipole, if viewed macroscopically. There are, however, major and minor divergences from the basic dipolar field. Major divergences are interpretable as indications of structure (thermal currents?) within the geoid proper and are of mostly academic interest. Minor differences are of more interest to the mineral prospector since they may be attributable to local variations in either the ferromagnetic susceptibility or the natural rock magnetism or both. Since ferromagnetic susceptibility and natural rock magnetism change measurably from one rock type to another, accurate detailed mapping of the local geomagnetic field often provides valuable information about the subsurface geology (even in heavily drift-covered areas). Aeromagnetic surveys can provide information about the type, general attitude, configuration and complexity of the geo-superstructure. Local elements associated with known ore bodies can often be identified, and the existence of similar local elements elsewhere may lead to the discovery of new ore bodies. Aeromagnetic prospecting can be applied to the delineation of buried contacts and disruptions, or the location of areas of possible plutonic differentation and its varied products.

Considerable speed and accuracy is inherent in this survey method. Interpretation is considerably influenced by geologic control and also by techniques of data analysis. Mathematical analysis of the data by high speed electronic computors provides the information necessary to help discriminate between deeply buried and near-surface perturbations of the field, and noise. Interpretation must always be flexible enough to be revised in the light of new geological, geochemical or geophysical data.

The results of an aeromagnetic survey are most usually used to delineate areas of interest as targets for further geophysical exploration on the ground.

INTRODUCTION TO AERORADIOMETRY

Basic Concepts

Radioactivity is the spontaneous disintegration of the nucleus of one or more atoms and the emission of energy and particles of mass. Gamma radiation is a product of the process in which a nucleus in the excited state makes a transition to a lower (and more stable) energy state. The energy difference is emitted as a photon or gamma ray. The gamma spectra of nuclei consists of sharp lines indicating that the nucleus has discrete energy levels and are therefore somewhat characteristic of each individual radioelement. Natural terrestrial radiation is made up of contributions from about 50 naturally occurring radio-isotopes unevenly distributed in rocks and soils. Much terrestrial radiation is supplied by three isotopes. These are potassium -40 (K^{40}), thorium -232 (TH^{232}), and uranium -238 (U^{238}). These radio elements are normally the only ones in sufficient abundance to produce the intensity of gamma flux that might be detected some distance above the ground. Since a particular emission energy is characteristic of a particular radio element, measurement within a narrow energy band can serve to discriminate between these three main sources of gamma radiation.

Detection System

When a gamma ray strikes certain natural or synthetic crystals, (normally a thallium sodium iodide crystal) a scintillation (a minute flash of light) is produced. The scintillation is converted to electrical energy and is amplified in the photomultiplier tube coupled to the crystal. The brilliance of the scintillation is directly proportional to the energy of the gamma ray. Thus the photomultiplier output may be calibrated to read the gamma ray energy directly. Discriminatory electronic circuitry is used to record 'counts' only if the gamma energy falls within certain ranges ("windows"). The Exploranium DiGRS-2000 has four such windows, the mean energy and window width of each being independently variable. The response of a detector is a complex function of the crystal efficiency and several circuit parameters.

Three crystals, each coupled to 3 photomultipliers are employed to record flux from the spectrums of the three most abundant radio elements (K^{40}, Th^{232}, U^{238}) and the total gamma ray count. The three crystals have an "effective aperture" of approximately 800 feet when flown at 300 feet terrain clearance at 110 m.p.h. (Effective aperture defines the major diameter of the eliptical area sampled by the detection system during one sampling period).

Methodology

The layout of the flight pattern and specification of terrain clearance is one area in which there is considerable variability and sometimes divergence of opinion. Of prime importance is knowledge of some of the geological parameters of the anticipated nature of the target. For example, size, shape, attitude, depth, the overburden conditions and local topography will strongly influence the field procedure.

When aerial surveying first commenced, it was intuitively reasoned that, as geophysical targets, uranium deposits should be treated as point sources of radiation. However, because of mechanical and chemical dispersion, one anomalous area in the Texas Coastal Plain containing most of the important uranium deposits, covers tens of square miles.

With respect to terrain clearance, satisfactory agreement between ground and airborne gamma-spectrometry measurements is attainable up to a terrain clearance of 500 feet.

AIRBORNE FIELD PROCEDURE

The survey was flown in a fixed wing aircraft towing an airfoil "bird" containing the proton magnetometer sensor head. The gamma-ray spectrometer crystals in their associated temperature and shock-resistant enclosure were mounted in aft section of the aircraft cabin. The electronic equipment associated with the magnetometer and spectrometer, the radar altimeter, camera, chart and digital recorders were all mounted in the aircraft proper.

During survey flights magnetic, spectroscopic and altitude data were recorded continuously on analog charts. At one second intervals the same data were recorded on digital tapes along with fiducial numbers. At four second intervals the split-image camera photographed simultaneously (1) the terrain (2) the clock and fiducial display panel. (Thus each terrain photograph is bordered by a photograph of the clock and fiducial number). At thirty second intervals time, job and line identification were recorded on the digital tapes.

The aircraft was outfitted with a Neyhard Automax Intervallometer camera. The photographic positioning method is described below.

PHOTOGRAPHIC POSITIONING SYSTEM

During flights the aircraft navigator roughly positions flight lines on mosaics made up of government photographs. Each four seconds the terrain photographing camera is triggered. It is possible to position the flight lines, in the office, by comparing the terrain photographs with the air-photograph mosaic, using the navigators map as a guide.

Solar flare warnings and predictions issued daily by the Space Disturbance Centre, Boulder, Colorado, were used to schedule flights during magnetically quiet periods.

Data processing is described in the following section.

Instrument specifications are given in Appendix IV.

DATA PROCESSING

The data processing consisted of 4 steps discussed under the following headings:

(1) Flight line positioning

(2) Paper tape editing and magnetic tape generation

(3) Variable selection and grid interpolation

(4) Mathematical analysis, computation, contouring

1. FLIGHT LINE POSITIONING

(a) Photographic Location Data

Terrain photographs taken in flight are bordered by an image of the clock-fiducial display. On each line certain prominent topographical features are recognized by comparing the terrain photograph with an air-photograph mosaic. The fiducial numbers associated with these features are marked on the line and data points evenly distributed along the line between these known positions.

(b) X-Y Location

An arbitrary rectangular coordinate system was superimposed on the flight line data observed by (a) or (b) above, with +Y north and +X east. The position of each data point is uniquely described by X (distance east of origin) and Y (distance north of origin).

2. PAPER TAPE EDITING AND MAGNETIC TAPE GENERATION

A listing of the contents of the paper tapes was made using an IBM computer as the data were transferred from paper tape to magnetic tape. The listing was examined and machine and operator errors corrected. A unique "sequence number" was given to each data point and its coordinates (position) calculated. Thus the magnetic data tape consists of a series of "field records", each field record comprising a sequence number, the X,Y coordinates of the point and the data from that point.

3. VARIABLE SELECTION AND GRID INTERPOLATION

The field records described above contain five geophysical variables (magnetic total intensity and four gamma ray spectrometer data) only one or one combination of which may be mapped at any one time. The variable to be mapped, (Z), is calculated or directly transferred to a work tape whose format is described by sequence number, X,Y,Z.

The data in the work tape was input to programs obtained from Varian Associates, Palo Alto, California. These programs take the flight line data and by mathematical manipulation interpolate the 'random' linear data points to the intersection point of a uniform grid covering the area. This process also involves a controllable amount of filtering and/or smoothing.

4. MATHEMATICAL ANALYSIS, COMPUTATION, CONTOURING

The interpolated grid obtained by the process described above is most suitable for various forms of computerized mathematical analysis (ie. trend surface removal, Fourier filtering, computation of second derivative, etc.) or may be directly input to the mapping program. The contour mapping program produces a plot tape which enables maps to be produced off-line on any compatible Calcomp plotter available. These plots are then checked and title blocks drafted on to produce the final map.

The accompanying maps are only two of several possible displays of the data. Further analysis, presentation and data processing are available upon request.

Of particular interest might be the display of other channels of the spectroscopic data either singly or in some mathematical relation to one another, ie. total count - K40 or 6 [Bi + Tl]. The magnetic data may also be subjected to further analysis (removal of regional, etc.).

Report submitted September 17, 1969

[redacted]

D. Sutton, MSc

[redacted]

J. Cerne, MS

[redacted]

N. Dowds, B.A.Sc

APPENDIX

SPECIFICATIONS OF THE V-4937A MAGNETOMETER SYSTEM

Performance

Range:	20,000 to 100,000 gamma (worldwide)
Sensitivity:	± 1/2 and ± 1 gamma in any field.
Sampling Rate:	manual and "clock" operation permits any timing sequence.

Power Requirements

22-30 V, 6 amps for magnetometer, 60 watts for analog recorder and 100 watt maximum for digital recorder.

Physical Specifications

Console:	size - 19 x 17 x 24 inches; Weight 68 lbs.
Analog Recorder:	dual channel - 15 x 10 x 10 inches, 30 lbs.
Scanner-coupler:	fucical counter, ident. control, 24 hr. clock, 40 lbs.
Recorder:	size - 14 x 11 x 28 inches; Weight 41 lbs.

Data Output

Digital Recording:	BCD 1-2-4-8 (four line output) "O" state - 18 to -30v through 100K ohms 1 state -1 to +3v through 100k ohms
Print Command:	Positive going 12 to 25v pulse; 15M second.
Auxiliary Channels:	A & B for radio altimeter and navigation equipment.
Analog Recording:	Galvanometric -1 mA full scale into 1500 ohms Potentiometric: 100mV full scale. Minimum load resistance 20K Full scale resolution of the least most significant digits of the total geomagnetic field 0-99, 0-999 at 1 gamma sensitivity; 0-49, 0-499 at 1/2 gamma sensitivity.

APPENDIX

SPECIFICATION OF THE EXPLORANIUM DIGRS - 2000 SPECTROMETER

Crystals — Three 6" x 4" NaI (TI) each coupled to three photomultiplier tubes.

Spectrum Stabilization — Pulse height at output of detector maintained constant by spectrum stabilization using Cesium 137 as reference. Cesium 137 has an ultra-stable single gamma emission at 662 MeV, and half life of 32 years.

Channels — Four. Each independently adjustable for E (peak energy level of channel-count) and E (range of energy level counted)

Approximate values used:

	E	E
Potassium 40	1.47 Mev	150 Kev
Bismuth 214	1.76 Mev	180 Kev
Thallium 208	2.62 Mev	270 Kev
Total count	2.05 Mev	1.2 Kev

Differential Linearity 1%

Resolution Better than 8.3% at .662 MeV & 1000 V

Mechanical Configuration - Designed to conform to TID - 20893

Recommended U.S.A. electrical ar.. echanical standard for nuclear instruments and power supplies.

Temperature Stability - Approximately .1% per °C

All pulse and analog processing circuiting is temperature compensated. Integrated circuits used throughout.

APPENDIX

INSTRUMENT SPECIFICATIONS

Aircraft

Type and Model:	Excalibur 800 (Beechcraft Twin Bonanza modified by Swearingen Aircraft, San Antonio, Texas)
Power:	Two 400 H.P. Lycoming 10-720-AIA engines.
Gross Weight:	7900 pounds
Empty Weight:	5300 pounds
Useful Load:	2600 pounds
Fuel Capacity:	230 gallons (U.S.)
Performance at 7900 lbs. Gross:	Climb - 1535 feet per minute (at sea level) Cruise - 230 miles per hour. Range - 1200 miles.

APPENDIX

Instrument Specifications

Camera

Type:	Neyhard Automax 35 m.m. pulse camera
Model:	G-2 with auxiliary data box
Pulse Rate:	Up to 10 frames per second
Film Format:	0.738" x 0.738" square picture with 0.200" x 0.738" data area.
Magazine:	Mitchell 400 foot 35 m.m.
Lenses:	(a) 17 m.m. F/14 Super-Takumar Fish-eye (b) 35 m.m. F/2.0 Super Takumar
Data Box:	(a) 24 hour Accutron Clock (b) Frame counter (c) Available for optional feature
Dimensions (less magazine):	8 3/8" high, 4 1/2" deep, 6 1/4" wide.
Weight (less lens and magazine):	12 lbs.

Government

Disclaimer

This page was inserted by the Coal and Minerals Development Branch, to provide a reference that Figures 1, 2 and 3 listed in the table of contents are not contained in the assessment report on file.