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Radio Geochemical Mapping of Schirmacher Range Central Dronning Maud Land, East Antarctica

A. S. CHAWLA, S.N. KAK AND RAVI KAUL

Atomic Minerals Division, Deptt. of Atomic Energy, Hyderabad - 500 016

Abstract

Schirmacher Range of East Antarctica was systematically studied for geological and radiometric information. Total radioactivity, eU, eTh and K abundances were measured using calibrated portable gamma-ray spectrometer. Computer processed thematic contour maps for total radioactivity, radioelements and their ratios were generated. These have enabled precise delineation of litho-geochemical variations and structural trends with diagnostic radiometric signatures.

The studies highlight the efficacy of gamma-ray spectrometric data for gaeochemical mapping and its use for regional geological studies. The study has suggested that application of the technique, preferably on aerial platform can be time effective for coverage of large areas at reconnaissance level in logistically difficult terrains such as that of Antarctica.

Introduction

A systematic effort for uranium resource evaluation of Antarctic Landmass was initiated in 1976 under "Antarctica International Radiometric Surveys", covering two areas in Trans-Antarctic Mountains and one part of Marie Byrd Land by Airborne Gamma-Ray Spectrometric method (Zeller & Dreschhoff, 1980). Though no significant uranium deposit could be identified yet the method has been found very effective for geological and geochemical mapping.

During the IX Indian Scientific Expedition, systematic' gamma-ray spectrometric measurements in parts of Central Dronning Maud Land covering Schirmacher Range of East Antarctica exposed between 70°44' to 70°46' S latitude and 11°25' to 11°55' E longitude were carried out using a calibrated portable four channel gamma-ray spectrometer. This data was processed and analysed on PC-AT in the Aerial Survey-Remote Sensing Group of the Atomic Minerals Division, Department of Atomic Energy, India.

Methodology

Schirmacher Range was surveyed at a grid interval of 500 m (approx.) taking 25 N-S traverses across the regional foliation. The geological and radiometric data were collected for 131 sites. Radiometric data were processed and corrected for background and inter-channel corrections. The absolute radio-element abundance were converted into thematic contour map of total Counts Per Second (cps), Total $_eU_3O_8$, K (%), eU (ppm), eTh (ppm) and their ratios eTh/eU, (K/eU) x 10^4 and eU/eTh.

Brief Geology

The area is represented by crystalline basements of mobile belt type with large compositional variations due to ultra-metamorphism (Ravich *et al.,* 1975) and have been assigned Proterozoic age (James *et al.,* 1983). Kaul *et al.*, (1985 a,b) have grouped Schirmacher range into Precambrian basement ortho- and para-gneisses and dolerite dykes, pegmatites and quartz veins as younger intrusions. On the basis of mineral assemblages and mode of occurrence, these gneisses have been further sub-divided into four and six lithological units by Singh (1986) and Sengupta (1986). These respectively have been taken as base for the present studies. The present data is also compared with another sketch map of the area (Kampf *et al.,* 1985) for structural details (Fig. 1).

Discussions and Results

Spots with higher concentration of eU and eTh are correlatable with relatively higher amount of mona'zite, zircon and traces of gumite in the representative rock samples. A few

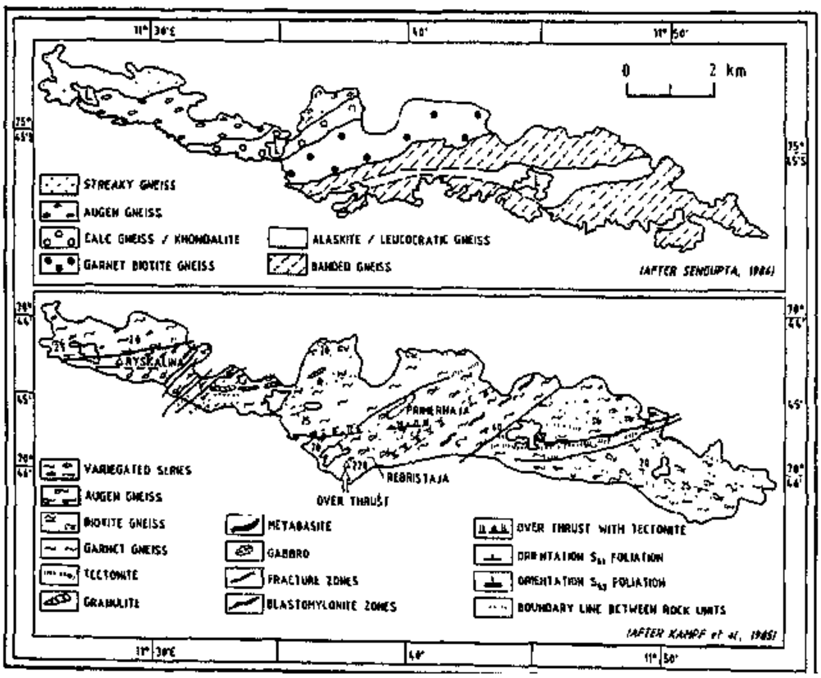

Table 1: Radioelemental Distribution in Rocks of Schumacher Range

Rock Type	Total cps		eU ppm		eTh ppm		K %	
	Range	Avg.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Streaky gneisses	34-95	70	1.00	0.65	3.85	1.09	1.85	0.90
Augen gneisses	60-102	87	3.06	0.59	3.64	1.71	2.67	0.71
Banded gneisses	36-127	97	1.92	1.00	9.98	3.10	3.32	0.75
Garnet biotite gneisses	84-125	103	1.01	0.46	11.38	2.62	2.07	0.28
Leucocratic gneisses/alaskites	87-126	107	1.44	0.37	9.00	2.97	2.18	0.78
Calc gneisses/ Khondalites	90-122	108	1.97	0.83	14.51	4.80	2.41	0.67

cps — counts per second

potassium and uranium anomalies correspond to the pegmatites, in the area. It is observed that the gneisses with more of mafic component show low radioactivity (<70 cps) and larger variation, whereas the felsic units have relatively higher radioactivity (≥ 100 cps) and less variation (see Table 1). The thematic radiometric contour maps define contacts between various gneisses and some structural features very well. Most of these elements are obvious especially on total radioactivity maps. However, a few trends/boundaries need more critical analysis of absolute radioelemental abundance and their ratio maps (Fig 2).

Radiometric Distribution

The streaky gneisses occurring in the westernmost end of Schirmacher range are essentially of granitic composition with fine, dark streaks of biotite/hornblende and have low radioactivity amplitude with larger variations (34-95 cps). The latter have low average K %, reflecting higher mafic content, observed vis-a-vis much larger enclaves of pyroxene-granulite and basic charnockite patches.

The augen-gneisses in the west-central part consist of very coarse clots of feldspar and quartz-feldspar with matrix essentially of biotite and hornblende. The radioactivity ranges between 60-102 cps. However, the uranium values are relatively higher eTh and K distribution is homogeneous.

The major portion of eastern Schirmacher is occupied by banded gneisses, with distinct light and dark colour bands having large compositional variations. These are broadly separable as biotite banded gneisses and garnetiferous banded gneisses. This variation is reflected as larger variations in radioactivity (36-127 cps) with relatively higher amount of eTh.

The garnet-biotite gneisses, the calc-gneisses, and the alaskites/leucocratic gneisses are relatively more felsic units of Schirmacher range, occupying essentially the central part. The last one mentioned is extending as a wide band within the banded gneisses. These units have relatively higher radioactivity amplitude (84-125 cps).

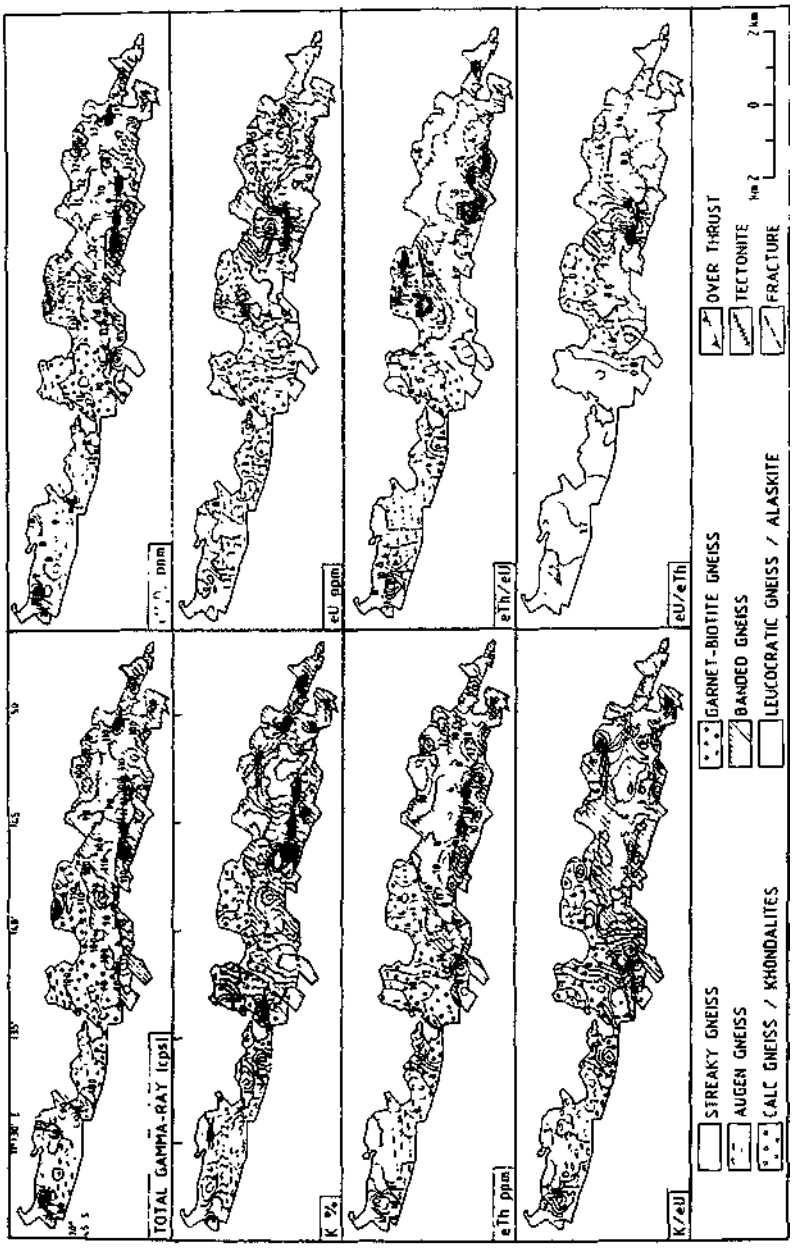

Fig.2. Thematic Radio Geochemical Maps of Schirmacner Range, East Antarctica.

With an essentially granitic composition, the garnet-biotite gneisses, having large clots of garnet and biotite, do not show regular banding. The radioactivity values range between 84-125 cps. Due to high thorium and low uranium, Th/U and K/U values are high.

The alaskite/leucocratic gneisses show high radioactivity (87-126 cps) with low variation. Radioelemental distribution is homogeneous.

The calc-gneisses are banded, with variable calc-silicate assemblage. These are associated with khondalites and have radioactive range of 90-122 cps.

Geological Correlation

If the radiometric contour maps are compared with the known geological map, the most conspicuous feature, in majority of the area, is the striking linearity of contours marking the foliation trend of the litho-units.

The contact of streaky gneisses and augen gneisses is well demarcated from contour pattern on total radioactivity maps; larger difference in eU, eTh and K values and contours getting relatively wide spaced in augen gneisses.

The contact between augen gneisses and calc-silicates/khondalites unit can be marked from subtle variation in contour pattern on eTh, K, eTh/eU and K/eU ratio maps.

The contact of garnet-biotite gneisses with adjoining calc-gneisses and banded gneisses are well recognised from all the contour maps except K and eU/eTh as garnet-biotite gneisses have relatively higher concentration of eTh and lower concentration of eU than adjoining rocks.

The alaskites/leucocratic gneisses show homogeneity in eTh and K. Thus contours with wider spacing of K, eTh, eTh/eU and K/eU significantly separate this unit from its surrounding banded gneisses on contour maps of these parameters.

Structural Correlation

Structural elements like overthrust, tectonite zone and NE-SW trending fracture system mapped by Kampf *et al.,* 1985 (Fig.l) have been very clearly demarcated by radiometric thematic maps.

A distinct E-W linearity for 2.5 km in total radioactivity contour and eTh contour corresponds to the overthrust whereas tectonite zone is manifested in all the contour maps. Alignment of uranium anomalies and drag in contour pattern correspond to the above mentioned NE-SW trending fracture system.

Conclusion

The geochemical information obtained through gamma-ray spectrometry, besides being a direct method for evaluation of radioactive minerals is of considerable value in (i) geochemical classification of rocks, (ii) mapping the lithological boundaries, and (iii) delineating the structural trends having radiometric signatures.

These advantages could be best exploited in terrains like Antarctica for attempting a time-effective approach for larger coverages for the generation of basic geological/geochemical information, besides generating voluminous data for radioactive mineral and other associated element prospection, if any, in future.

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