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The integrating study between the radioactive survey and the magnetic survey of Carbonatite plugs using GIS South-east of Libya

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Abstract

Due to the economic importance of carbonatite rocks in terms of the presence of rare elements such as uranium and thorium, there are 527 known carbonatite sites around the world including sites R33 and R34A. Both of these sites are located on the eastern edge of the Kufra Basin in the AL-Uwaynat area, south east Libya**.**

Through the ground survey of carbonatite complex, R33 and R34A that located at the eastern edge of the Kufra basin AL- Uwaynat area. The several radioactive anomalies of uranium and thorium were detected. Where we found the highest value for the uranium in the carbonatite rock R33 120 ppm and the lowest value is 40PPM while the highest value of R34 is 240PPM and the lowest was 70PPM **.**

By the study Gamma ray log of the well CH7 the highest value is 730 C.P.S at depth 130m.Through the magnetic survey, the relationship was found between the radioactive anomalies and the magnetic anomalies.

Keywords: Radioactive survey, Magnetic survey, Carbonatite, Uranium, Gamma ray log.

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دراسة تكاملية بين المسح الاشعاعي والمسح المغناطيسي لصخور الكربوناتايت باستخدام تقنية نظم المعلومات الجغرافية جنوب شرق ليبيا

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الخلاصة

نظرا للأهمية الاقتصادية لصخور الكربوناتايت من ناحية تواجد العناصر النادرة مثل اليورانيوم والثوريوم، وبشكل عام هناك 527 موقعا معروفا للكربوناتايت على كوكب الأرض ومن ضمنهم الموقعين R33 و R34A اللذان يقعا على الحافة الشرقة لحوض الكفرة بمنطقة العوينات.

خلال المسح الارضي لمعقد الكربوناتايت R33 و R34A التي تقع على الحافة الشرقية لحوض الكفرة بمنطقة العوينات، تم تحديد العديد من الشاذات الإشعاعية لليورانيوم و الثوريوم، حيث و جد أعلى قيمة لليورانيوم في صخور الكربوناتايت R33هي 120ppm و اقل قيمة هي 40ppm، بينما أعلى قيمة في R34 هي 240ppm و اقل قيمة هي 70ppm.بواسطة دراسة سجل أشعة جاما للبئر CH7، و جدت أعلى قيمة للإشعاع 730C.P.S عند عمق 130m. و من خلال المسح المغناطيسي وجدت علاقة بين الشاذات الاشعاعية و الشاذات المغناطيسية.

الكلمات المفتاحية: المسح الإشعاعي، المسح المغناطيسي، الكربوناتيت، اليورانيوم، سجل أشعة جاما.

Introduction

Carbonatites and alkaline-carbonatite complexes were considered controversial ever since A.G. Högbom began detailed geological work at the Alnö Island alkaline carbonatite complex in 1889. The history of carbonatite research up to 1966 is well summarized in the 1st and 2nd editions of the widely available benchmark publication

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entitled ‘The Geology of Carbonatites’ by Heinrich 1980. A number of additional reviews have been performed since that time, including the book edited by K. Bell 1989entitled ‘Carbonatites: Genesis and Evolution’. However, the most important review from an exploration geologist's point of view is probably the compilation of (Wooley and Kjarsgaard, 2008a)entitled ‘Carbonatite occurrences of the word; map and database’, available free of charge for download from the Geological Survey of Canada website. The highly descriptive and factual nature of this publication avoids traps and controversies associated with the genesis of carbonatites, and takes into consideration some of the key suggestions of (Mitchell, 2005) who attempts toimprove currently accepted classification of (Le Maître, 2002) by making it more relevant to geological mappers and exploration geologists. The descriptive approach, in combination with the availability of data as spreadsheets, will make the (Wooley and Kjarsgaard, 2008a) compilation a valuable source of information for years to come, since spreadsheets can be easily updated and customised by the user.

Carbonatites are defined by the International Union of Geological Sciences (IUGS) as igneous rocks containing more than 50% modal primary carbonates (Le Maitre,2002). Depending on the predominant carbonate mineral, a carbonatite is referred to as a ‘calcite carbonatite’, ‘dolomite carbonatite’, or ‘ferrocarbonatite’, where the main carbonate is iron-rich. If more than one carbonate mineral is present, the carbonates are named in order of increasing modal concentrations. For example, a ‘calcite dolomite carbonatite’ is composed predominately of dolomite. If non-essential minerals (e.g. biotite) are present, this can be reflected in the name as ‘biotite-calcite carbonatite.

There are currently three main hypotheses explaining the origin of carbonatite melts: (1) immiscible separation of parental carbonated silicate magmas at crustal or mantle pressures (Woolley 2001) (2) crystal fractionation of parental carbonated silicate magmas such as olivine melilitites or kamafugites (Veksler and Lentz,2006); and (3) low-degree partial melting of carbonated mantle peridotite below 70 km depth (Rer.nat, 2019).

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Mineralized carbonatites and alkaline-carbonatite complexes are highly sought after, multi-commodity, but poorly understood exploration targets (Richardson and Birkett)They are the main source of niobium (Mackay and Simandl,2014a) and rare earth elements (Simandl,2014), which are considered critical metals for key economic sectors in industrialized countries (European Commission,2017), and have become popular exploration targets for mining companies worldwide. Alkaline-carbonatite complexes are significant sources of Cu, apatite, fluorite, vermiculite, and other commodities. Most modern studies on carbonatites address their origin and aim to improve our understanding of the Earth's mantle (Bell and Simonetti,2010).

In the study area Carbonatite complexes are igneous rocks consisting of alkali intrusion synite with apatite vermiculite and magnetite. Forming circular intrusive masses. Southeastern carbonatite (R33- R34A) consist of two ring structure, the two centers are five kilometer apart and both intrusions have similar dimensions; an intrusive body approximately three kilometers in diameter surrounded by Nubian sandstone.

The interpretation of the airborne radiometric survey identified several anomalies. during ground scintillometer survey were established that anomalies mostly thorium dominant and one anomalies of uranium dominant, the highest values were obtained from the biotite-apatite and lower readings were found in the central agglomerate complex and in the magnetite mineralization .magnetic survey identified a shallow magnetic body M21 in R33 this indict a shallow intrusive rocks intersecting with sedimentary rocks as part of eastern flange Kufra basin.

The location of the study area:

The study area is located in the south-east of Libya between longitude32027418 to 32027422 and latitude 22063134 to 22063130 as shown in the figure 1.

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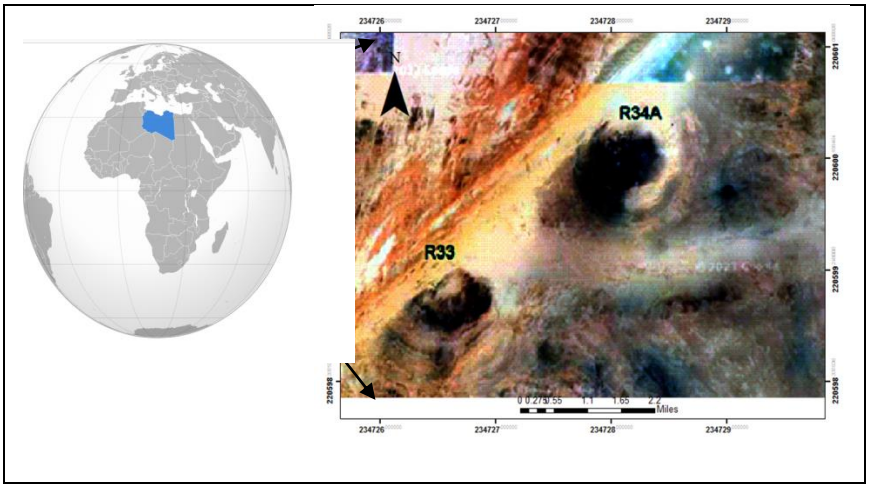

Figure 1. Shows the study area of R33 and R34A carbonatite rocks (satellite image)

Geology of study area

Strongly folded Precambrian metamorphic rocks consisting mainly of gneiss granulite, and amphibolite, crop out in the east in eastern part.

The basement complex comprises a variety of metamorphosed and gneissic rocks, altered acid and basic igneous bodies. Local swarm-like dolerite dykes were injected after the last folding phases including carbonatite play.

The Precambrian is unconformable overlain by weak metamorphosed Cambrian sediments sub horizontal Paleozoic-Mesozoic sediments, forming part of the eastern margin of the kufra basin, these sediments are partly continental and partly marine and comprise in terbeds of sandstone, siltstone and shale with occasional conglomeratic and calcareous beds.

The Precambrianbasement and the later sediments are intruded bycarbonatite plug acid, alkaline, intermediate, and basic rocks of a major igneous province, probably cambro- Ordovician to Devonian in age.

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This consists of under- saturated ring complexes, and more basic ring dykes and cone- sheet complexes.
There are two small poorly exposed ring complexes in the west of the area, which have a suite of minerals suggesting an association with a nearby basic intrusion of a car bonatitic composition.
The intrusion consists of carbonatitic agglomerate which appears to cut the apatite- vermiculite rock and syenite forms the main intrusive body. The apatite- vermiculite rock contains large lenses (100by30m) of massive course- grained magnetite and it is also layered vertically. The major intrusive rocks contain a little nepheline.

The study method:
The integrated method was used between radioactive survey from the scintillometer survey using GR245 device for R33 and R34, in addition to analyzing magnetic survey data and Gamma ray data for the exploration well, and these results were displayed using GIS.

Data collection
- Radioactive data "radioactive map".
- Magnetic Data "magnetic Map".
- Geological data "geological map".
- Gama ray log data for the CH7 well.

Data analysis and processing
The data was analyzed and processed using the GIS program, where the analog data was converted into digital data by georeferenced, so that the computer can deal with it. As for the gamma ray Log Data, digitization was performed and entered into the excel program and a gamma ray log diagram was drawn as shown in figure 2.

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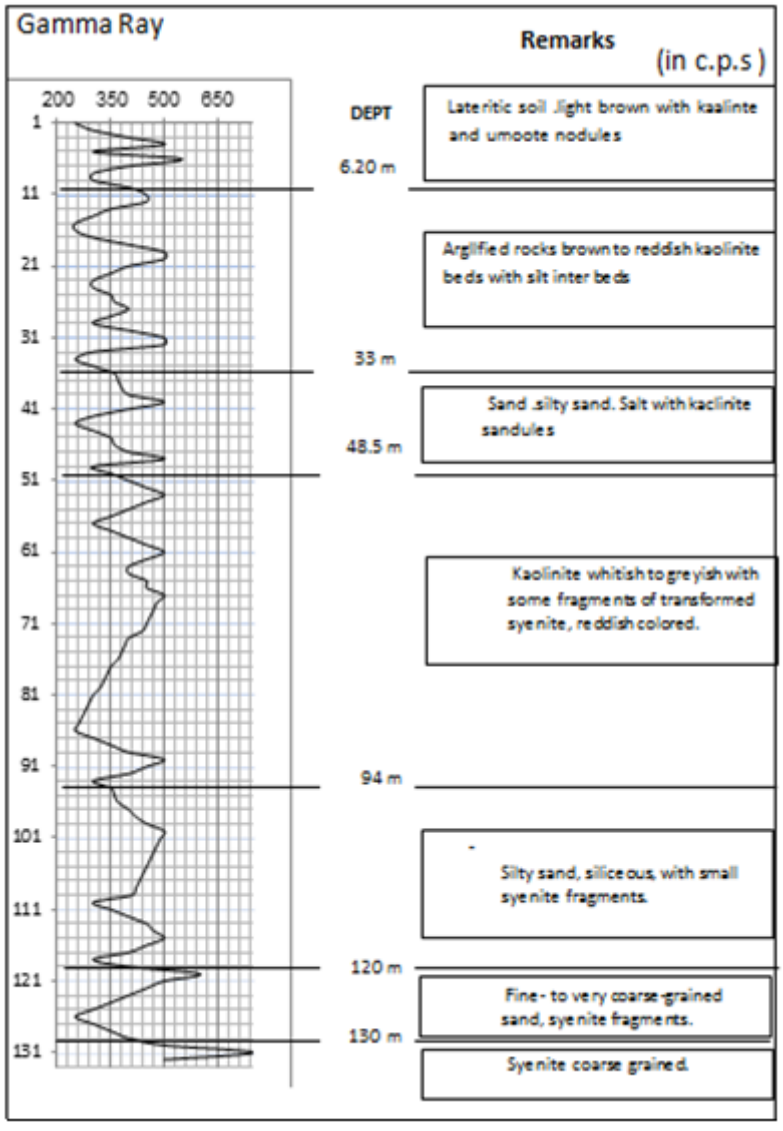

Figure 2. The GRL of the CH 7borehole in the R34A carbonatite rocks
(Industrial Research center 1979)

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The Results

From the results of the magnetic survey, the appearance of carbonatite rocks at site R34A, which intersects with magnetic body and surrounded by large faults, these faults decrease as we move away from the carbonatite rocks accompanying magnetic rock (Figure 3).

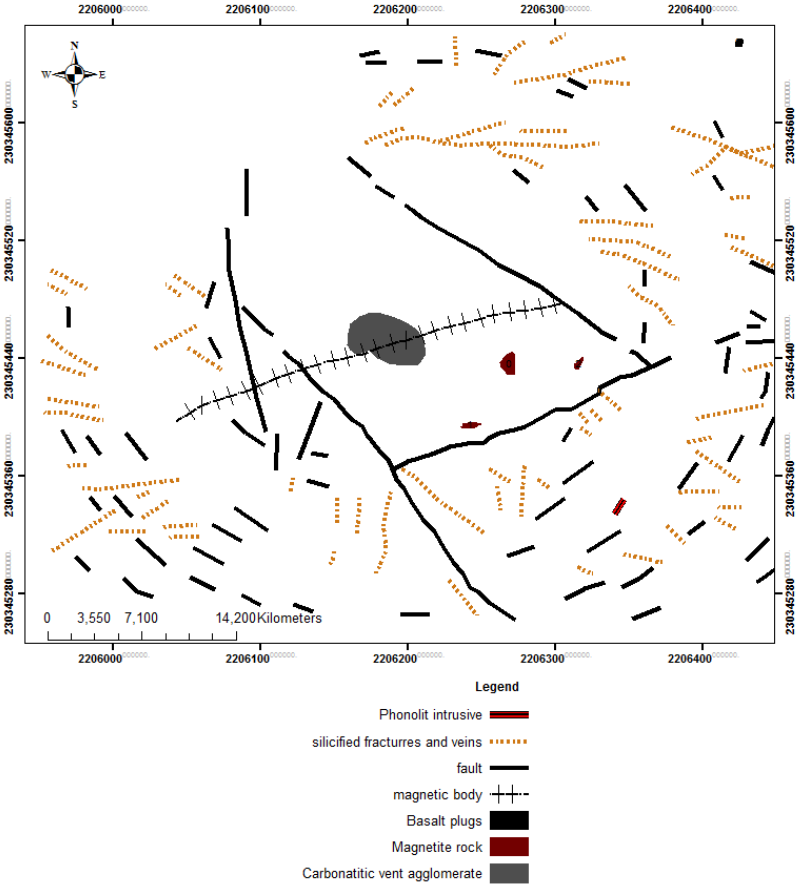

Figure. 3. Map showing the results of magnetic airborne survey using GIS for site R34A rocks
(Industrial Research center 1974 and Hunting Company).

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From the results of the magnetic and radioactive survey, it was found that there are five anomalies of uranium ranging from 40 ppm to 120 ppm concentrated around the carbonate rocks and magnetic body, and the presence of seven other anomalies of thorium centered in the northwestern part of the carbonate rocks (Figure 4).

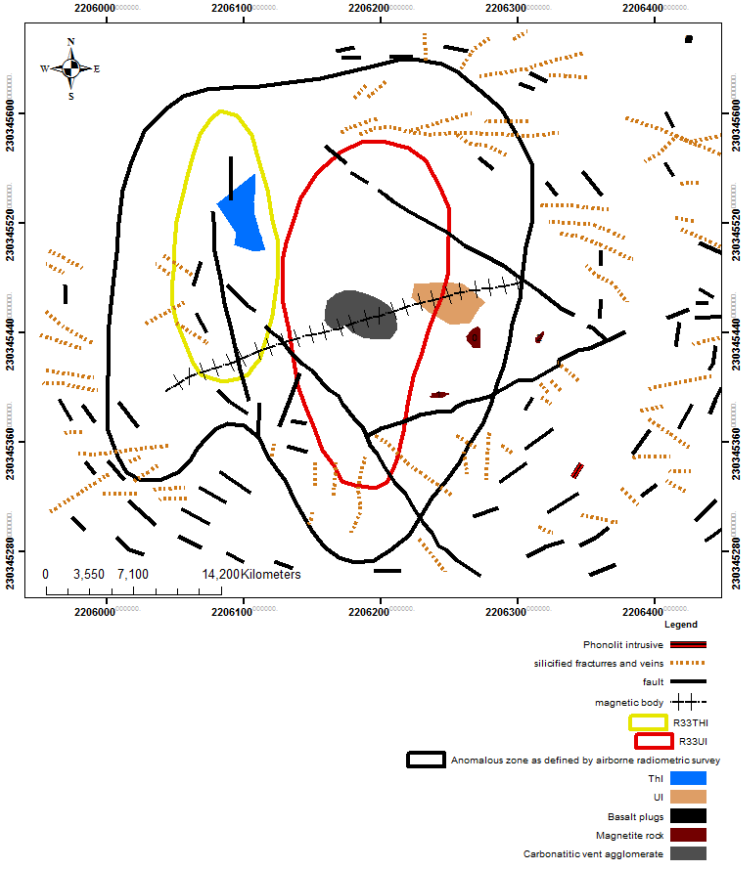

Figure 4. Map showing the spatial correspondence of the magnetic airborne survey and the ground radioactive survey using GIS for the site R34A
(Industrial Research center 1974 and Hunting Company)

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From the results of the magnetic survey, the radioactive survey and the geological Survey, it showed that the rocks of carbonatite, the main faults, the magnetic body, and the anomalies of uranium and thorium are concentrated in the rocks of apatite biotitesyenite rocks (Figure 5 & Figure 6).

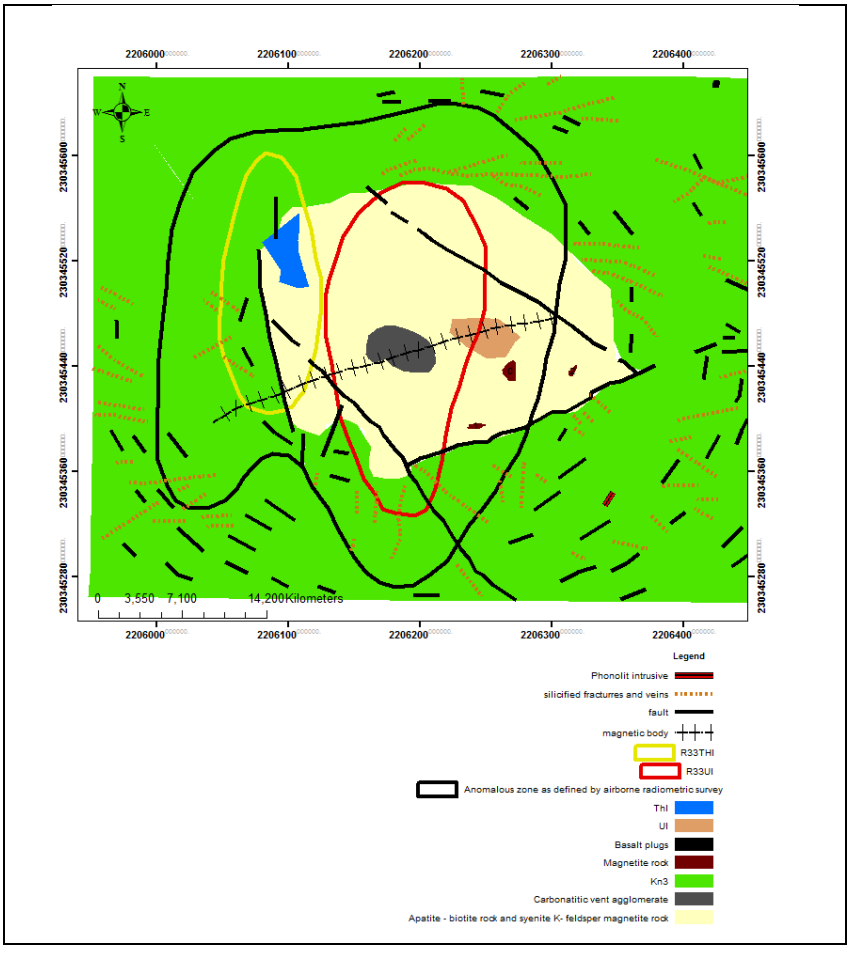

Figure 5. Map showing the spatial integration of the magnetic airborne survey, radioactive airborne survey and the geological formations in the site R34A using GIS
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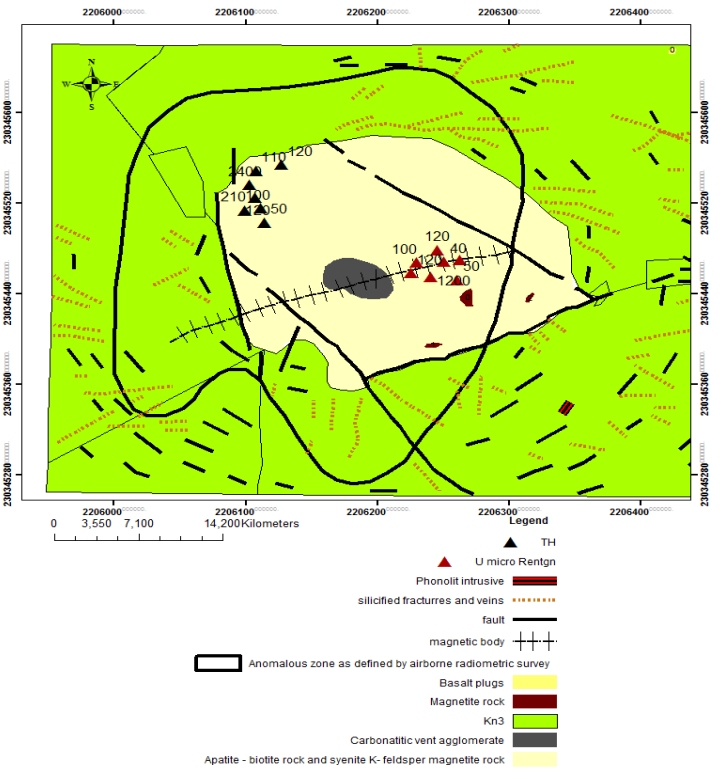

Figure 6. Map showing the spatial distribution of the radioactive ground survey integrated with magnetic survey and the geological formations of the site R34A
(Industrial Research center 1974 and Hunting Company)

From the results of the match between the geological survey and the radioactive survey of the R33 site, it was found that there are 4 anomalies of uranium ranging from 70 ppm to 240ppm centered on the rocks of kn3 (Figure 7).

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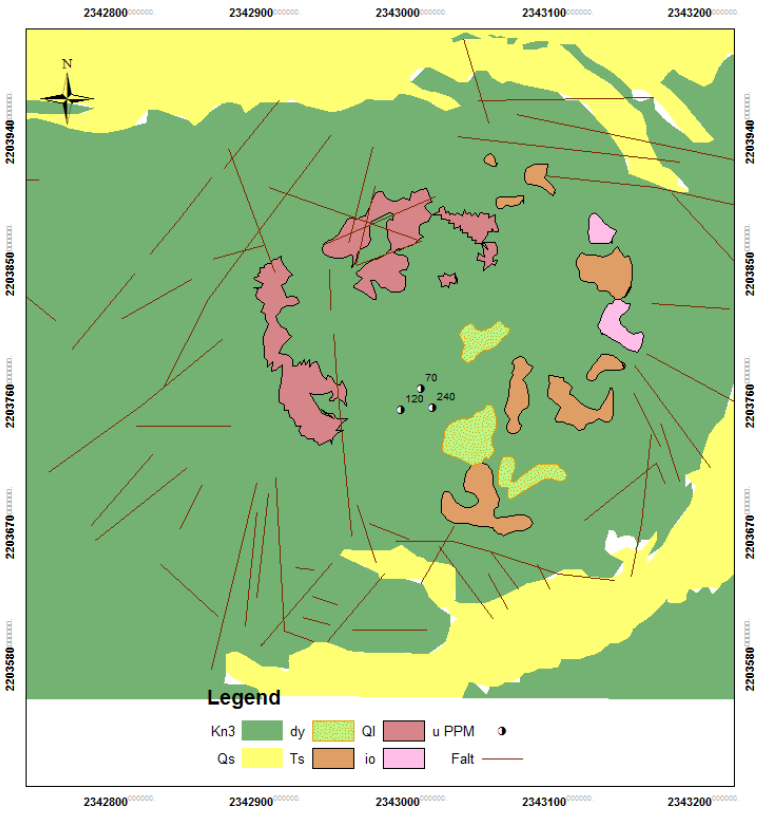

Figure 7. Map showing the spatial distribution of the radioactive ground survey integrated with the geological formations of the site R33 (Industrial Research center 1974 and Hunting Company)

And by analyzing the CH-7 well represented in the gamma ray log, it was divided into seven regions in terms of the change in the intensity of gamma rays.From these results, it was found that syenite rocks located at a depth of 130 m to 131 m contain the highest radiation content up to 750 cps as seen in figure 2, the results of Gamma ray log in CH-7 well are gathered in table 1.

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TABLE 1. Results of Gamma ray log in CH-7 well.

Depth	1m-11m	11m-33m	33m-48.5	48.5m-94m	94m-120m	120m-130m	130m-131m
Gamma Ray CPS	260 to 550	240 to 500	250 to 500	245 to 510	300 to 500	245 to 300	500 to 750
Thickness	6.20m	22m	15.5m	45.5m	26m	10m	1m

Conclusion

Through the radioactive survey was specify two of the anomalies R33 and R34A. Over the study of the anomaly R33, the presence of a radioactive anomaly of uranium is located within the carbonatite rock U1, and the radioactive concentration is determined by 40 PPM to 120 PPM while the radioactive anomaly R34A was located within the sandstone rocks of Carboniferous age, and the radioactive concentration was determined for the highest value 240PPMand the lowest value 70PPM.

Over the magnetic survey showing the uranium anomalies are located within the magnetic anomaly. And this matching illustrates the relationship between the uranium and the igneous body that nearby of the surface. It can be concluded that uranium has a relationship with plutonic igneous rock that nearby the surface, and this is supported the hypotheses for hydrothermal activity.

Through the results that obtained by the gamma ray log from exploration well CH17, showing the highest value of the concentration is 730C.P.S at depth 130m. This indicates that the carbonatite rocks are the highest value and the main source of these surface anomalies.

References:

Agterberg, 2021,Aspects of regional and worldwide mineral resource prediction

Ann.E.Mccafferty, 2023, National-Scale Geophysical, Geologic, and Mineral Resource Data and Grids for the United States,

تم استلام الورقة بتاريخ: 6/ 4/2024م وتم نشرها على الموقع بتاريخ: 30/ 4/2024م

Canada, and Australia: Data in Support of the Tri-National Critical Minerals Mapping Initiative.

Commission, E. 2017,*Report on critical raw materials for the EU.*

ELe Maître RW. 2002, Igneous rocks: a classification and glos-sary of terms. Cambridge (UK): Cambridge University.

Ltd, I. r. 1974,*Industrial research Centre and Hunting geology and geophysics Ltd* . Industrial research Centre and Hunting geology and geophysics Ltd .

Mackay DAR, S. G. 2014, Geology, market and supply chain of niobium and tantalum. *a review. Miner Depos.*

Rer.nat, 2019, Evidence for Magma–Wall Rock Interaction in Carbonatites from the Kaiserstuhl Volcanic Complex (Southwest Germany).

RW., L. M. 2002, *Igneous rocks: a classification and glossary of terms.* Cambridge (UK): Cambridge University Press.

Simandl GJ, F. R. 2014, SimandPortable X-ray fluorescence in the assessment of rare earth element-enriched sedimentary phosphate deposits.

Veksler IV, L. D. 2006,*Parental magmas of plutonic carbonatites, carbonate-silicate immiscibility and decarbonation reactions.* Veksler IV, Lentz D. 2006. Parental magmas of plutonic carbonatites, carbonate-silicate immisci Montreal (QC): Mineralog.

Woolley AR, K. A. 2008,*Carbonatite occurrences of the world: map and database.* Geological Survey of Canada.