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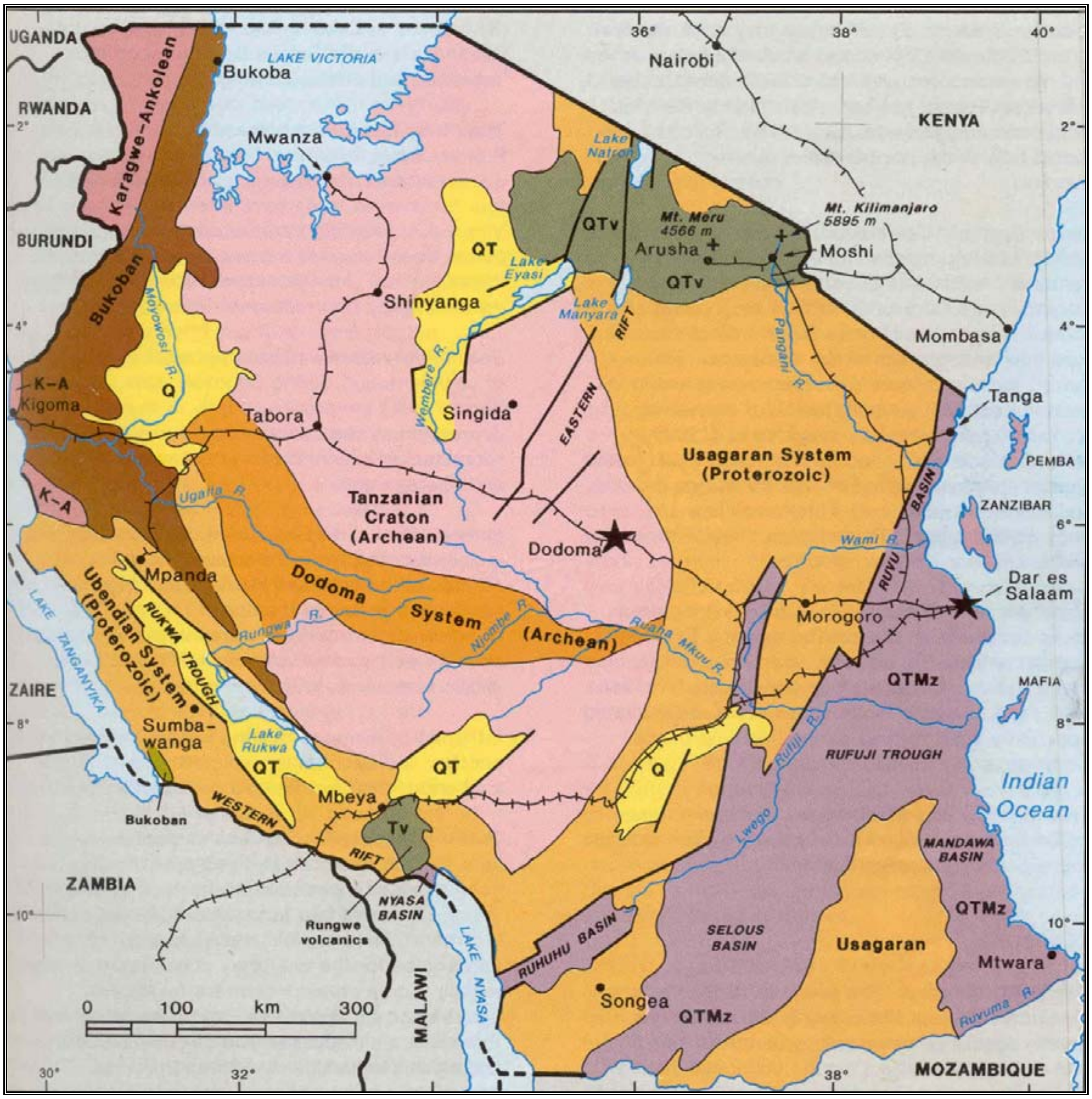
ABSTRACT

Airborne countrywide survey delineated anomalous radiometric areas in Tanzania which were grouped into Blocks A up to G. Regional airborne survey and ground follow up work indicated that among these blocks Blocks A and B are the most prospective. Uranium mineralizations associated with Karroo sandstones were discovered on Block A and calcrete related secondary mineralization associated with mbuga were detected on Block B. The unconformity between Karagwe-Ankolean and Bukoban Systems of Block C and G appeared to be less prospective for potential vein like type uranium deposits than the Ubendian/Bukoban Unconformity. Therefore, Block G and part of Block C was regarded not potential whilst the remaining part of Block C was assumed to be potential. Uranium in phosphate was proven on Block D but erratic grades and low tonnage did not justify further exploration. Continuation of exploration for uranium in acid volcanics and carbonatites (Block D, E and F) and uranium in Upper Proterozoic shales (Block F) was discouraged due to low uranium levels in trachybasalts of Monduli Juu, carbonatites of Galappo and Panda and copper bearing shales of Chimala. Tanzania is relatively under explored due to the low uranium exploration density in the country compared to that of some African countries and developed countries. The discovery of uranium deposits in Malawi, which bounds Tanzania to its south western part, makes areas north of Lake Nyasa that are located along the trend of Malawi uranium zones and adjacent areas east of Lake Nyasa to be more potential for uranium mineralization. Ongoing uranium exploration in the country, mainly in Bahi area within central Tanzania and southern part of the country have revealed further that there is a potential for uranium mineralization. The concession areas have not been investigated at their own but the potentiality of blocks in which they are located makes these areas prospective for uranium mineralization.

1.0 GEOLOGICAL FRAMEWORK AND REGIONAL METALLOGENY OF TANZANIA

Tanzania is mainly covered by Precambrian rocks. The remaining eastern part of the country and outliers within the Precambrian rocks comprise Phanerozoic rocks **(Figure 1).**

Figure 1: Geological map of Tanzania.



The Archaean Tanzania Craton is constituted of Archaean rocks which are granitic complexes, Dodoman System and greenstone belts. The Proterozoic mobile belts of the Ubendian System on the west, Mozambique Belt to the east and Usagaran System in the southeast surround the Archaean Tanzania Craton. The Proterozoic mobile belts of the Karagwe-Ankolean and Bukoban Systems bound the Archaean Tanzania Craton to the northwest. The Karroo rock formations overlie the Precambrian rocks and occur mainly in southwest Tanzania and minor exposures are found in the north eastern part of the country. Alternating continental and marine sedimentary rocks of Lower Jurassic to Quaternary occur along the coastal zone. The intrusive rocks of various ages vary from ultramafic to felsic rocks. These include dolerites, gabbros, granites, syenites, kimberlites and carbonatites.

1.1 Archaean Rocks

The Tanzania Craton occupies the central part of Tanzania. The Tanzania Craton mainly comprises granitoids with outliers of rocks of the Dodoman System in the central part of the country and greenstone belts in the northern portion of Tanzania, east and south of Lake Victoria.

1.1.1 The Archaean Granitoid Terrane

The Archaean granitoids constitute the largest portion of the Tanzania Craton, but there are also gneisses, schists, quartzites, migmatites, amphibolites and granulites. Intrusions include ultramafic to felsic intrusive rocks such as serpentinite, gabbro, dolerite, diorite, kimberlite, granites and syenites. The metamorphic grade ranges from amphibolite to granulite facies.

1.1.2 Dodoman System

The rocks of Dodoman System occur as an elongated belt trending WNW. The Dodoman System comprises sericite and quartz schists, hornblende gneisses and granite gneisses, ferruginous banded quartzites, migmatites, granites, amphibolites and talc-chlorite and corundum-bearing rocks. There are also metamorphosed mafic and ultramafic rocks. Intrusive rocks include ultramafic and mafic rocks. The felsic intrusions are granites and pegmatites. The metamorphic grade of the Dodoman System is of amphibolite facies. The Dodoman System hosts minor mineral occurrences of gold, corundum, talc and soapstone.

1.1.3 Greenstone Belts

The greenstone belts occur in the Lake Victoria Gold Field in the northern part of the country, east and south of Lake Victoria. The Lake Victoria area is intruded by mafic to felsic intrusions of various ages. These include ultramafic rocks, gabbros, dolerites, granites, syenites, diorite and lamprophyries. The greenstone belts are regionally metamorphosed to greenschist facies and in places near granitic intrusions into epidote amphibolite facies.

More than 90% of the gold produced in Tanzania has been mined from the greenstone belts in the Lake Victoria Gold Field. The ultramafic complexes are potential hosts to chromite-nickel-platinum mineralization.

1.2 Proterozoic Rocks

Proterozoic mobile belts of various ages and grades of metamorphism surround the Archaean Tanzania Craton. The Tanzania Craton is in contact with the Ubendian System on the west and southwest and the Usagaran System in the southeast. Bounded to the west by the Karagwe-Ankolean System, the Bukoban System borders the Tanzania Craton to the northwest. The Mozambique System is situated east of the Tanzania Craton.

1.2.1 Ubendian System

The Palaeoproterozoic Ubendian System is located on the southwestern and western margin of the Archaean Tanzania Craton. The Ubendian System is subdivide according to rock type and degree of metamorphism into Wasinsi, Ubende, Wakole, Ufipa, Ikulu and Katuma

Series. Also the Ubendian System is subdivided on the basis of lithological and structural features into blocks.

The Ubendian System comprises high-grade metamorphic rocks of originally sedimentary and igneous origin. The rocks include granulite, amphibolite, migmatite, gneiss, schist, quartzites and marble. Granites are the major intrusive rocks, but there are also gabbro-norites, eclogites, metamorphosed amphibolites, dolerites, peridotites and carbonatites. The granites range to granodiorites and, and in zones of strong ductile deformation, are gneissose, with foliation trending parallel to the strike of Ubendian rocks.

The metamorphic grade of the Ubendian System is mainly amphibolite or granulite facies.

Within the Ubendian System, gold and silver were produced as primary minerals in Lupa Gold Field and a by product of copper and lead in the Mpanda Mineral Field. Other minerals occurring in the Ubendian System include chromium, platinum, nickel and copper. Usagaran System

The Usagaran System contains rocks of Paleoproterozoic age that were deposited in geosynclinal troughs. The Usagaran System comprises sedimentary rocks and volcanic rocks of the Konse Group and gneisses, amphibolites and lenses of granulites of the Isimani Suite. The Konse Group trends NE-SW and is bordered by the Tanzania Craton on the west and the Isimani Suite on the east. The Isimani Suite is of high metamorphic grade, upper amphibolite to granulite facies and is unconformably overlain by the Konse Group. The Konse Group is composed of low-grade metavolcanic rocks and metasedimentary rocks.

The Ndembera Series unconformably ovelies the Usagaran rocks, and comprise felsic to intermediate volcanic rocks and quartzite. The Ndembera Series is unmetamorphosed or metamorphosed to greenschist facies and intensively folded along axes of various trends but not as intense as the Usagaran System.

The Isimani Suite was metamorphosed to granulite-upper amphibolite facies. Later on, the Isimani Suite, Konse Group and intrusive dolerite underwent retrograde metamorphism to greenschist-amphibolite facies.

1.2.2 Karagwe-Ankolean System

The Karagwe-Ankolean System occurs in the northwest part of Tanzania and unconformably overlies sheared granitoids of the Archaean Tanzania Craton. The Ukinga Series, which is surrounded by the Ubendian System in the southwestern part of Tanzania, is an outlier of the Karagwe-Ankolean System.

The Karagwe-Ankolean System comprises mainly argillaceous formations that have been slightly metamorphosed to argillites, phyllites and schists. There are also arenaceous formations now represented by quartzite. The Ukinga Series are metamorphosed to middle greenschist facies.

Ultramafic and mafic rocks and granites intruded the Karagwe-Ankolean rocks. The mafic and ultramafic intrusions are layered and comprise peridotites, pyroxenites, norites, anorthosites and granophyres. The metamorphism in the Karagwe-Ankolean System is very low and mainly increases towards the base of the Karagwe-Ankolean System.

Mineral resources associated with the Karagwe-Ankolean System include cassiterite, wolframite, nickel, copper, gold, silver, niobium-tantalum, magnetite, talc, ochre, mica, uranium, thorium, beryllium, lithium, bastnasite, semi-precious stone, cobalt, platinum, chromium, titanium, vanadium and iron. Some of the minerals occurring in the same system in neighbouring countries have not been located in Tanzania.

1.2.3 Bukoban System

The major sequence of the Bukoban System in Tanzania occurs west of the Tanzania Craton. Several small and isolated outliers of Bukoban System are situated in the Tanzania Craton and Ubendian System. The Bukoban System comprises sedimentary rocks of anorogenic and continental origin, amygdaloidal basalts, and andesites. The sedimentary rocks include sandstones, siltstone, shales, red beds, chert, conglomerates, quartzites, greywackes, and dolomitic limestones. The rocks of the Bukoban System are unmetamorphosed except where they have been subjected to local cataclasis.

Mineral resources known to occur in the Bukoban System include sands, dolomite, lime, ochre and uranium. Other mineral resources are copper, lead, silver and tin.

1.2.4 Mozambique Belt

The Archaean Tanzania Craton in the west and Mesozoic sedimentary rocks to the east bound the Mozambique Belt in Tanzania. The Mozambique Belt contains intensively deformed metasedimentary rocks and intrusions. The major rock types include granitoids, granulite, meta-anorthosites, gneisses, amphibolites, marbles, pegmatites, mafic and ultramafic rocks, migmatites, quartzites and schists. The metamorphic grade in the Mozambiquian Belt is amphibolite to greenschist facies, pyroxene granulites, granulite, amphibolite facies, almandine-amphibolite facies.

Most of the economic minerals in the Mozambique Belt formed during metamorphism, and the belt hosts minor hydrothermal mineralization including that of base metals and gold. Other minerals include copper minerals, graphite and magnesite. Gemstones are the major minerals in the Mozambiquian belt and include ruby, tanzanite, garnet, tourmaline, sapphire, scapolite, emerald, alexandrite, quartz, zircon, kyanite, apatite and corundum.

1.3 Phanerozoic Rocks

There is no record of the geological history of East Africa from the end of the Precambrian to the beginning of Upper Palaeozoic. The rocks that formed thereafter during the Phanerozoic period are of the Carboniferous to Lower Jurassic Karroo System, and of Mesozoic and Cainozoic ages.

1.3.1 Karroo System

The Karroo rocks unconformably overlie the Precambrian suites of various ages and pass into marine rocks to the east. The sedimentary rocks of continental origin in southwestern Tanzania are the major rocks of the Karroo System. The northeastern part of the country contains minor marine sedimentary rocks. The major Karroo basins trend NNE to NE, while the small basins are aligned in a NW direction between Lake Nyasa and Lake Tanganyika. The Karroo rocks which are mainly sandstones, siltstones and shales are about 7000 m thick. The Karroo sedimentary rocks are subdivided into K1 to K8 units each ranging in thickness from few metres to 1 000 m thick.

Tanzania, specifically the south western part of the country, has coal of economic significance exists. Mining of coal in the Songwe-Kiwira coalfield has been going on for decades. One type of uranium mineralization is associated with Karroo rocks.

1.3.2 Mesozoic rocks

The Mesozoic rocks that occur along the coastal margin of Tanzania and in parts of the rift troughs overlying Precambrian or Karroo rocks. The Mesozoic sedimentary rocks are altenating transgressive and regressive sequences. The Jurassic rocks comprise limestones, sandstones, silstones, clays, marls and evaporites and unconformably overlie the Precambrian rocks.

The Cretaceous rocks associated with regression are mainly continental and deltaic sedimentary rocks intercalated with thin marine beds. The continental units include sandstones, siltstones and mudstone. The marine beds that were deposited during transgression are coral limestones, silty shales and mudstones.

The majority of the marine Early Cretaceous sedimentary rocks occur in the southern part of Tanzania. The isolated Early Cretaceous marine sedimentary rocks are found in the central eastern and northeastern part of the country. Several invertebrate species exist in these formations. The Late Cretaceous rocks occur mainly along the central coastal strip of Tanzania and rarely in the southern coastal part of the country.

The widespread intrusion of carbonatites and kimberlites occurred in Cretaceous time. The Cretaceous carbonatites occur in southern and central Tanzania. The carbonatites in northeastern Tanzania intruded in Neogene time. Most of the kimberlites occur in the central part of the Archaean Craton. The Mesozoic rocks are unmetamorphosed.

The major economic rocks associated with the Jurassic sedimentary rocks in the coastal belt are limestones and evaporites like gypsum, anhydrite and salt. Limestones are also found in Cretaceous strata. Cement is produced near Tanga. Exploration for oil has been going on since 1953 along the coastal zone in Late Cretaceous sedimentary rocks, but no oil has been discovered. Natural gas has been discovered at Songosongo.

1.3.3 Cainozoic

Tertiary sediments were deposited during alternating periods of regression and transgression that followed Cretaceous transgression. Like the Mesozoic rocks, the Cainozoic formations are mainly of marine origin. The Tertiary strata were deposited along the coastal belt mainly in the southern part of Tanzania and Zanzibar Islands.

The Palaeogene rocks occur in the southern coastal area of Tanzania as a narrow strip overlain by marine and continental Neogene rocks. The Paleocene rocks associated with regression periods are clays, silty layers, marl bands and silty limestones. There are calcareous, sandy and shelly limestones that represent transgressive episodes. The thickness of Palaeocene rocks varies form 600 m to 60 m.

The deposition of Neogene sedimentary rocks, associated with coastal subsidence and worldwide transgression, created open shelf conditions along the coast. The Miocene strata in the Tanzania coastal area are mainly transgressive and comprise clays, silts, and sandy coral limestones, while the Pliocene sequences are mostly regressive and contain sandstones, clays and coral limestones.

The Neogene volcanic rocks overlie the Precambrian rocks in the southwest and northeast part of the country. The volcanic rocks of Neogene age in southwest Tanzania are exposed in the Rungwe District. The central rift valley and Meru-Kilimanjaro areas contain Neogene volcanic rocks in the northeast part of the country. The Quaternary period was characterised by depositional and erosional cycles related to mainly sea level and climate changes and tectonics.

Mineral deposits of Cainozoic age include the Tertiary surface and residual deposits. Other mineral deposits are marine, lacustrine and fluviatile as well as Quaternary marine and beach deposits.

Alluvial gold has been panned in the Lake Victoria Goldfield, Lupa Goldfield, Mpanda Mineral Field, and other areas with gold occurrences in Precambrian rocks. Secondary gold is associated with Cainozoic, Tertiary and Miocene events. The Cainozoic alluvial gold placers include quartz sand and gravels, eluvial and palaeochannel gold placers. Fluviatile and lacustrine placers around the margins of the southern part of Lake Victoria are potential for secondary gold. The eluvial deposits include placers on the Upper Tertiary erosion surface, detrital quartz in red soils overlain by ferricrete, placers on the sub-Miocene erosion surface, and quartz debris in saprolite and mottled clay zones of the laterite profile. Fossil placers include the detrital gold in the Kavirondian System and Bukoban System.

The Wazo Hill limestones, where cement production has been going on since 1966, are of marine origin and Miocene age. The Miocene sandstones at Pugu Hills have been mined for kaolin since 1942. The clays that are interbedded with kaolinitic sandstones at Pugu Hills are mined for bricks and tiles. The exploration of hydrocarbons in Tertiary coastal rocks, like limestones, sandstones and shales, started in 1953.

The lake and river alluvium of Quaternary age includes mbuga deposits that formed in flooded areas of internal drainage like the Rukwa Trough, Buhoro Flats, Wembere Depression and Malagarasi Basin. Minerals associated with lake beds include limestone, gypsum, rock phosphate, diatomite and meerschaum. Surface limestones overly lime-rich rocks in the main areas of Tanzania. Other residual deposits are kaolin, bauxite and manganese. Marine and beach deposits include the coral reefs and heavy mineral concentrates along the coast.

1.4 Intrusive rocks

The intrusive rocks range from ultramafic to felsic volcanic rocks.

The ultramafic and mafic intrusive rocks of different ages occur as unmetamorphosed or metamorphosed rocks in different parts of Tanzania, but are abundant in the Archaean and Proterozic rocks. The late-Archaean to Proterozoic ultramafic and mafic intrusions are mainly serpentinite and gabbro. The ultramafic and mafic complexes are related to the greenstone belts. Karroo dolerite dykes trend N-S and ENE and intruded along faults that were reactivated by rifting of the East African System.

The ultramafic and mafic rocks host titaniferous magnetite, chromium, platinum, nickel and copper. Other minerals hosted in ultramafic and mafic rocks are garnet, corundum, vermiculite and talc.

1.4.1 Granitic Rocks

The granites are subdivided into syn-, post- and late-orogenic granites. The syn-orogenic, and to some extent post-orogenic, granites constitute a large part of Tanzania and are not related to mineralization. The late-orogenic granites in Archaean and Proterozoic rocks are scarce, small and discordant to the general trend. Some of the late-orogenic granites are plutonic, form the cores of gneiss domes, or occur in complex intrusions. Mineralization is associated with some late-orogenic granites.

The late-orogenic granites are of various types. The late-orogenic granites in most parts of the Archaean and Proterozoic rocks of Tanzania are represented by dykes, as for the molybdenite-bearing granite dykes of central Tanzania, aplites and pegmatites that cut the synorogenic granites and migmatites, and lamprophyres.

The late-orogenic dykes occur in central Tanzania. The late-orogenic mineralization is associated with accessory molybdenum and some of the dykes in Dodoma contain pyrite and chalcopyrite. Gold at Madengi Hill in Dodoma is related to a late-orogenic dyke phase. The late-orogenic micro-granites occur as lenticular masses in synorogenic granites in the Lake Victoria Gold Field. The late-orogenic granodiorites occur in several places within the Archaean Lake Victoria Gold Field and Proterozoic Lupa Gold Field mainly as diapirs with different aureole effects including injection and alteration. Gold mineralization in the Lake Victoria Gold Field is spacially related to late-orogenic granodiorites that occur as small bodies encountered only in mine working or drilling. The late-orogenic albitisation in most gold district in Tanzania is related to emplacement of granodiorites. Southwestern Tanzania is characterised by alaskitic granites that are spatially related to lead, copper, gold and silver mineralization in the Mpanda Mineralfield. The late-orogenic granites in the Karagwe-Ankolean System are associated with tin and tungsten mineralization. Mineralization of beryl and columbite in Uganda, Rwanda and Burundi occurs in late-orogenic pegmatites.

1.4.2 Pegmatites

Different types of pegmatites occur in synorogenic granites, migmatites and metamorphic rocks of the Archaean and Proterozoic terranes. The pegmatites are abundant in the Proterozoic Usagaran and Ubendian Systems, rare in the Archaean Dodoman System, almost absent in the Archaean Nyanzian System, and do not exist in rocks younger than Proterozoic age. Pegmatites host mica, beryl, uraninite, monazite-columbite-tantalite, allanite, vermiculite, phlogopite and feldspar.

1.5 The East African Rift System

The East African Rift System is part of the Afro-Arabian Rift System that extends from Mozambique to Turkey. The main branches of the East African Rift System are the Eastern Rift or Gregory Rift and Western Rift. The Eastern Rift extends from Ethiopia to Tanzania and the major faults trend north-south. Extending from Uganda to Tanzania, the Western Rift has major faults that trend NE in the north and NW in the south. The Eastern and Western Rifts join north of Lake Nyasa in Tanzania and extend southward along the lake.

1.5.1 Volcanism Related to the East African Rift System

The emplacement of kimberlites, carbonatites and hot springs is related to the East African Rift System.

There are over 200 kimberlites in Tanzania. The kimberlites are concentrated in the Tanzania Craton mainly south of Lake Victoria, with outliers in the Proterozoic mobile belts. Interpretation of the airborne geophysical survey and satellite images designated over 630 dipolar magnetic anomalies.

The carbonatites associated with the volcanic field occur in northern and southern Tanzania. Isolated carbonatites occur in central part of the country.

The hot springs and contained gases are mainly related to rifting, some are associated with volcanoes and there are a few outliers.

1.5.2 Cainozoic Volcanoes

Cainozoic volcanoes occur in northeastern and southwestern Tanzania. Mineral resources associated with rifting include those related to carbonatites (REE and apatite), kimberlites (diamond) and volcanic rocks (building material). Gases such as carbon dioxide and helium gases are associated with hot springs. Diamondiferous kimberlites include the Mwadui kimberlite that has produced several million carats of diamonds over the past 50 years.

2.0 POTENTIALITY OF URANIUM MINERALIZATION IN TANZANIA

The potentiality of the area is discussed basing on previous regional work done on country and block scales. The individual concession areas are assessed with respect to uranium mineralization by using such regional and block information as well as their extrapolations. Geosurvey International in 1976-1980 carried out uranium exploration on country wide and regional scales. Further ground follow-up was undertaken by Uranerzbergbau of Germany in 1978-82.

2.1 Previous work done

Geosurvey International from 1976-1980 carried out airborne geophysical surveys comprising country wide survey followed by regional surveys in selected blocks. Airborne geophysical survey comprising magnetics, radiometric and electromagnetic methods was carried out all over the country. Spacing of the flight lines was 1 km and tie lines 10 km. Regional detailed surveys were carried out by Geosurvey International and as well as Uranerzbergbau. The delineated anomalous areas potential for follow up by further work include the following:-

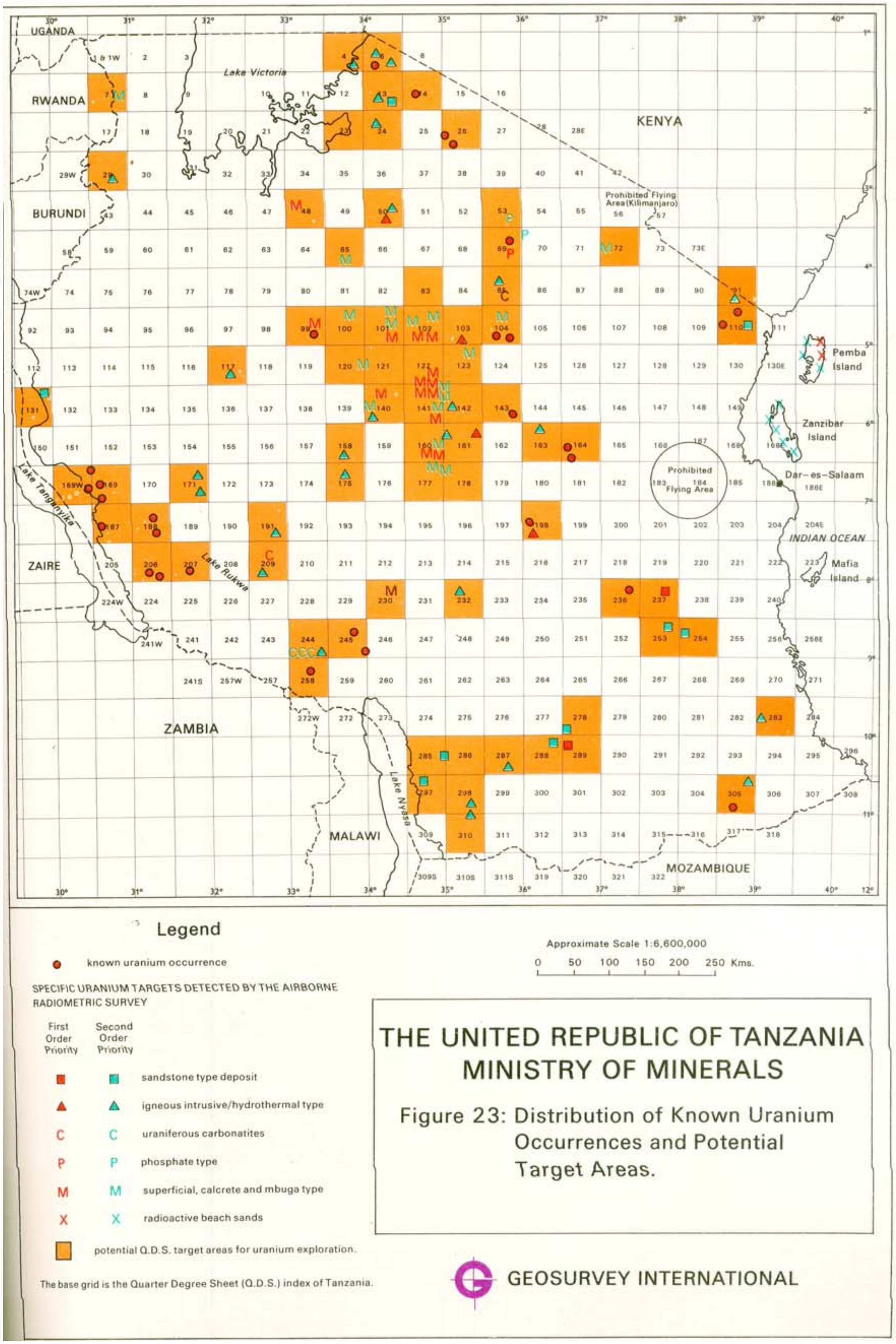
- Sandstone and siltstone of Karroo System;
- Igneous/intrusive type;
  - Carbonatite; and
  - Intra-intrusive rocks.
- Hydrothermal type;
  - Unconformity vein type in Ubendian and Karagwe-Ankolean System
- Phosphate rocks;
- Superficial calcrete and mbuga deposits; and
- Radioactive beach sand.

The distribution of the radiometric anomalous is shown in (

Figure 2).

Other companies which are currently doing some works or recently have done work to follow the anomaly established by Geosurvey International are Western Metals in the southern part, Mantra of Australia and Uranex in the central part.

Figure 2: Distribution of known uranium occurrences and potential target areas (after Geosurvey International, 1980).



All the first and most second order priority anomalies over *mbugas* and superficial sediments occur in the confines of the craton mainly within the boundaries of two internal drainage basins of Bahi *mbugas* and Lake Eyasi. Uranium exists elsewhere within and outside the craton but suitable conditions within Bahi *mbugas* and Lake Eyasi enabled airborne geophysical survey to detect this type of anomalies.

All high priority anomalies, first and most second order priority uranium anomalies have the following features:-

- occur within internal drainage basins,
- occur at/or close to the head waters of any particular drainage system where the areas are relatively high altitudes and erosion dominates and superficial sediments are thin. This explains why uranium mineralization occurs close to the surface and has been detected by airborne survey.
- Occur over dykes which have been detected in aeromagnetic survey with exception of Handa anomaly. Such dykes are the probable source of vanadium which is responsible for the precipitation of carnotite.

Maps produced from the data were interpreted at a scale of 1:100,000. In addition to this, these results were incorporated into a regional interpretation of Tanzania at a scale of 1:2,000,000. These maps support the reports that were prepared following the exploration work and results. Anomalous radiometry areas designated as Blocks A to G **(Table 1 and Figure 3),** were delineated as potential with respect to uranium mineralization.

Table 1: Anomalous radiometric areas designated into Blocks A to G (modified after Geosurvey International, 1980).

Block	**Block name**	**Favourable geological environment**
A	Karroo	Sandstone, veinlike (unconformity)
B	Dodoma	Calcrete
C	Tabora and Kigoma	Calcrete, veilike (unconformity), intra-intrusive (granites), sandstones
D	Minjingu and Galappo	Sedimentary (phosphate), intra-intrusive (carbonatite)
E	Monduli-Tarosero	Volcanics
F	Mbeya-Njombe	Sedimentary (black shales), intra-intrusive (carbonatite), veinlike (unconformity)
G	Bukoba	Veinlike (unconformity), intra-intrusive (granite), sandstone

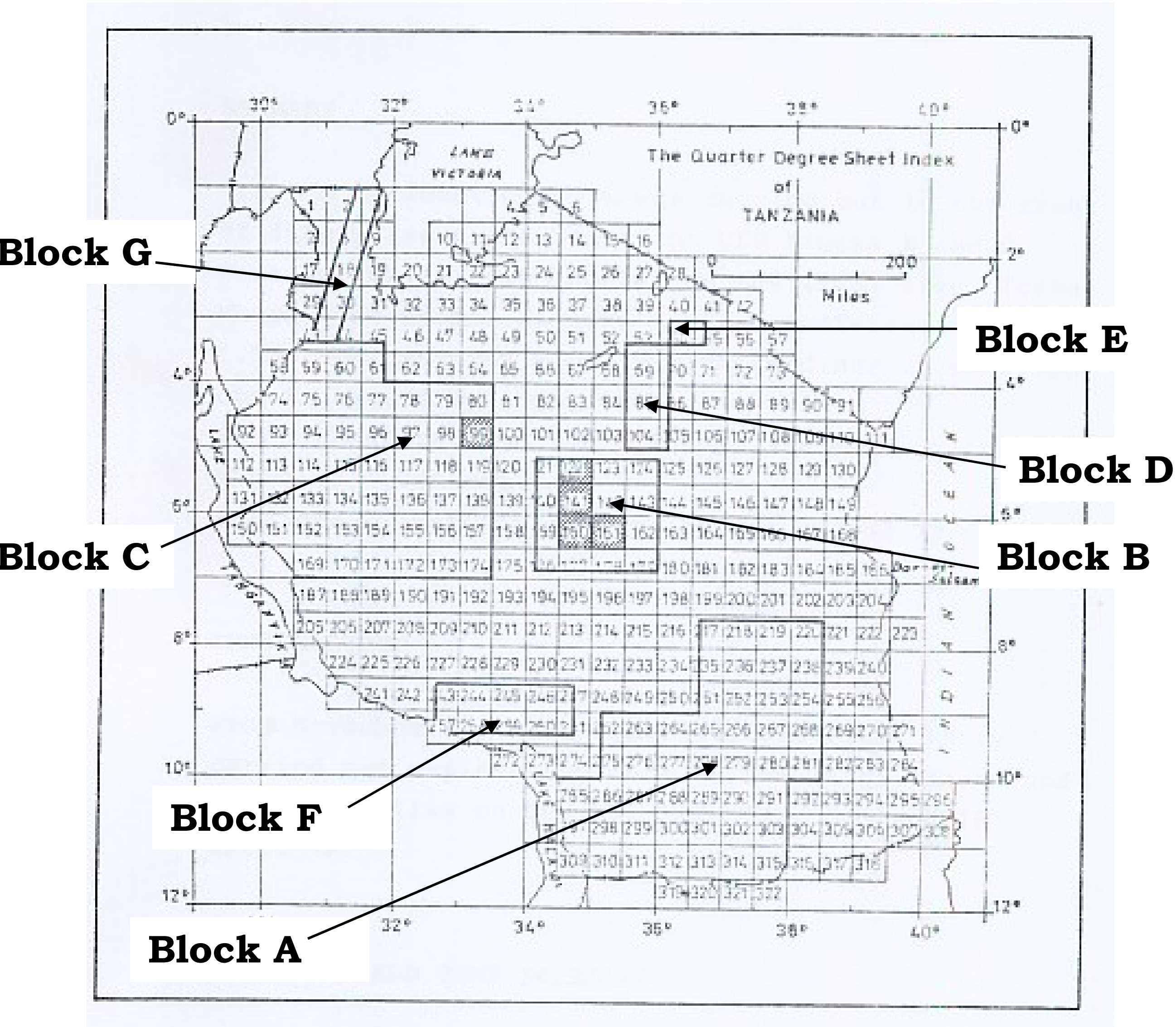


Figure 3: Location of blocks of uranium airborne anomalies.

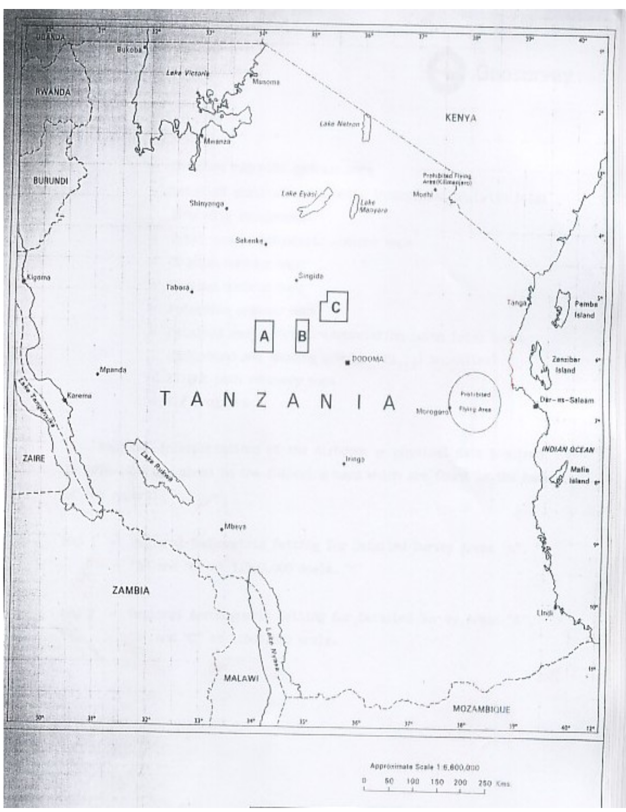
A number of uranium occurrences discovered by combined airborne and ground follow-up surveys occur in different geological environment **(Table 2).**

Table 2: Distribution of uranium mineralization in Tanzania with respect to geological set up (after Geosurvey International).

Age	System	Uranium Block
Tertiary to recent	Volcanic rocks related to East African Rift System in northeast Tanzania (Ngorongoro-Kilimanjaro) and south west Tanzania (Rungwe)	D and E
	Inland terrestrial deposits in rift troughs whereby internal basins are filled with sands, clay and calcrete (mbuga)	B and C
Carboniferous-Lower Jurassic	Karroo (mainly continental facies in grabens) followed by Jurassic-Quaternary Marine sediments along coastal line	A
Upper Proterozic	Bukoban	G, C and F
Middle Proterozoic	Karagwe Ankolean	C and G
Lower Proterozoic	Usagrana and Ubendian	A, B, C, D and F
Archaean	Dodoman, Nyanzian and Kavirondian	A, B, C, D and F

Country airborne geophysical anomalies carried out in 1976-79 by Geosurvey International revealed high density radiometric anomalies within three areas in central Tanzania designated A, B and C **(Figure 4)**

Figure 4: Location of areas (Block A, B and C) for detailed investigation (after Geosurvey International, 1980).



These areas, which coincided with seasonal swamps (mbugas), were subjected to further detailed airborne investigation. The total surveyed area was 6,500 square kilometres. The survey involved magnetics, radiometric and electromagnetics.

Description	**Area A**	**Area B**	**Area C**
Date survey flown	October 1979	August 1979	August-November 1979
Flight line spacing	250 m	250 m	250 m
Flight line direction	E-W	E-W	N-S
Tie line spacing	5 km	4 km	5 km
Sample interval	N-S	N-S	E-W
Flying height	50 m	50 m	50 m
Map presentation scale	90 m	60 m	90 m
Map presentation scale	1:25,000	1:25,000	1:25,000
Approximate area	2044 km^2	1653 km^2	2800 km^2
Approximate line kilometres	10,500 km	7,700 km	12,000 km

The detailed survey defined a total of 307 anomalies of different sources. The important anomalies are 81 and are related to mbugas. Out of these 44 anomalies were regarded as priorities and together cover an area of about 133 square kilometres each anomaly ranging from 0.5 to 14.5 square kilometres. These anomalies are evenly distributed in areas A and B but occur in the central to south eastern portion of area C. The anomalies are comparable to anomalies in Yeelirrie in Australia.

Granitic rocks of the Archaean Craton are characterised by high total counts, potassium channel being the main contributor to these high counts. The source rocks are granites and granite-gneisses, whose potassic feldspars and thorium bearing accessory minerals gave rise to the high counts. The granitic rocks of various types include north west aligned unit in the south west over which high total counts were recorded. The contaminated granites occur in the south east. In the east against the margin of Tanzania Craton, the rocks there show high counts compared to that of the synorogenic granites to the west.

Uranerzberghau carried out exploration of uranium in Tanzania from 1978 up to 1980. The sizes and work carried out in each of the uranium airborne anomaly blocks are shown in **Table 3.**

Table 3: Work done by Uranerzberghau and coverage in uranium airborne blocks.

Block	**Block name**	**Area sq.km.**	**Work done**	**Favourable geological environment**
A	Karroo	135,000	Helicopter supported ground check of airborne anomalise and reconnaissance traverses in Karroo. Detailed prospecting at Mkuju and Madaba anomalies.	Sandstone, veinlike (unconformity)
B	Dodoma	37,000	Investigation of mbuga (concerete occurrences) at Isuna, Bahi, Dodoma East and	Calcrete

			Makutupora	
C	Tabora and Kigoma	142,000	Investigation of mbuga (concerete occurrences) at Ndala, Ugalla River and Igombe Helicopter supported ground check of airborne anomalies in Kigoma and Mpanda area	Calcrete, veilike (unconformity), intra-intrusive (granites), sandstones
D	Minjingu and Galappo	13,000		Sedimentary (phosphate), intra-intrusive (carbonatite)
E	Monduli-Tarosero	2,000	Helicopter supported ground check of airborne anomalies in northern slope of Tarosero volcano	Volcanics
F	Mbeya-Njombe	19,000	Chimala copper prospect Panda carbonatite Reconnaissance prospecting in Njombe	Sedimentary (black shales), intra-intrusive (carbonatite), veinlike (unconformity)
G	Bukoba	10,000	Helicopter supported ground check of airborne anomalies in Bukoba and Biharamulo	Veinlike (unconformity), intra-intrusive (granite), sandstone

Areas covered by investigation work that was conducted by Uranerzbergbau in 1978 are in blocks B and eastern part of Block C and are shown in **Figure 5**.

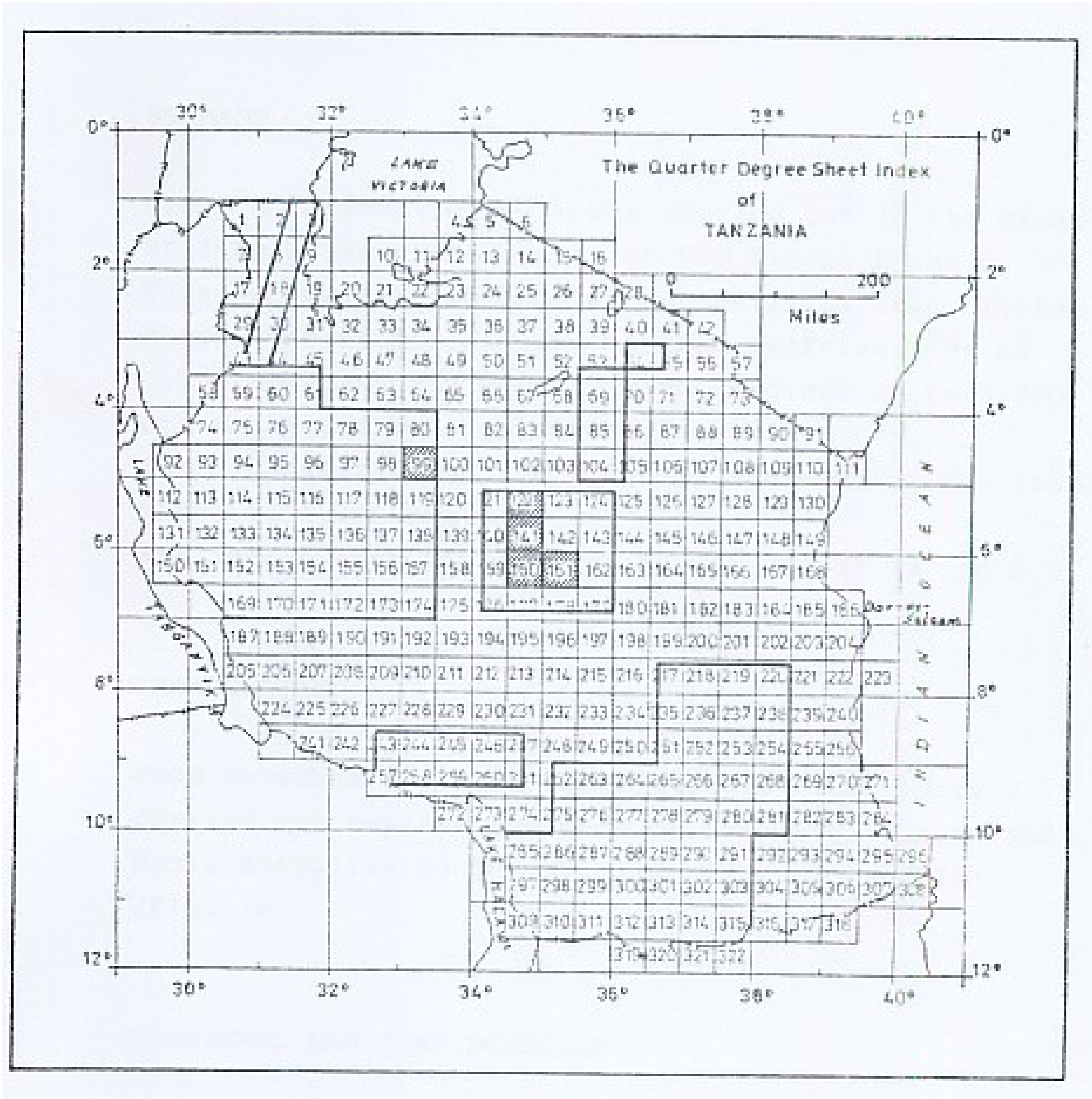


Figure 5: Location of Itigi (QDS 160 and 161), Iseke (QDS 122 and 141) and Ndala (QDS 99) anomalies investigated

The 1978 exploration included the following:-

- Evaluation of existing information by interpreting 78 maps of Geosurvey International;
- Helicopter survey to investigate on the ground the Selous and Mkuju airborne anomalies (Block A) whereby filed work included grid-controlled radiometry, trenching and sampling;
- Investigation of Minjingu phosphate (Block D) by a grid-controlled geological-radiometric survey, trenching (3) and channel sampling;
- Investigation of Galappo area (Block D) comprising geological mapping, footborne radiometry and sampling;
- Geological traversing, footborne radiometry, gridding, trenching and sampling at Itigo, Iseke and Ndala (Block B and C).

Summary of work done in 1978 is shown in the following **Table 4**.

Table 4: Summary of work conducted in by Uranerzbergbau in 1978.

Activity	Quantity
Geosurvey airborne maps 1:100,000 interpreted	78
Hours of helicopter reconnaissance, covering approximately 20,000 km^2	43
Line km carborne, uncontrolled	115.5
Line km footborne, grid controlled (SRAT SPP2)	47.7
Trenches with 83.5 m^3 excavation	6
Samples taken	311
Samples dispatched	302
SRAT readings	940
Geological mapping	5 km^2

2.1 BLOCK A

Investigation for uranium mineralization in Block A, where Karroo rocks are the host rocks, was undertaken in 1976-1982 and the most recent in 2000s. Field work in the Karroo comprised regional and detailed investigations. The most prospective part of Karroo sediments were investigated in 1980 with the following objectives:-

- Collection of data by helicopter supported traverses to enable interpretation of structural setup and distribution of sedimentary facies of the Karroo basins on regional scale.
- Investigation of the Mkuju and Madaba group of anomalies by closer spaced traverses in order to define in details the structural and sedimentary settings with particular attention to features that control uranium mineralization.
- Map and prospect by closer spaced lines the areas surrounding the known anomalies in order to determine any new anomalies or possible extensions of the known anomalies; and
- Detailed investigation of anomalies and mineralizations that were previously ground checked in the 1979 investigation programme by checking their extent and nature by means of gridding and trenching followed by subsurface investigation by percussion or diamond drilling of the Madaba mineralizations.

Regional helicopter supported investigation involving assessment of 78 airborne anomalies ended up by giving the following results:-

- Out of the investigated airborne anomalies 25 anomalies were not detected or too weak to justify ground check up;
- The 53 ground checked anomalies are in sandstones and mudstones/siltstones of Karroo System and uranium values in samples vary from 4 ppm to 3.21% U_3O_8.
- Visible secondary uranium mineralization was observed in 22 anomalies in QDS 253/2, 254/1, 289/1, 289/2 and 309/4.

The areas of main interest are clusters of anomalies that occur at Mkuju, Madaba and Bamba Bay. The areas and anomalies found in these areas are summarised in **Table 5.**

Table 5: Anomalies clustering in areas of main interest.

Location	Number of anomalies
Mkuju	14
Mkuju South	11
Madaba-Lukuliro	14
Bamba Bay Basin	1 (visible uranium mineralization in sandstones)

Other weak anomalies occur in several areas as shown in **Table 6.**

Table 6: Other weak anomalies.

Location	Number of anomalies	Maximum U_3O_8 content (ppm)	Host rock
Stiegler's Gorge Group	4	110	Adsorptive uranium in grey siltstone or shale
Mahenge	1	38	Usagaran System
Liwale	1	2	Karroo
Njenje River	1	113	Karroo
Lukimwa River	1	20	Karroo
Nampunga River	1	23	Karroo
Ruvuma River	1	97	Zircon-bearing migmatite biotite gneiss of Usagaran System
Ruhuhu River Basin		129	Siltstones or shales
Mkuju	15	110	Adsorptive uranium in grey siltstone or shale
Mkuju	1	38	Usagaran System
Liwale	1	2	Karroo
Njenje River	1	113	Karroo
Lukimwa River	1	20	Karroo
Nampunga River	1	23	Karroo
Ruvuma River	1	97	Zircon-bearing migmatite biotite gneiss of Usagaran System
Ruhuhu River Basin		129	Siltstones or shales

Selous and Mkuju anomalies in the southern part of Tanzania were investigated. A group of 20 uranium anomalies are located at Selous which is about 260 km to the south west of Dar es Salaam. The host rocks are the Upper carboniferous to Lower Jurassic Karroo

System. Ground check of Selous anomalies discovered several significant mineralization at Lukuliro and Madaba being characterised by a calcareous and vanadium bearing facies in oxidised sandstones. At Lukuliro mineralization is partly controlled by limestone band and can be followed over lateral distance of 800 m. Channel samples from trenches gave an average of 2,066 ppm U_3O_8 over thickness of 1.6 m. Mineralization at Madaba extends along the strike for over 100 m. A sample collected from oxidised sandstones turned the highest assay of 6,160 ppm over 0.9 m. The Selous mineralization is peneconcordant sandstone type mineralization.

2.1.1 Mkuju anomalies

Mkuju anomalies are situated near Mkuju River, about 210 km to the south west of Madaba. The anomaly in this area is 4.5 x bg. Three mineralised zones occur within an area of 4 square kilometres. Geological mapping, footborne radiometry, trenching and sampling were carried out in the area. Mineralization is associated with no-calcareous phosphorous bearing facies within non-oxidised coarse grained sandstone. The uranium mineralization at Mkuju is rollfront-type. The three mineralised zones are probably single roll. Channel samples turned an average of 1,459 ppm U_3O_8 over 3.4 m and 4,379 ppm U_3O_8 over 3.15 m.

2.1.2 Madaba-Lukuliro area

Additional detailed investigations were carried out in Mkuju area in the south and Madaba-Lukuliro area in the north of Block A. The work included gridding, radiometric/geological mapping and trenching and was undertaken on anomalies 289/1A, 289/3G and 289/3I. Within the anomalous zones, areas of readings above 10 x bg reach up to 300 x 50 m. Secondary uranium mineralization in form of phosphuranylite and metaautunite occur in very coarse to gritty, yellow-white sandstone. Within the anomalous zones such as 289/3I there are areas with strongest mineralization with 4.695 ppm U_3O_8 over 1.9m. The results are as shown in the following table. Uranium mineralization covers an area of 11 x 11 km at Mkuju and 13 x 25 km at Madaba-Lukuliro. The Lukuliro anomalous zone up to 250m x 25m with 2 x bg have been delineated. Within these anomalous zones secondary uranium mineralization of carnotite and francevillite up to 1m thick occurs in medium grained, bleached, white sandstone layers within pink and red sandstones. Maximum uranium content of channel samples are 2.507 ppm over 2.6m. The five mineralizations at Lukuliro are aligned in a northwest strike direction of the sandstone and probably belong to one or more conformable, anomalous horizons.

At Madaba carbonatic sandstones host uranium mineralization. At this area two sub-horizontal anomalous zones vertically 25 m apart were traced for several hundreds metres. Secondary uranium minerals are uranophone, fracevillite, sengierite and gummite the later indicating an insitu alteration from a primary uranium oxide. The summary of the results from the additional exploration programme is as follows:-

- Uranium mineralization consists of yellow and green secondary minerals and in places is enriched but of limited extent up to several hundred metres;
- Uranium mineralization is related to strong supergenic processes above or at the fossil groundwater level related to tertiary peneplain, marked by remnant mesa with 3 to 5 m thick lateric capping underlain by light coloured zone with strong kaolinisation, leaching and bleaching. The strongest uranium mineralization are clearly spatially related to the laterite/kaolin zone as is well exposed in numerous break-aways;

- The degree of supergenic mobilisation and enrichment of uranium is strong at Mkuju and moderate at Madaba;
- Uranium mineralization is associated with iron hydroxides and oxides and appears to be controlled by permeability changes;
- Uranium mineralization is lenticular and the type of mineralization such as roll fronts, sheet-like, trend-like, cannot be determined.

From 1978 to 1979 uranium exploration work was carried out on seven blocks and based on anomalies interpreted from airborne data of GeoSurvey International. These anomalies were investigated on the ground with helicopter and vehicle support. Exploration targets of 1980 were sandstone-type (Group A) and unconformity-type (Group C) uranium mineralization.

Activities carried out in Block A and part of Block C area shown in **Table 7.**

Table 7: Investigation activities carried out in Block A and C.

Work done	Block A	Block C
Helicopter hours	740	50
Fixed wing hours	270	95
Line-km radiometric-geological traversing	380	
Geological mapping Sq. km	2600	
Outcrops and detailed sections geology and radiometry	227	
Like-km grid controlled geology and radiometry	580	
Line km carborne radiometry		136
Ground control points marked for aerial photography	27	
Ground control points remarked for aerial photography	12	
Ground control points surveyed for latitude, longitude and elevation	23	
Aerial photography	3000	
Airborne anomalies investigated on the ground		6
Diamond drilling	689	
Ground checks geology and radiometry		18
Shallow percussion drilling	887	
Trenches	75	
Hand auger drilling	763	
Trenches with 198 m^3 excavation	63	

Line-km dozing of access tracks	104	
Samples collected	1364 (including 124 stream sediments)	82
Samples dispatched for laboratory analysis	1228	75

Karroo rocks are of fluvial-continental origin. Three units were mapped namely coloured series, hanging wall series and cliff sandstone. The coloured sandstones are coarse grained. Carbonate cement in these rocks is not uniformly distributed. The rocks are overlain by carbonatic horizon which is about 0-15 m thick and resistant to weathering thus forming a plateau and known as plateau sandstone. The plateau sandstone is composed of medium and coarse grained to conglomeratic sandstone. The coloured series is overlain by the hanging wall series which consist of no carbonatic fine grained sandstone. These rocks are well sorted and lithified. Cliff sandstone form prominent cliffs, as a result of distinct change in depositional environment, rise steeply above the terrain underlain by Lower or Middle Karroo series. The grain size is coarse to conglomeratic. The rock is porous with pore sapace partly filled with iron oxide/hydroxide. The cliff sandstone has the lowest radiometry which ranges from 40 to 50 cps. Four samples gave an average of 3 ppm U_3O_8. During mapping new radiometric anomalies were detected. All anomalies except two are within soil derived from coloured series (9) and hanging wall series (12). The two anomalies in cliff sandstone are doubtful because they occur in sandstones of the Lukuliro River area where cliff sandstone and hanging wall series could not readily be distinguished. Six of the 25 anomalies are visibly mineralised and occur in hanging wall sandstone or plateau sandstone in the area of known anomaly group 253/1a, 253/2a, 253/3a, 253/4c and 254/1.

Stream sediment geochemistry was aimed at testing geochemistry for locating buried mineralization. A total of 124 stream sediment samples were taken. Uranium values range from less than 5 ppm to 70 ppm U_3O_8. One zone with values ranging from 8 to 32 ppm U_3O_8 occur in an area underlain by coloured series near the center of QDS 253/2. The maximum of 70 ppm U_3O_8 was found in an area of where no anomaly was detected. The areas upstream from both anomalous zones should be followed-up with foot borne radiometry and detailed geochemical sampling. Stream sediments down stream from known surface mineralization are not anomalous or weak anomalous. Stream sediment samples from known anomalous zones were negative probably due to the fact that all samples were taken from coarse river sands.

Detailed geology and radiometry was grid controlled and helicopter/vehicle supported. Anomalies that were investigated at Madaba River area are 253/1a, 1b, 1c, 1d, 2a, 3a, 4c, 6a and 8e. All anomalies were discovered in 1978-79 with an exception of anomalies 253/1d and 8e that were discovered in 1980. The anomalous areas vary in size from 100 m to 500 wide and 300 to 1,500 m long.

Anomaly number (from north to south)	Grid area (km^2)	Anomalous area grater than 100 cps width x length	Mineralised area (discontinuous secondary uranium mineralization as pockets and lenses) width x length
253/2a	1	Main zone 400x600 m	Main zone 400x400 m, NNW trend, 2 zones
253/3a	1	200x650 m	Main zone 100x300 m, NNE trend, 2

			zones
253/1c	3	500x700 m	150x700 m, E-W trend
253/1c-6a	3	150x300 m	150x250 m, NS trend
253/6a	3	Main zone 300x800 m	Main zone 200x600 m, EW trend, 5 zones
253/4c	1	Main zone 150x500 m	Main zone 30x100 m, NW trend, 4 zones
253/1b	9	500x1,500 m	500x1,500 m, NE trend
253/1a	9	100x250 m	30x75 m, NS trend
253/1d	9	350x500 m	Main zone 30x150 m, NE trend, 3 zones
253/8e	9	500x750 m	100x350 m, ENE trend

All anomalies are visibly mineralised on the surface with secondary minerals uranophane, francevillite, tyyamunite, meta-tyuyamunite, carnotite, sengierite and meta-uranocircite. The secondary uranium minerals occur as pockets and lenses within two stratiform horizons. The mineralised pockets and lenses are 0.5 to 2.0 m thick, 5-20 m wide and 10 to 100 m long. The radioactive horizons are up to 15 m thick, 500 m wide and 1,500 m long. The two anomalous zones occur in lateritic soil, cliff sandstone, hanging wall series and coloured series. Features of the two anomalous zones are summarised in **Table 8.**

Table 8: A summary of features of anomalous zones.

Depth (m)	Description	Radiometric background (cps)
2-15	Lateritic soil	
10-60	Cliff sandstone	45
70	Hanging wall series	55
Over 170	Coloured series	65-70 including plateau sandstone (100-110)

The upper radioactive horizon

The upper radioactive horizon called 1b-level after anomaly 253/1b is 60 to 70 m below the base of cliff sandstone with anomalous radioactivity centered on the boundary between hanging wall series and coloured series. Anomalies 253/2a-1c-6a-1b-8e-8d-8b at Madaba River area were stratigraphically correlated with ib-level over a strike length of 12.5 km in the north south and from north to south. In the area of Lukuliro River anomalies 253/3a-4d-4b-4c are associated with 1b-horizon. Within anomaly 253/1c uranium mineralization occurs mainly at the base of Plateau sandstone. Highest uranium grade of 0.18% U_3O_8 over 1.6 m was intersected in one of the six trenches excavated in the area. At anomaly 253/1b uranium mineralization occurs in plateau sandstone.

Area	**Anomalies**	**Association of uranium mineralization**	**Highest uranium grade**
Madaba River	253/2a-1c-6a-1b-8e-8d-8b	Upper radioactive horizon 1b-level	

Lukuliro River	253/3a-4d-4b-4c	Upper radioactive horizon 1b-level	
Anomaly 253/1c		Base of plateau sandstone	0.18% U_3O_8
253/1b		Plateau sandstone	
253/3a		Plateau sandstone and hanging wall series	0.16% U_3O_8 over 0.9 m
253/6a		Plateau sandstone and hanging wall series	1.06% U_3O_8 over 1.3 m
253/4c		Basal section of hanging wall series	0.08% U_3O_8 over 1.25 m
253/8e		Basal section of hanging wall series	
Between 253/1c and 253/6a		Basal section of hanging wall series	
253/1c-6a			1.6% U_3O_8 over 1.00 m
253/8d		Basal section of hanging wall series	
253/2a		At grain size changes of fine, medium and coarse hanging wall sandstones.	0.31% U_3O_8 over 2.05 m

The lenses are 5 to 10 m wide and up to 50 m long. The lenses are superimposed vertically and lined up laterally over a thickness of about 15 m, a width of 200 m and a length of more than 500 m.

North south trending faults in one trench of anomaly 253/1c has a vertical displacement of about 0.5 m. Secondary uranium mineralization was also observed along hematite stained joints associated with a fault with vertical displacement of 10-20 m in the area of 253/8d. In trenches of anomalies 253/1c, 2a and 6a uranium mineralization is associated with limonite staining and manganese concretions indicating distribution of uranium minerals by recent or old groundwater activity.

The lower radioactive horizon

This horizon was called 1a-level after anomaly 253/1a and is located within coloured series about 40 m below the 1b-horizon. The 1a-level is a strongly carbonatic, coarse grained to conglomeratic sandstone which contains mudstone clasts, limestone clasts, limestone nodules and sauria bones up to .2 m long. The maximum thickness of 1a-level sandstone is 4 m. The rock colour is white with red mottles. Different to the 1b-horizon, the 1a-level does not contain massive limestone lenses and secondary surface mineralization is not associated with colour changes. Over a distance of 2.5 km in west northwest and a width of about 500 m, six mineralization areas associated with the 1a-level. One of the two trenches sunk on anomaly 253/1a, showed the best mineralization of 1.2% U_3O_8 over 0.6 m. Secondary uranium mineralization is confined to coarse grained channel sandstone containing abundant mudstone clasts. The underlying medium grained sandstone is white-red banded and only occasionally mineralised. Two trenches excavated on anomaly 253/1d in north west assayed 0.33% U_3O_8 over 1.5 m and 0.87% U_3O_8 over 0.7 m. The mineralized zone of 253/1d measures 30 x 150 m and trends north east. Similar to the 1b-level, the 1a-horizon is open-ended on both sides. Anomalies 253/8a and 8c are of 1a-level.

Drilling

Six diamond boreholes amounting to 689 m were drilled at Madaba River area. The results are summarised in **Table 9.**

Table 9: Diamond drilling results of Madaba River area

Drill hole number	Depth	Water table	Logging from-to	Grade/thickness ppm U_3O_8 from-to	Maximum grade ppm U_3O_8 thickness
1	75.75	-	130/7.5-9.5 m	123/9.3-9.8 m 256/22.75-24.25 m	345/0.5 m
2	150.25	20	-	-	-
3	97.60	22	-	-	-
4	181.50	31	196/156.5-158.5 m 196/168.5-170.0 m	45/159.40-162.25 m core loss	64/0.7 m
5	142.00	46	3500/119 m	2900/118.15-118.65 m	0.29%/0.5 m

Bore hole DDH intersected visible secondary uranium mineralization from 20.75-26.25 m averaging 143 U_3O_8 over 5.5 m including a maximum of 345 ppm U_3O_8 over 0.5 m. The mineralization occurs in greenish-grey coloured Plateau sandstone overlain and underlain by red coloured sandstone. Bore hole DDH intersected 150 m of Coloured series with anomalous bone fragments at 25 m below surface. Although greenish-white sandstone was encountered from 122-131 m no increase in radioactivity was recorded on the down hole log at the colour change. DDH 3 went through 98 m of Coloured series. Bone fragments were intersected at 30 m and 66 m below surface. DDH 4 intersected 181 m of Coloured series. A series of colour changes were intersected and one of them gave 45 ppm U_3O_8 over 2.85 m. Along DDH 5, a weak anomaly along coincided with the contact between hanging wall and coloured series and the lower boundary of a grey coloured horizon in the lower part of hanging wall series.

Western Metals conducted field work 2006 to evaluate the uranium anomalies in Tanzania. Some of the areas investigated by Western Metals for uranium mineralization are shown in Error! Reference source not found.. Work done includes ground based radiometric surveys, trench sampling, geological mapping and surface sampling. The ground radiometric surveys identified five anomalous areas of radioactivity within an area of 2 km length and a width, at surface, ranging from 100 to 300 metres. The anomalous trend defined by historic airborne radiometric survey extends over 7 kilometres. More field work is being carried out by the company.

Figures 6a, b & c. Tenements owned by Western Metals in the Karroo formations southern Tanzania with Airborne radiometric anomalies and Henri anomaly location. The tenement is close or adjacent to Mkuju block. (after Western Metals, 2006).

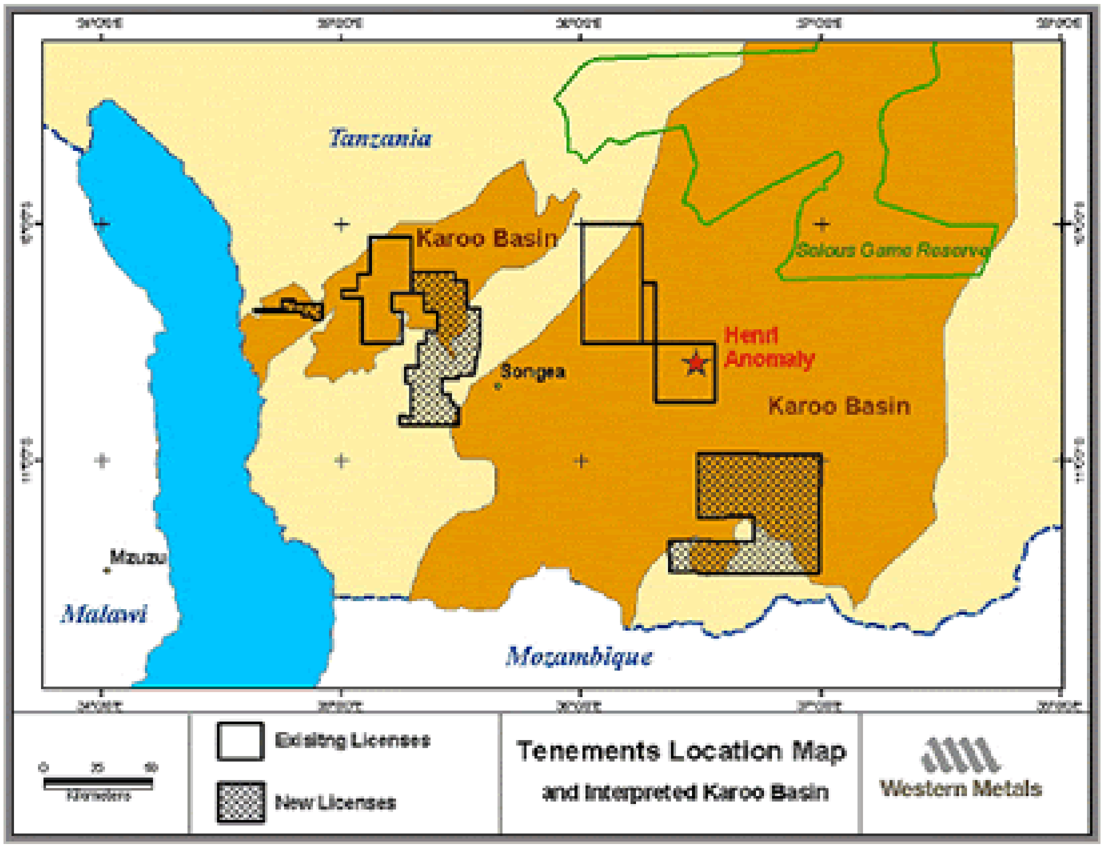
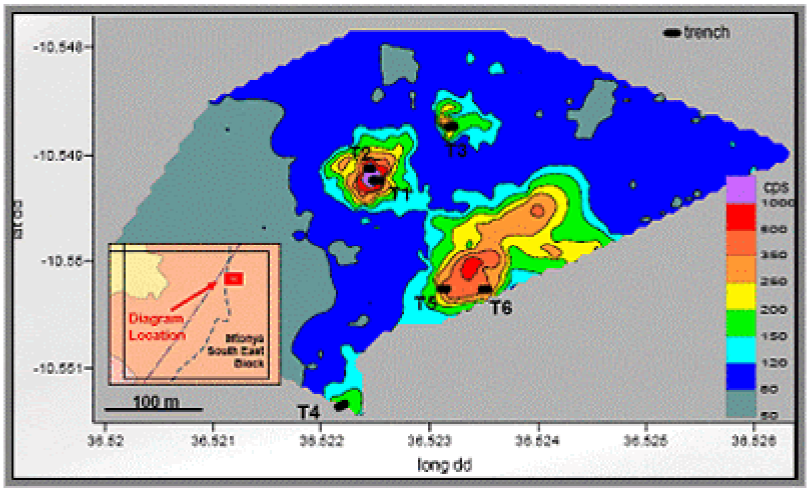


Figure 6b: Henri Anomaly: Contoured ground radiometric data and trench locations. The figure shows trench and soil anomaly locations.



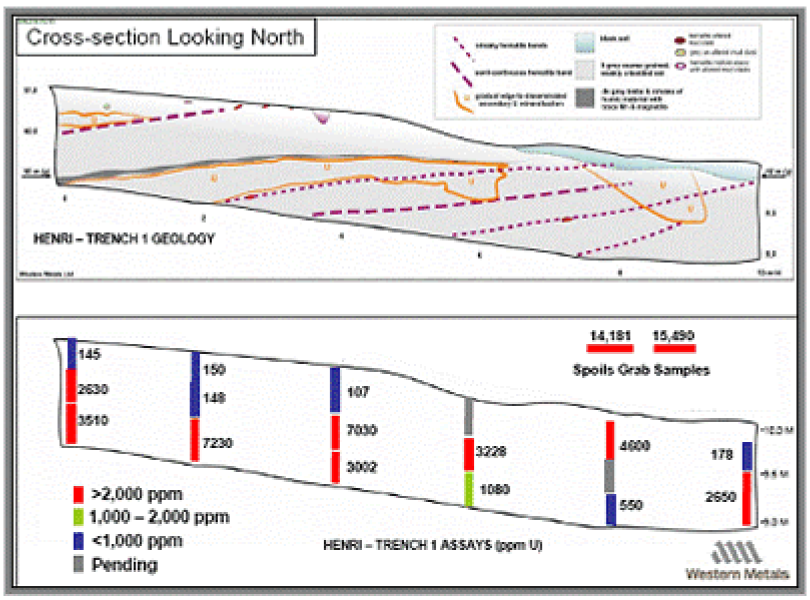
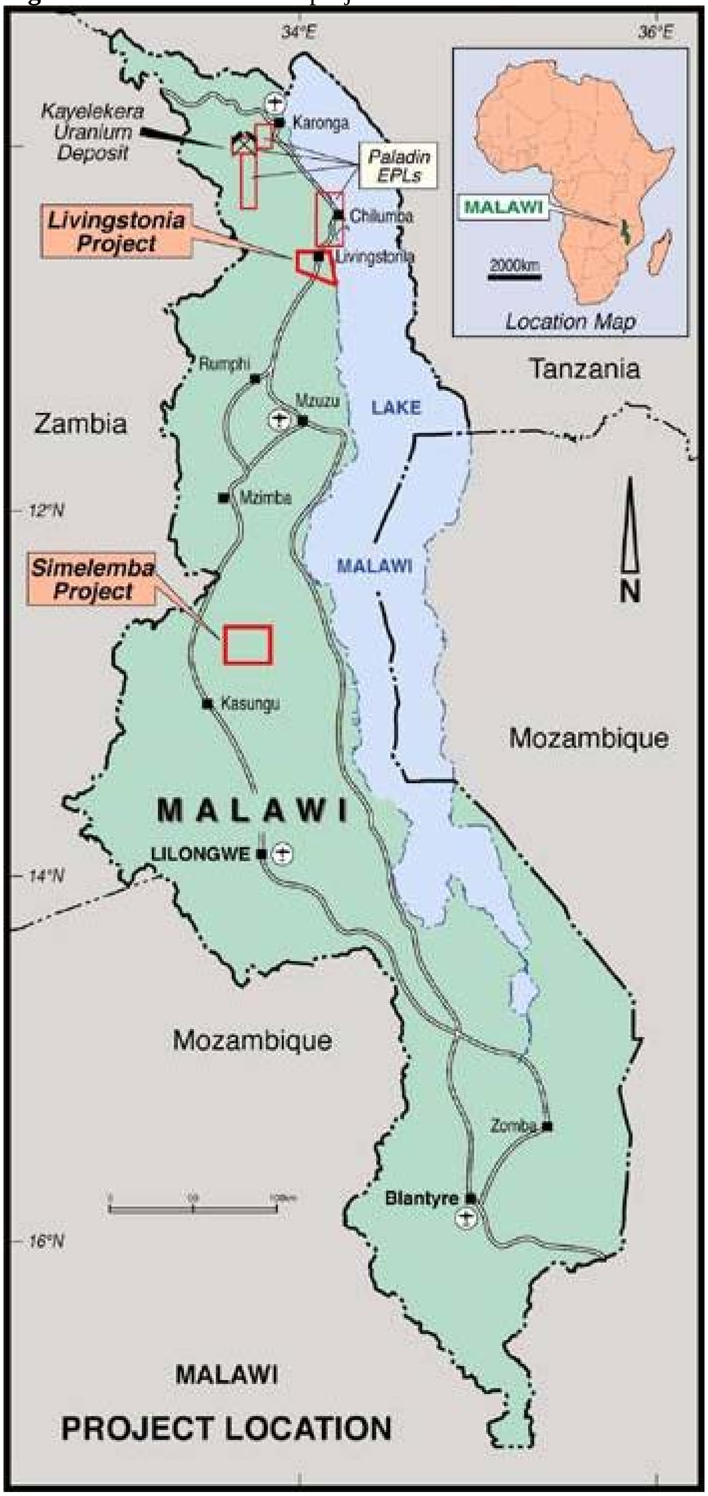


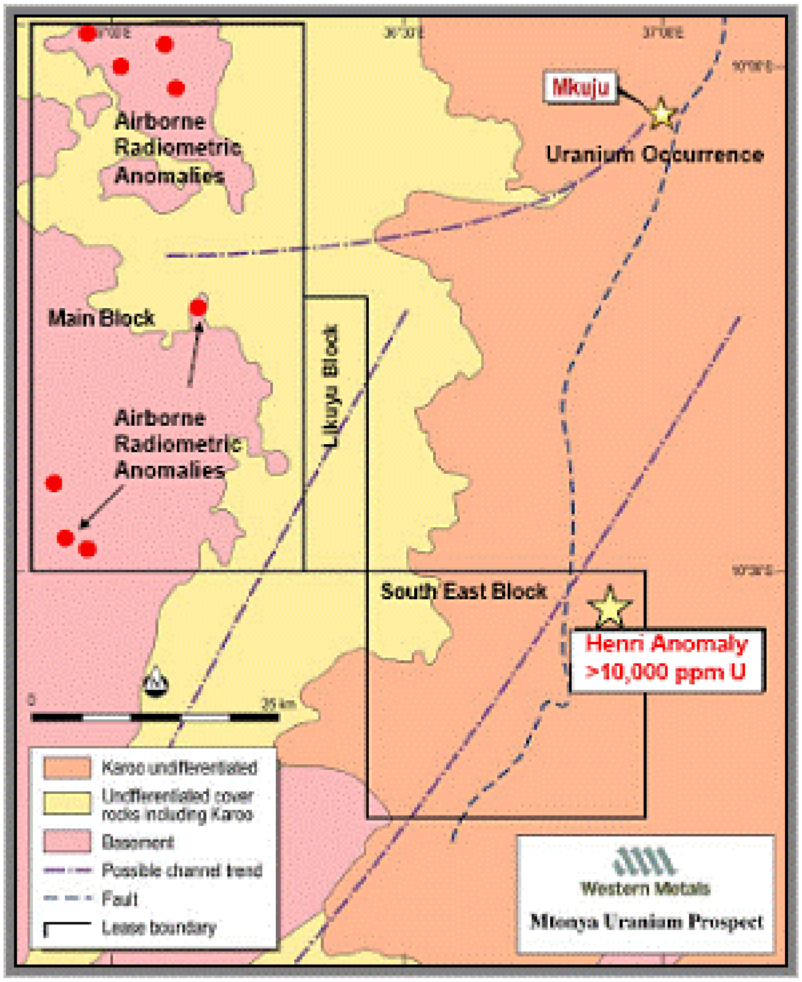
Figure 6c: Henri Anomaly: Trench 1 north facing geological mapping and assays (U ppm) The figure shows trench and soil anomaly locations.

Figure 7. Malawi advanced projects from websites



Due to the presence of uranium deposits in Malawi as in the figure above Figure 7, including the Kayelekera deposit that contains a resource of 13,630 tonnes of uranium oxide (Error! Reference source not found.) hosted by the Karroo formations, there are possibilities that areas east and north of Lake Nyasa in Tanzania can host uranium mineralization.

Figure 6: Uranium deposits in Tanzania explored by Western Metals (Kayelekera deposit in Malawi is located west of areas of Karroo rocks hosting uranium mineralization after Western Metals, 2007)



Testing of one of the strongest radiometric anomalies by foot borne scintillometry at Mtonya, showed an anomalous zone of 20 metres long and 1.5 m thick. The anomaly occurs within soils on top of sandstones. Maximum readings increased with depth up to over 15,000 cps in a 20 cm deep sample hole. Weaker anomalies in the range 150-500 cps were also located in the area. Four samples collected from the anomalous zone turned 980 ppm U_3O_8. Figure 3 shows the approximate extent of the airborne radiometric anomaly and the location of the peak sample.

Airborne radiometric data shows that the granites and gneisses of the Usagaran System contain uranium and therefore area source rocks for redox style deposits. This implies that the western margins of the Karroo sediments, including any palaeo-channels cut into the basement, are prospective for uranium.

2.1. BLOCK B

Mbuga known to host uranium mineralization are located in Central Tanzania. The areas include Bahi, Lake Hombolo, Makutupora, and Kibuga. Others are Issuna, Kianju, Manyoni and Iseke.

2.1.1 Bahi mbuga

Calcretes as suitable host rocks for uranium mineralization are developed in palaeodrainage system. Tertiary rifts faulting determined the present position of calcrete hosted uranium mineralization whereby is preserved in depressions and subjected to erosion in uplifts. A ground check of airborne anomalies and reconnaissance survey was carried out in seven areas of Block B. Mbuga at Bahi North, Bahi East, Bahi South, Issuna, Lake Hombolo, Makutupora and Kibuga were checked.

Most of the airborne anomalies are related to subrecent, very low grade superficial uranium enrichments in calcareous and gypsiferous clays with 100 to 300 ppm U_3O_8 over 0.5 m and in sheet calcretes related to silicated basement containing 90 to 496 ppm in grab samples from Bahi North prospect. The mbugas are interpreted as indicative for Tertiary palaeo-drainage system.

Geological mapping, car borne and foot borne radiometry, trenching, hydrogeochemistry and sampling was carried out on Block B on Bahi north, Bahi east, Bahi south, Issuna, Lake Hombolo, Makutupora and Kianyu Mbungas. The Bahi depression was produced by rift faulting and filled with fluviatile and lacustrine sediments of Mio to Pliocene age. Work done is shown in **Table 10**.

Table 10: Work carried out in Bahi area in 1979.

Work	Quantity
Car borne radiometry	555 line km
Foot borne radiometry	87 line km
Gridding	10 line km
Line cutting	9 line km
Airborne anomalies	13
Trenches	7
Pits	3
Grab and channel samples	74
Water samples	25
Geophysical airborne map interpretation	1

The Archaean basement comprises the Dodoman System with metasediments, biotite granite and pegmatites and intrusive biotite granites. The granites are highly radioactive with 250-450 c/s and hot spots up to 1,500 c/s. Rift faulting generated sedimentary basins including Bahi depression which was filled with fluviatile and lacustrine clastic sediments consisting of grey white, fine to coarse granied, poorly sorted sandstones with variable amounts of feldspar. The matrix is kaolinitic clay and silt. Secondary cementation and coating of pore space by amorphous silica is common. Sandstone is porous and interbedded with conglomerate and clays. Transported ferrous iron is evidenced. Diamond drilling by the Geological Survey of Tanzania in 1953 intersected a 15 cm of 0.24% uranium in strontianite at a depth of 68.3.

2.1.1.1 Bahi north prospect

Foot borne traverses were carried north of Dingiyo Hill and along Kisalalo River. A grid was laid at Kisera River and carborne traverses along tracks and roads were run. Three airborne uranium anomalies ranging from 3 x bg to 4.2 bg were checked on the ground. A 4.2 x bg airborne anomaly of uranium was delineated in mbuga north northeast of Dingiyo Hill. The anomaly extends for about 4 km to the east eastsouth **(Figure 7).**

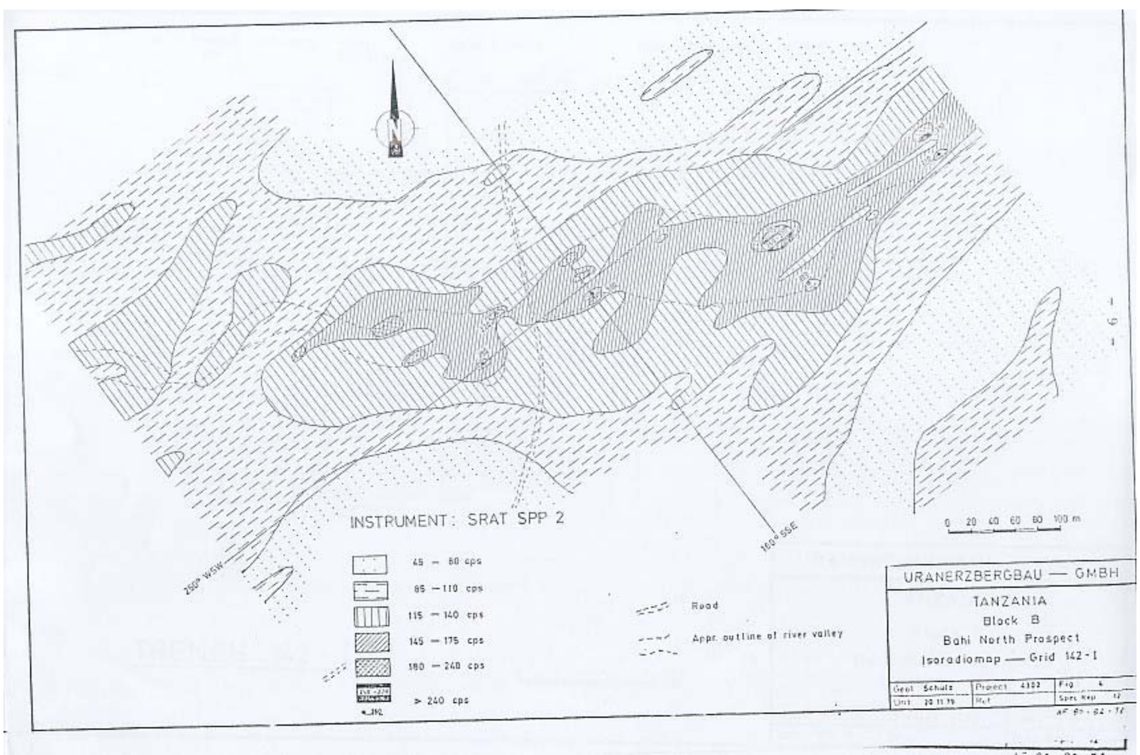


Figure 7: Isoradiomap of Bahi North Prospect.

On the surface radiometry ranges from 120 to 320 c/s. The Kisalalo anomaly is a 4 x bg uranium airborne anomaly. Ground check up showed 2,500 c/s in strong silicified calcrete with carnotite mineralization. Three grab samples turned 130 ppm to 471 ppm U_3O_8. About 400 m west of the calcrete mineralization there occur quartz rich, fine to medium grained biotite granite that showed 150 c/s to 250 c/s with hotspots up to 2,500 c/s. Two grab samples from hotspots gave 9 ppm U_3O_8. About 1.5 km west of the mineralized calcrete revealed a maximum of 450 c/s (bg is 120 c/s). Two grab samples gave 11 and 43 ppm

U_3O_8. The calcrete at Kasera River showed radiometric readings between 130 and 500 c/s whilst black clayey soils gave 90 to 142 c/s and areas of alluvial sand cover showed 50 to 80 c/s. Two calcrete grab samples gave 66 ppm and 52 ppm U_3O_8. At about 3 km west northwest of Lamaiti a laterite gave 150 c/s. In the northern part, which comprises Kilimatinde cement intercalated with minor calcrete, radiometric values ranges from 60 to 150 c/s. Two grab samples from Sola River bed gave 5.2 ppm an less than 2 ppm U_3O_8 in Kilimatinde Cement and calcrete. From the Bahi Swamp a 6 inch intersection of 0.24% U_3O_8 (radiometric assay) from a core drilled in 1953 is reported. The mineralization was encountered in a depth of 68 m.

Trenching

Two trenches were sunk on the mbuga anomaly northeast of Dingiyo Hill **(Figure 8).** The first trench is located about 5 km east northeast of Dingiyo Hill. From 1.6 to 2.0 m yellow uranium mineralization was observed on joints and cracks in grey clay. Radiometry increases from 320 c/s in the gypsiferous clays to 1,000 c/s in slightly mineralised horizon and decreases in the calcrete down to 700 c/s. The highest uranium content is 187 ppm U_3O_8 over 0.3 m in the uppermost of the grey clay with the uranium mineralization. The second trench was sunk about 3 km northeast of Dingiyo Hill. Radiometry increases with depth from 250 c.s in black calcareous clay to 1,250 c/s in the calcrete. The highest uranium content is 120 ppm over 0.3 m in the lower most part of the calcrete.

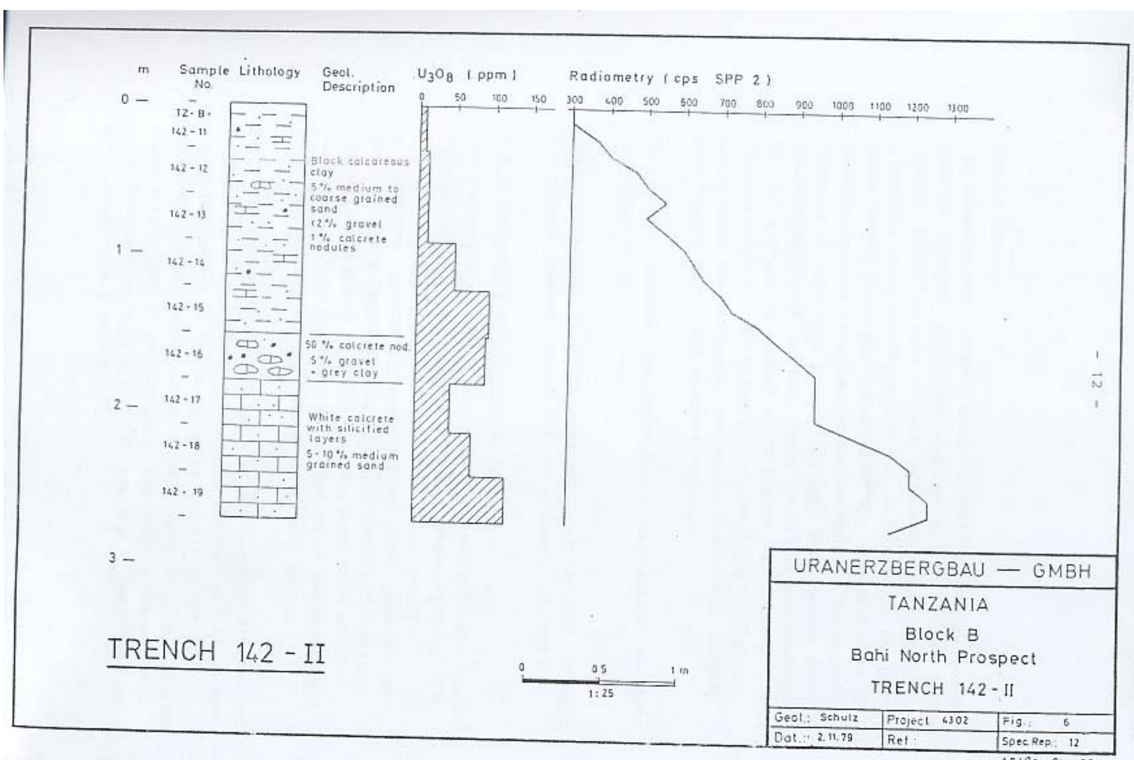


Figure 8: Trench 142- II showing distribution of uranium and radiometry along the soil horizon.

Hydrogeochemistry

The uranium content in stream water of Baba River is 16 ppb. The uranium is being leached from an area rich in uranium in the northern part of QDS 142. Water sample from a water well showed 275 ppb uranium and probably is due to contamination by solid particle.

Bahi east prospect

A total of 4 airborne uranium anomalies ranged from 4.4 x bg to 8.0 x bg were checked by foot borne traverses. The uranium airborne anomalies of 4.6 x bg and 6.3 x bg are related to black mbuga clay. Radiometry vary from 100 to 200 c/s. Silicified calcretes along dry river beds turned maximum radiometric readings of 1,100 c/s. The background of the calcrete is 150 c/s. The uranium content of two grab samples is 26 ppm, 70 ppm and 281 ppm. Water sample from waterhole showed less than 1 ppb U_3O_8. Stream water sample from Kigwe River turned 100 ppb U_3O_8.

2.1.1.2 Bahi south prospect (Rugosi area)

Adjacent to the fault scarp along the south western edge of Bahi swamp eight uranium airborne anomalies of 2.3 to 5.7 x bg were plotted to determine whether the anomalies are due to contrast and elevation differences between swamp and outcrop area or mineralization. Foot borne and in places car borne scintilometer traverse were made. The rocks at areas 1 and 2 are mainly biotite gneiss with 120 to 160 c/s background cut by dolerite dykes. A narrow quartz pyrite vein in aplitic granite showed 500 to 900 c/s and assays of 61 to 224 ppm U_3O_8 and 358 to 387 ppm thorium. Locations of samples collected area shown in **Figure 9 and Figure** 10**.**

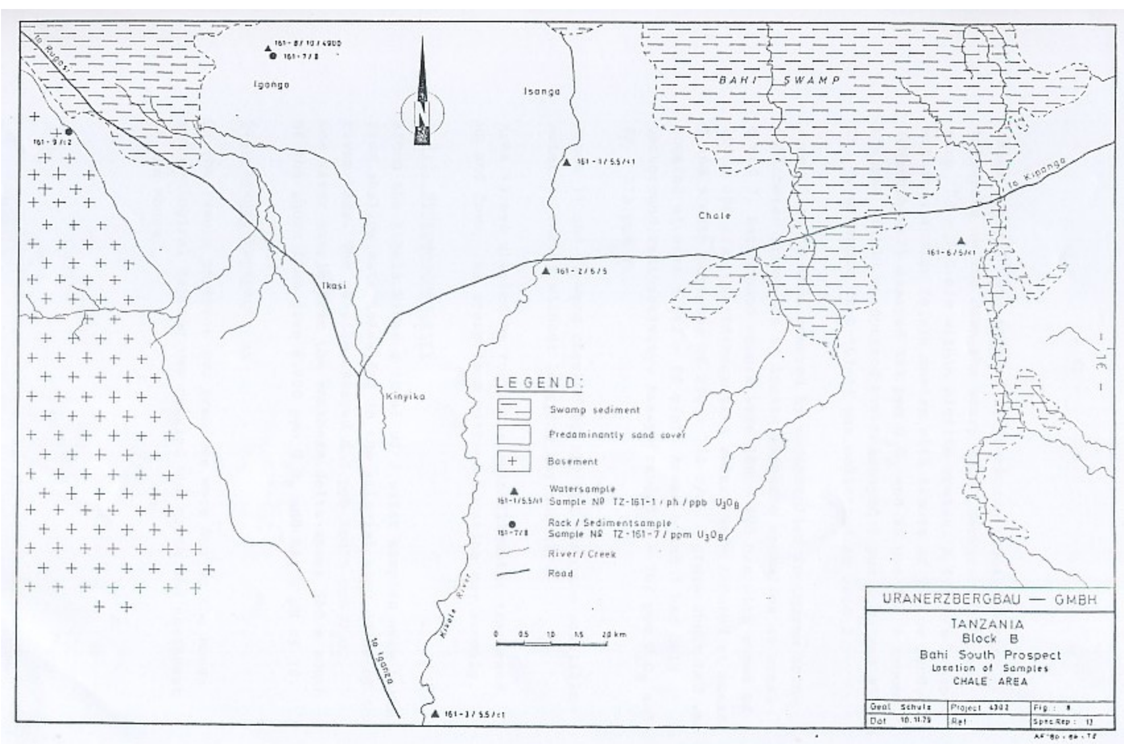


Figure 9: Location of samples in Bahi South Prospect at Chale area.

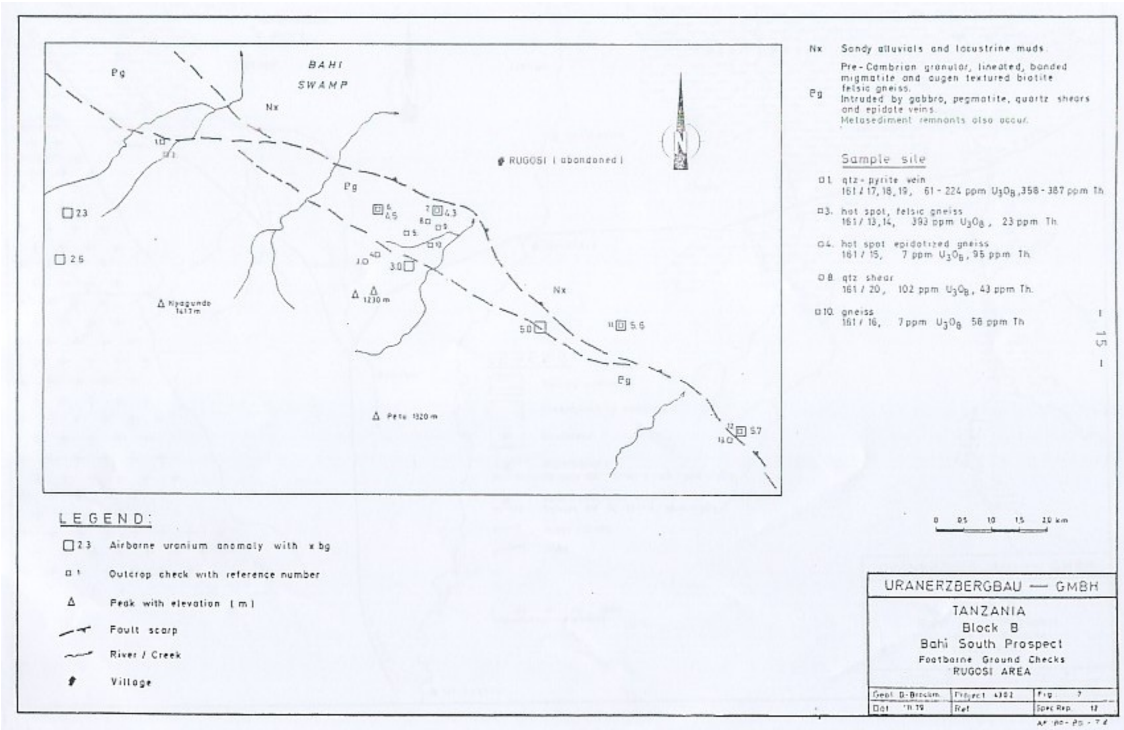


Figure 10: Geological map of Bahi South Prospect showing sample locations.

At areas 3 and 4 background counts were 100 to 180 c/s within bitite gneiss. A 400 c/s hotspot within granular felsic gneiss with traces of yellow product, probably uranophane, assayed 393 ppm U_3O_8 and 23 ppm thorium. A second hotspot within epidotised gneiss assayed 7 ppm U_3O_8 and 95 ppm thorium.

Area 5 to 10 had background counts ranging from 100 to 400 c/s with zones of 200 to 300 c/s. Quartz magnetite shears at areas 8 and 9 showed hotspots of 250 to 750 c/s. A green chert bed at area 5 recorded 60 to 80 c/s. Assay ranged from 7 to 102 ppm U_3O_8 and 43 to 273 ppm thorium. In areas 11, 12 and 13 no anomalous zones were delineated.

A total of 3 water samples were collected from shallow waterholes along Kihola River. The samples assayed less than 1 ppb and 5 ppb U_3O_8. One water sample from the southern delta about 500 m south of the shore line gave 4,900 ppb U_3O_8.

2.1.1.3 Lake Hombolo prospect

Within superficial sediments adjacent to the man made Lake Hombolo, a 4.3 x bg uranium anomaly was interpreted from airborne radiometric data at QDS 162. Uncontrolled car borne traverses made from Zipisa along a western margin of Lake Hombolo located a 2 x bg airborne radiometric anomaly over an area of 150 x 200 m within grey mbuga clays. A trench sunk intercepted brownish grey calcareous clays containing calcrete nodules associated with yellow uranium mineralization between 1.8 and 2.6 m. The maximum assay was 285 ppm over 50 cm with an average of 197 ppm over 1.6. **Figure 11** shows the location of anomalies and trenches.

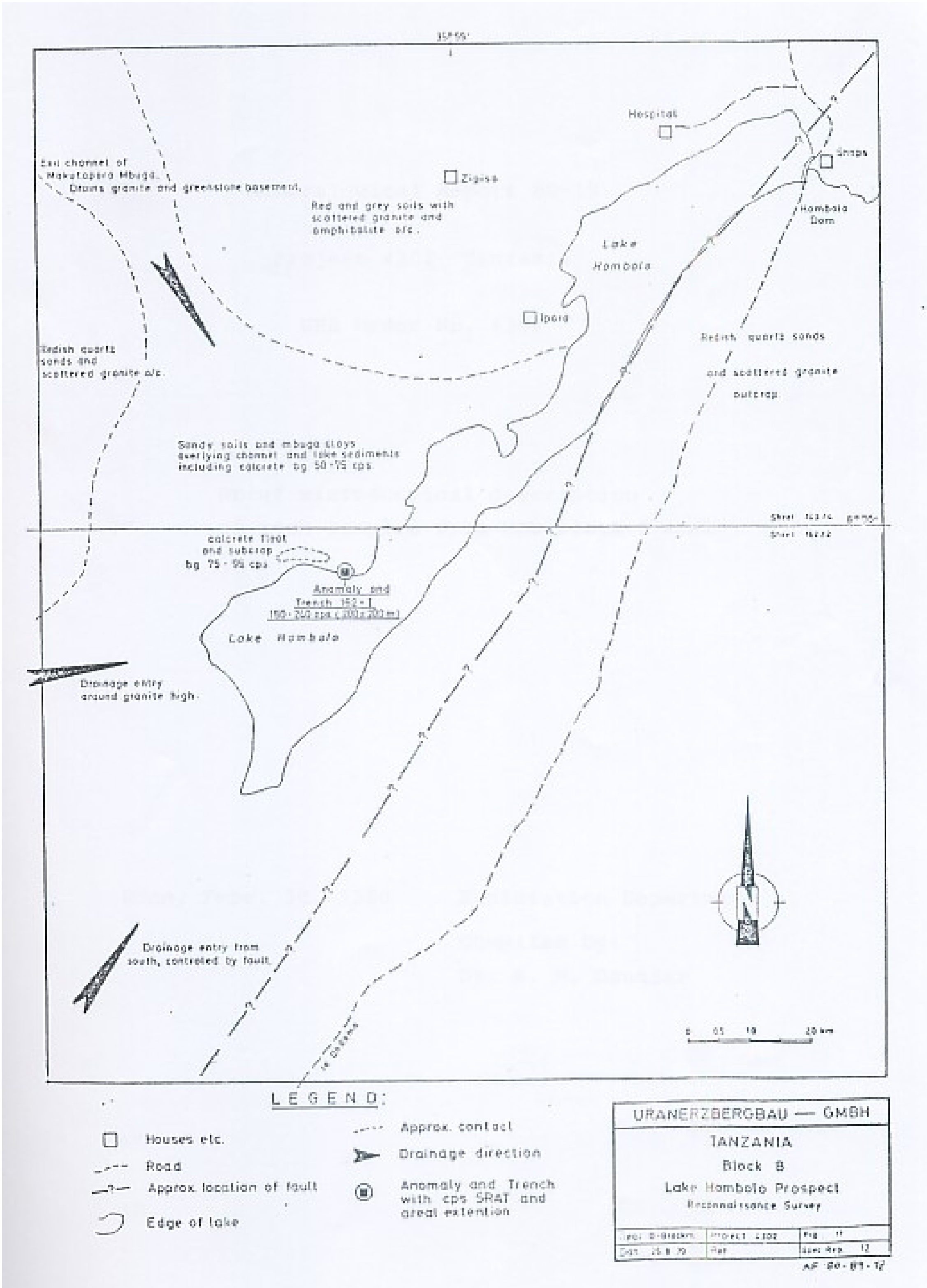


Figure 11: Location of anomalies and trenches.

2.1.1.4 Makutupora prospect

A water test and production well for the Dodoma Town water supply at Makutupora. A chip sample from borehole recorded 110 c/s and turned 500 ppm U_3O_8. Car borne scintillometer traverses across an area with mbuga clays at about 3.5 km to south southwest and 7 km to the north east of Makutupora Village. One anomaly of 1.5 x bg was located in mbuga clays. Trenching within mbuga clay exposed calcareous black clays with near surface enrichment of uranium up to 95 ppm U_3O_8 caused by evaporation of surface water. Water samples were collected from 16 water bores. The assay results ranged from less than 1 ppb to 27 ppb U_3O_8. Four assays between 4 and 27 ppb U_3O_8 were regarded as anomalous due to the fact that the samples were located within or adjacent to the zone of calcrete development with uranium mineralization at the intersection of Kitope and Makutupora channels. The results of the work carried out area shown in **Figure 12**.

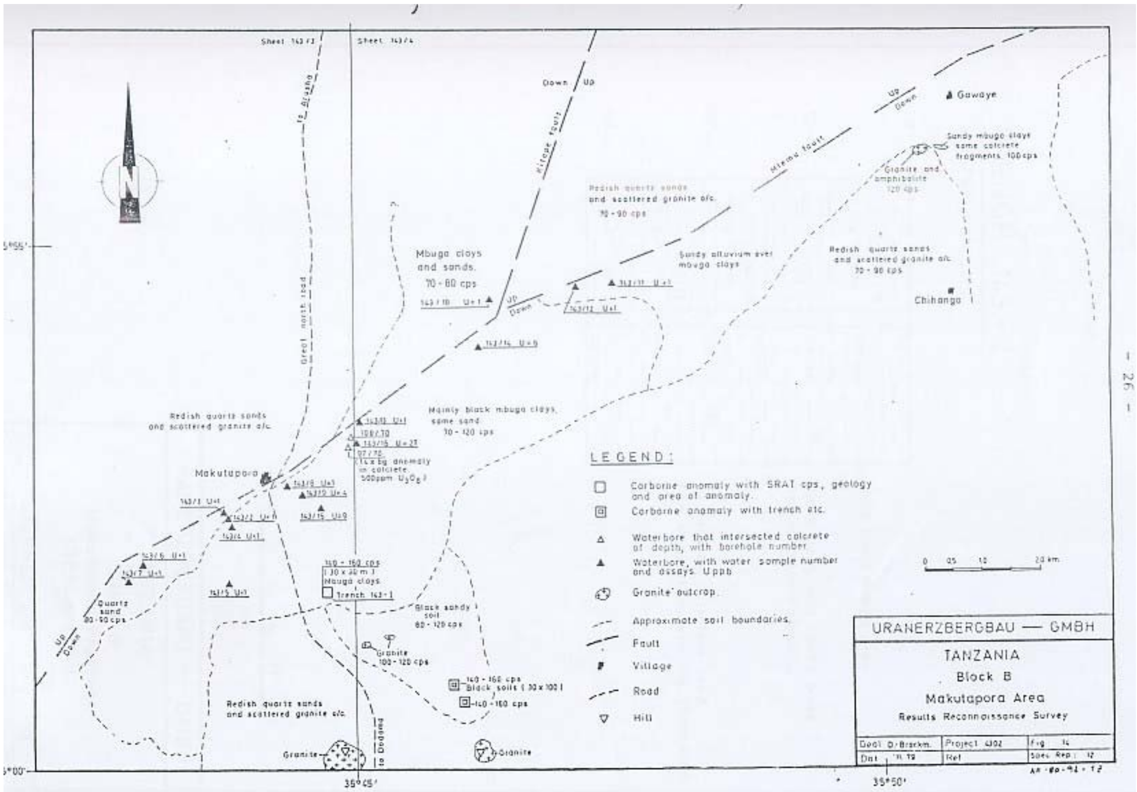


Figure 12: Results of investigations in Makutupora area.

2.1.1.5 Kibuga Mbuga

Five anomalies (3.0 - 4.3 x bg) occurring within Kibuga Mbuga were investigated **(Figure 13).** The investigation comprised car borne scintillometer traverses from Ilindi to Kibuga Hill and along Msisi Road as well as foot borne scintillometer traverses over Kibuga Hii-Msisi Road. The results showed that all the anomalies are not distinct radiometric highs.

It is assumed that the anomalies formed by contrast between the 100-120 c/s background with the 130-150 c/s maxima of the mbuga clay compared with the 70-90 c/s background of the surrounding superficial soils. Sheared aplitic granite with associated quartz, pegmatite and hydrothermal veins north of Ilindi have a background of 200-250 c/s with hotspots of 450-800 c/s. Minor hematite after pyrite turned assay results of 23-66 ppm U_3O_8.

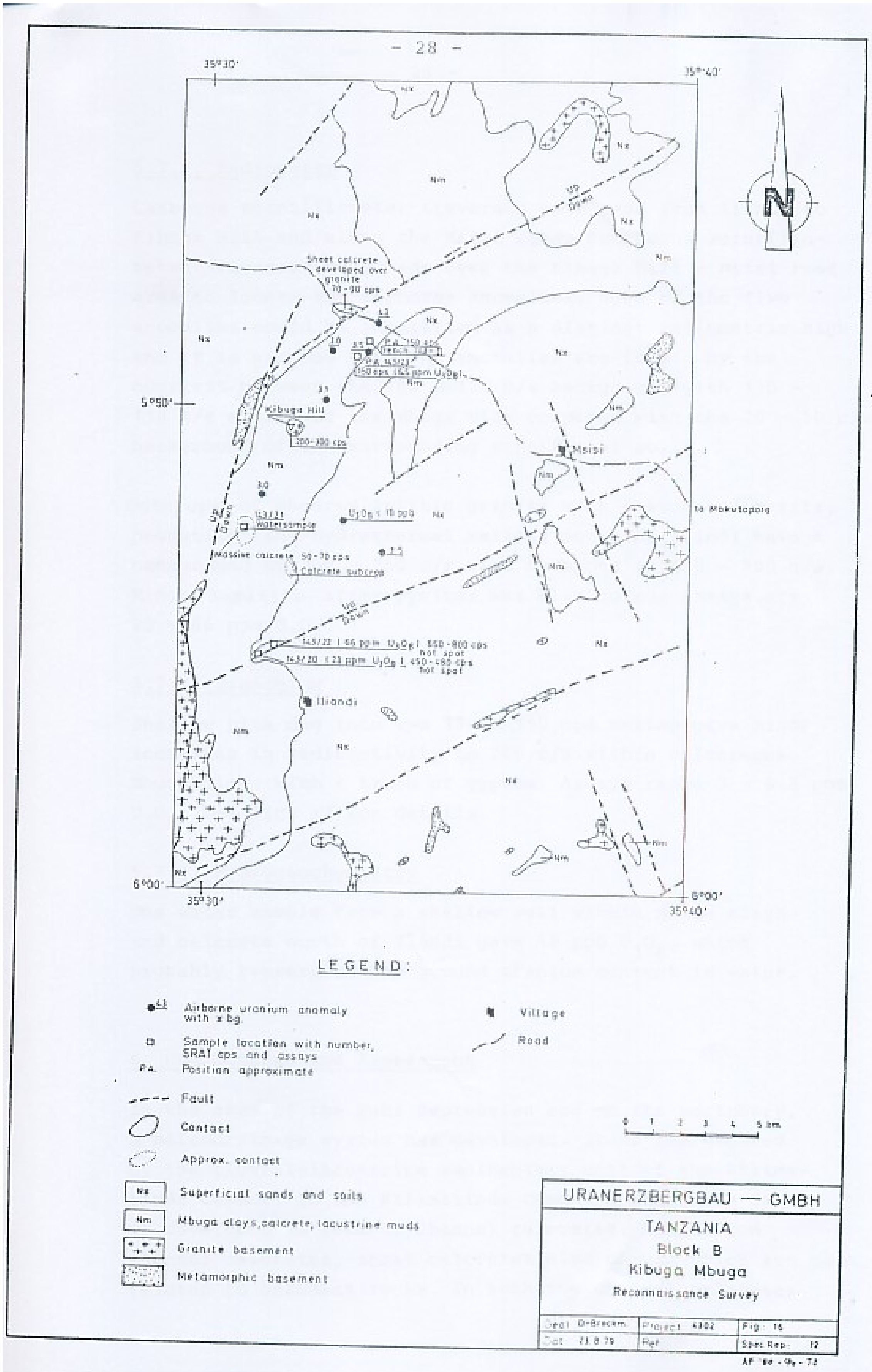


Figure 13: Geological map showing location of radiometric anomalies and samples collected.

Pits dug into two maxima of 130-150 cps showed increase with depth in radioactivity to 260 c/s within mbuga clays with trace of gypsum. Assay results showed 3.0-6.5 ppm U_3O_8. Water sample from a shallow well within mbuga clays and calcrete north of Ilindi gave 10 ppb U_3O_8, this probably representing background uranium content in water.

The Itigi, Iseke and Ndala anomalies are located in the investigated area within Block B and C which is underlain by Archaean granitic rocks and metasediments of Dodoman System. The basement is overlain by recent sediments, mainly sand and gravel. Local depressions caused by rift faulting developed as local drainage basins. These mbugas are water flooded during rain season. The lithological sequence consists of black clays with small calcrete nodules, black and grey clay with carbonate in matrix and grey carbonatic clay with calcrete nodules. These sediments often contain anomalous uranium values and might be hosts of mineralization of the calcrete type.

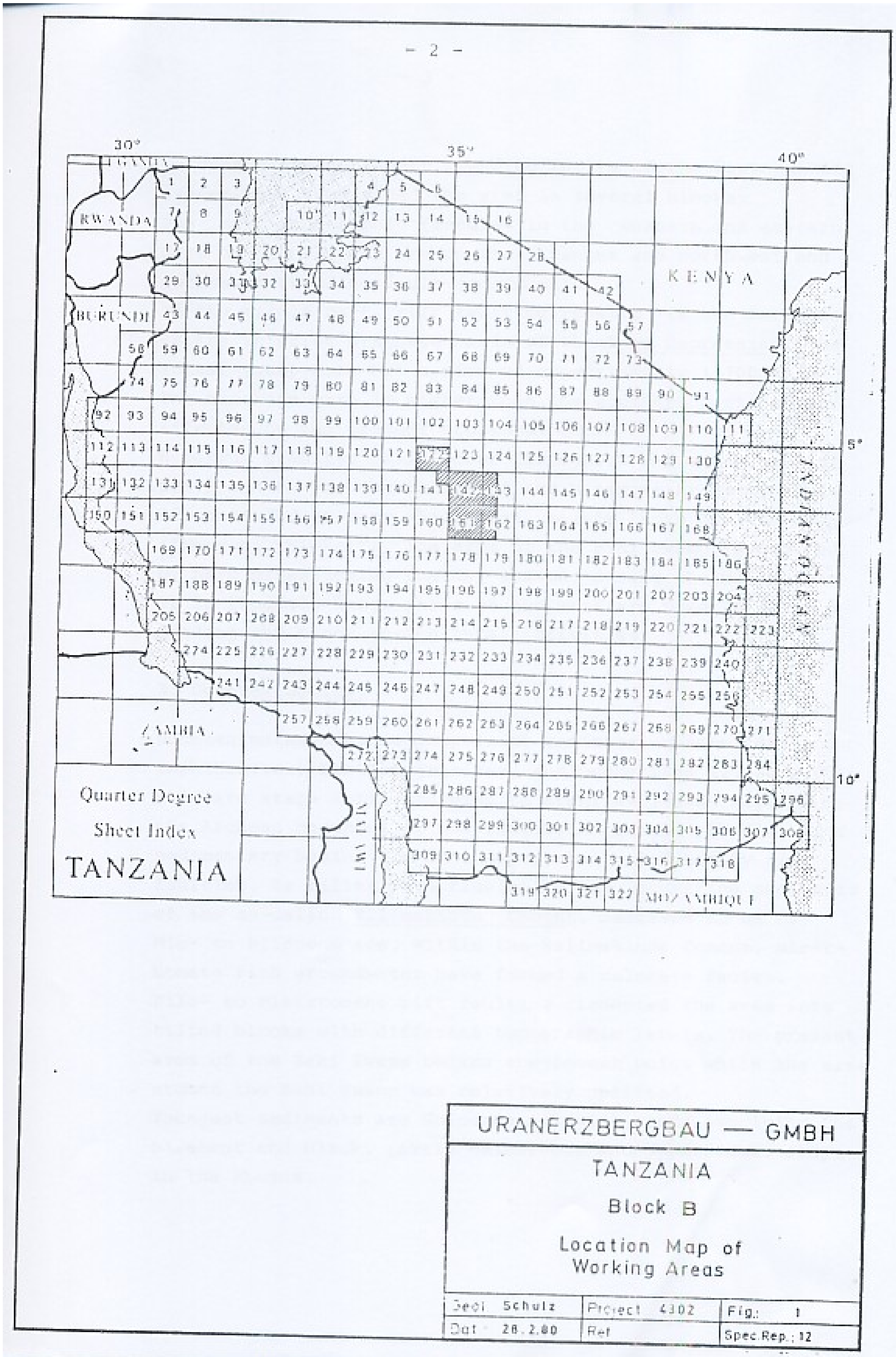


Figure 14: Location of areas that were investigates in Block B.

Grid-controlled foot borne radiometry, geological traversing, trenching and sampling were carried out over three mbuga type anomalies in Itigi area **(Figure 14)**. SRAT readings showed values up to 1,500 cps (11 x bg). Three trenches sunk at Issuna, Kianju and Manyoni exposed uranium enrichment and in places visible mineralization mainly in the transition zone between black clay and grey calcareous clay. Assay results turned values ranging from 13 to 387 ppm U_3O_8. Itigi anomaly consists of seven airborne anomalies on five different mbugas. The four highest airborne anomalies, namely Itigi, Issuna, Kianju and Manyoni were checked on the ground.

2.1.1.6 Issuna Mbuga

The Issuna Mbuga on QDS 122/4 is 11 km long in north south direction and about 1.5 km wide. A 29 x bg. airborne radiometric anomaly is located in the northern part of mbuga near Jungumi River. The grid measured 275 m north south and 300 m east west. Profile distance was 25 m and measuring distance was 20 m. The anomaly trends north northeast. The highest SRAT readings are 500 cps (3.5 x bg) on the surface and 1.4 cps (10 x bg) in a 25 cm deep hole.

Two trenches were sunk on mbuga and geological mapping was carried out north and northeast of mbuga. The trench sunk on the northeastern tributary exposed black clay with radiometric readings of 180 c/s at the surface to 280 c/s at depth **(Figure 15).** The radiometric readings in the Kilimatinde Cement and the carbonate facies showed 300 – 320 c/s. Samples collected along the intersections of the Kilimatinde Cement and carbonate facies gave 12 ppm U_3O_8 over 0.5 m. Calcretes in palaeo-channels at Issuna contain uranium enrichments ranging from 96 to 496 ppm U_3O_8 in grab samples. At Issuna the calcrete has been uplifted by late Tertiary to early Quaternary rift tectonic movements and dissected by recent drainage.

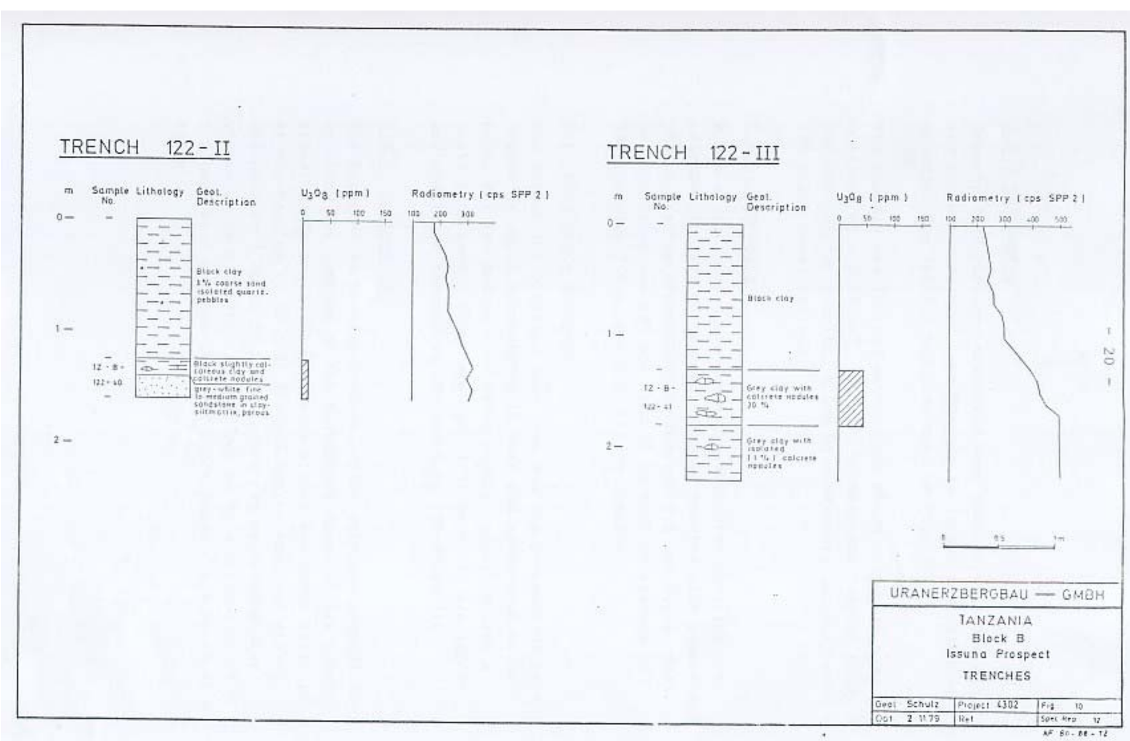


Figure 15: Horizons and uranium values within trenches 122-II and 122-III.

A trench on the radiometric maximum intersected 1.3 m mbuga with small amounts of calcrete nodules, gypsiferous transition zone and calcareous clay with abundant calcrete nodules **(Figure 16).** On cracks in the grey clay and calcrete nodules minor amount of yellow carnotite occur. The highest SRAT readings ranging from 1,300 to 1,500 cps (10-11 x bg) occur in the transition zone and in the lower part of the black clay. The uranium vales were as high as 213 ppm U_3O_8. The calcareous zone has an average radioactivity of 900 cps (7 x bg). Uranium values range between 74 and 314 ppm U_3O_8 with an average of 194 ppm U_3O_8 over 1.3 m. Biotite granites with 80 to 200 cps surround the mbuga.

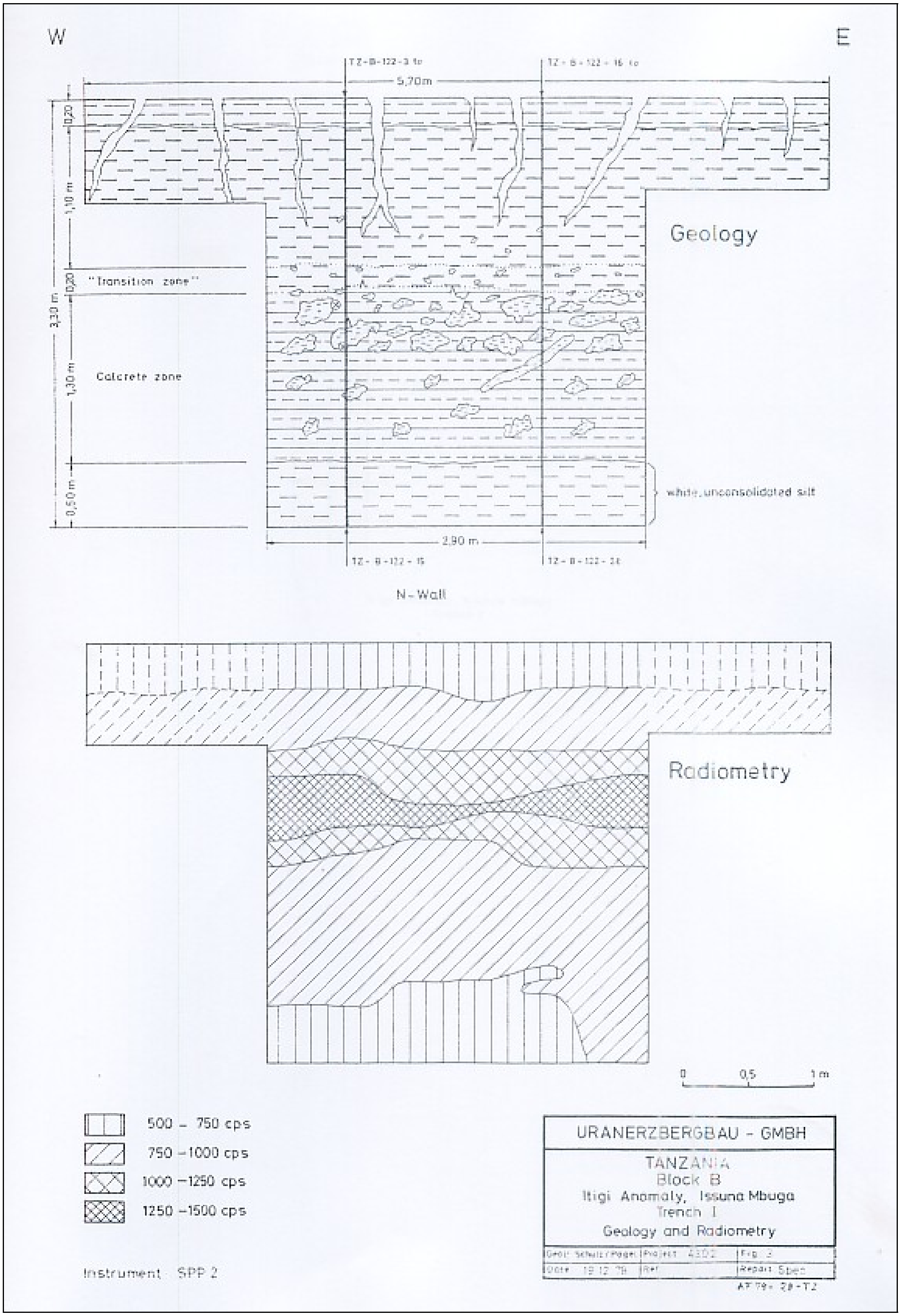


Figure 16: Trench I sunk on Issuna mbuga Itigi anomaly.

The palaodrainage, which is believed to have a certain potential for uranium mineralization, is buried by younger mbuga sediments, thus making them difficult to be explored. A blind mineralization of the calcrete type lies at depth of 65 m under mbuga cover along a water borehole in Bahi Swamp, whereby an intersection of 15 cm showed 0.24% U_3O_8. Very low grade superficial uranium enrichments were found in calcareous and gypsiferous clays (100-300 ppm U_3O_8 over 0.5 m). Grab samples from palaeochannel gave uranium contents from 96 ppm to 496 ppm U_3O_8.

Radiometric values of biotite granite range from 50 to 250 c/s whilst of pegmatites vary from 70 to 125 c/s. The uranium content of the basement rocks ranges from less than 5 ppm to 25 ppm U_3O_8. The radiometric background of the Kilimatinde Cement is 90 to 100 c/s. The maximum reading was 950 c/s near the contact to calcrete. A grab sample gave 217 ppm U_3O_8. Two grab samples from conglomeratic material overlying basement gave 41 ppm and 44 ppm. Along Jangumi River readings in calcrete showed 250 to 600 c/s with a maximum of 1,500 c/s. Three other grab samples from massive calcrete gave 97 ppm, 16 ppm and 125 ppm.

2.1.1.7 Kianju Mbuga

The Kianju mbuga is situated on QDS 141/2 south of Issuna Mbuga and has a roundish shape with a 5 km diameter. Two airborne anomalies of 13 x bg and 7 x bg were checked on the ground. The 13 x bg anomaly is near the eastern rim of the mbuga. A radiometric grid survey extended 900 m along north south direction and 270 m to 930 m in east west direction. Profile distance was 100 m and profiles were run east west with a measuring distance of 30 m. The radiometric survey revealed a 450 m long anomalous zone in north northeast direction with 600-800 cps, measured in 25 cm deep holes. The maximum is 850 cps (7 x bg). A trench (Figure 17) was dug over the radiometric maximum **(Figure 17)**. The highest SRAT readings of 850-1050 (7-8 x bg) in the trench were in transition zone between the black clay and the calcareous zone and in the lower part of the black clay. No secondary mineralization was observed. Samples from 0.5 m thick transition zone contain up to 352 ppm U_3O_8. Uranium content in calcareous zone ranges from 200 U_3O_8 on the top and 11 ppm U_3O_8 on the bottom.

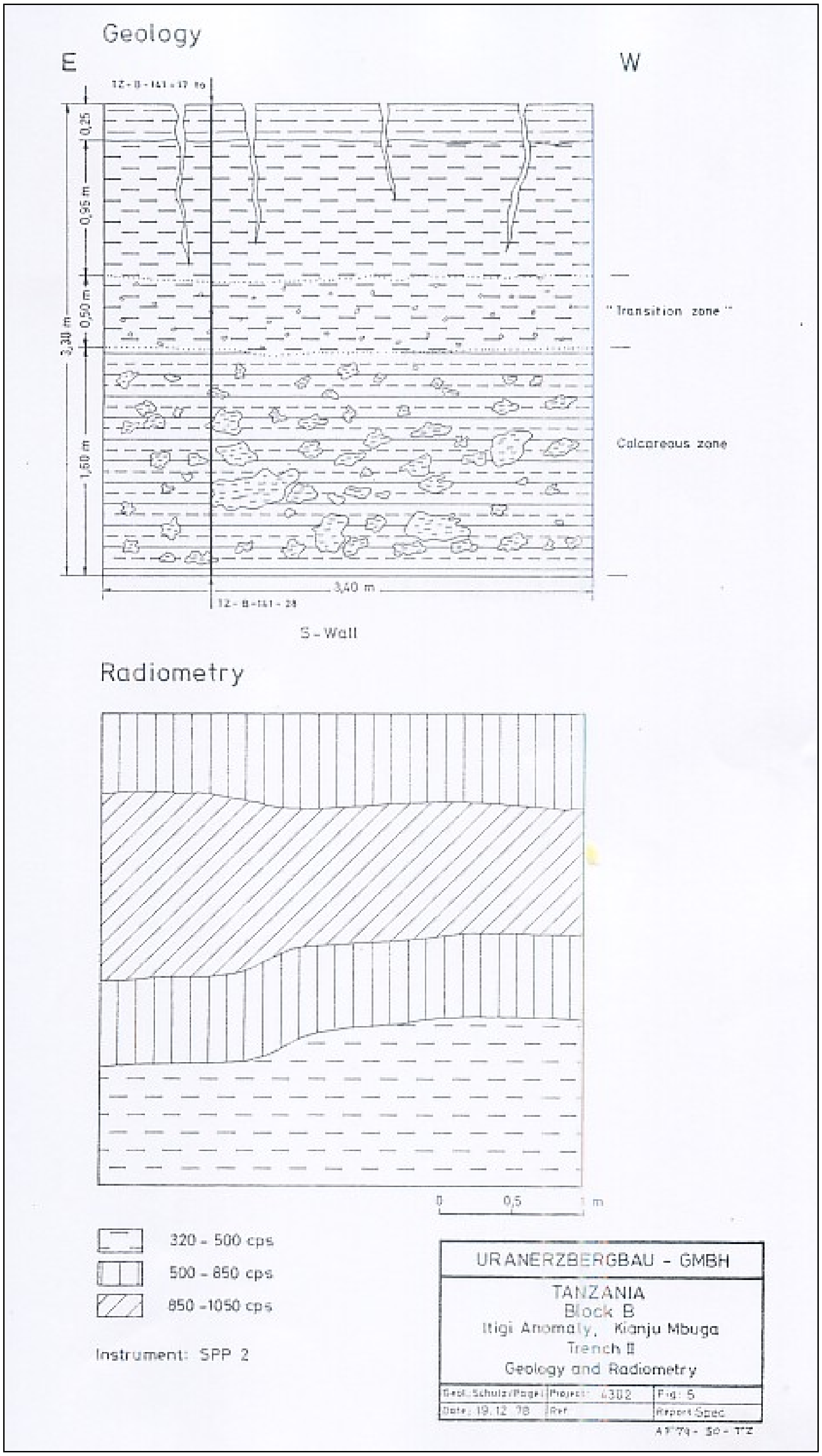


Figure 17: A trench dug over the maximum radiometric**.**

In trench shown in **Figure 18** no transition zone between the black clay and calacareous zone is developed. The maximum SRAT readings of 700 cps (6 x bg) occur in the lower part of the black clay. Uranium values in this zone are between 13 and 25 ppm U_3O_8, indicating disequilbrium conditions. Uranium values in calcareous zone are between 56 and 92 ppm U_3O_8.

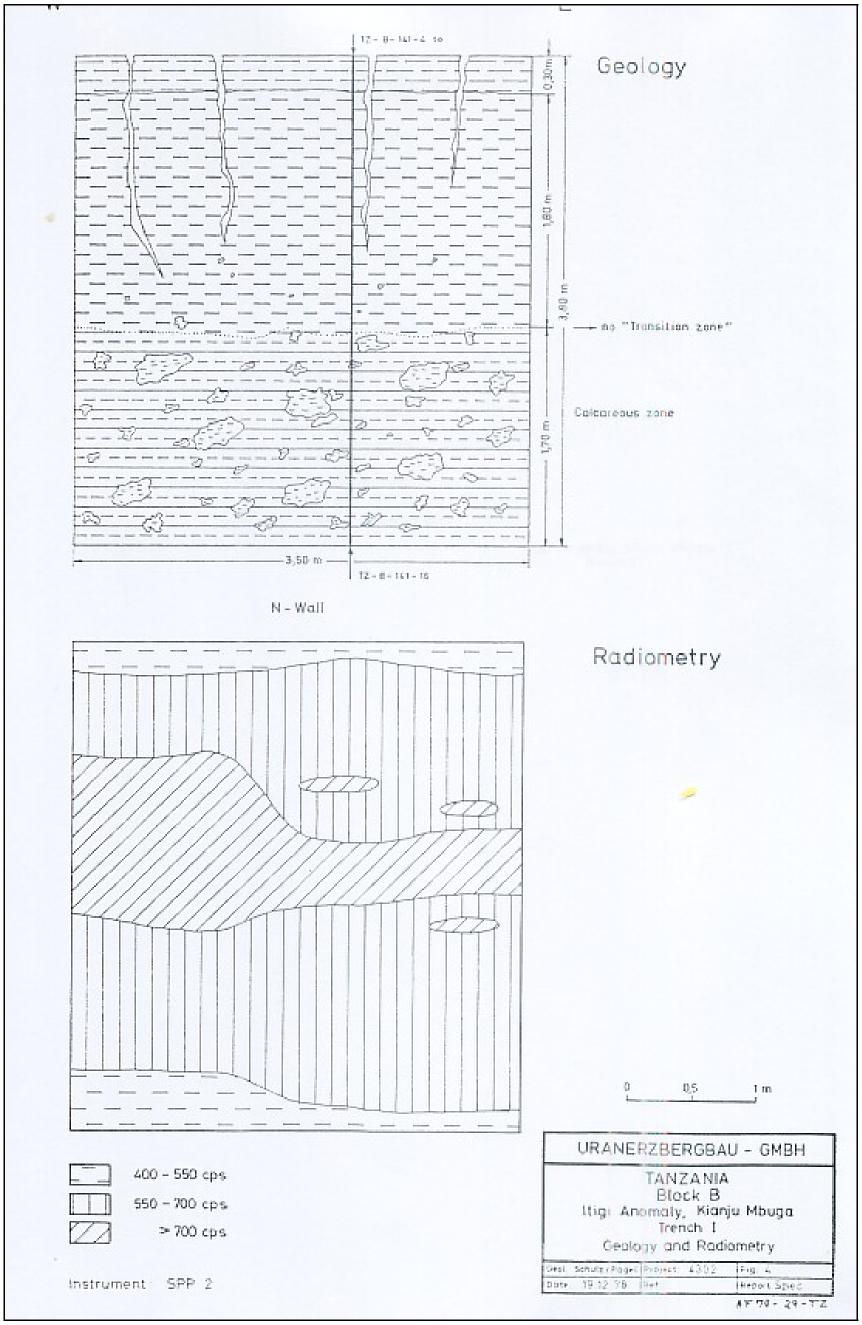


Figure 18: A trench sunk in a zone without a transition zone between black clay and calcareous zone.

The 7 x bg airborne anomaly is 2.5 km south west of the 13 x bg airborne anomaly. The geology in the trench is similar to the above mentioned trenches and a transition zone is not developed. The highest radiometric values range from 950 to 1075 cps (7-8 x bg) over 0.35 m and is at the boundary between black clay and calcareous zone. In the upper 10 cm of calcareous zone spotted secondary uranium mineralization was observed and analytical results showed 387 ppm U_3O_8, decreasing with depth to 76 ppm U_3O_8.

2.1.1.8 Manyoni Mbuga

Manyoni Mbunga is within QDS 141/2 and trends east northeast with a width of 2 km along north south. The geology of Manyoni anomaly is different from the Issuna and Kianju mbugas. The Manyoni anomaly is a 15 x bg airborne anomaly and is within pegmatite.

Fragments of schriftgranite were found along the anomaly. A grid measuring 1,400 m along north south and 300 to 780 m east west with a profile distance of 100 m and measuring distance at 30 m was used in the survey. The anomaly extends for 180 m along north northwest direction and has an average width of 20 m. SRAT readings range from 975 to 1250 cps (7-9 x bg) with a maximum of 2,700 cps in a 30 cm deep hole. In the southern continuation of this maximum, three additional isolated radiometric maxima of 1450 to 1750 cps occur. A trench dug on one of the maxima **(Figure 19)** intersected A horizon with 88-100 ppm U_3O_8, B horizon containing 58-88 ppm U_3O_8 and C horizon with 18-58 ppm U_3O_8.

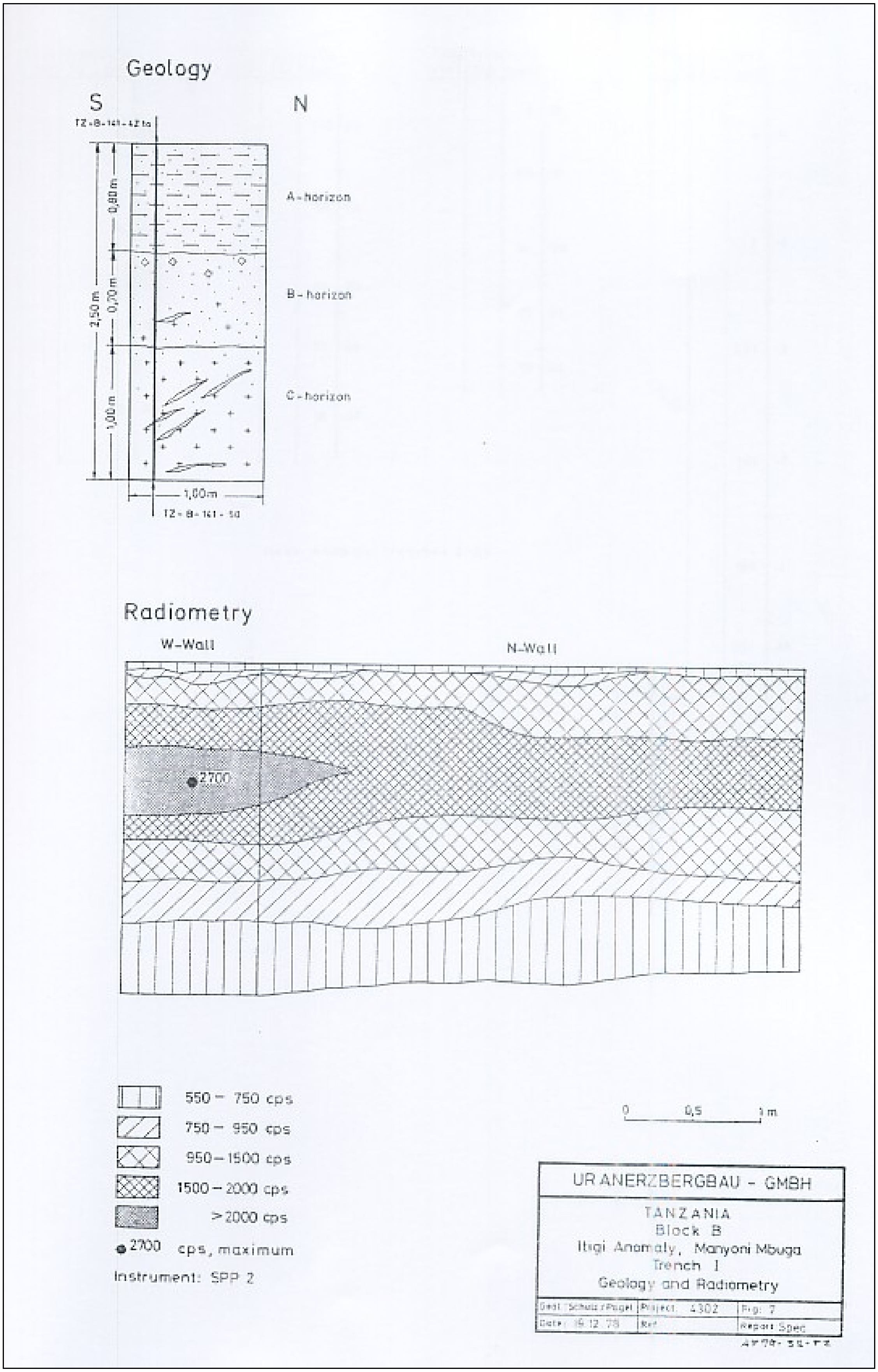


Figure 19: Trench I excavated on Manyoni Mbuga within the Itigi Mbuga (after, Uranerzbergbau, 1980).

The radiometric maximum of 2,700 cps (22 x bg) lies within B horizon. The radiometric intensity decreases with depth.

2.1.1.9 Iseke Mbuga

The Iseke Mbuga is located at about 90 km west southwest of Dodoma on QDS 160/4 and 161/3. Exploration activities on the eastern part of the mbuga included foot borne radiometry and relogging of trenches sunk by GeoSurvey International. The stratigraphic succession is similar to that of mbuga at Itigi. Secondary uranium mineralization was encountered in trench where the highest ARAT readings ranged between 1,450 and 1,700 cps (15 x bg) over 2.1 m. Samples from this zone turned 230 ppm U_3O_8. Contrary to the Itigi anomalies, the Iseke anomaly has high content of gypsum **(Figure 20)** which is at the base of the black clay and increases to 70% in grey clay and decreases with depth. Secondary uranium mineralization occurs as coating in the gypsiferous zone. The highest SRAT readings range between 1,450 and 1,700 cps (15 x bg) over 2.10 m. Samples contain about 230 ppm U_3O_8.

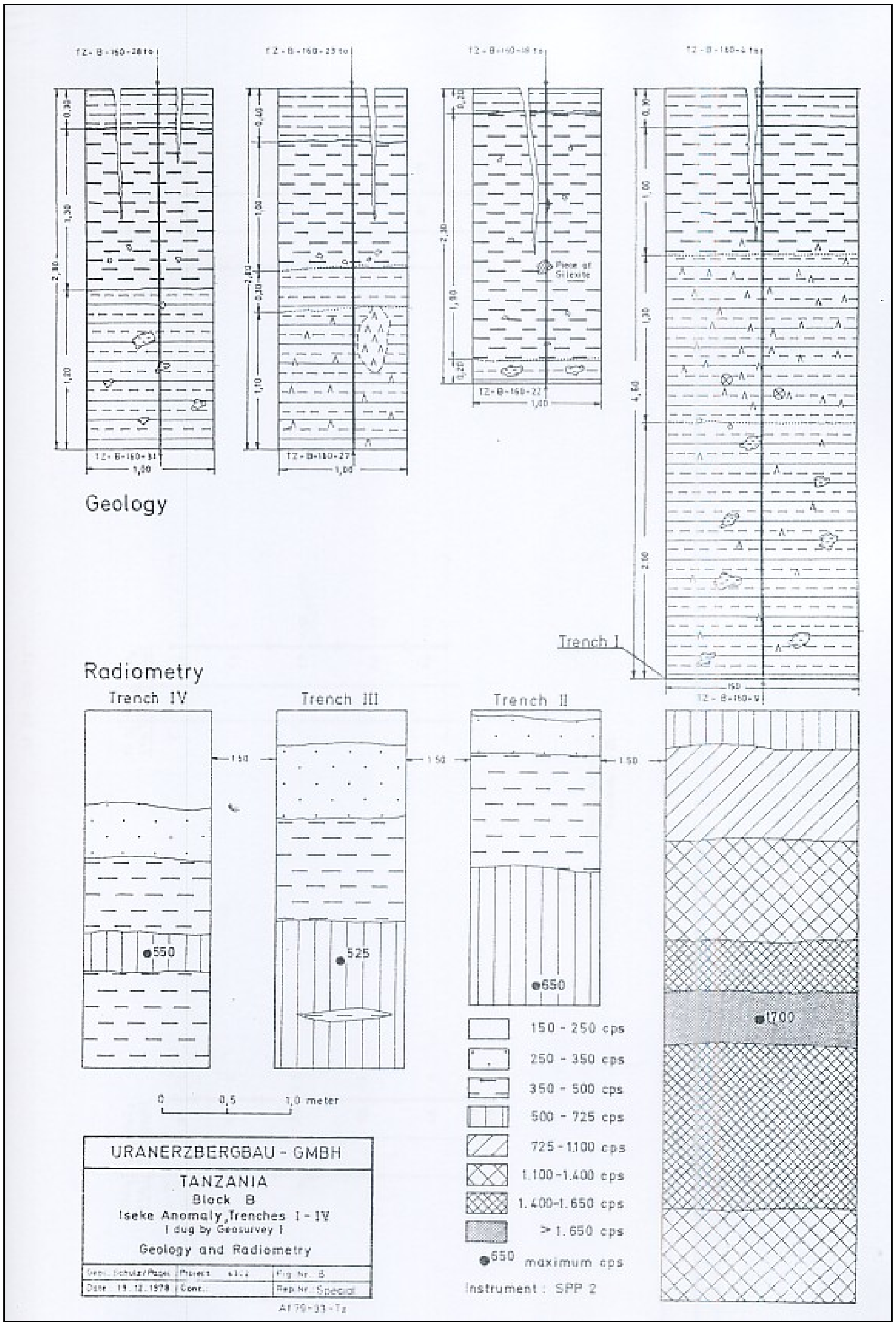


Figure 20: A trench sunk at Iseke.

2.1.1.10 Ndala Mbuga

The Ndala Mbuga is situated in QDS 99/4 and is 36 km long along north south and 15 km wide along east west direction. Ground radiometry was carried out on two airborne anomalies at Ndala Mbuga which is located at about 320 km north west of Dodoma within Block C. Sections and analytical result curves are shown in Figure 21, Figure 22, Figure 23 and Figure 24.

Maximum SRAT readings are 550 cps (5 x bg) and 350 cps (3 x bg). Channel samples collected by GeoSurvey showed that maximum uranium values ranging from 80 to 95 ppm

U_3O_8 occur in the transition zone between black clay and grey calcareous clay similar to Itigi and Iseke. There are two airborne anomalies on Ndala Mbuga, the 6 X bg and 15 x bg anomalies. The 6 x bg anomaly gave SRAT readings of up to 550 cps (5 x bg) in a 0.2 to 0.3 m deep hole. A total of 34 samples analysed. The highest U_3O_8 content of 98 ppm occurs in the top soil of trench 1. The transition zone and black clay contain 53 to 70 ppm U_3O_8. The uranium content decreases from maximum 190 ppm in black clay to less than 100 ppm in calcareous zone. Soil samples from B horizon turned 21 to 59 ppm U_3O_8. Cross sections of trenches sunk area with horizon geology, uranium assay and radiometry readings are shown in **Figure 21, Figure** 22**, Figure** 23**Figure 24**.

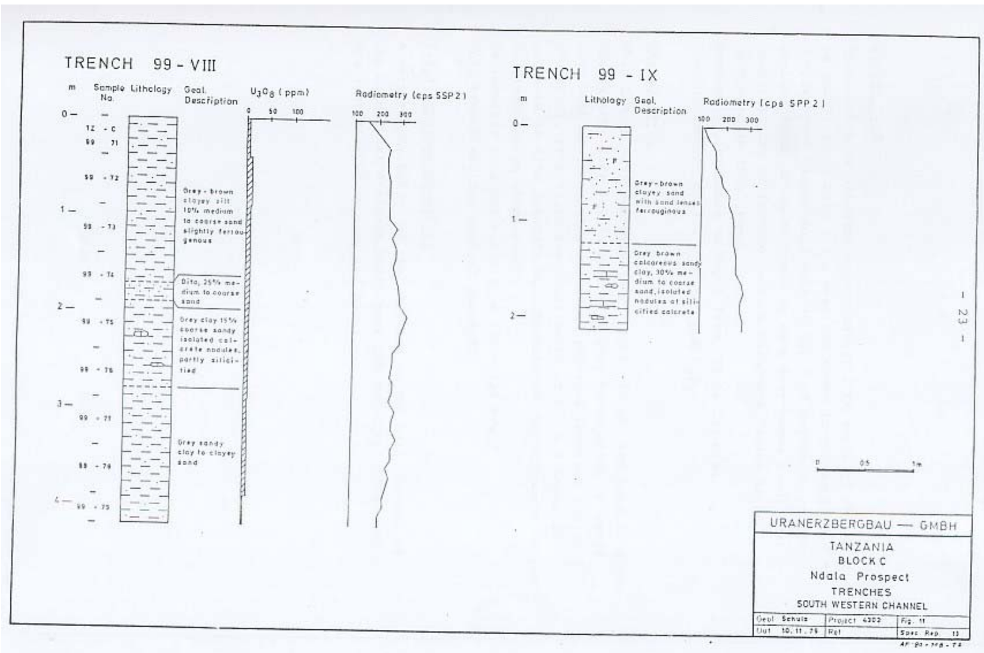


Figure 21: Trench sunk at Ndala.

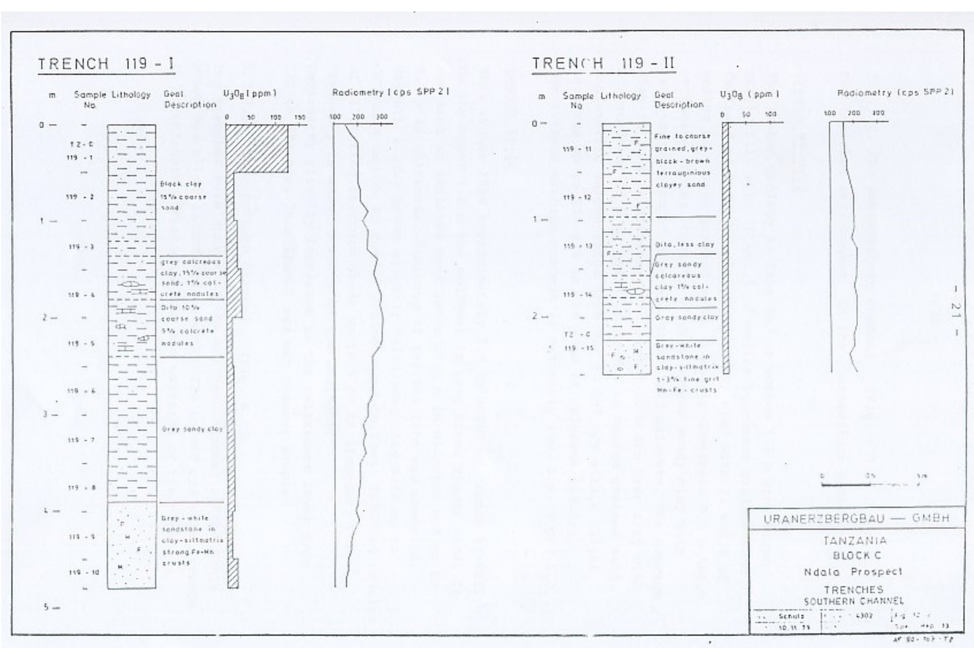


Figure 22: Trench dug on Ndala mbuga.

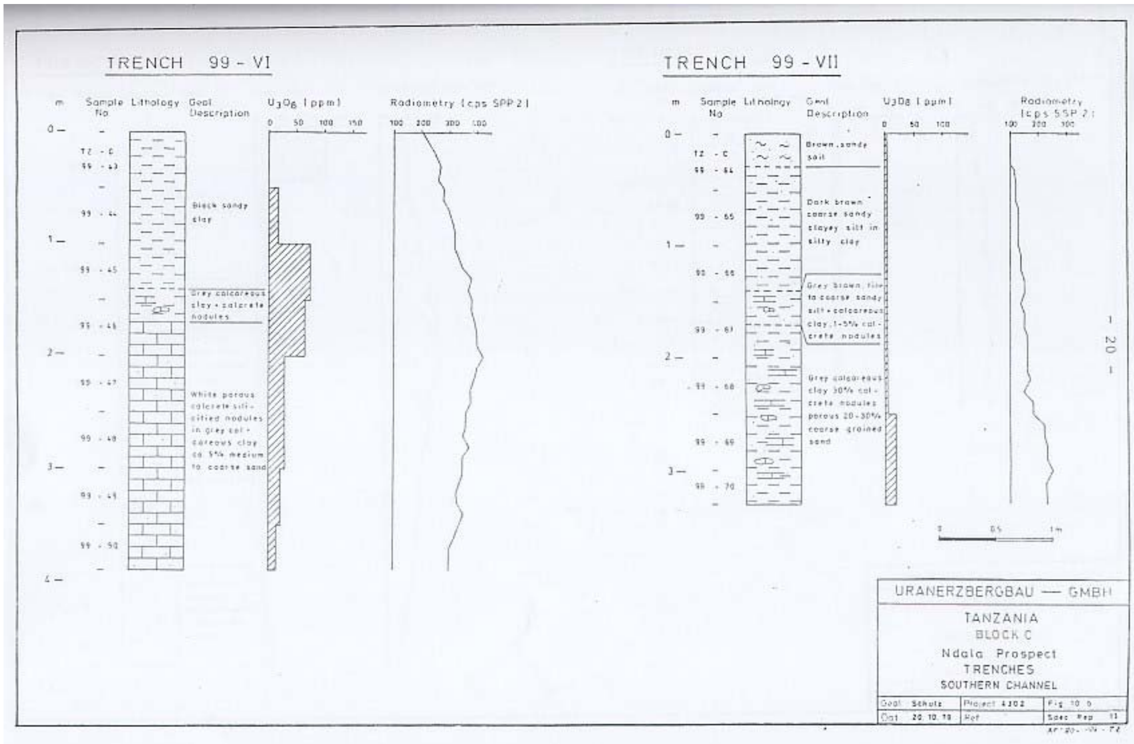


Figure 23: Trench sunk on Ndala Mbuga.

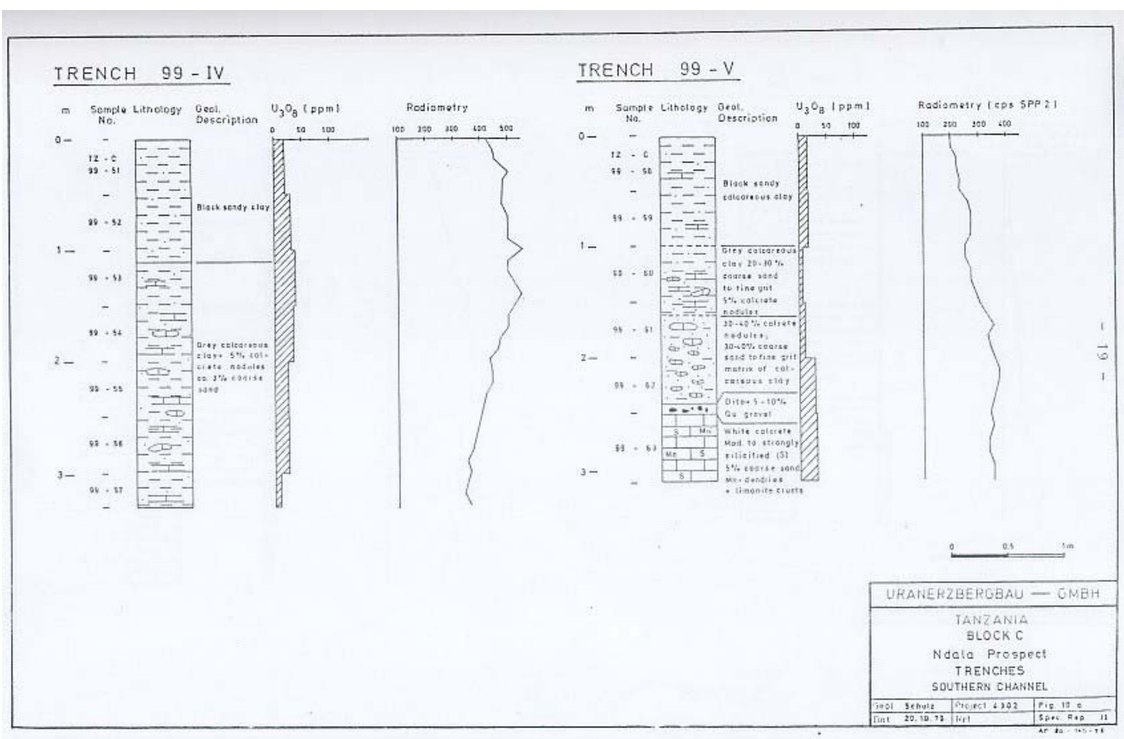


Figure 24: Trench sunk over Ndala mbuga.

Recently Uranex carried out exploration of uranium associated with mbuga in Bahi area central part of Tanzania. At Bahi north prospect pitting and trenching results indicated a consistent high grade and wide uranium mineralization at shallow depth. The assay results returned 0.823 to 2.376 kg/t of U_3O_8.

2.2. BLOCK C

The most prospective part of Block C covers the area east of Mpanda **(Figure 25).**

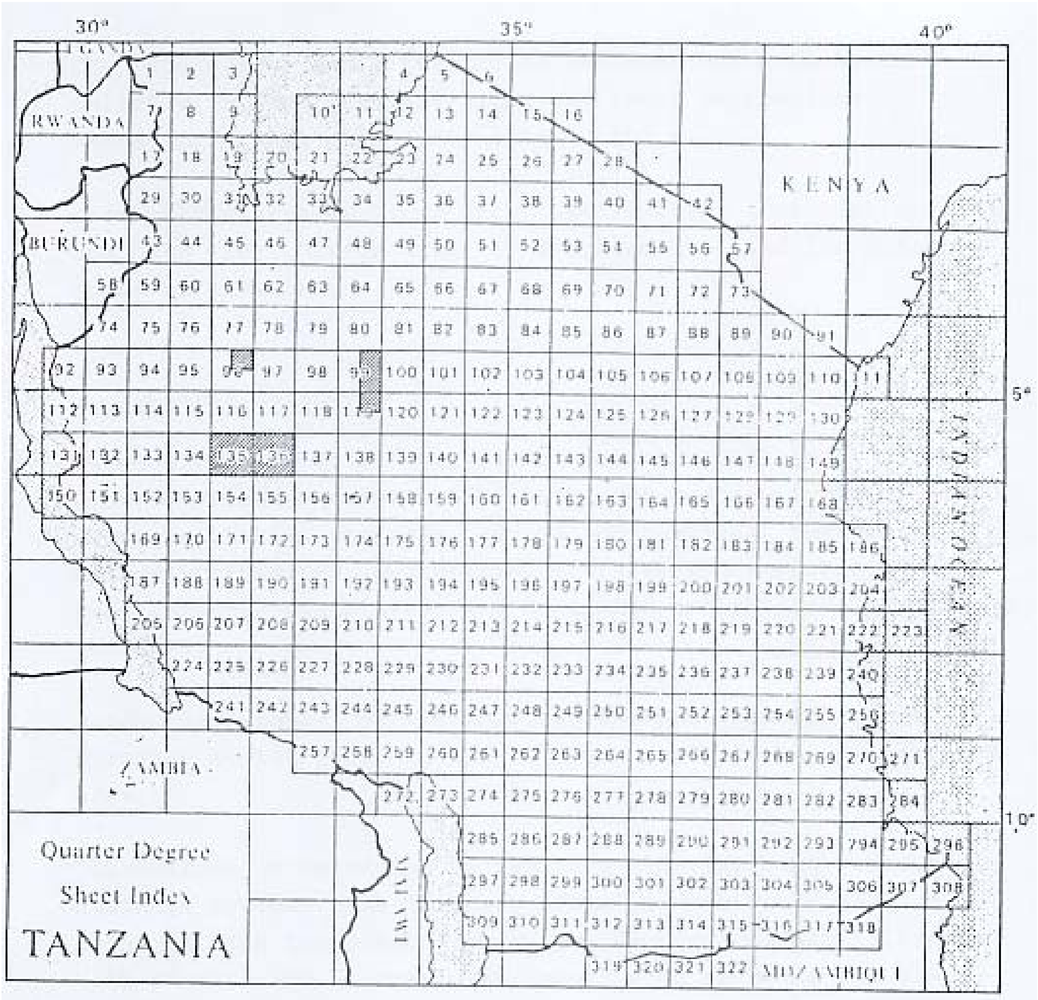


Figure 25: Location of working areas in Block C.

The aim was to check the prospectivity of uranium deposits related to unconformity between the Bukoban System and Ubendian System. Prospecting work conducted in Block C comprised of check up of anomalies related to mbuga and unconformity.

- Ground check up of airborne anomalies of Mbuga-type in the eastern part of block; and
- Airborne anomalies related to the Proterozoic unconformity in the western part of the block.

The works carried out included a helicopter supported ground check of 34 airborne anomalies and radiometric traversing of further 23 airborne anomalies.

The results of this work showed that the airborne anomalies are related to unconformity between Upper Proterozoic Bukoban System and the underlying Middle Proterozoic Karagwe-Ankolean System and Lower Proterozoic Ubendian System. The potentiality of unconformity related uranium mineralization was negative except for the southern part. Most of the airborne anomalies are caused by contrast or mass effect and very low uranium values of less than 17 ppm U_3O_8.

Several of the geological factors controlling unconformity related uranium deposits are missing. However, this was not the case at the metamorphic series of the Ubendian System that might be favourable for the occurrence of unconformity related uranium deposits.

A helicopter supported reconnaissance survey within the western part of Block C in the Kigoma and Mpanda areas was carried out in September 1979. The target was the unconformities between the Upper Proterozoic Bukoban System and the pre-Bukoban Itiaso Group, and the Ubendian System as well as the outcropping contact between Bukoban and the Ubendian Systems. Field work comprised ground checks of airborne by foot borne and sampling as well as rim-flying radiometry. The activities carried out area:-

- Checking 34 airborne anomalies by radiometric traversing and sampling;
- Checking radiometrically 23 airborne anomalies by helicopter traverses;
- Checking on the ground 4 additional localities; and
- Sampling and analyzing 96 samples for uranium.

About 57 locations were selected basing on ranking done according to geological setting and significance for future exploration. The eastern part of Block C is covered by Archaean basement, Ubendian System, Karagwe-Ankoelean System and Bukoban System.

- In addition to check of airborne anomalies radiometric rim flying was carried out along:-
    - Unconformity Bukoban/PreBukoban (Itiaso Group) (QDS 112 and 132)
    - Unconformity Pre Bukoban (Itiaso Group/Ubendian System) (QDS 151 and 152)
    - Unconformity Bukoban/Ubendian Syatems (QDS 113, 153, 154 and 171).

The rim flying surveys revealed negative results. Maximum readings did not exceed 1.5 x bg. Average reading on helicopter traverses recorded 30-50 cps over rocks of Bukoban System, 30-50 cps over the Itiaso Group and 80-100 cps over Ubendian gneisses.

- Check of other locations such as Mpanda Mine, Longonya River, Uvinza, Mpanda and Kamarapaka.

Mpanda Gold Mine

Radiometric readings on the ore damp at the Mpanda gold mine that operated between 1947 and 1960 did not exceed 60 cps. Rocks and ore samples revealed less than 3 ppm U_3O_8.

Longonya River

The area is covered by rocks of Itiaso Group and has typical turbidites or submarine canyon indications. Breccia of wildflysch chowed 70 cps and 14 ppm U_3O_8 whilst arcosic wacke turned 70 cps and 3 ppm U_3O_8.

Uvinza

Results of helicopter traverses over Ubendian gneisses cropping out in a Bukoban window in the valley of Malagarasi River east of Uvinza showed 80 cps and 3 ppm U_3O_8.

Kamarapaka

Mica schist at Kamarapaka turned less than 3 ppm U_3O_8.

The results of helicopter supported airborne follow-up survey in western part of Tanzania indicate negative results with respect to vein-like type targets unconformity of Bukoban System and Pre Bukoban (Itiaso Group)/Ubendian System. However, along the southern part of Bukoban/Ubendian unconformity the environment for vein-like type uranium mineralization can be found and therefore further investigations are recommended.

Most parts of Block C underlain by rocks of Bukoban System and PreBukoban Itiaso Group are of no interest for further exploration of uranium. The SRAT reading on the ground range between 40 and 130 cps over Bukoban rocks and from 50 -110 cps over rocks of Itiaso Group. Uranium content of Bukoban rocks sampled at anomalous zones revealed low values of less than 3 ppm with a maximum of 14 ppm U_3O_8. Itiaso rocks turned less than 3 ppm up to 15 ppm U_3O_8. The airborne anomalies in these sediments were probably caused by contrast or mass effects since they are located at the floor of abrupt terminating sandstone plateaus of rocks of the Bukoban System.

Ground check of anomalies within the Ubendian System outside to the unconformity revealed negative results by turning radiometric readings ranging from 60-500 cps. Uranium content of Ubendian granites and gneisses ranges from less than 3 ppb to 7 ppm U_3O_8. The only high value of 11.3% U_3O_8 associated with columbite was picked up in soil over highly metamorphosed gneisses. This mineral indicated unfavourable conditions in relation to economic uranium mineralization as well as to processing.

At the south east area near the unconformity of Bukoban/Ubendian and Bukoban/Karagwe-Ankolean ganites similar conditions were found. Interpreted anomalies occur in biotite-granites and gneisses at the foot of the Bukoban plateau. Contrast effects as source of higher readings cannot be excluded. SRAT values range from less than 3 ppm to 17 ppm U_3O_8. The only exception of the anomalies in this area is a fluorite bearing granite within the Karagwe-Ankoelean that turned 17 ppm U_3O_8. Uranium is associated with fluorite. Large faults or vein structures were not found thus ruling out the possibility of having economic vein-type uranium mineralization within this granite. This occurrence points to the appearance of possible uranium source rocks.

General conditions of vein type uranium deposits have not been found above the unconformities. However, there are possibilities that such conditions can be found through intensive exploration along the southern part of the Bukoban/Ubendian unconformity (mainly Ikulu Series). Therefore, exploration for uranium should not be carried out in the entire area of Block C west with the exception of some parts in the south west where the Bukoban/Ubendian unconformity appears (QDS 135, 152, 153, 154, 170 and 171). Efforts should be directed towards investigations of the Ikulu Series to prove if favourable environments area present for vein-like type deposits.

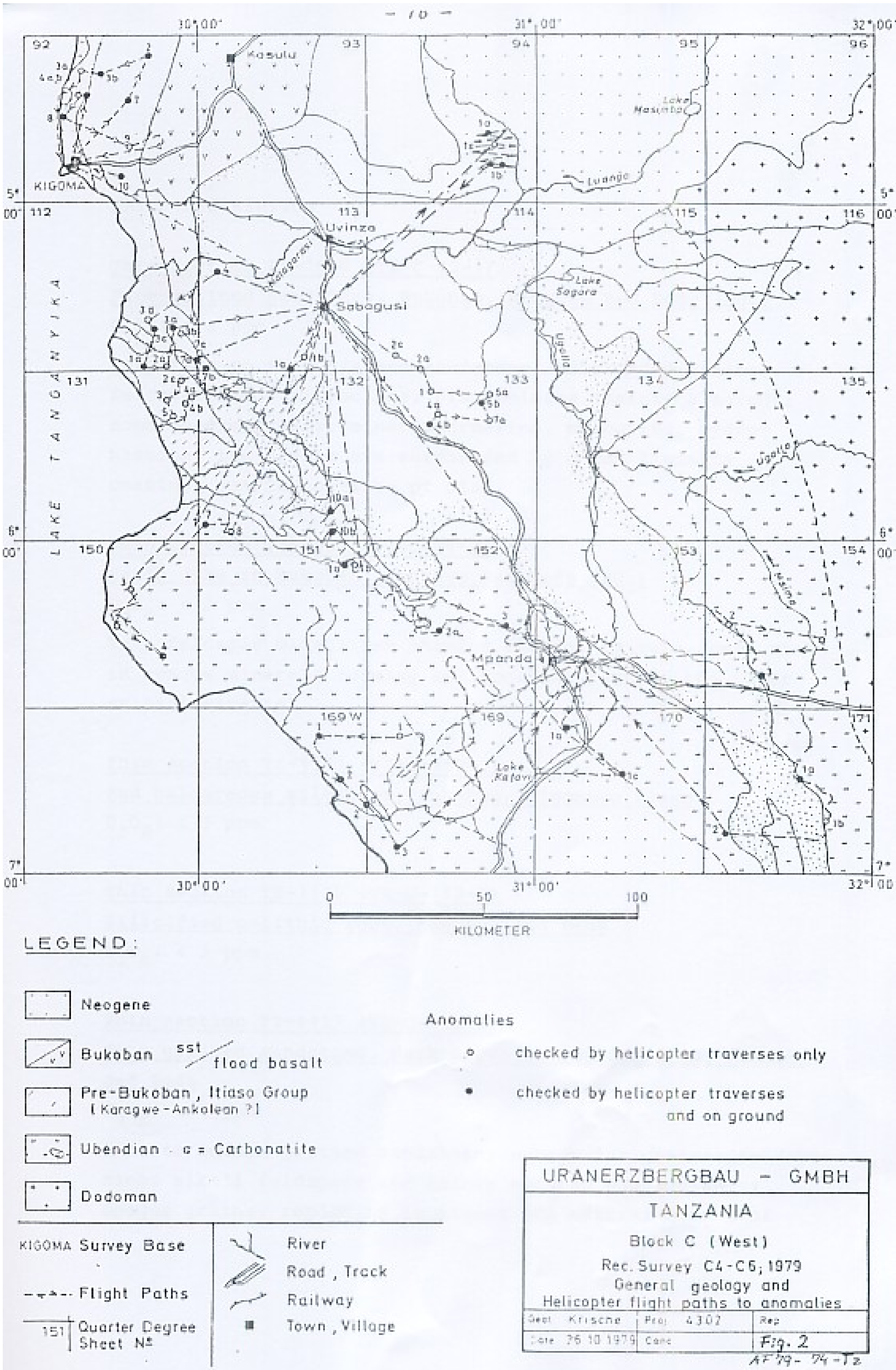


Figure 26a shows the areas investigated in Ugalla River area. Trenches were sunk and the geological sections showing geology, uranium values and radiometry readings are shown.

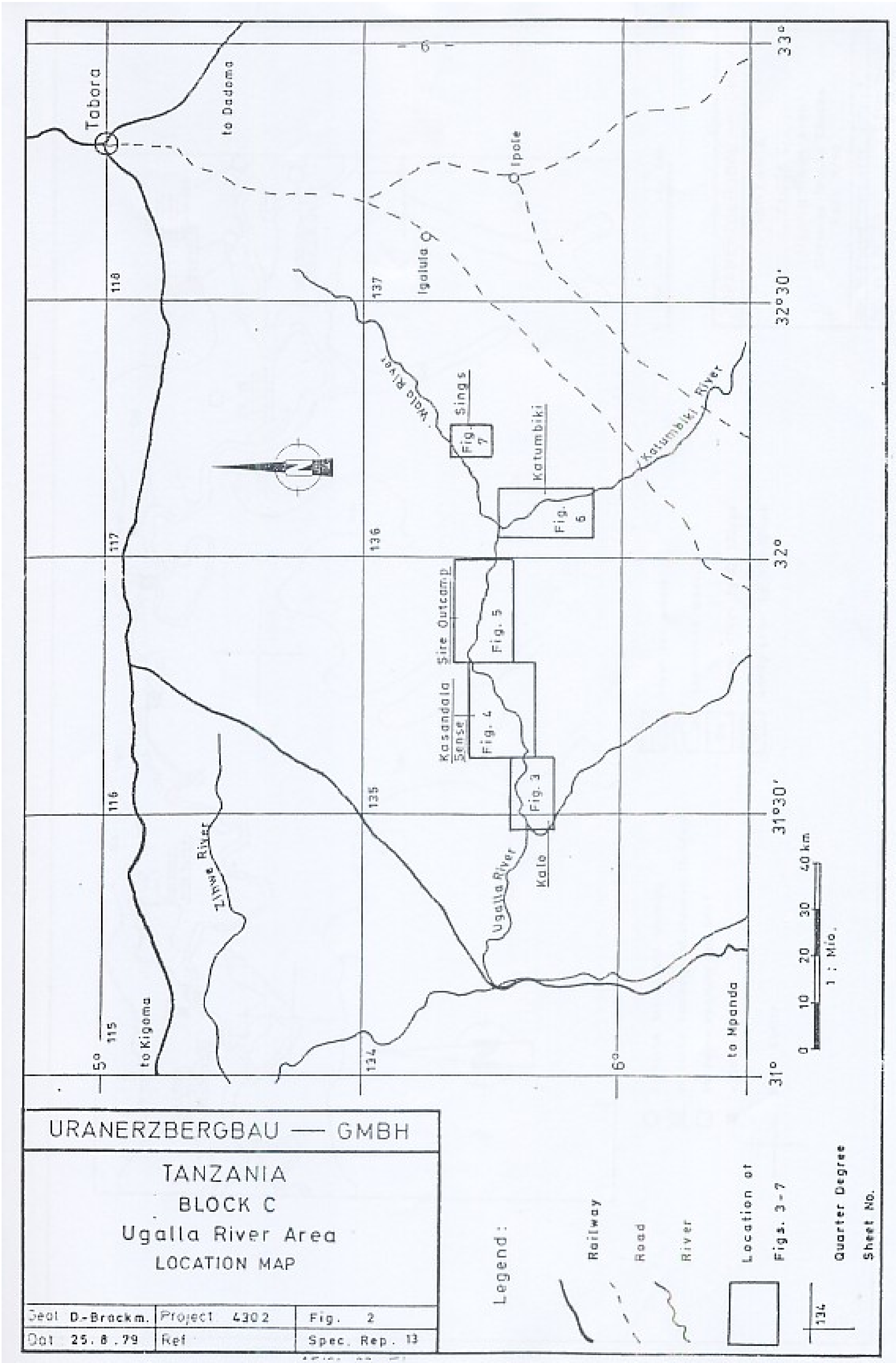


Figure 26b: Location of Ugalla River area.

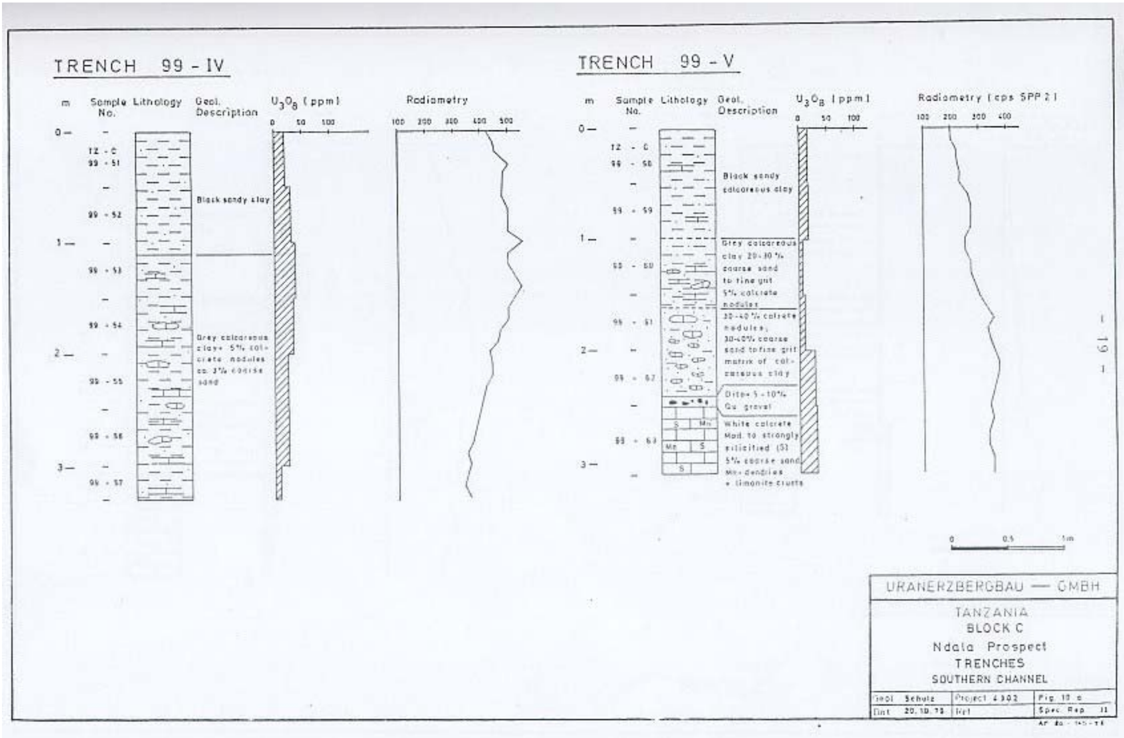


Figure 27: Trenches sunk in Ndala prospect.

Prospects in Igombe and Ugalla River were investigated and the results are shown.

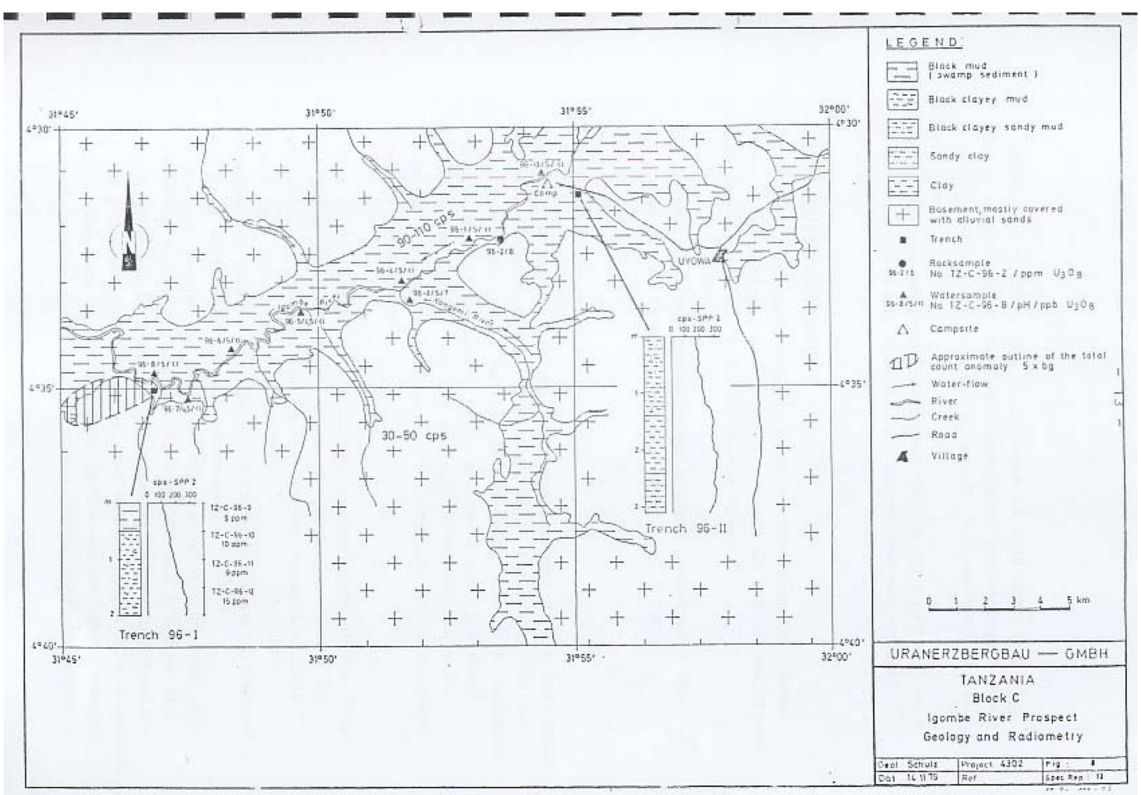


Figure 28: Igombe River Prospect.

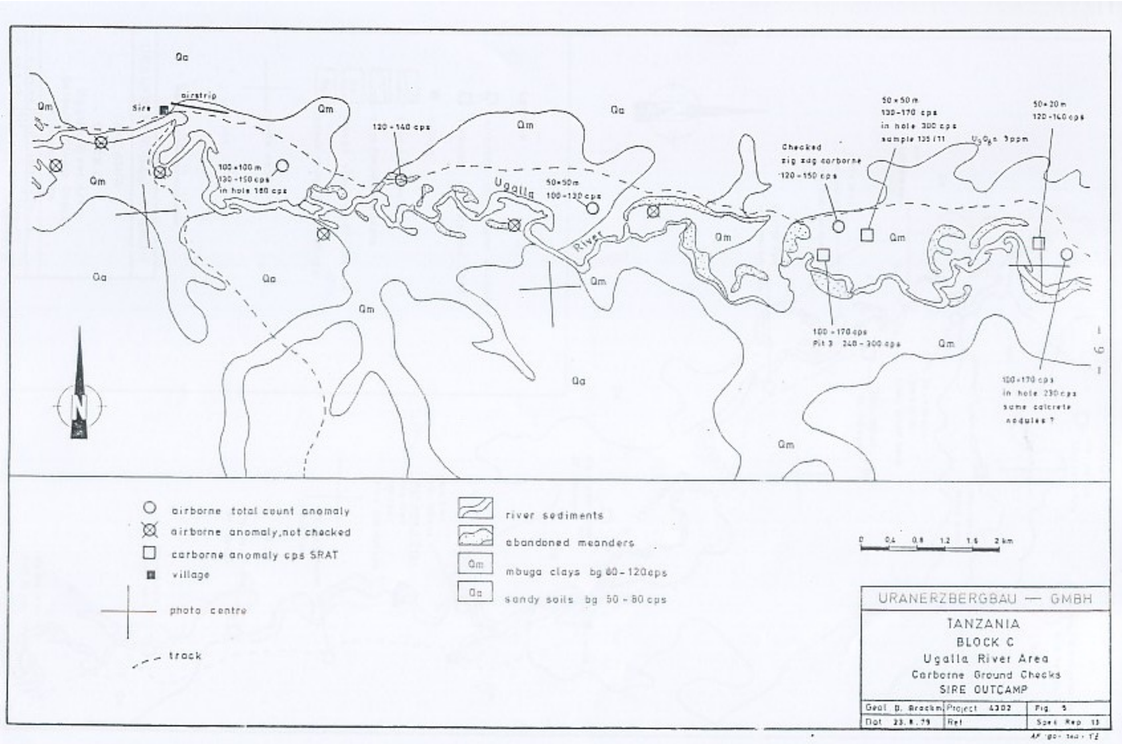


Figure 29: Ugalla River prospect.

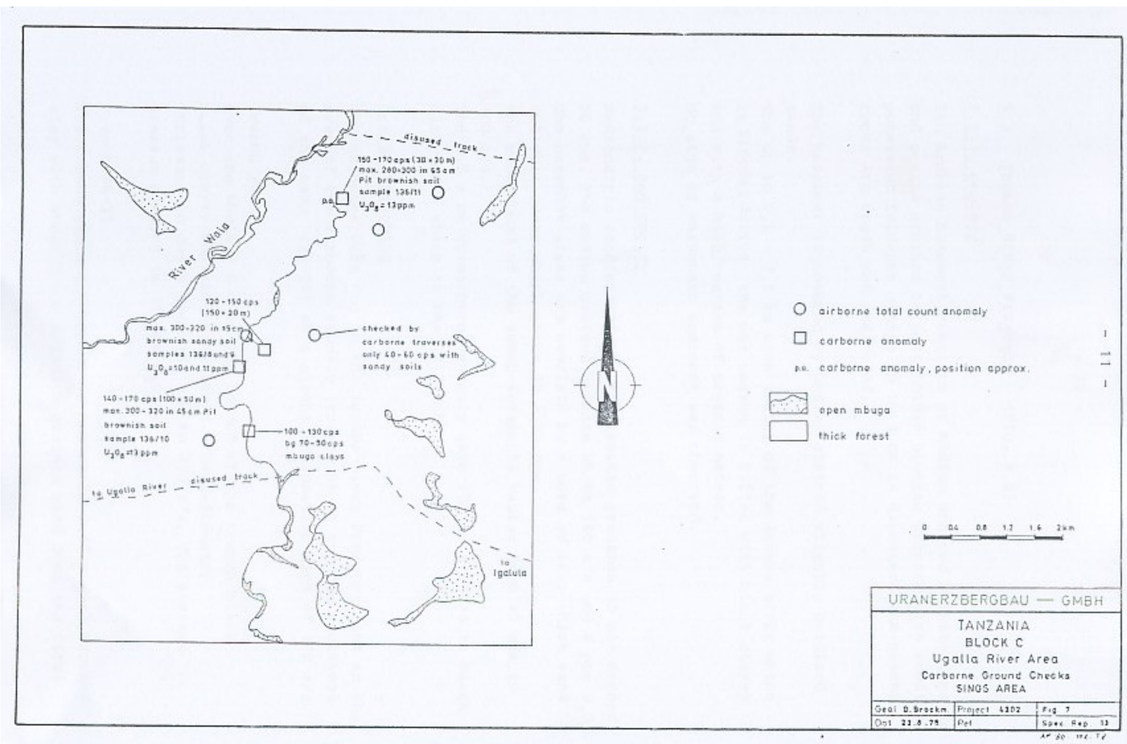


Figure 30: Ugalla River prospect.

2.3 BLOCK D

The Galappo carbonatite and Minjingu Phosphate **(Figure 31)** were investigated for uranium mineralization.

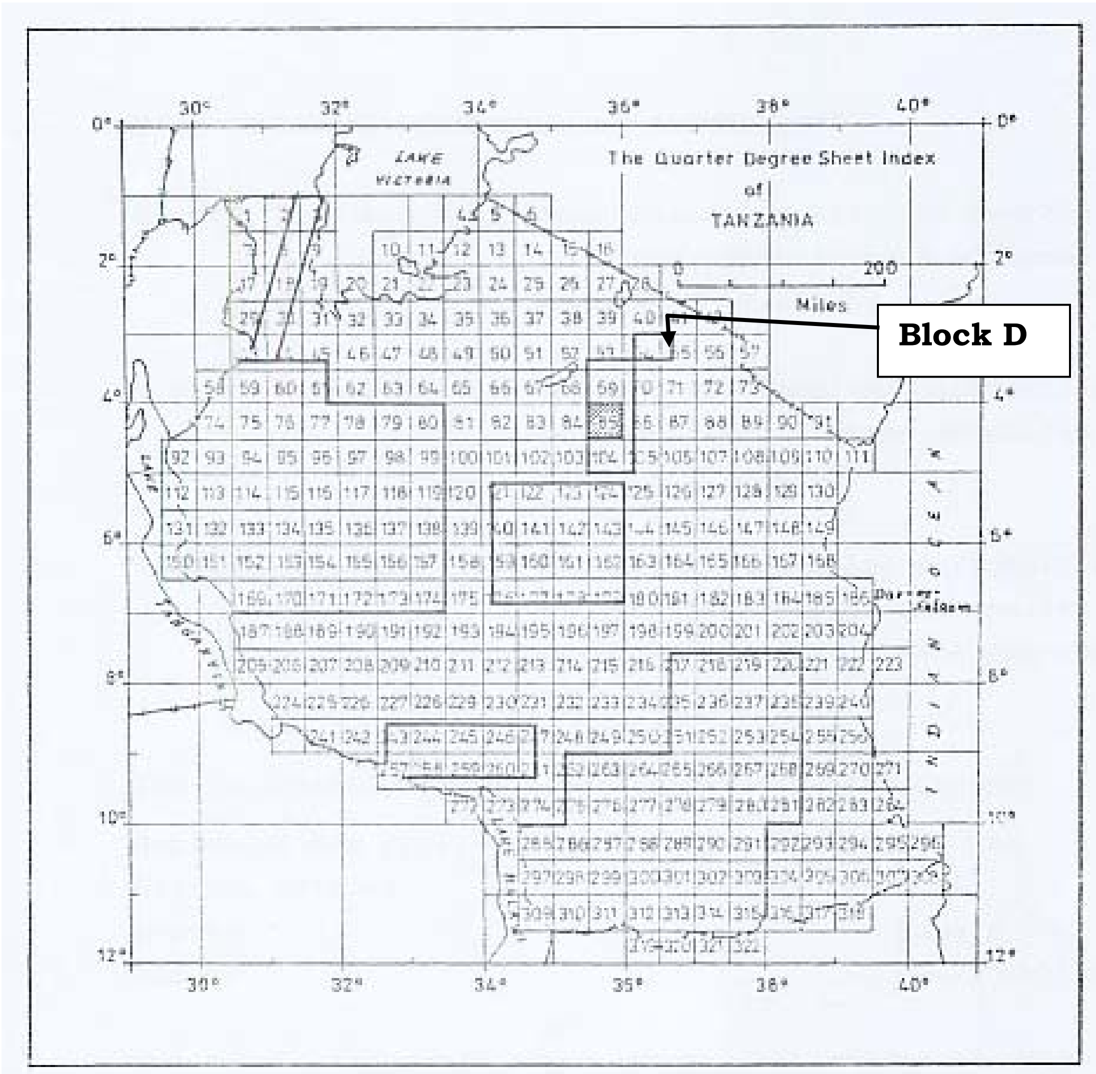


Figure 31: Investigation area in Block D (Galappo area shaded).

Galappo carbonatite

Work carried out in Galappo carbonatite **(Figure 31)**, which is located at about 60 km south of Minjingu (Block D), is geological mapping, foot borne radiometry and sampling. The results of this work showed SRAT readings varying from 180 cps (2 x bg.) to 4,500 cps (50 x bg.), with an average of 1,000 cps (11 x bg.) on a 400 m long traverse across the northern dike. Rock sample analyzes yielded uranium values between 5 and 283 ppm U_3O_8. The average reading on a 1 km long traverse across the southern carbonatite dike is 350 cps (4 x bg.). In this zone the uranium values range between 5 and 177 ppm U_3O_8. The relatively low uranium content indicate that the high SRAT readings are partly due to thorium bearing minerals.

Minjingu phosphate

Phosphate at Minjingu was discovered in 1956 by New Consolidated Goldfields Limited and they did considerable work to estimate the reserves. STAMICO and other foreign companies also investigated the area.

The Minjingu phosphate prospect (Block D) is located 109 south west of Arusha. Grid controlled foot borne radiometry and sampling of old trenches, costeans, pit cuttings and outcrops were conducted. Uranium content in grab samples of hard phosphate rock ranged from 11 to 803 ppm U_3O_8. The highest uranium content of three channel sampled trenches in hard phosphate rock is 162 ppm U3O8 over 2.7 m. Soft phosphate rock contains 19 to 833 ppm U_3O_8. The highest interval of two channel sampled costeans in soft phosphate rock is 728 ppm U3O8 over 1.1 m. The distribution of uranium in guano-type phosphate is controlled by a former island within Lake Manyara. Hard phosphate is non-calcareous, siliceous phosphate facies. Soft phosphate rock is non-siliceous, calcareous phosphate facies and uranium mineralization in this type can be 40 m thick over an area of 1,400 x 200 m. Analytical results of rock samples indicate that the soft phosphate rock has higher potential with respect to uranium mineralization compared to hard phosphate.

The results of Galappo and Minjingu areas were negative and no further work was recommended on the two deposits.

2.3. BLOCK E

Anomalous uranium values of 25 ppm U_3O_8 recorded in trachytic extrusives of the Tarosero Volcano **(Figure 32)** are caused by accessory uranium bearing mineral. The lateral distribution of the anomalous host rock is large and uniform but the uranium values are too low to justify further investigations.

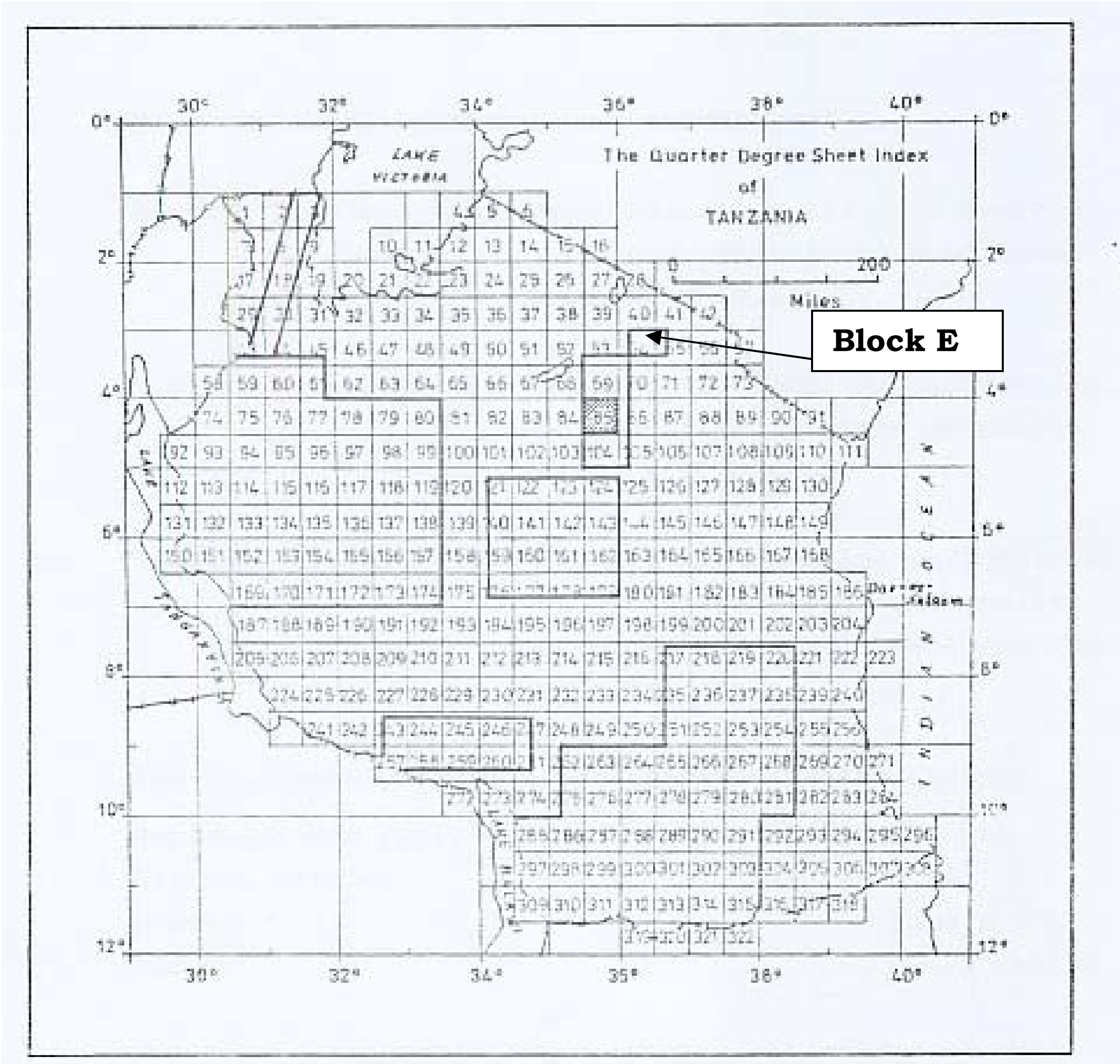


Figure 32: Location of Block E where investigation for uranium was carried out in trachytic extrusives of the Tarosero Volcano.

2.4. BLOCK F

Three targets were explored on Block F **(Figure 33).** The targets are Chimala copper prospect, Panda carbonatite and Proterozoic unconformity.

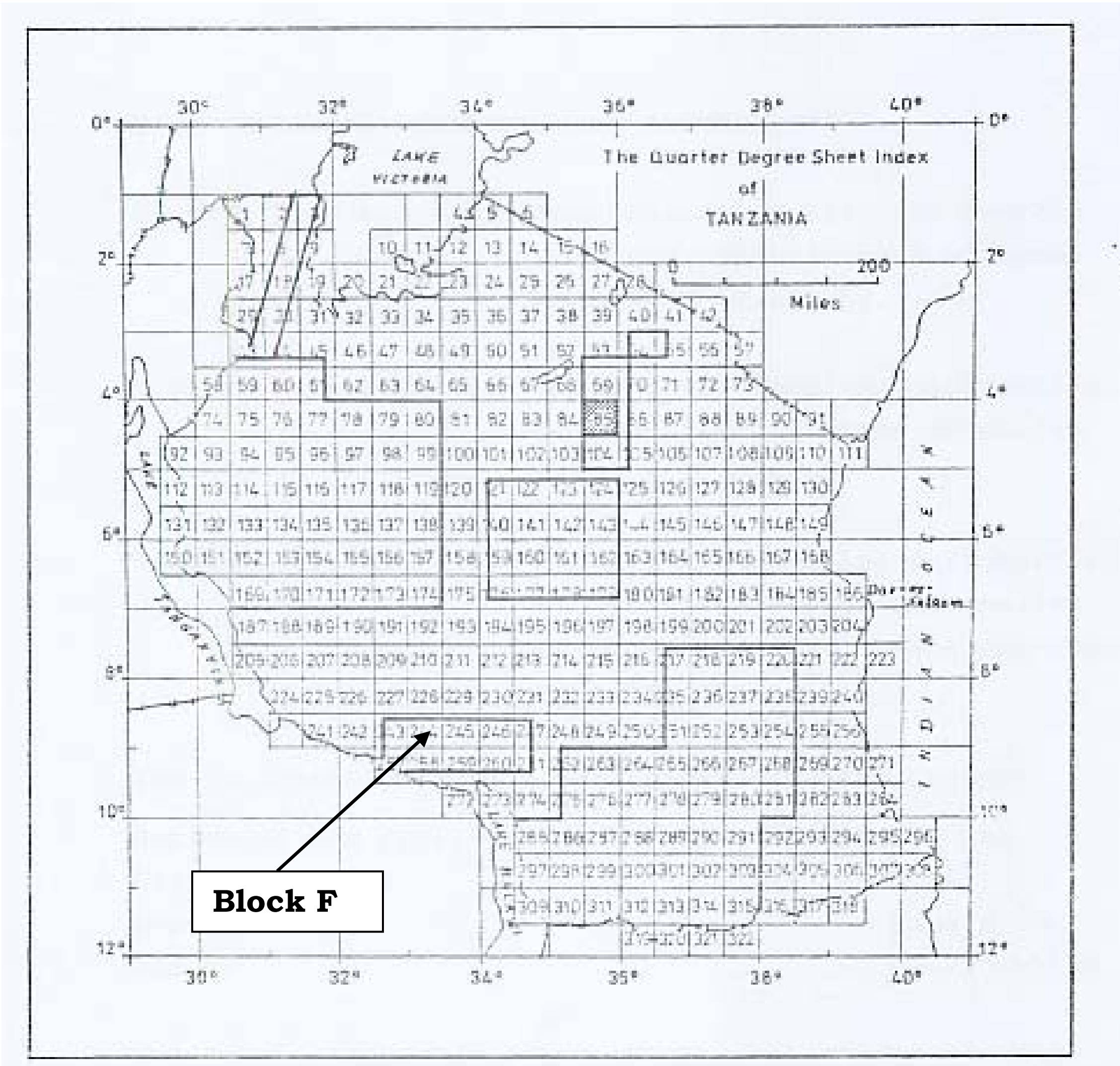


Figure 33: Investigation area of Block F.

Chimala copper prospect

GEOMIN in 1971-72 investigated Chimala area for potential of copper. Four copper bearing shale horizons were investigated by trenching and drilling. The cupriferous shales occur within the Upper Proterozoic Bukoban System. The potential for uranium was investigated by Uranerz on assumption that the rocks hosting the Chimala copper occurrence is equivalent to the Shaba and Zambia Copper Belts which contain uranium deposits.

Uranium values at Chimala averaged 122 ppm U_3O_8 and are associated with primary copper mineralization in a conformable ferruginous shale of fine sandstone. The ferruginous horizon is 0.05 – 0.10 m thick and over 3 km long in the Kimani Zone. The ferruginous layer is in the centre of the cupriferous horizon B which consists of green malachite stained shale and is 0.15 to 2.00 m thick. The uranium mineralization in the ferruginous horizon is syngenetic to copper mineralization. Copper and uranium probably accumulated on the sea floor in shallow marine back reef environment as evidenced by nodules of primary copper mineralization and the presence of stromatolitic dolomite. The ferruginous horizon of the Ruaha Zone is not radioactive and does not contain primary copper mineralization. The low grade and thickness of the radioactive horizon at Chimala copper prospect make the area non prospective.

Panda carbonatite

The carbonatite and its surrounding alteration zones show a high radioactive background of 250-500 cps with frequent hot spots of 1,000 to 3,000 cps. The radioactivity is mainly due to thorium with only rare spots of low grade uranium mineralization. Thorium ranges from 40-2,775 ppm. The content of U_3O_8 is between 8 and 481 ppm with an average of 30 ppm. Uranoium is bound to the refractory mineral pyrochlore similar to Galappo carbonatite. The area is not potential for large tonnage low grade uranium deposit. Sengeri Hill has minimum content of U_3O_8 and strong thorium mineralization and the area is also not prospective.

Proterozoic unconformity

The unconformity between Bukoban System and underlying Ukingan rocks and Ubendian Systems respectively is not favourable for unconformity related uranium deposits.

The targets in Block F, namely Chimala copper prospect, Panda carbonatite and Proterozoic unconformity, all turned negative results.

2.5. BLOCK G

Investigation for uranium mineralization was carried out along the contact between Bukoban System and Karagwe-Ankolean System **(Figure 34).**

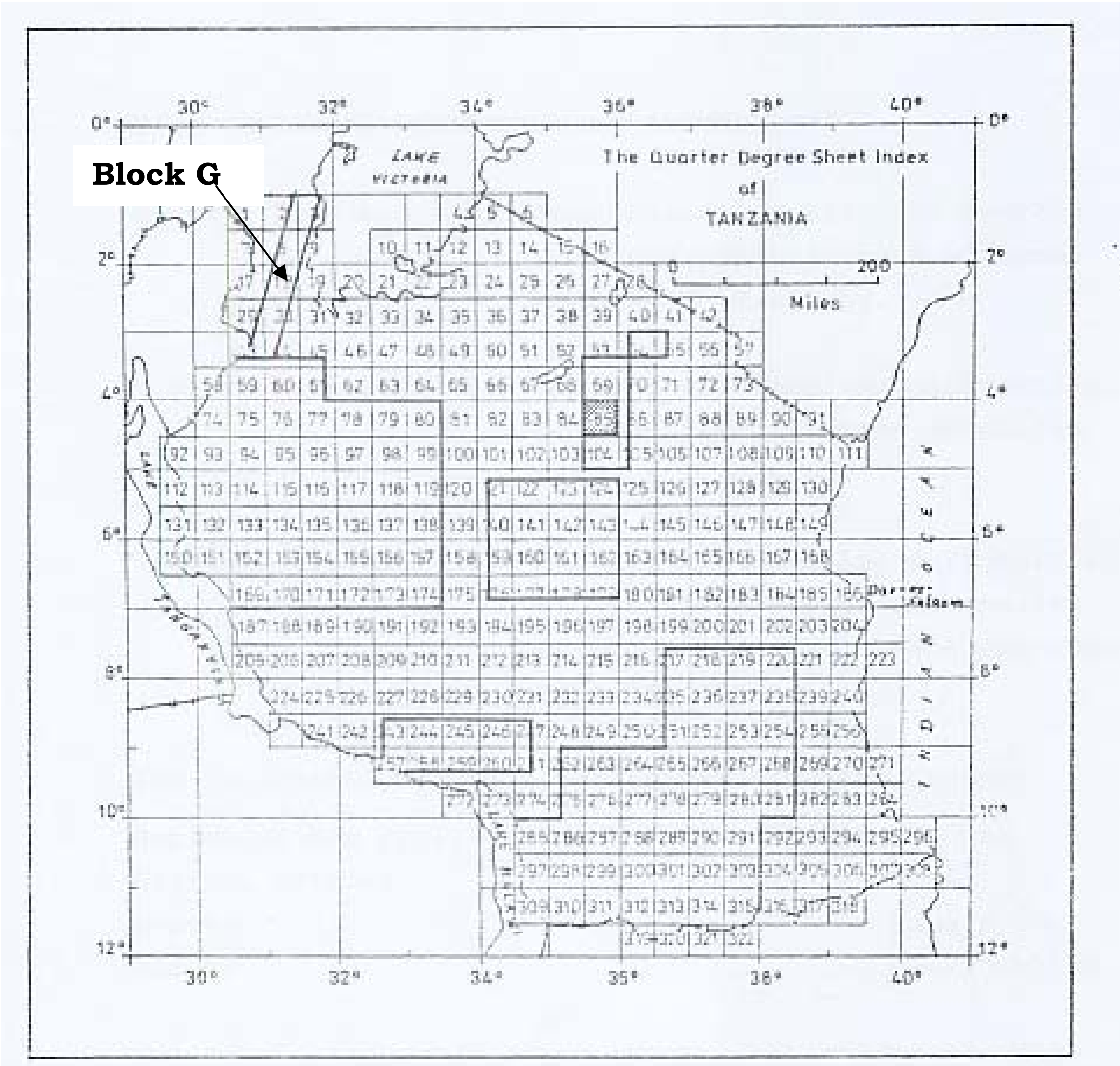


Figure 34: Block G where uranium investigation focused along the contact between two Proterozoic mobile belts.

Investigation focused on the following:-

- To check the potential of unconformity related uranium mineralization at the contact between the Bukoban System and the Karagwe-Ankolean System;
- To investigate the potential of uranium mineralization within the Karagwe-Ankolean System west of the contact; and
- To check on the ground the detected airborne anomalies.

No further investigations are recommended for block G because the results were negative because of the following:-

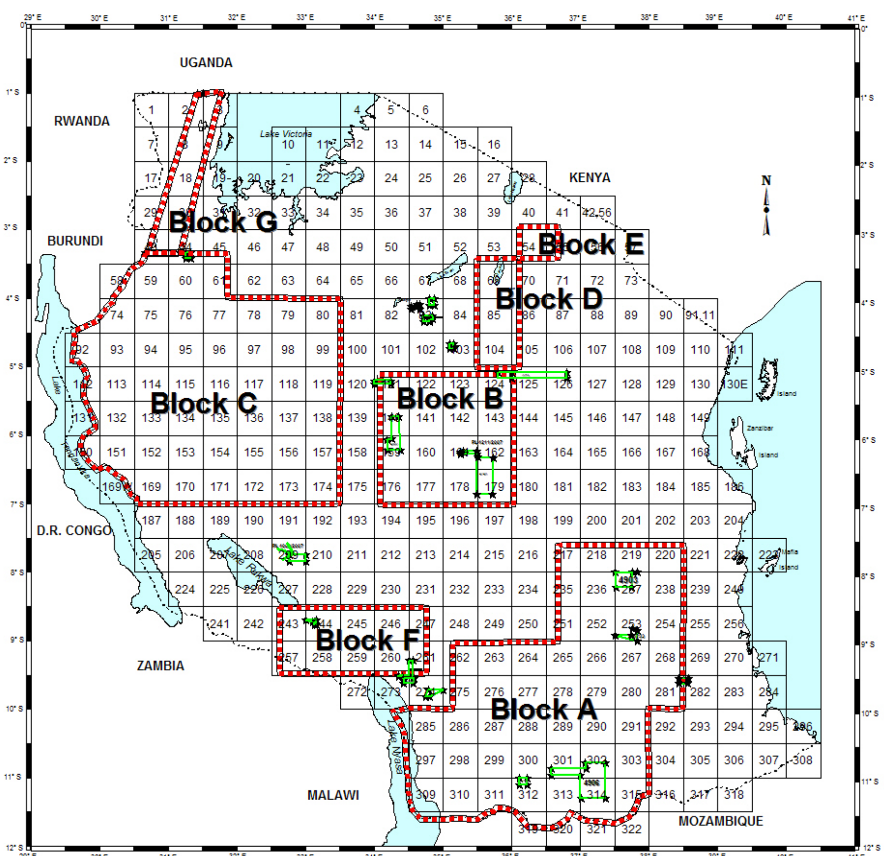
- The original angular unconformity is missing;
- The two systems are separated by a major fault;
- Rocks of Karagwe-Ankolean System were derived from deep water sediments; and
- The near coast shelf sediments which host rocks of uranium mineralization within the Proterozoic metasediments do not occur in the area investigated.

Although Blocks A and B have been earmarked by previous investigation work that are the most promising up to now date uranium exploration in Tanzania is minimal compared to other African and western countries. Despite favourable geology for uranium deposits and several known occurrences, the historical expenditure on uranium exploration in Tanzania is estimated at US$4 per km^2 compared to US$16 per km^2 in western Africa and US$224 per km^2 in the United States of America.

3.0 POTENTIALITY OF AREAS OF INTEREST

Within the areas of interest no exploration work has been specifically done since the issuance of the mineral rights. The assessment of the concession areas in this report are purely based on the location of the mineral licences relative to the blocks earmarked by previous work as potential for uranium mineralization (Error! Reference source not found.). The second factor that has been used in this report to assess the potentiality of the mineral licences is the radiometric total intensity maps that were made after the country wide airborne geophysical survey.

Figure 37: Location of areas of interest relative to the blocks delineated as potential for uranium mineralization by airborne geophysical surveys conducted in 1976-1980 (The blocks are in red figures whilst the areas of interest are in green with black corner points).



Block	Block name	Favourable geological environment	Mineral properties within the block	Block classification
A	Karroo	Sandstone, veinlike (unconformity)	4903, 4906, 4753 4751,4909, 4433, 4335,4345,4254 & 4346	MKUJU AND MADABA BLOCK
B	Dodoma	Mbuga and calcrete	PL 4211/2007, 4902, 4905, 4748 and 3316,4448/2007	BAHI BLOCK
C	Tabora and Kigoma	Mbuga and calcrete, veinlike (unconformity), intra-intrusive (granites), sandstones	PL 2603/2004	
F	Mbeya-Njombe	Sedimentary (black shales), intra-intrusive (carbonatite), veinlike (unconformity)	4907, 4749, PL 4297/2007	MALAWI EXTENSION BLOCK
Within or near Greenstone belt		Probably Mbuga type,There are several occurrence worldwide including the Yeerlie deposit in western Australia .	4749, , PL 4046/2007, PL 4063/2007	CLOSE TO BAYI BLOCK

Block B

Locations of the areas of interest relative to Block B which is potential for uranium mineralization related to mbuga or calcrete type are shown in **Figure 35**

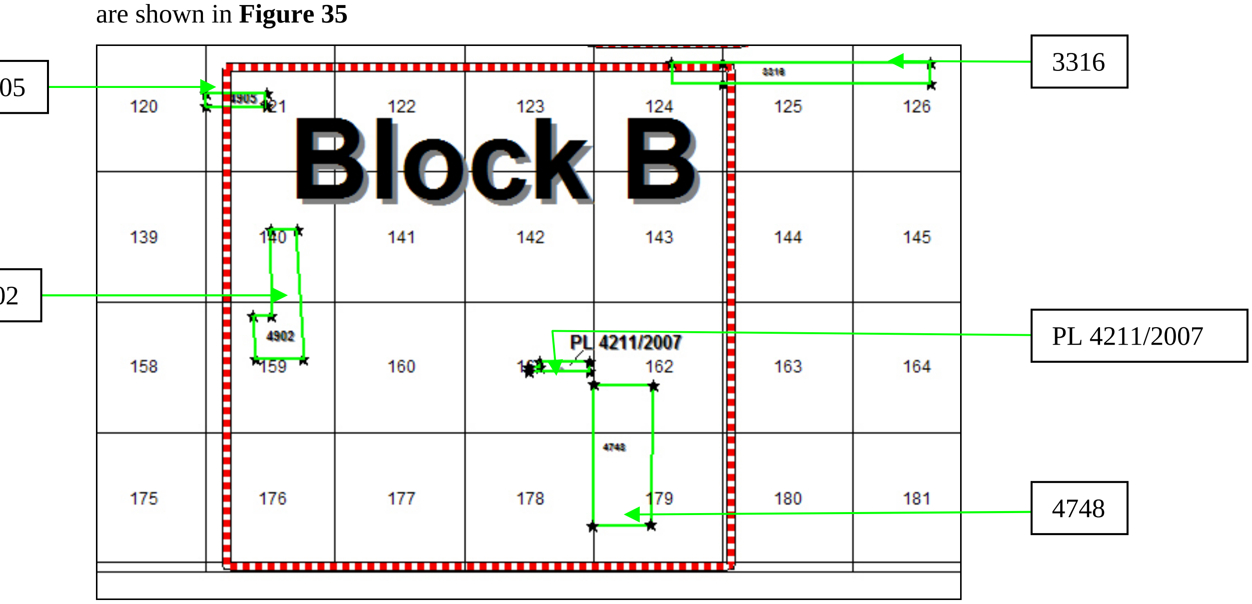
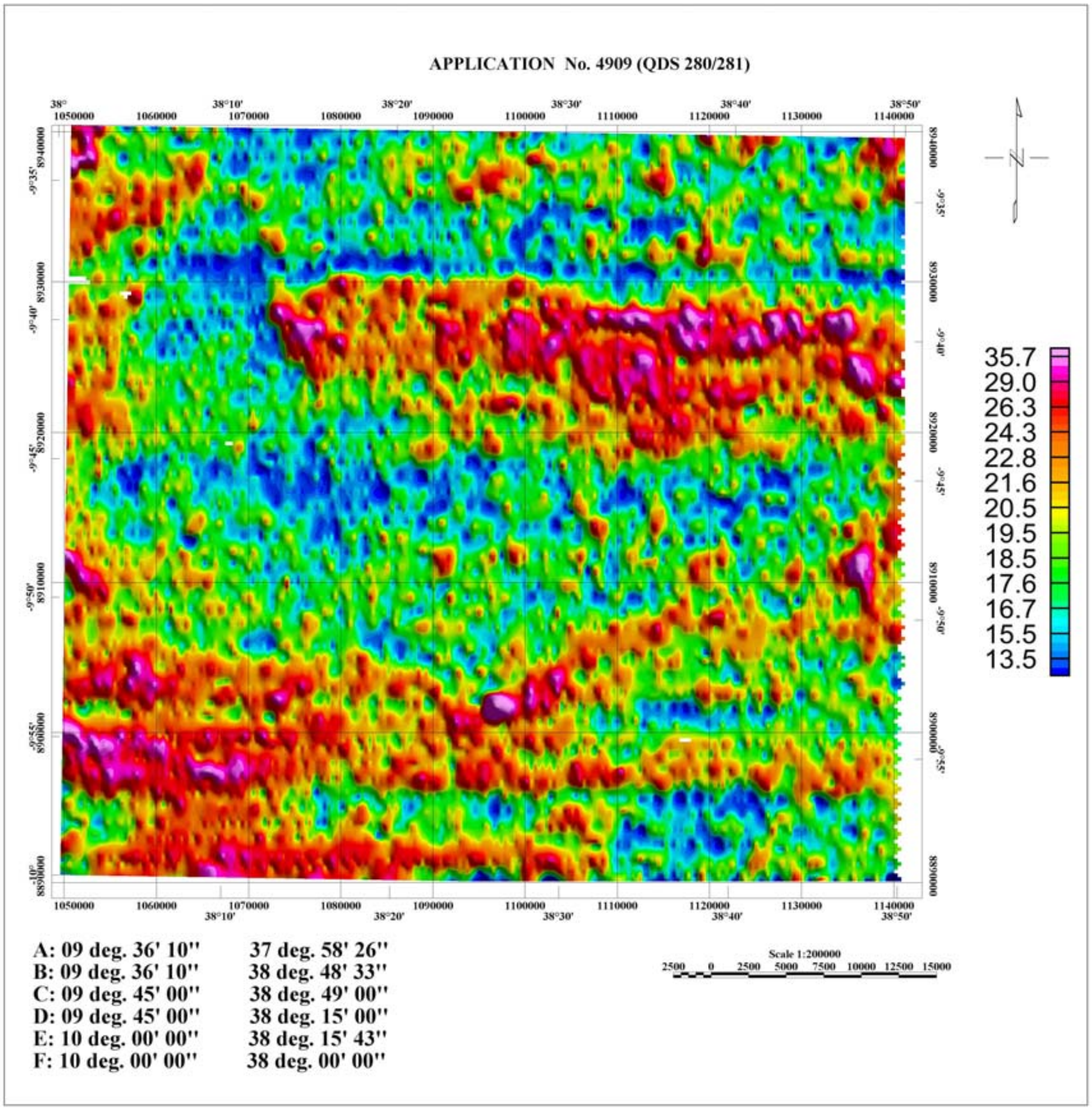


Figure 35: Location of areas of interest relative to uranium potential Block B.

The radiometric total intensity map of an area north of PL 4211/2007 shown in Error! Reference source not found. indicates that the area is of high



intensity Figure 39 The license falls on block A uranium mineralization Potential, strong patch anomalies can be observed. The property is close to Mkuju uranium occurences. It has been classified as Mkuju block.

Total intensity radiometric isoline map for area 4902 is shown in **Figure 36.**

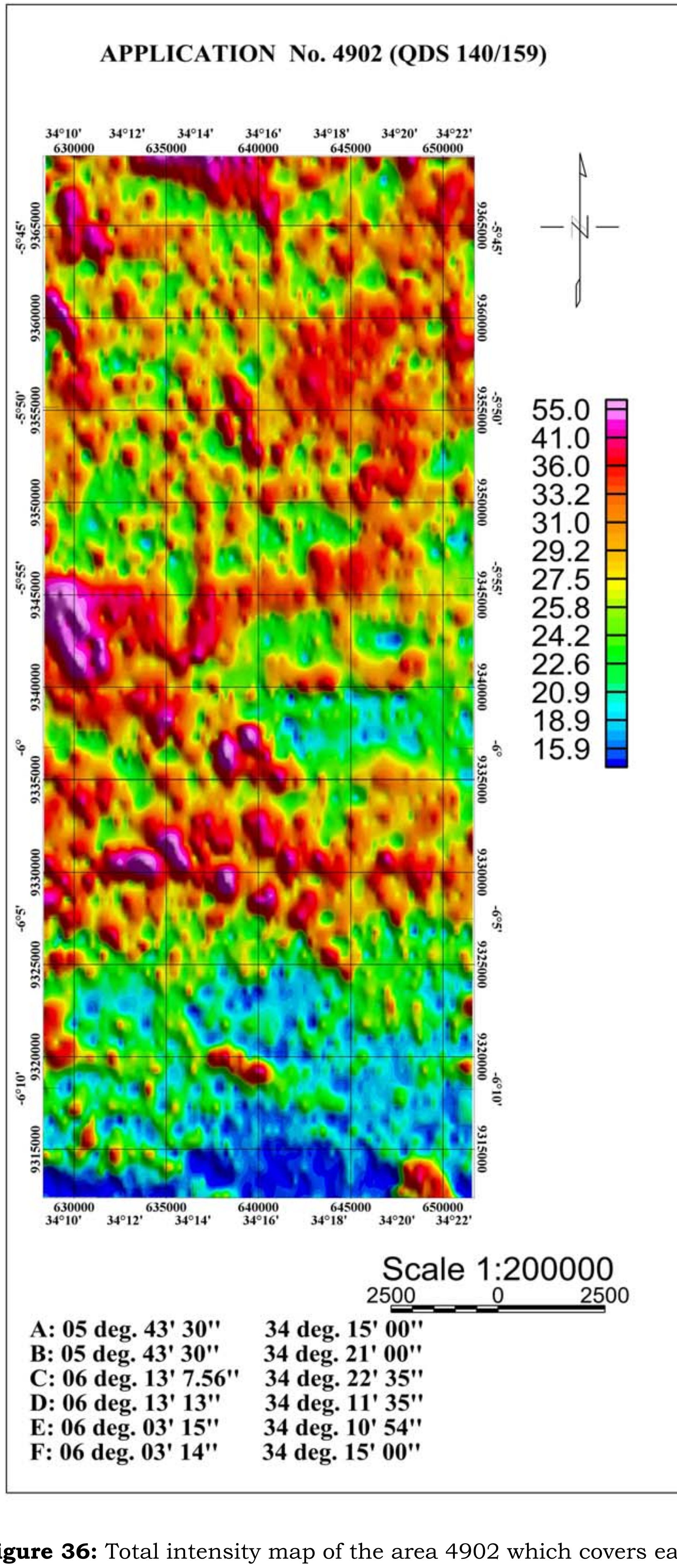


Figure 36: Total intensity map of the area 4902 which covers eastern half of the map.

Block A

Block A is known to host uranium mineralization and airborne anomalies within rocks of Karroo System **(Figure 37).** In addition to this west of this area within the neighbouring Malawi several uranium deposits and mineralization have been discovered. Due to the northern trend of clusters of the uranium deposits in Malawi it is possible that similar mineralization can be found on the eastern part as well as the northern areas of Lake Nyasa in Tanzania.

Block F

Block F also is potential for hosting uranium mineralization related to unconformity.

Areas under application 1789 and 4947 which occur between Blocks A and F as well as PL 4068/2007 which is located north of Block F, are situated out of uranium potential blocks **(Figure 37).** Still, because they are located north of the trend of uranium zones in Malawi it is possible that they are potential for uranium mineralization.

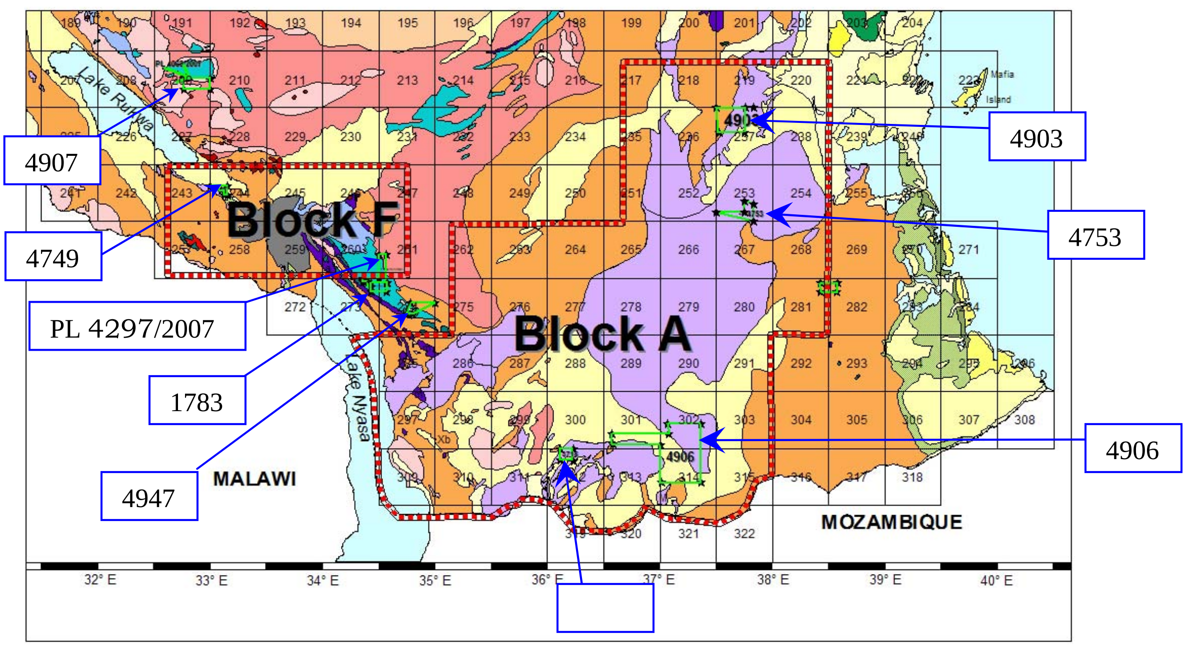


Figure 37: Location of concession areas within Block A hosting uranium mineralization related to Karroo rocks and Block F which is potential for unconformity type uranium mineralization (Uranium deposits have been discovered in neighbouring Malawi).

FIGURE 41.1

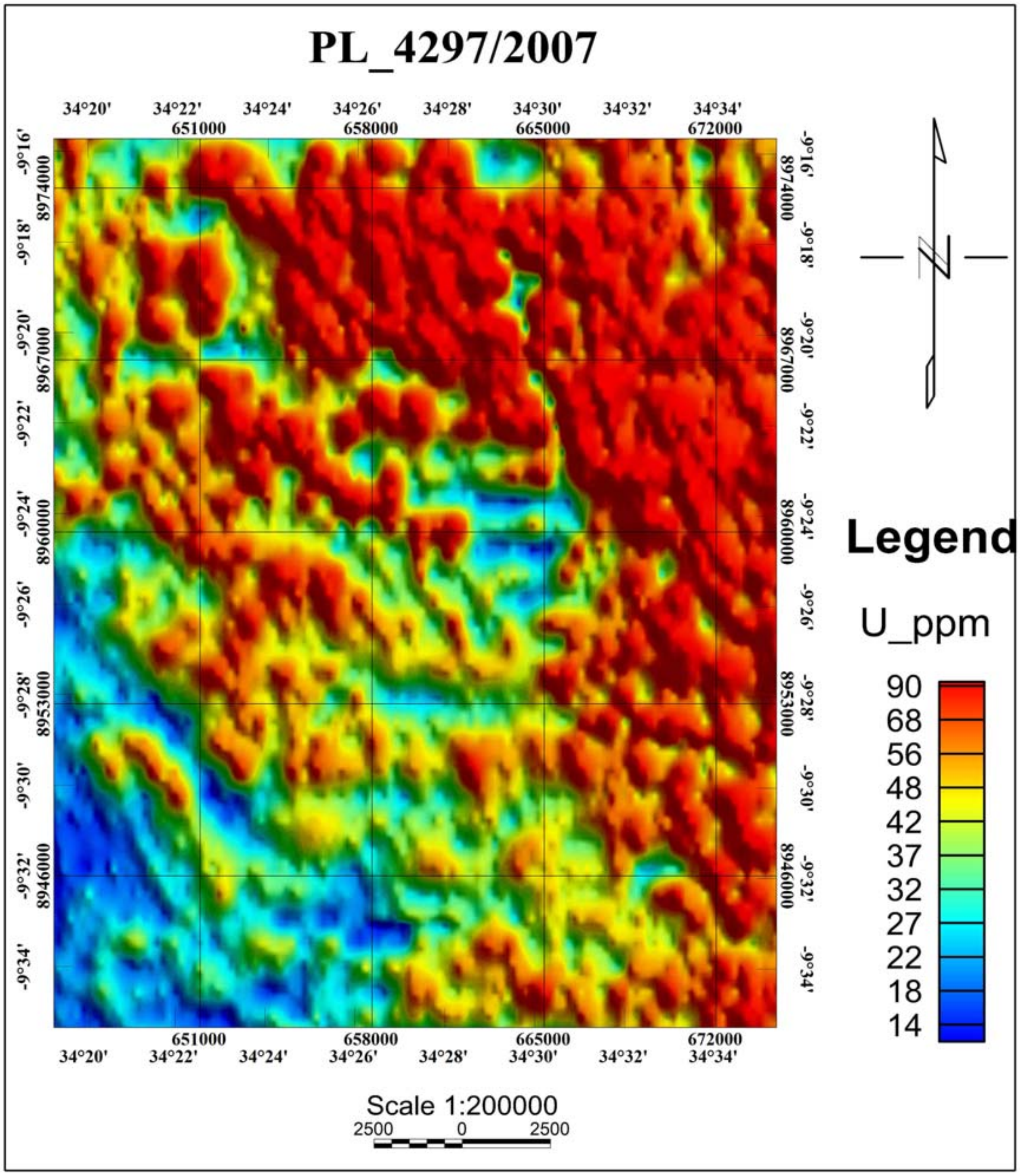


Figure 41.1

The license is located along lake Nyasa with strong NW trend uranium intensity as shown above. It lies on Block F as described by GeoSurvey International. It falls on Malawi uranium extension block.

The total intensity radiometric data of the area 4907 indicates that most of this area is of high intensity **(Figure 38**). This makes the area worthwhile for a follow-up despite of being located outside the uranium potential blocks.

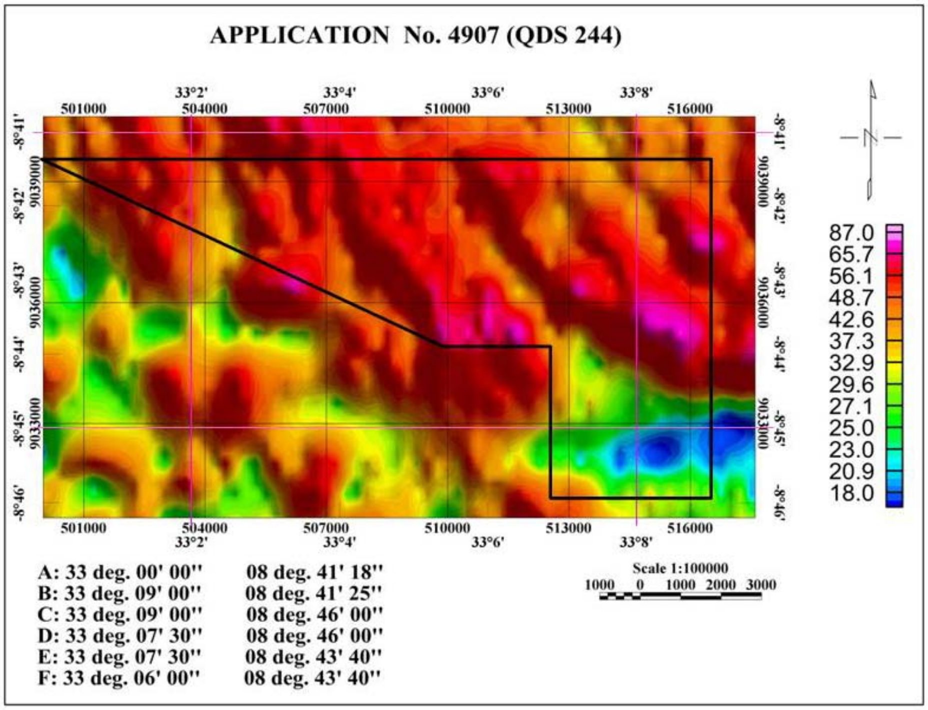


Figure 38: Total radiometric intensity of area 4907 (QDS 244). Strong NW trend uranium anomaly corresponds to the NW Karroo troughs between Lake Nyasa and Lake Rukwa. The anomaly strike length is worth follow up.

Area 4903,4906,4909 which occur in Block A known to host uranium mineralization in Karroo rocks, is characterised by relatively high radiometric total intensity **(Figure 39).**

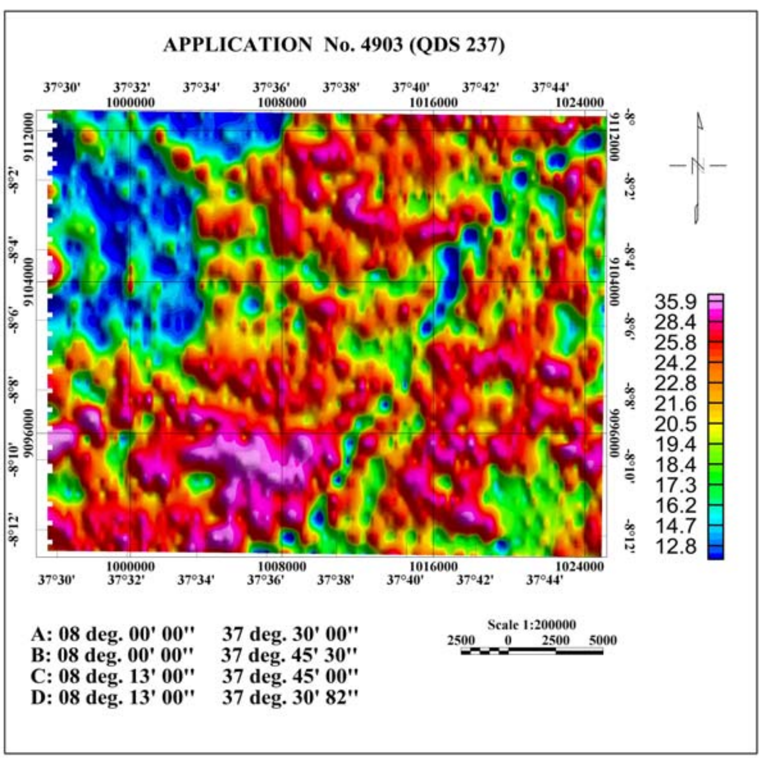


Figure 39: Total intensity radiometric map of area 4903. **The license occurs in Block A as described by GeoSurvey International. Strong NE uranium anomalous trend along Karroo. The license is located very close to Madaba Uranium occurence and it falls on MKUJU BLOCKS.**

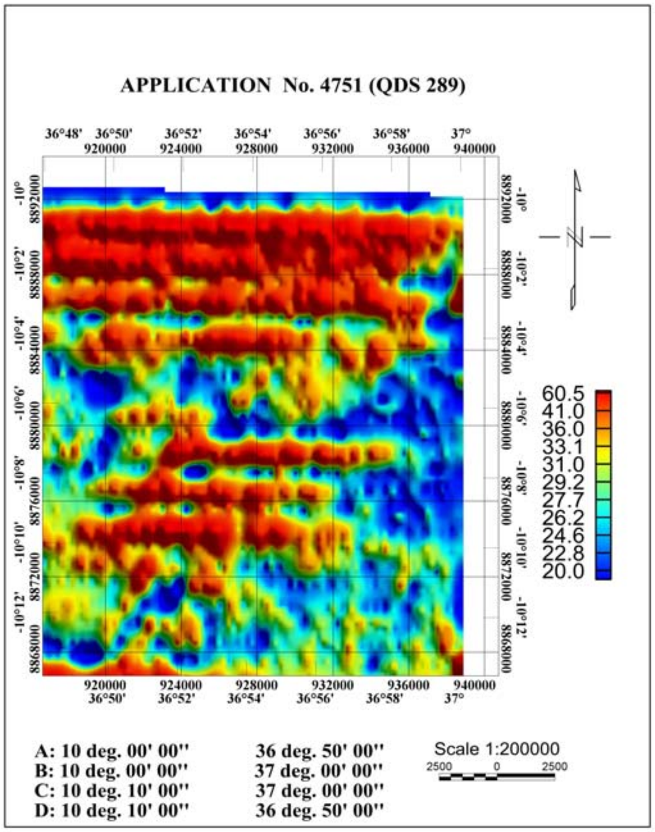
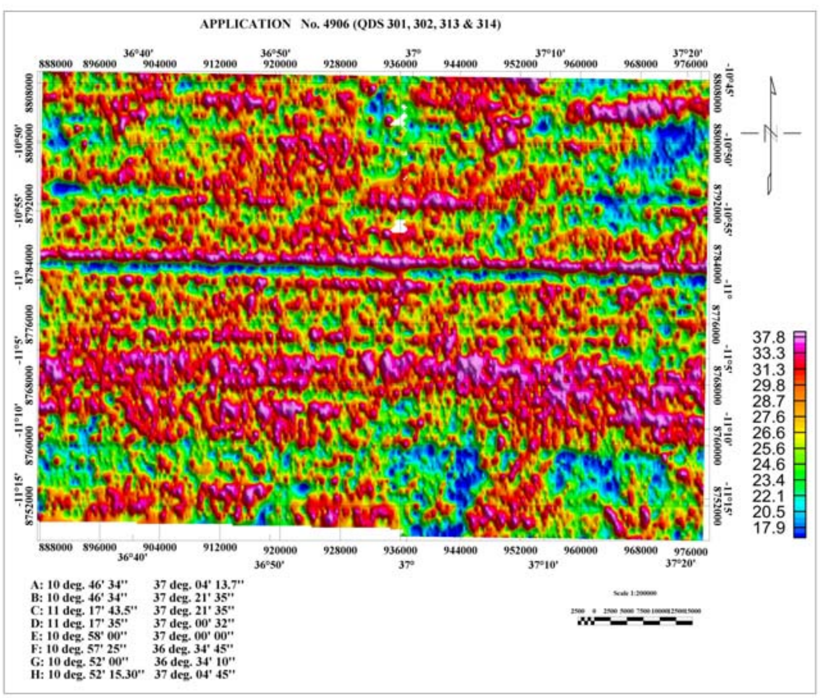


Figure 43.1 Appl 4751 above shows strong NE uranium intensity trend along the Karroo at Mkuju block nearby Mkuju radiometric anomaly and Western Metals Henri anomaly.

Figure 43.2 PL 4906 below



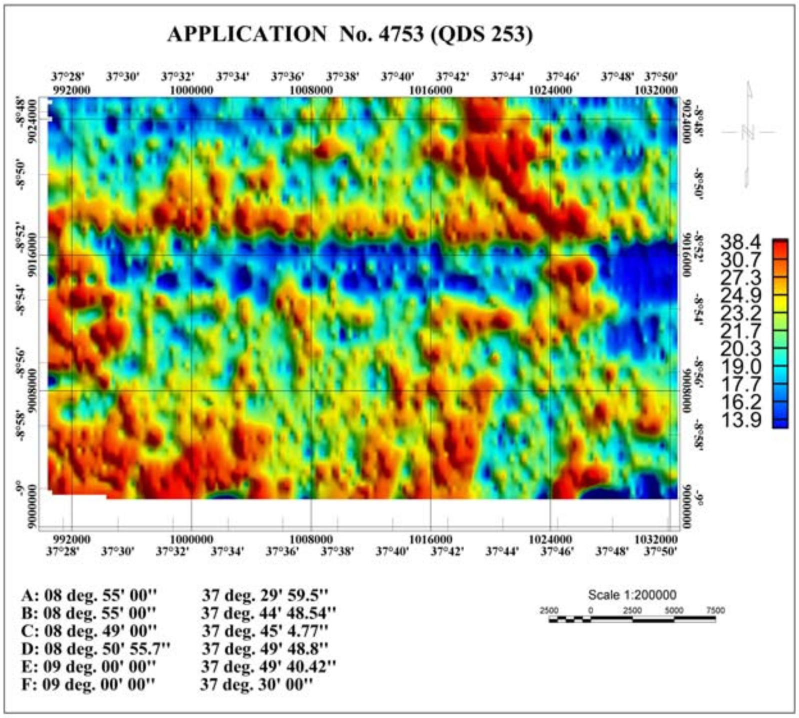


Figure 43.3 This license is situated in Block A classification as GeoSurvey International uranium potential block. It is close to Madaba uranium occurrences along the Karroo trough. Its prospect is indicated by above uranium intensity with widespread trends. It is in the Madaba block.

The south western part of area 4749 is relatively elevated in values of radiometry (Figure 40).

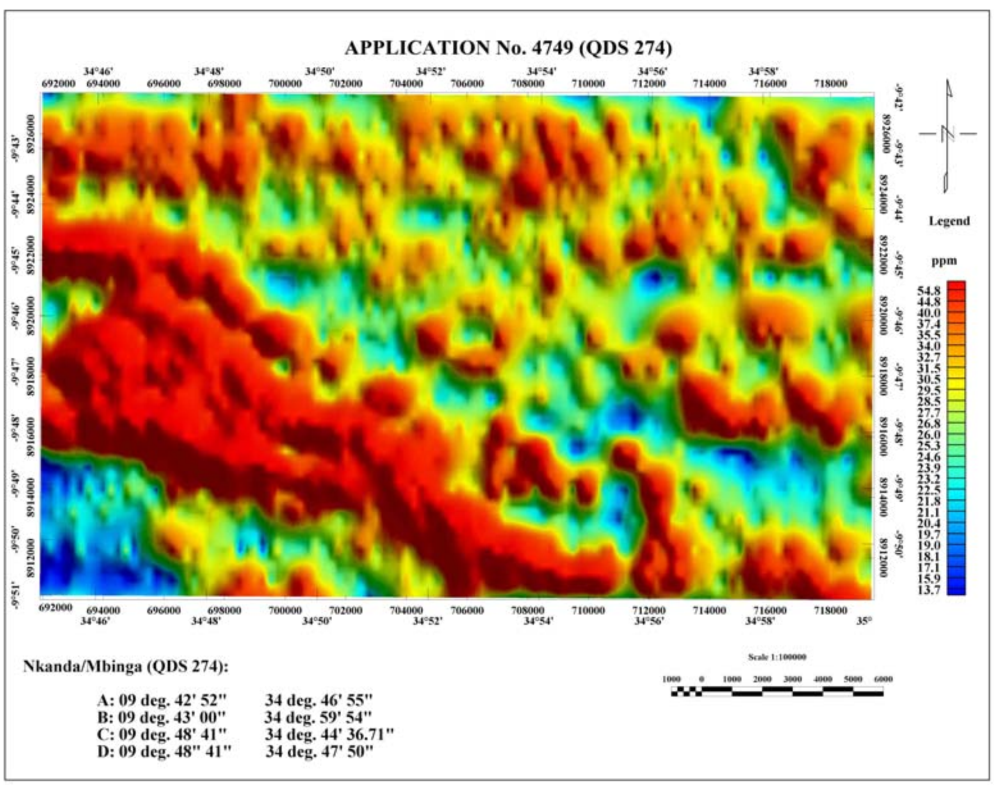


Figure 40: Total intensity of area 4749.The license is situated along Lake Nyasa with significant NW trend as shown above it is also located between block F and block A anomalous blocks. The intensity makes it worthy of follow up work.

Other areas

One area of interest, PL 2603/2004, occurs within QDS 244 and lies at the northern end of Block C and just south of the Block G **(Figure 41).**

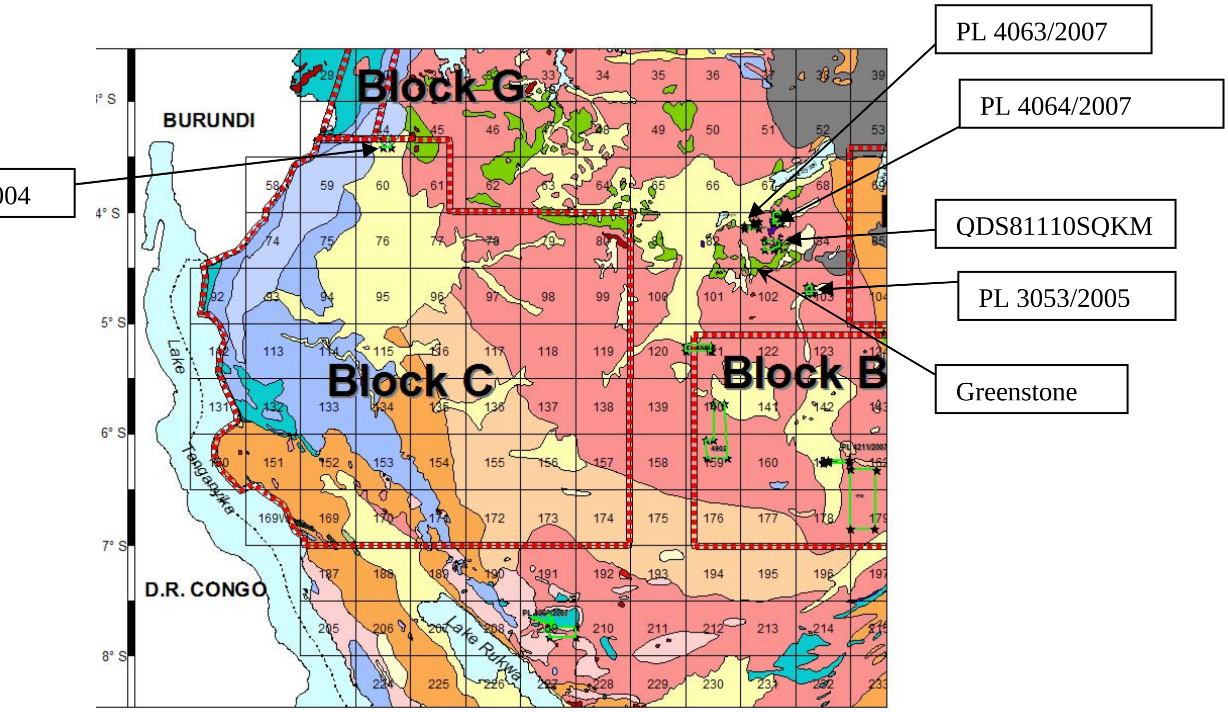


Figure 41: An area under PL 2603/2004 which is potential for uranium mineralization in QDS 44 within Block C and areas potential for gold exploration in QDS 83.

The areas within QDS 83 **(Figure 41)** occur within or near greenstone belts, therefore are potential for gold. These areas are PL 4063/2007, PL 4064/2007 and QDS81110SQKM. Although the area for PL 3053/2005 occurs outside the uranium potential blocks, it still can be considered to be potential for uranium mineralization. This is because it is located over mbuga just north of the Bahi mbugas famous for uranium mineralization and the properties have significant high uranium intensity see figure 45.1.

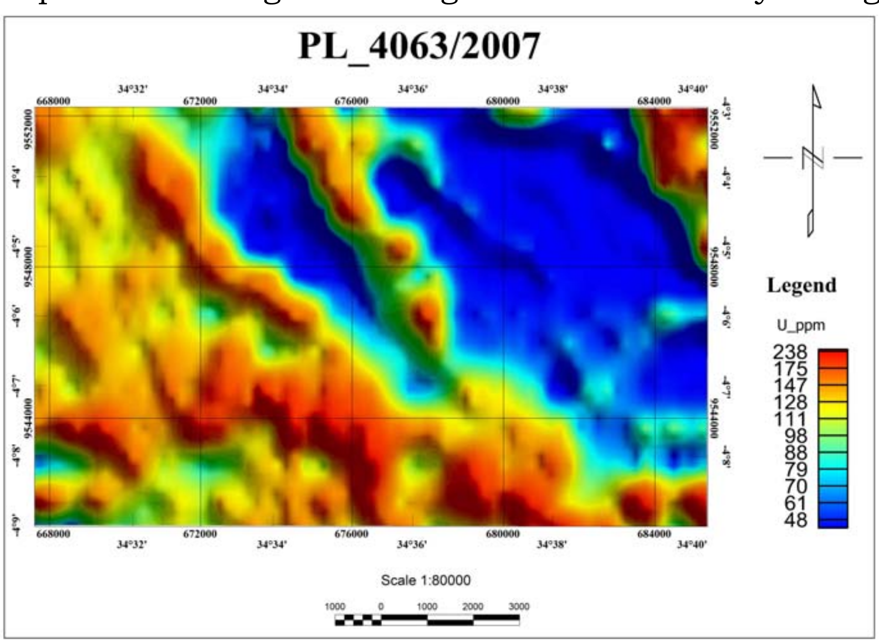


Figure 45.1 PL 4063/2007 Prospect uranium intensity map The license is located in greenstone belt with significant north west uranium anomaly trend as shown in the figure above, it occurs north of Bahi Mbuga which is classified as Block B uranium potential. The anomaly occurs in Mbuga might be possible extension of Block B anomaly. The anomaly makes it worthy of further exploration.

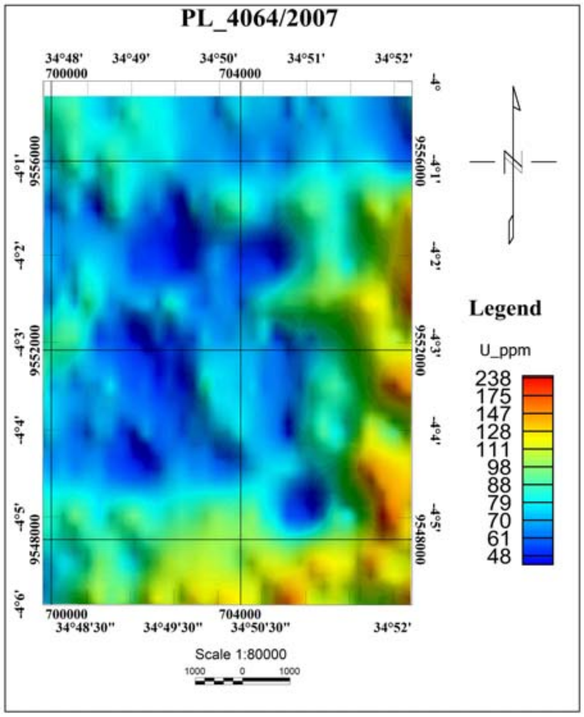


FIGURE 45.2 PL4064/2007 The above license occur in greenstone belt near block B but have significant anomaly as shown above. The anomaly might be Bahi mbuga extension anomaly and makes it worthy to do follow up exploration.

4.0 DISCUSSIONS AND CONCLUSIONS

Based on the past exploration carried out in 1970s-1980s, Blocks A and B are the most promising areas for uranium exploration. Other areas that were considered potential are Blocks C and F. The rest were neglected as non potential to uranium mineralization. The ongoing exploration in Tanzania is focused mainly on Block A within Karroo formations and B where uranium mineralization is associated with mbuga.

Recently, companies like Western Metals and Uranex have reported potential uranium areas on their websites. East of Lake Nyasa, Western Metals of Australia is still working on its grounds and the results so far are encouraging more investigations and explorations to be carried out. In addition to the ongoing uranium exploration in areas seen as promising for uranium mineralization in Tanzania, on the western part of Lake Nyasa in Malawi several uranium deposits have been discovered. One of these deposits is the Kayelekera deposit that contains a resource of 13,630 tonnes of uranium oxide hosted in Karroo rock formations.

Investigations for mineralization in the areas of interest have not been undertaken. The closeness of the area to areas with known uranium mineralization associated with sandstones of Karroo System and mbuga makes the concessions highly prospective. Exploration activities have to be undertaken. The existing information and experience acquired during exploration of uranium in other areas of the country and abroad have to be used to investigate the area. Still, the work so far carried out is not conclusive but confirms the potential of Karroo rocks and mbuga with respect to uranium mineralization. It is recommended to continue with the investigations on regional as well as detailed scales.

Primary uranium occurs in igneous rocks in varying amounts depending largely on type of rocks. Many anomalies were detected over exposed granites of the Tanzania Craton. Most of these anomalies were given third or low order priorities for follow-up because of the natural tendency of uranium to accumulate in granites. Granites have an average uranium content of 4 ppm and ranges from 2.2-21.0 ppm. In the craton, this is shown by large number of uranium anomalies picked by airborne survey over granites. Uranium in some granites is dispersed as ionic or molecular disseminations (labile uranium) which is firmly not bonded in crystal structures of naturally occurring uranium minerals such as uraninite and coffinite or as minor substitutions for major and essential elements in secondary minerals such as monazite and zircon.

Several anomalies were detected over mbugas and superficial sediments which overlie rocks of the Tanzania Craton. Some of these anomalies were given first and second order priorities for ground follow-up because of their exceptionally high uranium. Mineralization occurs at various depths within the mbuga. Labile uranium is very mobile and is easily released by chemical weathering thus being the source of uranium for secondary mineralization. This process is common in the craton as it is evidenced by many granite anomalies and secondary uranium mineralization existing in some of the mbugas in the granitic terrain. Uranium forms complexes with most of the natural aqueous solution such as water, fluorides, phosphates, sulphates, carbonates and chlorides the most important being those of carbonates and phosphates. The presence of calcretes, calcareous sediments and carbonates nodules and lack of phosphate in the craton indicates that carbonates are one of the most important mobilising factors in the craton.

The results have indicated that several different uranium minerals of one or more modes of formation are present. These anomalies, in addition to showing existence of uranium in the area, indicate that search for higher tonnages and grades should be carried elsewhere, such as at depth in the mbuga.

The following are recommended for a follow up:-

- Carry out gravity survey in order to determine its depth and extent.

  Gravity survey is favoured in place of resistivity and seismic surveys due to costs in the given conditions. Resistivity survey likely would not give imprecise results due to high salinity of ground water. Seismic surveys would give a false picture due to presence of calcrete and silicrete horizons within the sediments.

- Carry out amanometer survey using a portable radon detector in order to locate any concentration of uranium mineralization at depth and select sites for drilling.
- The results of interpretation of the gravity survey and radon detector will lead to selection of grid pattern and drill the mbuga up to bedrock. Auger machine can be used in soft sediments which constitute much of the mbuga. Calcrete and silcrete layer can be penetrated by diamond drilling.
- Logging of bore holes using a gamma-ray spectrometer,
- Conduct hydrocheochemical studies of water entering and being trapped in the mbuga in order to define the geochemical regimes in which uranium may be fixed or

precipitated. Apart form this study helping to determine sites of uranium depositions it will also assist in building a model of uranium geochemistry which could be applied as an exploration tool elsewhere in the craton.

- Follow-up of delineated anomalies involving ground spectrometer survey, pitting, trenching, augering, drilling, geochemical sampling and assaying.

Tanzania has favorable regulatory and stable political conditions for exploration, as evidenced by the boom in its gold mining sector in the last 10 years as well as strong investment in nickel, platinum and coal exploration.

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