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Full Length Research Paper

Occurrence of low grade concentration of niobium and tantalum in the granites of Eastern Uis region of Namibia: An exploration based study

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The Uis region of Namibia is noted for its rare metal pegmatites that contain tin and the associated elements. However, during the Reconnaissance Geological study carried out by the author earlier, a granite area had shown high value of Ta_2O_5 and Nb_2O_5. This granite area was therefore subjected to a detailed exploration studies for tantalum-niobium mineralization. Localized enrichment of Ta_2O_5 and Nb_2O_5 is seen to occur in the investigated area and is confined to a small portion as reflected in a 3 m composite sample (from surface up to 3 m depth, sample No. ABH-19 having a value of 312.95 ppm of Ta_2O_5. When compared with the average crustal abundance of tantalum (1.7 ppm) and niobium (20 ppm), this area contains slightly higher concentration. Considering the analytical results, this area has no potential for extraction of niobium and tantalum economically and has only academic significance.

Key words: Niobium, tantalum, exploration, granite, Uis, Namibia.

INTRODUCTION

Tantalum (Ta) occurs associated with niobium (Nb) in the mineral "tantalite-columbite" {(Fe, Mn) (Ta, Nb)$_2$06}. Also it is usually associated with tin in varied proportions. Tantalum is mainly used in electronic industries in manufacturing capacitors for mobile telephones, computers etc.

Most of the tantalum reserves of the world occur in Thailand, Australia, Brazil, Africa, Canada and China. Pegmatites are the largest source of tantalum in the world. Much impetus has been laid on the studies related to tantalum and niobium oxides due to their petrogenetic significance in reconstructing the evolution of rare elements enriched in granitic pegmatites (Aurisicchio et al., 2001; Cerny et al., 1985; Cerny and Ercit, 1985; Cerny and Ercit, 1989; Robles et al., 1999; Belkasmi et al., 2000). The Greenbushes pegmatite near Perth in Western Australia has one of the world's largest resources of tantalum.

In addition to pegmatites, certain alkali granites and related rocks are also known to contain tantalum and niobium in large quantities, though with low grade concentration. Pitinga deposit in Amazonia and Ghurayyah deposit in the North West of Saudi Arabia are such granites resources. The latter is reportedly the largest single accumulation of tantalum metal with an estimated inferred mineral resource of more than 385 million tonnes to a depth of 250 m (Forrest and Cheetham, 2002) and of having a grade of 245 g/t of Ta_2O_5.

Reconnaissance geological study was earlier carried out by the author in about 3000 sq km area (Figure 2a) and taking a cut-off-grade of 150 g/t of Ta_2O_5, some potential areas were identified (Singh, 2007a and b; Singh, 2008; Singh, 2009).

In most of the potential areas, the occurrence of tantalum and niobium was in pegmatites except one area where the anomalous value of Ta_2O_5 and Nb_2O_5 was reported in granite (Singh, 2009). The present paper deals with the results of the exploration work carried out in this granite area. The granites have been studied and characterized by several researchers in various parts of the world in terms of rare-metal mineralization and whole-rock geochemical and petrographic composition (Abdalla et al., 1998; Rub et al., 1998; Helba et al., 1997; 1969; Beskin et al., 1994; Syritso, 1993; Syritso et al., 2001; Yin, et al., 1995).

Mineralization of rare metals has been reported from peraluminous pegmatitic granites of Slovakia by Chudik et al. (2008). Imeokparia (1985) has worked on the mineralization of rare-metal in granitic rocks of the Tongolo Anorogenic Complex of Northern Nigeria.

Levinson (1974) has discussed various attributes of geochemistry that are helpful in exploring the rare metals occurring in granites and pegmatites. Singh and Singh

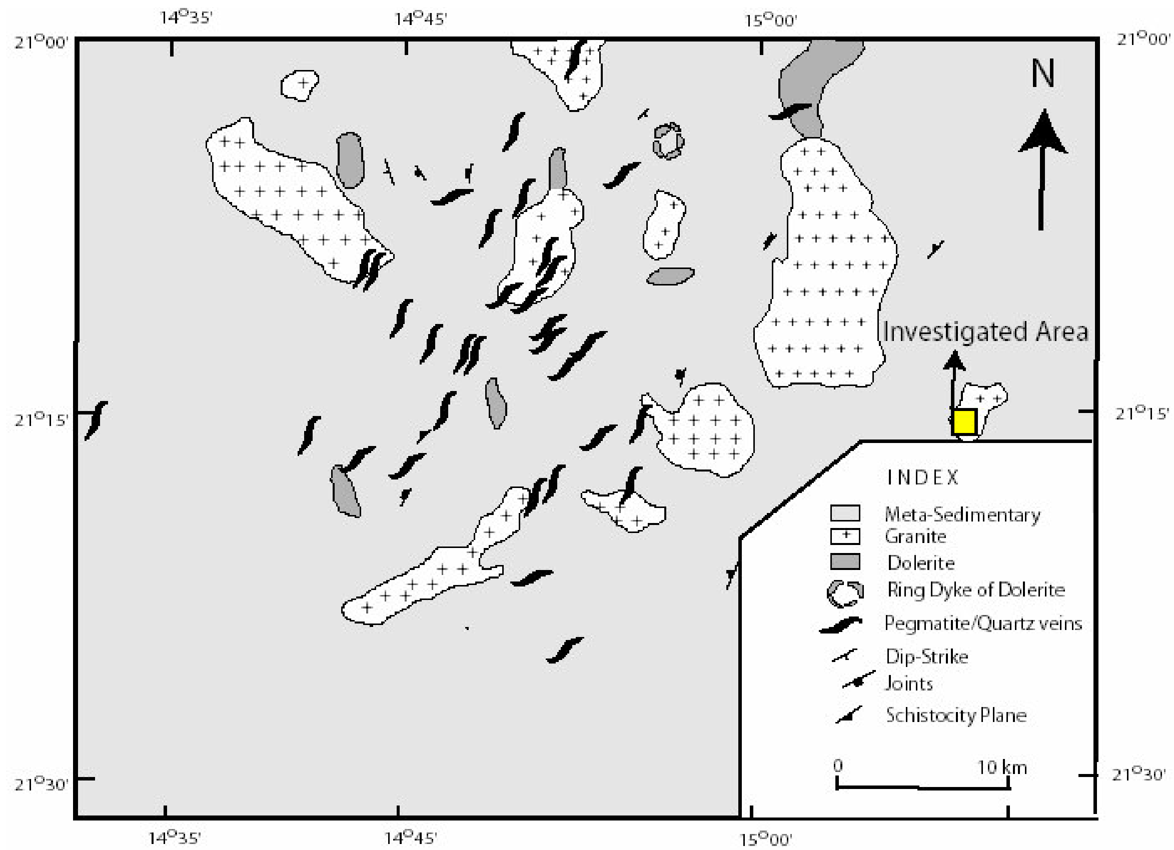

Figure 2a. Geological map of Uis region (modified after geological survey of Namibia, 2000) showing area of investigation.

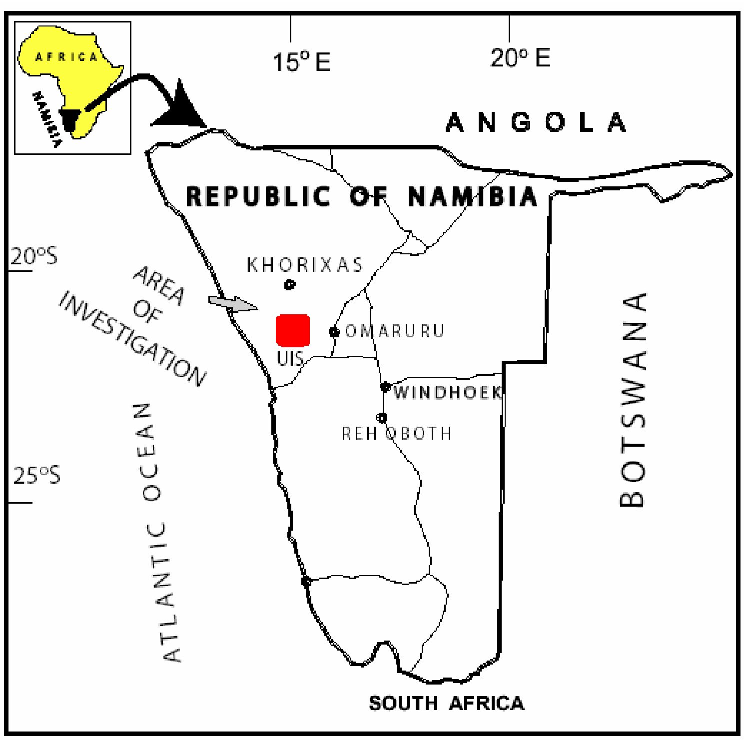

Figure 1. Map of Namibia showing Uis, the area of investigation.

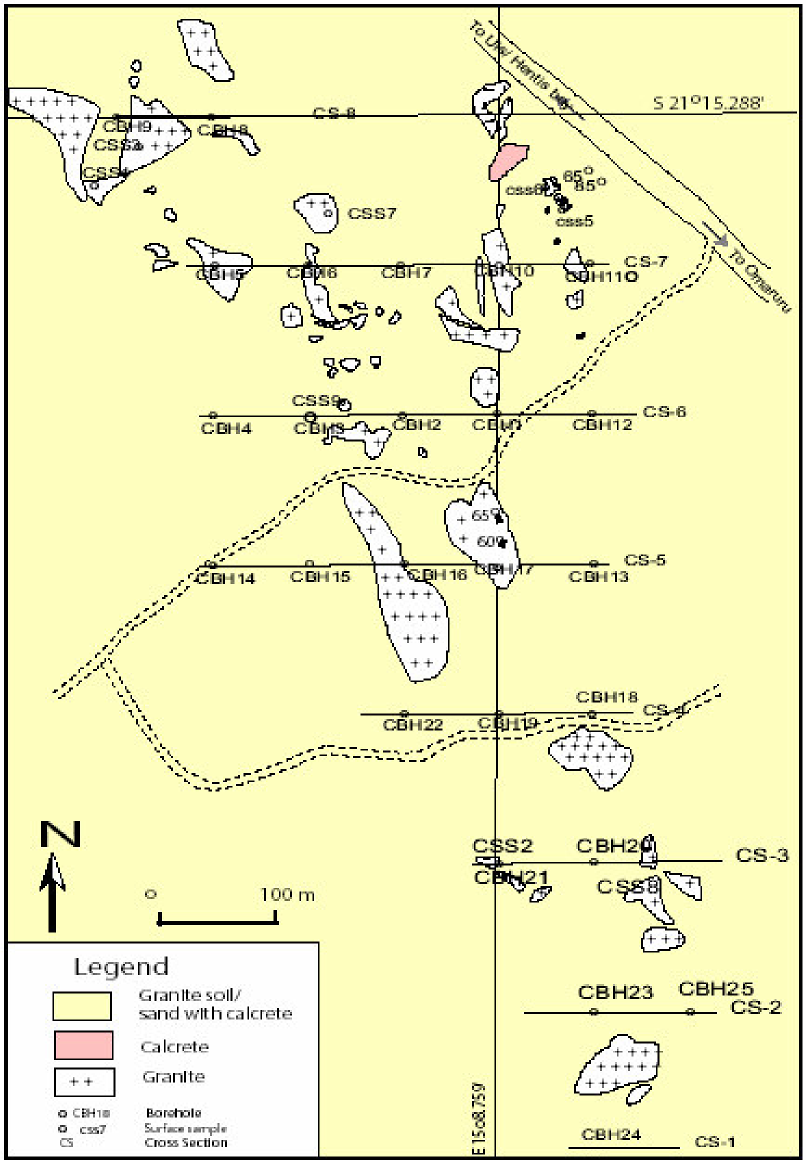

Figure 2b. Geological map of eastern Uis region.

Table 1. Details of surface samples of granite with corresponding values of Ta_2O_5, Nb_2O_5 and SnO_2.

S. No.	Sample No.	Nature of samples	Assay in ppm		
			Ta_2O_5	Nb_2O_5	SnO_2
1	CSS-1	Coarse grained granite	3.6	35.2	12.4
2	CSS-2	Biotite granite	3.4	17.3	10.0
3	CSS-3	Biotite granite	5.5	74.2	11.9
4	CSS-4	Medium grained granite	7.6	80.1	8.2
5	CSS-5	Coarse grained granite	9.0	85.9	11.1
6	CSS-6	Coarse grained granite	6.2	71.5	13.6
7	CSS-7	Medium grained granite	6.5	68.3	10.9
8	CSS-8	Medium grained granite	6.8	44.3	12.4
9	CSS-9	Medium grained granite	3.5	51.1	13.6

Table 2. Details of borehole samples of granite with corresponding values of Ta_2O_5, Nb_2O_5 and SnO_2. **Bore hole No:** CBH-1 (Reduced level: 976.140, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 5	3.12	27.6	7.2
2 - 5			
5 - 10	4.23	44.3	9.8
10 - 15	5.13	49.1	9.8
15 - 20	4.13	36.9	9.4

Bore hole No: CBH-2 (Reduced level: 976.300, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	4.05	20.9	7.4
1 - 6	4.49	44.9	11.0
6 - 11	3.8	48.1	11.4
11 - 16	4.18	50.8	10.6
16 - 20	4.16	51.0	10.3

Bore hole No: CBH-3 (Reduced level: 977.720, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	14.5	61.5	12.5
1 - 6	4.8	54.0	11.2
6 - 7	2.1	36.8	8.5
7 - 12	25.2	1.7	13.1

Borehole was closed due to drilling breakdown at 12 mt depth.

Bore hole No: CBH-4 (Reduced level: 978.520, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	2.1	38.6	7 .7
1 - 3	7.9	29.5	10.7
3 - 4	2.8	22 .9	8.7
4 - 6	4.8	32.0	11.4
6 - 8	6.1	61.9	11.0

Drilling was abandoned due to break down at 8mt depth.

Bore hole No: CBH-5 (Reduced level: 982.540, Angle: Vertical)

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 5	2.4	54.0	9.30
5 - 10	3.70	56.0	9.80
10 - 15	2.10	58.0	10.90
15 - 20	3.50	56.40	10.60

Bore hole No: CBH-6 (Reduced level: 978.920, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	2.20	54.90	11.75
1 - 6	3.40	60.20	17.7
6 - 11	2.10	56.80	14.60
11 - 16	3.0	57.3	17.7
16 - 20	2.0	56.6	16.0

Bore hole No: CBH-7(Reduced Level: 978.30, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_5
0 - 1	1.90	35.20	12.8
1 - 5	5.59	58.2	6.2
5 - 6	2.50	48.30	13.30
6 - 11	2.70	64.20	16.30
11 - 16	3.0	64.0	19.0
16 - 20	2.30	56.50	8.60

Bore hole No: CBH-8 (Reduced Level: 984.290, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	1.80	25.80	6.70
1 - 6	5.50	62.5	11.8
6 - 11	7.60	61.3	11.7
11 - 16	2.60	63.5	11.0
16 - 20	6.24	57.3	17.45

Bore hole No: CBH-9 (Reduced Level: 983.290, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	5.57	22.5	9.9
1 - 6	6.18	46.7	22.2
6 - 8	6.9	59.1	13.8
8 - 13	4.39	37.6	16.7
13 - 18	6.67	51.4	68.8
18 - 20	5.22	56.5	14.6

Bore hole No: CBH-10(Reduced Level: 981.230, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 5	7.83	46.8	10.2
5 - 10	4.13	52.4	11.7
10 - 15	6.76	51.3	15.9
15 - 20	5.27	49.65	12.75

Bore hole No: CBH-11(Reduced Level: 979.490, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	3.59	37.6	10.7
1 - 5	4.17	43.5	9.3
5 - 8	2.79	24.3	7.7
8 - 13	3.95	47.3	10.2
13 - 18	3.87	51.2	10.8
18 - 20	4.07	48.1	10.3

Bore hole No: CBH-12(Reduced Level: 977.990, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 5	7.01	48.1	11.0
5 - 10	4.24	49.3	9.6
10 - 14	4.6	51.5	11.2
14 - 15	1.92	20.1	7.65
15 - 20	3.64	50.0	11.6

Bore hole No: CBH-13(Reduced Level: 974.960, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 2	2.24	22.7	7.3
2 - 7	1.92	21.2	12.6
7 - 12	4.06	38.8	9.7
12 - 15	3.22	36.6	9.1
15 - 20	2.3	22.1	7.1

Bore hole No: CBH-14 (Reduced Level: 978.460, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 5	4.2	20.1	13.6
5 - 10	4.62	59.3	14.6
10 - 15	3.18	46.4	11.6
15 - 20	3.25	52.85	11.50

Bore hole No: CBH-15 (Reduced Level: 975.710, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	1.79	20.9	7.6
1 - 6	3.48	52.6	11.1
6 - 11	3.09	46.4	15.8
11 - 16	5.47	51.4	13.4
16 - 20	3.39	46.7	17.3

Bore hole No: CBH-16(Reduced Level: 976.250, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	2.54	33.2	7.4
1 - 4	3.59	46.3	11.4
4 - 6	2.22	31.9	6.7
6 - 11	2.10	61.80	7.80
11 - 16	1.80	58.60	7.70
16 - 19	2.10	56.20	10.60

Bore hole No: CBH-17(Reduced Level: 976.000, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 5	2.40	56.30	9.20
5 - 10	2.50	57.20	9.20
10 - 14	2.20	57.0	11.80

Bore hole closed at 14mt due to drilling break down.

Bore hole No: CBH-18 (Reduced Level: 971.830, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	6.72	53.6	11.3
1 - 6	10.19	69.95	12.85
6 - 11	6.70	1.40	35.30
11 - 16	7.60	1.60	53.50
16 - 20	6.60	1.60	50.80

Bore hole No: CBH-19(Reduced Level: 973.210, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 3	312.95	38.9	9.9
3 - 8	4.74	76.7	12.6
8 - 13	4.93	80.7	12.9
13 - 18	6.1	72.2	13.8
18 - 20	48.6	106.0	15.3

Bore hole No: CBH-20 (Reduced Level : 970.260, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 3	3.7	44.5	8.2
3 - 8	3.48	50.4	42.5
8 - 13	3.54	51.8	9.5
13 - 18	5.5	52.0	12.2
18 - 20	3.6	50.5	13.35

Bore hole No: CBH-21(Reduced Level: 971.830, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 2	1.20	26.90	5.80
2 - 7	1.90	48.90	6.80
7 - 12	2.10	52.0	7.50
12 - 17	1.90	58.30	7.70
17 - 20	2.10	62.20	7.70

Bore hole No: CBH-22 (Reduced Level: 973.600, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	1.0	25.4	7.8
1 - 3	1.60	25.20	8.10
3 - 4	1.50	18.70	9.60
4 - 6	5.60	29.0	8.10
6 - 11	1.90	56.30	10.80
11 - 16	2.40	64.20	13.30
16 - 20	2.70	56.90	10.60

Bore hole No: CBH-23 (Reduced Level: 968.460, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 3	10.1	23.1	11.3
3 - 8	3.72	36.7	19.1
8 - 13	3.0	41.8	10.7
13 - 18	2.73	43.0	15.7
18 - 20	1.58	26.2	5.5

Bore hole No: CBH-24 (Reduced Level: 966.290, Angle: Vertical)

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 1	6.13	17.5	82.1
1 - 4	1.99	18.8	8.6
4 - 9	3.58	46.1	12.55
9 - 14	5.04	44.95	10.85
14 - 19	3.04	43.9	8.8
19 - 20	5.57	47.6	8.9

Bore hole No: CBH-25 (Reduced Level: 967.350, Angle: Vertical).

Depth (m)	Assay (in ppm)		
	Ta_2O_5	Nb_2O_5	SnO_2
0 - 2	1.50	30.90	20.0
2 - 7	1.70	54.30	11.90
7 - 12	2.10	57.20	8.80
12 - 17	3.30	59.30	13.50
17 - 20	1.90	58.60	11.20

(1997 and 2001) have studied the granites of Rajasthan, India with special reference to their geochemistry and tungsten mineralization. Thus it is of imperative interest to see the occurrence of tantalum and niobium in the granites of Uis region.

The investigated area lies at a distance of 27 km east to Uis Township which, in turn, is located about 370 km NW of Windhoek, the capital city of Namibia (Figure 1). The investigated area is well connected with Uis-Omaruru road. An area of 66 ha (0.66 sq km) was surveyed and geologically mapped and subjected to detailed exploration activities which involved surface sampling, bulk sampling and reverse circulatory drilling.

GEOLOGY OF THE AREA

Regional geology

Though nearly half of Namibia is covered by young sediments belonging to Kalahari and Namib deserts, yet varied geology of the country, comprising rocks of Archean to Phenerozoic age, encompass over 2600 million years of the history of earth. In the central and northern part of country, there are me and consists of quartz and plagioclase. Granite porphyry tamorphic inliers consisting of highly deformed gneisses, amphibolites, metasediments and associated intrusive rocks (Geological Survey of Namibia, 2000) of Paleoproterozoic age (2200 - 1800 Ma) (Table 3).

The Damara Sequence and related rocks are particularly important for their economic mineral depoits. Nosib, Swakop, Otavi, Auas, Kuiseb are the major groups in this sequence and the basal strata were laid down between 850-700 mn years ago. Pegmatites containing tin, columbite/ tantalite, rare earths and gemstones occur at various strata levels (Geological Survey of Namibia, 2000).

Metasedimentary rocks constitute the oldest rocks regionally in the investigated area consisting of quartzite, phyllites, quartz-schists, quartz-mica-schists and mica schists of grey to light greenish colour. These metasedimentary rocks belong to the Amis River Formation, Swakop Group of 1000 - 545 ma (Geological Survey of Namibia, 2000). Schistosity is striking NE-SW to N-S plunging gently S to SE. These rocks have suffered extensive erosion but the resistant ones still occupy ridges and hills.

The granites of the investigated area also belong to the Damara Sequence of rocks. The alkali feldspars in the granite are medium to course grained and the granite is pink in color. Petrographically, the granites are found to have variation like quartzolite, granite porphyry, alkali granite and graphic granite. Quartzolite is fine grained and consists of quartz and plagioclase. Granite porphyry

Table 3. The general stratigraphic succession of Namibia (Geological Survey of Namibia, 2000).

Age (mn years)	Geological era	Group/Complex/Sequence	Composition
65 -	Tertiary to Alluvial	Kalahari, Namib	Sedimentary Quarternary
120 - 65	Cretaceous	Post-Karoo intrusive complexes	Magnatite
500 - 120	Carboniferous to Cretaceous	Karoo sequence	Sedimentary Volcanic
570 - 500	Cambrian	Nama group	Sedimentary
1000 - 570	Namibian	Damara sequence, Gariep complex	Sedimentary, Magnatite,Granite
1800 - 1000	Mokolian	Sinclair and Rehoboth sequences, metamorphic complex	Sedimentary, Namaqua Volcanic, Gneiss
2000 - 1800	Lower Mokolium	Khoabendus and Haib groups	Metamorphic

consists of orthoclase, quartz and tourmaline occurs as essential minerals while biotite and ilmenite as accessory. In alkali granite, microcline, orthoclase and quartz are essential minerals while tourmaline, biotite, anorthite and muscovite are accessories. In case of graphic granite, the essential minerals are plagioclase, quartz, microcline and biotite and the accessory minerals are anthophyllite and tourmaline.

These granites, granite-gneisses and meta-sedimentary rocks have been intruded by pegmatites and aplites and are integral component of geo-tectonic set up of the area. These pegmatites and aplites strike parallel to that of metasedimentary rocks and vary in width from less than 1 m to over 25 m.

Sometimes these pegmatites also cut across the metamorphic rocks. According to geological survey of Namibia (2000), these pegmatites were emplaced between 550 and 460 Ma and belong to a 120 km long and 24 km wide, NE - SW striking belt that stretches from cape cross to Uis region. There are three distinctly identified swarms of pegmatites; Uis pegmatite swarm, the Karlowa pegmatite swarm and the Strathmore pegmatite swarm. The important minerals of the pegmatites are quartz, microcline to microclinoperthite, albite and muscovite while cassiterite, columbite- tantalite series of minerals, zircon and lithium minerals like amblygonite occur as accessory minerals (Diehl, 1993). The internal zoning is not noticeable in these pegmatites. The cassiterite occupies the fractures that developed later in the pegmatites and contain tin, tantalum and niobium in varied concentrations. They are mostly tabular, pod-like, lensoid and vein-like bodies in shape.

Among the intrusive rocks also occur basic intrusives in the form of dolerite dyke. Generally these dykes cut across the formations and have intruded all the rocks and are younger in age. It also forms ring like structure (Geological Survey of Namibia, 2000; Singh, 2009).

Local geology

Out of an area of ~ 3000 sq km surveyed during the reconnaissance geological study (Figure 2a), a small area of 700 m x 1500 m was studied in detail and was subjected to drilling (Figure 2b). Regionally the metasedimentary country rocks are intruded by granite (Figure 2a) along their strike (N-S direction). These intruding granites and granite gneisses are younger in age than the metasedimentary rocks but are older than the pegmatites and aplites of the area.

At the contact of metasedimentary rocks and granites, there is extensive feldspathization. Megascopically K-feldspar seems to be dominating among feldspars and contains big tabular crystals which are spread in linear fashion in the granite body. Quartz and alkali feldspars are the essential mineral components of these intrusives while tourmaline occurs as accessory. These granite gneisses follow the trend of metasedimentary rocks. These granite bodies crop out as domes and hillocks and have been subjected to high degree of weathering and at places have been converted into granitic sand and soil due to weathering (Figure 2b). The granite invariably contains high content of biotite. At few places these granites have been calcretized which is a light colored deposit of calcium carbonate formed over the granitic mass by leaching process. This can be seen located at the north-eastern portion of the studied area (Figure 2b). Tantalite-columbite concentrations have been found at some places in the alkali-granite.

METHODOLOGY

Mapping

The survey work was accomplished with the help of total station and GPS (Global Positioning System). The geological mapping was completed at a scale of 1:2000 for which help of surveyor was taken.

Drilling

RC drilling (Reverse Circulatory Drilling) is a non-coring operation and only powder sample is recovered with small amount of cuttings, chips and small pieces. This work was awarded to M/s. 'Hardrock Drilling', Namibia. The output was recovered continuously with RC drilling but for geological and lithological variation, the output for every metre of drilling was collected and stacked separately. The physical properties of the output were observed and every metre was logged. Geological logging and sampling were done simultaneous to drilling.

In general, 5 m composite samples were prepared but depending on the lithological variation, the length of the composite samples was reduced.

Sampling

One of the surface samples collected earlier by the author during Geological reconnaissance study from this area showed an anomalous value of 245 ppm of Ta_2O_5. This created interest and the area was given attention for exploration in detail and exploratory drilling was undertaken.

Bulk sampling: Since the area of investigation is composed mainly of granite, therefore to have an actual realization of recovery of niobium and tantalum from the granite, a total of 2.2 tonnes of representative bulk sample was prepared.

Surface rock sampling: Surface rock samples from the granite outcrops have also been collected and analyzed to see the content of Ta_2O_5 and Nb_2O_5 in them. In total 9 surface rock samples were collected from the entire block.

Borehole sampling: After completing the reconnaissance geological investigations, surface sampling and bulk sampling work, Reverse Circulation (RC) Drilling was undertaken. This provides the first order information with respect to the extent of concentration of tantalum and niobium in the granite body.

A total of 25 RC boreholes were drilled in this area. Since the area is covered with alkali granite, therefore all the boreholes were drilled vertical. A grid of 100 m x 200 m was followed. Since the granite follows the strike of the meta-sedimentary rocks, therefore the east-west separation of the boreholes was taken as 100 m while the north-south separation was maintained at 200 m (Figure 2b). The depth was kept as 20 m. except in some cases (CBH-3, CBH-4, CBH-16 and CBH-17) where drilling had to be abandoned before 20 m depth due to breakdown of the drilling machine. The cumulative length of these boreholes is 473 m. from which a total of 125 composite samples were prepared and analyzed for their Ta_2O_5, Nb_2O_5 and SnO_2 contents. Details of all the boreholes with their corresponding values of Ta_2O_5, Nb_2O_5 and SnO_2 are shown in table 2.

Geochemical analyses

The collected samples have been processed (split, crushed and pulvarised) at 'Analytical Laboratory Services', New castle Street, Windhoek, Namibia and were subsequently analysed for their tantalum, niobium and tin content and recalculated for their Ta_2O_5, Nb_2O_5 and SnO_2 contents in ppm in Mintek Laboratory, South Africa. It was carried out in ICP-MS aided with multi-channel Perkin Elmer analyzer.

RESULT AND DISCUSSION

The details of the analysis have been reported with respect to their niobium and tantalum contents. The head assay of bulk samples has given a value of 18 ppm of Ta_2O_5, 66 ppm of Nb_2O_5 and 14 ppm of SnO_2. Although values are not important for further exploration targets, they are 3 - 4 times above the background values.

All the nine surface granite samples were analysed and all of them were found to contain less than 10 ppm of Ta_2O_5, the maximum being 9 ppm, while their Nb_2O_5 content is slightly higher. Six samples have given Nb_2O_5 content between 50 and 100 ppm whereas three have given below 50 ppm. Thus the granites have a non-uniform and non-continous concentration of tantalum and niobium at the surface as indicated by localized enrichment of these elements at a few places. The details of surface granite samples with tantalite values are, shown in Table 1. This is supported by values of Ta_2O_5 analyzed in the borehole samples (table 2).

From this area 125 composite samples were analysed. Only one sample has given a good value of 312.95 ppm of Ta_2O_5 (ABH-19, 0 - 3 m) which is a 3 m composite sample. One sample shows a value of 48.6 ppm of Ta_2O_5 (CBH-19, 18 - 20 m) while the remaining samples have given very low values (Table 2). In case of Nb 2O5, 60 borehole samples have shown a value between 50 ppm and 100 ppm while one sample has given a value over 100 ppm (CBH-19, 18 - 20 m).

Considering the average crustal abundance of tantalum to be 1.7 ppm and that of niobium to be 20 ppm (Wedepoh, 1969 - 1978), the investigated area contains slightly higher concentration of these elements. Only one localized segment of 3 m thickness has shown an anomalous mineralization of tantalum.

CONCLUSIONS

On the basis of exploration activities carried out, in the area of study, the following could be ascertained. The meta-sedimentary rocks occur as the oldest rock units of the studied area and are intruded by granites, granite-gneisses and dolerites. They all are further intruded by the still younger rare metal pegmatites and aplites that generally occur parallel to the strike of the meta-sedimentary rocks but at times they also cut-across them. The pegmatites have very coarse grained quartzo-feldspathic fabric and generally have a thickness from less than one metre to over 25 m. The internal zoning is not noticeable and they have a general trend of NE-SW. The pegmatites and quartz veins contain variable concentrations of Ta_2O_5, Nb_2O_5, and SnO2 and the lithium minerals occur as disseminated grains.

In so far as the studied granite area is concerned, there is only localized enrichment of Ta2O5 in a small portion which have been recognized in a 3 m composite sample (from surface up to 3 m depth, sample No ABH-19 (0 - 3 m) with a value of 312.95 ppm. The occurrence and distribution of low concentrations of niobium and tantalum indicates that the area is not suitable for the extraction of these metals economically at commercial scale and is a subject of academic importance only.

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