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Tantalite exploration in "Block-A" of Uis region, Namibia

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Abstract: Based on reconnaissance geological studies, carried out by the author, which provided the potential locales of tantalite mineralization over the surface, the present block (known as Block-A) was identified and subjected to surface and sub-surface exploration involving geological mapping, surface sampling, trenching, pitting, drilling and bulk sampling. The results of the exploration reveal that the tantalite mineralization in this area occurs in discontinuous patches and pockets of varying dimensions. They are found in pegmatite bodies occurring parallel to the strike of meta-sedimentary rocks. These pockets have variable concentrations of Ta_2O_5. Since the overburden of these pegmatite bodies is thin, these pockets could be mined out manually using hand-operated tools and the Ta_2O_5 concentrates, which have a good market in the region, could be produced in small processing plants locally.

Keywords: exploration, drilling, trenching, pitting, tantalite, pegmatite, Uis, Namibia.

Resumen: A partir de estudios de reconocimiento geológico llevados a cabo por el autor, los cuales proporcionaron el potencial local de mineralizaciones de tantalita en superficie, se identificó el presente bloque (conocido como Bloque A), el cual fue explorado en superficie y en subsuelo mediante técnicas de cartografía geológica, muestreo de superficie, trincheras, pequeñas excavaciones, sondeos y toma de muestras globales. Los resultados de la exploración mostraron que la mineralización de tantalita en esta región tiene lugar en forma de parches y bolsadas discontinuas de dimensiones variables. Las mineralizaciones están ubicadas en cuerpos pegmatíticos dispuestos paralelamente a la dirección de las rocas meta-sedimentarias. Las bolsadas tienen concentraciones variables de Ta_2O_5. Puesto que el recubrimiento de los cuerpos pegmatíticos es delgado, estas bolsadas podrían ser explotadas mediante herramientas manuales y los concentrados de Ta_2O_5, los cuales tienen una buena penetración comercial en la región, podrían ser generados en pequeñas plantas de procesamiento locales.

Palabras clave: exploración, sondeos, trincheras, pequeñas excavaciones, tantalita, pegmatita, Uis, Namibia.

Tantalum owes its name from *"tantalus",* a character in Greek mythology. It is a rare metal and occurs in the mineral "tantalite" whose chemical composition is (Fe, Mn) (Ta, Nb)$_2$0$_6$. This mineral can be identified on the basis of its diagnostic features like: hardness (6), specific gravity (5.2-7.9), lustre (sub-metallic), colour (iron black) and streak (dark red to black). It is generally associated with niobium (mineral: columbite) and tin in varied proportions. In early times, it was used mainly as filament material in incandescent electric lamps (Miller, 1959). However, the current demand for tantalum is mainly driven by the electronic industries where this metal is being used for making capacitors for mobile telephones, computers, video cameras, etc. These applications account for nearly 60% of global tantalum consumption.

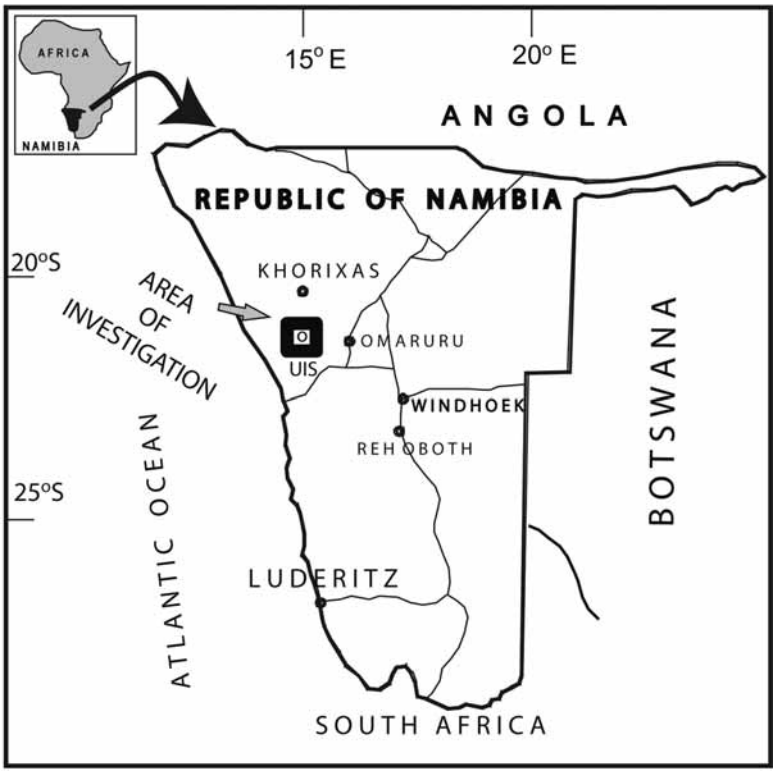

Figure 1. Location map of the investigated area (Uis region, Namibia).

Tantalum world reserves mostly occur in Thailand, Australia, Brazil, Africa, Canada and China. Some of the important ones to mention are: Greenbushes, Wodgina, Cattlin Creek and Bald Hill deposits belonging to Sons of Gwalia in Western Australia; Manitoba Province and British Columbia in Canada; Mibra mine in Rodonia state of Brazil; Yichun mine in Central China; Kenticha tantalum mine in Ethiopia; Abu Dabbab in Egypt; and Congo, Rwanda, Burundi, Uganda, Nigeria and Mozambique in Central Africa. Tin slag containing tantalum is generated primarily in Thailand and Malaysia with smaller quantities in Brazil and Africa. In fact Africa is considered to be the world's largest undeveloped resource base of tantalum (Jones, 1999).

The pegmatites are considered to be one of the important sources of tantalite throughout the world. Based on the mineralogy, chemistry and their emplacement depth, the pegmatites may be classified as abyssal (high grade, high to low pressure), muscovite (high pressure, low temperature), rare element (low temperature and pressure) and miarolitic (shallow level) types (Ginsburg et al., 1979; Ginsburg, 1984). The rare element pegmatites have been further sub-divided into three families: (1) LCT pegmatites with Li, Rb, Cs, Be, Ga, Sn, Ta>Nb with subordinate B, P, and F; (2) NYF pegmatites with Nb>Ta, Ti, V, REE; and (3) pegmatites with a mixed geological signature (Cerny, 1991). Singh (2007a), while carrying out reconnaissance geological studies in the Uis belt (Namibia), identified potential blocks and collected samples from a regional area of about 3000 sq. km. The study revealed that the samples from the mineralized zones had tantalum values higher than niobium values. This puts the pegmatites of the Uis belt to be of first type of Cerny's classification, that is LCT pegmatites. Some of the surface samples collected from the pegmatite quartz veins of this area revealed high values of Ta2O5 with a maximum of 1092 ppm. However, local variations cannot be ruled out (Singh, 2007b) and in Block-A the pegmatites show a mixed geological character. The rare element pegmatites are regarded to be mainly the products of highly differentiated fertile granites and constitute a special class among the pegmatite group (Banerjee, 1999). The petrogenetic significance of the pegmatites has been worked out by many researchers in view of the evolution of rare elements present in them (Aurisicchio et al., 2001; Cerny and Ercit, 1985, 1989; Cerny et al., 1985; Robles et al., 1999; Belkasmi et al., 2000).

Namibia has large mineral reserves that contribute significantly to the Namibian economy. However, in international terms, the mineral potential of Namibia still remains unexplored and except diamond, the potential of other minerals has not yet been assessed.

The present paper reveals the outcome of exploration activities carried out in one of the potential blocks, henceforth

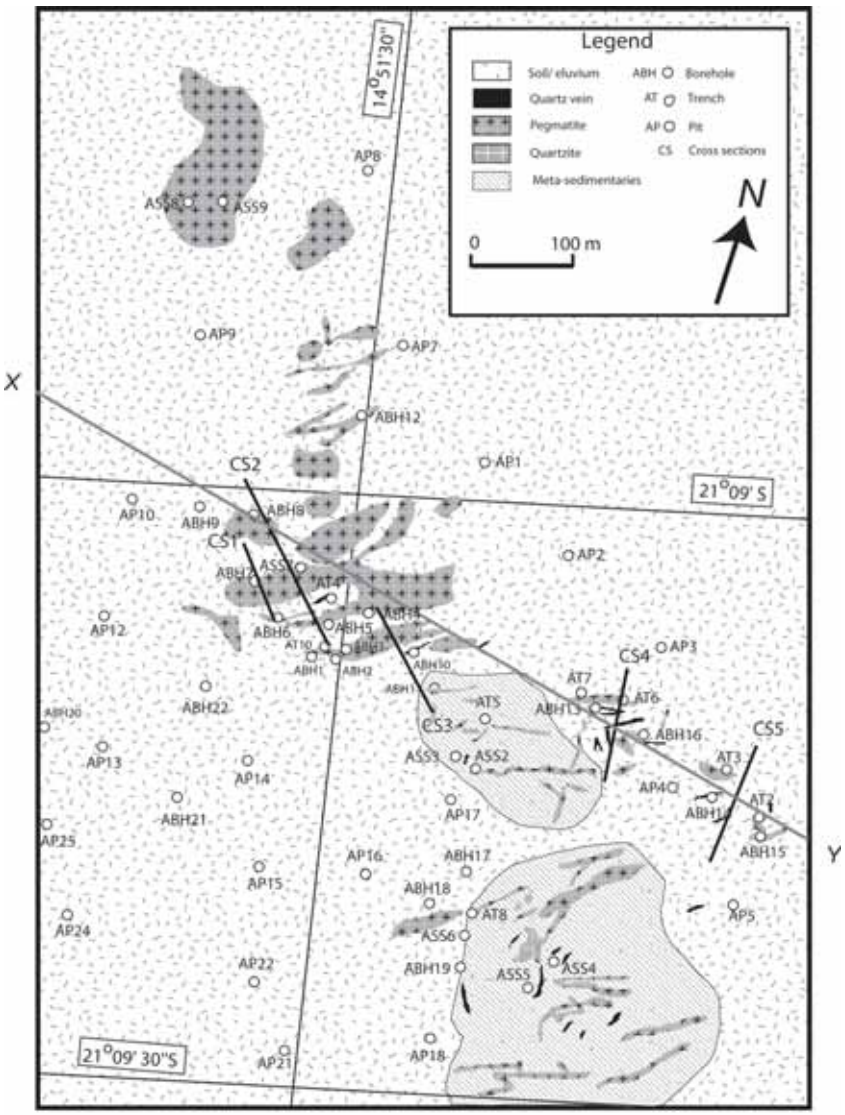

Figure 2. Geological map of "Block-A" (Uis region, Namibia). See Fig. 1 for location.

called "Block-A". The block is located at about 20 km NW of Uis, Omaruru district, Namibia. Uis town is located about 370 km NW of Windhoek, the capital city of Namibia (Fig. 1). This block can be approached by Uis-Welwitchia main road. This block covers 85 hectares (0.85 sq. km) of the surveyed and geologically mapped area, which has been subjected to detailed surface and sub-surface exploration activities.

Geological setting

Regional geology (Uis region)

Meta-sedimentary rocks are the oldest rocks occurring in the area and include quartzites, phyllites, quartz-schists, quartz-mica-schists and mica schists. Striking in NE-SW to N-S direction, these meta-sedimentary rocks have a south to southeast gentle dip. These meta-sedimentary rocks belong to Amis River Formation included in the Swakop Group and have an age that ranges from 1000 Ma to 545 Ma (Geological Survey of Namibia, 2000). These rocks suffered extensive erosion and occupy the hills and ridges.

The main intrusives include granite and granite gneisses and are younger than the meta-sedimentary rocks but older than the pegmatites and aplites of the area. These intrusives can be seen as weathered hills as well as occupying the higher relief portions. The essential mineral components of these intrusives are quartz and alkali-feldspar whereas tourmaline occurs as prominent accessory. The alkali feldspars in the granite gneiss are medium to coarse grained. At the contact of the intrusive granites with the sedimentary rocks extensive feldspathization is observed. These intrusive granites and granite-gneisses follow the

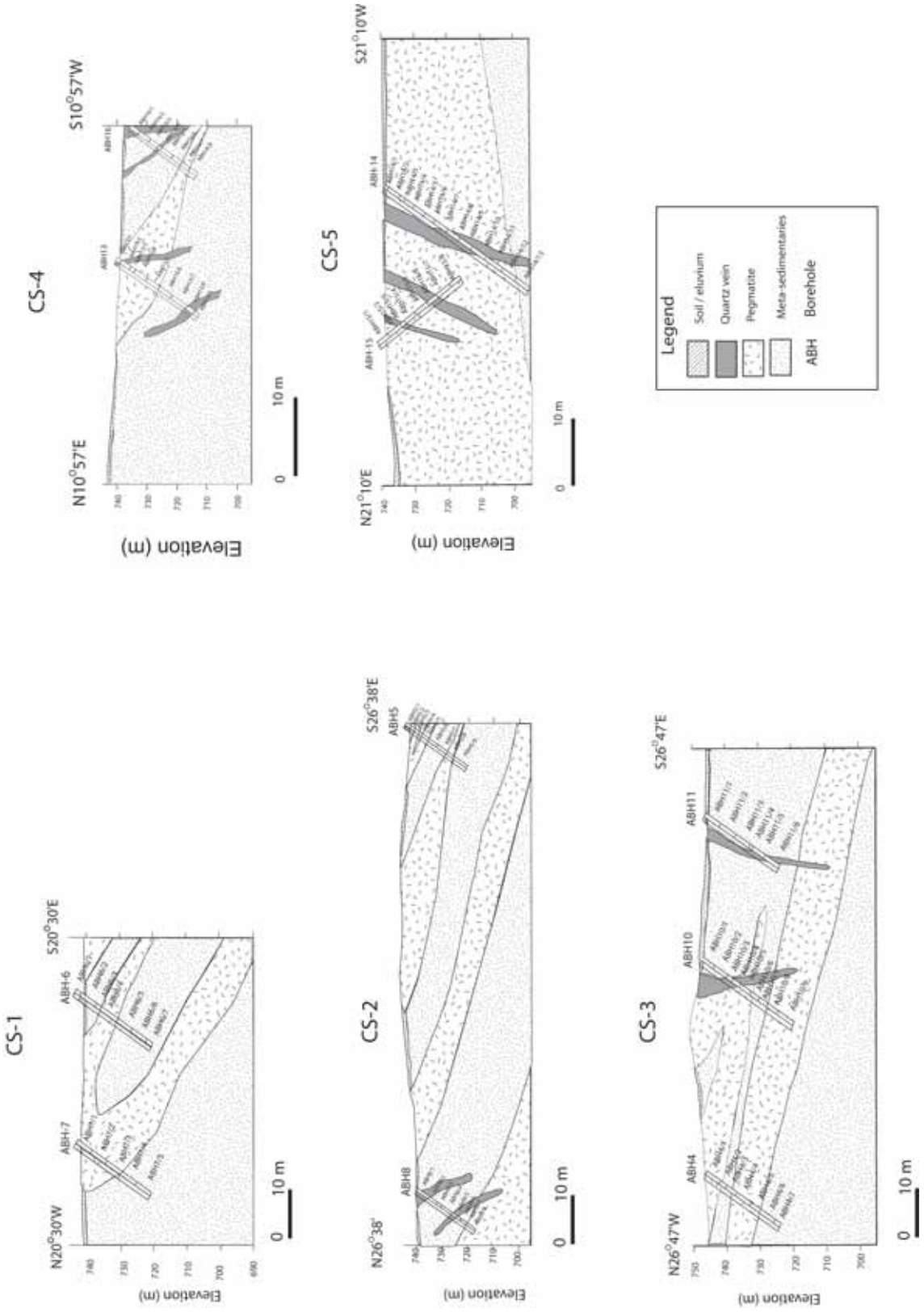

Figure 3. Geological sections based on borehole data (see Fig. 2 for location). NW-SE sections (CS1, CS-2 and CS-3) and NNE-SSW sections (CS-4 and CS-5). The horizontal scale is slightly exaggerated in order to visualise the geometry of the pegmatite bodies and quartz veins. The exaggeration factor in a) is V = 0.64 H, whereas the exaggeration factor in b) is V = 0.47 H.

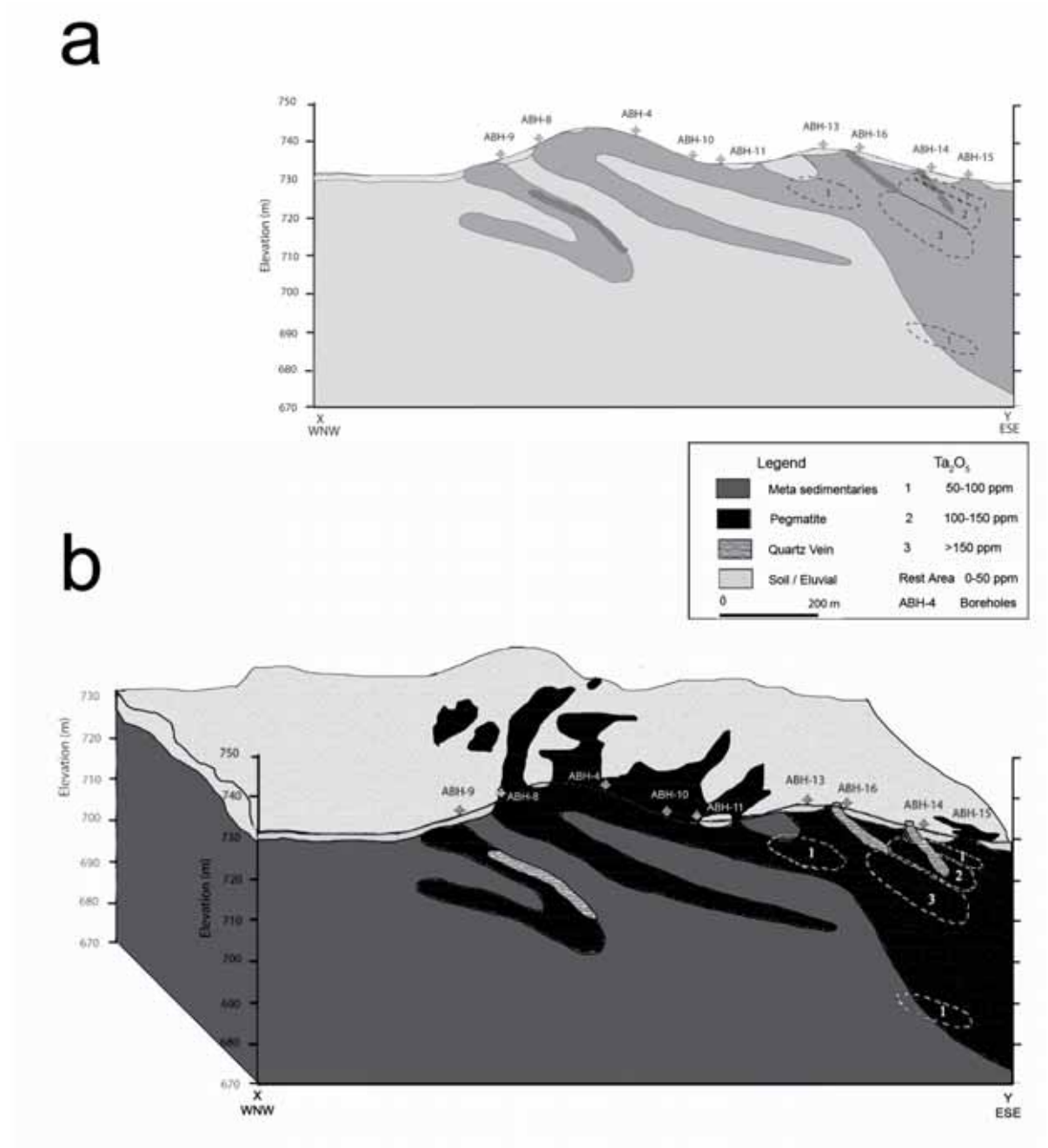

Figure 4. a) Large scale WNW-ESE geological section along section line X-Y (see Fig. 2 for location) and b) 3-D block diagram based on the geological section shown in a). The vertical scale is exaggerated in order to visualise the geometry of the pegmatite bodies and quartz veins. The exaggeration factor is V = 8.36 H.

trend of meta-sedimentary rocks. The granites, granite-gneisses and meta-sedimentary rocks have been further intruded by pegmatites and aplites that generally appear in bodies parallel to the strike of the meta-sedimentary rocks but in places cut-across them. They were emplaced between 550 Ma and 460 Ma (Geological Survey of Namibia, 2000). These acidic pegmatites of the Uis region are complex in nature and contain several rare elements and minerals that include quartz, microcline to microclinoperthite, albite and muscovite while the accessory ones are cassiterite, columbite-tantalite series of minerals, zircon and lithium minerals such as amblygonite. These rare metal pegmatites do not show noticeable internal zoning. The cassiterite closely relates to albite and muscovite rich replacement zones and occupies the fractures later on developed in the pegmatites. They contain variable concentrations of tin, niobium, tanta-

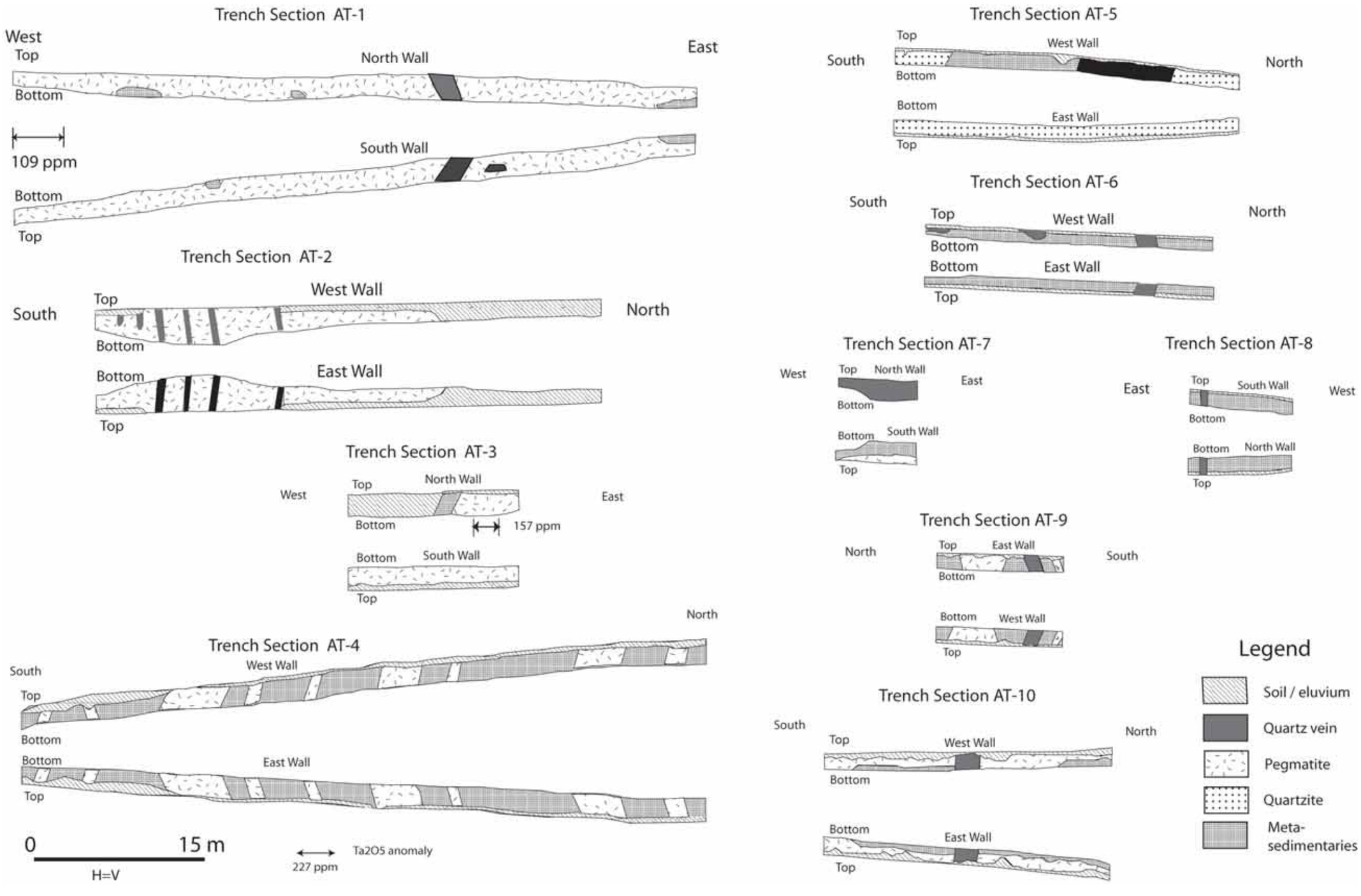

Figura 5. Geological interpretations of walls of trench sections AT-1 to AT-10 (see Fig. 2 for location).

Table I. Details of surface rock samples in Block-A with their corresponding tantalite values.

S.No.	Sample No.	Nature of sample	Assay in ppm		
			Ta_2O_5	Nb_2O_5	SnO_2
1	ASS-1	Quartz with tourmaline	22.1	55.8	7.5
2	ASS-2	Plagioclase with tourmaline	47.8	112.0	30.3
3	ASS-3	Quartz with muscovite and black specks	7.5	12.8	5.3
4	ASS-4	Quartz with tourmaline	2.2	3.1	5.4
5	ASS-5	Quartz with iron oxide	1.7	2.0	3.5
6	ASS-6	Quartz vein	1.6	3.9	3.1
7	ASS-7	Plagioclase with muscovite	11.2	49.8	52.8
8	ASS-8	Quartz vein	1.7	5.5	4.5
9	ASS-9	Orthoclase and quartz	28.4	156.0	9.9
10	ASS-10	Quartz vein	31.2	22.6	11.4
11	ASS-11	Quartz vein	24.3	19.0	10.1
12	ASS-11A	Plagioclase with quartz	28.1	19.7	16.9
13	ASS-12	Quartz vein	42.2	20.6	9.0
14	ASS-13	Quartz with muscovite and black specks	7.7	19.2	4.2
15	ASS-14	Quartz and plagioclase with black specks	10.0	16.4	16.8
16	ASS-15	Quartz piece with few black specks	1.7	9.6	2.0
17	ASS-16	Quartz with black specks	6.5	6.7	2.4
18	APEB	Black pebbles	484.0	822.0	35.0

lum and lithium. The pegmatites belong to a 120 km long and 24 km wide, NE-SW striking belt that stretches from Cape Cross to Uis. Three distinct swarms formed by these complex pegmatites may be identified: the Uis pegmatite swarm, the Karlowa pegmatite swarm and the Strathmore pegmatite swarm (Geological Survey of Namibia, 2000).

Basic intrusives in the form of dolerite dykes also occur among the intrusive rocks. The dykes are hundred to few hundreds of metres in width and several hundreds of metres in length. Generally, these dykes cut across the meta-sedimentary rocks and intruded all the rocks, and therefore, are younger in age. They occur as "ring dyke" complexes at certain places (Singh, 2007a).

Local geology ("Block-A")

Meta-sedimentary rocks form the country rocks of the studied area and include mica-schists, quartz-schists, quartz-mica-schists and quartzites (Fig. 2). In the study area these meta-sedimentary rocks strike from E-W to ESE-WNW direction and gently dip southerly. Locally, they also show N-S strikes with easterly dips. They are part of the meta-sedimentary rocks described in the previous section and are 1000 Ma to 545 Ma old (Geological Survey of Namibia, 2000). The drill data reveal that they are thicker than 50 m in the studied area (Fig. 3). These meta-sedimentary rocks were intruded by pegmatites and quartz veins both striking mainly in E-W direction. The pegmatite bodies, generally, have a thickness of less than 50 m (Figs. 3 and 4) and are common in the studied area (Fig. 2). The pegmatites contain very coarse-grained quartz-feldspathic material, however, a gradational reduction in the grain size has been observed in these pegmatite bodies at places grading into granite. The pegmatites and quartz veins contain varied concentrations of tantalum (tantalite) and niobium (columbite) occurring as disseminated grains. The quartz veins show pinch and swell structures and vary in thickness from half a metre to about 10 metres and exceptionally more, and are erratic in occurrence. In general, their surface exposure is of small extent and discontinuous but pervasive, and are mostly tabular, pod-like, lensoid and vein-like bodies in shape.

Table II. Details of lithologs of individual trenches in A-Block with their corresponding assay.

Trench No.: AT-1

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	4.0	Quartz-feldspathic material in both walls	AT-1/1	109.0	150.0	38.9
4.	9.0	Quartz-feldspathic material in both walls	AT-1/2	15.9	93.5	21.2
9.0	12.3	Quartz-feldspathic and meta-sedimentary in north wall while Quartz-feldspathic material in south wall	AT-1/3	33.2	127.0	35.9
12.3	17.0	Quartz-feldspathic material in both walls	AT-1/4	15.0	120.0	36.1
17.0	22.5	Quartz-feldspathic and meta-sedimentary in south wall while Quartz-feldspathic material in north wall	AT-1/5	17.5	60.6	12.3
22.5	31.0	Quartz-feldspathic material and meta-sedimentary in north wall and only Quartz-feldspathic material in south wall	AT-1/6	18.4	53.3	17.0
31.0	34.0	Quartz-feldspathic material in both walls	AT-1/7	19.2	49.3	12.0
34.0	35.0	Quartz-feldspathic material and quartz in both walls	AT-1/8	11.9	52.8	7.6
35.0	36.0	Quartz vein in both walls	AT-1/9	13.6	49.6	8.4
36.0	38.0	Quartz-feldspathic material and quartz in both walls	AT-1/10	11.7	61.8	7.2
38.0	40.0	Quartz-feldspathic material in north wall while Quartz-feldspathic material and quartz in south wall	AT-1/11	11.9	53.4	6.5
40.0	48.0	Quartz-feldspathic material in both walls	AT-1/12	8.7	29.2	7.0
48.0	57.0	Quartz-feldspathic material and meta-sedimentary in both walls	AT-1/13	82.9	140.0	0.6

Trench No.: AT-2

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	4.4	Top 20 cm soil, quartz and Quartz-feldspathic material in west wall while Quartz-feldspathic material in east wall	AT-2/1	38.0	58.3	27.8
4.4	5.4	Quartz and Quartz-feldspathic material in both walls	AT-2/2	4.5	12.9	14.7
5.4	6.4	Quartz and Quartz-feldspathic material in both walls	AT-2/3	7.5	34.2	20.5
6.4	8.0	Quartz and Quartz-feldspathic material in both walls	AT-2/4	37.4	77.3	39.3
8.0	9.5	Quartz-feldspathic material in both walls	AT-2/5	16.2	34.0	24.5
9.5	10.5	Quartz and Quartz-feldspathic material in both walls	AT-2/6	87.5	67.2	33.6
10.5	15.0	Quartz-feldspathic material in both walls	AT-2/7	13.2	42.5	26.9
15.0	17.2	Quartz and Quartz-feldspathic material in both walls	AT-2/8	79.3	51.0	21.0

Note : from 17.2m to 42.2m the sample was not analysed because it consisted mainly of soil and eluvium material.

Trench No.: AT-3

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	1.5	Soil and calcrete in north wall while Quartz-feldspathic material in south wall	AT-3/1	19.5	31.3	14.4
1.5	3.0	Soil and calcrete in north wall while Quartz-feldspathic material in south wall	AT-3/2	16.8	73.7	5.8
3.0	5.0	Soil and calcrete in north wall while Quartz-feldspathic material in south wall	AT-3/3	32.3	46.3	19.8
5.0	7.0	Soil and calcrete in north wall while Quartz-feldspathic material in south wall	AT-3/4	12.5	24.7	19.0
7.0	9.5	Soil, calcrete and meta-sedimentary in north wall while Quartz-feldspathic material in south wall	AT-3/5	46.6	65.2	34.2
9.5	11.0	Quartz-feldspathic material in both walls	AT-3/6	42.9	74.6	18.8
11.0	12.5	Quartz-feldspathic material in both walls	AT-3/7	157.0	228.0	35.6
12.5	14.2	Quartz-feldspathic material in both walls	AT-3/8	53.9	81.8	43.4

Trench No.: AT-4

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	1.8	Top 30 cm soil, meta-sedimentary and Quartz-feldspathic material in both walls	AT-4/1	39.4	131.0	40.4
1.8	2.8	Top 30 cm soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-4/2	41.5	62.0	29.2
4.3	7.0	Top 30 cm soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-4/3	16.1	57.0	40.6
10.8	17.5	Top 30 cm soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-4/4	6.0	69.9	16.5
19.0	20.2	Top 30 cm soil, Quartz-feldspathic material in both walls	AT-4/5	10.0	182.0	68.4
23.2	27.0	Top 30 cm soil, meta-sedimentary and Quartz-feldspathic material in both walls	AT-4/6	8.7	90.6	20.0
29.0	33.5	Top 30 cm soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-4/7	3.8	24.2	5.6
35.9	36.7	Top 30 cm soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-4/8	13.8	62.8	7.7
46.5	50.5	Top 30 cm soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-4/9	61.8	87.9	26.7
54.0	55.6	Top 30 cm soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-4/10	44.2	75.4	24.3

Trench No.: AT-5

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	5.0	Top 20 cm soil, quartzite in both walls	AT-5/1	3.8	24.3	11.7
5.0	10.0	Top 20 cm soil, meta-sedimentary in west wall while quartzite in east wall	AT-5/2	16.6	137.0	29.3
10.0	15.0	Top 20 cm soil, meta-sedimentary in west wall while quartzite in east wall	AT-5/3	7.9	24.3	5.8
15.0	17.0	Soil, meta-sedimentary and quartz vein in west wall while soil and quartzite in east wall	AT-5/4	1.3	13.0	3.7
17.0	19.0	Top 20 cm soil, quartz in west wall while quartzite in east wall	AT-5/5	1.6	15.7	4.2
19.0	21.0	Top 20 cm soil, quartz in west wall while quartzite in east wall	AT-5/6	1.9	27.6	5.3
21.0	23.0	Top 20 cm soil, quartz in west wall while quartzite in east wall	AT-5/7	5.4	20.6	4.5
23.0	24.5	Top 20 cm soil, quartz in west wall while quartzite in east wall	AT-5/8	2.2	16.5	3.7
24.5	30.0	Top 20 cm soil, quartzite in both walls	AT-5/9	12.3	59.7	6.7

Trench No.: AT-6

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	2.5	Top 20 cm soil, quartz and meta-sedimentary in west wall while soil and meta-sedimentary in east wall	AT-6/1	15.5	46.1	15.3
2.5	5.7	Top 20 cm soil, quartz and meta-sedimentary in both walls	AT-6/2	11.2	49.2	9.8
5.7	8.4	Top 20 cm soil, quartz and meta-sedimentary in both walls	AT-6/3	4.9	27.8	5.3
8.4	10.4	Quartz and meta-sedimentary in west wall while soil and meta-sedimentary in east wall	AT-6/4	39.3	37.3	11.6
10.4	18.3	Soil and meta-sedimentary in both walls	AT-6/5	8.1	43.6	16.9
18.3	19.5	Quartz vein in both walls	AT-6/6	15.5	22.7	67.3
19.5	21.5	Soil and meta-sedimentary in both walls	AT-6/7	13.0	6.1	18.8
21.5	25.0	Soil and meta-sedimentary in both walls	AT-6/8	15.2	12.6	37.8

Trench No.: AT-7

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	1.0	Quartz in north wall while Quartz-feldspathic material and meta-sedimentary in south wall	AT-7/1	25.5	55.7	15.8
1.0	2.0	Quartz in north wall while Quartz-feldspathic material and meta-sedimentary in south wall	AT-7/2	15.9	39.7	7.8
2.0	3.0	Quartz in north wall while Quartz-feldspathic material and meta-sedimentary in south wall	AT-7/3	2.7	6.3	5.3
3.0	4.0	Quartz in north wall while Quartz-feldspathic material and meta-sedimentary in south wall	AT-7/4	1.2	3.2	1.3
4.0	5.0	Quartz in north wall while Quartz-feldspathic material and meta-sedimentary in south wall	AT-7/5	1.4	4.9	1.4
5.0	6.0	Quartz in north wall while Quartz-feldspathic material and meta-sedimentary in south wall	AT-7/6	1.7	3.8	3.5
6.0	7.0	Quartz in north wall while Quartz-feldspathic material and meta-sedimentary in south wall	AT-7/7	2.3	4.3	2.9

Trench No.: AT-8

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	1.0	Top soil of 20 cm and meta-sedimentary in both walls	AT-8/1	2.8	22.6	6.5
1.0	2.0	Quartz vein in both walls	AT-8/2	2.6	13.5	8.0
2.0	9.0	Top soil of 20 cm and meta-sedimentary in both walls	AT-8/3	4.5	31.2	10.7

Trench No.: AT-9

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	2.0	Top soil and meta-sedimentary in both walls	AT-9/1	11.5	56.0	22.8
2.0	6.0	Soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-9/2	12.2	108.0	55.0
6.0	7.5	Top soil and meta-sedimentary in both walls	AT-9/3	11.2	44.4	5.4
7.5	8.8	Quartz vein in both walls	AT-9/4	21.2	20.9	4.8
8.8	10.0	Top soil and meta-sedimentary in both walls	AT-9/5	22.6	39.5	9.1
10.0	11.0	Soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-9/6	13.4	54.0	8.4

Trench No.: AT-10

Length (m)		Lithology	Sample No	Assay (ppm)		
From	To			Ta_2O_5	Nb_2O_5	SnO_2
0.0	5.0	Soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-10/1	77.0	85.8	7.6
5.0	11.5	Soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-10/2	27.3	44.0	6.4
11.5	13.5	Quartz vein in both walls	AT-10/3	39.8	59.2	36.5
13.5	20.0	Soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-10/4	10.0	16.4	16.8
20.0	25.0	Soil, Quartz-feldspathic material and meta-sedimentary in both walls	AT-10/5	28.2	72.2	5.5

Table III. Details of pit-lithologies in Block-A with their corresponding assay.

Pit No: AP-1 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.70	Reddish brown soil mixed eluvial with pieces of quartz, k-feldspar and fragments of granite, schist and quartzite	AP-1	12.5	44	10.3

Pit No: AP-2 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.90	Soil mixed with pieces of quartz, k-feldspar and fragments of granite and quartzite	AP-2	5.2	24.6	12.2

Pit No: AP-3 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.90	Brown soil mixed with calcrete, pieces of quartz, k-feldspar and fragments of granite, schist and quartzite	AP-3	2.1	5.2	9.8

Pit No: AP-4 Location: stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.15	Reddish brown sand with soil	AP-4	53.9	67.3	21.7
0.15	1.0	Soil mixed with quartz, k-feldspar and granite fragments				

Pit No: AP-5 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	1.0	Reddish brown soil mixed with pieces of quartz, k-feldspar and fragments of granite, quartzite and schist	AP-5	36.6	72.6	27.2

Pit No: AP-6 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.15	Brown sand	AP-6	43.2	67.5	19.8
0.15	1.0	Soil mixed with rock fragments (schist, granite and quartzite) and pieces of quartz and k-feldspar				

Pit No: AP-7 Location:

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.90	Reddish brown soil mixed eluvial with pieces of quartz, k-feldspar and fragments of granite, schist and quartzite	AP-7	12.1	30.2	11

Pit No: AP-8 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.15	Brown sandy- soil with quartz and k-feldspar pieces	AP-8	6.8	33.4	12.1
0.15	0.70	Bed rock (granite)				

Pit No: AP-9 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	1.0	Brown soil mixed eluvial with pieces of quartz, k-feldspar and fragments of granite, schist and quartzite	AP-9	6.8	30.2	9.6

Pit No: AP-10 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.15	Brown sand	AP-10	3.8	47.8	11.4
0.15	1.0	Soil mixed with rock fragments (schist, granite and quartzite) and pieces of quartz and k-feldspar				

Pit No: AP-11 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.20	Brown sand	AP-11	45.9	82.4	16.7
0.20	0.75	Soil mixed with calcrete, granite fragments and pieces of quartz and k-feldspar				

Pit No: AP-12 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.60	Brown soil mixed with calcrete and fragments of granite and schist and pieces of quartz and k-feldspar	AP-12	26.6	48.4	9.9

Pit No: AP-13 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.75	Brown top soil with eluvial	AP-13	19.9	35.5	16.9
0.75	1.0	Calcrete mixed soil fragments of granite and pieces of quartz and k-feldspar				

Pit No: AP-14 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.25	Fragments. Eluvial mixed soil with calcrete and pieces of quartz, k-feldspar and granite	AP-14	40.2	126	19.4

Pit No: AP-15 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.60	Soil mixed with calcrete and pieces of quartz, k-feldspar and granite	AP-15	34.4	46.9	14

Pit No: AP-16 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.30	Stream sand with pebbles of quartz and k-feldspar and fragments of granite and schist	AP-16	37	43.5	17.7

Pit No: AP-17 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.10	Brown top soil	AP-17	16.6	31.3	13
0.10	0.80	Soil mixed with calcrete				

Pit No: AP-18 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.90	Stream sand with pebbles of quartz and k-feldspar and fragments of calcrete and schist	AP-18	25.9	43.7	20

Pit No: AP-19 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.15	Brown top soil	AP-119	24.4	37.2	26.3
0.15	0.85	Calcrete mixed with soil				

Pit No: AP-20 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.15	Brown top soil with pieces of quartz and k-feldspar and rock fragments	AP-20	22.3	43.6	17.4
0.15	0.80	Bed rock (schist)				

Pit No: AP-21 Location: Stream bed

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.6	Brown top soil with eluvial and quartzite rock	AP-21	26.4	48.2	16.1
0.6	0.90	Quartzite bed				

Pit No: AP-22 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.10	Reddish brown soil	AP-22	53.6	149	21.9
0.10	0.90	Soil mixed with calcrete and pieces of quartz and k-feldspar				

Pit No: AP-23 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.10	Reddish brown soil	AP-223	122	112	14.4
0.10	0.80	Soil mixed with calcrete and pieces of quartz and k-feldspar and fragments of schist				

Pit No: AP-24 Location: Ground surface

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.20	Light brown soil	AP-24	26.3	44.2	18.7
0.20	0.35	Soil mixed with calcrete and pieces of quartz and k-feldspar and fragments of schist				

Pit No: AP-25 Location:

From	To	Lithology	Sample No	Assay (ppm)		
				Ta_2O_5	Nb_2O_5	SnO_2
0	0.20	Brown soil	AP-25	26.3	36.6	14.1
0.20	0.85	Soil mixed with calcrete and pieces of quartz and k-feldspar and fragments of schist				

Methods of study and exploration activities

The reconnaissance geological study carried out gave a positive indication with a maximum value of 1092 ppm of Ta_2O_5 in the surface rock samples from the area (Singh, 2007a). Hence, detailed exploration was undertaken in this block.

Mapping

The survey work was carried out with the help of a total station and a GPS (Global Positioning System). The geological mapping was completed at a scale of 1:2000 (Fig. 2).

Surface rock and eluvial sampling

Seventeen surface rock samples from the exposed quartz veins and pegmatite bodies were collected and analyzed (Table I). Besides, one combined sample was prepared containing dark coloured pebbles, with streak resembling tantalite collected from different places of the block and was separately analyzed (sample 18 in Table I).

Trenching and pitting

To dig out the pits and trenches, Jack hammer was used along with other manually operated tools. The company *"A-Z Renovations and Creations, Namibia"* was awarded the trench excavation work. Composite samples were prepared from trenches, with lengths of 1 m or more depending on the lithology. Wherever quartz vein/bodies were encountered a uniform sample length of 1 m was maintained. One composite sample was prepared from each pit.

Trench excavation was carried out to understand the behaviour of pegmatite quartz veins and their surficial nature in this block. This helped, up to an extent, to

Table IV. Details of the litholgs of boreholes in Bock-A with corresponding tantalite values.

BH No.: ABH-1, RL : 739.708, Angle: 61°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, dark brown powder with fine cuttings of K-feldspar, quartz and muscovite	ABH-1/1 (0-1)	26.8	84.0	15.6
1-4	White powder with cuttings, chips and few pieces of quartz, K-feldspar and muscovite	ABH-1/2 (1-5)	38.9	86.4	14.5
4-5	Light grey powder with cuttings, chips and few pieces of quartz, K- feldspar and muscovite				
5-10	Dark brown powder with fine cuttings of K-feldspar, quartz and muscovite from meta-sedimentary rocks	ABH-1/3 (5-10)	7.52	57.1	19.9
10-12	Dark brown powder with fine cuttings of K-feldspar, quartz and muscovite from meta-sedimentary rocks	ABH-1/4 (10-13)	12.5	77.2	11.9
12-13	Greyish brown powder with fine cuttings of K-feldspar, quartz and muscovite from meta-sedimentary rocks				
13-14	Pinkish white to light grey, quartz vein material mixed with eluvial and consists fine cuttings of quartz, K-feldspar muscovite and rock	ABH-1/5 (13-14)	47.1	91.6	40.4
14-19	Light brown powder with fine cuttings of quartz, K-feldspar rock and biotite	ABH-1/6 (14-19)	48.1	122	21.4
19-20	White to greyish white powder with fine cuttings of quartz, K-feldspar, muscovite and biotite from pegmatite	ABH-1/7 (19-22)	16.9	36.6	20.4
20-21	White powder with fine cuttings of quartz, K-feldspar, muscovite and biotite from pegmatite				
21-22	Greyish white powder with fine cuttings of quartz, K-feldspar, muscovite and biotite from pegmatite				
22-26	Dark brown powder (meta-sedimentary rocks) with fine cuttings of quartz, K-feldspar and rock	ABH-1/8 (22-26)	6.44	40	16.8

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-2, RL : 742.001, Angle: 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-3	Grey powder with cuttings, pieces of rock, quartz, K-feldspar and muscovite from pegmatite	ABH-2/1 (0-3)	41.45	88.2	20.45
3-5	Brown powder with fine cuttings of K-feldspar, quartz and muscovite from meta-sedimentary.	ABH-2/2 (3-5)	18.55	83.1	27.95
5-7	Greyish white powder with fine cuttings and chips of quartz, K-feldspar and muscovite from pegmatite	ABH-2/3 (5-7)	34.7	102	27.1
7-9	Brown powder with fine cuttings of quartz, K-feldspar, muscovite and schist	ABH-2/4 (7-9)	6.96	70.1	15.7
9-11	Light greyish brown powder with fine cuttings of quartz, K-feldspar, muscovite from pegmatite	ABH-2/5 (9-11)	38.2	117	18
11-12	Brown powder with fine cuttings of quartz, K-feldspar, rock (schist) and muscovite	ABH-2/6 (11-16)	32.3	102	18.9
12-13	Light brown powder with fine cuttings of quartz, K-feldspar, rock (schist) and muscovite				
13-16	Brown powder with fine cuttings of quartz, K-feldspar, rock (schist) and muscovite				

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
16-20	Greyish brown powder with fine cuttings of quartz, K-feldspar, rock (schist) and muscovite	ABH-2/7 (16-21)	9.05	62.6	11.6
20-21	Greyish powder with fine cuttings of quartz, K-feldspar, rock (schist) and muscovite				
21-22	Greyish powder with fine cuttings of quartz, K-feldspar, rock (schist) and muscovite	ABH-2/8 (21-23)	11.3	50	16.3
22-23	Light greyish powder with fine cuttings of quartz, K-feldspar, rock (schist) and muscovite				

* The corresponding depth of the samples is given in parenthesis

BHNo. :ABH-3, RL: 744.381, Angle: 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Brown powder with cuttings of, chips and pieces of quartz, K-feldspar and rock from meta-sedimentary	ABH-3/1 (0-5)	18.6	79.2	12
1-5	Greyish brown powder with cuttings of, chips and pieces of quartz, K-feldspar and rock from mete-sedimentary				
5-6	Greyish brown powder with cuttings of, chips and pieces of quartz, K-feldspar and rock from mete-sedimentary	ABH-3/2 (5-10)	8.3	68.8	16.8
6-10	Light greyish brown powder with cuttings of, chips and pieces of quartz, K-feldspar and rock from mete-sedimentary				
10-15	Light greyish brown powder with cuttings of, chips and pieces of quartz, K-feldspar and rock from mete-sedimentary	ABH-3/3 (10-15)	13.55	77.85	18.7
15-16	Greyish white powder from pegmatite with fine cuttings and chips of quartz, K-feldspar muscovite and biotite	ABH-3/4 (15-20)	29.8	71.15	28.7
16-20	White powder from pegmatite with fine cuttings and chips of quartz, K-feldspar muscovite and biotite				
20-21	White powder from pegmatite with fine cuttings and chips of quartz, K-feldspar muscovite and biotite	ABH-3/5 (20-22)	59.1	112	36.6
21-22	Light greyish brown powder from pegmatite with fine cuttings and chips of quartz, K-feldspar muscovite and biotite				
22-24	Dark brown powder with fine cuttings of quartz, K-feldspar, muscovite and schist	ABH-3/6 (22-24)	53.6	101	30.9

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-4, RL: 748.271, Angle: 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-2	Sample loss, light brown to pink powder from pegmatite with cuttings and chips of quartz, plagioclase	ABH-4/1 (0-2)	72.6	102	18.4
2-5	Pinkish white powder with cuttings and chips of plagioclase, quartz and muscovite	ABH-4/2 (2-5)	39.3	121	37.5
5-6	Dark greyish brown powder with fine cuttings of quartz and K-feldspar from schist	ABH-4/3 (5-10)	5.39	48.5	17.5
6-10	Dark brown powder with fine cuttings of quartz and K-feldspar from schist				

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
10-15	Pinkish white powder from pegmatite with fine cuttings of plagioclase, quartz and muscovite	ABH-4/4 (10-15)	42.8	118	41.7
15-18	Pinkish white powder from pegmatite with fine cuttings of plagioclase, quartz and muscovite	ABH-4/5 (15-18)	44.6	119	49.3
18-23	Dark brown powder with fine cuttings of quartz, K-feldspar and muscovite	ABH-4/6 (18-23)	17.6	64.3	13.3
23-25	Dark brown powder with fine cuttings of quartz, K-feldspar and muscovite	ABH-4/7 (23-25)	28.35	72.15	16.05

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-5,RL: 744.526,Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-2	Sample loss, pinkish white powder with cuttings, chips and few pieces of quartz, plagioclase and rock	ABH-5/1 (0-2)	75.8	78.4	14.45
2-4	Dark brown powder from schist with fine cuttings and chips of quartz, plagioclase, muscovite and rock	ABH-5/2 (2-4)	41.7	81.0	21.4
4-6	Light pink powder with fine cuttings of quartz, plagioclase, muscovite	ABH-5/3 (4-6)	36.1	77.9	23.0
6-7	Dark brown powder with fine cuttings of quartz, plagioclase and rock	ABH-5/4 (6-7)	7.9	65.3	9.3
7-10	Greyish white powder from pegmatite with fine cuttings of quartz, plagioclase, and rock	ABH-5/5 (7-10)	31.1	119	18.8
10-13	Dark brown powder with fine cuttings of quartz, plagioclase, biotite and rock (schist)	ABH-5/6 (10-15)	17.9	56.1	19.1
13-14	Light brown powder with fine cuttings of quartz, plagioclase, biotite and rock (schist)				
14-15	Dark brown powder with fine cuttings of quartz, plagioclase, biotite and rock (schist)				
15-18	Dark brown powder with fine cuttings of quartz, plagioclase, biotite and rock (schist)	ABH-5/7 (15-18)	23.1	115.0	22.7
18-20	Light greyish powder with cuttings and chips of quartz, plagioclase and muscovite from pegmatite.	ABH-5/8 (18-21)	24.3	57.3	23.3
20-21	Greyish white powder with cuttings and chips of quartz, plagioclase and muscovite from pegmatite.				
21-27	Dark grey powder with fine cuttings of quartz, plagioclase, biotite and rock (schist)	ABH-5/9 (21-27)	9.5	64.1	17.1

* The corresponding depth of the samples is given in parenthesis

BHNo. ABH-6 , RL: 741.455, Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-2	Loss of sample, light pinkish powder with cuttings and chips of quartz, K-feldspar, muscovite from pegmatite	ABH-6/1 (0-2)	19.33	41.0	16.25
2-7	Dark brown powder with fine cuttings of quartz, K-feldspar rock, muscovite and biotite from schist	ABH-6/2 (2-7)	39.1	66.2	44.8

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
7-9	Dark brown powder with fine cuttings of quartz, K-feldspar rock, muscovite and biotite from schist	ABH-6/3 (7-9)	6.51	56.8	10.5
9-10	Greyish white powder with fine cuttings and chips of quartz, K-feldspar, muscovite from pegmatite	ABH-6/4 (9-14)	18.9	133.0	32.8
10-14	White powder with fine cuttings and chips of quartz, K-feldspar, muscovite from pegmatite				
14-19	Dark brown powder with fine cuttings of quartz, K-feldspar rock, muscovite, biotite and schist	ABH-6/5 (14-19)	9.4	49.9	14.2
19-23	Dark brown powder with fine cuttings of quartz, K-feldspar rock, muscovite, biotite and schist	ABH-6/6 (19-24)	11.8	41.7	8.4
23-24	Brown powder with fine cuttings of quartz, K-feldspar rock, muscovite, biotite and schist				
24-26	Brown powder with fine cuttings of quartz, K-feldspar rock, muscovite, biotite and schist	ABH-6/7 (24-26)	5.98	51.3	15.7

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-7, RL : 741.222, Angle: 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-5	Loss of sample, pinkish white powder with cuttings and chips of quartz, plagioclase, muscovite, tourmaline from pegmatite	ABH-7/1 (0-5)	18.9	97.9	63
5-10	Pinkish white powder with little cuttings and chips of quartz, plagioclase, muscovite, tourmaline from pegmatite	ABH-7/2 (5-10)	43.3	62	33.2
10-15	Pinkish white powder with little cuttings and chips of quartz, plagioclase, muscovite, tourmaline from pegmatite	ABH-7/3 (10-15)	86	124	72.7
15-17	Greyish brown powder with fine cuttings and chips of quartz, K-feldspar, biotite and schist	ABH-7/4 (15-20)	13.1	73.4	27.1
17-20	Dark brown powder with fine cuttings and chips of quartz, K-feldspar, biotite and schist				
20-25	Greyish brown powder with fine cuttings and chips of quartz, K-feldspar, biotite and schist	ABH-7/5 (20-25)	23.4	60.9	20.6

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-8, RL : 740.004, Angle: 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, greyish white powder from quartz vein with cuttings and chips of quartz, plagioclase and muscovite	ABH-8/1 (0-5)	18.7	46.9	8.9
1-5	Pinkish white powder from quartz vein with cuttings and chips of quartz, plagioclase and muscovite				
5-10	Light brown powder with cuttings of quartz, K-feldspar and muscovite and meta-sedimentary rocks	ABH-8/2 (5-10)	4.24	42.1	14.4
10-11	Reddish brown powder with fine cuttings of quartz, K-feldspar and meta-sedimentary rocks	ABH-8/3 (10-11)	5.63	61.1	18.3
11-15	Brown powder with cuttings of quartz, K-feldspar and meta-sedimentary rocks	ABH-8/4 (11-15)	5.72	59.4	15.7

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
15-17	Pinkish white powder with cuttings of quartz, K-feldspar and muscovite from quartz vein	ABH-8/5 (15-17)	25.6	111.5	24.15
17-19	Brown powder with fine cuttings of quartz, K-feldspar and meta-sedimentary rocks	ABH-8/6 (17-19)	4.19	46.7	8.8
19-22	Greyish brown powder with fine cuttings of quartz, K-feldspar, plagioclase and meta-sedimentary rocks	ABH-8/7 (19-22)	4.1	52.5	12.4
22-26	Pinkish white powder from pegmatite with fine cuttings of quartz, plagioclase, muscovite and rock	ABH-8/8 (22-26)	11.3	63.8	16.9

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-9, RL : 736.798, Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-3	Loss of sample, brown powder mixed with soil with cuttings and chips of plagioclase, quartz, muscovite, biotite and schist	ABH-9/1 (0-3)	9.01	64	11.95
3-7	White powder with fine cuttings of quartz, plagioclase, and muscovite from pegmatite	ABH-9/2 (3-7)	23.1	113	29.9
7-9	Brown powder with cuttings of quartz, K-feldspar and rock (schist) pieces	ABH-9/3 (7-12)	10.22	69.85	17.8
9-12	Greyish brown powder with cuttings of quartz, K-feldspar and rock (schist) pieces				
12-15	Greyish brown powder with cuttings of quartz, K-feldspar and rock (schist) pieces	ABH-9/4 (12-15)	4.67	48.5	19.6

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-10, RL : 747.697, Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-5	Loss of sample, brown powder with cuttings, chips and pieces of quartz, plagioclase, muscovite and schist	ABH-10/1 (0-5)	30.1	63.4	12.65
5-9	Brown powder with cuttings, chips and pieces of quartz, plagioclase, muscovite and schist	ABH-10/2 (5-9)	28.8	53.6	11.1
9-11	Light grey powder with fine cuttings of quartz, K-feldspar and muscovite from quartz vein	ABH-10/3 (9-11)	7.79	52.8	7.67
11-12	Brown powder with fine cuttings of quartz, K-feldspar, muscovite and schist	ABH-10-4 (11-12)	13.3	83.4	16.2
12-15	Light grey powder with fine cuttings of quartz, K-feldspar, muscovite from pegmatite	ABH-10/5 (12-15)	28.8	61.8	15.4
15-18	Greyish powder with fine cuttings of quartz, K-feldspar, muscovite from meta-sedimentary rocks	ABH-10/6 (15-18)	20.4	118	12.7
18-22	Brownish powder with fine cuttings of quartz, K-feldspar, muscovite and schist	ABH-10/7 (18-22)	14.7	55.25	17.6
22-27	Light grey powder with fine cuttings of quartz, K-feldspar, muscovite from pegmatite	ABH-10/8 (22-27)	8.46	42.8	9.9
27-31	Greyish white powder with fine cuttings of quartz, K-feldspar, muscovite from pegmatite	ABH-10/9 (27-31)	7.07	37.1	9.6

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-11, RL : 746.035, Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-5	Loss of sample, dark brown powder from meta-sedimentary rocks with cuttings and pieces of rock, quartz and K-feldspar	ABH-11/1 (0-5)	2.36	37.3	8.55
5-6	Dark brown powder from meta-sedimentary rocks with cuttings and pieces of rock, quartz and K-feldspar	ABH-11/2 (5-10)	1.85	19.8	8.9
6-10	Light brown powder from meta-sedimentary rocks with cuttings and pieces of rock, quartz and K-feldspar				
10-15	Light brown powder from meta-sedimentary rocks with cuttings and pieces of rock, quartz and K-feldspar	ABH-11/3 (10-15)	2.15	24.1	5.01
15-16	Light brown powder from meta-sedimentary rocks with cuttings and pieces of rock, quartz and K-feldspar	ABH-11/4 (15-16)	4.42	28.45	9.85
16-20	Pinkish white powder from quartz vein with fine cuttings of quartz, K-feldspar, muscovite	ABH-11/5 (16-20)	24.8	45.4	11
20-25	Brown powder with fine cuttings and chips quartz, K-feldspar, muscovite and schist	ABH-11/6 (20-25)	3.3	22.9	5.75

* The corresponding depth of the samples is given in parenthesis

BHNo. :ABH-12, RL : 733.910, Angle : 60°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Pink colour powder admixed with surface soil, cuttings and pieces of K-feldspar and quartz from pegmatite	ABH-12/1 (0-3)	6.03	44.7	9.3
1-3	Pink colour powder cuttings of K-feldspar and quartz				
3-4	Pinkish white powder with pieces and cuttings of quartz and K-feldspar	ABH-12/2 (3-4)	25.4	103	29.3
4-6	Greyish powder with fine cuttings of quartz, K-feldspar, muscovite and rock	ABH-12/3 (4-6)	4.19	45.15	9.35
6-11	Greyish white powder with fine cuttings of quartz, K-feldspar, plagioclase, muscovite	ABH-12/4 (6-11)	8.9	52.4	10.2
11-16	Greyish white powder with fine cuttings of quartz, K-feldspar, plagioclase, muscovite	ABH-12/5 (11-16)	3.58	39.6	11.3
16-21	Greyish white powder with fine cuttings of quartz, K-feldspar, plagioclase, muscovite	ABH-12/6 (16-21)	5.43	35	4.6
21-26	Greyish white powder with fine cuttings of quartz, K-feldspar, plagioclase, muscovite	ABH-12/7 (21-26)	5.77	41.8	8.6
26-30	Greyish white powder with fine cuttings of quartz, K-feldspar, plagioclase, muscovite	ABH-12/8 (26-30)	9.62	50.4	13.9

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-13, RL : 740.873, Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, greyish white powder from quartz vein with fine cuttings of quartz and K-feldspar	ABH-13/1 (0-1)	5.6	79.2	11.5
1-6	Pinkish colour powder with cuttings of quartz, K-feldspar, muscovite from pegmatite	ABH-13/2 (1-6)	9.1	23.3	13.8

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
6-7	Pinkish colour powder with cuttings of quartz, K-feldspar, muscovite from pegmatite	ABH-13/3 (6-7)	6.9	55.3	15.8
7-12	Pinkish white powder with fine cuttings of quartz, plagioclase, muscovite from pegmatite	ABH-13/4 (7-12)	75.9	197.0	16.5
12-16	Pinkish white powder with fine cuttings of quartz, plagioclase, muscovite from pegmatite	ABH-13/5 (12-16)	26.55	68.35	23.45
16-21	Brownish powder with fine cuttings of quartz, K-feldspar, muscovite and schist	ABH-13/6 (16-21)	20.0	40.6	13.5
21-27	Light greyish brown powder with fine cuttings of quartz, K-feldspar, muscovite and schist	ABH-13/7 (21-27)	12.7	48.3	9.8
27-29	White powder with fine cuttings of quartz, K-feldspar, muscovite from quartz vein	ABH-13/8 (27-29)	13.0	115.0	13.6
29-31	Greyish brown powder with fine cuttings of quartz, K-feldspar, muscovite and meta-sedimentary rocks	ABH-13/9 (29-31)	4.5	82.7	11.7

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-14, RL : 738.777,Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Surface soil with powder from pegmatite and pieces and cuttings of quartz, k-feldspar	ABH-14/1 (0-1)	37.7	68.5	17.2
1-5	Pinkish white powder of pegmatite with pieces and cuttings of quartz and k-feldspar	ABH-14/2 (1-5)	46.4	78.8	15.4
5-7	Light brown powder with pieces of granite gneiss, quartz, mica flakes	ABH-14/3 (5-7)	60.9	99.1	39.8
7-8	Light pink powder of pegmatite with pieces of k-feldspar and muscovite	ABH-14/4 (7-8)	127	169	102
8-13	Pinkish white powder of pegmatite with pieces of k-feldspar, quartz, muscovite	ABH-14/5 (8-13)	133	227	34.3
13-17	Greyish powder with cuttings and chips of quartz, plagioclase, muscovite and rock	ABH-14/6 (13-18)	219	417	41.3
17-18	Greyish white powder with cuttings and chips of quartz, plagioclase, muscovite and rock				
18-23	White powder of quartz vein with cuttings and chips of quartz, plagioclase, muscovite and rock	ABH-14/7 (18-23)	21.5	35.5	11.7
23-28	White powder of quartz vein with cuttings and chips of quartz, plagioclase, muscovite and rock	ABH-14/8 (23-28)	23.9	54.95	15.9
28-33	White powder of quartz vein with cuttings and chips of quartz, plagioclase, muscovite and rock	ABH-14/9 (28-33)	42.2	69.6	16.7
33-38	Light pinkish powder of pegmatite with fine cuttings of quartz, k-feldspar, and muscovite	ABH14/10 (33-38)	38.65	91.6	29.75
38-42	Light pinkish powder of pegmatite with fine cuttings of quartz, k-feldspar, and muscovite	ABH-14/11 (38-42)	44.4	80.6	18.4

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
42-43	Light pinkish powder of pegmatite with fine cuttings of quartz, k-feldspar, and muscovite	ABH-14/12 (42-45)	65.6	115	5.7
43-45	Pinkish white powder of pegmatite with fine cuttings of quartz, k-feldspar, and muscovite				
45-49	Brown powder with fine cuttings of quartz, K-feldspar and meta-sedimentary rocks	ABH-14/13 (45-49)	14	64.2	14

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-15, RL : 741.759,Angle: 60°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-5	Loss of sample, light brown powder with cuttings and chips of quartz, plagioclase and muscovite	ABH-15/1 (0-5)	9.4	24.9	18.8
5-8	Light brown powder with cuttings and chips of quartz, plagioclase and muscovite	ABH-15/2 (5-8)	1.5	17.3	8.1
8-10	Pinkish white powder with fine cuttings of quartz, K-feldspar, muscovite from quartz vein	ABH-15/3 (8-10)	25.7	47	29.3
10-15	Brownish powder with fine cuttings of quartz and K-feldspar	ABH-15/4 (10-15)	4.55	31.65	12.85
15-18	Brownish powder with fine cuttings of quartz and K-feldspar	ABH-15/5 (15-18)	3.7	24.6	16.3
18-21	Pinkish white powder from quartz vein with fine cuttings of quartz, K-feldspar and muscovite	ABH-15/6 (18-21)	48.8	73.4	26.2
21-26	Pinkish brown powder with fine cuttings of quartz, K-feldspar and muscovite	ABH-15/7 (21-26)	115	170	29.1
26-29	Pinkish brown powder with fine cuttings of quartz, K-feldspar and muscovite	ABH-15/8 (26-29)	2.5	21	7.2

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-16, RL: 737.092, Angle : 61°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, pinkish white powder with cuttings and chips of quartz, plagioclase, muscovite from quartz vein	ABH-16/1 (0-3)	27.3	34.8	22.6
1-3	Pinkish white powder with cuttings and chips of quartz, plagioclase, muscovite from quartz vein				
3-8	Brown to greyish brown powder with cuttings and chips of quartz, plagioclase, muscovite and schist	ABH-16/2 (3-8)	14.9	61.9	23.4
8-10	Brown to greyish brown powder with cuttings and chips of quartz, plagioclase, muscovite and schist	ABH-16/3 (8-10)	6.48	50	12.9
10-11	White vein quartz powder with fine cuttings of quartz, K-feldspar and muscovite	ABH_16/4 (10-11)	37.85	61.05	10.35
11-16	Brown powder with cuttings and chips of quartz, plagioclase, muscovite and rock (schist)	ABH-16/5 (11-16)	5.33	47.55	15.7

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
16-19	Brown powder with cuttings and chips of quartz, plagioclase, muscovite and rock (schist)	ABH-16/6 (16-19)	10.1	56.2	16.6
19-22	White pegmatite powder with fine cuttings of quartz, K-feldspar and muscovite	ABH-16/7 (19-22)	23.5	69.3	19
22-25	Brown to greyish brown powder of schist	ABH-16/8 (22-25)	3.53	45.3	8.5

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-17, RL : 747.971,Angle: 61°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, light pink powder of pegmatite with cuttings of quartz, k-feldspar, muscovite and soil with eluvial	ABH-17/1 (0-4)	6.7	14.9	1.22
1-4	Light pink powder of pegmatite with cuttings of quartz, k-feldspar and muscovite				
4-5	White powder of quartz vein with fine cuttings of quartz, k-feldspar, plagioclase and muscovite	ABH_17/2 (4-5)	14.2	34.4	9.6
5-10	Pink powder of pegmatite with fine cuttings of quartz, k-feldspar, muscovite and pieces of granite	ABH-17/3 (5-10)	9.85	21.75	1.9
10-15	Pink powder of pegmatite with fine cuttings of quartz, k-feldspar, muscovite and pieces of granite	ABH-17/4 (10-15)	1.69	21.55	5.05
15-17	Pink powder of pegmatite with fine cuttings of quartz, k-feldspar, muscovite and pieces of granite	ABH-17/5 (15-17)	2.32	23.4	6.6
17-22	White to pinkish white powder of quartz vein with fine cuttings of quartz, k-feldspar, and muscovite	ABH-17/6 (17-22)	6.42	19.5	9.9
22-27	Pinkish brown powder of pegmatite with fine cuttings of quartz, k-feldspar, muscovite and pieces of granite	ABH-17/7 (22-27)	24.1	20.3	3.4

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-18, RL: 745.642, Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, light pinkish brown powder of pegmatite with cuttings, and chips of quartz, plagioclase, muscovite, eluvial and soil.	ABH-18/1 (0-5)	7.05	36.8	10.55
1-5	Light pinkish brown powder of pegmatite with cuttings, and chips of quartz, plagioclase and muscovite				
5-10	Light pinkish brown powder of pegmatite with cuttings, and chips of quartz, plagioclase and muscovite	ABH-18/2 (5-10)	2.9	33.3	9.1
10-15	Light pinkish brown powder of pegmatite with cuttings, and chips of quartz, plagioclase and muscovite	ABH-18/3 (10-15)	6.3	56.1	10.6
15-19	Pinkish brown powder of pegmatite with cuttings, and chips of quartz, plagioclase and muscovite	ABH-18/4 (15-19)	4.3	48.2	8.8
19-24	Greyish white to white powder of pegmatite with fine cuttings, and chips of quartz, k-feldspar, muscovite	ABH-18/5 (19-24)	10.8	60.1	26.2

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
24-29	Greyish white to white powder of pegmatite with fine cuttings, and chips of quartz, k-feldspar, muscovite	ABH-18/6 (24-29)	7.2	52.9	13.9
29-32	Greyish white to white powder of pegmatite with fine cuttings, and chips of quartz, k-feldspar, muscovite	ABH-18/7 (29-32)	4.1	47.4	11.1
32-33	Light brown powder of pegmatite with fine cuttings, chips and pieces of quartz, k-feldspar, muscovite	ABH-18/8 (32-33)	5.0	60.5	14.8
33-36	White powder of quartz vein with fine cuttings, and chips of quartz, k-feldspar, muscovite	ABH-18/9 (33-36)	15.8	79	21.9
36-39	Greyish brown powder of pegmatite with fine cuttings, and chips of quartz, k-feldspar, muscovite	ABH-18/10 (36-39)	11.55	67.45	16.85

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-19, RL : 747.088, Angle: 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, pink powder of pegmatite with cuttings, and chips of quartz, plagioclase, eluvial and soil.	ABH-19/1 (0-5)	7.9	25.7	1.45
1-5	Pinkish brown powder of pegmatite with cuttings, and chips of quartz and plagioclase				
5-7	Pinkish brown powder of pegmatite with cuttings, and chips of quartz and plagioclase	ABH-19/2 (5-7)	5.5	36	4.12
7-12	Pinkish brown powder of pegmatite with cuttings, and chips of quartz and plagioclase	ABH-19/3 (7-12)	6.8	22.2	1.69
12-14	Pinkish brown powder of pegmatite with cuttings, and chips of quartz and plagioclase	ABH-19/4 (12-14)	7.9	21.4	2.16
14-19	Pinkish white powder of quartz vein with fine cuttings, and chips of quartz, k-feldspar, muscovite	ABH-19/5 (14-19)	9.8	41.75	5.84
19-24	Pinkish brown powder of pegmatite with cuttings, and chips of quartz and plagioclase	ABH-19/6 (19-24)	9.6	38.1	4.48
24-28	Pinkish brown powder of pegmatite with cuttings, and chips of quartz and plagioclase	ABH-19/7 (24-28)	9.2	36.6	3.89

* The corresponding depth of the samples is given in parenthesis

BHNo. :ABH-20, RL : 746.122, Angle : 62°(from horizontal)

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-3	Dark greyish brown powder of meta-sedimentary rocks with cuttings and chips of rock, quartz, k-feldspar and biotite	ABH-20/1 (0-3)	3.96	31.3	18.5
3-4	White quartz-vein powder with fine cuttings of quartz, plagioclase, muscovite and biotite	ABH-20/2 (3-4)	4.79	8.75	6.10
4-9	Greyish brown powder of meta-sedimentary rocks with cuttings and chips of rock, quartz, k-feldspar and biotite	ABH-20/3 (4-9)	1.29	29.45	13.15
9-14	Greyish brown powder of meta-sedimentary rocks with cuttings and chips of rock, quartz, k-feldspar and biotite	ABH-20/4 (9-14)	15.45	51.5	10.9

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
14-19	Greyish brown powder of meta-sedimentary rocks with cuttings and chips of rock, quartz, k-feldspar and biotite	ABH-20/5 (14-19)	2.39	31.6	13.8
19-23	Greyish brown powder of meta-sedimentary rocks with cuttings and chips of rock, quartz, k-feldspar and biotite	ABH-20/6 (19-23)	3.41	27.4	15.1

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-21, RL : 737.013, Angle : vertical

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Loss of sample, brown powder, top soil with cuttings and pieces of calcrete, quartz, k-feldspar and muscovite	ABH-21/1 (0-1)	2.59	14.10	7.0
1-6	Creamish colour powder with fine cuttings of calcrete, quartz, plagioclase, k- feldspar and muscovite	ABH-21/2 (1-6)	<0.1	2.07	6.4
6-11	Creamish colour powder with fine cuttings of calcrete, quartz, plagioclase, k- feldspar and muscovite	ABH-21/3 (6-11)	0.4	4.36	4.9
11-16	Creamish colour powder with fine cuttings of calcrete, quartz, plagioclase, k- feldspar and muscovite	ABH-21/4 (11-16)	1.24	9.77	5.6
16-20	Dark greyish brown powder of meta-sedimentary rocks with fine cuttings of rock, calcrete and biotite	ABH-21/5 (16-20)	<0.10	16.0	7.10

* The corresponding depth of the samples is given in parenthesis

BH No.:ABH-22, : 735.700, Angle : vertical

Depth (m)	Lithology	Sample No.	Assay (ppm)		
			Ta_2O_5	Nb_2O_5	SnO_2
0-1	Light brown powder of top soil mixed with eluvial and fine cuttings of plagioclase, quartz, and muscovite from meta-sedimentary rocks	ABH-22/1 (05)	2.99	4.98	15.30
1-5	Light brown powder with fine cuttings of plagioclase, quartz, and muscovite from meta-sedimentary rocks				
5-10	Light brown powder with fine cuttings of plagioclase, quartz, and muscovite from meta-sedimentary rocks	ABH-22/2 (5-10)	4.36	7.00	14.10
10-15	Light brown powder with fine cuttings of plagioclase, quartz, and muscovite from meta-sedimentary rocks	ABH-22/3 (10-15)	3.78	20.6	8.95
15-20	Light brown powder with fine cuttings of plagioclase, quartz, and muscovite from meta-sedimentary rocks	ABH-22/4 (15-20)	1.32	<0.10	5.90
20-25	Creamish white to white powder with fine cuttings of calc-silicate, quartz, k-feldspar.	ABH-22/5 (20-25)	2.31	<0.10	5.90
25-28	Light brown powder with fine cuttings of plagioclase, quartz, and muscovite from meta-sedimentary rocks	ABH-22/6 (25-28)	5.11	11.40	13.10

* The corresponding depth of the samples is given in parenthesis

ascertain the presence of more sets of parallel quartz veins, their continuity, structural behaviour and relation with the host rocks.

Ten trenches were excavated in this block with a total excavation of 532.61 m. 277.5 m of trench were logged. In general, the depth of trench was from 1 to 1.5 m and the width about 1 m. However, at some places where big quartz body/vein was encountered, the depth of trench was increased up to 2 m or even more. All the trenches were mapped at a scale of 1:100 (Fig. 5).

Seventy-seven trench samples were prepared from the 10 trenches. Table II shows the details of lithologs of trenches with their corresponding value of Ta_2O_5.

A total of twenty-five pits were excavated to understand the behaviour of soil and eluvium. The pit dimension was 1 metre wide, 1 metre long and the maximum depth was also 1 metre, depending on the depth of the bedrock encountered.

The lithology and corresponding tantalite values of individual pits are presented in Table III.

Drilling

Subsequent to the surface sampling and reconnaissance geological work, Reserve Circulation (RC) Drilling was carried out. RC drilling is an effective tool to have first order information regarding the extent of mineralization and to unravel the subsurface geology.

The RC drilling operation is non-coring and only powdered sample is recovered with small amount of cuttings, chips and small pieces. The RC drilling work was accomplished by the company "Hardrock Drilling, Namibia". The output was recovered continuously with RC drilling but to check geological and lithological variations, the output for every metre of drilling was collected and stacked separately. The physical properties of the output were measured and every metre was logged. Geological logging and sampling were done simultaneous to drilling. Usually, 5 m long composite samples were prepared but the length of the composite samples was reduced in some places depending on the lithological variations.

In this block, twenty-two RC boreholes were drilled to know the depth of quartz veins associated with pegmatite, which is the main tantalite bearing rock in this area (Fig. 2). No grid was followed for drilling because of the erratic nature of the quartz veins. The cumulative length of these boreholes is 602 m from which one hundred and sixty four composite samples were prepared and analysed for Ta_2O_5, Nb_2O_5 and SnO_2. Details of the lithologs of all the boreholes of the block are provided in Table 4. Except for two bore holes (ABH-21 and ABH-22) all the remaining boreholes are inclined. The maximum depth of borehole in this block is 49 m while the minimum depth is 15 m. Five cross-sections were constructed using borehole lithologs (Fig. 3).

Bulk sampling

To know average tantalite recovery from the quartz veins, 2.2 tonnes of sample were collected from all the quartz veins exposed over the surface of the block as well as encountered in the trenches in the block. Besides, one tonne of eluvial sample was also collected from the surface of this block to determine the average content in the eluvials occupying the block.

All the samples were analyzed for their tantalum, niobium and tin content and recalculated for their Ta_2O_5, Nb_2O_5 and SnO_2 content in ppm, in Mintek Laboratory, South Africa. The analysis was carried out in ICP-MS having a multi-channel analyzer of Perkin Elmer make.

Results and discussion

The category-wise details with respect to the tantalite content of the samples analysed are discussed below.

Trench and pit samples

Out of the total seventy-seven trench samples (Table II), two samples have a value over 100 ppm of Ta_2O_5 (AT-3/7 with 157 ppm and AT-1/1 with 109 ppm). Besides, five samples have a value between 50 and 100 ppm (AT-2/6 with 87.5 ppm, AT-2/8 with 79.3 ppm, AT-3/8 with 53.9 ppm, AT-4/9 with 61.8 ppm and AT-10/1 with 77.0 ppm). These high value samples are quartz-feldspathic pegmatites. All the remaining samples have a value less than 50 ppm. Thus the quartz-feldspathic rocks (pegmatites) have a non-uniform and non-continuous tantalite mineralization at the surface as indicated by localized tantalum enrichment at few places. This is also supported by the values of Ta_2O_5 analysed in the pit material samples (Table III). Out of twenty-five pits, only one pit sample has a value over 100 ppm (AP-23 with 122 ppm). Two pit samples have values between 50 and 100 ppm (AP-4 with 53.9 ppm and AP-22 with 53.6 ppm). The rest of samples have lower values. Moreover, six trench samples and three pit samples have Nb_2O_5 values between 100 and 150 ppm, while three trench samples have values higher than 150 ppm. All the samples have concomitantly low values of SnO_2 (Tables II and III).

Chemical analysis of surface rock samples

The seventeen surface rock samples collected from this block (Table I) have a Ta_2O_5 value below 50 ppm. The maximum value of 47.8 ppm is observed in sample ASS-2. However, the dark coloured pebbles collected from this block have a Ta_2O_5 value of 484 (sample APEB). Thus, the surface has an erratic distribution of Ta_2O_5 in varying proportions. Besides, two samples have Nb_2O_5 values more than 150 ppm, while all the samples have low SnO_2 values (Table I).

Analysis of bulk samples

The head assay of bulk sample gave a very low value of Ta_2O_5 (20 ppm), Nb_2O_5 (22 ppm) and SnO_2 (12 ppm), on record. The head assay of eluvial sample gave a value of 17.5 ppm of Ta_2O_5, 39.5 ppm of Nb_2O_5 and 18.5 ppm of SnO_2. The analytical values obtained support the view that the concentration of tantalite and the associated minerals is irregular in nature.

Drilling samples

Out of a total of one hundred and sixty four composite samples prepared from twenty-two boreholes (Table IV), four samples have a value higher than 100 ppm of Ta_2O_5 (ABH-14/4 with 127 ppm, ABH-14/5 with 133 ppm, ABH-14/6 with 219 ppm and ABH-15/7 with 115 ppm). The first three samples belong to a single borehole and occur consecutively with a cumulative thickness of 11 metres and ABH-15/7 is a 5 m sample. Three samples have a value between 50 and 100 ppm (ABH-4/1 with 72.6 ppm, ABH-5/1 with 75.8 ppm, ABH-7/3 with 86 ppm and ABH-13/4 with 75.9 ppm). The remaining samples have, however, a low value of Ta_2O_5.

To visualize the irregular distribution of tantalite in the studied area, a cross section was constructed (Fig. 4) on the basis of the borehole and surface data. This reveals that the tantalite mineralization is more concentrated towards the southeastern part of the studied area. In addition, twenty samples have values 100 to 150 ppm of Nb_2O_5 and five samples have more than 150 ppm of Nb_2O_5. As far as SnO_2 is concerned, only one sample has a value between 100 and 150 ppm and the rest have low values (Table IV).

This implies that certain horizons of the area are mineralized with tantalite in varying concentrations. In addition to the presence of tantalite, the area also contains variable concentrations of niobium. The concentration of Ta_2O_5 above 100 ppm has been recorded in three surface samples, nine trench samples, three pit samples and twenty-three borehole samples. The drilling and trenching work revealed that the pegmatite bodies are either exposed on the surface or have a shallow overburden that can be seen in the cross sections (Fig. 3). Due to thin overburden in the area, it may be taken up for manual mining at a small to medium scale.

Conclusions

Based on the exploration activities carried out in Block-A, the points below could be ascertained.

The meta-sedimentary rocks are the oldest units of the studied area and are intruded by granites, granite-gneisses and dolerites. The granites, granite-gneisses and meta-sedimentary rocks have further been intruded by younger pegmatite and aplite dykes and quartz veins that generally occur parallel to the strike of the meta-sedimentary rocks but cut across them in places.

These rare metal pegmatites are formed by very coarse-grained quartz-feldspathic material and generally have a thickness of less than 50 m. They do not have noticeable internal zoning and exhibit a general trend of NE-SW. The quartz veins show pinch and swell structures and vary in thickness from half a metre to about 10 metres and exceptionally more, and are erratic in occurrence having a small surface extent. They occur mostly as tabular, pod-like, lensoid and vein-like bodies. Both the pegmatites and the quartz veins contain variable concentrations of Ta_2O_5, Nb_2O_5, SnO2 and lithium minerals occurring as disseminated grains. The distribution of tantalite is irregular in the pegmatites and the mineralization is more concentrated towards the southeastern part of the studied area. Moreover, tantalite enrichment in small to medium pockets occurs over the surface and extends up to variable depths. This is reflected by values of 157 ppm Ta_2O_5 in a 1.5 m portion of trench-3 (AT-3/7) and in a 4 m portion of trench-1 (AT-1/1) with 109 ppm. Near trench 3, a borehole (ABH-14) shows a 11 m thick zone of mineralization (from 7 m to 18 m depth) with an average value of 172 ppm (average of 127 ppm, 133 ppm and 219 ppm from three samples). Besides, one pit (AP-23 with 122 ppm) and the black pebbles scattered over the surface have also shown surface enrichment of tantalite but only at localized places. In addition, 10 samples have Nb_2O_5 values above 150 ppm and 30 samples between 100 and 150 ppm. Almost all the samples have a low SnO_2 value.

Thus, the localized mineralization of tantalite can be mined out / quarried out at a small to medium scale and the Ta_2O_5 concentrates may be obtained installing small processing plants.

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