Journal of Environmental Chemistry and Ecotoxicology Vol. 2(7), pp. 117-119, September 2010
Available online http://www.academicjournals.org/jece
ISSN-2141-226X ©2010 Academic Journals

Short Communication

EDXRF analysis of tantalite deposit of Mai-Kabanji, North-western Nigeria

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Accepted 1 July, 2010

The tantalite deposits of Mai-Kabanji area of Zamfara State Nigeria was studied for the elemental compositions by Energy dispersive x-ray fluoresce (EDXRF) spectrophotometry, physical properties and anionic composition by standard methods. The results indicated high concentrations of tantalum oxide, Ta_2O_5 (31.990%±0.83) and other valuable oxides of niobium, Nb_2O_5 (0.029%), titanium, TiO_2 (1.702%±0.42) and iron, Fe_2O_3 (1.702%±0.30) were also high. Physical properties tested showed high resistance on ignition (LOI 3.00%) and low alkalinity (8.51), grey colour, specific gravity range (7.2 - 8.0) and an average size of 0.12 mm. Sample was generally richer in tantalum oxide and other valuable mineral oxides of niobium, titanium, iron and manganese than other samples it was compared with, hence, it is economically valuable for exploration.

Key words: Tantalite, tantalum, niobium, EDXRF.

INTRODUCTION

Tantalite is the most important mineral form of tantalum, a specialty metal used mainly in the electronic industry for the manufacture of capacitors and in several specialty alloy applications (Adetunji et al., 2005).

Tantalum powder is used in the production of capacitors for electronic circuits in medical application such as hearing aids, peacemakers, ignition of motor control modules, air bags, GPS, ABS system in automobiles, laptop computers, cellular phones, play-stations, video cameras etc (Ruiz et al., 2004).

Tantalum and niobium oxides respectively, are major compositions of tantalite ore and columbite. If the concentration of tantalum oxide is higher than that of niobium oxide in the ore, the ore is tantalite while on the other hand, if the concentration of niobium oxide is higher than that of tantalum oxide, the ore is columbite. Large deposits of tantalite exist across the world, namely in Germany, Sweden, Norway, USSR, Nigeria and Namibia (FMSMSD, 2007).

This paper studies the elemental compositions of tantalite deposit of Mai-Kabanji area of Zamfara State, Nigeria by Energy Dispersive X-Ray Fluoresce (EDXRF) spectrophotometry, physical properties and anionic composition of the mineral with the aim of identifying the mineral potentials for exploration and exportation was also considered.

MATERIALS AND METHODS

All the reagents used were analytical grades. Samples were collected at the different areas under study. They were packed in plastic containers, manually crushed and sieved with a 355 mm electric shaker (Gallpmark).

Sample preparation for EDXRF

The EDXRF analysis was conducted at the Centre for Energy Research and Training of the Ahmed Bello University, Zaira, Nigeria. The procedure used in this assay was reported by Funtua (1999b), Hassan and Umar (2004) and Adetunji et al. (2005). Each of the pulverized samples (0.3 g) was homogenized with 3 mg of an organic binder (polystyrene dissolved in toluene). This was pressed

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Table 1. Results of Percentage oxides from XRF analysis.

Element	% Element	Oxide	% Oxide
Ca	2.020	CaO	2.826
Ti	1.020	TiO_2	1.702 ± 0.42
V	0.570	V_2O_5	1.018
Cr	0.390	Cr_2O_5	0.570
Mn	0.210	MnO	0.302
Fe	5.500	Fe_2O_3	7.871 ± 0.30
Ni	0.010	NiO	0.013
Cu	0.082	CuO	0.103
Zn	0.054	ZnO	0.067
Ta	13.100	Ta_2O_5	31.990 ± 0.83
Ga	0.042	Ga_2O_3	0.071
Pb	0.052	PbO	0.056
Rb	0.010	Rb_2O	0.011
Sr	0.008	SrO	-
Y	0.007	Y_2O_3	-
U	0.012	U_3O_8	0.014
Zr	0.063	ZrO_2	0.085
Nb	0.010	Nb_2O_5	0.029
Co	0.370	CoO	0.471 ± 0.34
		Total	47.09

± indicate limit of detection.

Table 2. Results of physical properties of the mineral.

Physical property	Quantity
Loss on ignition (%)	3.00
pH	8.51
Colour	Grey
Average size (mm)	0.12
Specific gravity	7.2 - 8.0

Table 3. Results of the confirmatory determination of anions.

Sample	NO_3^-	HCO_3^-	Cl^-	SO_4^-
(mg/l)	750	12.5	300	283.94

at 10 tons with a hydraulic press (SPECAC) to form a pellet of 19 mm diameter die. The pellets were introduced into the energy dispersive spectrophotometer consisting an annular 25 m ci Cd–109 isotope as the excitation source emitting Ag-K x-ray (221 keV) and a Mo X-ray tube (50 kV, 5 mA).

Loss on ignition

Each of the pulverized samples (2.0 g) was placed in platinum crucibles and fired in a laboratory muffle furnace operated at 1000°C for 2 h, then removed and cooled in desiccators for 10 min before the final weights were taken. The loss on ignition was calculated as:

LOI = Weight before firing – Weight after firing

pH test

Each of the grounded samples (10.0 g) was weighted, dissolved, in a 10 cm^3 of distilled water, and was stirred vigorously to ensure homogeneity. The pH was measured after calibration.

Determination of anions

Anions, nitrate, biocarbonate, chloride and sulphate were determined according to standard methods (Ademoroti, 1996).

RESULTS AND DISCUSSION

The results of percentage elemental and oxide composition obtained from the Mai-Kabanji sample are shown in Table 1. The result revealed high percentage of tantalum (13.100%) followed by iron (5.50%), then calcium (2.02%) and titanium (1.02%). Percentages of other elements are less than 1. Similar trend were also observed for their oxides.

Table 2 shows the important physical properties for the mineral identification and industrial characterization.

Table 3, showed the result of the confirmatory determination of anionic constituents of the samples. The sample was tested for group analysis of anions prior to these confirmatory tests conducted.

DISCUSSION

The mineral composition of the tantalite deposit of Mai-Kabanji area was evaluated for mineralogy. The following were found: %Ta_2O_5 (31.990 ± 0.83), %TiO_2 (1.702 ± 0.42), %CaO (2.826), %Fe_2O_3 (7.871±0.30) and %V_2O_5 (1.018) as major composition of the ore. The result from Table 1 was within the range of eight tantalite samples across Nigeria reported by Adetunji et al. (2005) which had ranges as follows: %Ta_2O_5 (59.58 - 8.00), %TiO_2 (33.38 - 3.81) and %Fe_2O_3 (10.69 - 2.86). There is no universally accepted range for evaluating the %Ta_2O_5 of tantalite mineral. However, this evaluation varies as authors reported different percentages of %Ta_2O_5 as rich tantalite mineral. Ruiz et al. (2004) reported 10% Ta_2O_5, Funtua (1999a) reported 21 - 30% Ta_2O_5 while Adetunji et al. (2005) reported 25% Ta_2O_5. It was discovered that the %Nb_2O_5 (0.029) in this study was very low compared to other samples analyzed by reported author (37.48 - 19.74). This could be due to high purity tantalite of this area and the variation of the mineral ore from one ore vein to the other (Adetunji et al., 2004). The %Fe_2O_3 (7.871 ± 0.30) of this sample is indicating the presence of Ilmenite another valuable mineral.

Another mineral present is $\%TiO_2$ (1.702±0.42). This oxide is used for production of bicycles for cycling because it is light.

Obiajunwa, (2001) reported the presence of Hf, Zn, Zr, Co, Pb, Rb and Y. Table 1 shows the concentrations of these elements in the sample under study except for Hf. These elements exist as impurities but their presence determined the separation method and mineral applications for radioactive purposes based on the presence of radioactive elements such as Y, Th, and U in tracer quantities, another value addition.

Physical properties are important in mineral characterization; one of such is colour. Tantalite has similar physical properties with columbite. Table 2 shows the physical properties of the tantalite. The LOI (Table 2) entails low volatile matter, thus greater percentage of the material was retained after excessive heating at 1000°C, while the pH (Table 2) showed low alkalinity close to neutrality. In the laboratory isolation, tantalum element is mainly absorbed by the methly isobutyl-ketone (MIBK) organic layer.

The knowledge of the ligand field however, is important in this separation. The anionic composition of the mineral reveals the presence of high nitrate (750 mg/l) and low bicarbonate (12.50 mg/l). This will no doubt assist in adjusting the pH to 11 during isolation of the tantalite-columbite concentrate in NH_4OH (Htwe, 2008).

Conclusion

The mineral composition in terms of the oxides and elemental concentrations of the tantalite deposit of Mai-Kabanji was determined by EDXRF and was found to contain high concentration of $\%Ta_2O_5$ (31.990) within the accepted limit of rich tantalite deposits across the world. Other mineral oxides were also determined in the tantalite mineral including Fe_2O_3, TiO_2 and V_2O_5.

Physical properties tested showed low composition of volatile matter and anionic composition. The tantalite is generally suitable for exploration and exploitation.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the contributions of Mr. Ojo S. of the Federal Ministry of Mines and Steel Development, Zamfara State office and Mallam Sulaiman of the State Ministry of Environment and Solid Mineral. We also acknowledged the contributions of Mallam Chika .M and Mrs. Aishat Alhassan for their encouragement.

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