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Mineralization of asbestos in carbonatite complex of Tiruppattur, Tamil Nadu, India

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Abstract: *EDAX spot-analyzes of 22 riebeckite in a vein in ultramafic rock along shear zone occurring 1 km west of Mottusulakkarai village located 25 km SW of Tiruppattur Town are studied. The chemical composition show that they all K-rich magnesio-riebeckite, belonging to high grade asbestos group. The mineral assemblage present in the vein is riebeckite, crocidolite, chrysotile, tremolite, anorthoclase, ferrocarbonate, dolomite, hercynite, K-feldspar, biotite, ilmenorutile, apatite, vermiculite and quartz. Olivine and hypersthene are present rarely with chysotile. Veins are found in pegmatite - aplitic syenite, ultramafic and in carbonatite. The magnesioriebeckite, crocidolite, chrysotile and tremolite have gradational variation. They are K-Rb rich and might have been formed from K- rich fluids filling vugs or passing through veins along shear zone present in syenite, carbonatite and ultramafic. The abnormal abundance of K, Rb, Al in ultramafic indicates that the rocks might have been formed at high PTX condition above the stability of plagioclase in mantle horizon. Riebeckite formation is suppressed by crystallization of K-feldspar or carbonates under high P_{CO2}.*

Keywords: Asbestos, Carbonatite complex of Tiruppattur, Magnesioriebeckite, Ultramafic, Agpaitic syenites, Tschermakite

1. INTRODUCTION

Asbestos of riebeckite, crocidolite, chysolite and tremolite occur as vein deposits in alkali syenites, ultramafic rocks and carbonatites [1-8]. They may be used for insulation of thermal system, as surfacing or reinforcing, fire proofing, acoustic textile and decorating materials. Very few sources produce solid opaque massive holocrystalline material of light to dark blue that can be used to create attractive cabochons. However, its fiber produces carcinogen and mesothelioma making health-hazard.

2. FIELD, PETROGRAPHY AND GEOCHEMISTRY

Magnesioriebeckite is common accessory mineral in miarolitic pegmatite-aplite syenite [1] with pinching and swelling structure in SW part of carbonatite complex of Tiruppattur, Tamil Nadu India. Crocidolite is dark-green fibrous magnesio-riebeckite. Chysotile is green coloured magnesia bearing fibrous asbestos often associates with olivine. White coloured fibrous tremolite is associated with serpentine. The top and bottom portions of vein in ultramafic / carbonatite are comprised with abundant riebeckite layers along joint, cleavage or shear planes. They have been coated with thick layers of massive riebeckite along inner and outer walls from which fibril of riebeckite grown towards central portion from top to bottom or bottom to top of vein / vug. Over dunite / peridotite exposure of tremolite asbestos are found along serpentine veins. In ferrocarbonatite and dolomite carbonatite formed from deep-seated magma chamber [3-5] are significantly enriched with volume of magnesioriebeckite riebeckite up to 40 percent. Fine-grained carbonates are seen along top and bottom of veins which are composed of thick patches of riebeckite. These veins are lying parallel to ultramafic layers. An alkali syenite complex is enclosed by arc-shaped ultramafic body. Carbonate-rich feldsic miarolitic veins carrying magnesioriebeckite are found along joint, cleavage and shear along foliation planes of the ultramafic body. The geology and evolution of the carbonatite complex (Fig. 1) is well described [1-8]. The thickness of natural fibril varies from <0.2μm and length extends up to100mm. Fibrils processed are bluish white in colour and appears to be very soft (Fig:-2). Intergranular cavities of varying from 6 x 5 μm to 10x2 μm are seen. Such cavities allow free growth of mineral grains with euhedral forms. Some fibrils and platelets are steeply (Fig. 3) dipping perpendicular to their length.

Fig:-1 *Simplified sketch map of concentration of magnesioriebeckite (R) in the SW portion of carbonatite complex of Tiruppattur, Tamil Nadu*

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Secondary growths of small crystals (2x0.2 µm) perpendicular to peripheral portions of large crystals are seen.

Fig:-2 *Processed bluish green magnesioriebeckite*

Some porphyritic ultramafics, pyroxene phenocryst is replaced by amphibole with release of calcium with development of amphibole cleavage; the amphibole is replaced by development biotite. The biotite is then oxidized to iron oxide which is removed by weathering process leaving empty spaces in the ultramafic. Such cavernous ultramafic rock carrying cavities

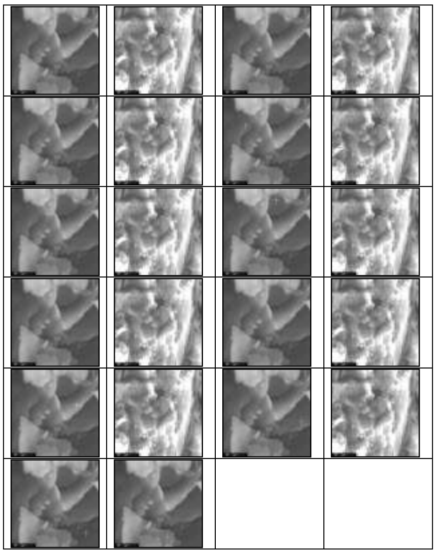

Fig:-3. EDAX spot analyses listed in the Table 1. They represent the composition of some of other mineral grains intimately associated with individual grain. The Table: 1 represents sequential order of spot analyses.

Table 1 *EDAX Chemical compositions of carbonatite-lava sample. Trace elements were determined.*

EDAX analyses of Riebekite fibres and associated minerals

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
SiO2	27.65	29.82	26.72	20.77	19.77	30.15	24.03	33.42	28.29	27.45	27.73	24.73	48.93	46.22	39.05	32.74	30.36	37.13	40.13	66.16	57.62	57.00
Al2O3	17.59	19.90	18.25	14.56	14.53	19.84	14.88	20.40	15.43	16.00	15.62	16.02	15.15	19.21	21.76	18.02	15.75	13.02	7.42	9.85	14.51	3.86
FeO	22.07	15.20	20.32	37.20	37.62	18.53	23.84	9.72	13.78	13.71	14.01	13.49	7.56	3.01	3.40	4.91	20.43	14.63	28.44	3.60	2.41	1.05
MgO	12.23	4.98	13.89	5.69	7.06	8.65	11.37	6.64	16.12	14.18	16.41	16.00	2.70	1.72	2.40	9.50	3.47	4.85	2.02	2.26	2.24	1.08
CaO	0.59	0.55	0.36	0.62	0.32	0.60	0.60	0.48	0.53	0.73	0.79	0.56	1.21	0.26	0.00	0.41	0.42	0.32	0.53	0.56	0.49	0.56
Na2O	0.00	0.00	0.00	0.23	0.16	0.00	0.00	0.00	0.00	0.37	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
K2O	2.83	4.96	1.29	2.73	1.85	3.34	1.26	3.25	1.42	2.17	1.24	0.91	3.61	5.84	4.90	3.13	2.80	2.83	1.63	2.57	3.38	0.70
TiO2	0.64	0.59	0.34	0.67	0.99	0.71	0.78	0.95	0.54	0.00	0.31	0.33	0.41	0.24	0.00	0.25	0.70	0.45	1.06	0.16	0.00	0.13
P2O5	0.00	0.11	0.25	0.17	0.37	0.21	0.30	0.39	0.12	0.28	0.37	0.31	0.17	0.17	0.00	0.00	0.12	0.48	0.15	0.15	0.00	0.00
SO3	0.34	0.74	0.38	0.00	0.00	0.36	0.66	0.32	0.41	0.48	0.61	0.59	0.14	0.50	0.00	0.20	0.42	0.65	0.45	0.36	0.00	0.00
CO2	4.10	12.94	7.00	0.00	5.87	7.39	9.85	15.69	14.42	13.03	11.59	15.84	12.37	16.28	21.60	21.59	12.71	13.16	7.29	7.77	13.60	30.78
F	1.76	1.83	2.23	0.44	1.37	0.91	4.07	1.73	2.79	2.14	2.46	3.27	1.72	1.10	2.27	3.59	4.05	4.26	1.56	0.80	1.12	0.85
Cl	0.17	0.29	0.13	0.10	0.10	0.23	0.38	0.21	0.22	0.17	0.33	0.25	0.15	0.18	0.00	0.10	0.26	0.13	0.27	0.20	0.06	0.00
Sc	0.33	0.48	0.27	0.79	0.23	0.54	0.49	0.38	0.44	0.37	0.45	0.41	0.38	0.22	0.00	0.27	0.34	0.15	0.39	0.44	0.04	0.11
Cr2O3	0.41	0.47	0.24	0.81	0.59	0.49	0.59	0.47	0.25	0.43	0.48	0.38	0.16	0.21	0.00	0.20	0.28	0.17	0.33	0.28	0.06	0.10
CoO	0.33	0.45	0.10	0.67	0.57	0.70	0.46	0.39	0.08	0.38	0.45	0.32	0.18	0.14	0.08	0.25	0.24	0.22	0.30	0.35	0.20	0.11
NiO	0.07	0.38	0.22	0.00	0.15	0.21	0.11	0.25	0.08	0.26	0.29	0.20	0.20	0.11	0.06	0.16	0.09	0.23	0.00	0.23	0.24	0.08
Rb2O	0.75	1.09	0.82	1.24	1.51	0.58	0.83	0.81	0.74	0.96	0.92	0.80	0.71	0.59	0.67	0.45	0.71	0.63	0.89	0.65	0.47	0.54
SrO	1.29	1.15	1.65	1.87	1.47	1.42	1.31	0.61	1.33	0.74	1.44	0.89	0.91	0.75	0.71	0.75	1.10	1.06	1.54	0.80	0.91	0.67
Y2O3	1.96	1.24	1.48	3.57	1.76	1.82	0.94	1.14	0.28	1.59	1.30	1.26	1.10	1.16	0.74	0.97	1.33	1.33	2.04	0.65	0.43	0.31
ZrO2	1.93	1.64	1.96	3.28	1.65	1.67	1.65	1.38	1.10	2.44	1.83	1.75	0.87	1.33	1.09	1.27	1.98	1.96	1.61	0.75	0.94	0.97
Nb2O5	2.96	1.20	2.13	4.59	2.06	1.68	1.60	1.37	1.64	2.13	1.37	1.44	1.37	0.77	1.28	1.24	2.45	2.34	1.94	1.40	1.28	0.95
Sum	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Rittmann, Norm																						
zr	2.74	1.80	2.46	4.22	3.63	2.28	2.13	1.98	1.30	3.14	2.78	2.14	1.24	1.86	1.26	1.53	2.61	2.55	2.57	1.01	1.22	0.98
ilru	1.71	1.08	1.23	2.64	2.90	1.37	1.71	1.39	1.00	0.84	0.90	0.92	1.13	0.70	0.48	0.77	1.96	1.70	2.57	0.79	0.53	0.49
mt	2.68	1.85	0.36	4.59	6.53	2.39	2.19	1.17	1.10	1.52	1.09	1.28	0.85	0.47	0.48	0.48	2.18	1.54	3.15	0.34	0.26	0.04
ap	0.00	0.23	0.41	0.26	1.18	0.46	0.59	0.76	0.25	0.58	0.65	0.56	0.28	0.29			0.27	1.01	0.32	0.28		
anh	0.46	0.82	0.51			0.46	0.85	0.47	0.50	0.63	0.80	0.71	0.23	0.70		0.19	0.54	0.85	0.77	0.45		
sif4	6.67	5.41	7.53			3.41	14.29	6.64	9.22	7.33	8.11	10.97	6.44	4.25	7.22	11.31	14.48	14.85	0.64	2.98	3.90	2.00
sicl4	0.29	0.45	0.26			0.46	0.75	0.47	0.40	0.31	0.55	0.46	0.28	0.35	0.19	0.19	0.48	0.27	0.77	0.45	0.16	
fescry	1.60	1.08	1.43	2.85		1.71	1.28	1.28	0.60	1.36	1.19	1.12	1.02	0.99	0.29	0.67	1.09	0.85	1.80	0.90	0.21	0.24
feconi	0.57	0.77	0.31	0.95		1.59	0.75	0.93	0.20	0.84	0.99	0.71	0.56	0.35	0.19	0.48	0.44	0.64	0.51	0.90	0.63	0.16
cc	10.60	24.86	16.3		24.12	19.12	23.88	41.55	32.88	31.01	26.16	36.73	31.75	43.05	47.58	47.05	31.46	31.72	21.34	19.93	32.58	57.08
ol			30.7	18.19																		
hy			3.69	18.20	4.35																	
rieb	24.23	23.83	9.78		35.36	31.42	12.74		12.78	25.04	11.09	11.99					5.39					
croci				28.47																		
cry	28.79				21.94	12.75	25.00		20.15	8.75	21.78	10.71							17.93			
cor	19.67						13.86		1.30	2.20	3.38											
an				6.85																		
fels													22.88		26.16	16.29	13.61	16.71	12.85	16.05	22.14	
ns														11.11								1.43
sil		26.35	25.05	12.76				19.99	18.30	16.45	20.54	21.68	4.58		3.92	11.64	20.09	13.32	10.22	6.53	3.80	
qz		11.49						23.08					28.76	35.95	12.40	9.39	5.39	14.01	24.55	49.38	34.53	37.57

ranging between 2 and 15 mm is seen 1 km south of Garigaipalli village [2].

The top and bottom layers vein deposit may also be processed for recovery of riebeckite from ultramafic / carbonatite. Rittmann norms [9] indicate low concentration of riebeckite is seen with enrichment of carbonates, feldspar, anhydride, magnetite and quartz.

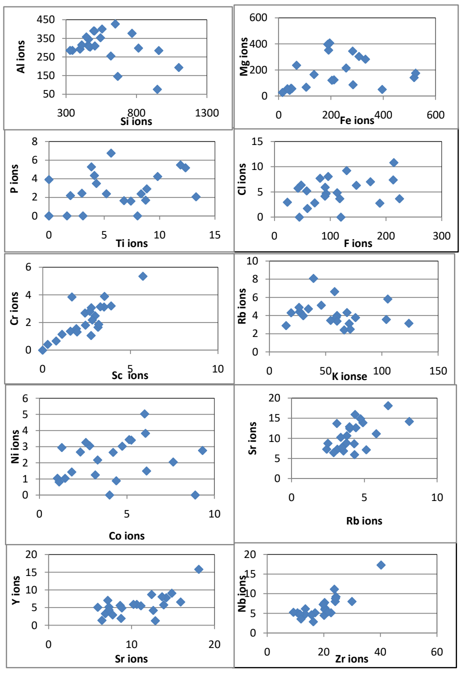

Fig. 4: Bi-component variation of major and trace elements in magnesioriebeckite.

Si ions vary between 329 and 948. Al between 76 and 285 ions (Fig. 4). They positively increase Si 635 and Al 427 ions and then they negatively deplete downward. Mg and Fe (t) show positive correlation, the enrichment shows their ultramafic decent Enrichment of P against Ti ions is oscillatory. Amphiboles are generally enriched [10] in F and Cl ions. The positive correlation of F and Cl ions reduces activities of Si ions significantly. Cr against Sc and Ni against Co are indicate ultramafic decent. Similar variation between Rb against K; Sr against Rb; Y against Sr and Nb against Zr are also support this view. In order to control silica deficiency corundum and hercynite are formed.

3. DISCUSSION

Riebeckite formation is suppressed by presence of CO_2, P_2O_5, HF, SO_3 gases in closed system of veins and vugs [2]. The origin of riebeckite in this area is not clearly known. Some riebeckite in veins and vugs are altered step by step oxidized and finally transformed to iron oxides by increasing alkalis and silica during normal course alkali-magmatic differentiation [11]. Under enrichment [1, 12] of alkalis over alumina agpaitic state of magmatic crystallization from shonkinite magma leads to early crystallization feldsic minerals with high content of K ions before crystallization of mafic minerals [1, 6]. K-rich silica undersaturated magma differentiates from shonkinite magma. At this state, enrichment of Si and Al increases by increasing viscosity of fluids on cooling inducing high fluid pressure sealing inner walls of cavities but promoting free growth inside of veins and vugs consuming available volatiles very similar to miarolitic growth [2]. Both ultramafic and soil derived from it are alumina enriched and the source material might have been derived from tschermakite bearing ultramafic rock subjected to above PTX conditions of stability field break down of plagioclase at mantle [13]. The abundance of (K+Rb) over Na and Al enrichment in ultramafic might have been derived from deep mantle source.

4. CONCLUSIONS

Bundles of riebeckite are amenable for industrial processing. The recovered asbestos is considered to be valuable products. The filler material is useful for manufacture of talcum powder, rubber, paper, construction and textile industries. The exploration of tremolite asbestos is to be conducted on dunite, peridotite exposures. High grade magnesioriebeckite are observed in ferrocarbonatite and beforsite emplaced in ultramafic rocks. Riebeckite exploration is to be conducted along shear, cleavage and joint planes of ultramafic rock.

List Item –Article. 1-5

List Item Figures 1-4

List Item –Table 1. EDAX Analyses & norms

List Item –References 13

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