

RARE-EARTH MINERALS IN THE ROCKS OF SUBSTRATE OXIDATION ZONE (MOLIBDENUM AND URANIUM KATTASAY- ALATANGIN ORE FIELD IN UZBEKISTAN)

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ABSTRACT

The group of molybdenum-uranium deposits (Alatanga, Kattasay, Dzhekindek and Razveduchastok) is located on the southeastern part of the Chatkal range, 125-130 km far from Tashkent to East. The first two deposits in terms of uranium reserves are medium, the other two are small, and in general “... are complex because they contain significant amounts of molybdenum and less tin (Kattasay)”

Keywords: *molibdenum, uranium, deposit, Kattasay-Alatanga ore field, rare-earth mineral*

INTRODUCTION

In the geological structure, uranium deposits are confined to the Babaitag subvolcanic intrusive massif P1-P2 of age, the frame of which is the middle carbonic granitoids, late carbonic volcanic covers of

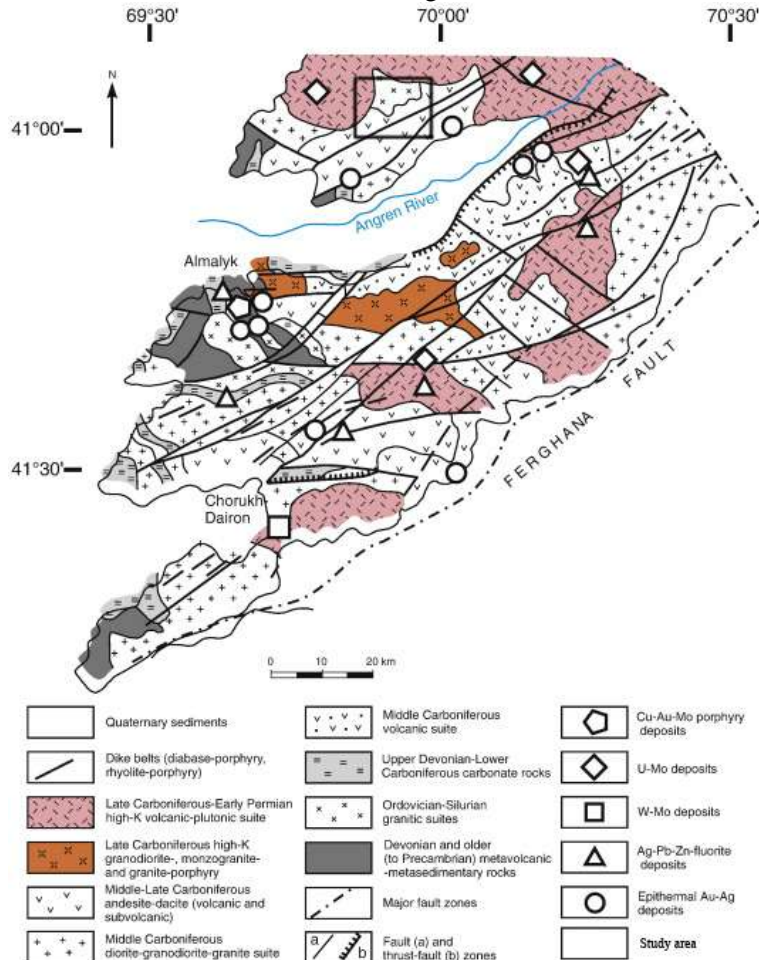


Figure 1: Geological map of study area

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andesites and rhyolites with horizons of tuffogenic sandstones. There are numerous dykes of diabases, micrographs, and less often lamprophyres complete magmatic activity. Melnikov *et al.*, (1996) and Laverova *et al.*, (2012) noted the connection between complex tin-molybdenum-uranium mineralization and the hydrothermal process; several stages of the uranium ore process are distinguished in it: albite, greisen and carbonate, beresite, quartz - sulfide-carbonate, quartz - sulfide - barite, nasturan - sulfide and ore - quartz-barite - fluorite - calcite and quartz - dickite.

Brief information on the presence of rare-earth elements (REE) and rare-earth minerals (REM) in the study area is given by Melnikov *et al.*, (1996). According to them, typomorphic elements of greisens are Sn, Mo, La, Li, to a lesser extent W and Bi; TR carbonate is a rare mineral in the quartz-sulfide-carbonate stage; the sequence of mineral formation in the Kattasay-Alatanga ore field and it is believed that Ti is involved in the alkaline stage of the hydrothermal process, P, REE (the latter relate to minor components); similarly according to them, characteristic of high-temperature stages were brought from a magmatic source and deposited on the ion-exchange geochemical barrier as a paragenetic association minerals of the albite mineralization stage.

MATERIALS AND METHODS

Study Methods

Our field studies consisted in predominantly tracking zones of surface changes in rocks outside the Alatanga and Kattasay deposit. During these field works, manifestations of oxidation zones developed along beresited, quartz-sulfide-carbonate, quartz-sulfide-barite rocks have been established. Mineral composition study of the rocks was carried out on a microprobe (JEOL, Japan). It has been established that the prevailing forms of REM in quartz-feldspar rocks, conditionally referred to as beresites, are their monazite and xenotime phosphates (rarely) (Fig. 2).

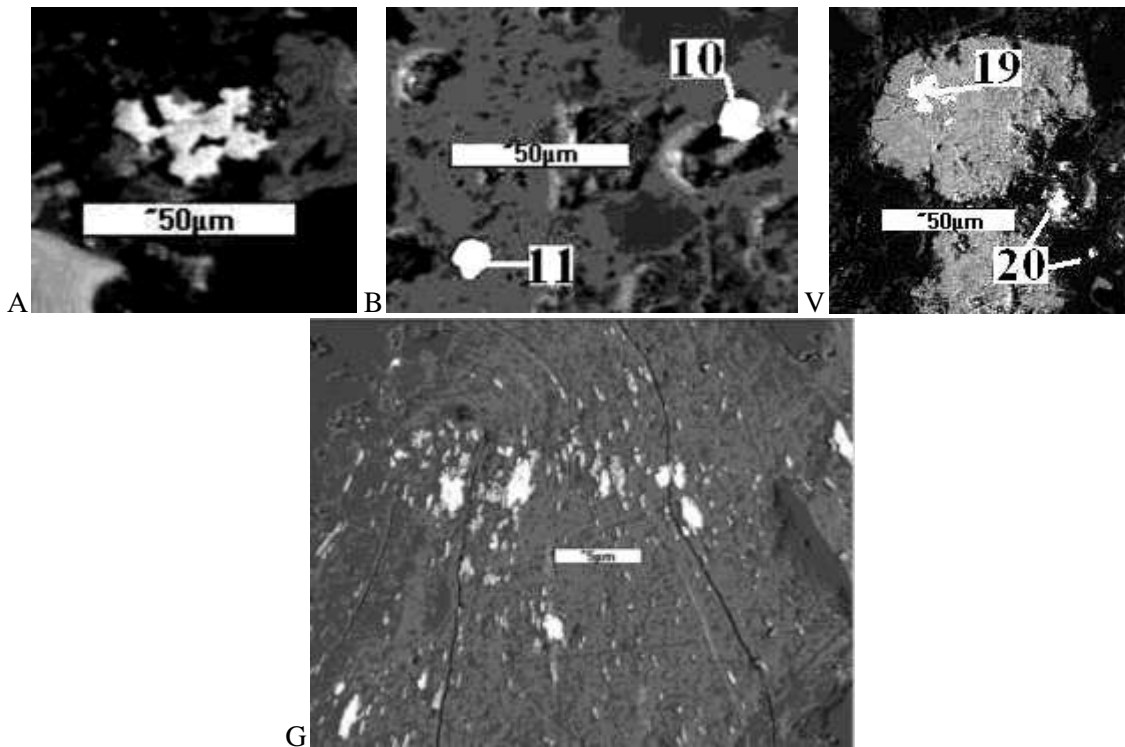


Figure 2: Monazite (bright) in: quartz (A, B-11; sample H12), in quartz-feldspar metasomatite (G, sample K673); xenotime (bright) in: quartz (B-10, sample H12), titanium (B-19, sample H13) and yttrium phosphate in quartz (20, *ibid.*).

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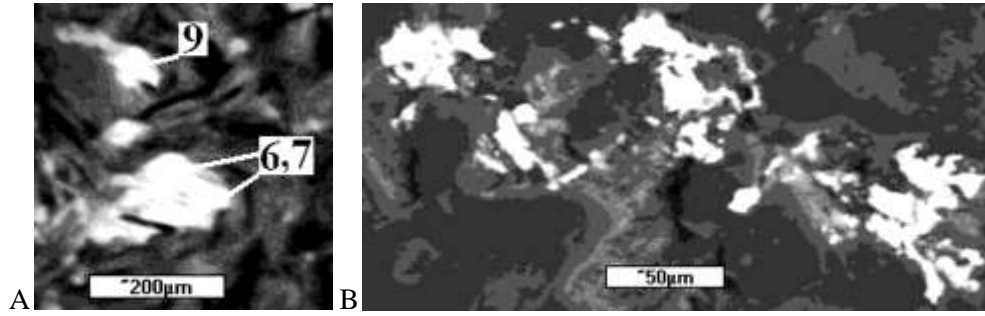


Figure 3: Isolation of REE Ce_g in the form of: carbonates (bright) in quartz - mica (A-6.7; Sample H12); oxides - (bright, 9; ibid.) and mica feldspar aggregate (B, sample H13).

RESULTS AND DISCUSSION

Morphologically, cerium and yttrium minerals have various forms of precipitation from irregular to relatively defined grains of five to twenty microns and are relatively often associated with titanium minerals. Similar “placer” of monazite and titanium minerals is shown in Fig.2-g. An increase in the sizes of REM occurs in the transition of the latter to carbonate and oxide compounds (Fig. 3) with a simultaneous decrease in the content of phosphorus and REE, the appearance of oxides of other elements, in particular, PbO, ThO (Table 1).

Table 1: Content of components in monazite (1-3), xenotime (4.5), yttrium phosphate (6), carbonate (7) and cerium oxides (8, 9), (wt.%).

Compo nents	Analysis and figures numbers								
	1	2	3	4	5	6	7	8	9
	Fig. 2. A	Fig.2.B- 11	Fig. 2. G	Fig. 2. B-10	Fig. 2. B-19	Fig. 2. B-20	Fig. 3. A-6.7	Fig. 3. A-9	Fig. 3. B
SiO		4.59	2.26			18.13	38.96	1.24	31.08
Al ₂ O ₃		1.67	1.34					1.61	
K ₂ O		1.40	0.35						
CaO	0.37		0.42			3.92	0.64	0.50	0.51
TiO ₂					1.83				
Fe ₂ O ₃								11.71	
P ₂ O ₅	30.28	29.14	30.94	33.26	36.76	24.35	20.34		
PbO						8.30			
La ₂ O ₃	14.42	14.26	16.31			4.83	7.19	13.80	15.40
Ce ₂ O ₃	39.48	35.21	39.48			7.62	21.72	31.68	38.71
Pr ₂ O ₃	2.47	2.00				1.24	1.03	0.65	2.13
Nd ₂ O ₃	10.56	10.15	8.90			5.74	5.65	7.00	9.88
Sm ₂ O ₃	0.62	0.88			0.20				0.65
Gd ₂ O ₃	1.04	0.71		2.21	1.99	0.71	1.08	0.44	1.16
Dy ₂ O ₃				5.88	6.66	2.30			
Er ₂ O ₃				3.57	4.77	1.30		0.41	
Yb ₂ O ₃				3.10	4.76	1.10			
Ho ₂ O ₃				1.26	1.41	1.17			
Y ₂ O ₃				50.26	40.04	14.90			
Sc ₂ O ₃					0.29				
ThO					1.30	3.05	3.40		0.76
Σ REE	68.59	63.21	55.79	66.75	59.83	35.17	36.67	46.48	67.93

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Further REM redeposition takes place at the quartz-sulfide-carbonate and quartz-sulfide-barite stages, which is well observed in the salband areas of the development of sulfide-containing quartz veins (Fig. 4).

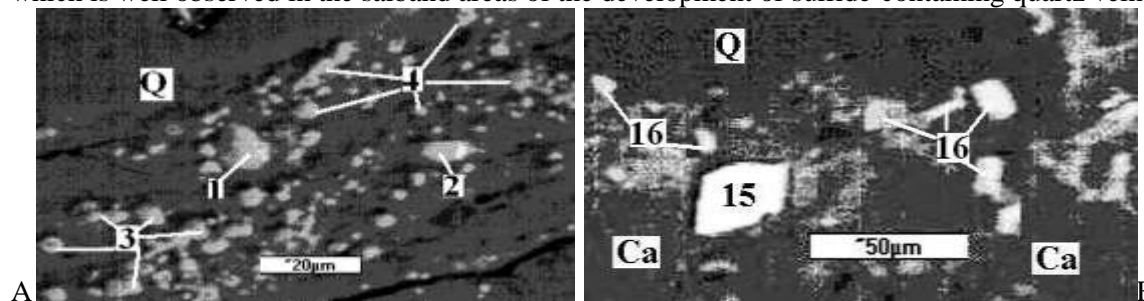


Figure 4: A) inclusions of REE Ce_g phosphates (3, 4 and others smaller), iron oxides (1, 2) in the mica aggregate in contact with the quartz-sulfide-containing vein (Q). B) inclusions of yttrium-containing carbonates REE Ce_g (16), metazeunerite (15) in the contact zone of carbonate (Ca) partially replaced by siderite (irregular light emissions) and quartz (Q).

Table 2: Component contents in REE Ce_g phosphates (3, 4), yttrium-containing REE Ce_g carbonates (16), metazeunerite (15) and iron oxides (1, 2), (wt.%).

Components	Analysis Numbers					
	3	4	16	15	1	2
SiO	18.60	15.04			3.81	4.63
Al ₂ O ₃	35.14	36.18				
K ₂ O		2.16				
CaO	0.98	1.12	15.34		0.72	0.68
SO ₃					0.66	1.00
Fe ₂ O ₃			0.79	1.77	93.03	91.65
MnO					0.49	0.28
P ₂ O ₅	21.88	23.61				
CuO	2.91	1.97		1.47	0.47	0.89
UO ₂				50.91		
As ₂ O ₅				19.90		
La ₂ O ₃	4.31	4.45				
Ce ₂ O ₃	10.03	11.19	10.44			
Nd ₂ O ₃	3.10	3.58	7.76			
Gd ₂ O ₃			1.22			
Y ₂ O ₃			1.98			
ΣREE	17.44	19.22	21.40			

In the oxidation zone of quartz-sulfide-carbonate formations, REEs, acquiring the greatest mobility, are associated with titanium-containing compounds, form Y_g carbonates (Fig. 4-A), cavities and crusts are made in siderite in the form of REE Ce_g oxides (Fig. 5-B), accumulate (Nd, Sm, Gd with the sum of oxides up to 3%) in conjunction with tantalum and niobium. In oxidized rocks with the complete removal

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of all REEs, cerium appears to be the most inert, which is adsorbed on manganese crusts together with Cu, Pb (Fig. 6-A) or ferruginous-manganese kidneys together with Cu, Zn, Pb (Fig: 6-B; 7), (tab. 3).

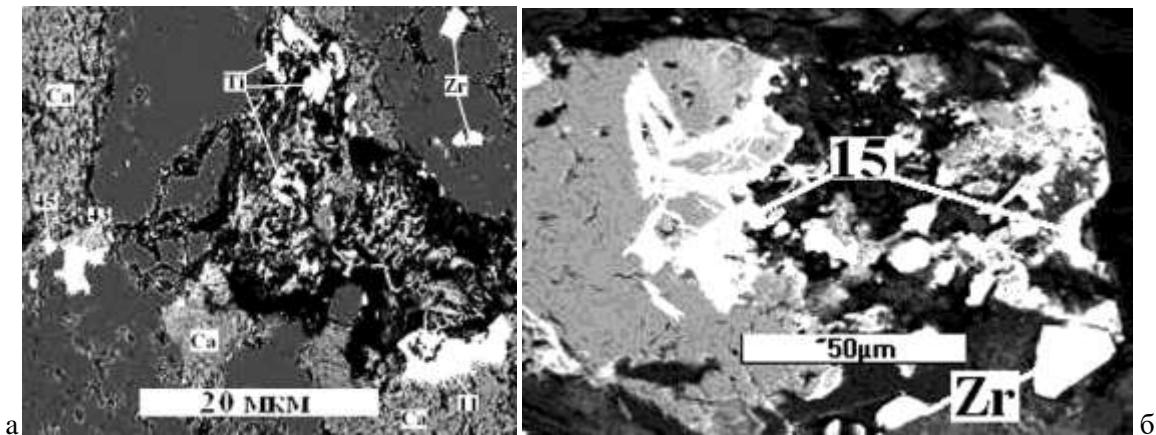


Figure 5: A) titanium-containing carbonates REM Y_g (43, 45) at the contact of quartz (dark) and carbonates (Ca). B) peels and streaks of REE Ce_g oxides (15) in siderite

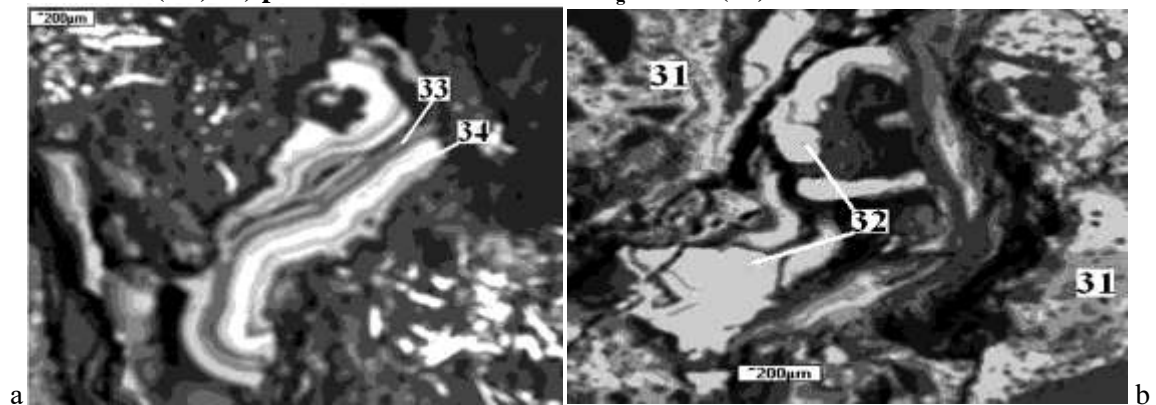


Figure 6: A, B) cerium-containing manganese peels with Cu, Pb, lead oxides (bright) in carbonate dark) (sample K801).

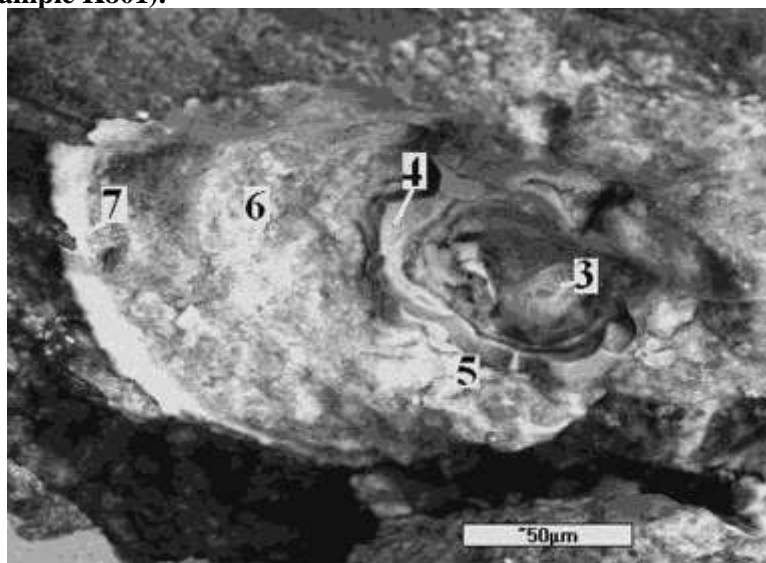


Figure 7: Cerium-containing ferruginous-manganese bud with Cu, Zn, Pb (sample K802).

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Thus, it has been found that in albited, chlorited, and sulfided granitoids, monazite forms abnormal clusters (20x30 µm) in albite, micron grains in rutile, at the REM stage of beresitization have a compact composition close to the theoretical composition (Semenov, 2001), tend to accumulate titanium minerals, which confirms the idea of Melnikov *et al.*, (1996) on the joint finding of Ti, P, REE characteristic of high-temperature hydrothermal solutions.

Table 3: Cerium-containing manganese peels (31, 32, 33, 34) and ferruginous-manganese buds (3-7) (wt.%).

Compo nents	Analysis Numbers								
	31	32	33	34	3	4	5	6	7
SiO					5.25	7.58	7.14	23.32	6.73
Al ₂ O ₃	5.76	5.25	10.39	10.96	10.11	8.45	6.62	18.52	1.54
CaO	0.16	0.52	0.70	0.18	1.23	0.46	0.88	0.25	0.75
FeO					2.07	1.83	6.76	5.17	2.54
MnO	15.57	16.39	16.77	12.86	17.69	18.20	13.24	2.86	3.14
SO ₃		1.87	1.72	1.75	1.10	1.69	1.28	0.65	1.54
CuO	12.70	13.22	11.66	10.56	2.38	16.11	3.95	1.75	1.99
ZnO					4.31	3.95	1.26	0.78	0.53
PbO	22.57	21.72	17.51	19.99	8.08	7.46	18.05	6.78	16.16
Ce ₂ O ₃	17.73	15.59	17.73	20.78	0.60	0.92	6.09	9.34	41.84

During the development (superposition) of the quartz-sulfide-carbonate, quartz-sulfide-barite stages, REMs are redeposited with a significant change in their elemental composition, morphology, forming zones with a length of the one mm. In rocks, characterizing the above stages of hydrothermal change and undergoing hypogene changes (especially sulfide-containing), the accompanying REM undergo radical changes up to the removal of all REEs except cerium. Paragenetic associations of cerium with Cu, Zn, Pb in the oxidation zone can be used as a search feature for finding ore concentrations of non-ferrous and other metals at deeper horizons.

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