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Research Article

RARE-METAL PEGMATITES OF DARVEZ AREA OF ALTINTAU ORE FIELD (WESTERN UZBEKISTAN)

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ABSTRACT
Altintau ore field aroused particular interest, when discovered crystals of beryl in pegmatite ores in 1928. Altintau pegmatite field is located in the South Bukantau zone of Central Kyzylkum, within the granitoid massif of the same name, which has an area of 150 km^2 erosional outcrops. The massif is composed of medium- and coarse-grained, often porphyritic biotite and granodeorites, trondhjemites, granites, also alaskitoid leucogranites. Pegmatites, greisens, and albitized granites are exposed in the apical projections of the massif. Massif granitoids break through volcanogenic-siliceous-terrigenous (C_{1-2}), carbonate (D_{1-2}-C_1) and metamorphosed terrigenous-clastic (S_1) sequences. Radiological age of the rocks of the massif is 257-280 million years, the average age is 264.8 million years (determined by the potassium-argon method at Institute of Geology and Geophysics), which corresponds to the Lower Permian. Based on feldspars of biotite granites and pegmatites of the massif, an Rb-Sr isochron with an age of 280.6 ± 1.5 million years was obtained with an initial strontium isotopic ratio of 0.70565 ± 5.

Keywords: *Rare-Metal, Altintau Ore Field, Pegmatite, Granitoid, Central Kyzylkum*

INTRODUCTION
The area of the described ore field is part of a large anticline structure. The core of the anticline is composed of Altintau granitoids (Babaev, 1960). The rocks composing the anticline strike in a direction close to latitudinal (270-280^0) and dip at an angle of 40-65º to the east and northeast (fig.1).
Rare metal pegmatites are often the most complex deposits of rare elements - Be, Ta, Nb, Li, Rb, Cs, Sn. Among the paragenetic types of pegmatites of this series, incompletely differentiated and fully differentiated pegmatites of microcline-albite, essentially albite types are in relation to tantalum and niobium. The main industrial types of pegmatite tantalum-niobium and tantalum ores are associated with albitized varieties of microcline-albite pegmatites, as well as albite types. The minimum content in tantaloniobium and tantalum ores of Ta_2O_5 is 0.015% (or Ta - 125 gram per ton), Nb_2O_5 is 0.008% (or Nb - 55 gram per ton). The associated components are lithium, rubidium, cesium, tin, sometimes beryllium, etc (Khamrabaev, 1975).
In the Darvez area of the Altintau field, pegmatite veins are widespread (fig.2). But, not all of these pegmatites contain industrial concentrations of rare metals, with the exception of some veins, to which complex tantaloniobate-rare alkaline metal and independent rare alkaline metal mineralization is confined (fig.3). Pegmatite veins differ from each other in type of textural-structural and mineralogical features.

MATERIALS AND METHODS
Pegmatite veins with industrial contents of tantalum, niobium, and rare alkali metals are exposed by ditches. Also, pegmatite veins with industrial contents of rare alkali metals are revealed on the right side of the Dzhangakly (left tributary of the Darvezsai). Microcline-albite pegmatites compose more than half of the vein bodies in this area. Depending on the shapes, sizes and elements of occurrence, they differ in the degree of differentiation and patterns of distribution of rare elements. In contrast to essentially microcline pegmatites, pegmatites of this type are characterized by an approximately equal content of microcline and albite or a predominance of albite with development of muscovite, large thicknesses,

lenticular, stock-like and often irregular shapes with swelling, constrictions and apophyses, which is due to their confinement to the intersection several systems of fault (Kostitsyn, 1991).

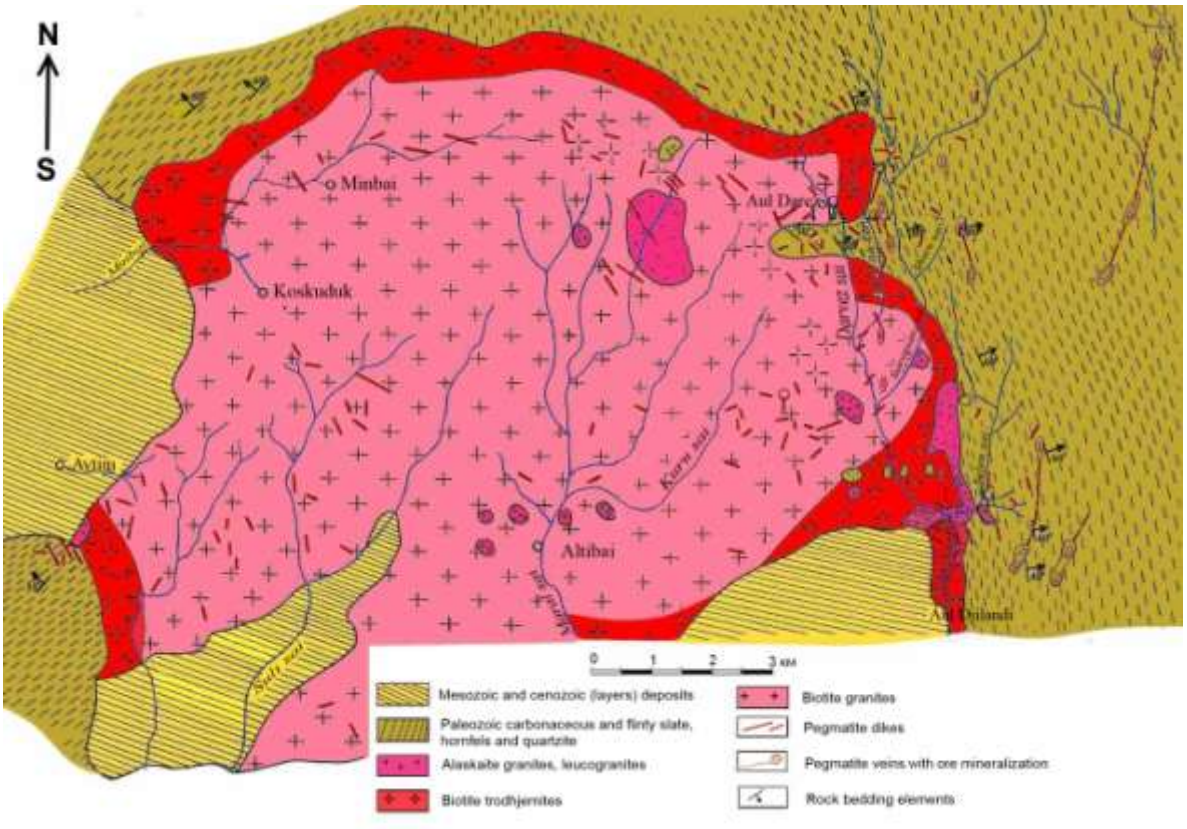

Figure 1: Geological map of the Altintau pegmatite ore field

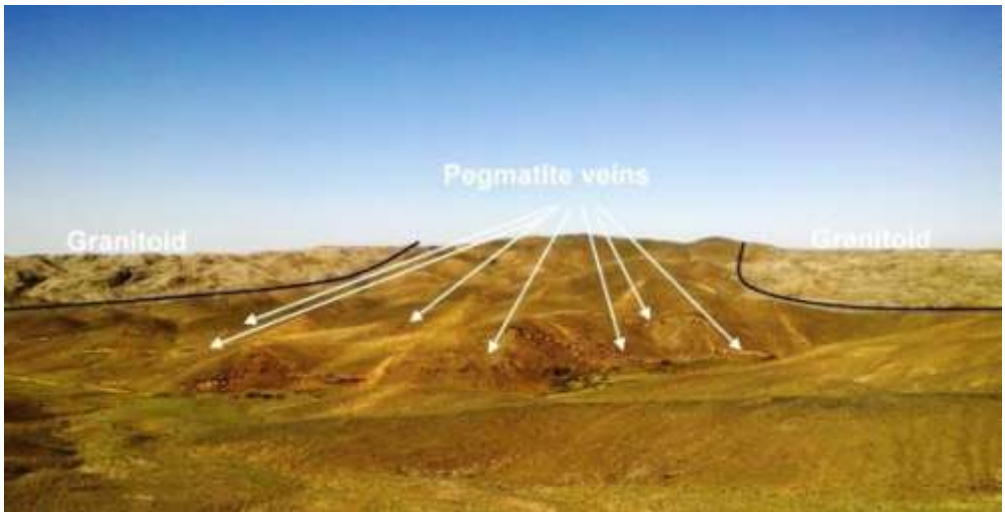

Figure 2: Pegmatite quartz veins intersecting the shale strata of Darvez area

№	Na	Mg	Al	P	K	Ca	Ti	V	Cr	Mn	Fe	Co	Ni	Ba	Sr
1*	**25000**	**18700**	**80500**	**930**	**25000**	**29600**	**4500**	**90**	**83**	**1000**	**46500**	**18**	**58**	**650**	**340**
2	33000	540	**120000**	**1200**	**78000**	2800	64	30	41	550	6500	0,69	5,40	42,0	42,0
3	8200	810	86000	600	**62000**	1900	160	51	62	**2300**	4000	0,32	4,30	260,0	58,0
4	29000	1600	71000	1300	**57000**	3200	160	45	66	440	4700	0,81	34,00	140,0	22,0
№	Li	Rb	Cs	Be	Nb	Ta	Sn	Mo	W	Cu	Zn	Pb	Tl	Sc	
1*	**32**	**150**	**3,7**	**3,8**	**20**	**2,50**	**2,5**	**1,1**	**1,30**	**47**	**83**	**16**	**1,00**	**10**	
2	7,7	**970,0**	**31,0**	4,00	**57,0**	**230,0**	**22,0**	**1,9**	1,1	8,6	11,0	16,0	**4,0**	0,75	
3	26,00	**1000,0**	**26,0**	**29,00**	**59,0**	**20,0**	**43,0**	**5,0**	**2,3**	6,3	22,0	**30,0**	**5,5**	0,57	
4	32,00	**1000,0**	**30,0**	**20,00**	**62,0**	**14,0**	**30,0**	**2,9**	2,0	7,2	42,0	19,0	**5,8**	1,20	
№	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
1*	**29**	**29**	**70**	**9**	**37**	**8**	**1,3**	**8**	**4,3**	**5**	**1,7**	**3,3**	**0,27**	**0,33**	**0,08**
2	2,0	1,1	1,4	0,16	0,66	0,23	0,075	0,17	0,052	0,31	0,064	0,19	0,043	0,28	**0,26**
3	0,74	1,2	3,2	0,37	1,4	0,26	0,13	0,16	0,026	0,14	0,019	0,071	0,01	0,096	0,0098
4	1,6	0,72	1,4	0,21	0,76	0,26	0,11	0,26	0,053	0,31	0,056	0,13	0,024	0,22	0,029
№	Bi	As	Se	Sb	Te	Ag	Au	Re	Pt	Zr	Hf	Cd	Th	U	
1*	**0,009**	**1,7**	**0,05**	**0,5**	**0,01**	**0,07**	**0,0043**	**0,0007**	**0,005**	**170**	**1,00**	**0,13**	**13**	**2.5**	
2	**0,62**	**8,2**	**4,6**	**2,5**	**0,033**	**0,20**	0,005	**0,001**	0,003	13,0	0,33	0,12	1,1	3,5	
3	**0,058**	**30,0**	**6,5**	0,44	**0,064**	**0,1**	0,009	**0,0029**	0,001	5,7	0,48	0,057	0,78	1,8	
4	0,29	**14,0**	**5,8**	0,32	**0,032**	**0,23**	**0,015**	**0,0021**	0,001	11,0	0,95	0,075	0,45	2,5	

Figure 3: Results of ICP-mass complex spectrometric analysis of tantalum-niobium and rare alkaline metal pegmatite veins of Darvez area of Altintau ore field (grams per ton)
*Note: 1 * - clarkes of elements*

Most pegmatite bodies of this type are 250-500 m long and 0.5-5.0 m in thickness. Usually, they are incompletely differentiated, which is due to the forms and elements of occurrence, also unfavorable conditions for the crystallization process or the discharge of tectonic stresses during the formation of pegmatites.

In some cases, most developed pegmatite bodies of the microcline-albite type, in which the main mass of the concentrated pegmatite melt reaches enormous sizes (up to 1 km in length and 10 m in thickness). Such bodies are characterized by a clear zoning and a higher concentration of ore minerals, also in certain zones with the formation of potentially industrial ores. General strike azimuth of the pegmatite veins is 255-260°, the dip is northwestern with angles of 65-70°, i.e. the vein with carbonaceous-clayed and quartz-mica shales. Also, xenoliths occur in pegmatite veins (Mamarozikov and Normatov, 2018).

Structure of most of the veins is heterogranular up to block type. Monomineral microcline zones sometimes appear in the central parts. In veins of this type, three primary textural-paragenetic zones can be conventionally distinguished:

1) heterogranular;

2) block type;

3) monomineralic microcline.

Accumulations of tantalocolumbite and tantalite are associated with relatively well differentiated veins in which the replacement process is manifested. In most pegmatites with rare-metal minerals, in contrast to minerals not containing them, process of replacement of early generations of microcline, plagioclase, albite, muscovite, quartz, and others is more appeared. Rare-metal minerals are formed after microcline. The most common form for the concentration of rare elements is represented by large veins (fig.4).

According to N.A. Solodov (Solodov *et al.*,, 1980), the world reserves of niobium and tantalum, represented by pegmatite deposits, are distributed as follows (the average contents of Nb_2O_5 and Ta_2O_5 are indicated in %): microcline pegmatites count for 3.9% (0.006; 0.004), for microcline-albite - 59.2% (0.011; 0.018), for albite - 9.4% (0.014; 0.017) and for albite-spodumene - 27.5% (0.010; 0.007).

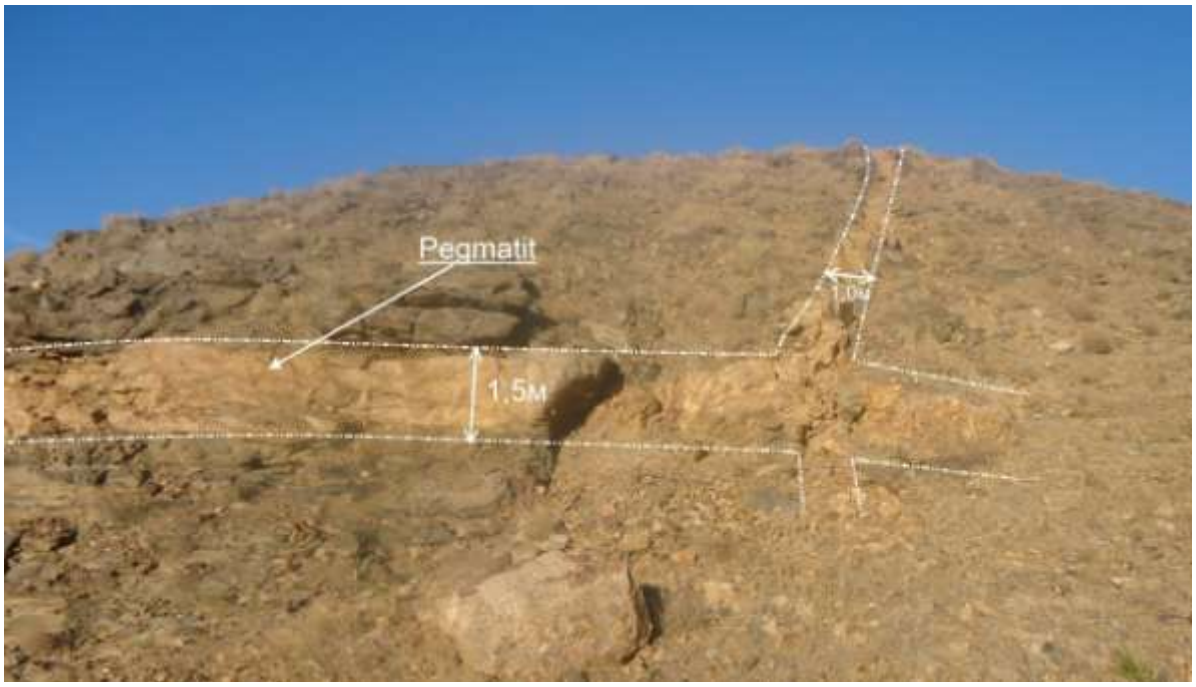

Figure 4: Perpendicularly intersecting pegmatite veins with industrial contents of rare alkali metals (right brookside of the Dzhangakly River)

RESULTS

Incompletely differentiated microcline-albite pegmatite vein (thickness more than 1.0 m, length 350 m) exposed by ditch No. 29/4, contains industrial concentrations of tantaloniobates (Ta –230 g/t, or Ta_2O_5 - 0.028%; Nb - 57 g/t, or Nb_2O_5 - 0.008%) and rare alkali metals (Rb - 970 g/t, or Rb_2O - 0.106%; Cs - 31 g/t, or Cs2O - 0.003%). Typically, the content of Ta_2O_5 and Nb_2O_5 in ores of incompletely differentiated pegmatites of the microcline-albite type varies from the minimum values in the outer quartz-albite zones (selvage) and to the maximum in the central quartz-albite-muscovite zones. The presence of micas in the late albite-containing zones is a good mark of the presence of tantalum-niobium proper and rare-alkaline metal mineralization in them. The same tendency is observed in many pegmatite veins of the Darvez area.

Minerals of the columbite-tantalite group are found everywhere in the studied pegmatite vein, and the size and shape of their segregations depend on the structure of the mineral association in which they are formed. In fine- and medium-grained quartz-albite, quartz-albite-muscovite, quartz-muscovite selvages they are found in the smallest dissemination form, measured in tenths and hundredths of a millimeter, increasing in their coarser-grained varieties up to 2 mm. The block (central) zone contains tantalite proper, which is localized in the microcline, quartz and pockets of large-plate albite in the form of large thick-plate crystals and smaller segregations in muscovite replacement complexes.

On the right side of the Dzhangakly (left brookside of the Darvezsai) and on its left side, incompletely differentiated, greisenized pegmatite veins with industrial contents of rare alkali metals (Rb 1000 ppm, or Rb_2O - 0.11%; Cs -28 ppm, or Cs_2O about 0.003%).

According to N.A. Solodov (Solodov *et al.*, 1980) industrial types of rare metal pegmatites contain 0.1% rubidium and 0.04% cesium. Rubidium does not form its own minerals, dissipating mainly in potassium (microcline, mica) minerals. In accordance with this, the highest content of rubidium oxide (1.3-1.5% and more) is observed in the muscovites of the quartz-muscovite zone of the above-mentioned Darvez pegmatite veins. Apatite is a cesium concentrating mineral in these veins. Microprobe analysis determined the content of Cs_2O in them - 1.57-1.78%.

CONCLUSION

Thus, based on the above material, we can conclude the following: 1) Large pegmatite veins of microcline-albite type with industrial contents of tantaloniobates (Ta_2O_5 + Nb_2O_5 - 0.036%) and rare alkali metals (Rb_2O - 0.11%; Cs_2O - 0.003%) are revealed in the Darvez area of Altintau ore field; 2) High concentrations of tantalum columbite and tantalite are associated with relatively well differentiated veins. In most pegmatites with tantalum-niobate minerals, the process of replacement of early generations of microcline, plagioclase, late albite, muscovite, quartz and others is more appeared; 3) content of Ta_2O_5 and Nb_2O_5 in ores of incompletely differentiated pegmatites of the microcline-albite type varies from the minimum values in the outer quartz-albite zones (selvage) and to the maximum in the central quartz-albite-muscovite zones; 4) Rubidium does not form its own minerals. Highest content of rubidium oxide (1.3-1.5% and more) is observed in the muscovites in Darvez area. Apatite is a cesium concentrating mineral in these veins. In these veins microprobe analysis determined 1.57-1.78% content of Cs_2O.
Development of large complex tantalum-niobium, rarely alkaline-metal pegmatite veins in the Darvez area testifies to its belonging to the significant objects of these metals ores.

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