

International Conference

GIS based solutions for ENP in the Southern Caucasus

Allanite - accessory mineral in Late Variscan granites of the Khrami crystalline massif

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Allanite

- Allanite or Orthite (ancient Greek ὀρθός - straight, regular) is a rare mineral of the island structure of the epidote group of the silicate class. It was discovered in 1810 by the Scottish mineralogist Thomas Allan (1777-1833).
- The chemical formula is $(\text{Ca}, \text{Ce}, \text{La}, \text{Y})_2(\text{Al}, \text{Fe})_3(\text{SiO}_4)_3(\text{OH})$.
- Average composition: CaO - 10.43; Ce_2O_3 - 10.13; MnO - 2.25; FeO - 8.14; Fe_2O_3 - 6.29; MgO - 0.13; Al_2O_3 - 16.25; SiO_2 - 30.81; H_2O - 2.79.
- Contains a significant amount of rare elements: Ce, La, Dy, Er, V.
- Thick tabular crystals. Color - brown to black. The surface is often metallic or glassy. Density 3.3-3.8. Hardness 5.5-6. Radioactive. Strong pleochroism (red-brown - brown-golden - green-brown).
- It occurs mainly in crystalline silicate rocks: granites, gneisses, syenites, crystalline schists, usually in the form of grains.



Fig. 1. Allanite. Picture by Robert M. Lavinsky

Khrami massif

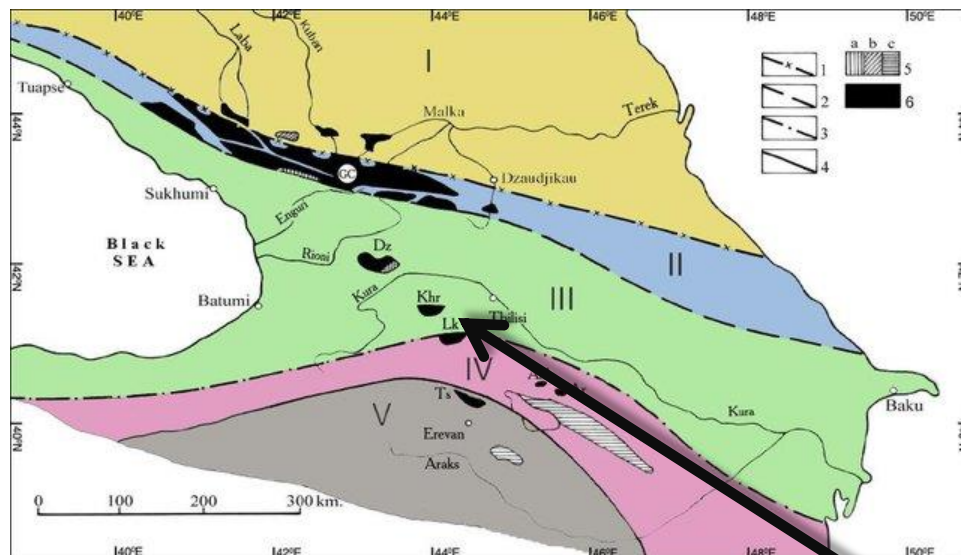
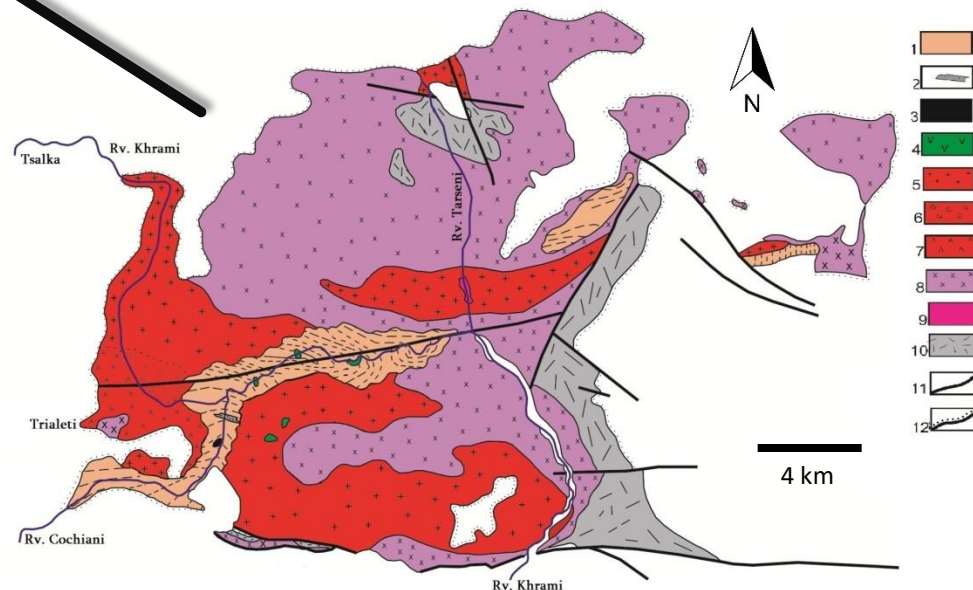


Fig.2. Tectonic subdivision of the Caucasus on the basis of the terrane analysis, simplified:

I. The Scythian platform; Accretionary terranes of the first order: II -Greater Caucasian terrane; III -Black Sea-Central Transcaucasian terrane; IV -Baiburt-Sevanian terrane; V -Iran-Afghanian terrane 1-4 -ophiolite sutures, marking the location of small and large oceanic basins: 1 -of Early? -Middle Paleozoic age, 2 -of Late Precambrian -Paleozoic age, 3 -of Late Precambrian-Early Mesozoic age, 4 -Mesozoic age; 5 -ophiolite terranes (obduction sheets): 5 a -Late Precambrian age, 5 b -Paleozoic age, 5 c -Mesozoic age; 6 -exposures of pre-Alpine crystalline basement. Lettered separate exposures: GC -Greater Caucasian; Dz -Dzirula; Khr – Khrami; Lk -Loki; Akh -Akhum; Ar -Asrikchai; Ts - Tsakhkunyats.

Fig. 3. Geological-schematic map of Khrami crystalline massif. According to Gamkrelidze and D. Shengelia (2005):

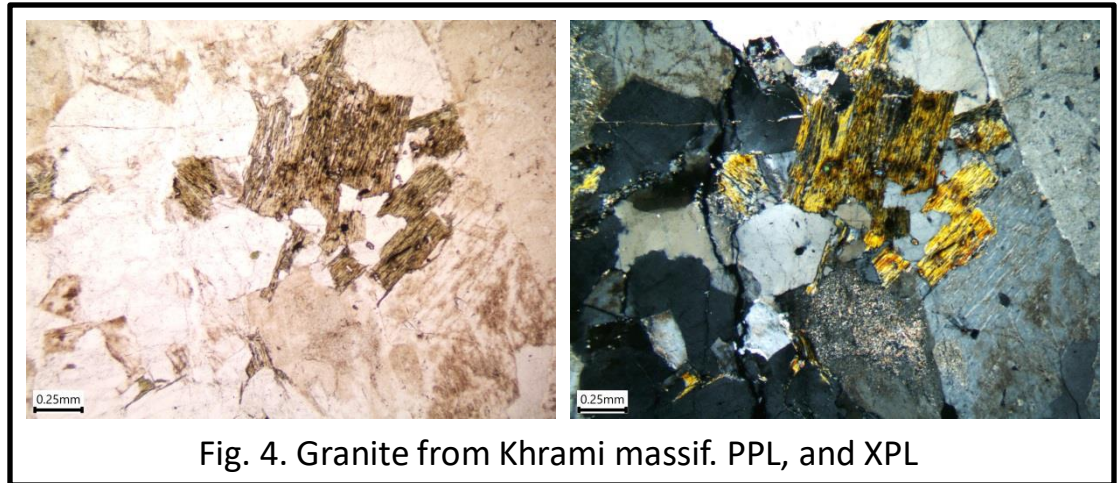
1-Pre-Cambrian gneiss-migmatitic complex; 2-Middle Paleozoic (?) metasandstone in the gneissic-migmatitic complex; 3-mantle serpentinite protrusives; 4-Paleozoic gabbroid; 5-8 granitoid complex: 5-Late Variscan microcline granite; 6-Late Variscan garnet granite; 7-Late Variscan biotite-allanitic granite; 8-Upper Paleozoic quartz porphyry; 9-Upper Paleozoic granite porphyries; 10-Upper Paleozoic volcanogenic-sedimentary complex; 11- Mesozoic-Cenozoic sediments; 12-ruptures; 13-transgressive arrangement.



Granitoids of Khrami massif

Late Variscan granitoids of the Khrami massif are represented by four types:

- biotite-hornblende-alanitic;
- Biotite;
- biotite-garnet granites;
- alaskites.



Their mineralogical composition is as follows:

- in biotite granites and alaskites there are: quartz, plagioclase, microcline and biotite (biotite is a secondary mineral in alaskites);
- Garnet-bearing granites – quartz, plagioclase, microcline, biotite and garnet (<3.5%);
- Biotite-alanite granites – quartz, plagioclase, microcline, biotite, hornblende and allanite.

In the granitoids of the Khrami crystalline massif, allanite is a rock-forming mineral of biotite-hornblende granites, where it occurs in the form of tabulated and well-defined prismatic crystals of brown-green colour. Biotite and sometimes garnet are found as inclusions in allanite. According to our data, the content of allanite in biotite-hornblende granites is significantly higher than the average content of allanite in granitoids and is 750 ppm and more.

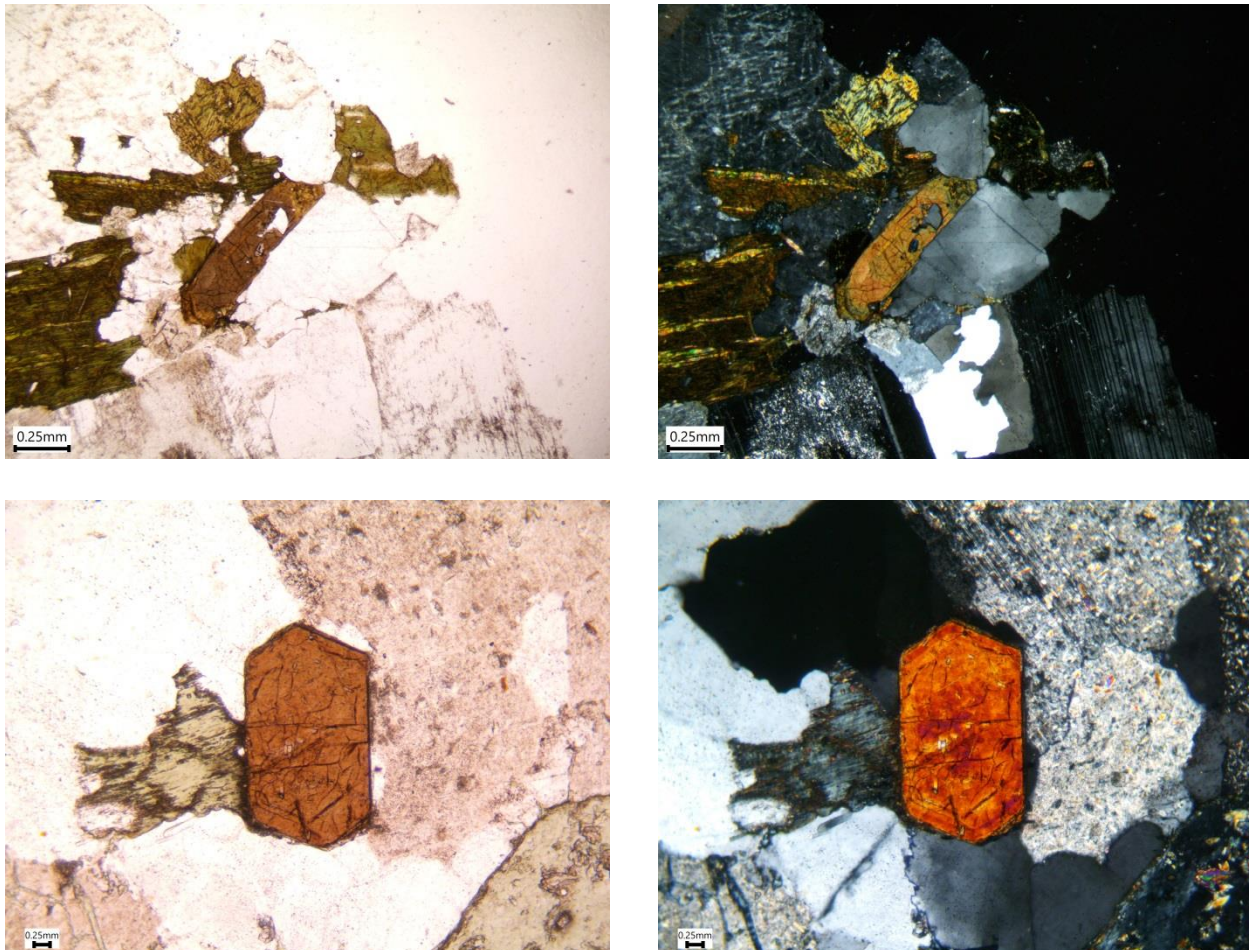


Fig. 5. Allanite prismatic crystal in biotite-hornblende granite. PPL and XPL

Allanite of magmatic and post-magmatic genesis have been established in the biotite-hornblende granites of the Khrami crystalline massif. Magmatic allanite is characterized by well-defined zoning and is often accompanied by secondary epidote veins.

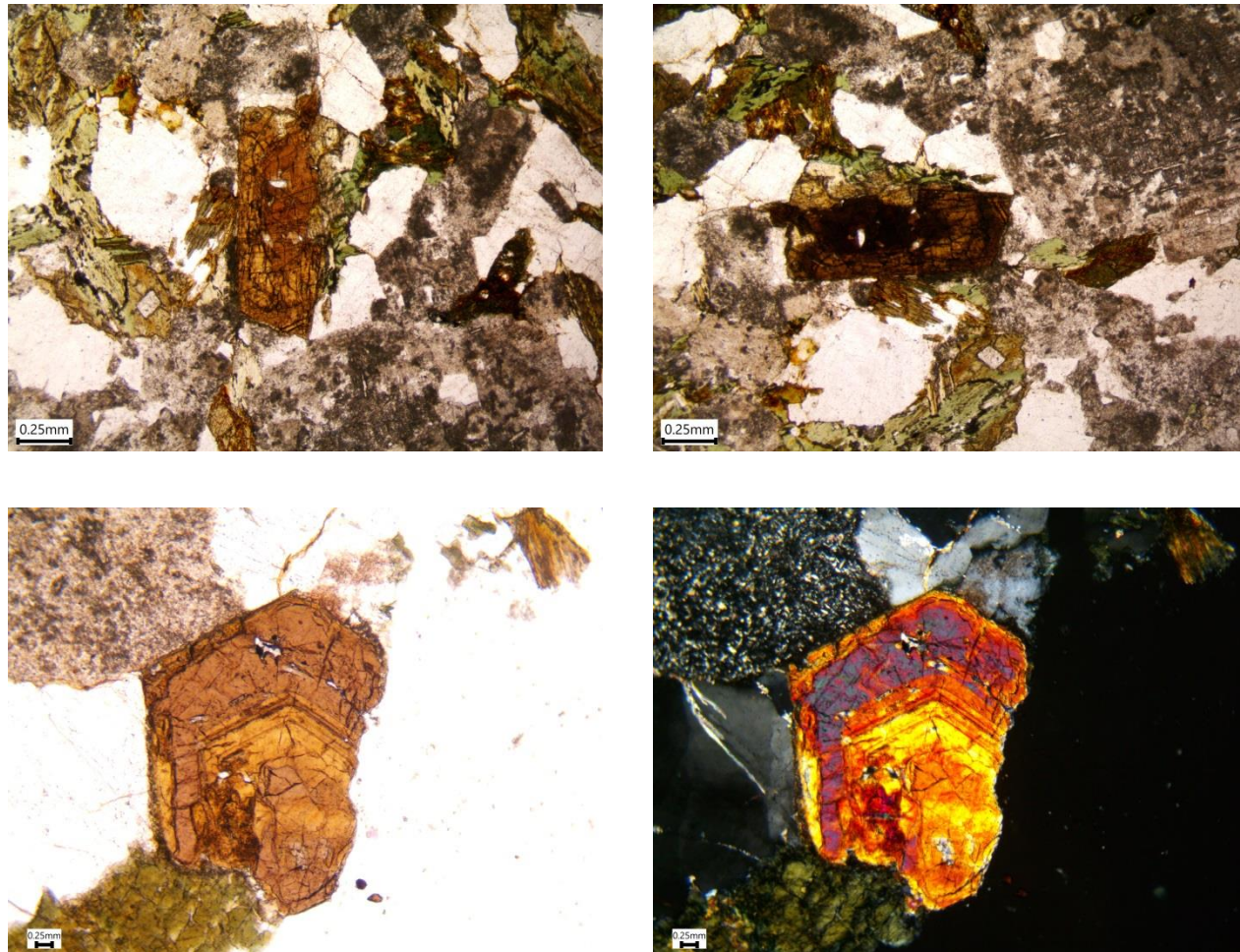


Fig. 6. Allanite crystal with epidote and chlorite and Zonal allanite. PPL and XPL

Microprobe analysis of Allanite from Khrami Massif

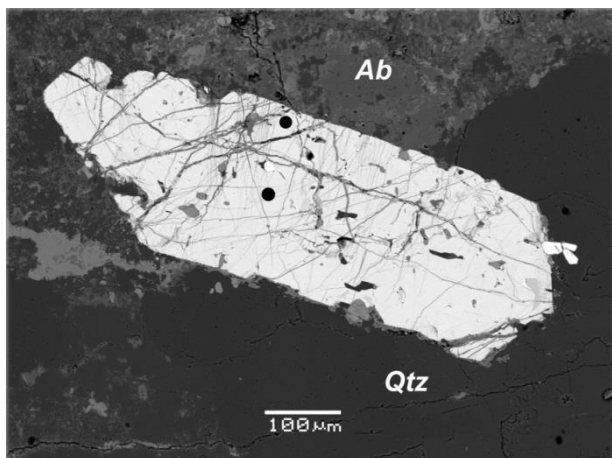


Fig. 7. BSE image of allanite. Black dots indicate microprobe measurement locations - in the core and margin.

Wt, %	Khrami Massif (average)		1	2	3	4	5	6	7	8	9	10
	Margin	Core										
SiO ₂	29.56	29.93	36.2	31.1	29.2	34.7	38.3	36.4	41.4	40.6	32.1	33.9
TiO ₂	1.82	1.62	-	-	-	-	-	-	-	-	-	-
Al ₂ O ₃	14.17	14.31	8.18	12.2	12.8	23.2	-	7.4	11.7	-	-	1.4
FeO ⁺ tot	16.77	16.32	10.1	11.2	3.8	10.8	10.7	2.3	7.3	10.5	17.8	12.2
MnO	0.20	0.23		0.9	1.2	0.8	-	1.8	-	-	-	0.3
MgO	0.34	0.29	0.61	0.4	0.1	-	-	-	-	-	-	-
CaO	10.20	10.02	5.48	0.71	15.9	15.4	0.9	14.7	-	17.8	-	3.1
SrO	-	0.14	-	-	-	-	-	-	-	-	-	-
ThO ₂	0.84	0.68	-	-	-	0.22	-	-	8.5	-	1.4	0.3
La ₂ O ₃	6.62	6.60	-	3.54	3.2	-	-	-	-	-	-	0.1
Ce ₂ O ₃	12.00	12.12	4.98	5.54	6.6	2.1	3.8	0.5	-	-	2.9	3.1
Pr ₂ O ₃	-	-	-	-	-	-	-	-	-	-	-	-
Nd ₂ O ₃	3.92	3.36	-	-	-	-	2.9	-	-	-	5.6	3.96
Sm ₂ O ₃	1.86	1.68	-	-	-	-	-	-	-	-	2.6	1.7
Gd ₂ O ₃	0.11	0.09		-	-	-	2.8	-	-	-	3.97	3.7
Y ₂ O ₃	0.16	0.13	29.8	3.71	13.3	8.7	29.8	28.1	31.2	31.1	29.3	27.2
Dy ₂ O ₃	-	-	-	-	-	-	4.3	2.8	-	-	4.6	4.3
Er ₂ O ₃	-	-	-	-	-	-	3.8	2.6	-	-	-	2.9
Yb ₂ O ₃	-	-	-	-	-	-	3.8	2.1	-	-	-	2.1
UO ₂	0.08	0.09	-	-	-	-	-	-	-	-	-	-
F	0.27	0.03	-	-	-	-	-	-	-	-	-	-
H ₂ O	1.60	1.93	4.59	0.85	2.29	3.02	-	-	-	-	-	-
Total	100.52	99.57	-	-	-	-	-	-	-	-	-	-

According to reference materials (Alekseev et al. 2012): 1 - Ytterbium orthite, Switzerland; 2 - Murmontite, Saxony; 3 - Faluna, Sweden; 4 - Ytriortite, Karelia; 5 - 6 from microcline-albitized leucogranites, Amur; 7 - from microcline-albitized leucogranites, Chukotka; 8 - from granosyenite-porphyry, Chukotka; 9 - from greisenized biotite granites, Amur; 10 - from the granites of the Far East massif; Average content of Y - Ni allanites (86 analyses)

Conclusions

- Allanite of granitoids of the Khrami massif belong to the cerium variety with high content of Ce_2O_3 , La_2O_3 and Nd_2O_3 .
- The appearance of allanite in the biotite-bearing granites of the Khrami crystalline massif is due to the concentration of rare earth elements in the granitic magma and the introduction of calcium by hydrothermal solutions.
- Allanite of the Late Variscan granitoids of Khrami crystalline massif, can be used as mineral resource, for the extraction of rare and rare earth elements. Which are used in many areas: in electronics, nuclear technologies, engineering, chemical industry, metallurgy etc.

Thank you for your attention!

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