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MINERALOGY OF GARNET-CONTAINING HORIZONS SOKHCHARV VALLEY (TAJIKISTAN WESTERN PAMIR).

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ABSTRACT:

The main object of the study is a large crystalline garnet, which noted in the form of large perfect crystals in both single and druse. The crystals of the pinkish, usually turbid almandine have a value from the pinhead to 7 cm, but preferably from 1-2 mm to 1 cm. In some layers of chloride shales, crystals of the same type usually found. Pomegranate crystals more or less easily separated from the host rock, from slate subjected to some weathering, garnet crystals pour themselves out when the piece of rock destroyed. Garnet crystals found in chlorite schists. The mineral composition of chlorite schists is quite simple and consists mainly of chlorite and fine-grained sericite. The stone crashed in a mechanical mortar to 1 mm, and then a magnetic and electromagnetic separation carted out, followed by the study of each individual fraction under a binocular microscope. The density and micro hardness of the garnet itself determined. For a more detailed study conducted chemical analysis of the mineral and of the breed itself and a diagram of the facial accessory of the mineral created.

KEYWORDS:

ALMANDINE, GRENADE, FACIES, EPIDOTE, AMPHIBOLITE, CRYSTAL, SHALES, GROSSULARITE, FRACTION.

1. Introduction

Work of the previous researchers in the region until 1968 were limited to determining the age and stratigraphic dismemberment of rocks tectonic zoning and a petrographic description of the magmatic description of magmatic rocks. The first information on the gold content and tungstenity of the area obtained in the process of geological imaging of a scale of 1:20,000, when shingle scales of scheelite and gold scattering established in the basins of the rivers Badzhudar and Khufdar. During this research, this type of pomegranate was not detected and did not any information or article about them[1]. The concept of zones of progressive metamorphism is familiar to all metamorphic geologists. Work by Barrow (1893) and later Tilley (1925) and others has substantiated the principle of correlation of mineralogical variation with physical parameters especiaily with temperature. Degrees of metamorphism recognized by index minerals characteristic of a particular rock composition. Work by Barrow and Tilley relates specifically to the pelitic rocks found in the Scottish Dalradian, where zones defined in terms of the first appearance of the index mineral. However, the use of index minerals continues to be the basis for separating facies with more complex problems, such as the separation between coexisting phases and its temperature dependence. For example, Turner and Verhoogen define the sub-facies of the green schist and amphibolite facies in terms of the classic is grad reactions of Barrow[2].This article presents new analyzes of the pomegranate and determines the composition of the chlorite schists and before that, no garnets of this type found in this area. Similar minerals from the facial affiiation of Otago, Scotland, Falun Switzerland, Kearney Aberdeen County, New York Adirondack Mountains. They related to the nature of garnets, producing reactions and ratios of garnet composition to a metamorphic grade. Much has been written on these topics and for the background of interested people it refers to articles: Sturt (1962), Banno (1965), Albee (1965), Hollister (1966), Atherton (1965, 1968), Saxena (1968) [3-8].

2. Geological setting

2.1 Regional geology

The territory of Tajikistan characterized by a complex and heterogeneous geological structure. Pamir situated at the Southwest part of the Tajikistan. From North to South

Pamir orogenic belt divided into five major regions: North Pamir, Central Pamir, South-East and South-West Pamir.In accordance with the adopted scheme of tectonic zoning, the territory of the Pamirs is located within two folded systems: Hercynian Gissar-North Pamir and Cimmerian - South Pamir, which are constituent parts of the Mediterranean fold belt. The main structural unit of the Hercynian fold system is the tectonic zone of the Northern Pamirs, the Cimmerian the Central and South-Eastern Pamirs. The area of work is located in the redistribution of the Kudara structural and formational zone of the folded system of the Central Pamir and timed to the superimposed deflection of the Bartang volcano-plutonic depression. The study area is on the right complex of the river Pyanj in the interfluve of Sokhcharv and Baju of the Rushan district of the Badakhshan Autonomous Region of the Republic of Tajikistan. (Fig. 1)

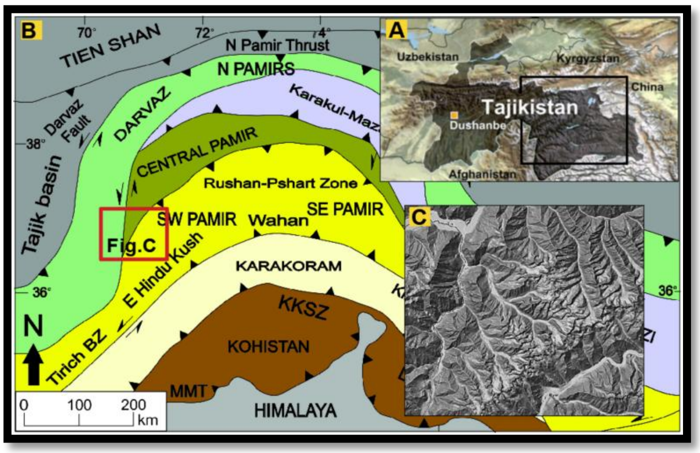

FIG. 1. ***A- THE REGIONAL MAP OF TAJIKISTAN WITH ADJACENT REGIONS. B-TECTONIC MAP OF PAMIR WITH FAULT ZONES. (MODIFIED AFTER ANGIOLINE ET AL. (2013)), C- STUDY AREA.***

2.2 Geology of study area

Within the area, there are sediments of the Vomar (T_3-J_{2vm}) and Bartang (P_{br}) series.Vomar series (T_3-J_{2vm}). The rocks of the series form the eastern and southern part of the region and are interbedded distinctly laminated carbonaceous-argillaceous shales and sandstones. The number of sandstones increases noticeably in the section in the southeastern part of the region. Clay-argillaceous shales are composed of carbonaceous-argillaceous substance, permeated with small scales of sericite and biotite. Bartang series (P_{br}). From the north, it bounded by the Bartang faults, from the east and southeast the rocks of this series crumpled into a synclinal fold. They lie on the sediments of the Vomar series, and in the northern part of the region on limestones of Cenomanian age with a slight erosion. Within the described region, the Pyanj subvolcanic and Sokhcharv intrusive complexes represent intrusive formations. The Pyanj subvolcanic: It unites dikes and small-sized arrays, confined to the area of development of the volcanoes of the Badzhudarin Formation. Sokhcharv intrusive complexes: It represented by one massif, which exposed on the extreme southwestern flank of the Rushan ore field. Itconfined to the southern boundary of the distribution of volcanic of the Badzhudarin Formation, and located mainly in the Perm upper-Triassic Vomar Series (Fig 2).The formation of the Quaternary system in the area of relatively insignificant due to sharply dissected relief, intensive erosion and demolition.

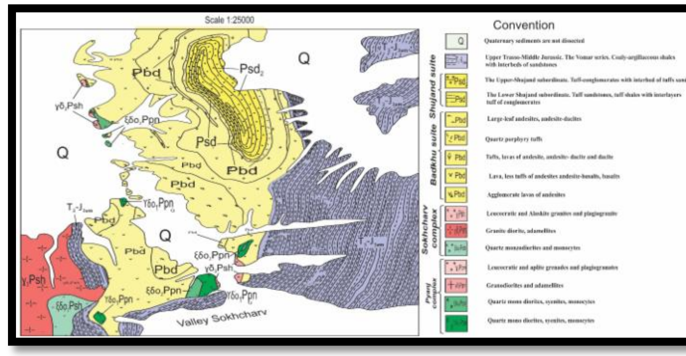

FIG.2. ***SCHEMATIC MAP OF STUDY AREA. MODIFIED AFTER DYSHUK ET. AL. (1977).***

3. Observation

Garnets belong to the most important rock-forming minerals. They are formed in a wide range of temperatures and pressures and in various media, participate in the formation of many mineral deposits, are observed in some igneous rocks as their primary constituent (in the main rocks pyrope, in granites-spessortin and almandine, in alkaline rocks-melanin and charlomite). Under the influence of acid magmas on the main metamorphic rocks, almandine is formed, biotite, hornblende, feldspar, sometimes with pyroxenes, tourmaline, sulphides[9].Quite often grenades found in crystalline schists. The composition of garnets here depends on the composition of the original rock. If the parent rocks are rich in Al and Fe is formed, almandine.

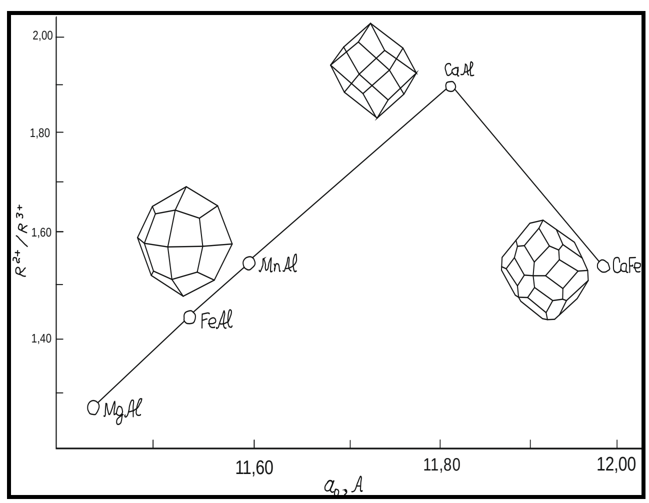

FIG.3.***THE CHANGES OF GARNET CRYSTALS RELATIVE TO THE RATIO OF CATIONS AND THE SIZE OF THE RIB OF A CUBIC CELL (ACCORDING TO KOSTOV 1971).***

The main schemes of the minerals of this group of garnet are isolated silicon-oxygen tetrahedral, connected by two and trivalent cations (Fig. 2). Depending on the elements of the cations occupying the place, garnet varieties are distinguished. The garnet group combines a number of isostructural species with a spatial group that crystallize in a cubic system. Symmetry of crystals 3L4 4L3 6L2 9P C (three axes of four-fold symmetry, four axes of three-fold symmetry, six axes of two-fold symmetry, nine symmetry planes and a center of symmetry). For mineralogists, garnets are particular interest, since they can serve as an example of the ease with which some elements replace each other.This group includes a number of minerals with the general formula R^{2+3} R^{3+2} $(SiO_4)_3$. The cubic structure of the garnet is stable in a very wide range of cationic substitutions. Isomorphic substitutions are susceptible to the position of the divalent cation R^{2+}, which can be occupied by Mg, Fe, Mn, Ca, and the position of the trivalent cation R^{3+}-Al, Fe, Cr.The final members of the group: props $Mg_3A_{l2}Si_3O_{12}$, almandine $Fe_3Al_2Si_3O_{12}$, spessartine $Mn_3Al_2Si_3O_{12}$called piralspit, and grossularite $Ca_3Al_2Si_3O_{12}$, andradite $Ca_3Fe_2Si_3O_{12}$ and uvarovitic $Ca_3Cr_2Si_3O_{12}$ are araldites. The structure of garnets consists of isolated groups $[SiO_4]$, located along the helical axis of the fourth order (Fig. 3).This explains the rhombs-decahedral (Fig. 4a) and tetragon-tri-octahedral (Fig. 4b) crystal, and the change in the ratio between divalent and trivalent cations seems to be responsible for the predominance of the rhomb dodecahedral shape for the calcium series of garnets, and tetragons- tri -octahedral for aluminum [10].

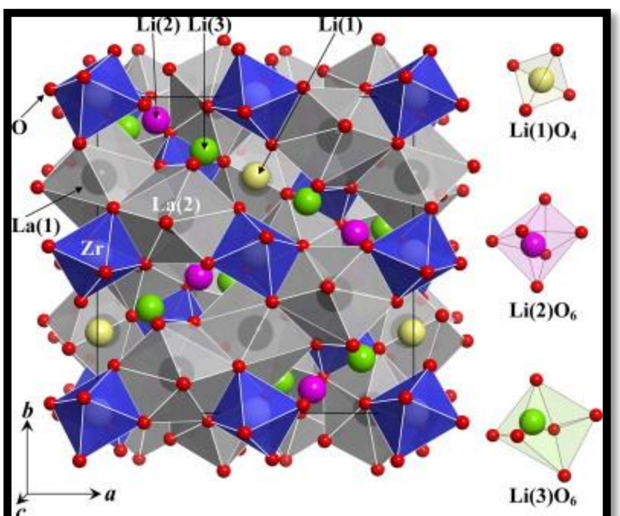

Fig.4. ***Structure of garnets***

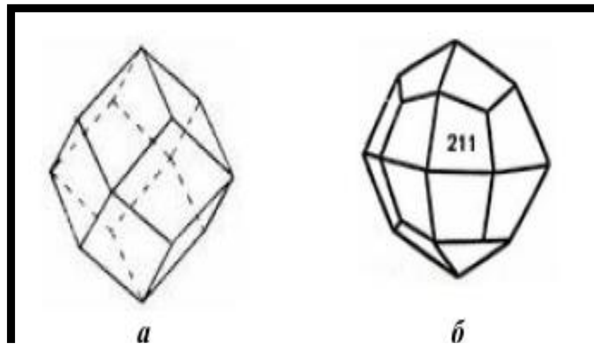

Fig.5. ***Typical habitats of garnet crystals are rhombododecahedron (a), tetragon trioctahedron (b)***

4. Sample and analysis

4.1 Sample characteristics

Almandine contains iron and aluminum cations. This mineral found in the shale of Sokhcharv valley, which are located 6-7km east part of the Sokhcharv village at an altitude of 3000 m. The mineral found both on the northern and southern slopes of the valley. On the southern slope of the valley among the shales, separate horizons are marked, composed entirely of large perfect almandine crystals 0.5-1 cm in size (Fig 5(A))on the northern part, accumulations of large garnet emissions also confined to a separate shale horizon. On this part, the crystal sizes reach 6cm (Fig 5(B)). All the crystals have a regular geometric shape and represented by the faces of the tetragonal-tri-octahedral.Other additional faces (110, 111, hkl(the *Miller indices*)) are not observed on the marked polyhedral. A characteristic feature of these, without exception, garnet crystals is the presence of rough shading on all faces. These dashed lines easily reveal the passage of axes, symmetries of the second, third and fourth orders (Fig 5(C)). On them, you can trace the passage of nine planes of symmetry.The mineral composition of chlorite shales is rather simple and consists mainly of chlorite and fine-grained sericite. For mineralogical studies, the rock crushed in a mechanical pounder to 1mm. Then, a magnetic and electromagnetic separation carried out, followed by the study of each individual fraction under a binocular microscope.The non-magnetic fraction with the help of heavy liquid (bromoform) divided into heavy and light differences. The initial weight of the sample was 0.75 kg. The magnetic part consisted entirely of iron shavings, which fell into the sample during mechanical crushing due to the iron pounder.

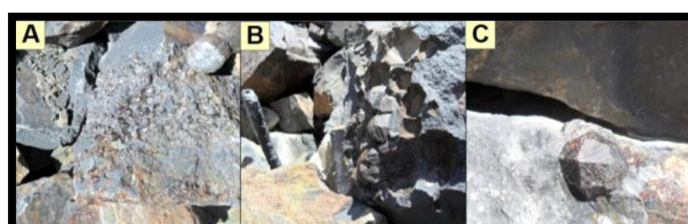

Fig 6. ***(A)Crystals of almandine inside chlorite***

schists on the southern part of Sokhcarv valley. (B)Crystals of pomegranate inside chlorite schists with negative traces of the northern part of Sokhcharv valley. (C)Fragment of an individual garnet crystal in shale.

The electromagnetic fraction weighed 0.3g, which is 0.04% of the initial mass of the sample. This fraction consists entirely of crushed fragments of pomegranate and dark green chlorite.

4.2 Analysis

The chemical composition of the shales themselves studied by complete silicate analysis in the Central Chemical Laboratory of the Main Department of Geology under the Government of the Republic of Tajikistan (Table 1). The results of mineralogical analysis of crushed garnet-bearing rocks given below.

The heavy nonmagnetic fraction weighs 0.035g and consists of zircon, sphene, apatite, and pyrite.

Table 1.

Chemical composition of chlorite shale

SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	P_2O_5	SO_3	H_2O	p.p.p	CO_2	Amount
1	2	3	4	5	6	7	8	9	10	11	13	14
36,1	0,97	17,03	4,48	22,98	1,86	2,28	0,050	0,051	0,25	-2,53	0,00	88,511
36,64	0,93	16,85	5,83	23,05	0,5	1,85	0,057	0,045	0,26	-2,54	0,00	88,552

Zirconia $ZrSiO_4$. It crystallizes in the tetragonal system in a ditetragonal-dipiramidal form of symmetry. In the nonmagnetic fraction, it occurs in the form of prismatic crystals 0.01-0.03 mm in size along the long axis. This mineral accounts for about 5% of the total mass of the heavy non-magnetic part. Under the influence of ultraviolet rays, the mineral under the binocular microscope glows yellow(Fig 6(A)).

Sphene $CaTiSiO_5$. Crystallizes in the monoclonalsynonym of the prismatic type of symmetry. In this fraction, sphene found in the form of fine granular fragments. Its color is yellow, transparent. The main diagnostic feature of the mineral is the shape of the crystals, diamond shine and the lack of luminescence. This mineral is about 15% of the total mass of the heavy nonmagnetic fraction. The debris found in the size of 0.05-0.1mm (Fig 6(C)).

Apatite$Ca_5(PO_4)_3(F,OH,Cl)$.Crystallized in a hexagonal system of hexagonal-dipyramidal symmetry. The color of

the mineral is pink, colorless. The mineral is 60% of the total mass and found to be 0.02-0.06 mm in size. Apatite diagnosed by a micro chemical reaction to phosphorus. For this, 2-3 apatite grains taken, placed on a watch glass and a few drops of nitric acid produced.After 2-3 minutes, several grains of molybdenum-ammonium crystals placed in the newly formed solution. After this process, the solution acquires a yellow color, which unambiguously indicates the presence of phosphorus. In addition, apatite luminesces in the short-wave ultraviolet rays in yellow(Fig 6(D)).

Pyrite FeS_2. It crystallizes in a cubic syngony in a dido-decahedral form of symmetry. In the fraction, it occurs in the form of crystals of a hexahedral shape with a size of 0.03 mm. The color of pyrite is light yellow. It is about 6-7% of the total mass of the non-magnetic fraction(Fig 6(B)).

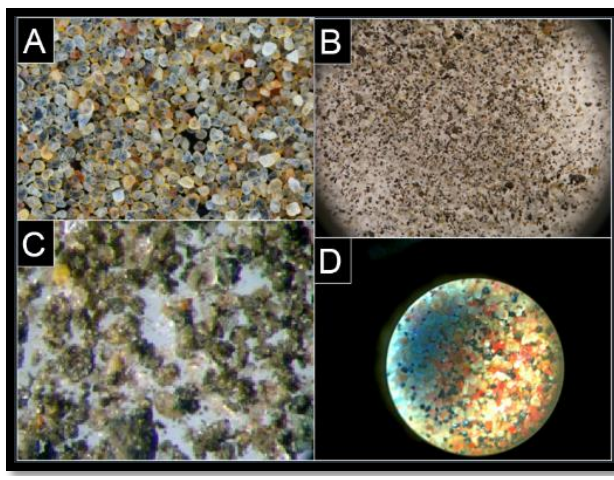

Fig 7. ***The heavy nonmagnetic fraction: (A) zircon, (C) sphene, (D) apatite, and (B) pyrite.***

Table 2.
Chemical composition of almandine

	Laft bank of the Sokhcharv valley of chlorite shale F-1/2017	Right bank of the Sokhcharv valley of chlorite shale F-2/2017	Falun Sweden-almandine garnet from garnet-chlorite rock	Keirni, Aberdeen-red garnet from banded garnet-biotite-sillimanite gneiss	New York, Adirondack-garnet Mountains of quartz gneiss
SiO_2	36.1	36.64	37.39	36.59	38.03
TiO_2	0.97	0.93	0.16	1.68	0
Al_2O_3	17.03	16.85	20.27	22.42	22.05
Fe_2O_3	4.48	5.58	0.83	0.04	0.88
FeO	22.98	23.05	36.37	32.11	29.17
MnO	0	0	0.86	1.42	1.57
MgO	1.86	0.5	3.85	5.41	6.49
CaO	2.28	1.85	0.41	0.54	1.8
Na_2O	0	0	0	0	0
Ka_2O	0	0	0	0	0
Amount	85.7	85.65	100.59	100.21	99.99
Chemical analysis with transformation into elemental composition					
Si	3.409	3.507	2.995	2.898	2.983
Ti	0.069	0.067	0.01	0.1	0
Al	1.896	1.901	1.956	2.093	2.038
Fe_{3+}	0.318	0	0.05	0.002	0.052
Fe_2	1.815	0.42	2.436	2.127	1.913
Mn	0	1.845	0.058	0.095	0.104
Mg	0.262	0.071	0.46	0.639	0.759
Ca	0.231	0.19	0.035	0.046	0.151
Na	0	0	0	0	0
K	0	0	0	0	0
Recalculation of chemical analysis for mineral variety(Minals (%))					
Pyrope	11.348	3.383	15.378	21.976	25.919
Almandine	78.653	87.604	81.494	73.17	65.352
Spessartine	0	0	1.952	3.277	3.562
Andradite	1.438	1.63	0.029	0.002	0.128
Grossular	8.56	7.378	1.148	1.575	5.038
Amount of min.	100	100	100	100	100
Modules (rel)					
X(Fe)	0.787	0.876	0.815	0.732	0.654
X(Mn)	0	0	0.02	0.033	0.036
X(Mg)	0.113	0.034	0.154	0.22	0.259
X(Ca)	0.1	0.09	0.012	0.016	0.052
X(Mg)/1-X(Mg)	0.128	0.035	0.182	0.282	0.35

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5. Resultsand discussions

The results of the chemical analysis of pomegranate from

Sokhcharv valley presented in Table 2. The data of chemical analysis of garnet indicate its belonging to the almandine series and its formula can be written in the following form: Fe_3 (Al, Fe)$_2$[SiO_4]$_3$. Analyzes were performed in the Central Chemical Laboratory of the Main Department of Geology under the Government of the Republic of Tajikistan.For comparison, the data of the chemical analysis of almandines from other regions of the world given[11].Analyzes in Table 2 were chosen with the following calculation to show the difference chemical composition of the almandine component and the nature of the garnets from the various paragenesis. These analyze show that Si: R + 3: R + 2 ratios in garnets are generally in good agreement with theoretical calculations.

To characterize the elemental and mineral composition, the chemical analysis of garnets recalculated into elemental composition and mineral variety using the Petro Explorer program, on the basic of which the facies belonging to garnets evaluated.For sub-homogeneous garnets, one representative analysis was used, and for the zonal differences there were two analyzes, in our opinion, corresponds to the most "peak" (corresponding max) of the preserved garnet composition (the main sign is low XFe), and the second - the minimum fixed PT (high XFe).

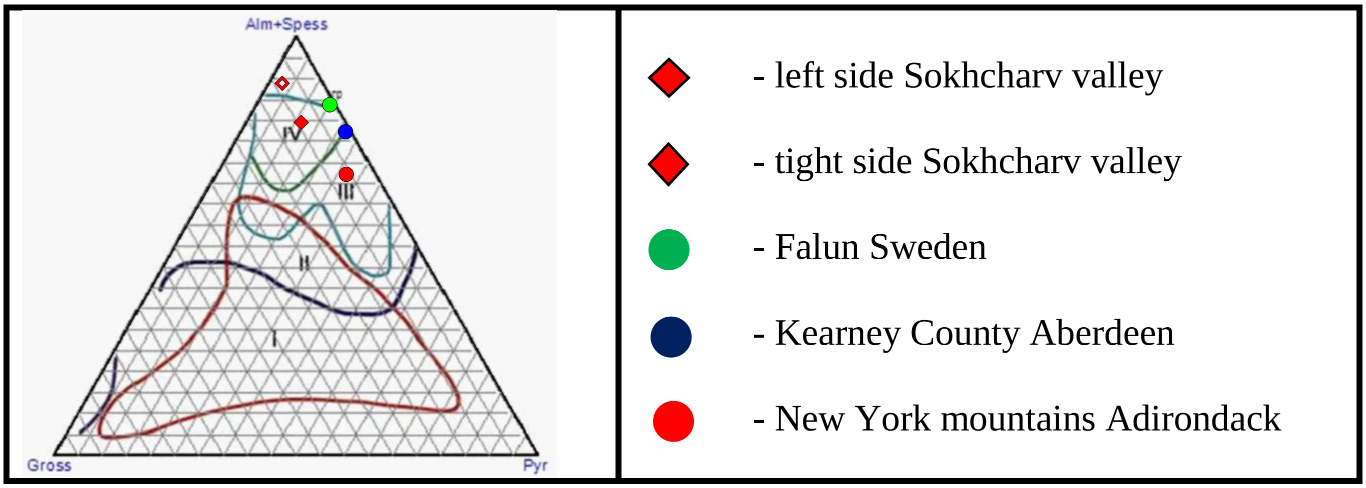

Fig. 8. ***The diagram of the facial affiliation of garnets according to Sobolev (1970) with the deposited points of the composition of garnets from Sokhcharv valley and other regions of the world. Facies: I - eclogite, II - granulite (together with facies of kyanite gneisses and shales), III - amphibolite, IV - epidote-amphibolite***

The same compositions subsequently used for thermos-barometric purposes, and sometimes the choice of analysis points corrected on the basic of geo-thermometer readings. In translation for the elemental composition, we see a substantial predominance of Si and Fe_2 +, less than-Al and Mg.The mineral composition of the analyzed sample is mainly represented by almandine, grossular, pyrope in decreasing order of content. In the presented diagram most of the samples fall into the amphibolite facies rock field, but some of the garnets have an increased content of the grossular component and go beyond the boundaries of the amphibolite facies, occupying fields of granulite and eclogite facies(Fig 7). The point of composition of the pomegranate, where the almandine pyrope and grossular predominate in order of predominance over the Dir is located north of the line of the epidoteamphibolite facies. Mainly it is grenades from the valley of the river. Sokhcharv, which gravitate toward the epidote-amphibolite facies field.

6. Conclusion

This scientific work is devoted to the study of the basic properties of garnet and the determination of physico-mechanical properties. As is known, pomegranate used as a cheap abrasive material. In this respect, Eastern Tajikistan, if it pays attention to the practical values of the pomegranate deposit, has an almost inexhaustible supply of garnet in mica, garnet shales and gneisses. This mineral found in the shapes of Sokhcharv valley, which is 6-7km east of the village of Sokhcharv at an altitude of 3000m. The mineral founded both on the northern and southern slopes of the valley. All the crystals have a regular geometric shape andrepresented by the faces of the tetragonal trioctahedral. Other additional faces (110, 111, hkl) are not observed on the marked polyhedral. A characteristic feature of these, without exception, garnet crystals is the presence of rough shading on all faces. These dashed lines easily reveal the passage of symmetry axes of the second, third, and fourth orders. On them, you can trace the passage of nine planes of symmetry. These formations can be used as a collection material in exhibitions, educational material for schoolchildren and geological (natural-science) special secondary and higher educational institutions.

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