51. **Aegirine**. 8 x 5 cm.
Series of vein nos. 123–134.
Specimen: A.M. Kuznetsov.

52. **Zircon**, crystal with pinacoidal face {001}
(it's very rare for this mineral).
6 x 4 cm, crystal 3.5 x 2.5 cm.
Vein no. 5. Specimen: I.V. Pekov.

53. **Titanite**, crystal 6 cm.
Svistunov Log. Specimen: S.V. Kolisnichenko.

Photos 51–55: M.B. Leybov.

54. **Ilmenite** with traces of plastic deformation.
13.5 x 14 cm. Specimen: Ural Geological Museum,
Ural State Mining University, #46779.

55. **Pyrochlore**, crystals.
(*left*) 4.5 x 3.5 x 4 cm, (*right*) 3.8 x 3.5 x 3.7 cm.
Vein no. 5. Natural Science Museum, Ilmeny State
Reserve (*left*) #3305, A.V. Donskov,
(*right*) #16637, L.A. Pautov and A.A. Agakhanov.


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5. MINERALS OF ALKALINE PEGMATITES, CARBONATITES, AND LATE VEINLETS IN THE VISHNEVYE MOUNTAINS

During 140-year period of study and mining of the Vishnevye Mountains (from 1841 to 1981), many researchers and mineral collectors identified and described to varying degrees 149 minerals from veins of alkaline pegmatites, carbonatites, and late pneumatolytic-hydrothermal and supergene assemblages opened by open pits, trenches, prospecting holes, and boreholes at the Vishnevye Mountains described area from Mt. Mokhnataya in the north to the Bolshoi Mauk River in the south.

Our research of alkaline pegmatites and vein carbonatites of the Vishnevye Mountains covers the period 1982–2020. During the preparation of the present paper, we carefully studied the materials of predecessors starting from the end of 19th century. At the beginning of our research, 149 minerals were known in the veins of the Vishnevye Mountains. To date, the list of minerals from alkaline pegmatites, carbonatites, and late mineralization contains **234** mineral species (Table 1) including **85** minerals, which we reliably identified; among them **3** minerals were identified in Russia for the first time – **garronite-Na**, **nioboaeschynite-(Y)**, and **franconite**, **7** minerals were found in the Urals for the first time: ***huanghoite-(Ce)***, ***kukharenkoite-(Ce)***, ***perrierite-(Ce)***, ***röntgenite-(Ce)***, ***thorutite***, ***yttrialite-(Y)***, and ***zirconolite***.

5.1. ELEMENTS, SULFIDES AND TELLURIDES

Gold, Au, was not observed in alkaline rocks or pegmatites of the Vishnevye Mountains, but it is known since 1823 at the southern and western locations of the Mauk middle reach and in the Gor'kaya valley along the western contact of miaskite massif and was produced from placers over the years. Many small carbonatite and carbonatite pegmatite bodies, including those enriched in sulfides are localized along this contact; by analogy with the locations toward south and characterized the similar geological structure, gold could be present in these bodies. It is known that during mining of zircon placers, gold was found in zircon concentrates of zircon "plant" 5-*R*; gold particles could be observed at present time.

We studied gold in concentrates of the Miass Exploration Crew obtained from loose sediments of the Gor'kaya River valley (Popov, Nikandrova, 1992*ofr*).

As indicated by 39 analyses, the gold fineness from the Gor'kaya River sediments is 820–1000 (0–17.95 wt. % Ag). The admixture-free gold grains are predominant; only two grains contain minor Cu, 0.6 and 1.6 wt. %.

Graphite, C, was observed by Isakov (1940*ofr*) in quartz veins of the Kurochkin Log. In 2015, V.A. Popov observed graphite in carbonatite-pegmatite in the open pits at Mt. Dolgaya. Graphite plates up to 1–2 mm are enclosed in large calcite individuals and have induction surfaces of crystallization with them.

Pentlandite, $(Fe,Ni)_9S_8$, was identified by Nikandrov (1985) in the core of borehole from the Kapitalnaya underground Mine in the Buldym ultramafic massif. At the depth of 96 m, the borehole intersected zone of bluish green coarse-grained richterite rock (up to 90% amphibole); such zones separate the Buldym massif into large blocks on the surface.

Sulfide aggregate of 1.5–2 cm thick in swell with rounded pyrrhotite and magnetite individuals up to 1 cm is localized at one contact of brown coarse-flake phlogopite veinlet of 7 cm thick that cross-cuts amphibolite. Sulfide aggregate is "streated"; thin pyrite and pyrrhotite veinlets enveloping large magnetite individuals are intermitted. Pentlandite veinlets are visually distinguished by their luster and good cleavage. Iron, Ni, and Co were detected in pentlandite using laser microspectral analysis. The strongest line in the powder X-ray diffraction pattern of pentlandite are (d, Å (*I*)): 3.05(8), 2.22(6), 1.777(10), 1.043(8), 1.028(7).

Chalcopyrite, $CuFeS_2$, was occasionally identified during the first years of the Vishnevye Mountains study; it was observed only microscopically in intergrowth with molybdenite or pyrite (Bonshtedt-Kupletskaya, 1951). Further, rare chalcopyrite crystals and grains up to 3 mm were found in pegmatite bodies and

Table 1. ***Alphabetical list and distribution of minerals in the vein bodies of the Vishnevye Mountains***

Mineral	Type of vein body				
	1	2	3	4	5
Actinolite			+		
Aegirine	•	+	••	+	
Aegirine-augite		+	+		
Aeschynite-(Ce)			+	+	
Aeschynite-(Y)			+		
Albite	••	•	•	+	+
Allanite-(Ce))	+	+	•	•	
Allanite-(La)			+		
Allophane					+
Aluminocopiapite					+
Alunite ?					+
Analcime	•		+	+	
Anatase		+	+		
Ancylite-(Ce)				+	
Ancylite-(La)	+			+	
Andradite			+		
Anhydrite					+
Ankerite				+	+
Annite	•	••	•	•	+
Aragonite					+
Arsenopyrite	+			+	
Atacamite					+
Azurite ?					+
Baddeleyite	+				
Banalsite		+			
Baotite			+		
Barylite				+	
Baryte				+	+
Bassanite ?					+
Bastnäsite-(Ce)			+	+	+
Bastnäsite-(La)				+	+
Bismuthinite			+		
Böhmite					+
Bornite			+		
Braunite ?					+
Brewsterite-Sr				+	
Britholite-(Ce)			+		
Britholite-(Y)	+		+		
Brochantite					+
Brookite			+		
Burbankite					
Calcite	+	+	+	••	+
Calkinsite-(Ce)			+		
Cancrinite	•	+			
Carbocernaite	+			+	
Cataplеiite			+		
Celadonite ?					+
Celestine			+		+
Cerianite-(Ce)	+				+
Ceriopyrochlore-(Ce)	+	+	+		
Cerite-(Ce) ?			+		
Cerussite ?				+	
Chabazite-Ca					+
Chalcocite			+		
Chalcopyrite	+		+	+	
Chamosite			+		+
Chevkinite-(Ce)		+	•	+	
Clinochlore			+	+	+
Clinoptilolite-Ca				+	
Clinozoisite			+		
Columbite-(Fe)		+	+		

Mineral	Type of vein body				
	1	2	3	4	5
Columbite-(Mn)				+	
Copiapite					+
Corundum			+		
Cosalite			+		
Covellite					+
Crichtonite			+		
Cubanite				+	
Davidite-(La)	+				
Dawsonite	+			+	
Delvauxite ?					+
Diaspore					+
Dingdaohengite-(Ce)			+		
Diopside	+	+	+	+	+
Dolomite				+	+
Donnayite-(Y)					+
Epidote			+		+
Fergusonite-(Ce)			+		
Fergusonite-(Y)			+		
Ferriallanite-(Ce)	+		+		
Ferri-barroisite		+			
Ferri-fluoro-katophorite			+		
Ferri-fluoro-nyboite			+		
Ferri-fluoro-winchite			+		
Ferri-katophorite			+		
Ferri-nyboite			+		
Ferri-winchite			+		
Ferro-ferri-taramite			+		
Ferro-ferri-winchite			+		
Fersmite		+		+	
Fibroferrite					+
Fluorannite			+		
Fluorapatite	+	+	+	•	
Fluorapophyllite-(K)				+	
Fluorcalciopyrochlore	+	+	•	+	
Fluorite	+	+	+	+	+
Fluoro-richterite				+	
Fluorophlogopite				+	
Franconite				+	+
Gahnite		+			
Galena	+		+	+	
Garronite-Ca				+	
Garronite-Na				+	
Geikielite				+	
Gibbsite				+	+
Goethite			+		
Gold				+?	
Gonnardite				+	
Graphite		+		+	
Grossular			+		
Gypsum					+
Halloysite					+
Halotrichite					+
Harmotome				+	
Hedenbergite			+		
Hematite					+
Hercynite	+		+	+	
Hessite		+	+		
Heulandite-Ca				+	+
Heulandite-K				+	
Heulandite-Sr				+	
Hillebrandite ?		+		+	

Mineral	Type of vein body				
	1	2	3	4	5
Hisingerite					+
Hochelagaite					+
Hollandite			+		
Huanghoite-(Ce)			+		
Huttonite ?				+?	
Hydrobiotite					+
Hydrocalciopyrochlore				+	
Hydrokenopyrochlore	+	+	+		
Hydrouranopyrochlore	+				
Hydroxylapatite				+	
Hydroxylbastnäsite-(Ce)			+		
Hydroxynatropyrochlore			+		
Ice					+
Illite					+
Ilmenite	•	+	•	•	
Kaolinite ?					+
Kobyashevite					+
Korobitsynite					+
Kukharenkoite-(Ce)			+		
Loveringite			+		
Lucasite-(Ce)			+		
Maghemite			+		
Magnesio-arfvedsonite				+	
Magnesio-ferri-hornblende			+		
Magnesio-fluoro-arfvedsonite			+		
Magnesio-hastingsite		+	+		
Magnesio-hornblende	+		+		
Magnesio-riebeckite			+		
Magnesite					+
Magnetite	+	+	+	+	
Malachite					+
Marcasite				+	+
Meionite				+	+
Melanterite				+	+
Mesolite					+
Microcline	••	••	•	+	
Millerite				+	
Mirabilite					+
Molybdenite	+	+	+		
Molybdite		+			
Monazite-(Ce)			+	+	
Monazite-(La)			+		
Montmorillonite					+
Muscovite	+	+	+		
Nacrite ?					
Nahcolite ?				+	
Natrojarosite			+		+
Natrolite	+			+	+
Nenadkevichite					+
Nepheline	••	+			
Nioboaeschynite-(Ce)			+	+	+
Nioboaeschynite-(Y)			+	+	
Nontronite					+
Nordstrandite				+	+
Nosean	+				
Nyerereite ?				+	

Mineral	Type of vein body				
	1	2	3	4	5
Opal					+
Orthoclase	+	+	+		
Oxycalciopyrochlore	+	+		•	
Oxyceriopyrochlore-(Ce)	+				
Oxyuranopyrochlore	+				
Paranatrolite					+
Parisite-(Ce)			+	+	
Pentlandite			+		
Perrierite-(Ce)			+	+	
Phillipsite-K			+		+
Phlogopite		+	+	•	
Pirssonite ?				+	
Posnjakite					+
Powellite			+		
Prehnite				+	
Pyrite		+	+	+	+
Pyrophanite	+				
Pyrrhotite			•	+	
Quartz			+	+	+
Rhabdophane-(Ce)					+
Richterite			+		
Riebeckite			+		
Romanechite					+
Röntgenite-(Ce)			+		
Rozenite				+	
Rutile	+			+	
Scheelite			+		
Scolecite				+	+
Shortite					+
Siderite	+	+	+	+	
Sodalite	•		+		
Spessartine		+			
Sphalerite	+	+	+		
Stilbite-Ca	+	+			
Stronalsite			+		
Strontianite				+	+
Synchysite-(Ce)			+		
Szomolnokite				+	
Tetradymite				+	
Thénardite					+
Thorianite			+		
Thorite	+			+	
Thorogummite				+	
Thorutite			+		
Titanite	+	+	•	+	
Todorokite					+
Tremolite				+	+
Trona				+	+
Vermiculite					+
Vernadite ?					+
Vigezzite				+	
Vishnevite	•				
Xenotime-(Y)			+	+	
Yttrialite-(Y)	+				
Zircon	•	•	+	+	
Zirconolite	+				

Note: Type of vein bodies: (1–4) pegmatite veins: (1) nepheline-feldspar, (2) biotite-feldspar, (3) pyroxene-feldspar, (4) carbonatite; (5) late hydrothermal veins and supergene minerals. *Mineral abundance:* (••) common, (•) minor, (+) rare.
Minerals found by the authors are highlighted in grey, including **minerals found for the first time in Russia are bolded;** ***minerals found for the first time in Urals are italicized and bolded,*** ? denote that the mineral was mentioned in literature without description or analytical data or the given data are not sufficient for the mineral identification. Total 235 mineral species.