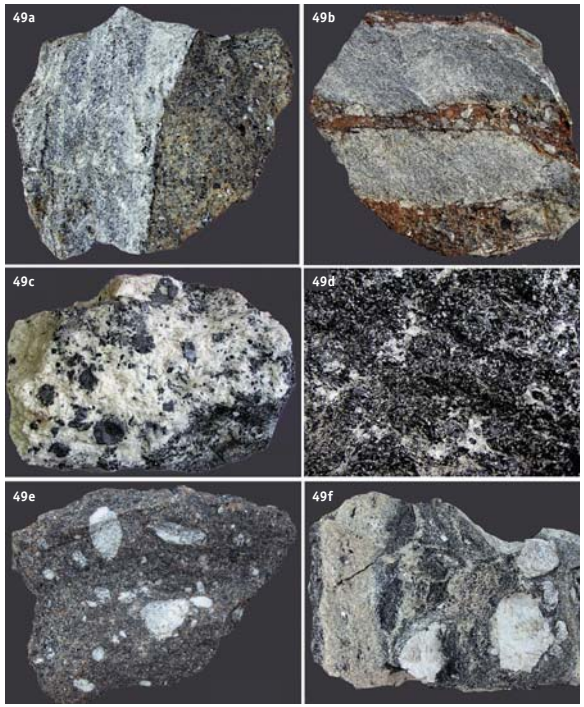



49. Varieties of vein carbonatites.
(a) annite-dolomite carbonatite (brownish-gray) contacting with miaskite,
(b) veinlets of calcite-dolomite carbonatite in miaskite,
(c) nodular pyrochlore-ilmenite-calcite carbonatite;
(d) melanocratic annite-calcite carbonatite;
(e) annite-dolomite carbonatite with syenite fragments («pea breccia»);
(f) contact of dolomite carbonatite and breccia of annite-dolomite carbonatite with fragments of nepheline-feldspar pegmatite.
Specimen size:
(a) 8 cm,
(b) 12 cm,
(c) 9 cm,
(d) 6 cm,
(e) 8 cm,
(f) 11 cm.
Open pit at Mt. Dolgaya.
Specimen and photo: V.A. Popov.

Below some examples.

**Ore zone no. 147** in the northern outer contact of the Central massif includes a vein series nos. 124–134 of the Salamatovsky area with the most known vein series no. 125 hosted by fenite replacing gneiss and porphyry granite, which was mined by open pit and was flooded. Currently, only dumps of this open pit are accessible; close and/or joined aegirine-feldspar, feldspar, and calcite-biotite-feldspar pegmatoid veins which are frequently brecciated and enriched in carbonate are observed (*Fig.* 48).

In the open pit at Mt. Dolgaya adjacent to ore zone no. 147, we observed various carbonatites (*Fig.*49). Calcite-bearing pegmatoid and carbonatite pegmatite veins and ore breccias with carbonate cement are distinguished by the high $Nb_2O_3$ content (0.10–0.12 wt.%) (Levin *et al.*, 1997).

Rutile, anatase, brookite, allanite-(Ce), bastnäsite-(Ce), chevkinite-(Ce), catapleiite, baryte, barylite, pyrrhotite, sphalerite, pyrite, molybdenite, quartz, chlorite, and arfvedsonite-quartz veins with fluorite, calcite, chevkinite-(Ce), and britholite-(Ce) were observed in the northwestern part of zone no. 147. The southern areas of ore zone no. 147 in the vicinity of vein nos. 47 and 46 are traced along strike for 4.2 km and to the depth of 300–500 m; an average thickness of the ore zone is 96 m with the $Nb_2O_5$ and $ZrO_2$ contents 0.092 and 0.36 wt. %, respectively.

**Ore zone no. 140** consists of several linear stockworks controlled by thrust (parallel to miaskite banding or at an acute angle to it) and fault clusters on the fold limbs ( *Fig*s.39, 40). The stockworks consist of nepheline-feldspar, biotite-microcline, and apatite-biotite veins and veinlets, and the most abundant biotite-calcite and calcite ore carbonatite. The length of the ore zone along strike is about 1700 m and about 1300 m along dipping (Levin *et al.*, 1997). The average thickness of the zone is 2.7 m; the $Nb_2O_5$ content is 0.14 wt. %. It was studied down the depth of 800 m by geologist of the Vishnevogorsk Mine Group and Geological Crew.

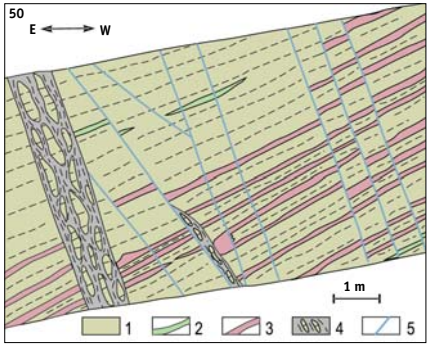
**Ore zone nos. 116, 148, and 150** were partly mined during exploration.

**Svetloozerskoe rare metal deposit** studied by the Vishnevogorsk Exploration Crew consists of three zones (the main zone is beneath the lake) with schlieren of zircon- and pyrochlore-bearing nepheline-feldspar pegmatites and carbonatites; the reserves of niobium ore are off-balance (Levin *et al.*, 1997).

## 4. LATE HYDROTHERMAL MINERALIZATION IN FRACTURE SYSTEMS

A late mineralization filling cross-cutting fractures is associated with the submeridional fractured zones in miaskite of the Sedlovidnaya body and Central massif in the northern part of the Vishnevye Mountains. Druse aggregates and isolated crystals of various minerals coat the fracture walls (Nikandrov, 1988*a*). On the basis of predominant composition and precipitation sequence the following mineral assemblages are recognized:

(1) quartz-chlorite (early),
(2) analcime-natrolite (zeolite),
(3) quartz-chlorite (with sulfides),
(4) donnayite-franconite (late carbonate), and
(5) thénardite-mirabilite (sulfate).




50. Structure of fracture system with natrolite-analcime mineralization,

(1) miaskite,
(2) microcline veinlets with pyrochlore,
(3) ore pyrochlore-bearing annite-calcite veinlets,
(4) crush zones,
(5) natrolite-analcime veinlets.
Kapitalnaya Mine, slope tunnel at the depth of 400 m.
*after Nikandrov (1985).*

*Analcime-natrolite mineralization* in nepheline-feldspar pegmatites with pyrochlore and zircon (vein no. 1 at Kurochkin Log, vein no. 5 at Mt. Karavay, and many veins at the sides of the Feldspar open pit at Mt. Dolgaya) is present in the central parts of veins with feldspar, annite, magnetite, and zircon. In the underground mines of the Kapitalnaya underground Mine, veins with analcime-natrolite mineralization and rare grains of other minerals cross-cut ore veinlets (*Fig.* 50).

*Quartz-chlorite mineral assemblage* (with pyrite, pyrrhotite, and galena) observed in the late calcite-pyrite-chamosite-quartz veins is embedded in quartz and fluorite growth zones and occurs as crusts on these minerals.

*Donnayite-franconite assemblage* contains adularia, muscovite, chlorite, albite, natrolite, Nb-bearing rutile, magnetite, calcite, ankerite, Mg-rich siderite, strontianite, burbankite, ancylite-(Ce), donnayite-(Y), korobitsynite, nenadkevichite, and franconite.

*Thénardite-mirabilite assemblage* (with trona) usually overgrows previous aggregates of analcime with natrolite, calcite, and shortite filling residual cavity.