PART 3. RODINGITES IN ULTRAMAFIC ROCKS: GEOLOGICAL SETTING AND VARIETIES

What is Rodingite

The bulk of the information given in this book concerns with minerals of rodingites, therefore the brief general description of these rocks will be useful.

"Petrographic glossary" (1981) gives the following interpretation of this term: *rodingite is a common name for contact metasomatic rocks formed as a result of alteration of basic rocks located adjacent to serpentinites or hosted by the latter. Rodingites also result from alteration of xenoliths of sedimentary and metamorphic rocks "dragged" into a serpentinite mélange. High CaO and lowered SiO_2 contents are characteristic of rodingites. The most common paragenetic mineral assemblages are: hydrogrossular*[1] *+ chlorite, hydrogrossular + vesuvianite + chlorite, prehnite + hydrogrossular + chlorite, and hydrogrossular + diopside + vesuvianite. The formation temperature of rodingites ranges from 250 to 450°C.*

Initially, the term rodingite (after type locality in the Roding basin) was suggested by P. Marshall in 1911 to refer to diopside-prehnite-grossular veins hosted in serpentinized peridotite of the Dun Range located east of the town of Nelson in the north of the Southern Island, New Zealand. In Russia, this term was not accepted in that period and in local literature, these rocks were usually reported as garnetized gabbro, garnetite, ophispherite, chlograpite, and other. Only since the 1970s the term *rodingite* has been established in Russian geological literature after studies of Yu.N. Kolesnik and G.V. Pinus (Mineralogy..., 1996; Antonov, 2003).

Currently, rodingites are recognized worldwide including oceanic bottom. They are found where serpentinized ultramafic rocks are intruded by more acidic dikes or where tectonized serpentinites host boudins of different chemical and mineralogical composition. Genesis of rodingites is debatable so far. Metamorphic, contact-metasomatic, magmatic, and palingenetic-metasomatic origin of rodingite is discussed. With such a variety of hypotheses many researchers agree that rodingites are formed under greenschist and prehnite-pumpellyite facies conditions (Antonov, 2003).

Geological Setting of Rodingites in Bazhenovskiy Ophiolite Complex

Within Bazhenovskiy ophiolite complex, rodingites are found only in serpentinites and serpentinized ultramafics of the dunite-peridotite massif and are spatially related to fault zones. Two morphological types of rodingites are identified: vein (dikes) and boudins (lenticular bodies).

The first type is more abundant and in some cases forms extended veins up to a few km long and up to 40–50 m in thickness; more frequently these veins are no longer than a few tens of meters and up to 1 m in thickness. Rodingitized gabbroic and diorite dikes belong to this type. The former occur at the western contact between serpentinites and gabbro-norite of the Asbest massif; the latter are associated with the eastern contact with rocks of the Reft gabbro-granite complex. Many dikes are brecciated and complicated by pinches and swells or are boudinaged.

[1] What the authors of Petrographic Glossary (1981) mean by "hydrogrossular" is unclear *(Editor's note)*.

The second-type rodingites are lenses and boudins no longer than a few meters. They resulted from crushing of dike complex and mélange of the other country rocks (for example, pyroxenite of the ophiolite assemblage).

Classification of Rodingites by Protolith and Other Features

The detailed study of rodingites revealed them to belong to various types. For example, different protoliths for the metasomatic rocks were established. In the first place, it is seen from relict fragments of primary rocks, which are occasionally retained during rodingitization. In addition, hydrothermally altered rodingites were found.

Gabbroic rodingite is the most abundant type within Bazhenovskiy ophiolite complex. It was identified by Kryzhanovsky (1907), Tatarinov (1928), and many other researchers. This rock replaced gabbroic dikes, which intruded ultramafic rocks during the formation of the late Asbest gabbro-norite pluton. Both dikes and boudins of such rodingite are found. Rodingitized gabbro with retained primary texture and mineral relics of magmatic rock is rare, but typical rodingite with the newly formed chlorite-diopside-grossular aggregate is more frequent.

Dioritic rodingite is the second in abundance within Bazhenovskiy ophiolite complex. It was described for the first time by Sokolova (1955, 1960). It replaces dikes of the Reft gabbro-granite complex, which also intruded an ultramafic body. These dikes are less rodingitized as compared to gabbro and are rodingitized diorite. This is caused by the Ca content in primary diorites and therefore the rodingitization process does not come to completion.

Granodioritic and plagiogranitic rodingites are less common within Bazhenovskiy ophiolite complex. They are mentioned by Antonov (2003). These rocks also replace dikes of the Reft gabbro-granite complex, which cut the ultramafic body. These dikes are even less rodingitized as compared to dioritic rodingite and the newly formed aggregates of rodingite minerals are developed only in dike margins immediately at the contact with serpentinites. This is caused by even less Ca content in primary felsic rocks and therefore, the rodingitization is negligible. Beautiful quartz-albite aggregate with bronze-brown radial stilpnomelane and greenish fibrous ferroactinolite is formed in the central part of these veins.

Pyroxenitic rodingite is uncommon within Bazhenovskiy ophiolite complex. It is described by Erokhin (2005_2). This rodingite replaces amphibolized pyroxenite (clinopyroxenite and olivine websterite), which is found in dunite-pyroxenite marginal complex at the boundary between gabbro-norite and ultramafic massifs. It occurs only as boudins, because pyroxenite gets into the ultramafic body only as a result of tectonic movements, which caused brecciation of the marginal dunite-pyroxenite complex. It is the most abundant at the dam between the Central and Northern open pits, within a thick tectonic zone. This rock is usually composed of the newly formed garnet-pyroxene aggregate, but occasionally contains relics of pyroxenitic amphibolites, which some researchers perceive as xenoliths of classic amphibolite.

High-Ti dioritic rodingite is extremely rare within Bazhenovskiy ophiolite complex. This rock, reported by Erokhin (2006_2), replaces thin boudinaged dikes cutting the ultramafic body. The degree of rodingitization of these dikes is low, caused by low Ca content in primary diorites. Brown Ti-rich pargasite and abundant disseminated perovskite are the major feature of such rodingitized diorite.

Gabbroic alkali rodingite is also rare (Erokhin, 2011). It replaces thin boudinaged dikes cutting the ultramafic body. The degree of rodingitization of these dikes is medium. Owing to the high alkali content in the rock matrix abundant clusters of phlogopite are observed. This is the main specific feature of such rodingitized gabbro. The newly formed Sr varieties and analogs of epidote and clinozoisite, as well as barium aluminosilicate cymrite are found in it.

Chromititic rodingite is quite rare within Bazhenovskiy ophiolite complex (Erokhin *et al.*, 2003_3). Many bodies of Bazhenovskiy chromitite hosted in serpentinite contain a cement composed of chlorite, vesuvianite, and garnet, i.e. minerals typical of rodingite. It is likely that chromitite served as a geochemical barrier, where excess Ca and Al precipitated during serpentinization of peridotite. The degree of rodingitization of this rock is very low. Mineralogy of xenoliths of chromite ore in rodingite matrix is reported in Mineralogy... (1996) and Antonov (2003).

Hydrothermally altered rodingites are abundant within Bazhenovskiy ophiolite complex (Mineralogy..., 1996; Antonov, 2003). They are observed at the lower level of the open pits, where they form complex, frequently porous bodies. Prehnite, apophyllite, carbonates, and zeolites are predominant in them. In this case, the rodingitization degree of the primary rocks is very high; not any relics are retained. Here, we observe dikes of gabbroic and dioritic rodingites, which were altered by hydrothermal fluids possibly derived from the underlying granite intrusion. Numerous potassium, sodium, and barium minerals and carbonates, which are not characteristic of standard rodingites and hosting serpentinites, support this hypothesis. This is the type of rodingites that are the major supplier of museum and collector's mineralogical material.