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The Main Types of the Urals Mafic-Ultramafic Complexes

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The mafic-ultramafic complexes and associated formationsare wide spread within the Ural folded belt, which is located on the boundary of the East European plate and West Siberian sedimentary basin. Two main types of the complexes having different nature are distinguished among them– the ophiolite and Ural-Alaskan, marking the Main Ural fault (MUF) zone (Savelieva et al., 2002, Efimov, 2010).

The ophiolite type complexes are well preserved in the Polar(Syum-Keu, Rai-Izand Voikar) and South Ural (Kraka, Habarny, Kempirsay and others) massifs of the MUF segments. They are presented by mantle peridotites and dunite-clinopyroxenite-gabbro rock complexes in association with the sheeted dolerite dyke complex.

The mantle peridotites show clear signs of substantial heterogeneity, expressed by the existence of massifs with different depletion degree - from essentially lherzolites (Kraka) to lherzolite-harzburgite (Syum-Keu) and chromite-bearing dunite-harzburgite (Rai-Iz, Kempirsay) ones. Furthermore in the South Urals massifs the presence of plagioclase lherzolites has been established. Peridotites everywhere have experienced high-temperature plastic deformations with the formation of folded structures and flow zones.

Peridotites of ophiolites are derivatives of different depthlevels of the mantle lithosphere according to the mineralogical and geochemical characteristics. For their most part(likerocks of spreading zones) they belong to spinel facies, but at the Polar Ural massifs are also present peridotites with signs of garnet facies. The existing range of peridotite varieties is of polygenic origin, related to different geodynamic settings (Shmelev,2011). At the oceanic environment in the process of partial melting in spinel facies lherzolites and diopside harzburgites (type I) have been formed. Simultaneously (?) in the process of polybaric melting in the garnet and then spinel facies there have been formed diopside harzburgites and harzburgites of moderately depleted type(II). At the suprasubduction setting the original peridotite shave undergone the fluid-induced partial melting with formation of depleted harzburgites (typeIII). In zones of intensive brittle-plastic deformations under the influence of percolating melts and fluids, the peridotites have experienced "depyroxenization" with the formation of dunite bodies and chromite deposits.

Dunite-clinopyroxenite-gabbro (DCG) complex in the Urals ophiolite massifs occupies a different position relatively the mantle peridotite section. In the normal position the dunites, clinopyroxenites (wehrlites) and layered olivine gabbro are located nearly at the border with peridotites and amphibole gabbro and gabbro-norites in the marginal (upper) part of the section. In other cases the complex rocks "underlie" peridotites demonstrating signs of moderate and high-pressure metamorphism. The formation of DCG complex and the sheeted dolerite dyke complex occurred in suprasubduction geodynamic setting according to the geochemical characteristics of rocks and minerals. During the tectonicdisplacement of ophiolite complexes into the upper crust horizons, the peridotites and gabbro have undergone deformation and metamorphism.

The Ural-Alaskan type complexes form the extended (for about 1000 km) chain of massifs in the central part of the Urals, which is called the Platinum-bearing Belt(PB). The PB massifs are located mainly among of metabasalts (hornfels andamphibolite), which correspond on their geochemical data to the SSZ ophiolites. In someobjects (Horasyur and others) it is established tectonic superposition of PB complexes with blocks of mantle peridotites and ophiolite gabbro with packages of dolerite dykes. The PB massifs together with the surrounding ophiolites are located in the basement of the Silurian Tagil island arc megazone. They are composed of three main rock complexes: dunite-clinopyroxenite, clinopyroxenite-gabbro and gabbro(gabbronorite). The rocks of the two last complexes are dominated (over 90%) among the PB formations.

The dunite-clinopyroxenite complex forms small subisometric bodies(Nizhny Tagil and others) in the

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western part of the PB. It is characterized byzonal structure, as well as by growth of iron content of silicates, alumina and REE contents in clinopyroxene in the dunite-clinopyroxenite series. Regular variations of rock and mineral compositions, side by side with the structural subconcentric pattern, linear orientations and magmatic tilling structures in dunites are the result of complex formation in the process of dynamic flow age differentiation (Shmelev, Filippova, 2010).The primary melt had magnesian composition of the ankaramite type. Chrome-platinum mineralization is related with dunites.

The clinopyroxenite-gabbro complex is composed of separate massifs ora series of bodies(lenses) inside the gabbro complex. It is presented by banded orisotropic anorthite olivine gabbro with numerous bodies of clinopyroxenites, wehrlites and olivinites. Structural, mineralogical and geochemical characteristics of the rocks also indicate that the complex belongs to cumulates. Variations of the mineralogical composition of gabbroids testify to their formation in the magmatic chambers of different depths. Copper-sulphide and titanomagnetite deposits(Kachkanar massif) are associated with gabbro and pyroxenites.

The gabbrocomplex is presented mainly by the Labrador gabbro norites. In comparison with the olivine gabbros, they are characterized by higher iron content and higher levels of trace elements with a comparable character of distribution. The stability of the rock compositions and lack of primary layer in gallow to attribute gabbro norites to the orthomagmatic formations. The magnetite contact-metasomatic deposits are related to the rock of complex and associated granitoides.

Basites of both complexes under the influence of late magmatic fluids have experienced high temperature hydration with the formation of hornblende gabbro and pegmatoids. The majority of the PB formations have also experienced high-temperature plastic deformation and recrystallization. Structural conformity of tectonic foliation and magmatic layering(banding) of rocks is seen as a consequence of the change of magmatic to plastic flow in the process of diapiric intrusion.

With the Ural-Alaskan type formations are also comparable gabbroic complexes (Maslo and Hordyus), associated with large ophiolite massifs of the Polar Urals. They are presented two-pyroxene and olivine gabbro with the island arc geochemical features.

The age and relationship of the formation of mafic-ultramafic complexes remain to be the subject of discussions (Fershtater, 2013). For the Polar and Southern Urals ophiolites it is reliably established the Ordovician (440-460 Ma) age of crystallization of gabbro and plagiogranites. However,for the associating mantle peridotites and chromites up to new the Precambrian datings have been obtained. The formation of the Ural-Alaskan and ophiolite complexes, apparently were close in time. The formation of dunite-clinopyroxenite and gabbroiccomplexes occurred in the Late Ordovician-Early Silurian(460-430 Ma). The rocks of the gabbroiccomplex and granitoides have been formed at the Silurian – EarlyDevonian(430-410 Ma) inclusively.The Vendian Sm-Nd datings (580-550 Ma)received for the rocks of clinopyroxenite-gabbro complex as well as for metaophiolites(amphibolites, gneisses) of the MUF zone in the Middle and Northern Urals need clarification.

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