Ophiolites of the Kamchatsky Mys Peninsula, Eastern Kamchatka

M.V. LUCHITSKAYA[1], N.V. TSUKANOV[2], W. KRAMER[3], S.G. SKOLOTNEV[1], and W. SEIFERT[3]

[1]*Geological Institute Russian Academy of Sciences, 119017, Pyzhevskiy str, Moscow, Russia, luchitskaya@ginras.ru, skol@ginras.ru, phone: (095) 2308158*

[2] *Institute of Oceanology, 117997, Nachimovskiy av. Moscow, Russia, paleogeo@sio.rssi.ru phone: (095)1246563*

[3] *GeoForschungsZentrum Potsdam, Telegrafenberg, D-14473 Potsdam, Germany, ws@gfz-potsdam.de phone: (0)331-2881375*

Geological setting. Kamchatsky Mys peninsula has composite fold-and-thrust structure, constructed by Cretaceous and Paleocene-Eocene volcanic and terrigenous-tuffaceous rocks and tectonic slices of serpentinite mélange, gabbroids and ultrabasic rocks [Khotin, 1976; Zinkevich et al., 1985; Rasnitsyn et al., 1985; Fedorchuk, 1989; Shapiro, 1987; Accretional ... , 1993; Boyarinova et al., 2000, 2001; Saveliev, 2004]. Its southern part (Afrika block) according to [Zinkevich et al., 1985] is constructed by four allochtonous complexes. They are composed of: 1) Aptian-Albian and Albian-Cenomanian calcareous-cherty-effusive assemblages (Afrika complex), 2) Campanian-Maastichtian cherty-tuffaceous and terrigenous deposits, 3) Paleocene-Lower Eocene chert-volcanic sequence (Kamensk complex), 4) serpentinite mélange and gabbroids. Serpentinite mélange contains unaltered ultrabasic rocks (Mountain Soldatskaya massif) and smaller bodies of gabbroids, Cretaceous and Paleogene tuffaceous and cherty rocks. Ophiolite fragments at Kamchatsky Mys peninsula are represented by gabbroids of Olenegorsk pluton and ultrabasic rocks of Soldatsky massif, by blocks of gabbroids with plagiogranites in serpentinite mélange, different basalts and calcareous-jasper-cherty deposits of Aptian-Cenomanian Afrika complex and tholeiite basalts, mudstones of Paleocene-Eocene Kamensk complex.

Field relations. Olenegorsk massif is composed of several tectonic slices, constructed by gabbroids with diabase dikes, rocks of layered complex and basalts. At the contacts of slices serpentinite mélange is developed. The Mt. Soldatskaya massif is the block of fresh medium-grained peridotites 200 meters in thickness in serpentinite mélange. Mélange also contains blocks of pillow-basalts, amphibolites, greenschists, tuffs, cherts, gabbroids. Large Olkhovaya Gabbro block, 1.5 km in diameter, 50 meters in thickness, contains plagiogranite material as a network of veins of irregular shape and as dike-shaped bodies, 1.5–2.0 meters in thickness, which intrude gabbros and enclose its xenoliths of angular form. Besides, plagiogranite-porphyre dikes, 5–7 meters in thickness, cutting gabbros and dolerite dikes exist. U–Pb SHRIMP datings of plagiogranites are 74.7±1.8 m.a. [Luchitskaya et al., 2006].

Pertrography. Ultramafic rocks from Mt. Soldatskaya massif are classified as spinel harzburgites. Olenegorsk pluton is composed of diallage gabbros, gabbro-norites. Layered series are present in two small tectonic blocks, enclosed in gabbro. Olivine gabbro-norite occurs in schlieren in the diallage gabbro. Diallage gabbros contain numerous serpentinite enclaves. Gabbroids of Olkhovaya Gabbro block are fine-grained hornblende gabbro and gabbro-norite and are intruded by dolerite dikes. The felsic rocks plot with trondhjemites on the Ab–An–Or diagram (O'Connor 1969).

Geochemistry. Peridotites of Mt. Soldatskaya massif have similar to the SSZ peridotites REE-patterns. Major element signatures of the "diallage gabbro" from the Olenegorsk Pluton indicate their cumulative origin. The REE patterns in the diallage gabbros are similar to those in the cumulates, crystallized from N-MORB melts. These gabbroids appear in the Philippine Sea gabbro field in a discriminant diagram according to Zlobin and Zakariadze (1985). Major- and trace element contents of parts of layered series rocks are transitional to ultramafic rocks. The REE pattern is similar to that of the gabbros, but REE totals are lower than in the gabbros. Olkhovaya block gabbroids have low TiO_2 , Zr, Y contents which make them similar to gabbroids of Phillippine Sea, referred to boninite series [Zlobin, Zakariadze, 1985]. REE

totals are nearly 1–4 chondrite norms. REE patterns are either subhorizontal or similar to those of N-MORB oceanic tholeiites. SiO_2 vs K_2O covariations in plagiogranites indicate that they are low-K rocks; they are also low-Al granitoids (Al_2O_3=11.34–12.91%). ORG-normalized [Pearce et al., 1984] patterns of plagiogranites are characterized by low LILE, approximately on the hypothetic ORG level, and are depleted in respect of HFSE, distinct Ta, Nb, Zr minimum are fixed. Rb vs Y+Nb covariations [Pearce et al., 1984] refer plagiogranites to volcanic arc granites. All above-mentioned features indicate that plagiogranites have supra-subduction origin. Plagiogranites are characterized by non-fractionated chondrite-normalized REE patterns with low REE totals at nearly 10 chondrite norms that are slightly higher than in gabboids. Geochemical modeling shows that plagiogranites with LREE depletion may be formed as a result of 70–80% fractional crystallization of gabbroic liquid. Basalts of the Afrika and Kamensk complexes in terms of major and trace element chemistry are similar to each other in the frame of moderately differentiated oceanic tholeiites. Following from their REE patterns and from a comparison with N-MORB averages according to Sun & McDonough (1989), most of these basalts are derived from depleted N-MORB melts. The REE totals are 20–50 times the chondritic value. The REE patterns of all basalt types mostly display weak Eu-anomalies. Dolerites forming the dikes in gabbros of the Olenegorsk pluton are compositionally similar to the basalts. Inferred from their REE patterns, the dolerites were derived from depleted N-MORB melts. Their REE patterns are roughly parallel to those of the basalts, but their REE totals are lower (15–20 times the chondritic value).

Mineralogy. The mineral composition signatures of peridotites of Mt. Soldatskaya massif, according to Hebert et al. (1989), indicate that these peridotites are of restite origin. The 2px thermometry resulted in 920°C crystallization temperature. Both the high Cr-Al characteristics of spinel and the Al_2O_3 content of orthopyroxenes enable a comparison with the subduction margins field (Bonatti & Michael 1989). Clinopyroxene compositions from Olenegorsk pluton gabbros on the TiO_2 vs. FeO/MgO diagram (Zlobin & Zakariadze 1985) fall in the field of clinopyroxenes from gabbroids formed in mid-ocean ridges. Spinel compositions from the rocks of the layered series are similar to that from the serpentinite enclaves in gabbroids of Olenegorsk pluton. Compositions of rock-forming minerals in the rocks of the layered series insignificantly differ from those in ophiolitic and oceanic cumulates (Hebert et al. 1989). However, the structural features of the studied fragments of the layered series, compositional signatures of the spinels and clinopyroxenes (enriched in basaltic melt components), the rock textures with xenomorphic plagioclase and clinopyroxene segregations among olivines, possibly indicate that the rocks of the layered series are produced by interaction between mafic melts and peridotites. Pyroxenes from Olkhovaya block gabbros are less titanium, chromian and aluminium, plagioclase is more calcic, than those of Olenegorsky pluton. Clinopyroxene compositions on the TiO_2 vs Al_2O_3 diagram [Zlobin, Zakariadze, 1985] fall in the field of clinopyroxenes from gabbroids, formed in supra-subduction zone setting.

Conclusions. On the basis of complex geological, geochemical, and mineralogical database we may distinguish the following ophiolite complexes (1) Aptian–Cenomanian complex: a fragment of ancient oceanic crust, composed of tholeiite basalt, pelagic sediments, and gabbroids, presently occurring in single tectonic slices (Afrika Complex) and in olistoplaques in Pikezh complex; (2) Upper Cretaceous complex, composed of highly depleted peridotite, gabbro, and plagiogranite, associated with island arc tholeiite, boninite, and high-alumina tholeiitic basalt of supra-subduction origin; (3) Paleocene–Early Eocene complex of intra–island arc or backarc origin, composed of gabbro, diabase (sheeted dikes) and basalt produced from oceanic tholeiite melts.

The work was supported by the Russian Foundation for Basic Research (projects № 02-05-64060, 04-05-65132, 05-05-64158) and from the German Ministry for Science and Research (BEO-Grant 03F16GUS).