New data on the origin of ophiolites in the Kamchatskii Mys Peninsula (Eastern Kamchatka)

Article *in* Doklady Earth Sciences · October 2001

9 authors, including:

S. G. Skolotnev
Russian Academy of Sciences
121 PUBLICATIONS 679 CITATIONS
SEE PROFILE

Nikolay Vasilievich Tsukanov
P.P. Shirshov Institute of Oceanology
142 PUBLICATIONS 571 CITATIONS
SEE PROFILE

Wilhelm Seifert
FH Münster
30 PUBLICATIONS 381 CITATIONS
SEE PROFILE

Martin Zimmer
Helmholtz-Zentrum Potsdam - Deutsches GeoForschungsZentrum GFZ
95 PUBLICATIONS 1,714 CITATIONS
SEE PROFILE

Doklady Earth Sciences, Vol. 381, No. 8, 2001, pp. 881–883. Translated from Doklady Akademii Nauk, Vol. 380, No. 5, 2001, pp. 652–655.

GEOLOGY

New Data on the Origin of Ophiolites in the Kamchatskii Mys Peninsula (Eastern Kamchatka)

S. G. Skolotnev[1], W. Kramer[2], N. V. Tsukanov[3], W. Seifert[2], M. Zimmer[2], K. Gedike[2], R. Freitag[2], B. V. Baranov[3], and D. I. Alekseev[3]

Presented by Academician Yu. M. Pushcharovsky May 26, 2001

Received June 4, 2001

The southern part of the Kamchatskii Mys Peninsula in the Kamchatka folded area is characterized by the development of a relatively complete succession of tectonically isolated ophiolite members [1–4]. Ophiolite fragments consist of gabbroids of the Olenegorsk Massif, ultramafics of the Mount Soldatskaya Massif, basalts and jasper–calcareous rocks of the Aptian–Cenomanian Complex, basalts, argillites, and autoclastites of the Paleocene–lower Eocene Kamenskii Complex, and separate blocks of basalts and gabbroids from the serpentinite melange (Fig. 1). The northern part of the peninsula hosts island-arc tholeiites and boninites that compose the lower part of the upper Maestrichtian–Eocene Stolbovskaya tuffaceous–sedimentary group (Lower Tarkhovka Subformation) [1, 5].

The geochemical and mineralogical data obtained during field works of 1997–1998 allow a new interpretation of primary relationships between now tectonically isolated ophiolite fragments and discrimination of several different-age and different-origin ophiolitic complexes.

The analyzed ultramafics of the Mount Soldatskaya Massif can be classed with clinopyroxene-bearing harzburgites. In terms of the ratio of $Cr^{\#}$ (47–61) and $Mg^{\#}$ (53–60) values in spinels (Fig. 2), Cr_2O_3 and Al_2O_3 contents in orthopyroxenes (0.5–0.6% and 1.37–1.8%, respectively), and the REE distribution pattern (Fig. 3), the studied peridotites are close to those from the Troodos Massif [6, 7] and Mariana Trough [8], which are interpreted to have formed in the suprasubduction setting. The formation of similar peridotites is thought to be related to the partial melting of depleted restite peridotites in the suprasubduction environments. This process is accompanied by the generation of island-arc tholeiites or boninites.

Gabbroids of the Olenegorsk Massif are dominated by dialaggoid gabbro with serpintinite xenoliths, dolerite dikes, and tectonic inclusions of rocks of the banded complex. In terms of the TiO_2 and Al_2O_3 contents (0.72–1.08 and 2.80–3.25%, respectively) in clinopyroxenes, gabbroids are classed with the MORB variety [9] (Fig. 4). In terms of the $Cr^{\#}$ value of spinel (43–64), serpentinite xenoliths and rocks of the banded complex are close to harzburgites from the Mount Soldatskaya Massif (Fig. 2). These spinels are characterized, however, by an extremely irregular TiO_2 content (0.23–7.99%), which is caused by their interaction with the primary melt in the magma chamber [10].

The REE distribution pattern in the gabbro and dolerites of the Olenegorsk Massif indicates that these rocks were crystallized from tholeiitic melts of the N-MORB type. Moreover, gabbro are characterized by the well-manifested positive Eu anomaly, which is typical of mafic cumulates (Fig. 3).

Gabbroids from one of the studied large blocks in the serpentinite melange exposed in upper reaches of the Pervaya Ol'khovaya River (Fig. 1) are represented by gabbro and gabbronorites. The enclosed clinopyroxenes with the low TiO_2 and Al_2O_3 contents (0.19–0.24 and 1.22–1.39%, respectively) fall into the field of clinopyroxenes from suprasubduction gabbroids [9] (Fig. 4). The REE distribution pattern in these gabbroids is similar to the subhorizontal one (Fig. 3). Being characterized by low concentrations of TIO_2 (0.07%), Zr (15 ppm), and Y (1.8 ppm), they are united into a single group with the boninite-series gabbroids of the Philippine Sea [11].

Taking into consideration the composition and distribution patterns of REE (Fig. 3), basalts of the Afrika and Kamenkskii massifs are close to each other and are assigned to oceanic tholeiites.

Geochemical and mineralogical properties of peridotites from the Mount Soldatskaya Massif show that they formed in suprasubduction settings and represent restites of the island-arc tholeiite or boninite melt. Among studied plutonic rocks, complementary with

[1] *Geological Institute, Russian Academy of Sciences, Pyzhevskii per. 7, Moscow, 109017 Russia*
[2] *Geological-Geophysical Center, Telegrafenberg 1, Potsdam, Germany*
[3] *Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovskii pr. 36, Moscow, 117851 Russia*

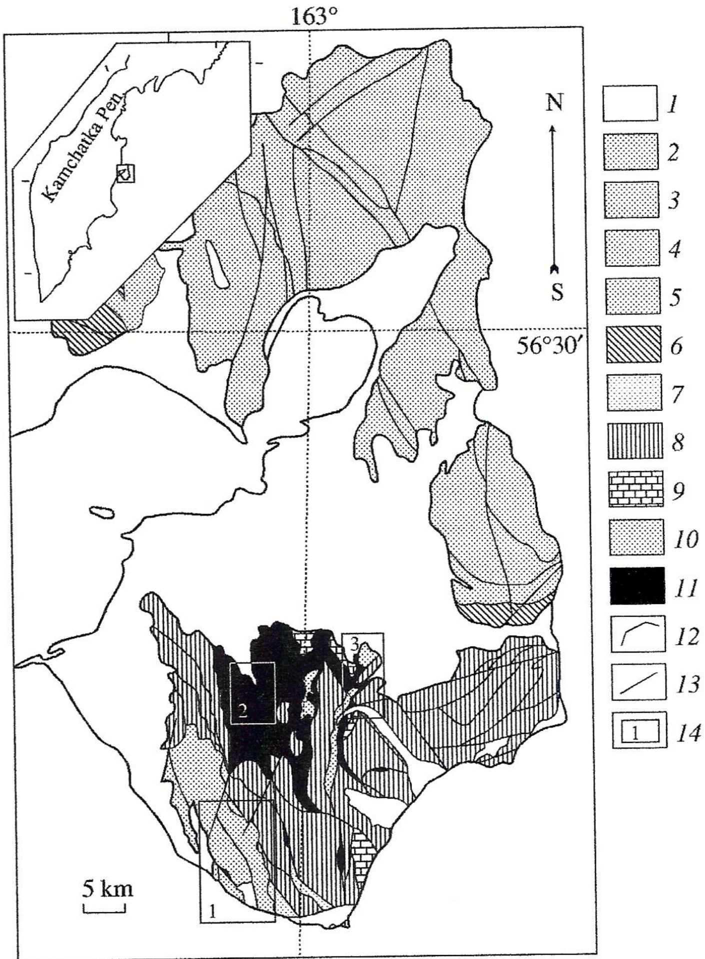

Fig. 1. Geological scheme of the Kamchatskii Mys Peninsula (based on [1, 3]). (*1*) Pliocene–Quaternary sediments; (*2*) Tyushev Group; (*3*) Baklanov sequence; (*4*) Rifov sequence; (*5*) Vereshchagin sequence; (*6*) Tarkhov sequence; (*7*) Kamenskii Complex; (*8*) Pikezh Complex; (*9*) Afrika Complex; (*10*) gabbroids of the Olenegorsk Massif; (*11*) serpentinite melange; (*12*) geological boundaries; (*13*) faults; (*14*) study areas: (1) Olenegorsk Massif, (2) Mount Soldatskaya Massif, (3) upper reaches of the Pervaya Ol'khovaya River. The inset shows location of the study area in the Kamchatka Peninsula.

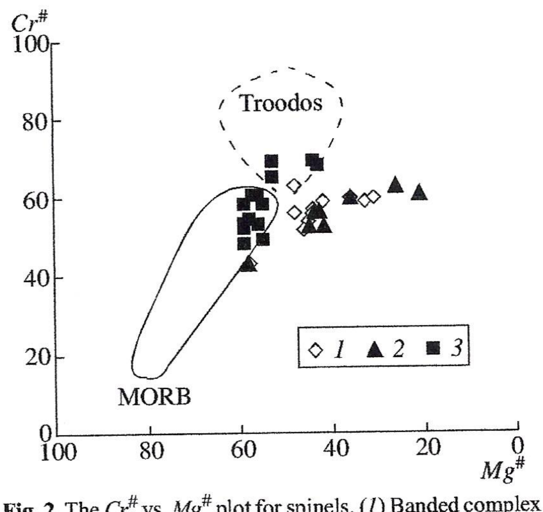

Fig. 2. The $Cr^{\#}$ vs. $Mg^{\#}$ plot for spinels. (*1*) Banded complex of the Olenegorsk Massif; (*2*) ultramafic inclusions from the Olenegorsk Massif; (*3*) peridotites from the Mount Soldatskaya Massif.

these rocks could be the boninite-type gabbroids that compose a large block in the serpentinite melange in upper reaches of the Pervaya Ol'khovaya River. The volcanic part of this ophiolitic complex is represented by island-arc tholeiites or boninites of the upper Maestrichtian–lower Tarkhovka Subformation (Stolbovskaya Group).

Gabbroids of the Olenegorsk Massif enclose xenoliths of serpentinites similar to peridotites of the Mount Soldatskaya Massif that experienced the impact of the mafic melt. Consequently, these gabbroids cannot be older than peridotites of the Mount Soldatskaya Massif, i.e., older than the Late Cretaceous. By geochemical criteria, they are close to tholeiitic oceanic basalts from both the Aptian–Cenomanian Afrika and Paleocene–early Eocene Kamenskii complexes. However, when the age of gabbro is taken as not older than the Late Cretaceous, only Paleocene–early Eocene basalts can represent a member of this ophiolitic succession. Geological relationships point to the formation of these

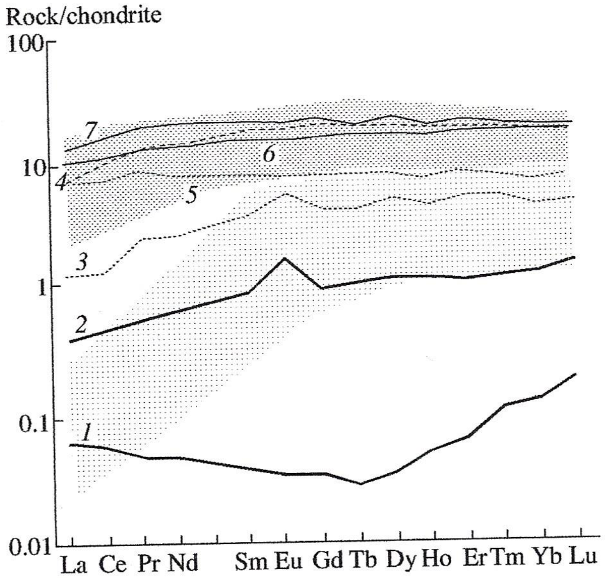

Fig. 3. REE spectra in representative samples from ophiolites of the Kamchatskii Mys Peninsula. (*1*) Harzburgite from the Mount Soldatskaya Massif (9851-1); (*2–4*) Olenegorsk Massif: (*2*) troctolite (9814-4), (*3*) gabbro (9806-1), (*4*) dolerite (9801-1); (*5*) gabbro from upper reaches of the Pervaya Ol'khovaya River (9863-1); (*6*) basalt from the Afrika Complex (9868-1); (*7*) basalt from the Kamenskii Complex (9819-2). Areas of abyssal ultramafics (light shade) and depleted tholeiites (dark shade) are given after [12]. Normalized to chondrites after [13].

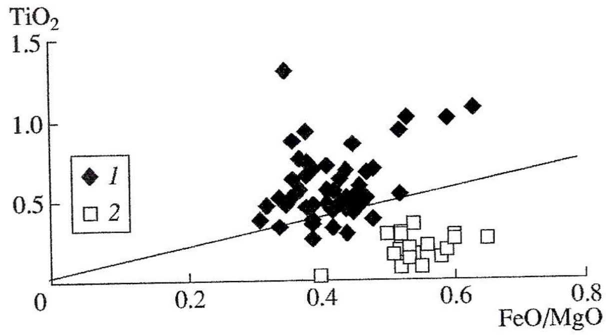

Fig. 4. TiO_2 vs. FeO/MgO in clinopyroxenes from gabbroids. The line dividing areas of clinopyroxenes from mid-oceanic (upper part) and island-arc (lower part) gabbroic plutons is based on [9]. Massifs: (*1*) Olenegorsk; (*2*) Pervaya Ol'khovaya.

rocks in the spreading center near or within the volcanic arc.

Tholeiitic basalts forming together with Aptian–Cenomanian jaspers and limestones thin tectonic sheets and olistostromes (Afrika Complex) [4] among Upper Cretaceous tuffaceous rocks of the Pikezh Complex represent another, older ophiolitic association that was accreted in the frontal part of the paleoarc during the Late Cretaceous.

Thus, our data allow the following ophiolitic complexes to be distinguished: (1) Aptian–Cenomanian complex that corresponds to a fragment of the ancient oceanic crust and is composed of tholeiitic basalts and pelagic sedimentary rocks; (2) Upper Cretaceous complex consisting of highly depleted peridotites, gabbro, and basalts of the island-arc tholeiite and boninite series; (3) Paleocene–Early Eocene complex formed in the arc or back-arc settings and composed of gabbro, diabases, and basalts produced by oceanic tholeiitic melts.

REFERENCES

1. Boyarinova, M.E., *Geologicheskaya karta poluostrova Kamchatskii Mys, masshtaba 1: 200 000* (Geological Map of the Kamchatskii Mys Peninsula: Scale 1 : 200 000), St. Petersburg: VSEGEI, 1999.
2. Vysotskii, S.V., *Ofiolitovye assotsiatsii ostrovoduzhnykh sistem Tikhogo okeana* (Ophiolitic Associations of Pacific Island-Arc Systems), Vladivostok: Akad. Nauk SSSR, 1989.
3. Zinkevich, V.P., Kazimirov, A.D., Peive, A.A., and Churakov, G.M., *Dokl. Akad. Nauk SSSR*, 1985, vol. 285, no. 4, pp. 954–958.
4. Fedorchuk, A.V., *Izv. Vysshch. Uchebn. Zaved., Geol. Razved.*, 1990, no. 2, pp. 3–14.
5. Fedorchuk, A.V., Peive, A.A., Gul'ko, N.I., and Savichev, A.T., *Geokhimiya*, 1989, no. 12, pp. 1710–1717.
6. Dick, H. and Bullen, T., *Contrib. Miner. Petrol.*, 1984, no. 86, pp. 54–76.
7. Kay, R.W. and Senechal, R.G., *J. Geophys. Res.*, 1976, vol. 81, no. 5, pp. 964–970.
8. Bloomer, S.H. and Hawkins, J.W., *The Tectonic and Geological Evolution of South-East Asia Seas and Islands*, Wash. (D.C.), 1983, part 2, pp. 156–187.
9. Zlobin, S.K. and Zakariadze, G.S., *Magmatizm, metamorfizm i geodinamika aktivnykh okrain plit na primere mezozoiskogo Tetisa* (Magmatism, Metamorphism, and Geodynamics of Active Plate Margins Exemplified by the Mesozoic Tethys), Moscow: Nauka, 1993, pp. 413–433.
10. Tartarotti, P. and Vaggelli, G., *Italy–Memorie di Sci. Geol.*, 1995, vol. 47, pp. 201–215.
11. Zlobin, S.K. and Zakariadze, G.S., *Geokhimiya*, 1985, no. 11, pp. 1567–1577.
12. Johnson, K.T. and Dik, H.J., *J. Geophys. Res.*, 1992, vol. 97, pp. 9219–9241.
13. Evensen, N.M., Hamilton, P.J, and O'Nions, R.K., *Geochim. Cosmochim. Acta*, 1978, vol. 42, pp. 1199–1212.