Ophiolites in collisional and accretionary structures of northeastern Russia

Sergey D. SOKOLOV
Geological Institute, Russian Academy of Sciences, Moscow, Russia (sokolov@ginras.ru)

In the northeast of Russia, one finds four principal tectonic features. In the west, there lies the Siberian craton; further east, the Verkhoyansk–Chukotka thrust-and-fold belt (referred to as "the Mesozoides" in Russian literature); the Okhotsk–Chukotka continental margin volcanic belt; and finally, the Koryak–Kamchatka thrust-and-fold belt.

The Verkhoyansk–Chukotka and Koryak–Kamchatka thrust-and-fold belts have contrasting structural patterns. The Verkhoyansk–Chukotka belt has a distinctly mosaic pattern. It is dominated by northwestern trends, modified by the so-called "Kolyma Loop." The Koryak–Kamchatka belt typically shows linear structural features of northeastern strike. They conform well to the general structural grain of the Circum-Pacific orogenic belts. Both foldbelts are overlapped by the Okhotsk–Chukotka volcanic belt of Albian–Campanian age.

The differences in the structural styles between the Verkhoyansk–Chukotka and Koryak–Kamchatka belts result from their dissimilar geological histories. Structural features of the Mesozoides were mostly shaped by collisional processes, and this area shows widespread terranes with continental crust (microcontinents). Ophiolites are encountered in collisional structures of the Kolyma Loop and in the South Anyui suture (SAS).

Ophiolites and metamorphic rocks of the Kolyma Loop are composed of a package of tectonic sheets overthrust on Paleozoic deposits or form small lenses along strike-slip fault zones. The ophiolites contain serpentinized harzburgites and dunites, gabbro, and gabbro-amphibolites of cumulate origin, metabasalts, ophicalcite, and ophiolitoclastic breccias. Geochemical and geological data imply that these ophiolites are fragments of oceanic crust or a backarc basin formed in a suprasubduction zone setting [Oxman et al., 1995].

Metamorphic rocks associated with the ophiolites are subdivided into two assemblages: (1) polymetamorphic rocks and (2) greenschists [Oxman et al., 1996, 1998]. Three stages of metamorphism are established (^{40}Ar-^{39}Ar dating, [Layer et al., 1993]: (i) 419–430 Ma with T = 450–500°C and P < 2.0 kbars; (ii) 370 Ma with T = 450–620°C and P = 4.0–6.0 kbars; and (iii) 174 Ma ophiolites that were obducted onto the continental margin of the North Asian craton during the Middle Jurassic collision.

The South Anyui suture is known to contain Paleozoic and Mesozoic ophiolites [Natal'in, 1984; Lychagin, 1997; Sokolov et al., 2002]. Paleozoic age is shown by gabbroids of the Vurguveyem massif (332 Ma, ^{40}Ar/^{39}Ar dating on whole rock, by E. Korago; and 312 Ma, ^{40}Ar-^{39}Ar dating on amphibole, by P. Layer, 2002) and Aluchin ophiolites, occurring along the south margin of the South Anyui suture. Triassic age (226 Ma, ^{40}Ar/^{39}Ar dating on hornblende, by P. Layer, 2002; and 220 Ma, ^{40}Ar/^{39}Ar dating on hornblende, by J. Hourigan, 2003) was established recently from a sheeted dike complex in the ophiolites of the Atamanovsky massif [Ganelin et al., 2003]. The central part of the SAS contains some small ophiolite bodies with inferred Late Mesozoic age [Natal'in, 1984; Lychagin, 1997]. The ophiolites are interpreted as fragments of the Anyui–Angayucham oceanic basin, which closed in the terminal Early Cretaceous as a result of collision of the North American and Eurasian plates.

The Koryak–Kamchatka fold area provides an example of accretionary continental margins shaped through successive docking onto the continent of geodynamically diverse outboard terranes of various ages arriving from the ocean. This area displays terranes that are fragments of island arcs, ophiolites, turbidite sequences, oceanic crust, and accretionary prisms. It is typical that in general the structural features, rock assemblages, and newly formed continental crust become younger toward the ocean.

In the northern part of the Koryak Highland, ophiolites make up a system of thrust sheets that formed through subduction of Pacific plates beneath the margin of the Asian continent [Ruzhentsev et al., 1982; Sokolov, 1992]. Here, one finds Late Paleozoic and Mesozoic ophiolites that are fragments of oceanic crust, backarc basins, and island arcs. These ophiolites are typically associated with mélanges and numerous accreted chert/basalt assemblages.

The south part of the Koryak Highland shows Alaskan-type ultramafic–gabbroic assemblages, which, along with Late Cretaceous oceanic and island-arc rock complexes, were obducted onto the margins of the Asian continent, composed of turbidites of Upper Cretaceous–Middle Eocene age [Batanova and Astrakhantsev, 1994].

In Kamchatka, ophiolites are chiefly encountered along its eastern coast. Here, three ophiolite assemblages of various ages and origins are found: (1) fragments of oceanic crust of Aptian–Albian age; (2) Late Cretaceous depleted suprasubduction peridotites, gabbroids, and plagiogranites in association with island-arc tholeiites and boninites; and (3) gabbroids and dolerites of Paleocene–Early Eocene age originating from a backarc or intraarc basin (Zukanov et al., 2002; Luchitskaya et al., 2004).

These studies were carried out under project nos. 05-05-66947 and 05-05-65052.