ISSN 1028-334X, Doklady Earth Sciences, 2007, Vol. 417A, No. 9, pp. 1312–1314. © Pleiades Publishing, Ltd., 2007.
Original Russian Text © V.A. Stepanov, V.G. Moiseenko, A.V. Mel'nikov, V.E. Strikha, 2007, published in Doklady Akademii Nauk, 2007, Vol. 417, No. 3, pp. 379–381.

GEOLOGY

The Stanovoi Nickeliferous Province of the Russian Far East

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Received June 7, 2007

DOI: 10.1134/S1028334X07090048

The Baikalide nickeliferous province was distinguished in the southern framing of the Siberian Craton by Godlevskii [1]. A series of dunite–troctolite–gabbro intrusions (Lukinda, Lucha, and Il'deus) with low-grade copper–nickel mineralization was discovered in the eastern part of this area within the Amur region in the last century. Therefore, the southern framing of the Aldan Shield was considered as one of the possible new nickeliferous provinces [9]. In the early 21st century, several nickeliferous areas with high-grade epigenetic copper–nickel sulfide mineralization (Dzhalta, Kun-Man'e, and Nyandomi) were found in this area and the eastern Khabarovsk region. Based on these data, we distinguished a new potential nickeliferous province (Stanovoi) in the southeastern framing of the Siberian Craton.

GEOLOGICAL STRUCTURE

The Stanovoi nickeliferous province extends along the southeastern margin of the Siberian Craton over 1300 km at a width of 250–300 km (figure). It contains several nickel ore occurrences with moderate to large sizes of inferred resources. The nickeliferous province is located in the eastern part of the Stanovoi megablock, which is bordered by the Stanovoi and Mongol–Okhotsk deep faults in the north and south, respectively [2]. The megablock represents the framing of the Aldan protomassif (the fold-block or granite–greenstone belt affected by Mesozoic tectonomagmatic activation). The area comprises several blocks of metamorphic rocks of the Lower Archean (Zverev–Chogar and Zeya) and Upper Archean (Stanovoi and Gilyui) complexes.

Bodies of metamorphosed mafic and ultramafic rocks (Maisk–Dzhanin Complex), charnockites, enderbites, and granites are closely associated with the Lower Archean granulite complex. The intrusions spatially associated with the Upper Archean Stanovoi Complex are represented by prefold gabbroamphibolites, metapyroxenites, anorthosites, and gabbroanorthosites (Drevnii Dzhugdzhur and Olekma–Kalar); quartz diorites and granodiorites (Tok–Algoma); and plagiogranites (Drevnii Stanovoi). The Early Proterozoic sequences host small bodies of differentiated ultramafic and mafic rocks of the Lukinda and Il'deus complexes, as well as large granitoid massifs of the Udokan and Tukuringra complexes.

The Mesozoic tectonomagmatic activation produced the Stanovoi plutonic system of large granitoid plutons (Late Jurassic–Early Cretaceous Tynda–Bakaran Complex). The Early Cretaceous volcanics are associated with small meso- and hypabyssal granodiorite–granite and granite–leucogranite intrusions of the Early Cretaceous Irakan Complex. The Early Cretaceous Dzhalta cortlandite–pyroxenite–gabbro complex of minor intrusions, sills, and dikes was recently recognized in [7, 8].

NICKEL MINERALIZATION

The nickel mineralization of the Stanovoi province belongs to the sulfide PGE–Cu–Ni formation [6]. It is genetically related to three different-age mafic–ultramafic complexes: a Late Archean anorthosite and gabbroanorthosite complex, an Early Proterozoic dunite–troctolite–gabbro complex, and an Early Cretaceous cortlandite–pyroxenite–gabbro complex.

Nickel potential of the anorthosite and gabbroanorthosite massifs. The anorthosite and gabbroanorthosite massifs compose the Dzhugdzhur–Stanovi

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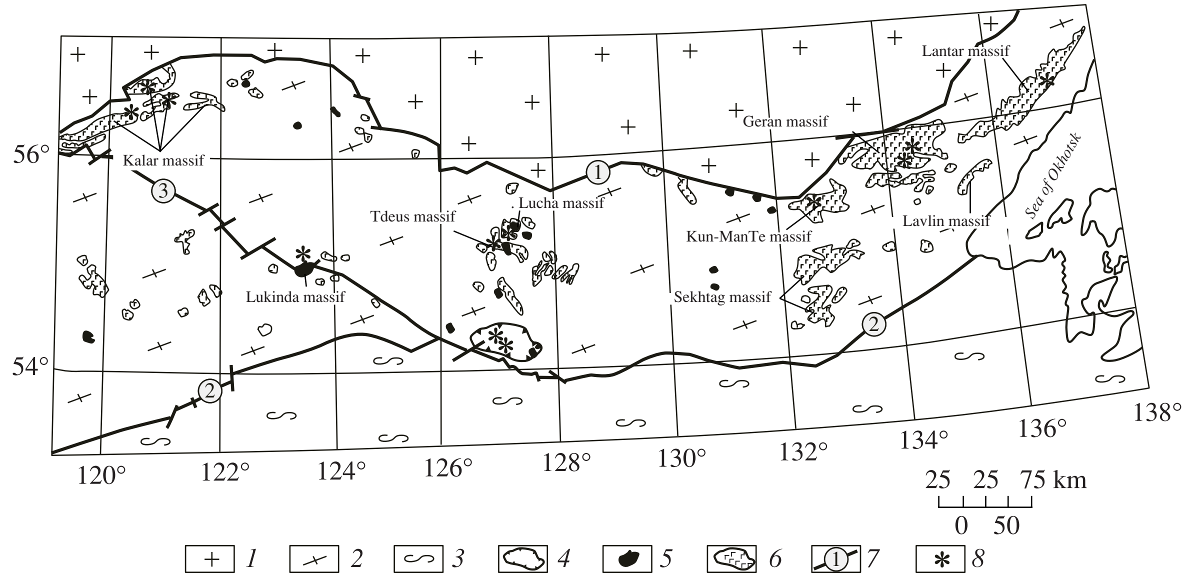

The Stanovoi nickeliferous province. (*1*) Aldan Shield; (*2*) Stanovoi megablock; (*3*) Mongol–Okhotsk fold zone; (*4*) field of minor Early Cretaceous cortlandite–pyroxenite–gabbro intrusions and dikes; (*5*) Early Proterozoic dunite–troctolite–gabbro intrusions; (*6*) Late Archean anorthosite and gabbroanorthosite intrusions; (*7*) deep faults: (1) Northern Stanovoi, (2) Mongol–Okhotsk, (3) Dzheltulak; (*8*) Cu–Ni ore occurrences.

belt extending over 1300 km along the northern boundary of the nickeliferous province [4]. The Ni potential of the Kalar, Kun–Man'e, Geran, and Lantar intrusive massifs is most interesting.

The Cu–Ni mineralization in gabbroanorthosite massifs of the Stanovoi nickeliferous province is developed as both independent minerals (Kun–Man'e and Lantar massifs) and associated components in the ilmenite–magnetite deposits (Kalar and Geran massifs). The Ni content in the ilmenite–magnetite ores is no more than 0.2–0.3%. Relatively high-grade Cu–Ni ores of the Lantar massif are located at its bottom in the gabbro and gabbroanorthosite horizons with layers of pegmatoid varieties. By contrast, the copper–nickel ores of the Kun-Man'e massif are confined to the small peridotite intrusions with syn- and epigenetic sulfide mineralization.

Nickel potential of the dunite–troctolite–gabbro intrusions. The dunite–troctolite–gabbro intrusions are small (from tens of square kilometers to a few hundred square kilometers in size). They include coarse-layered mafic–ultramafic rocks: dunites, troctolites, olivine gabbro, anorthosites, pyroxenites, gabbronorites, and gabbro. These rocks are characterized by high contents of Mg and Al; low contents of Ti, P, alkalis; and undersaturation with silica [5]. The age of the intrusions is considered Early Proterozoic [2]. The Lukinda, Il'deus, and Lucha nickeliferous massifs are best studied.

Copper–nickel mineralization in the dunite–troctolite massifs is represented by low-grade (uneconomic) disseminated ores with a Ni content up to 0.4%. The presence of high-grade bottom lodes is doubtful because of the small sizes of the intrusions, which could not produce significant volumes of sulfide mineralization. Only mafic–ultramafic dike series with epigenetic copper–nickel mineralization in these massifs may be interesting for prospecting.

Nickel potential of the cortlandite–pyroxenite–gabbro intrusions.

Based on the study of nickel deposits in North Korea, Zimin [3] distinguished the nickel-bearing formation of hornblende mafic rocks in the Far East. He believed that this formation has a Late Proterozoic age. The Cu–Ni mineralization related to the minor intrusions, sills, and dikes of the Early Cretaceous Dzhalta cortlandite–pyroxenite–gabbro complex was established in the Dzhalta nickeliferous cluster of the Dambukin metamorphic block. The Dambukin block is composed of Early Archean metamorphic rocks of the Dambukin Group, which is dominated by gneisses (often, graphite-bearing) and crystalline schists with layers and lenses of ferruginous quartzites and calciphyres. They host small intrusions (up to 5 km^2), sills, and dikes of cortlandites, hornblendites, hornblende pyroxenites, and gabbronorites. The dikes and sills are up to 1–2 km long (the thickness varies from tens of meters to a few hundred meters). The hornblende mafic rocks universally contain syngenetic dissemination of sulfides, such as pyrrhotite, chalcopyrite, and pentlandite (up to 1–5%). In some cases, the content of sulfides increases to 10–20% in epigenetic stringer and massive ores. The Ni content is no more than 0.3% in the syngenetic disseminated ores and as much as 3% in the epigenetic ores (Nikelevoe and Strelka ore occurrences).

CONCLUSIONS

Thus, we have distinguished the Stanovoi potential nickeliferous province in the southeastern framing of the Siberian Craton. The province is confined to the Stanovoi megablock bordered by the Stanovoi and Mongol–Okhotsk deep faults in the north and south, respectively. The nickeliferous province consists of Lower–Upper Archean and Lower Proterozoic metamorphic rocks. They are crosscut by Early Archean–Mesozoic intrusive complexes. The nickel mineralization is represented by the sulfide PGE–Cu–Ni formation. It is genetically related to three different-age mafic–ultramafic complexes: a Late Archean anorthosite and gabbroanorthosite complex, an Early Proterozoic dunite–troctolite–gabbro complex, and an Early Cretaceous cortlandite–pyroxenite–gabbro complex. The copper–nickel mineralization was found in all three complexes, but the Dzhalta Complex (Early Cretaceous cortlandite–pyroxenite–gabbro minor intrusions) is most promising for the discovery of small and medium Cu–Ni deposits with high-grade ores. However, the small sizes of nickeliferous intrusions and thick oxidation zones of sulfide ores hamper the discovery of ore deposits.

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