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GEOLOGY

Tectonic Position and Origin of Volcanosedimentary Rocks of the Polyarnyi Uplift (South Anyui Suture, Western Chukotka)

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The South Anyui Suture (SAS) resulted from the closure of a past oceanic basin and subsequent collision between the North American and North Asian continents [1–4]. Many geological aspects of this essential tectonic element of Mesozoides in Northeast Russia remain unclear so far. This concerns, first, the problem of the existence period of the paleoceanic basin. In this connection, the structural position, age, and origin of relatively widespread volcanosedimentary rocks are very important issues.

Recent data [5, 6] indicate that the SAS is composed of nappes. New materials on the structure, age, and origin of different lithostructural complexes in the SAS obtained during field work in 2000–2003 suggest that some traditional views on the geological structure and tectonic development of the region should be revised.

It is believed that the suture is largely composed of terrigenous (frequently flyschoid) Upper Jurassic–Lower Cretaceous sediments. Their lower section includes rare volcanogenic–siliceous and ultramafic bodies [1–3, 7, 8]. The volcanics of this region are most thoroughly described in [3, 9]. Paleozoic volcanosedimentary rocks are known only in the Polyarnyi Uplift, where limestones with Visean corals have been found during geological mapping [10].

Most of the previous researchers support the riftogenic nature of the South Anyui zone and consider rocks of this zone as basement outcrops [8, 11] or tectonic blocks [2, 3]. According to the later point of view, Paleozoic volcanogenic–carbonate rocks of the Polyarnyi Uplift are allochthonous bodies that are tectonically displaced northward from the Alazeya–Oloi fold system [5]. Bondarenko [6] attributed limestones together with underlying volcanics to an autochthon. He suggested that rocks of this association are products of the Early Carboniferous continental rifting within the passive margin of the Chukotka–Arctic Alaska microcontinent. It should be noted that although these rocks are very important for interpretation of the SAS origin, the composition of volcanics and geodynamic settings of their formation remain unstudied thus far.

The Polyarnyi Uplift is located in the western part of the Chukot segment of the SAS in the Bol'shoi and Malyi Anyui interfluve area (Figs. 1, 2). It is composed of Triassic terrigenous sediments of the Anyui–Chukot fold system ("autochthon"), which are tectonically overlain by volcanosedimentary rocks with serpentinite bodies [5]. The autochthon and allochthon are intruded by Albian–Cenomanian granitoids, which can be viewed as stitching intrusions.

The volcanosedimentary sequence, the major lithostructural complex of the Polyarnyi Uplift, is composed of pillow, massive, and often amygdaloidal basalts, andesites, and dacitic andesites with phenocrysts of feldspars or dark-colored minerals. Volcanics alternate with graywackes and tuffaceous–terrigenous sediments. The section of such a kind is similar to the Koran'veem or Kul'pol'nei complex that formed in the Kimmeridgian–Tithonian ensimatic island arc [4, 6, 12]. This complex usually occupies the upper structural position (Fig. 2).

In the upper reaches of Polyarnyi Creek, the Koran'veem Complex discordantly overlies volcanosedimentary rocks enclosing limestone and serpentinite bodies. The thrust zone hosts serpentinite and greenschist lenses dating back to 156.5 ± 3.9 Ma (Ar–Ar dating of bulk rock sample by P. Leyer). The limestones yielded remains of Lower Carboniferous corals *Faberophyllum, Turbophyllum*, and *Caniophyllum* [10]. The relationships between these limestones and volcanics are frequently unclear. In some areas, one can see

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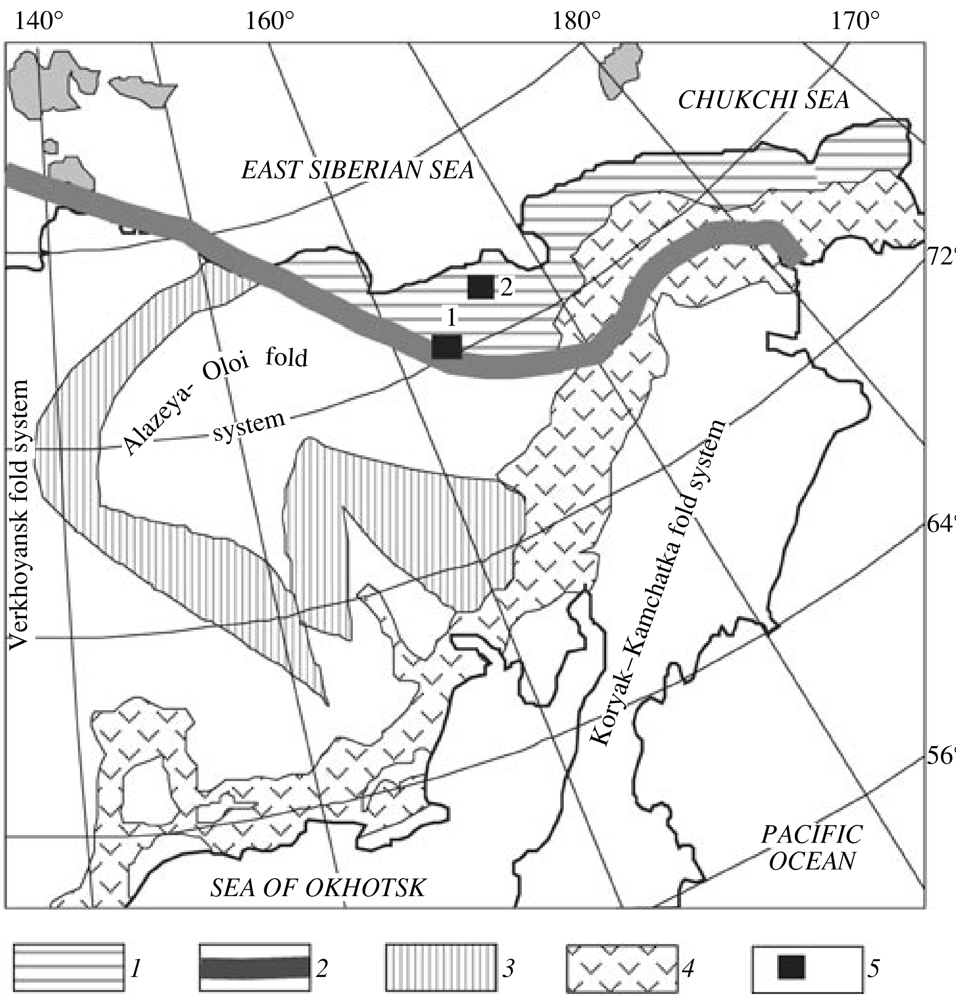

Fig. 1. Tectonic scheme of northeastern Asia and location of uplifts with Paleozoic rocks. (*1*) Structures of the Anyui–Chukot fold system; (*2*) South Anyui suture; (*3*) structures of the Kolyma loop; (*4*) Okhotsk–Chukot volcanogenic belt; (*5*) uplifts of western Chukotka. Uplifts: (1) Polyarnyi, (2) Alyarmaut.

a stratigraphic contact between them [6] or the limestones contain fragments of volcanics [9]. In other cases, some bodies make up redeposited (olistostrome) horizons among younger volcanics. Therefore, the volcanosedimentary complex probably comprises rocks of different ages.

Our observations revealed that the volcanosedimentary complex consists of two sequences. The lower (basaltic–siliceous–carbonate) sequence overlies thrust faults. It is composed of pillow and massive (largely aphyric) basalt flows with lenses of jasperoid cherts. The lower visible part of the sequence virtually lacks cherts but encloses numerous dolerite dikes and sills. The upper part of the section hosts interbeds (up to 1–2 m thick) of black and green cherts, which form locally a horizon approximately 15 m thick. Cherts contain recrystallized undeterminable small radiolarian remnants. The upper part also encloses limestone boulders and blocks (up to 1 m across) enveloped by basaltic flows.

In the right-hand watershed of Polyarnyi Creek, limestones with the bitumen odor make up laterally discontinuous bodies lying above rocks of the basaltic–siliceous association. The carbonate bodies have a stratigraphic lower contact in this area.

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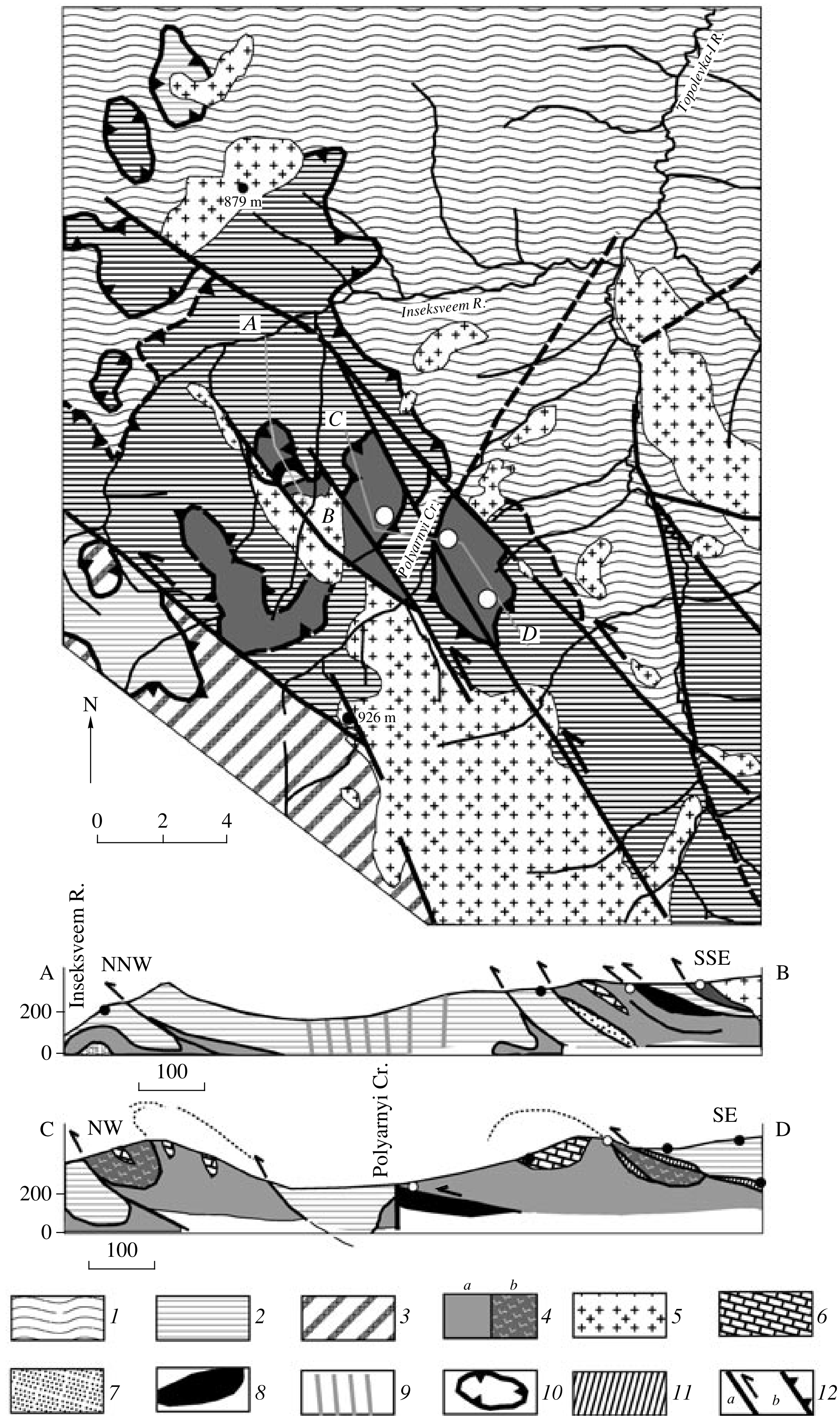
Fig. 2. Geological map of the Polyarnyi Uplift. (*1*) Subarkosic flysch of the Chukotka microcontinent; (*2*) Koran'veem complex: basalts, andesites, and dacites with tuffaceous–terrigenous flysch; (*3*) South Gremuchinskii complex: pillow basalts and cherts; (*4*) Carboniferous Polyarnyi complex: (*a*) basalts and cherts, (*b*) intermediate and acid volcanics and tuffs; (*5*) Albian–Cenomanian granodiorites and gabbro diorites; (*6*) limestones; (*7*) conglomerates and conglobreccia; (*8*) serpentinized ultramafics; (*9*) dolerite, diorite, and dacite dikes; (*10*) tectonic clips; (*11*) green schists; (*12*) faults: (*a*) subvertical with indication of lateral displacement, (*b*) thrusts.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Polyarnyi Cr.
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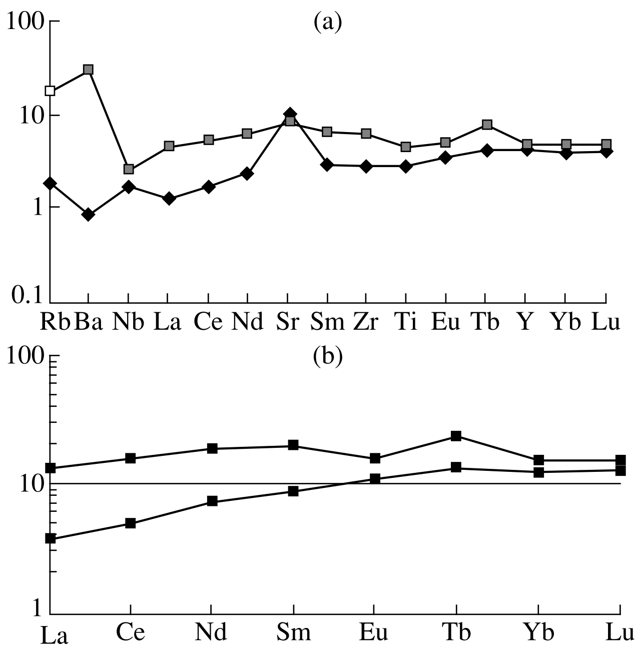

Fig. 3. Spidergram (a) and REE distribution for basalts of the volcanosedimentary complex of problematic age.

The upper (volcanogenic–carbonate) sequence is composed of massive intermediate and acid lava flows and subvolcanic bodies. The volcanics contain limestone blocks and boulders. In the present-day structure, the sequence has a tectonic lower contact. In the right-hand watershed of Polyarnyi Creek, the contact is marked by lenticular bodies of serpentinites and greenschists.

Sheets of aphyric pillow basalts (with lenses of red jasperoid cherts and brown-red clayey–siliceous rocks), which occur south of the volcanosedimentary complexes of the Polyarnyi Uplift, occupy a structurally higher position (Fig. 2). These rocks are similar to the Gremuchii Complex developed in the southeastern part of the SAS [4, 12]. Geochemical data on basalts suggest their genetic relation to oceanic spreading. Findings of radiolarian remains point to the Jurassic (pre-Kimmeridgian) age of the aphyric rock complex [6].

All the examined samples of basalts and dolerites from the volcanogenic–siliceous–carbonate sequence demonstrate intense secondary alterations. Basalts are characterized by moderate and low contents of TiO_2 (0.6–1.71 wt %).

Spidergrams plotted for two basalt samples are similar to those for the MORB-N volcanics (Fig. 3a). The basalts show the Nb maximum and minimum. Figure 3b shows that they are depleted in LREEs relative to MREEs and HREEs (La/Sm = 0.42–0.67, La/Yb = 0.30–0.86). This REE pattern is typical of basalts derived from the depleted source and is consistent with low Ti contents.

The analysis of the first geochemical data revealed that basalts of the volcanogenic–siliceous–carbonate sequence most likely formed in the back-arc spreading basin.

The formation setting of the upper sequence enclosing limestone blocks remains an unsolved problem. Its intermediate and acid volcanics indicate island-arc genesis. This inference is also supported by observations of Lychagin [9], who attributed them to the sodic ferrobasalt–icelandite–rhyolite formation.

The above data are inconsistent with the concept of the autochthonous position of the volcanogenic–siliceous–carbonate sequence and its possible correlation with the Vernitakveen Formation of the Anyui–Chukot fold system. Limestones of the Polyarnyi Uplift were deposited in a different facies setting, as compared to their Carboniferous counterparts in the Alyarmaut Uplift. The latter limestones accumulated in shallow-water marine environments with relatively high-energy hydrodynamics as is evident from microstructures of sediment roiling and reworking. The sediments contain a terrigenous admixture represented by quartz and mica grains, as well as intermediate and acid volcaniclastics. The carbonate sediments of the Polyarnyi Uplift were deposited in a deeper and calmer environment near an organogenic (probably, biohermal) buildup: they enclose diverse, although rare organic remains. Facies environments governed the chemical composition of limestones from the uplifts. Relative to Polyarnyi limestone, Alyarmaut limestone is characterized by higher contents of the insoluble residue, Rb, Sr, and Zr. The Vernitakveem Formation contains not only limestones and basic volcanics, but also sandstones, which are lacking in the Polarnyi section.

Thus, Lower Carboniferous limestones and associated volcanics of the Polyarnyi Uplift cannot be considered an element of the exhumed Paleozoic section of the Anyui–Chukot fold system [6] or as the Mesozoic basement of the Southern Anyui suture [8, 10, 11]. These rocks represent an allochthonous constituent of tectonic nappes thrusted northward onto the margin of the Chukotka microcontinent.

The volcanosedimentary rock association can be divided into two autonomous complexes. The lower sequence formed in the back-arc basin, whereas the upper sequence is probably related to the evolution of an island arc. The presented data on the composition of volcanics from the Polyarnyi Complex and their geodynamic interpretation are the first and most important pieces of evidence in favor of the existence of fragments of the Upper Paleozoic oceanic crust in the SAS. This inference contradicts traditional views on the formation of the South Anyui zone as a response to Mesozoic rifting and confirms the concept of long-term existence of the Anyui oceanic basin.

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