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MORPHOTECTONICS AND THE EVOLUTION OF PLUM-RIFTOGENIC MAGMATISM OF GORYACHEGORSK VOLCANIC PLATEAU (KUZNETSKIY ALATAU)

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Introduction

The Goryachegorsk volcanic plateau forms the western periphery of the adjacent Nazarovskaya and North Minusinsk Devonian depressions of the Minusinsk trough. The plateau volcanites transgressively overlap the fold-block Baikal-Salair construction of the northeastern part of the Kuznetsk Alatau. In the early Devonian, a classical volcano-plutonic alkaline-basic formation was formed here. Plutonic - alkaline-gabbroid part of it is first described systematically in the work (Grinev, 1990) and was further studied by O.M. Grinev, V.V. Vrublevsky, I.F. Gertner and other researchers. In 1982-1986 during the geological additional survey of 1:50 000 scale, the volcanic rocks were divided into three successively formed strata: the bazaryrskaya → bereshkaya → ashpanskaya (V.N. Markov et al., 1986). The strata were described in detail geologically-petrographically, but they were not studied as volcanic-tectonic structures (VTS) and also did not receive petro-geochemical certification. Researches of authors in the last 5-10 years fill this gap.

Results

Morphotectonics of the VTS Goryachegorsky plateau

One of the most important tasks in the study of paleovolcanic fields is to identify the types and primary appearance of the morphostructures composing the volcanic fields, which is directly related to the geodynamic setting of their formation. During the analysis of topobias, geological maps and satellite images, supported by field observations, it was found that within the Goryachegorsky Plateau there are three intergrown areal paleovolcanoes: the dome-ring Batanyul-Semenovsky and Sharypovsky and the dome Nichkuryupsk-Saralinsky (fig. 1). In addition, to the west and south of the plateau in the Kuznetsk Alatau, there are markedly eroded Palatninsk and Central Martayginskaya VTS. Within the last of these, most of the alkali-gabbroid plutons of the Kuznetsk-Alatau province are located. And to the east of the plateau within the west of the Severo-Minusinsk depression, Salbatskaya and Chebakovskaya (Chernozernaya) negative (synclinor) ring VTS are located, to which the Kopievskaya dome and the dome-ring Shirinskaya VTS are adjacent to the east. These morphostructures have approximately the same size with external diameters from 40 to 60–70 km (fig. 1).

To restore the initial appearance of the morphostructures, their structures and formations, the authors investigated the unique in terms of the set of nepheline bearing rocks Batanayul-Semenovskaya VTS. According to the constructed constructions, the VTS was a central-area areal volcano with an external diameter of 40–45 km and a cone-shaped structure of 3–5 km in height. The base of paleovulcano is composed of platobasalts of the bazyr stratum: subalkaline picrobasalts, trachybasalts, limited to leukobasalts 1.0–1.5 km thick.

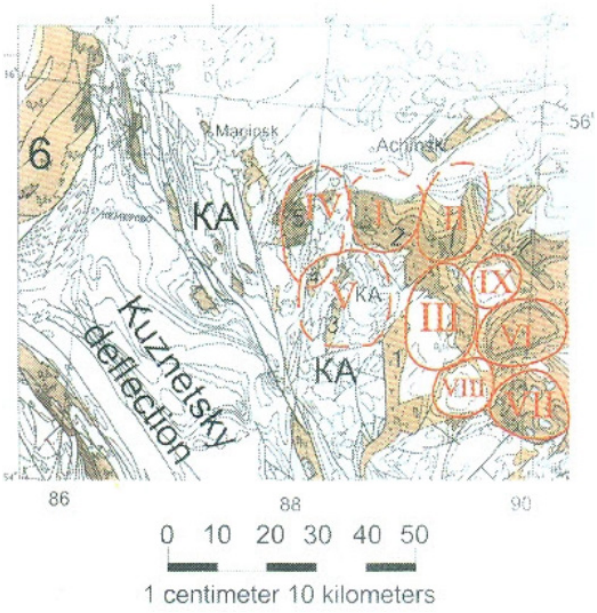

Figure 1. Tectonic scheme of the Devonian stage of development of the Kuznetsk Alatau (KA) and adjacent structures of the Minusinsk trough.

Structures of the Devonian paleorift: 1 – Saralinsky graben, 2 – Goryachegorsk volcanic plateau (north-western of the North Minusinsk depression), 3 – Rastai graben, 4 – Talanovsky graben, 5 Palatninskaya graben-syncline, 6 – The northern part of the Kolyvan-Tomsk folded area. Devonian ring morphostructures: I – Batanayul-Semenovskaya, II – Sharypovskaya, III – Nichkuryup-Saralinskaya, IV – Palatninskaya, V – Central Martayginskaya, VI – Kopyevskaya, VII – Shirinskaya, VIII – Chebakovskaya, IX – Salbat.

The middle part of the paleovolcano is composed of the bereshkaya stratum and has the most complex petrographic composition and structure. During its formation, there was a simultaneous eruption of sub-alkaline picrobasalts, trachybasalts, basalt trachyandesites, trachyandesites, trachytes and trachiriodocytes, as well as a series of alkaline differentiates; tefrits, phonotefrits, tefrifonolits and phonolits. Up to foidolitov varieties. At the same time, if bazaars are characterized by coarse-grained, cuesta-like relief of arcuate and radial types, then only fragments of low-grader, non-stretched, and arcuate small-crooked relief are found on the bereshkaya stratum, on which numerous structures of the central type and their clusters with a diameter of 1–3, 6–8 are laid. and up to 10–

12 km. On the whole, the circular range of the bereschkaya stratum has a diameter of about 24 km, and the thickness of volcanic rocks varies from 300–500 m to 3.0 km, depending on the scale of the MCT components. Some MCT have been intruded by the rod-dyke-shaped bodies of the main foidoliths and alkaline syenites, weakly exposed by erosion and accompanied by arenols of phenites.

The upper part of the building – ashpanskaya stratum, marks the final stage of volcanism. It has a substantially picrobasalt-trachybasalt and trachyte composition with limited participation of basanites and is closest in composition to the basyrites. The formation of the sequence is completed by subsurface subsidence, attenuation of volcanism, and substitution of volcanics up the section by red-colored terrigenous-sedimentary accumulations. The diameter of the ashpanite range is about 12 km with a thickness of about 1.0–1.5 km. In the present-day state of the Goryachegorskoye plateau, its strata are nested in each other along the system of arc and semicircular faults, occur at the same hypsometric level and are markedly eroded. During the middle-upper Devonian and Carboniferous, the most subsided northern and eastern periphery of the studied VTS and the entire plateau were covered with areal rhythmic lagoon-continental strata of the post-rift cover. The active stage of rifting in the area lasted about 10–15 Ma, was accompanied by three pulses of volcanism and was replaced by a long sub-platform regime D_{2-3}–C, and then P.

Evolution and geochemical features of volcanism

Subalkaline olivine-pyroxene picrobasalts and trachybasalts should be recognized as the original magma for the volcanites of the bazyrsky and ashpansky strata, and for the bereschky pyrobasalts and basanites. The processes of magma segregation cannot be excluded, especially if we compare the petrographic composition of volcanics with the rocks of the Kiya-Shaltyrsky and Goryachegorsk plutons.

Initially, differentiation of initial magmas for bazarites and ashpanites proceeded along a Fenner trend with a weak alkalinity and ended with the formation of a contrasting association, picrobasalt, trachybasalt-trachyte. Two differentiated series are characteristic of the Bereshsky stratum: trachybasalt-trachyte and alkaline tephrite-phonolitic. The Bowen trend clearly dominated here.

Geochemically, volcanites of all three strata and foidolite and alkaline-syenitic bodies penetrating them possess obvious geochemical affinity, as well as similarity with OIB. The spectra of their compositions in the diagrams were located between the OIB and E-MORB reference points, which clearly manifested themselves in the OIB and exceeded its values. At the same time, the spectra contain weakly pronounced Nb–Ta and Hf minima characteristic of IAB.

According to the Eu/Eu* index, all the rocks studied are mantle (0.78–1.07) and only trachyte (0.38–0.42) show significant influence of crustal matter.

On known discriminant triple and double geochemical diagrams, the compositions of volcanics fall into the fields of intra-plate continental basalts and basalts of destructive margins. They form compact ellipsoidal fields of figurative points at the OIB frame, slightly stretching in the direction of N-MORB and IAB. In the Condi diagram, rock composition points are located in the field of plume sources between the PM and OIB reference points. Early Devonian volcanic rocks of other areas of the Minusinsk zone have comparable characteristics (Grinev et al., 2016; Grinev et al, 2018; Vorontsov et al., 2013; 2015; 2017).

Conclusions

In the early Devonian, three impulses of sub-alkaline and alkaline basaltic volcanism manifested themselves within the Goryachegorsky Plateau and adjacent areas. As a result, an alkaline-basic volcano-plutonic Goryachegorsk formation was formed that was unique in petrographic composition. In its original form, the area had a multi-apex medium-high-mountain volcano-tectonic relief, in the form of a series of closely spaced volcanoes of the central type. The modern erosional surface of the plateau is about 4.8 thousand km^2 and an approximate volume of 12 thousand km^3.

The magma-generating system that formed the plateau had a branched-cellular structure of the feeding centers of the mantle foundation. The generation, differentiation and introduction of magmas into the limits of the crust has found a tectonic-magmatic pulse-wave character. The main source of primary magmas was the mantle-plume PREMA reservoir, which interacted during ascent with the asthenosphere mantle, and in the later differentials with the material of the earth's crust.

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