16th INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE
S G E M 2 0 1 6

SCIENCE AND TECHNOLOGIES IN GEOLOGY, EXPLORATION AND MINING
CONFERENCE PROCEEDINGS

VOLUME I

GEOLOGY

HYDROGEOLOGY, ENGINEERING GEOLOGY AND GEOTECHNICS

30 June – 6 July, 2016
Albena, Bulgaria

DISCLAIMER

Published by STEF92 Technology Ltd., 51 "Alexander Malinov" Blvd., 1712 Sofia, Bulgaria
Total print: 5000

ISBN 978-619-7105-55-1

ISSN 1314-2704

DOI: 10.5593/sgem2016B11

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SPATIAL DISTRIBUTION OF SYNKINEMATIC SILLS IN DETACHMENT ZONE BY THE EXAMPLE OF ANDESITES AND DACITES OF SHADORON COMPLEX (EASTERN TRANSBAIKALIA)

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ABSTRACT

Territory of Transbaikalia is considered as the one of largest provinces of Cordillera-type metamorphic core complexes (MCC). MCC represent fragments of middle and lower parts of continental crust tectonically exhibited in consequence of large amplitude straining within the bounds of Andean (Californian) type active continental margin [8, 14]. Wide-spread igneous processes are also spatially interconnected with straining. From amongst of developments of such igneous activity are synkinematic sills and dikes. It is deemed that they gave rise to short-lived thermal events leading to low gradient metamorphism and brittle-plastic or plastic deformations in detachment zones [14].

Meanwhile geochemical peculiarities of such complexes are usually studied less than they should be although they define kind of interaction between mantle melt and crust melting products. There is description of such synkinematic bodies, which localize in Borschovochny metamorphic complex framing, given in this work. Performed investigation of subvolcanic rocks is based on silicate analysis and ICP-MS results, represented at variation and multielement diagrams. It allows interpreting chemical composition peculiarities, distribution and accumulation degree of petrogenic, in general, rare and trace elements and describing the geodynamics of synkinematic magmatic processes phenomenon.

Keywords: metamorphic core, synkinematic bodies, Eastern Transbaikalia, detachment zone

INTRODUCTION

Metamorphic core complexes are composite geological structures. Processes of their forming embrace different layers of the earth's crust [11]. Formation of such complexes is related not only to metamorphic processes and intense tectonic deformations but also to synkinematic magmatism phenomena. Large-amplitude tension and multiple magmatism processes relation issue has always been rather complicated and important [1, 7]. Herewith in literature major attention is paid to plutonic granitic magmatism, "bimodal" and basaltic volcanism processes [3]. Meanwhile synkinematic hypabyssal magmatism phenomena are considered generally in kinematic aspect controlling the temperature regime of deformations [7]. However these very rocks complexes determine the kind of abyssal sources and earth crust relation in tension zones of active continental margins. Hence, study of geochemical features of synkinematic complexes allows learning about nature of heterogeneity of continental margin lithosphere.

In present work we analyze geochemical and geodynamic features of detachment zone subvolcanic association and non-metamorphosed strata of Borschovochny core complex (Eastern Transbaikalia).

GEOLOGICAL POSITION OF BORSCHOVOCHNY CORE COMPLEX

Forming of Eastern Transbaikalia structures, which are included to Mongol-Okhotsk belt, is determined by mesozoic collision of Transbaikalian-Stanovaya zone paleozoic margin and Argunsky microcontinent. Within the bounds of considered region these structures are represented by Hantay-Daursky and Aginsky terraines, which belong to sutural zone at collision place of two continental blocks. The zone is confined with Eastern-Aginskaya and Onono-Turinskaya branches of Mongol-Okhotsk abyssal fault [9] (fig.1). Mezozoic activization of the region has led to large amounts of granitoids melting, especially in Hantay-Daurskaya zone, and thrust structures development. Overthrust nappe series and multiple plicative deformations, plenty of magmatic rocks are features of Aginsky terrain internal structure [13]. In late Jurassic and Cretaceous periods Aginskaya synform and post-collision superimposed depressions formed [8]. Collision processes have affected paleozoic margin of Transbaikalian-Stanovaya zone and Argunsky microcontinent too. Large granite batholiths formed here. In granitization manifested itself especially intensely. There is large amount of metamorphic core complexes in this region [8].

So, within the limits of structures mentioned above there are two branches, which include metamorphic core complexes, oriented to the northeast and coupled with Mesozoic depressions. Western branch is located in Hilokskaya zone of Eravninsky terrain. It consists of well researched Zagansky, Yablonovy and other metamorphic core complexes. Eastern branch is located in Argunsky microcontinent and consists of Tsagan-Oluevsky, Western and Eastern Kutomarsky complexes. Within the Aginsky terrain such structure belongs to Borschovochny dome that is equidistant from metamorphic complexes of eastern and western branches [5, 8, 14].

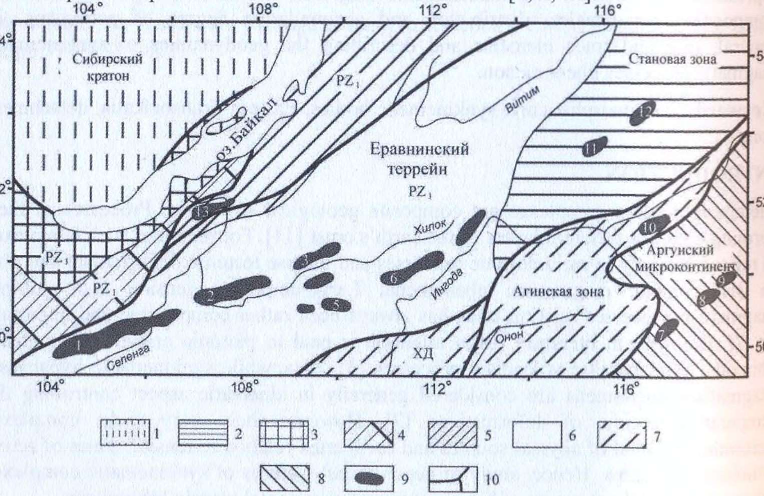

Figure.1. Schematic map showing metamorphic core complexes in the structure of the Transbaikaia [8] 1 – Siberian craton plate; 2 – Stanovaya zone (fragment of the craton terrain which was transformed in the early Cretaceous); 3–5 – structures of the Transbaikalia (Paleozoic margins of the Siberian continent): Vend-Cambrian back-arc basin (3), Vend-Cambrian island-arc terrains with the juvenile crust (4),

Vend-Cambrian island-arc terrains with the pre-Vend base (5), Cambrian-Sillur island-arc terrains and back-arc basins (6); 7 – structures of the Mongol-Okhotsky folded belt); 8 - Argun microcontinent with the pre-Cambrian crust; 9 – complexes of metamorphic cores; 10 – main faults. Numbers show complexes of metamorphic cores: 1 – Butuliyin - Nursky, 2 – Zagansky, 3 – Tsagankhunteisky, 4 – Bezymyanny, 5 – Malkharansky, 6 – Yablonovy, 7 – Tsagan-Oluevsky, 8 – West Kutomarsky, 9 – East Kutomarsky, 10 – Borshchevochny, 11 -Tungirsky, 12 – Nenyuisky, 13 – Selenginsky.

STRUCTURE OF BORSCHOVOCHNY CORE COMPLEX

It is possible to distinguish three structural-material complexes in borschovocnhy granite-gneiss dome. These rocks have different genesis and composition, different levels of metamorphisc transformations development, specificity of structure and deformations. The first one is the core as such made up of Jurassic mesocratic granites, less frequently of granodiorites and granosyenites with clearly expressed gneisoidness and old metamorphic rocks of amphibolites facies. The second one is represented by detachment zone that frames the core and consists of Paleozoic dynamometamorphic rocks (phyllonites, coal and mica containing schists, quartzites, albite-chlorite-epidote-actinolite and albite-epidote-chlorite schists, also cataclasites and mylonites, which formed upon granites, granite-gneisses, gneisses of different composition). The third one consists of non-metamorphosed covering rocks, which confines core complex и incorporate sediment-volcanogenic rocks association average-late jurassic and late cretaceous.

Detachment zone non-metamorphosed covering complex structure is additionally complicated with synkinematic magmatism phenomena, which are represented by hypabyssal bodies of shadoron andesite-dacite complex and trachyandesite-basalts and trachydacites of abagatuysky complex presence. Subvolcanic formations often are spatially associated to high-angle normal faults series, which separate lows out of detachment dynamometamorphites [12].

Materials

Hypabyssal bodies of shadoronsky and abagatuysky complexes belonging to northwest framing of Borschovochny metamorphic core complex have been considered in details. Synkinematic bodies of these complexes are sills, sometimes dikes from 50 m to 2 km long and up to 100 m thick.

Actual materials for the study are samples collected at northern part of Borschovochny dome. Mineral composition of shadoronsky complex andesites is represented by large plagioclase grains immersed in pilotaxitic groundmass. Dacites composition feature is presence of plagioclase, quartz, occasionally mica grains immersed in microfelsitic groundmass. Overall volume of such phenocrysts in intermediate and felsic rocks does not exceed 30 %. Rather widespread and significant are secondary replacement processes expressed in feldspar grains transformation into saussurite, calcite, sericite and albite. There is orthoclase appearing with general texture-structural pattern maintenance in subalkalic rocks (trachyandesites and trachydacites) of abagatuysky complex. Secondary transformations also are represented by propylitization processes, so we can observe secondary chlorite and calcite appearing. At that such change is not uniformly expressed.

METHODS AND RESULTS

The studies of the chemical composition of the igneous rocks are based on the results of 18 silicates and trace element analyzes. Silicate analysis carried out by X-ray fluorescence on instrument Oxford ED-2000. Trace element composition was determined by ICP-MS on the device Agelent 7500cx. Analytical researches were conducted at the center of collective use "Analytic Center of Natural Systems Geochemistry" of Tomsk State University (Russia).

Comparison between obtained results and geochemical characteristics of volcanic rocks from other complexes has been carried out. The one of the objects for comparison is Snake Creek volcanic complex allocated within the Snake Creek Range – a classical example of cordilleran type core, which is situated at the border between States of Utah and Nevada in USA [3]. The other is kataevskaya suite, which consist of upper Triassic volcanites, belonging to core zones of Butuliyin – Nursky and Zagansky metamorphic core complexes (Eastern Transbaikalia) [2].

According to chemical composition study results volcanites of shadoronsky and abagatuysky complexes are differentiated pretty much. There are moderate TiO_2 and Al_2O_3 contents and low P_2O_5 content. General silica accumulation degree varies in 49 - 72 mass % range. Total alkali content in shadoronsky complex samples varies from 1,5 to 5,5 mass % with K-Na, less K specifics. In abagatuysky complex rocks alkali content is between 3,7 and 9,4 mass % with K-Na specifics (fig. 2).

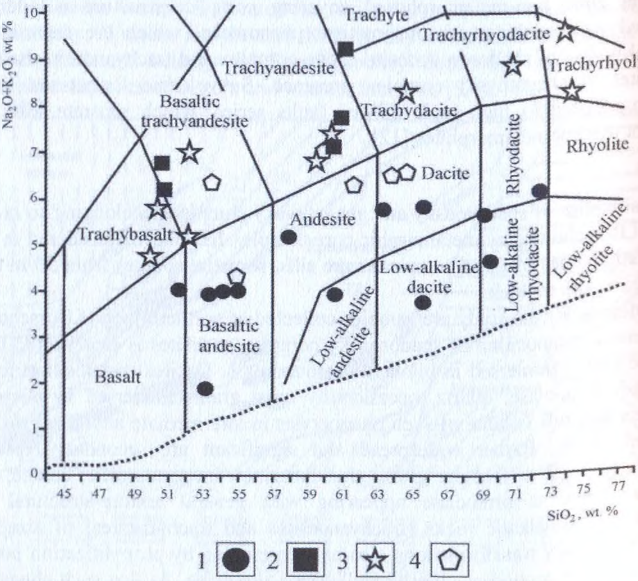

Figure.2. TAS-diagram [6];
Numbers show: 1 – shadoron formation, 2 – abagatuysky formation, 3 – kataevskaya formation, 4 – Snake Creek formation

At the diagram we can see that figurative points of shadoron complex rocks are in fields of basalts, andesibasalts, andesites, dacites and rhyodacites with normal and low levels of alkalinity. Composition points of Abagatuysky complex rocks are in high alkalinity fields of trachyandesibasalts, trachyandesites and trachydacites. It is shown at figure 2 that there is continual differentiation of composition for volcanites from both complexes. At that Shadoronsky complex rocks have normal alkalinity and Abagatuysky complex rocks have high alkalinity.

Chemical composition features allow to say that Shadoronsky complex rocks are similar with ones from Snake Creek and Abagatuysky complex rocks are similar with ones from kataevskaya suite, which is framing Butuliyin – Nursky and Zagansky metamorphic core complexes.

One of geochemical features of Shadoronsky and Abagatuysky complexes metavolcanites is mobile elements (such as Rb, Sr, Ba) contents dispersion, what might be caused by superimposed metasomatic processes (fig. 3). Rare elements (La, Nb, Zr), light rare earth elements (La = 12 – 54 g/t) and radioactive elements (Th = 0,4 – 21,4 g/t, U = 0,1 – 5,4 g/t) contents variations are less significant. In case with Shadoron formations REE distribution distinguish with medium-high level of LREE fractioning in comparison with HREE ($(La/Yb)_n$ = 19 – 29, $(La/Sm)_n$ = 1,4 – 4,7; REE are chondrite-normalized according to Sun, McDonough, 1989). In case with Abagatuysky complex rocks REE differentiation is less significant ($(La/Yb)_n$ = 2,6 – 8; $(La/Sm)_n$ = 2,3 – 3,0). Spectra shape of metasomaticly altered rocks samples is complicated with clearly expressed Eu anomaly.

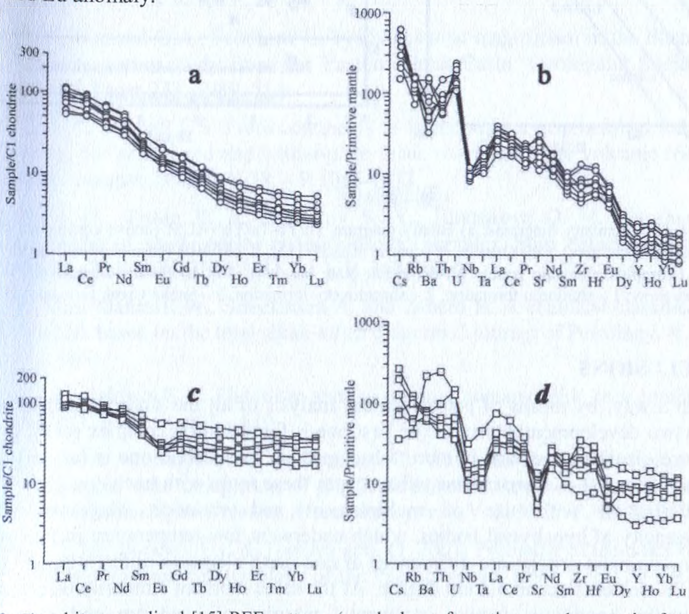

Figure.3. Chondrite-normalized [15] REE patterns (a - shadoron formation, c - abagatuysky formation), and primitive mantle-normalized [15] multi-element spectra (b - shadoron formation, d - abagatuysky formation).

Examination of metavolcanites multielement spectra, which have been primitive mantle normalized [15], performs according to petrochemical classification. Negative Nb – Ta plateau and Zr-Hf differentiation are common features for both singled groups. Discrete distribution of Ba and Sr is shown in shadoronsky complex volcanites the best way. This may be caused by magmatic material and crust fluid interaction during synkinematic bodies intrusion. Overall level of least mobile elements (Zr, Nb, Y and REE) accumulation and character of their distribution may indicate heterogeneity of volcanites formation source.

Composition points have been put on Th/Yb – Ta/Yb and Th/Ta – Yb variation diagrams for volcanites geodynamic nature clarification (fig. 4). The diagrams show that volcanites from both complexes arised in conditions of active continental margin. Row approximation to intraplate magmatism products area has been stated for a number of samples. This may be result of intermixture of volcanites parental magma from different sources.

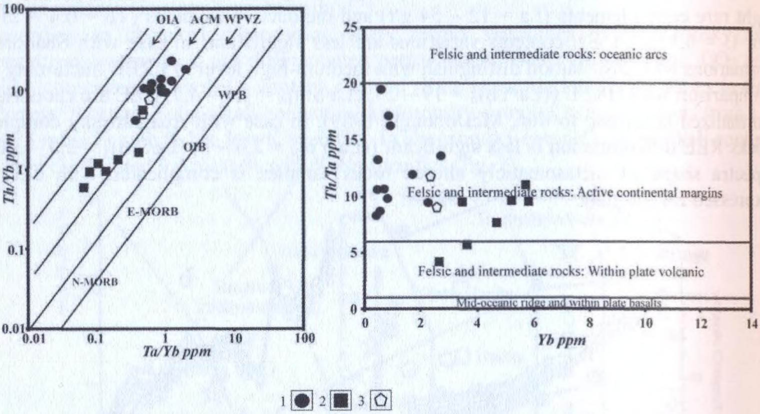

Figure.4. Geochemistry diagrams: a) Binary diagram Th/Yb-Ta/Yb (ACM (active continental margin), OIA (ocean island arcs), OIB (basalts of oceanic islands) [12], E - MORB (basalts of mid-ocean ridges), WPVZ (Intraplate volcanic zone), WPB (within plate basalts)) [10]; b) Binary diagram Th/Ta – Yb. Numbers show: 1 – shadoron formation, 2 – abagatuysky formation, 3 – Snake Creek formation [4].

CONCLUSIONS

In such a way, by means of petrochemical analysis of all the studied samples we can define two developmental trends. The first one is for shadoron complex rocks. It shows moderate alkalinity increase in more felsic species. The second one is for. In this case alkalinity increase is more intense, what relates these rocks with trachytes. Geochemical characterization with use of multielement and variation diagrams confirms heterogeneity of hypabyssal bodies, which underwent low-temperature metamorphism. In this case main criteria are differences in rare earth elements differentiation and LIL and HFS elements accumulation degree. At the same moment similarity of magmatism geodynamic conditions (active continental margin) of shadoron and abagatuysky complexes has been stated. This statement has been confirmed by comparison with Snake Creek volcanic rocks and analogous rocks from Transbaikalia territory.

Observable dissimilarities in rocks composition and some approximation to intraplate magmatism products composition probably is the result of mantle component involvement. This may be caused by subducting oceanic crust fragment breakaway under the impact of hot spot.

ACKNOWLEDGEMENTS

The work was supported in part by the Ministry of Education and Science of the Russian Federation (State Project No. 2282). The examinations of samples were performed on the equipment of Analytic Center of Natural Systems Geochemistry of Tomsk State University.

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