Geological and structural location of the Yagodninsky hydrothermal-magmatic system

Boykova I.A.
Institute of Volcanology and Seismology, FEB RAS, Petropavlovsk-Kamchatsky, Russia

Tectonic zoning allow us to reveal that the Yagodninsky deposit of active mineral admixtures and zeolitic rocks is located in the South Kamchatka Trough of the same folded-block zone. Superimposed on each other Upper Cretaceous and Eocene-Lower-Miocene to Pleistocene tectonic and magmatic processes resulted in the dome-ring volcano-tectonic structure from 35-40 to 45-50 km in size (fig.1)

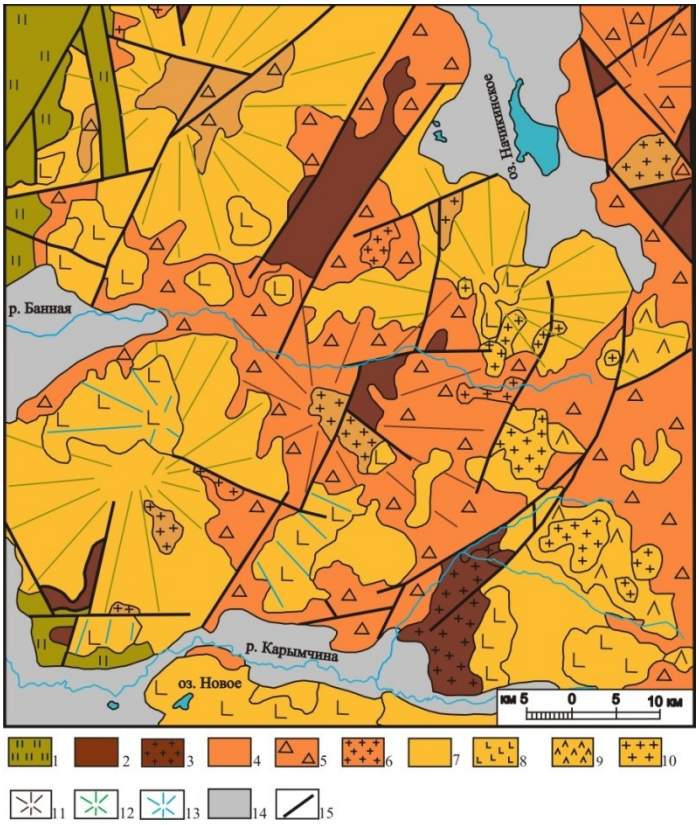

Fig. 1. The 1: 200 000 scale map of the Banno-Karymshinsky volcanogenic-ore center. The data are from the state geological survey. (editor A.K. Borovtsev, 2002.).

1-3 – The Eocene-Lower Miocene Nizhniy structural formation: 1 – siliceous-volcanogenic, 2 – terrigenous, 3 – intrusive-subvolcanic diorite -monzonite. 4-6 –The Middle-Upper Miocene Sredniy structural formation: 4 – intermountain molasse (tuffaceous sandstones), 5 – volcanic (rhyodacites – andesites), 6 – extrusive-subvolcanic complex of rocks of from acidic to medium composition. 7-10 – The Verkhniy structural formations: 7 – basalt, 8 - rhyolite, 9 - basalt-andesite, 10 – extrusive-subvolcanic complex of rocks of from basic to acid composition. 11-13 – The various age volcano-tectonic structure: 11 – Miocene, 12 – Pleiocen, 13 – Pleistocene. 14 – Modern alluvial formations. 15 – The main faults.

The available data on the region geological structure [2, 3, 5] evidence that this structure is the Banno-Karymshinsky long-lived volcanogenic-ore center. It comprises Eocene-Lower Miocene, Middle-Upper Miocene, Pliocene-Quaternary and Pleistocene volcanic-tectonic structures of the second-order. Contrast magmatism (from basic to rhyolite) is characteristic for the two last stages. The formation of flows, cinder cones and basaltic dikes of Late Pleistocene occurs in the last phases of stages. High-amplitude vertical tectonic movements characteristic for South-Kamchatka horst anticlinorium resulted in rising of from Cretaceous to Upper Miocene rock in the form of variously shaped blocks in the center of the structure and formation of the block-breccia mosaic in the Banno-Karymshinsky volcanogenic-ore center's exo-contact N-NW zone. Intrusions and extrusive-subvolcanic complexes of various composition and age are associated with blocks junction.

The volcanogenic-ore center's core (the Mount Yagodnaya area and the 1081 m mark) is composed of several Neogene volcanic complexes: the rhyodacite Karymshinsky complex, the andesite-basalt Yuzhno-Bystrinsky and the basal-andesite-dacite Nachikinsky. In addition it comprises not only blanket volcanogenic deposits but similar in composition and age intrusive and extrusive-subvolcanic facies (Fig. 2).

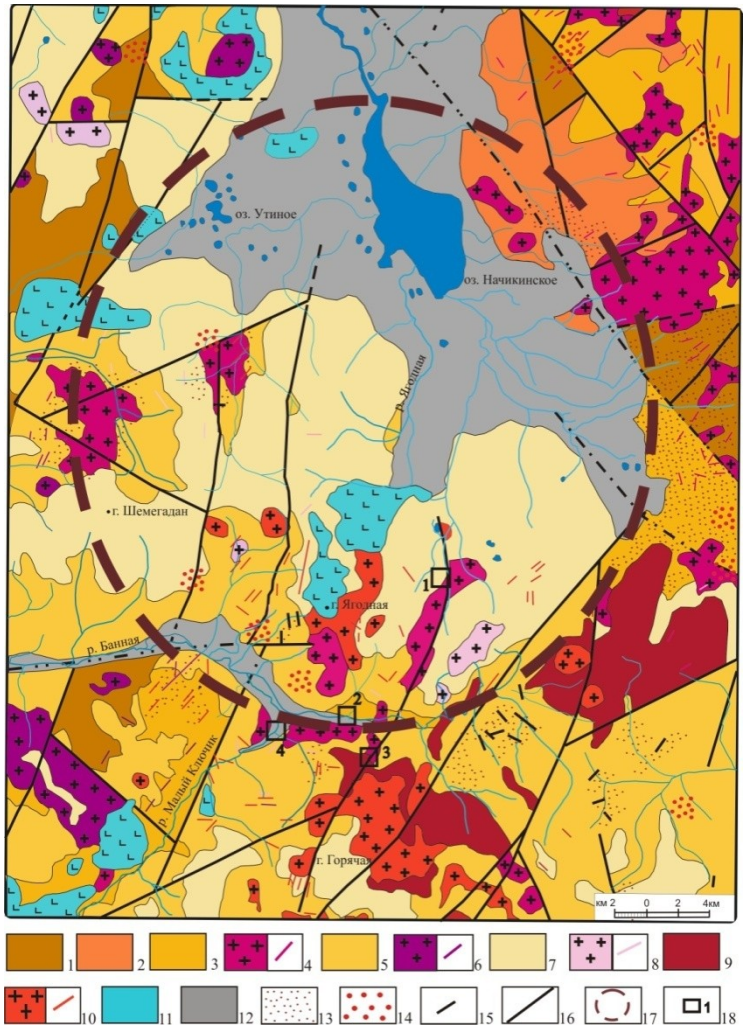

Fig. 2. The 1: 200 000 scale schematic geological map of the Yagodninsky-Banniy hydrothermal-magmatic system. The data are from the state geological survey. (editor A.K. Borovtsev, 2002.).

1 - Sedimentary and igneous-sedimetary rocks from the Nizhniy structural formation (Zhirovsky complex on the western zone and the Mytnovsky complex on the eastern zone). 2-6 - Rocks from Sredniy structural formation. 2 - sandstones, sand tuffs, and tuffs of average to acid compositions (Poperechensky complex). 3 - lavas, tuffs, and tuffs glomerations (andesites to andesite-basalts) (the Yuzhno-Bystrinsky complex). 4 - subvolcanic intrusions and dykes of average and mafic composotions in this complex. 5 - ignimbrites, fused tuffs, and tuffites from the Karymshinsky rhyodacitic complex. 6 - subvolcanic dacite-rhyodacitic intrusions and dykes of this complex. 7-12 Rocks from Verkhniy structural formation: 7 - lavas and tuffs of andesite-basalts from the Nachikinsky complex; 8 - subvolcanic intrusions and dykes of this complex; 9 - lavas, tuffs, and ignimbrites of Balaganchikovsky rhyolitic complex; 10 - extrusive-subvolcanic bodies and dykes of this complex; 11 - basalts and cinder cones of Middle to Upper Quaternary age; 12 - modern alluvial sediments. 13 - Field of hydrothermally altered rocks: propylites, secondary quartzites, argillizated rocks. 14 - Zones of mostly quartz bearing rocks with sulphide and other mineralization. 15. Quartz and quartz-carbonated lodes. 16. Faults. 17. - Conventional border of the Yagodninsky-Banniy hydrothermal-magmatic system, revealed using interpretation of satellite images. 18 - Mineral deposits: 1 - Yagodninsky zeolitic deposit, 2 - Bolshebanniy geothermal deposit, 3 - Banniy epithermal ore, 4 - Maliy Banniy thermal springs.

The Yagodninsky deposit area and the field of development of the most intensively altered by hydrothermal-metasomatic processes rocks are associate with the center of this tectonic-magmatic block of heterochronous contrast magmatism manifestations.

The fields of secondary quartzites with quartz-adular and quartz-carbonate veins and epithermal ore mineralization of the pyrite type develop on the block's periphery. Bolshebanniy geothermal deposit was formed in the same part of volcanogenic ore center [5,18].

So, published data, archive materials and our own data analysis allow us to reveal that the central block of the Banno-Karymshinsky volcanogenic ore center is the Yagodninsky long-lived ore-forming hydrothermal-magmatic system [5]. The same-named deposit of active mineral additives and zeolite raw material is directly associated with the 1081 m mark, which is Pliocene rhyolite extrusion with three differently directed powerful lava flows [4].

Central parts of the flows are composed by thin-slabby fluidal rhyolites, while margin zones are composed by obsidian.

The vent facies of extrusion and margin zones of short flows include spherolitic and dark-green perlite which form single bodies as thick as 25 to 30 m. At the final stage of evolution of the near-surface magmatic chamber, rhyolites of the vent facies were ruptured by basaltic dykes. The extrusion and the related rocks of subvolcanic facies were formed at the final, presumably Late Pleistocene, stage of evolution of the volcanic-plutonic structure of Miocene-Pleistocene age. The bottom of this structure is composed by andesitic tuffs, rhyolitic lavas, and tuffs from earlier eruptions.

An average thickness is chiefly represented by effusive dacites that are overlapped by dacite-ryolitic tuffs. The latter are highly altered by hydrothermal-metasomatic processes into ceolitolithes and are pay section for deposits [1]. We can presume a multi-channeled magmatism of Miocene-Pliocene-Pleistocene period for this zone: structurally similar, but smaller extrusion is located 1 km to the west from marker 1081. The area within Mount Yagodnaya (see fig. 2) is a complex and compositionally contrasted (from rhyolites to basalts) subvolcanic body. This gives evidence for powerful differentiated magmatic chamber that produce single near-surface chambers with acid melts (subvolcanic intrusions that cool down through Pleistocene-Holocene period), which in turn are sources of heat and fluid feeding for the hydrothermal system. Such cooling acid magmatic chamber is located beneath Mount Goryachaya being related to the formation of the Bolshebanniy geothermal deposit. But as shown above, the Yagodninsky hudrothermal-magmatic system includes several large extrusive-subvolcanic diorite complexes - quartz diorite-porphyrites that supply the system with heat and fluids.

References:

1. Bojkova I.A Petrograficheskaja i petrohimicheskaja harakteristika produktivnoj tolshhi ceolitovyh tufov Jagodninskogo mestorozhdenija (Kamchatka). // Petrografija magmaticheskih i metamorficheskih gornyh porod. Materialy XII Vserossijskogo Petrograficheskogo soveshhanija s uchastiem zarubezhnyh uchenyh. Petrozavodsk: Karel'skij nauchnyj centr RAN, 2015. 590 s.
2. Kraevoj Ju.A., Ohapkin V.G., Serezhnikov A.I. Rezul'taty gidrogeologicheskih i geotermicheskih issledovanij Bol'shebannoj i Karymchinskoj gidrotermal'nyh sistem // Gidrotermal'nye sistemy i termal'nye polja Kamchatki. Vladivostok: Izd-vo DVNC AN SSSR, 1976. S. 179-211.
3. Leonov V.L., Rogozin A.N. Karymshina – gigantskaja kal'dera-supervulkan na Kamchatke: granicy, stroenie, ob#em piroklastiki // Vulkanologija i sejsmologija. 2007. № 5. S. 14-28.
4. Nasedkin V.V., Solov'eva T.N., Nistratova I.E. i dr. Sravnitel'naja harakteristika mineral'nogo sostava ceolitovyh porod gory Jagodnoj i produktov sovremennogo mineraloobrazovanija doliny r. Bannoj p-ova Kamchatka // Sovremennye gidrotermy i mineraloobrazovanie. M.: Nauka, 1988. S. 70-85.
5. Serezhnikov A.I., Zimin V.M. Geologicheskoe stroenie Paratunskogo geotermal'nogo rajona, vlijanie otdel'nyh geologicheskih faktorov na sovremennuju gidrotermal'nuju dejatel'nost' // Gidrotermal'nye sistemy i termal'nye polja Kamchatki. Vladivostok: Izd-vo DVNC AN SSSR, 1976. S. 115-142.
6. Sergey N. Rychagov, Irina A. Boikova and Elena I. Sandimirova. Yagodninskaya-Bannaya Hydrothermal-Magmatic System: A Geological-Geochemical Model and Importance for Socio-Economic Development of Russia's Kamchatka Krai // Proceedings World Geothermal Congress 2015. Melbourne, Australia, 19–25 April 2015.