The Geological Position of the Karymchinskaya Hydrothermal System (Kamchatka, Russia)

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ABSTRACT
This article provides information about the geological characteristics of the Karymchinskaya hydrothermal system and its connection with the Karymshina Eocene-Pleistocene caldera identified within the Banno-Karymshinskiy region in 2006. We have generalized the published data and library materials on the geological structure of the region. This paper describes information from the field work conducted in 2008, which included identifying the region’s geological structure. In addition geologic cross-section of the Praviya Karymchina river valley was constructed, which is in the unloading part of the hydrothermal system. We proved the connection between the Karymchinskaya hydrothermal system and the Karymshina caldera and identified the possibility of a gigantic magma chamber located in its depth. We conclude that this magma chamber is not an edifice of Gorachaya mountain - as earlier scientists supposed - and that it is a heat source for the hydrothermal system.

1. INTRODUCTION
The Karymchinskaya hydrothermal system is located 65-70 km west-southwest from Petropavlovsk-Kamchatskii in the Banno-Karymshinski area. Surfice outcrops of the system are represented by several thermal platforms in the valley of the Pravaya Karimchina (fig. 1). Outcrops of the hot springs are along a 2.5 km stretch of the riverbed, and also along the Bolshoi stream (an eastern tributary of the river) 900 m from its mouth. Absolute marks of thermal outcrops are 370-460 m.

The first data and detailed description of Karymchinsky sources are found by the doctor V.N. Tjushovym who had visited hot keys in 1906 (Tjushov, 1906). Then B.I. Piip in his book Thermal Keys of Kamchatka, which described different springs and partially mentioned the geological structure of the area (Piip, 1937).

2. GENERAL INFORMATION ABOUT THE AREA OF STUDY AND HISTORY OF THE KARYMCHINSKY HYDROTHERMAL SYSTEM
Integrated geological and hydrological research of Karymchinsky hydrothermal system was first conducted in 1968 by A.I. Serezhnikovym (Serezhnikov and Zimin, 1976), and V.G. Ohapkinym (Kraevoi et al., 1976). All outcrops described by the previous researchers, as well as newly opened ones in the upper courses of the Teplii stream have been surveyed. In addition, the hydro-geothermal map of the springs with calculations of the general heat output were made, and monitoring investigations were conducted. There were four areas of surficial discharge of the hydrothermal system: Northeast, Teplii Kluch, the Big stream and Southwest stream (fig. 1).

The integral characteristics of Karymchinsky hydrothermal system are described in the articles of U.A. Kraevoi, V.G.

Figure 1: Plan view of the Karymchinsky hydrothermal system (locator map in square at top-left). Rhyolite-dacite extrusions are indicated in black. A dotted oval delineates the Katyynshina caldera. The working area is marked by a grey box in the upper frame and enlarged in the lower fram. In the botton frame I-IV indicate sites of surficial thermal discharge: I – the Northeast, II – the Teplii Kluch, III – the Big stream, IV – the Southwest stream.

Ohapkin, A.I. Serezhnikov, and V.M. Zimin. (1976). The result of these works was that the Karymchinskaya hydrothermal system is dated to the pool accumulated with the high Miocene-Pliocene volcanic rocks, broken through with Miocene-Pliocene intrusions and extrusions. The
hydrothermal discharge is in a controlled regional fracture zone of northeast orientation. As a result of the integral works, the hypothetical model of Karymchinskoye hydrothermal system (together with Bolshe-Bannoy system) has been presented, in which the magma chamber located in the bowels of the Goryachaya Mountain was proposed to be the heating source of the thermal water (Kraevoi et al., 1976; Serezhnikov and Zimin, 1976). Also the heat supplied to the Karymchina system was supposed to be provided by the endogenic fluid, according to the V.V. Aver'ev early thoughts. (Aver'ev, 1966).

2.1. The geological position of the Karymchinskaya hydrothermal system

During 2004 to 2006 the staff of the geology and geothermal laboratory of the Institute of Volcanology and Seismology in the Far East Division of the Russian Academy of Sciences found the new Karymchinska caldera (with a 15 km short axis, and a 25 km long axis) (fig. 1). This caldera is considered to be the largest one in Kamchatka (Leonov and Rogozin, 2007). Today, reconstruction of the caldera borders allows us to model of the modern Karymchinsky hydrothermal system in a new way.

Field work in 2008 resulted in construction of the geological structure scheme of an area of Karymchinsky hydrothermal system (fig. 2).

On the scheme you can see that surficial discharge of the hydrothermal system is concentrated around the undiffernetiated deposits from before the caldera stage. Approximately two kilometres above the Praviaya Karimchina River there is a group of fractures, which forms the western border of the Karymchina caldera.

Also stratigraphic columns have been drawn (fig. 3) and interpreted to construct geological cross-sections of the valley borders of the Praviaya Karimchina River (fig. 4). From this we discovered that Goriachaya Mountain (1310) was a rather ancient volcano as the composing dacitic lavas were under the ignimbrites of the Karymchina caldera (fig. 4, cross-cut A-A’). Therefore, the supposition about a magma chamber’s presence in Goriachaya Mountain, which was the source of hydrothermal system is groundless.

Figure 3: Stratigrafic columns and comparison of the contacts of deposits on the left and right banks of the Praviaya Karimchina River (columns 1, 2, 3) and (columns 4, 5, 6), respectively: 1 – rhyolite extrusions (Q1); 2 – ignimbrites of the Karymchina caldera (Eocene-Pleistocene); 3 – dacitic lavas, Goriachaya Mt (N2); 4 – undifferentiated deposits from before the caldera stage (N31-N2); 5 – extrusions before the caldera stage (N31-N2). The stratigraphic column locations are indicated on fig. 2.

Everywhere numerous persilicic lavas are dated near the caldera borders - domes, dikes, short lava flows (Rogozin, 2007), thus age of these formations is quite young ranging from 0.5-0.8 million years (Leonov and Rogozin, 2007).

The collapse in the upper riverbed of the Praviaya Karimchina in the area of the Visyachie lakes at the mark of 801.0 m (fig. 2) is connected with the series of fractures forming the western border of the Karymchina caldera. Earlier in the 20th century, geologists found out that the volcanic andesite-dacite device consisting of the poorly destroyed crater and block lava flow, slipped down in the valley of the the Praviaya Karimchina River (Serezhnikov and Zimin, 1976).

3. A DISCUSSION OF THE DATA

The discovery of the Karymchina caldera and the data from the works conducted in 2008 has allowed us to conclude that the Karymchinsky hydrothermal system is directly connected with the caldera and dated to its western border. As for the heat source for Karymchinsky hydrothermal system it is supposed to be a big magma chamber above which the Karimchina caldera formed in Eocene-Pleistocene. It is supposed that this chamber continues to heat subsurface fluids and waters circulating around it. As previously mentioned, surficial hydrothermal discharge is
controlled by a regional fracture zone of northeast orientation (Kraevoi et al., 1976; Serezhnikov and Zimin, 1976). The dominant role of the formation of the faults on the west side of the caldera is to serve as conduits, which bring thermal waters to the surface from depth.

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