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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 Praviaya 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-Karymshinskii area. Surfice outcrops of the system are represented by the 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, amd 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.

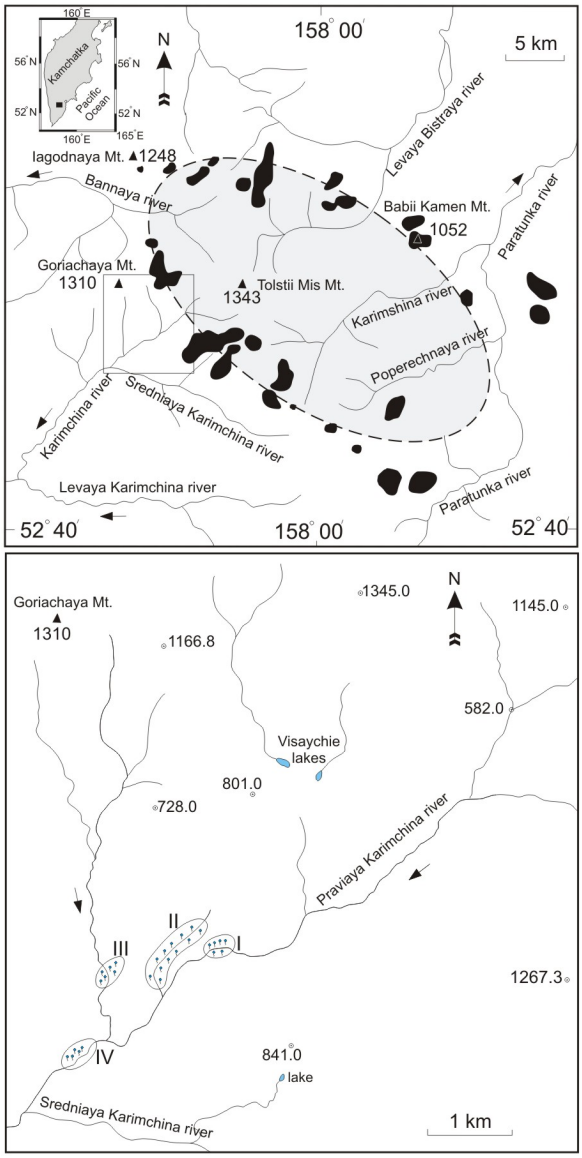

Figure 1: Plan view of the Karymchinsky hydrothermal system (locator map in square at top-left). Rhyolite-dacite extrusions are indicated in black. A dotted oval delineates the Katymshina caldera. The working area is marked by a grey box in the upper frame and enlarged in the lower fram. In the botton 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 Karymchinskoj hydrothermal system (together with Bolshe-Bannoj 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 Karimchina 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 Karymshina 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.

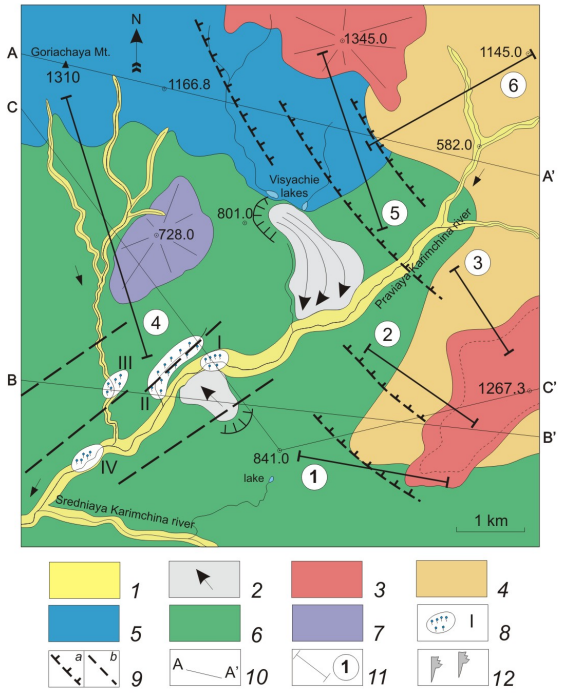

Figure 2: A plan view of the geological structure of Karymchinsky hydrothermal system (made from 2008 field work results): 1 – deposits in river valleys (Q_4); 2 – landslide deposits (Q_4), the arrow shows the direction of landslides; 3 – rhyolite extrusions (Q_1); 4 – ignimbrites of the Karymshina caldera (eopleistocene) 5 – dacitic lavas the Goryachaya (N_2); 6 – undifferentiated deposits from before the caldera stage (N^3_1-N_2); 7 – extrusions before the caldera stage (N^3_1-N_2); 8 – sites of surficial discharge from the hydrothermal system; 9 – faults: (a) a series of faults forming the western border of the Karymshina caldera, (b) a regional fracture zone of northeast orientation; 10 – lines of geological cross-sections; 11 – the locations of cross-sections described in the text; 12 – hot wells (located on cross-sections, see fig. 4).

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 undifferentiated 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 Karymshina caldera.

Also stratigraphic columns have been drawn (fig. 3) and interpretted 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 Karymshina 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.

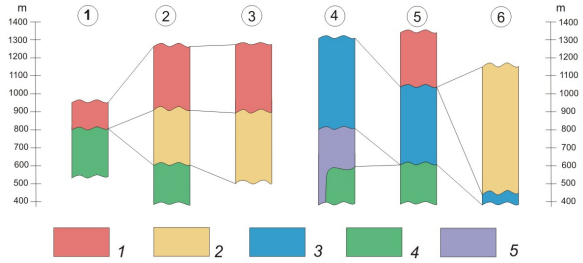

Figure 3: Stratigrafic columns and comparison of the contacts of deposits on the left and right banks of the Praviaya Karimchina River (columns 1, 2, 3) and (columns 4, 5, 6), respectively: 1 – rhyolite extrusions (Q_1); 2 – ignimbrites of the Karymshina caldera (Eocene-Pleistocene); 3 – dacitic lavas, Goriachaya Mt (N_2); 4 – undifferentiated deposits from before the caldera stage (N^3_1-N_2); 5 – extrusions before the caldera stage (N^3_1-N_2). 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 Karymshina 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 Karymshina 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.

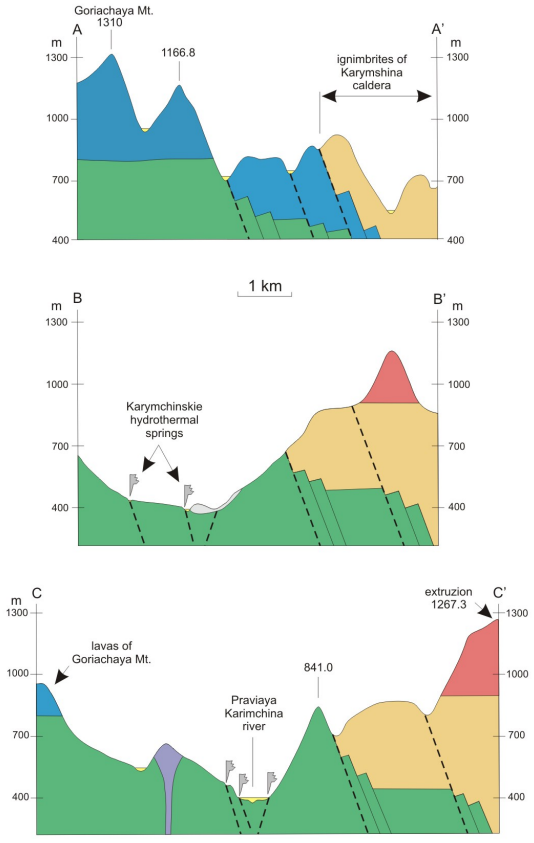

Figure 4: Geological cross-sections of the Karymchinskoj hydrothermal system area. The location of the cross-sections and symbols are indicated on fig 2.

CONCLUSIONS

(1) The geological structural scheme of the Karymchinsky hydrothermal system is specified.

(2) The geological cross-sections of the valley borders of the Praviaya Karimchina river are reconstructed on the site of hydrothermal system discharge.

(3) A series of faults forming the western border of the Karymshina caldera were found, their integral role in formation of hydrothermal system was shown.

(4) It is concluded that there is communication between the Karymchinsky hydrothermal system and with the Karymshina caldera; the assumed magma chamber in its bowels is considered to be the heat supply for hydrothermal system.

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