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GENESIS OF THERMAL WATERS IN CAUCASUS

Guram J. Buachidze

Georgian Geothermal Association, Academy of Sciences,
Tbilisi, Georgia 380008

ABSTRACT

Regularities of thermal waters are based on the consideration of geological, hydrogeological and geothermal conditions. The main factor of thermal water distribution is geotectonic structure, which determines conditions of its formation. One can judge about these conditions in accordance with chemical and especially gas compositions of the underground hydrosphere. Systematization of all types of thermal waters within the Caucasus folded system gives us possibility to elaborate a genetic classification of the thermal waters, in which there are gas constituent, on the first place, then hydrogeological structure and finally the chemical composition of water. The regularities of distribution provided for the distinguishment of the regions rather promising for utilization of thermal waters.

INTRODUCTION

The Caucasian segment of the Mediterranean Alpine Belt has a very complicated geological structure and is noted for its rich and various thermo-mineral resources. That is why its thermal waters' regularities may be representative in any young folded region.

Regularities of thermal waters formation and distribution are based on the consideration of geological, hydrogeological and geothermal conditions.

The latters depend upon the geotectonic structure which determines conditions of thermal waters formation. One can judge about these conditions in accordance with temperature distribution and chemical and, especially, gas compositions of the underground hydrosphere (Buachidze, 1979, 1979a).

INITIAL DATA

Peculiarities of the geotectonic structure of the Caucasus determine heat regime at depth. Average values of heat flow for different geotectonic regions are given in Table 1 (Buachidze et al., 1974). Analysis of these data and the hydrogeothermic map (Fig. 1) allows the following conclusions: the greatest values characterize the central parts of folded systems, mean and/or the lowest ones being confined to submontane and intermontane troughs. The formers have absolute dimensional coincidence with the Quaternary eruptive manifestations and with the region of carbonic acid gas occurence, this fact pointing to the plutonic nature of the heat anomalies (Buachidze et al., 1980).

For temperature distributions a very important factor is the high heat resistance of thick sedimentary strata in troughs (Buachidze, 1979).

Geological structure and temperature distribution predetermine the nature of gas zonality (Buachidze et al., 1989) which show us conditions of the thermal waters' formations.

These conditions are affected by rather specific hydrogeological environment as well. From this point of view the region under investigation may be subdivided to the areas of thermal water occurence within young folded structures with waterhead systems, and the areas of thermal water occurence within submontane and intermontane troughs with artesian basins. This subdivision is rather conventional and hypothetical, for we are not always certain of the location of a hydrogeological structure. For instance, the main horizon of thermal water in West Georgia is developed in the Mesozoic deposits which crop out within the folded system of the Great Caucasus Southern Slope and then subside into the platform (Georgian Block).

Systematization of all types of thermal waters in the Caucasus gives possibility to elaborate morphogenetic classification of the thermal waters (Buachidze et al, 1970) with the gas

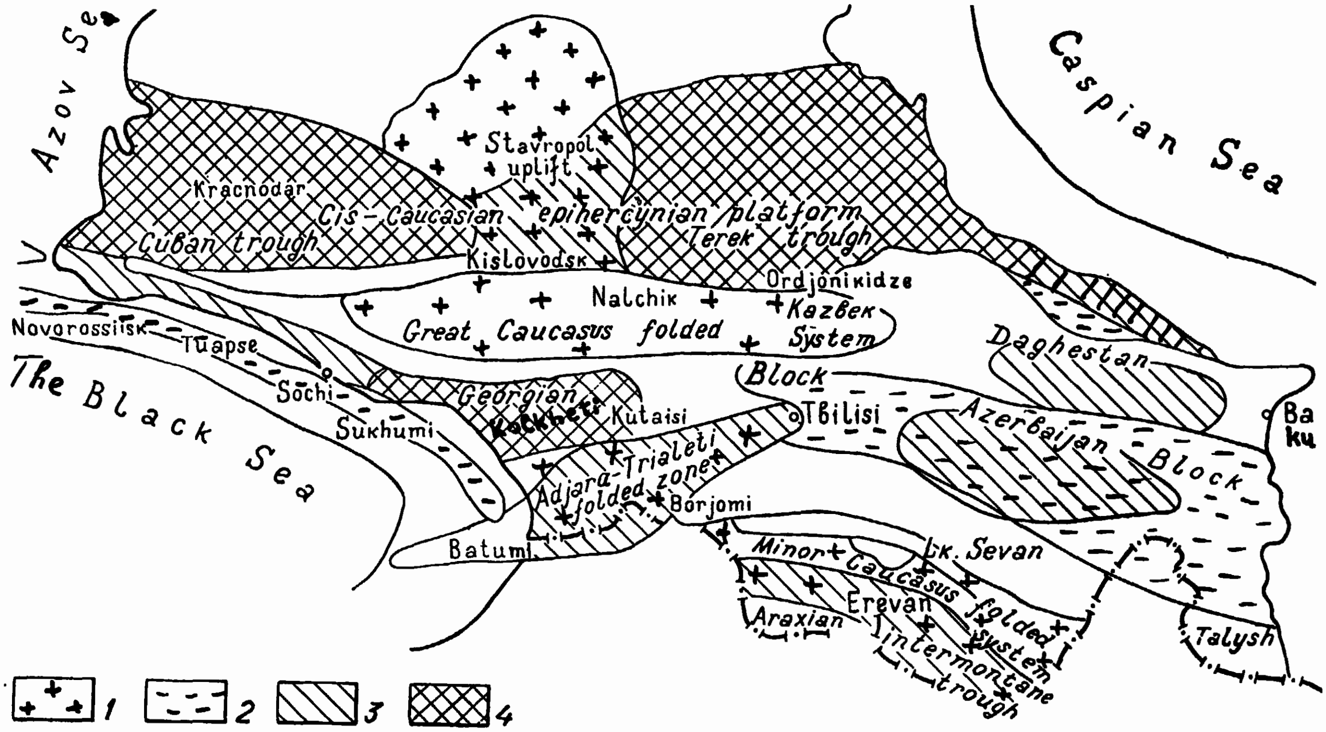

Fig. 1. 1—the zone of maximal heat flow, 2—the zone of minimal heat flow, 3—the perspective area of thermal waters, 4—the most promising artesian basin with *t* 100°((Kuban, Terek-Caspian, Kolkheti).

Table 1. Heat flow values for the Caucasian tectonic region.

Tectonic units	Number of estimations, n	Mean value in Wm^2, $\bar{x}$	N o t e
Cis-Caucasian (Scythian) Platform	17	63	Stavropol Uplift - n=7, $\bar{x}$=84; the rest part - n=10, $\bar{x}$=46
Great Caucasus folded system	9	75	Excluding those for Karmadon and Matsesta (hydrogeological anomalies) - n=7, $\bar{x}$=80
Transcaucasian Block (intermontane trough)	38	33	West submersion zone - n=12, $\bar{x}$=41; the rest part - n=26, $\bar{x}$=32
Adjara-Trialety folded system (North part of the Minor Caucasus)	11	55	Central part - $\bar{x}$=84; east termination - $\bar{x}$=50
Folded zone in the Southern part of the Minor Caucasus (Armenia)	10	84	
Araksian intermontane trough	5	50	

Table 2. General classidication of thermal waters in the Caucasus

The type	The gas constituent	Hydrogeological structures	Physical and chemical peculiarities				Specific micro-components	Waterbearing rocks and conditions of circulation	Typical representative
			Ionic composition	Mineralization, gramme/litre	pH	Temperature, maximum °C			
Tbilisi I	N_2	Orogenic waterhead systems	HCO_3-Cl, Na	0.2-0.8	7.9	60	H_2S, H_2SiO_3, F	Fissuring systems of anticlines of volcanogenic rocks, circulation is intensive	Tbilisi, sp. "A", Ely-Sy (Azerbaijan), Torgvas Abano (Georgia)
Maikop	CH_4	Submontane and intermontane artesian basins	Cl, Na	10.0-35.0	8.0	100	H_2SiO_3, Br, J	Subsided layer of sedimentary and volcanic-sedimentary rocks; circulation if very low	Maikop, b.1 (North Caucasus), Horga, b.21 (Georgia), Makhach-Kala, b.27 (Daghestan)
Arzny	CO_2	Orogenic waterhead systems	Cl-HCO_3, Na	10.0-15.0	6.5-6.8	60	H_2SiO_3, Br, As	Subsided layer of carbonic rocks, zone of deep faults, circulation is rather low	Arzny, b.3 (Armenia), Dary-Dag, b.1 (Azerbaijan), Vani-Amagleba, b.23 (Georgia)

constituent on the first place and then the type of hydrogeological structure. Physical and particularly chemical peculiarities of water allow us to distinguish concrete types for which are determined specific microcomponents, water-bearing rocks, conditions of circulation and at last the typical representative. According to the above principle we distinguished 14 types of thermal waters (Buachidze et al., 1980), but now for our purposes we have reduced them to 3 types (Table 2).

GENERAL MODEL

Summing up all the regularities of thermal waters one can conceive a general hydrogeological picture. Waterhead systems which are confined to the central parts of folded structures are rich in acid carbonated thermal waters of mean mineralization. Peripheral districts of the folded structures (sometimes the upper part of the centre as well) represent the areas of development of recent nitrogen thermal springs of low mineralization. In the zones of troughs, where water-exchange is obstructed, artesian basins are characterized by methanic thermal waters of mean and high mineralization. Herein 'washed' structures are rich in nitrogen poorly mineralized thermal waters.

GEOTHERMAL RESOURCES

Thermal waters have a huge amount of energetic resources. Consideration of thermal waters of the Caucasus leads to the conclusion that hydrothermal potential of submontane and intermontane troughs' area exceeds 3 times that for the young folded structures (Buachidze et al., 1980). Among the artesian basins one should recognize as the most promising the Azovo-Kuban, the Tersko-Caspian and Kolkheti ones (Fig. 1). Thermal water reserves of the mentioned basins make up 2/3 of the total Caucasian resources. Above 30% from the thermal water reserves of the above basins are characterized by a temperature reaching 100°C and above, this determining their use for power economy (geothermal power stations).

Thermal waters of the rest artesian basins and young folded structures are characterized by temperatures ranging from 40 to 65°C. Their resources are rather significant this indicating their utility in national economy (hot-water supply and heating of districts and enterprises, utilization for farming, in light and food industry, and at last at the balneologic resorts).

Utilization of the heat of the Earth's 'interior' in the Northern Caucasus (Makhach Kala, Grozny, etc.) and in the Transcaucasus (Zugdidi, Tbilisi, etc.) revealed advantage in changing the traditional fuels; this incidentally also eliminates environmental polution. Production economics estimations conducted for the existing resources proved their equivalent to be 2 million tons of conventional fuel per year.

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