ESTIMATION OF ZUGDIDI AND TBILISI THERMAL WATER DEPOSITS

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Owing to its geological location Georgia has considerable resources of natural thermal waters and has long tradition of their exploitation. Nowadays approximately 250 natural thermal springs and artificial wells are known, as well as spring clusters with water temperature of 30-108 degrees. Although the geothermal potential of the country exhibits a promising resource, currently the situation is changed for the worse at the majority of thermal water deposits in Georgia, since the irrational exploitation of thermal deposits and due to climate changes led to decrease of well pressure and debits. This paper summarizes the geothermal potential of Georgia based on existing data and outlines one of the major projects that have already implemented to assess the potential of Tbilisi geothermal field using the hydrodynamic digital modeling approach. As a result of modeling work, the 10 years perspective of thermal deposit of Tbilisi was assessed for present conditions of exploitation as well as its behavior under simulated geothermal circulation system.

Keywords: Thermal water, geothermal circulation system

Zugdidi geothermal field

Within the Zugdidi deposit, 25 wells have been drilled. These wells have produced 82^0 – 102^o C hot water with 25000 cubic meters discharge from the depth of 1272-2820 meters, which is equal to 42500 t of conditional fuel (annual production 250000 megawatt/hour). Thermal water containing horizon is represented by Lower Cretaceous limestone complex composed of layered and massive dolomitized fractured and karstic limestone by which the Urtian Brachyanticline is build At the west end of Tsaishi village, the anticline is broken by submeridional fault, along which the two blocks are shifted by 1000 m. In the up thrown wing a low-mineralized (0.8-1.0 g/l)

Regional geography and geology

Georgia is a country of Caucasus region of Eurasia. It covers the territory of 69,700 km^2 and is bounded to the west by Black sea, to the East Azerbaijan, to the north Russia and to the South by Turkey and Armenia. Owing to its special location, the climate of the country varies from the subtropical conditions on the Black sea coast to the continental in the east with cold winters and dry summers. Annual precipitation reaches 1000-2000 mm on the west coastal lowlands, when it can be only 400-1600 mm during spring and autumn. The mean temperature in winter is 5^0 C and in summer 22 ^{0} C, but the last value may increase if we take into account the very hot summers last years.

Geologically the territory of Georgia is located in the central and western parts of the Trans-Caucasus and lies between the Euro-Asiatic and Afro-Arabian plates. The geologic evolution of Georgia is controlled, to a great extent, by the development of the whole Caucasus segment of the Mediterranean belt. Three major tectonic units can be distinguished according to the geologic evolution of Georgia: 1) Fold system of the Greater Caucasus which represents a marginal sea in the geological past, 2) Trans-Caucasus inter-mountain area which marks the northern part of the Trans-Caucasus island arc, 3) Fold system of the Lesser Caucasus, the southern part of the ancient Trans-Caucasus island arc. Closely related to the geological evolution, Georgia whose about two third of territory is occupied by mountains is characterized by rough topography. The country lies between the Greater Caucasus in the north and the Lesser Caucasus range in the south. The intermountain area is divided by the Likhi ridge into the Kolkheti (Rioni) and Lueria (Kura) lowlands. The Meskheti and Trialeti ridges together with the volcanic highlands in the south make up the major geographic units in Georgia.

Geothermal regions of Georgia

Owing to the high geothermal potential in the South Caucasus and particularly in Georgia, a confirmed total reserve of 90,000 m^3/day, corresponding to a heat potential of 500,000 tons of equivalent fuel annually, have been recorded. The amount of thermal flow for the main parts of Georgia can be listed as follows: 1) The south flank of Caucasus Mountains - 100 mWm^{-2}; 2) Plate of Georgia; a) for the west zone 40 mWm^{-2} b) for the east zone 30mWm^{-2}; 3) Adjara-Trialeti folded system a) central part 90 mWm^{-2} b) the east zone 50 mWm^{-2} ; 4) Artvin- Bolnisi platform 60 mWm^{-2}. Figure 1 shows the main geothermal fields in Georgia. The reservoir formations are fractured karstic limestones of the Upper Cretaceous in the sedimentary trough and at the southeast where the reservoir formations are volcanic and sandstones of Paleocene-Middle Eocene in the fold system. The maximum heat flow is observed for the central zone of folded part of Georgia and the minimum for the plate. The heat flow for Adjara-Trialeti folded system is characterized by the middle range. The temperature condition of Paleocene- middle Eocene thermal water bearing complex is better investigated for Tbilisi region. This investigation revealed that temperature condition of this complex is influenced by depth of high thermal resistivity upper Eocene rocks as well as their thickness. From the surface of volcanic-sedimentary formation of middle Eocene the temperature of rocks increases to all direction from 20 ^{0}C till 100 ^{0}C. To the north-east the increase of temperature is less than to other directions because of nearness of the plate. On the contact of Cretaceous – Eocene temperature has remarkable variation: to the farthest west, where upper Cretaceous is raised till 500 m, we have temperature variation from 100 till 160 ^{0}C, when to the North and East, where the Cretaceous deeps till 600 m we have temperature about 240 ^{0}C.

By the amount of observed resources, their degree of thermal potential and exploitation perspectives thermal water deposits in Tbilisi and Zugdidi are the most promising; thus the assessment of their conditions should be regarded as the most important task.

Water of 80-85 ^{0}C is flowing, while in the downthrown wing is moving low-mineralized (0.8-1.0 g/l) water of 95-102^{0} C. Because of political and economical situation it was impossible to elucidate the character of hydrodynamic relationship between wells and shifted up thrown and downthrown blocks. So it is impossible to answer the questions about connectivity of deposit and present the total deposit report as well as its possible exploitation scheme.

Tbilisi geothermal field

Tbilisi is situated in Achara-Trialeti mountain system, which is divided by active geological faults. Part of this system represents drainage of sulphur water spa resort located in the central part of Tbilisi. The hot natural springs of spa resort are connected to the outcropping Middle Eocene sediments that occur along the Mtkvari (Kura) river valley. The recharge area is located to the west up in the mountains. Water from the natural springs has a temperature ranging from 40ºC to 50ºC, sulphur-hydrogen type, with mineralization of 0.4 to 1.0 g/l and the healing properties. In the north-west part of the city, in the Lisi district, several boreholes were drilled and sulphur containing water of temperature from 60ºC to 70ºC is being used for house heating purposes.

From the West to East this horizon submerges beneath younger sediments. 20-30 km away from the “Lisi” area oil deposit was found in anticline structures.

Thus three main districts have been identified in the thermal water deposit of Tbilisi (from West to East): 1. Lisi-Saburtalo district, 2.Central - bathes or old thermal district, 3. Samgori- Sartichala district. Close connections between central and Samgori-Sartichala district has been established. The hydrodynamic interconnections between Lisi-Saburtalo and other districts are not clear and should be investigated. Nowadays low

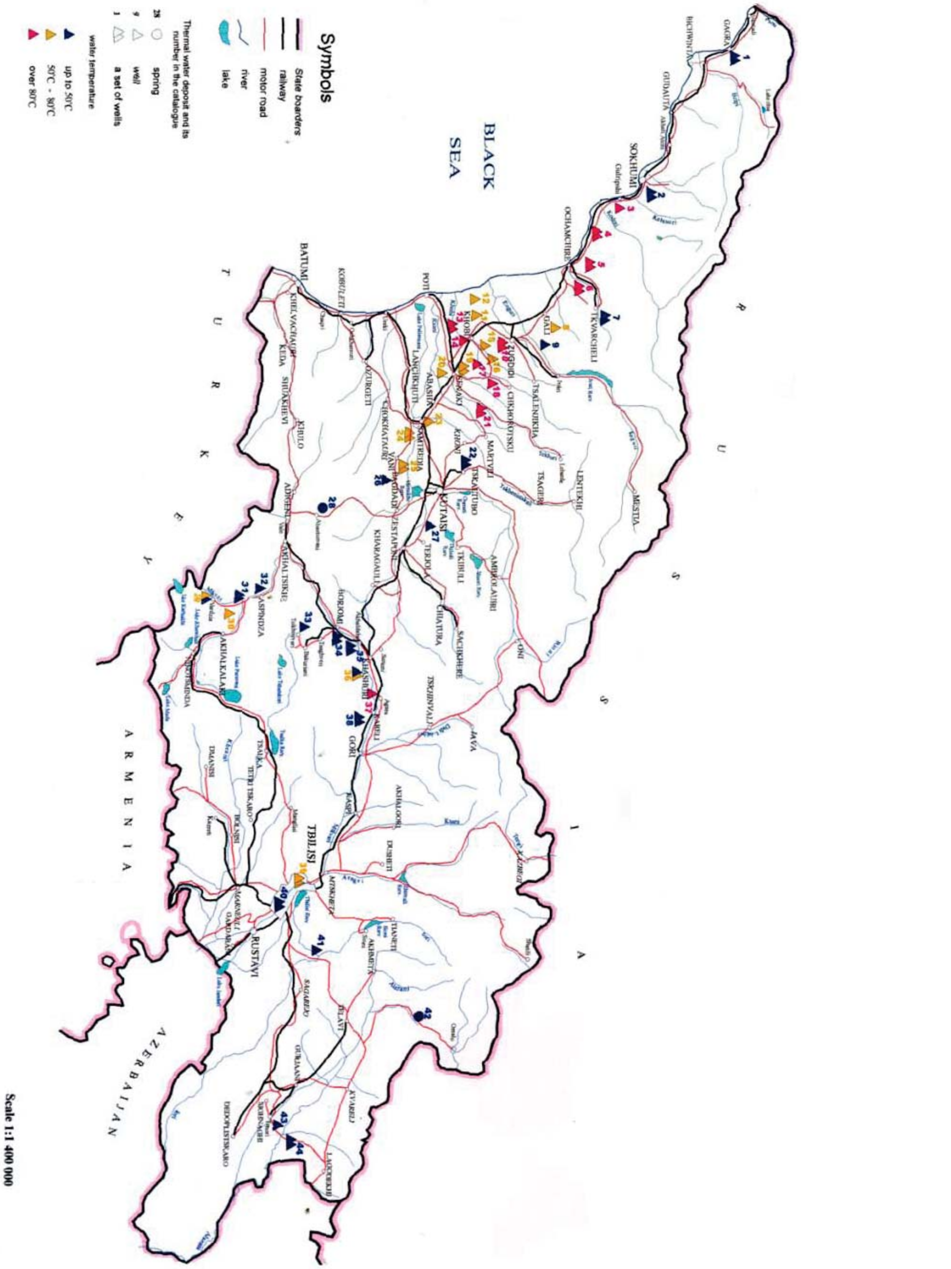

Fig. 1. Main geothermal fields in Georgia (Tsertsvadze N.et al. 1998)

temperature water of Central district is used for spa and hygienic purposes. High temperature (57-74 ^{0}C) waters of “Lisi” (wells 5, 7, 8) and Saburtalo (wells 1, 4, 6) are widely used for heating and hygienic purposes in total amount of 3800 m³ daily. It should be mentioned, that composition of water is similar in all three districts: low-mineralized 0.19-0.26 g/l, alkaline, sulphate-chloride-carbonate type, containing hydrogen sulfide.

Till now hydrodynamic relations between these three geothermal districts, as it was mentioned above (“Lisi”, “central” and “oil” deposit) is not properly investigated. It should be noted, that the intensive oil production at the oil field at 30 km to the north-east from the central thermal water deposit disturbed the regime of the central hydrothermal deposit and caused decreasing and desalination of spring in 1980s. Later, after stopping of intensive extraction, the regime of hydrothermal field was recovered. Besides, some anomalies of water level were discovered before and after local seismic events. Thus, it is evident that the regime of thermal waters is subjected to the influence of many factors: exogenous (precipitation, atmospheric pressure, tides) and the endogenous (earthquakes, creep, tectonic strain, oil production) impacts. Besides, there has been observed the decreasing of thermal water outflow in Lisi-Saburtalo area. After reviewing the data of discharge of river Mtkvari, and precipitation in the recharge area of thermal water deposit, revealed the

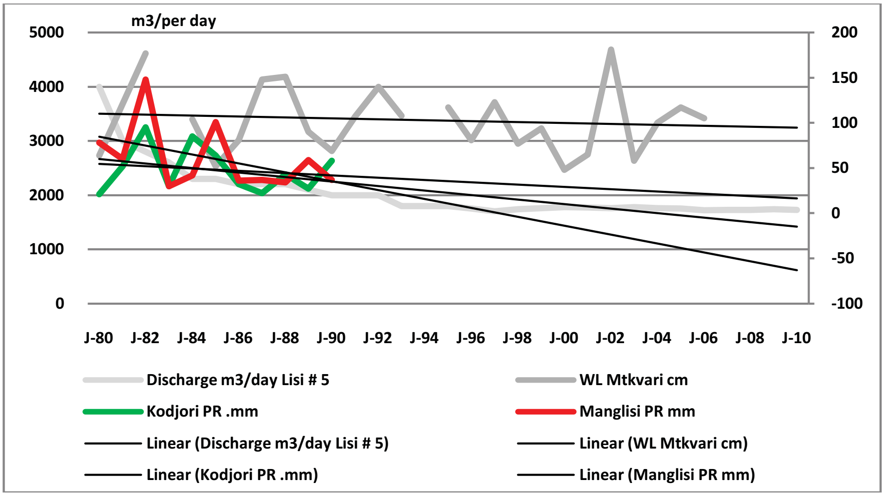

Fig. 2 Variation of parameters

interesting coincidence of decreasing in time precipitation, water level in Mtkvari and discharge of Lisi (well # 5) (Fig. 2)

Considering the above mentioned facts, we can assume that the decreasing of Tbilisi thermal water outflow, together with intensive and not correct exploitation of the wells, is a result of climate change processes that we observe in the region.

So it is evident that the absence of detailed regime observations of hydrogeothermal situation makes it impossible to develop a plan of rational environmentally reliable exploitation of these three deposits. (Buntebarth et al., 2009, Sakvarelidze et al., 2008)

Hydrodynamic digital model of Tbilisi thermal region and regularities of thermal field distribution

Urban centre Tbilisi is of a particular importance with its multilateral and dimensioned consumer existence, thermal waters resources, unlimited perspective of development and a population of 1.5 million. The use of heat energy of ground hydrothermal resources for therapeutic and heating aims is traditional worldwide, although detailed research into hydrodynamic and hydrochemical characteristics of this area is significant.

At present the scheme of exploitation of thermal waters in Tbilisi remains primitive, i.e. hot water goes from the well to user and then to sewerage. What is most important there is not any control of change in hydrodynamic parameters of deposit. As a consequence debits of separate wells decreases. No monitoring of wells under exploitation is operating and there is a lack of research of hydrodynamic relations between wells, which has negative effect on its exploitation.

To stop the tendency of decrease of pressure and debit of wells the idea of creation of an artificial geothermal circulation system (GCS) occurred. GCS would preserve geothermal deposit from depletion and expands exploitation time and what is most important, protect environment from pollution (bogging, thermal pollution), besides, liquidation of boiler houses decreases emission of carbon dioxide. And all that is directly connected to the climate change that we observe in southern Caucasus and generally all over the world.

Conclusions

Field hydrogeophysical investigations (tentative testing, regime hydrodynamic and microtemperature observations) have been carried out to assess the main thermo-hydrodynamic parameters of water containing horizons. Additionally, it have been confirmed, that the decreasing of thermal waters debit occurs not only due to no rational exploitation of them, it is affected by the world wide climate change processes.

Therefore, in future we recommend creation and implementation of geothermal circulation systems. This will help to achieve economical and ecologically approved exploitation of geothermal resources.

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