COUNTRY UPDATE FROM REPUBLIC OF GEORGIA

Guram Buachidze

Department of Mineral and Thermal Water, Institute of Hydrogeology, Georgian Academy of Science, Tbilisi, 380008, Georgia

Key Words: Thermal Water Fields, Resources, Direct Use, Georgia

ABSTRACT

The paper presents generalized data about the thermal waters of Georgia. The total flow of waters with temperatures ranging from 33 to 108°C exceeds 8000 l/s, making it equivalent to 0.5 million tons of conventional fuel per year. Employment of up-to-date techniques of water utilization is sure to increase this value up to 2 million tons of conventional fuel per year. 15-20 revealed fields, most of which are located in West Georgia, had considerable reserves of heat energy. This might be used to supply part of the power deficite under the current energetical crisis. Table list general characteristics of geothermal activity proceeding in Georgia.

INTRODUCTION

Nowadays the electric power shortage in Georgia reaches 5300 GWh/yr as 30% of the consumed energy. Under such conditions alternative sources, namely geothermal, acquire quite a special significance.

Utilization of geothermal energy commenced in ancient times, before Christ, as substantiated by archaeological excavations. Even the name of the capital that was founded as early as the 4th century A.D. is associated with thermal water: 'tbili' means warm. Traditional realms of thermal spring employment - sanitation and balneology - have since the middle of our century, after drilling deep wells and production of high-temperature water, been expanded to cover industry, agriculture and public utilities.

Distribution of thermal water fields within Georgia is subject to a number of regularities and is rather favourable for economic development. This is because most of these fields are located within the densely populated lowlands.

GENERAL ACCOUNT OF THE FIELDS

The primary waterbearing thermal horizons are Upper Cretaceous, fractured karstic carbonate rocks of the intermontane trough, in West Georgia, and Paleocene - Middle Eocene fissured volcanites and sandstones of the Adjara-Trialety folded system, in East Georgia (Buachidze et al., 1970).

Figure 1 presents a general scheme of the major fields, Table 1 lists the features of the main wells within the thermal water fields of Georgia. The far west is marked by the well-known Gagra resort with a copious balneological thermal water (47°C) discharge and a flow rate up to 30 kg/s. Then we come across Sukhumi-Dranda field, wherein, besides balneological utilities, the thermal water is emploed in a large flower green-house and for aeroport heating. East-South-Eastwards is smoothly evolves into one of the two major Kindghi-Okhurei fields (Table 2) supplying hot water to the primary hot-beds and greenhouses, extending over an area of 15 hectares and producing such exotic crops as papaya, heating a large poultry plant, processing tea mills and heating the settlements.

Further easwards there is another major field - Zugdidi-Tsaishi. Herein they use hot water at the Inguri paper mill as well as to heat the town of Zugdidi and numerous hotbeds. Proceeding to the South-East we come across the Kvaloni, Menji, Samtredia and Vani fields. The latter are special mainly for their local balneological use, but it is especially noteworthy that herein the thermal water is also employed for protecting citric plants should a need arise during extreme temperature drop.

The most popular Tskhaltubo resort is located at the east edge of West Georgia. Here subthermal water, circulating within the radioactive sands developed over the Cretaceous karstic limestones, are widely used for treatment (Buachidze, 1994). Within Vardzia-Nakalakevi field, that is located at the south edge of Georgia, Cretaceous volcanites, overlapped by thick lava sheets, contain carbonated thermal waters that flash to the surface under great pressure.

Finally, the east edge of Adjara-Trialety folded system is notable for the Tbilisi field. Here thermal water is tapped at the depth of 1.5-4.0 km within Paleocene - Middle Eocene volcanites at temperature up to 65°C. Along with traditional utilities, a dense net of hot-water supply pipes is also installed here using as much as 3.5 thousand cu m/day of water.

TOTAL RESOURCES

Exploration conuucted in Georgia has detected reserves of about 100.000 cu m/day of water with temperatures ranging between 60 and 108°C. 'Water heat energy amounts to 8.000 G cal per day making it equivalent to 0.5 million tons of conventional fuel per year (Buachidze et al., 1980). Still the country employs but a minor portion of the above energy. Its main consumers involve hot-beds - up to 37%, then heating and hot-water supply systems and farming units - about 24%

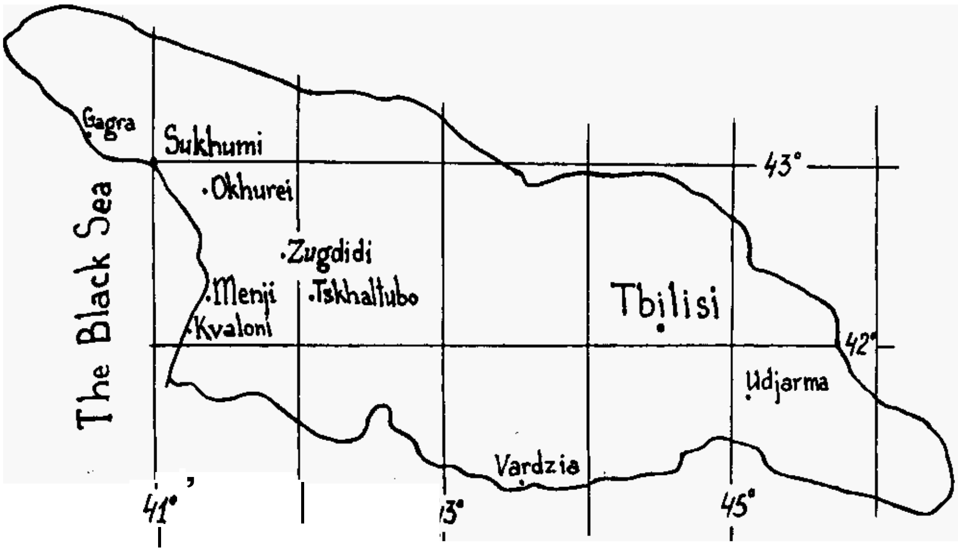

Figure 1. Scheme of thermal water fields in Georgia

Table 1. Main Wells of the Major Thermal Water Fields in Georgia

Type of well: A - artesian; E - exploration; I - injection; P - production, F - flashing.

Locality	Year rilled	Well Number	ype of Well	Max. Depth m	Max. Temp. °C	Well Output kg/s	ut
Kindghi	1985	2	P, A	3560	103	30.4	10.1
"-"	1984	IT	I, A	3645	100	36.0	11.4
"-"	1981	2T	P, A	3550	102	42.0	14.6
"-"	1982	6T	P, A	3714	100	24.0	7.6
"-"	1985	7T	P, A	3729	108	54.0	11.3
"-"	1986	8T	E, A	3615	100	24.0	10.1
"-"	1988	11T	P, A	3240	106	45.5	10.1
"-"	1988	12T	P, A	3525	104	45.6	12.1
"-"	1988	15T	P, A	3660	108	47.9	13.1
Okhurei	1988	3T	P, A	3356	106	76.4	18.1
Zugdidi-Tsaishi	1963	1	P, A	3728	82	19,2	0.3
"-"	1980	IT	P, A	1272	86	45.6	0.3
"-"	1980	2T	P, A	1904	87	33.6	0.4
"-"	1982	5T	E, A	2661	83	18.0	0.2
"-"	1983	8T	P, A	1675	84	72.0	0.0
"-"	1985	9T	I, A	2306	92	36.0	0.9
"-"	1985	10T	P, A	2803	102	36.0	0.6
"-"	1986	12T	I, A	2410	90	36.0	0.0
"-"	1986	13T	P, A	2195	84	30.0	0.0
"-"	1986	14T	P, A	2000	84	30.0	0.0
"-"	1987	17T	P, A	2749	94	36.0	0.0
"-"	1986	3-3	P, A	2401	84	36.0	0.2
"-"	1989	18T	P, A	2820	93	30.0	0.0
Tskaltubo	1989	3	P, A	2301	35	89;0	0.3
Pbilisi, L.	1975	1	E, A	2808	64	30.5	3.9
Pbilisi, Sb.	1976	IC	P, A	2867	64	4.0	11.7
Pbilisi, L.	1977	4T	P, A	3695	64	17.0	13.5
Pbilisi, L.	1978	5T	P, A	2255	62	25.3	2.9
Pbilisi, L.	1979	6T	P, A	3040	66	4.0	10.5
Cbilisi, L.	1980	7T	I, A	3702	62	5.0	2.6
Cbilisi, L.	1979	8T	I, A	2638	45	2.0	2.0
Vakalakevi	1981	9	P, F	340	42	12.0	18.0
Tota:						955.0	

each, production processes - up tp 12%, with agriculture consuming only 3%.

One should especially note that all the above data are cited as to 1991. Since then, due to certain events, geothennal activity has declined abruptly. As a result, most of the West Georgia fields have been

Table 2. Geothermal Fields in Best Georgia

Geothermal Fields	Kindghi	Okhurei	Zugdidi
Number of wells	E	2	10
Average depth, km	3.5	3.4	1.4
Depth range, km	3.1-3.7	3.0-3.6	0.8-2.0
Average yield, cu m/day	3.500	3.000	2.900
Maximum yield, cu m/day	4.500	b.000	b.000
Typical chemical composition	Cl-Ca-Na	Cl-Na-Ca	SO_4-Cl-Ca-Na
Mineralization. g/l	1.2-2.2	1.1-1.8	0.9-1.8

completely ruined and the thermal water is utilized mainly for sanitation. As for Tbilisi, only 3.5 thousand cu m/day are now used for hot-water supply. The above circumstances have stipulated decrease of the number (down to a half) of skilled specialists dealing in Geothermy. Also all investments have been stopped, which during the previous decades reached $8 million a year.

FUTURE ACTIVITY

Energy catastrophe that we have been facing during last few years has elucidated the significance of alternative energy sources, especially that of geothermal energy. At present both the general public and financiers are really ready to invest substantial means to ensure introduction of the Earth's heat to our economy. Geothermy specialists are also prepared to exert real activity. Feasibility projects have been developed for the Lissi-Saburtalo district of Tbilisi. There are two sites to be arranged there. It will take just a few months to accomplish the first one, while construction of geothermal hot-water supply utilities, covering the whole city, is sure to last several years. Several projects have also been developed aiming at restoration and reconstruction of the main thermal water fields within Best Georgia, but their commencement is retarded by temporary financial unstability.

Thus, the widespread employment of geothermal energy in the economy of Georgia is rather promising.

REFERENCES

Buachidze, G.J., Buachidze, J.M. and Shaorshadze, M.P. (1970). Hydrogeology of Georgia, Thersal Waters. In: Hydrogeology of the USSR, v.X, Nauka, Moscow, pp. 225-247.

Buachidze, G.J., Buachidze, J.M., Goderdzishvili, N.A., Mkheidze, B.S. and Shaorshadze, M.P. (1980). Geothermal Conditions and Thermal 'Waters of Georgia. Sobchota Sakartvelo, Tbilisi, pp.206.

Buachidze, G.J. (1994). Genesis of Thermal Waters in Caucasus. In: Transactions of GRC Annual Meeting "Restructuring the Geothermal Industry".

TABLE I. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY

	Geothermal		Fossil Fuels		Hydro		Nuclear		Total	
	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr	Capacity MW.	Gross Prod. GWh/yr
In operation in January 1995	-	-	2732	6643	1789	7525	-	-	4521	14168
Under construction in January 1995										
Funds committed, but not yet under construction in January 1995										
Total projected use by 2000	0,5	5,0	-	10000	-	10000	-	-	-	25000

TABLE 3. UTILIZATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT IN DECEMBER 1994

1) I = Industrial process heat; C = Air conditioning; A = Agricultural drying; F = Fish and other animal farming; S = Snow melting; D = Space heating; B = Bathing and swimming; G = Greenhouses; O = Other (please specify by footnote)

2) Enthalpy information is given only if there is steam or two-phase flow

3) Energy use (TJ/yr) = Annual average water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

Locality	Type[1]	Maximum Utilization: Flow Rate (kg/s)	Temperature (°C) Inlet	Temperature (°C) Outlet	Enthalpy[2] (kJ/kg) Inlet	Enthalpy[2] (kJ/kg) Outlet	*nu* Average Flow Rate (kg/s)	Energy Use[3] (TJ/yr)	[illegible]
Gagra	B	30	47	-			25	-	
Sukhumi, Dranda	G,B	25	90	35			22	160	
Kindga, Okhurei	G, A, F, D, B	360	105	35			350	3250	
Zugdidi, Tsaishi, Rechkhi	I, A, G, F, D, B	375	92	35			360	2700	
Kvaloni	F, B	87	97	35			85	695	
Mengi, Samtredia, Vani	F, B	150	65	35			130	515	
Tbilisi	F, D, G, B	60	62	10			50	320	
Ujarma	B	6	59	-			5	-	
Tskaltubo	B	250	33	-			220	-	
Vardzia, Nakalakevi	I, B	20	46	25			15	45	
Total		1363					1262	'685	

TABLE 4. SUMMARY TABLE OF GEOTHERMAL DIRECT HEAT USES

[1] Inst. thermal power (MWt) = Max. water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.004184

[2] Energy use (TJ/yr) = Annual average water flow rate (kg/s) x [Inlet temp.(°C) - Outlet temp.(°C)] x 0.1319

	Installed Thermal Power[1] MWt	Energy Use[2] TJ/yr
Space heating	66	2050
Bathing and swimming	–	–
Agricultural drying	6	180
Greenhouses	79	2490
Fish and other animal farming	64	2000
Industrial process heat	30	965
Snow melting		
Air conditioning		
Other uses (specify)		
Subtotal	245	7685
Heat Pumps	–	–
Total	245	7685

TABLE 8. WELLS DRILLED FOR DIRECT HEAT UTILIZATION GEOTHERMAL RESOURCES FROM JANUARY 1, 1990 TO DECEMBER 31, 1994
(Do not include thermal gradient wells less than 100 m deep)

[1] Type or purpose of well and manner of production

(a)
T = Thermal gradient or other scientific purpose
E = Exploration
P = Production
I = Injection

(b)
A = Artesian
P = Pumped

[2] Total flow rate at given wellhead pressure (WHP)

* Since 1991 any geothermal activity has been going down to z

Locality	Year Drilled	Well Number	Type of Well[1]	Total Depth m	Max. Temp. °C	Fluid Enthalpy kJ/kg	Well Output[2] Flow Rate kg/s	WHP bar
Kindghi	1985	2	P, A	3560	103		30,4	10,1
Kindghi	1988	15T	P, A	3660	108		47,9	13,1
Okhurei	1988	6/T	P, A	3356	106		76,4	18,1
Zugdidi-Tsaishi	1985	91	I, A	2306	92		36,0	0,9
Zugdidi-Tsaishi	1986	3-3	P, A	2401	84		36,0	0,2
Zugdidi-Tsaishi	1989	18T	P, A	2820	93		30,0	0,0
Tskaltubo	1989	3	P, A	230	35		89,0	0,3
Tbilisi	1978	5T	P, A	2255	62		25,3	2,9
Tbilisi	1980	7T	I, A	3702			5,0	2,6
Nakalakevi	1981	9	P, A	340			12,0	18,0
Total							338.0	

TABLE 6. INFORMATION ABOUT GEOTHERMAL LOCALITIES

[1] Main type of reservoir rock

[2] Total dissolved solids (TDS) in water before flashing. Put v for vapor dominated

[3] N = Identified geothermal locality, but no assessment information available
R = Regional assessment
P = Pre-feasability studies
F = Feasability studies (Reservoir evaluation and Engineering studies)
U = Commercial utilization

Locality	Location To Nearest 0.5 Degree Latitude NL	Longitude EL	Reservoir Rock[1]	Dissolved Soli mg/kg	atus[3] I anuary 1995	eservoir Temp. (stimate	Measu
Gagra	43°18	40°12	Limestone	2000	U	60	50
Sukhumi	43°00'	41°00'	"–"	1200	U	45	40
Okhurei	42°45'	41°25'	"–"	16M	U	140	120
Zugdidi	42°30'	41°51'	"–"	9M	U	110	100
Kvaloni	42°18'	41°50'	"–"	2600	U	90	100
Mengi	42°11'	41°13'	"–"	29W	U	80	75
Tskaltubo	42°18	42°36	"–"	800	U	40	40
Tbilisi	41°42'	44°48'	Volcanic	300	U	90	85
Udjarma	41°46'	45°18'	Sandstone	8500	U	50	60
Vardzia	41°20'	43°18'	Volcanic	19000	U	50	60
Total							

TABLE 9. ALLOCATION OF PROFESSIONAL PERSONNEL TO GEOTHERMAL ACTIVITIES (Restricted to personnel with a University degree)

(1) Government
(2) Public Utilities
(3) Universities
(4) Paid Foreign Consultants
(5) Contributed Through Foreign Aid Programs
(6) Private Industry

Year	Professional Man Years of Effort (1)	(2)	(3)	(4)	(5)	(6)
1990	65	–	9	–	–	4
1991	65	–	9	–	–	4
1992	60	–	7	–	–	7
1993	50	–	7	–	–	8
1994	30	–	5	–	–	3

TABLE 10. TOTAL INVESTMENTS IN GEOTHERMAL IN (1994) US$

Period	Research & Development Incl. Surf. Exp. & Exp. Drilling Million US$	Field Development Incl. Prod. Drilling & Surf. Equipement Million US$	Utilization Direct Million US$	Utilization Electrical Million US$	Funding Type Private %	Funding Type Public %
5 - 1984	8	67	42	–	–	100
5 - 1990	3	20	12	–	–	100

ince 1991 any geothermal activity is going down to zero