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Hydrogeochemical Studies of Hot Springs in Gilan Province, N-Iran

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ABSTRACT

Gilan Province is one of the most important tourism attraction area in Iran located in the Southern Caspian Sea. Average annual precipitation of the area is 1000 mm. The area is gained more than 10000 springs with discharge of up to 2 m^3/s mostly located in highlands and cold. 10 hot springs is known. All of them located in highlands and categorized in 3 regions: west, east and south of the province with maximum temperature of 36°C. There are also some cold springs with high EC. In the south of the province, hot springs are studied more and preliminary hydrogeochemical investigations indicate strong influence of natural groundwater in the system by using Giggenbach triangle diagram that strong tectonic activity of the area emphasizes their possible tectonic origin. In the south springs are utilized for Olive farming except Sangrood hot spring with water type of C4S1 in Wilcox diagram that is not suitable for farming. Baleonological application is the best choice among future planes at case of touristic attractively of the area.

1. INTRODUCTION

Gilan province is located in north of Iran and south of Caspian Sea (Figure 1) that is the 2nd smallest province of the country with an area of 14,042 km^2 and a population of 2,410,523. Gilan and two other provinces in the southern Caspian Sea have dense populations. The population density in Gilan is 171.7 inhabitants per square kilometer. Gilan province is characterized with highest precipitation in the Middle East with mean annual precipitation of about 1000 mm. The area is gained more than 10000 springs with discharge of up to 2 m^3/s mostly located in highlands and cold. Snow deposits, pastures and fruit farms, dense forests, orange, kiwi, tea and rice farms are the most common view of the all area from highlands in Alborz Mountains to lowlands near Caspian Sea coasts. Every year millions of tourists (mostly Iranians) come to visit the natural beauties of the area.

2. DISCUSSION

Geothermal investigations in Iran started in 1974. A later investigation by ENEL (Italian power generation company) in 1976 under affiliation of ministry of power, is actually the basis of all later studies and planes. The study was focused on quaternary volcanoes for electricity production.

As a result, some geothermal fields like Ramsar in north of Iran, Mahallat in central parts of Iran and Birjand in the eastern parts of the country were among all hopeful areas that left out. It should be concerned that all of the country benefits direct use of utilization specially baleonological purpose.

Also Gilan during all these years was not investigated for direct uses of geothermal resources. Even hot springs of Gilan province do not have high temperature like some other parts of Iran, but because of mentioned natural interests, they can be economically compatible.

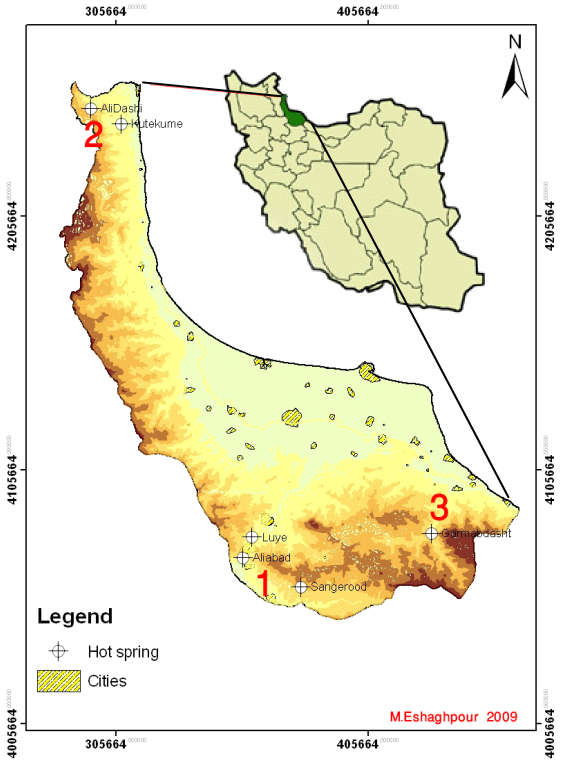

Figure 1: Location map of Gilan province and the six hot springs discussed in the text.

As it shown in figure 1, the hot springs in Gilan province can be categorized in 3 different geographical areas: Southern Gilan, Western Gilan and Eastern Gilan. In table 1 hydrogeochemical and geological specifications of the mentioned springs are summarized. All of the springs are located in highlands with a minimum elevation of 165 masl. Hot springs flow lithologicaly in hard rock formations. It should be kept in mind that the coastal plain has elevation below the surface of free Seas.

In southern parts of Gilan province, around Rudbar city where is shown by number 1 in figure 1, there are three hot springs: Luye, Sangrood and Aliabad. The two first ones sampled by the Regional Water Company of Gilan two times of each year in September and March indication not significant difference during dry and wet seasons. Sangrood hot spring is located near Sangrood village. The old morphology of the spring consists of travertine terraces mostly destroyed by mining and road construction unfortunately during past decades. At the moment hot

spring is flowing in both sides of the main road of the area. The spring is located in a horizontal distance of about 5 km away from coal mine of Sangrood. Precipitations flowing in Ruteh formation limstones, moving downward along a local fault, in contact with paleogene volcanic rock, heats and coming upward (figure2).

Temperature in the surface is about 32°C. CO_2 bubbles are visible in all of the springs (figure 3). Local people believe that in some decades ago the discharge of the spring was strongly more than present. Present discharge of the spring is about 2 l/s. According to Wilcox diagram, the water categorized as C4S1 type indicating high salinity hazard and low alkali hazard (figure 5). Villagers believe that irrigation with this water is seriously harmful for trees.

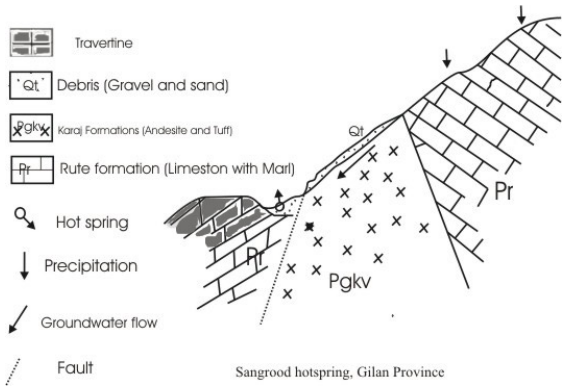

Figure 2: Geological crosss ection of Sangerood hot spring (modified after Shahbeyg, 1984).

Figure 3: A view of Sangrood hot spring and CO_2 bubbles.

Luye hot spring flows from a limestone formation in the western sides of Sefidrood valley (Gilan regional water company, 2008) with 34°C temperature and about 3 l/s discharge. Luye spring is located near Luye village in about 2 km distance from highway of Rasht-Ghazvin (Figure 4). The spring categorized as C2S1 type indicating medium salinity hazard and low alkali hazard (figure 5) and uses for irrigation of olive trees. Baleonological utilization is rare but some visitors come and use its natural small pool for treatment of some diseases like rheumatism.

Figure 4: A view of Luye hot spring and its natural pool.

Aliabad hot spring is located in distance about 2 km away from Sefidrood dam. The first sampling of the spring was carried out during a sudden visit of the area in august 2008. Major ions chemistry of the spring is shown in table 1. According to Wilcox diagram, its water categorized as C4S2 indicating very high salinity hazard and medium alkali hazard (figure 3). It is interesting that even worse quality of the water refer to Sangrood hot spring, hectares of olive trees are irrigated by this spring. Maybe there are other parameters in Sangrood hot spring that makes it worse for irrigation. Boron (B) can be a possible parameter that needs to study more.

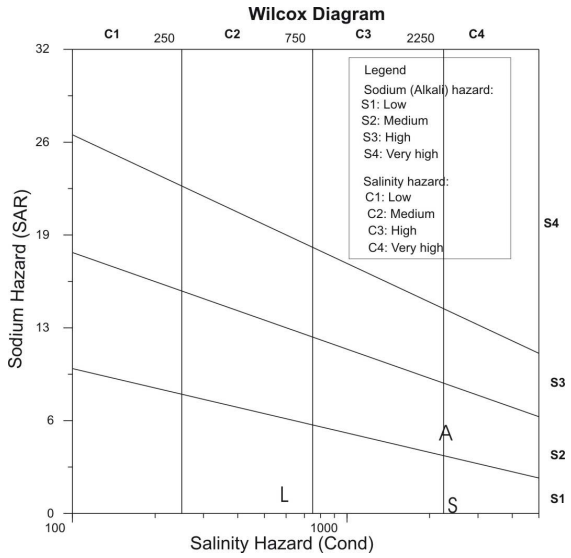

Figure 5: Wilcox diagram for salinity and alkali hazards. L: Luye hot spring, S: Sangrood hot spring and A: Aliabad hot spring.

Piper diagram can be used to interpret water-rock interactions (Hounslow, 1995). In figure 6, piper diagram of southern Gilan hot springs is shown. Sangrood hot spring

has Ca-Mg-HCO_3 facies indicating interaction with limestone of Ruteh formation. Luye hot spring has Ca-Mg-HCO_3-Cl-SO_4 facies and is low mineralized refer to other hot springs. Water facies of Aliabad hot spring is Na-Ca-Cl-SO_4.

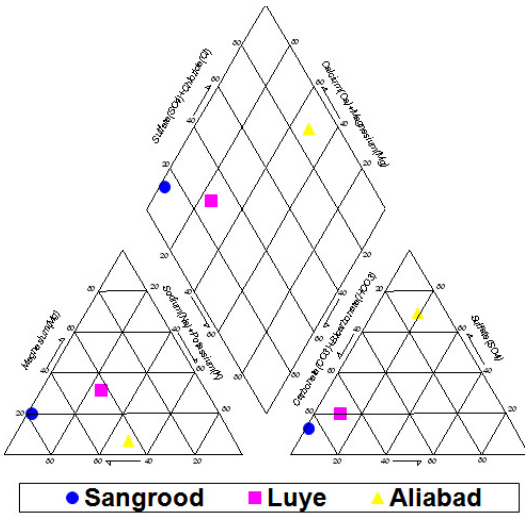

Figure 6: Piper diagram of south of Gilan hot springs.

There are other low temperature hot springs in west and east of the province marked with numbers of 2 and 3 respectively in figure 1 that have not sampled for major ion chemistry yet.

Alidashi and Kutekume in the northwest and Garmabdasht in the east are the hottest springs in the mentioned areas (Figure1). Kutekume hot spring is a low mineralized spring with EC about 752 µs/cm and low discharge of about 0.4 l/s (table 1). Alidashi hot spring has discharge of 3.5 l/s and temperature about 33^{o}C. There some constructions for baleonological purposes in Katekume hot spring area but water of Alidashi hot spring has no significant use.

In eastern parts of the province there is no any hot spring except Garambdasht spring near city of Rahimabad that is relatively high mineralized in hillsides of Eshkevar Mountains (Western Alborz). Even the temperature is relatively low (about 21^{o}C) but its mineral content is more even than Luye hot spring and all other hot springs in the western parts of the province. Garmabdasht hot spring has showing in bottom of Poolorood River valley in elevation of 458 masl. Lithology of the area is mostly consisting of Jurasic karstic limstones of Tizkooh formation. Close to Garmabdasht spring. There are plenty of cold karstic springs with discharges more than 20 l/s in the vicinity of mineral water. The area has strong tectonic activity.

Giggenbach triangle diagram (1988) is a fast responding K-Mg geothermometer with the slowly re-equilibrating Na-K geothermometer. This method is to assess the degree of attainments of water-rock equilibrium (Marini, no date). Hot spring of south of Gilan in figure 7 are located near Mg ^{½} vertex indicating immaturity of waters. Catastrophic earthquake of Rudbar in 1990 has occurred in south of Gilan and changed discharge of some of the springs, indicates that the heat source in the area is linked with tectonic activity.

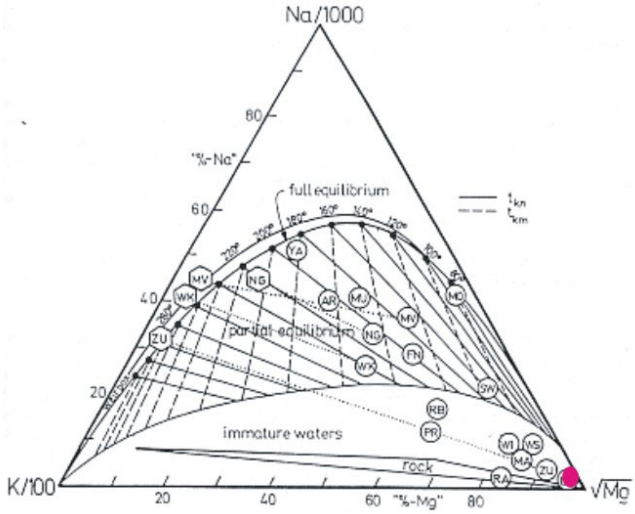

Figure 7: Giggenbach triangle diagram of south of Gilan hot springs (after Giggenbach, 1988).

3. CONCLUSION

All of the hot springs in Gilan province are located in the highlands of the Alborz Mountains and have moderate temperatures and are carbonate types. The heat source is not too deep and indicates a strong influence of surface ground waters and active tectonics of the area. Gilan hot springs can be used for direct use utilizations specially baleonological purposes.

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Table 1: Chemistry and geological information of hot springs of Gilan province. 1: South of Gilan, 2: West of Gilan, 3: East of Gilan.

	Area	Name	Date	x	y	z	T (°C)	Q (l/s)	Ca	K	Na	Mg	SO4	Cl	HCO3	CO3	pH	TDS	EC
1	Lowshan	Sangrood	Sep 07	379147	4059503	1113	32	2	22.5	0.05	0.53	5.8	3.72	0.3	24.7	0	6.22	1590	2524
	Rudbar	Luye	Sep 04	359722	4079076	480	34	3	2.52	0.08	1.39	1.82	1.17	0.65	4	0	7.1	362	575
	Manjil	Aliabad	Aug 08	356004	4070899	360	32	0.7	10.9	0.21	11.7	1.8	15.55	4.1	2.7	0	7.7	1492	2368

	Area	Name	X	Y	Z	Geology	Q (l/s)	Utilization	T (°C)	EC	pH
2	Lavandevil	Kuta'Kuma' 1	306080	4242104	165	Cretaceous Shale and Sandstone layers	0.40	Baleonology	36	752	9.1
	Lavandevil	Kuta'Kuma' 2	306093	4242242	234	Cretaceous Shale and Sandstone layers	0.05	Drinking	33	254	8.0
	Lavandevil	Kuta'Kuma' 3	306017	4242955	394	Cretaceous Shale and Sandstone layers	0.10	Cow farming	33	207	8.0
	Astara- Chamlar	Alidashi	292812	4245994	667	strongly tectonicized paleogene Andesite	3.50	no	32	263	9.3
	Astara- Chamlar	Abgarm	292824	4245897	680	Paleogene Andesite	1.00	no	31	258	9.3
	Astara	Gildeh	296149	4250474	839	Paleogene Sandstone and shale	0.02	Cow farming	30	127	8.3
	Date of Sampling: July & August 2009, EC: micro S/cm										
3	Rahimabad	Garmabdasht	430919	4080596	458	Jurasic Karstic limstone	2.00	no	21	1092	6.8
	2: Eastern Gilan Date of sampling: August 2009										