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Interpretation of Chemical Data from Geothermal Wells: 1021 Tamaseu and 605 Mihai Bravu in Bihor County.

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ABSTRACT

This paper presents an interpretation of the physic-chemical characteristics of geothermal fluids, coming from two wells: 1021 Tamaseu and 605 Mihai Bravu in Bihor County.

Using ternary diagrams: ternary diagram Cl-SO_4-HCO_3 and ternary diagram Na- K-Mg we establish nature of the geothermal waters and we do framing of the waters on the two diagrams.

Determining the type of the water by locating the geothermal fluid in the two diagrams, it is important for the subsequent use of geothermal energy for various purposes.

1. INTRODUCTION

The studied region is part of geological tectonic unit of the Pannonian Basin, representing southeastern extremity. It probably formed during neozoicului by sinking a large area of the Carpathian region. The geothermal wells, that were studied are presented on the map of figure 1.

Figure 1: The map of the country Bihor

In this area, geothermal waters are quartered in geothermal formations Pannonian ante.

Development of the aquifer Mihai Bravu is influenced by the complexity of structure of the crystalline foundation. This aquifer is superimposed on a very large part over Cretaceous neo Sânnicolau the east and west is situated over crystal blocks immersed in Miocene and Pliocene.

From the point of view of the reservoir energy, reservoir Tamaseu platform have energy strongly influenced by gas. Hydrostatic pressure of collector influences eruptive mechanisms in area. Region's geothermal features are particularly interesting by the way presented by geothermic subcontinental anomaly on the Alpine-Carpathian territory of interarcului of the Pannonian Basin.

We know today as on amid of subcontinent geothermal anomaly it overlapping more sub-regional anomalies, of which the most important are focused along the Tisza valley. This anomaly covers with its eastern flank the throughput of the Western Plain of Romania.

It should be noted that, with few exceptions, most of the region is covered by a thick package of sediments belonging to the Pliocene with Pannonian characteristics. As a general feature of these waters is degree the mineralization relatively high. [3]

2. EXPERIMENTAL PART

Used the physic-chemical analysis were performed ternary diagrams for the geothermal water, what we allowed characterization geothermal water [4, 5] of Tamaseu and Mihai Bravu.

Chemical analysis was performed in geothermal water wells: 1021 Tamaseu and 605 Mihai Bravu by sampling water. [6] Analysis of sodium, potassium, calcium, magnesium and iron was made by atomic absorption spectroscopy, using a spectrophotometer VARIAN SPECTRA AA 110. Analysis of silica [8], was made using UV-VIS spectrophotometric method, using a spectrophotometer CARRY 50.

Determination of carbon dioxide [9], was made by titration with hydrochloric acid solution in the presence of metilorange. CO_2 from the carbonates was determined by volumetric titration. The method is based on neutralization of carbonates with hydrochloric acid to bicarbonate step, using phenolphthalein as indicator.

Analysis of chloride [10], was made by titration with silver nitrate in the presence of potassium chromate as indicator (Mohr method).

Experimental data on the chemical composition of geothermal waters, taken in the survey are given in Table 1.

Table 1: Chemical composition of geothermal waters (concentrations of ions, mg /l)

Chemical Characteristics	Well 1021 Tamaseu	Well 605 Mihai Bravu
pH	7,4	7,9
Na^+	791	922
K^+	12	9,5
Ca^{2+}	8,2	11,7
Mg^{2+}	5,3	8,6
Cl^-	915	414
SO_4^{2-}	17	44
HCO_3^-	1160	991
SiO_2	41,3	49,7
Fe^{2+}	0,156	0,36
CO_2	1190	477
TDS	1820	2100

2.1 Results and discussion

Experimenting with some techniques of derivation the geoindicators Na - K - Mg - Ca, it can be Na, K, Mg a triangular diagram that can be used to distinguish waters balanced or partially balanced by the mixed water and immature, and Figure 2.

This allows the measurement of balance and combination of deep water can be made on several samples, [1,2]. Making a diagram are based primarily on the dependence of temperatures of the two reactions:

$K^+ - KAlSi_3O_8 = Na^+ - NaAlSi_3O_8$ or K - feldspar + Na^+ = Na - feldspar + K^+ (1)

$0.8\ KAl_3Si_3O_{10}(OH)_2 + 0.2\ MgAl_2Si_3O_{10}(OH)_8 + 5.4\ SiO_2 + 2\ K^+ = 2.8\ KAlSi_3O_8 + 1.6\ H_2O + Mg^{2+}$ (2)

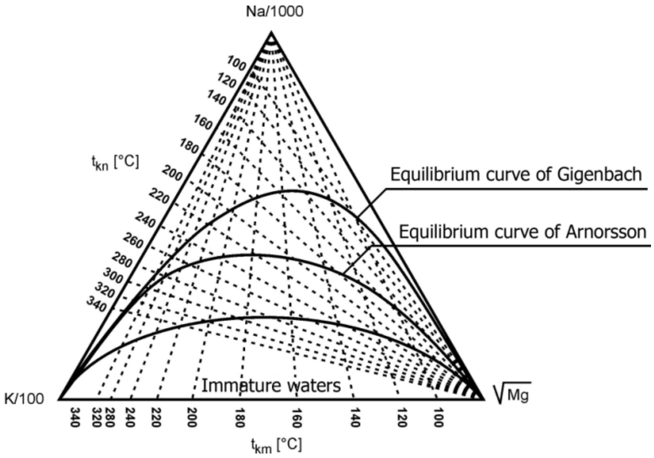

Figure 2: The ternary diagram Na - K - Mg for geothermal waters.

Theoretical temperature that depends on the correlation coefficients of concentration, can be used for preparation of two geotermometre:

$$t_{kn} = \left(\frac{1390}{1.75 + \log\left(\frac{C_{Na}}{C_K}\right)} \right) - 273.15 \qquad (3)$$

$$t_{km} = \left(\frac{4410}{14{,}0 - \log\left(\frac{C_K^2}{C_{Mg}}\right)} \right) - 273.15 \qquad (4)$$

where: t_{kn} - Na/K geothermometer temperature in Kelvin (Giggenbach (1988)

t_{km} - K/Mg geothermometer temperature in Kelvin (Giggenbach (1988)

C_{Na} - concentration of Na; C_K - concentration of K; C_{Mg} - concentration of Mg

Applying individual equations (1) and (2) leads balancing very different temperatures. Coordinates of a point on the diagram are calculated using the equations:

$$S = \frac{C_{Na}}{1000} + \frac{C_K}{100} + \sqrt{Mg} \qquad (5)$$

$$\%Na = \frac{C_{Na}}{10S} \qquad (6)$$

$$\%Mg = 100\,\frac{\sqrt{C_{Mg}}}{S} \qquad (7)$$

Because of nonlinear variation of the term CK^2, the starting point is taken on the concentration of magnesium. Concentrations Na and K are divided by 1000 and a 100 to fit best with geothermal waters. The data obtained are given in Table 2.

Table 2: Results for geothermal waters from two wells.

Well	Na (mg/L)	K (mg/L)	Mg (mg/L)	$\frac{Na}{1000}$	$\frac{K}{100}$	$\sqrt{Mg}$	% Na	% K	% Mg
1021 Tamaseu	791	12	5,3	0,791	0,120	2,30	24,63	3,73	71,63
605 Mihai Bravu	922	9,5	8,6	0,922	0,095	2,93	23,36	2,40	74,23

Were calculated, based on these data, temperatures of geothermometers:

- for drilling 1021 Tamaseu:

$$t_{kn} = \frac{1390}{\left(1{,}75 + \log\left(\frac{C_{Na}}{C_K}\right)\right)} - 273 = 116{,}46\ °C \tag{8}$$

$$t_{km} = \frac{4410}{\left(14{,}0 - \log\left(\frac{C_K^2}{C_{Mg}}\right)\right)} - 273 = 77{,}95\ °C \tag{9}$$

- for drilling 605 Mihai Bravu:

$$t_{kn} = 98{,}95\ °C \tag{10}$$

$$t_{km} = 66{,}78\ °C \tag{11}$$

On the majority of cations was built ternary diagram Na-K-Mg. The data obtained allowed the positioning of geothermal water, taken in the study, the ternary diagram N - K - Mg, Figure 3.

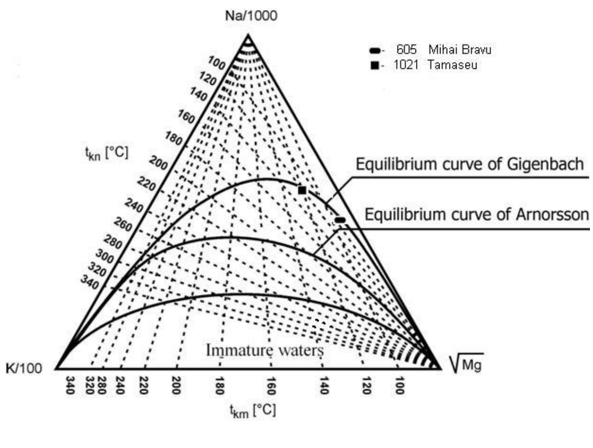

Figure 3: Ternary diagram Na - K - Mg for geothermal waters from wells: 605 Mihai Bravu and 1021 Tamaseu.

From Figure 2 it is noted that water from well 1021 Tamaseu is on the equilibrium curve of Giggenbach, water is considered balanced. The temperature is 116 - 78˚C for balanced geothermal waters from well1021 Tamaseu.

Water from well 605 Mihai Bravu is located the equilibrium curve of Giggenbach, water is considered balanced, is balanced at a temperature of 98 - 67˚C. Partial equilibrium may be the consequence geothermal fluid reactions with the rocks they penetrate, or could be the result of mixing waters from different areas of food temperature.

When the points of ternary diagram Na-K-Mg are found in the corresponding region metastable equilibrium, is a good indication that the chemical composition of these waters can be successfully used for calculations geotermometre. Another classification, depending the majority anions present in geothermal water is made using a triangular diagram Cl-SO_4-HCO_3, Figure 4, [9].

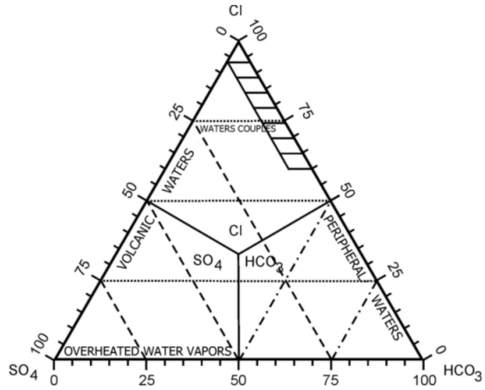

Figure 4: Ternary diagram Cl-SO4-HCO3 for geothermal waters.

Position of points inside the triangle is obtained by making the sum of concentrations three components, in mg/L, followed by calculating the percentage: % C1, % SO_4 and % HCO_3.

In this case is calculated:

- The sum of:

$$S = C_{Cl^-} + C_{SO_4^{2-}} + C_{HCO_3^-} \tag{12}$$

- Percentage composition Cl^- and HCO_3^-:

$$\% Cl = \frac{100C_{Cl^-}}{S} \tag{13}$$

$$\%_{HCO_3^-} = \frac{100C_{HCO_3^-}}{S} \tag{14}$$

- Percentage of sulfate is obtained as follows:

$$\% SO_4^{2-} = S - \left(\% Cl^- + \% HCO_3^{2-}\right) \tag{15}$$

- for drilling 1021 Tamaseu

$$S = C_{Cl^-} + C_{SO_4^{2-}} + C_{HCO_3^-} = 2092 \text{ [mg/l]}, \quad \%Cl = 43,74\ \% \quad \%HCO_3^- = 55,45\ \% \tag{16}$$

- For drilling 605 Mihai Bravu:

$$S = C_{Cl^-} + C_{SO_4^{2-}} + C_{HCO_3^-} = 1449 \text{ [mg/l]} \quad \%Cl = \frac{100C_{Cl}}{S} = 28,57\% \quad \%HCO_{3^-} = \frac{100C_{HCO_3^-}}{S} = 68,39\% \tag{17}$$

The data obtained are given in Table 3.

Table 3: Results for geothermal waters studied.

well	Cl^- [mg/l]	SO_4^{2-} [mg/l]	HCO_3^- [mg/l]	% Cl^-	% SO_4^{2-}	% HCO_3^-
605 Mihai Bravu	414	44	991	28,57	3,03	68,39
1021 Tamaseu	915	17	1160	43,74	0,81	55, 45

Were used the data obtained, to position the geothermal waters studied, within the ternary diagram Cl – SO4 – HCO3, Figure 5.

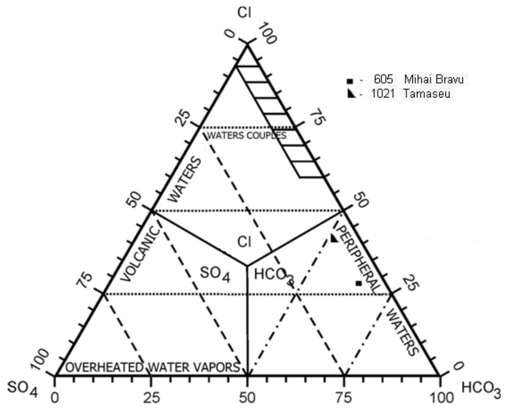

Figure 5: Ternary diagram Cl-SO4-HCO3 for waters from the two geothermal wells 1021 Tamaseu and 605 Mihai Bravu

Ternary diagram Cl-SO_4-HCO_3 for geothermal waters studied gives us the following information: for waters from wells 1021 Tamaseu and 605 Mihai Bravu, points are close the corner of HCO_3^- and are in field peripheral waters.

These waters are heavily bicarbonate, indicating that high concentration of HCO_3^-ions, the analysis found.The similarity between the two waters may be due and that from the same area, or could be due movement of groundwater.

2.2 Conclusions

For use the optimum conditions a geothermal water is necessary to know their chemical composition. Based on chemical analysis were characterized geothermal waters from two wells.

Using ternary diagrams, ternary diagram Na - K - Mg and ternary diagram Cl-SO_4-HCO_3 was determined that: water from well 1021 Tamaseu is located on the equilibrium curve Giggenbach, water is considered balanced. Water from well 605 Mihai Bravu is located the equilibrium curve of Giggenbach, water is considered balanced, is balanced at a temperature of 98 - 67˚C.

According to the ternary diagram Cl-SO4-HCO3 we established nature the geothermal waters from the two wells: 605 Mihai Bravu and 1021 Tamaseu. Waters studied are peripheral waters, heavily-bicarbonato, and the type sodo -bicarbonato-chloride.

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