Lakes, reservoirs and ponds, vol. **3**(1): 13-24, 2009

THE MINERALISATION DEGREE AND CHEMICAL COMPOSITION OF THE LAKES IN THE TRANSYLVANIAN PLAIN

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Abstract

The article was compiled from the processing of chemical analysis performed on samples taken during the campaign carried out in April 2004 by members of the group of hydrology from the Faculty of Geography, Cluj-Napoca, and the results published by a small number of specialists from various areas. After analyzing the factors that determine the chemical features of Transylvanian fresh water lakes it was the degree of mineralization that distinguished lakes without leakage from the lakes with drainage. Finally, based on analysis of ionic composition of lake water we determined the specific types of lakes in Transylvania Plain, which ranged from pure magnesian bicarbonate (Cătina) the prevalence of magnesium bicarbonate mixed in sulphated-magnesium bicarbonate and chloride mixed with predominance - sulfated mixed with sodium predominance.

Keywords: mineralization, chemical composition, hydrochimic type

1. General considerations

The main factors that determine the lakes chemical composition and the mineralization degree are soil and the underground characteristics of the basin.

The underground sources of alimentation influence the chemical concentration and the quantity of some ions. Therefore, the underground sources of alimentation are a very important factor that contributes to the high mineralization of the lake Ştiucii.

The morphologic and morphometric particularities of the lake basins and the afferent catch basins also have an important effect on the chemical concentration (fig. 1).

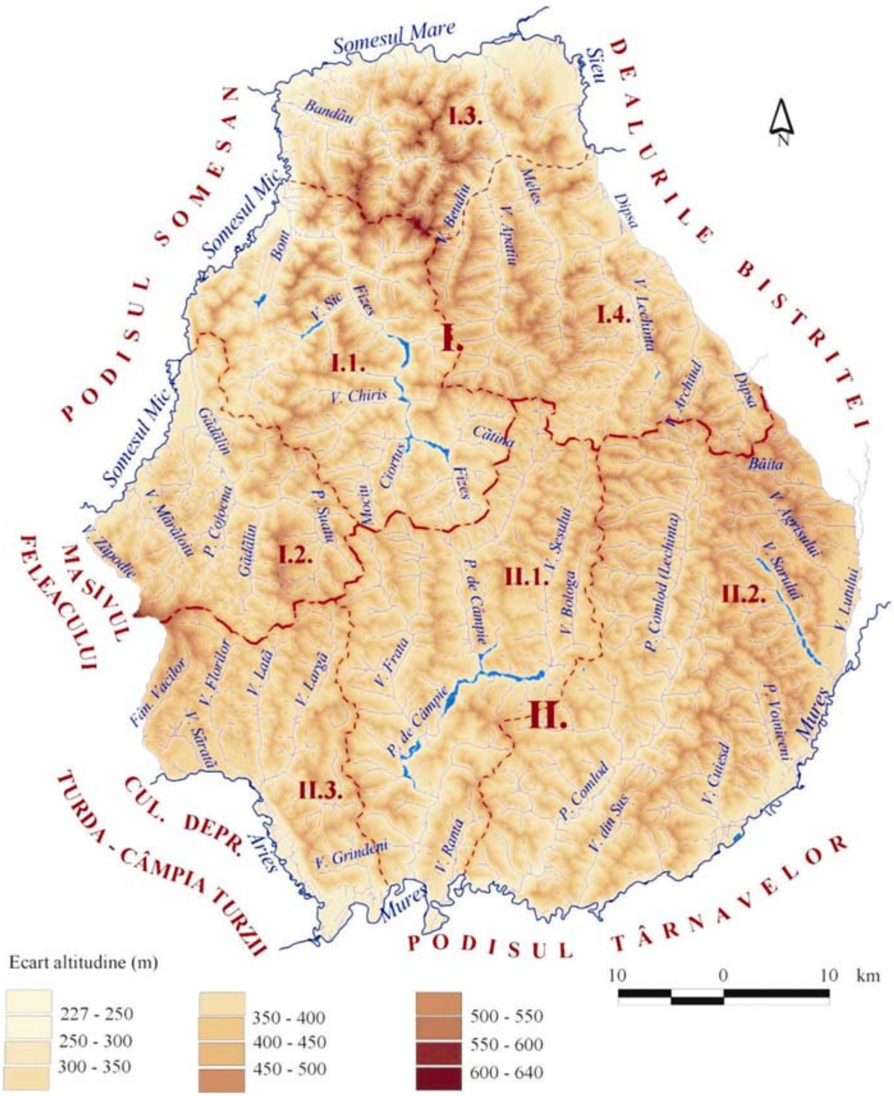


Fig. 1. The Transylvanian Plain and their subunits

I. *The Someşană Plain: I.1.The Fizeş Plain; I.2. The Sic Hills; I.3.Unguraş Hills; 1.4.Lechinţa Hills.*

II. *Mureşană Plain: II.1.Sărmaş Plain; II.2.Mădăraş Hills; II.3. Coasta Grindului*

Thus, in the case of extensive lakes we can determine an increase in the lakes' mineralization from upstream to downstream. The chemicals concentration and their variation depend on the water flow. Thereby the lakes defined by no discharge have a higher degree of mineralization (Ştiucii Lake) than the ones situated along the main rivers in which case the difference is assessed by the amount of chemical substances and the accumulated water volume contained in each catch basin afferent to every lacustrine unit.

Besides the factors we have already mentioned the degree of mineralization is influenced by a number of climate elements: the quantity of rainfalls on the surface of the lake basin and the quantity of water evaporated from the surface of the lake.
The index of aridity in the studied region varies yearly and multianual profile at around 1, which means that the same amount of salts will dissolve in different water volumes.

Consequently, the concentration of salts will be lower in spring than in mid-summer and autumn, when the volumes of water in the lakes are lower and defined by a higher concentration of salts.

2. Mineralization degree

Depending on the mentioned factors, the mineralization degree of lake water samples determined in the studied area have varied widely. Thus, mineralization in lakes without leakage (Ştiucii Lake) varied between 831, 7 mg / l (1963) and 977.4 mg / l (November 9, 1994).

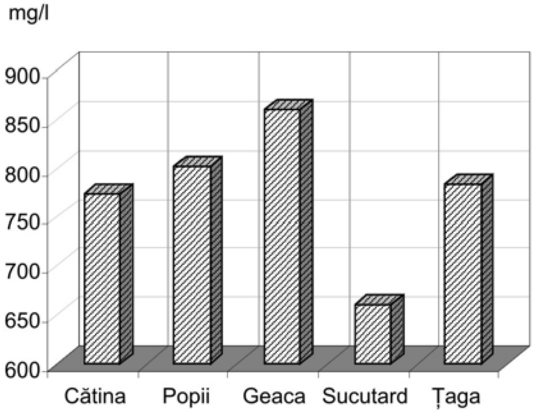


Figure. 2. Changes in mineral concentration in the water ponds along Fizeş (july 1997)

The degree of mineralization of the emersable lake water reached 660.1 mg / l at the lake Sucutard in July 1997 (L. Floca et al, 1997) and 1755.3 mg / l at Zau de Câmpie at March 17, 1955 (Gâştescu, 1963). The change in the degree of mineralization of ponds located along Fizeş course, determined by conducted on samples taken in July 1997, is leading us to an increase in the levels of minerals from lake Cătina to lake Geaca, where they reached maximum values. A severe reduction of mineralization was observed in the lake Sucutard, and then increasing values in the lacustrine complex Taga (fig. 2).

The mineral distribution in the lakes area is not uniform because of the influence of many local factors. Sometimes, the mineralization degree is higher at the shore due to the influence of the groundwater supply, the higher temperatures that affect the dissolution, and to the water agitation favoring the washing of the rock constituents.

Thus, samples taken from the Lake Ştiucii on the day of November 9, 1994 showed a mineralization of 977.4 mg / l on the right bank, 937.5 mg / l on the left bank and 873.7 mg / l in the middle.

Comparing the mineralization values determined from samples taken in April 2004 we discover that there is a somewhat different spatial distribution as the degree of mineralization is higher in the Cătina and Geaca lakes (fig. 3).

Perhaps mineralization values of lake water in Ţaga Mare I which were sampled in the campaign in April 2004 are not comparable with those published in 1997 (L. Floca), which mentions only the name of Ţaga, without specifying which of the two ponds were sampled for analysis.

The existing chemical analysis shows a fairly large variation in the degree of mineralization in the annual and multi profile.

The mineralization varies between reduced values in the case of the lake Cătina (147.6 mg / l) and higher in lakes Ştiucii (184 mg / l) and Geaca (171, 6 mg / l). Large variations in the degree of mineralization were determined in the lake complex of Taga.

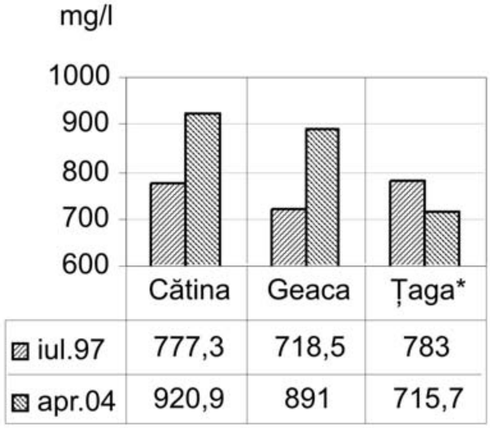


Figure. 3. Comparison between the degree of mineralization of water ponds on Fizeş

Thus, Ţaga Mare I mineralization recorded in April 2004 was 715.7 mg / l was almost double than 1322.9 gm / l recorded in 1963 (Gâştescu, Parichi, 1963).

The analysis of vertical distribution of the degree of mineralization of lake water does not show essential differences between the values recorded at the surface and bottom due to the reduced depth of most lakes.

More significant differences between the values determined at the two levels of minerals prevailed can be found in the ponds Geaca (79 mg / l) and Taga Mare (33 mg / l).

In most ponds water mineralization values are higher at lower and bottom levels (fig. 4).

Following the variation limits the mineralization values are, in the case of many Transylvanian lakes represented by high mineralization (500 - 1000 mg / l) and less often very high (> 1000 mg / l).

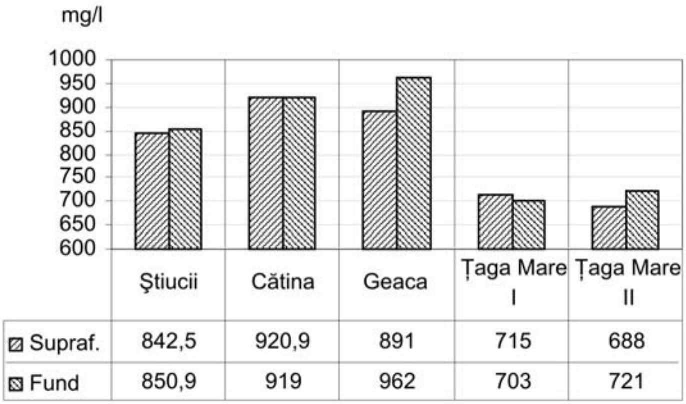


Figure 4. Water mineralization at upper and lower ponds sampling

3. Ionic composition

The content of major cations (Ca^{++}, Mg^{++}, Na^{+}) and anions (HCO_3^-, SO_4^-, Cl^-) in lake water and their diet depends on the particular physical conditions in specific geographic territories in which units are located lake.

Calcium (Ca^{++}) comes from the dissolution of sulphates and carbonates of complex Sarmatian sedimentary rocks. Calcium concentration in lake water varies not just by the nature of rocks and solutions, by mode of supply, but also by the intensity of the clorofiliene assimilation process of the aquatic plants. The amount of calcium dissolved in water lakes varied in large limits, falling from 43.3 mg / l in the Geaca Lake I and 284.81 mg / l in the Zau de Câmpie Lake.

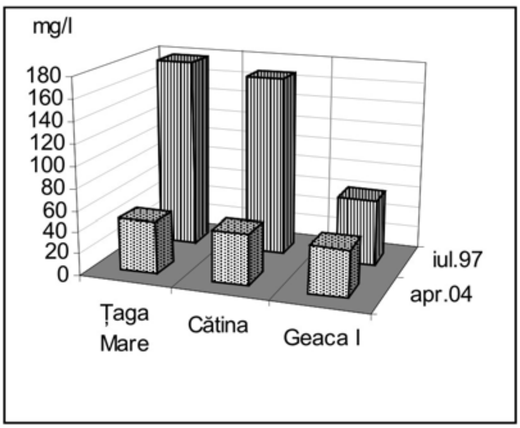


Figure 5. Changes in calcium content in water ponds in the Fizeş basin

In the period of maximum effluence during the spring and, in some cases, in flash floods in summer, lake water calcium content was higher. Thus, the Zau de Câmpie Lake at March 17, 1955 had a 284.81 mg / l of Ca^{++}, and in the Geaca Lake, in July 1953, there were 145.8 mg / l of Ca^{++}. In April 2, 2004, after a period of no liquid precipitation, the amount of calcium recorded in the ponds of Fizeş basin was less, falling from 43.3 mg / l (Geaca) and 64.1 mg / l (Ştiucii Lake).

Comparing the calcium content of water ponds in the two campaigns made clear that the levels were higher in July 1997 to April 2004, but remained the same laws of distribution. Thus, in both cases the highest values were recorded in Ţaga Mare and Cătina ponds, and lower the Geaca I Lake (fig. 5). Lower concentration recorded in April 2004 can be attributed to calcium assimilation by aquatic organisms.

Water from lakes in Transylvania Plain generally contains less remiss calcium than rivers in this region. This is mainly explained by biological and chemical processes in lakes that are greater than in gill waters.

Following the variation of calcium content on vertical for the water in Fizeş basin lakes determined by samples taken in April 2004, it is noted that in most cases amounts recorded at the bottom were higher than the surface, sometimes even almost double (to Ţaga Mare 80.2 mg / l to 44.9 mg / l).

Table 1. The chemical composition and the degree of mineralization of the lakes from Fizeş basin (April 2, 2004)

Lakes / Ions mg/l me.	Ştiucii		Cătina		Geaca		Ţaga Mare I		Ţaga Mare II	
	Supr.	Fund	Supr.	Fund	Supr.	Fund	Supr.	Fund	Supr.	Fund
Cl^-	170,0 **4,794**	170,0 **4,794**	50,0 **1,410**	52,0 **1,466**	72,0 **2,030**	68,0 **1,917**	90,0 **2,538**	92,0 **2,594**	78,0 **2,199**	88,0 **2,481**
SO_4^{--}	211,2 **4,398**	220,6 **4,593**	244,4 **5,087**	241,8 **5,034**	244,4 **5,088**	244,1 **5,082**	233,6 **4,863**	228,1 **4,749**	236. 6 **4,926**	236,1 **4,916**
HCO_3^-	206,9 **3,390**	210,0 **3,440**	404,8 **6,631**	395,3 **6,475**	355,6 **5,825**	412,1 **6,750**	202,0 **3,308**	178,0 **2,916**	187,2 **3,066**	213,6 **3,499**
Na^++K^+	141,8 **6,070**	141,4 **6,056**	86,7 **3,653**	85,9 **3,627**	87,1 **3,679**	87,5 **3,695**	92,0 **3,886**	91,6 **3,873**	85,3 **3,594**	90,0 **3,799**
Ca^+	64,1 **3,200**	59,3 **2,959**	46,5 **2,320**	54,5 **2,719**	43,3 **2,160**	70,5 **3,517**	44,9 **2,240**	80,2 **4,000**	51,3 **2,559**	36,9 **2,815**
Mg^{++}	48,7 **4,005**	49,6 **4,081**	88,5 **7,283**	89,5 **7,364**	89,5 **7,364**	79,8 **6,563**	53,2 **4,377**	33,1 **2,721**	49,6 **4,081**	56,4 **4,642**
Minera-lization	842,8 **25,85**	850,9 **25,92**	920,9 **26,38**	919,0 **26,68**	891,9 **26,14**	962,0 **27,54**	715,7 **21,21**	703,0 **21,85**	688,0 **20,42**	721,0 **22,15**

To this rule have strayed Ţaga Mare II and Ştiucii lakes where bottom values recorded were lower by 4.3 mg / l, respectively 14.4 mg / l (Table 1).

Magnesium (Mg^{++}) as calcium is inorganic and is found in the form of bicarbonate, sulfate or carbonate. Magnesium content of water in ponds varies depending on their water supply and the intensity of clorofilian assimilation processes.

In tests conducted during the campaign in April 2004 results that the water of most lakes in the Fizeş basin magnesium content was higher than that of calcium (Table 1). The exceptions were Ţaga Mare II and Ştiucii lakes where values were quite close.

Analysis undertaken in November 1958 at Ştiucii Lake reveal the same situation, meaning that values of magnesium content are lower than those of calcium (Tables 1 and 2).

Table 2. The chemical composition and the degree of mineralization of the lakes from Transylvania Plain

Lakes / Ions mg/l me.	Zau de Câmpie	Ştiucii		Cătina		Popii	Geaca		Ţaga	
	17. III. 1955	**29. XI 1958**	**1963**	**1963**	**Iulie 1997**	**Iulie 1997**	**Iulie 1953**	**Iulie 1997**	**1963**	**Iulie 1997**
Cl^-	106,79	100,0	124,1	42,5	70,0	70,0	91,4	95,0	42,5	100,0
	3,0	**2,8**	**3,500**	**1,199**	**1,974**	**1,974**	**2,5**	**2,679**	**1,199**	**2,820**
SO_4^{--}	120,0	260,6	129,9	405,4	128,0	132	130,0	114,0	341,8	108,0
	2,5	**5,42**	**2,705**	**8,440**	**2,665**	**2,748**	**2,7**	**2,373**	**7,116**	**2,249**
HCO_3^-	1194,1	381,2	359,9	457,6	323,3	359,9	290,9	378,2	597,9	335,5
	19,6	**6,2**	**5,895**	**7,495**	**5,296**	**5,895**	**4,7**	**6,195**	**9,794**	**5,495**
$Na^+ + K^+$	70,15	128,6	83,6	139,1	166,7	161,3	60,32	156,5	176,6	150,3
	3,5	**5,5**	**3,634**	**6,049**	**6,768**	**6,527**	**2,6**	**6,369**	**5,720**	**6,146**
Ca^{++}	284,81	94,2	79,3	100,2	89,25	77. 83	145,8	117,1	94,6	89,25
	14,1	**4,7**	**3,957**	**5,00**	**4,454**	**3,882**	**7,3**	**5,843**	**4,721**	**4,454**
Mg^{++}	-	51,07	54,9	74,2	-	-	-	-	69,5	0
	-	**4,2**	**4,517**	**6,105**	**-**	**-**	**-**	**-**	**5,718**	**0,000**
Minera-lization	1755,3	1015,7	831,7	1219	777,3	801,0	718,5	860,8	1322,9	783,1
	42,7	**28,82**	**24,21**	**34,28**	**21,16**	**21,03**	**19,8**	**23,46**	**34,26**	**21,16**

In tests conducted in 1963 (Gâştescu, Parichi) in three ponds in the Fizeş basin (Cătina, Ţaga and Ştiucii) it was showed that magnesium levels were lower than calcium (fig. 6).

Vertical variation in magnesium content is reduced in Ştiucii Lake and Cătina Lake and significant in other lacustrine units. Thus in Geaca and Ţaga Mare ponds has been a decrease in values with depth, while Ţaga Mare pond revealed an increase in magnesium content (fig. 7).

Sodium (Na^+), which is slightly soluble, has a share in water lakes in Transylvania Plain through the spread of clays and soils with high sodium content. This item has a considerable share in Ştiucii Lake, with more than 40% of the cations (April 2, 2004). In the ponds located along the Fizeş course, the share of sodium amount cations increased from the lake Cătina (27.6%) to the lake Ţaga Mare I (35.2%).

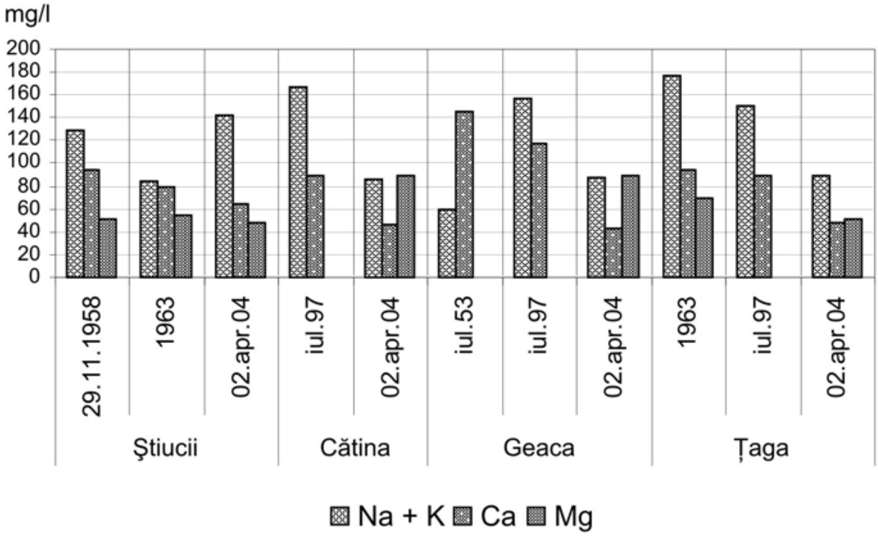


Figure 6. Changes in cations concentrations in water lakes in the Fizeş basin

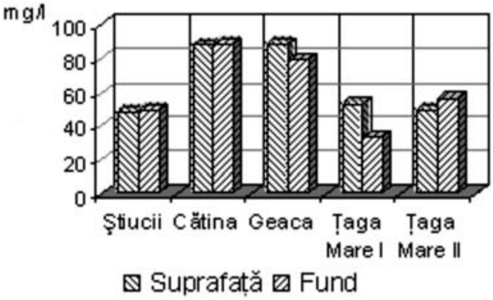


Figure 7. Vertical variation in magnesium content in water lakes in the Fizeş basin

Hydrogencarbonate or bicarbonate ($HCO3^-$) usually accompanies calcium, magnesium and sodium ions, and is the predominant anion in ponds in the upper Fizeş, with more than 50% of the m.e. anions (45% in the lake Jacket). A lower concentration of bicarbonate was discovered in ponds in the middle of Fizeş, where they held over 30% of the anions (April 2, 2004). Analysis of July 1997 highlighted the legitimate same spatial distribution, but the bicarbonate content was slightly higher, exceeding 50% of the anions in Cătina, Popii and Geaca ponds.

The highest values were recorded in March 17, 1955, when the content of bicarbonate in Zau de Câmpie Lake represented 78.1% of the anions.

There were found two maximum regarding variations in the amount of carbohydrate: one in spring caused by intensive washing of slopes by drip and enhance groundwater supply, the second in late autumn and winter, a result of groundwater supply and specific biological and chemical processes of such period.

Sulfate ($SO4^-$) has the main source the interbedded gyps distributed in the complex of the Sarmatian rocks or the one collected in the form of salt crystals in the soil.

Comparing the values of the sulfur content of lake water determined from chemical analysis in April 2004 with other analysis results quite significant variations in the levels of this chemical element. For example in Ştiucii Lake sulfur content was between 22.3% (1963) and 37.6% (November 29, 1958) of the anion amount and if Ţaga Mare between 21.2% (July 1997) and 48.3 % (April 2004).

Climatic conditions and water supply sources play an important role in the change of the amount of sulphates dissolve in water lakes. Changes in the amount of sulphates dissolve in water lakes in the Fizeş basin can be seen in fig. 8.

Chlorine (Cl^-) is associated mainly with sodium and can be of inorganic and organic origin. The inorganic origin is based on the dissolution of salts contained in the Sarmatian deposits and those from salt efflorescence. Chloride ions come also from industrial and household waste and are of organic origin.

Transylvanian Plain lakes have generally low chlorine content, which ranged from 6.6% me in Ţaga Mare (1963) and 38.1% in Ştiucii Lake (April 2004). High values of chloride in Ştiucii Lake is due to rich underground resources, which bring large amounts of water loaded with sodium chloride.

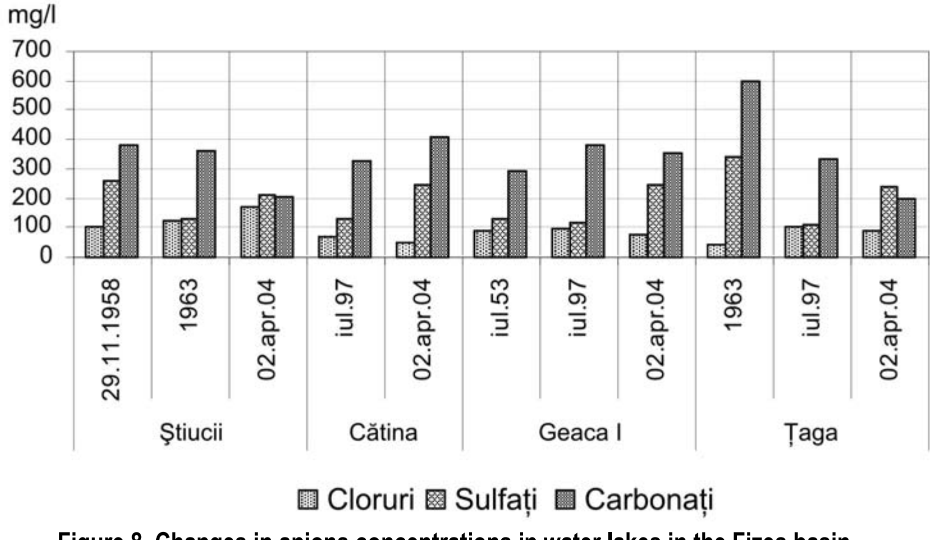
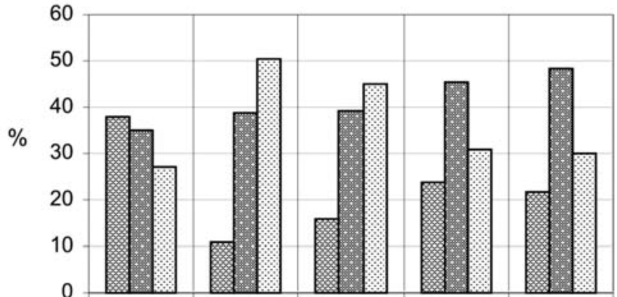


Figure 8. Changes in anions concentrations in water lakes in the Fizeş basin

4. Hydrochemistry classification of lakes

Depending on the concentration of salts in most cases units of Transylvanian Plain lakes were included under freshwater lakes, with a mineralization below 1 g / l. In some particular situations dictated by specific weather conditions (intense evaporative rainfall) were recorded salts concentrations that have exceeded 1 g / l, including some lakes in the brackish kind (Zau de Câmpie in March 17, 1955), Ştiucii (November 29, 1958) and Ţaga Mare (1963). Such metamorphoses are specific to lakes in hilly lands.

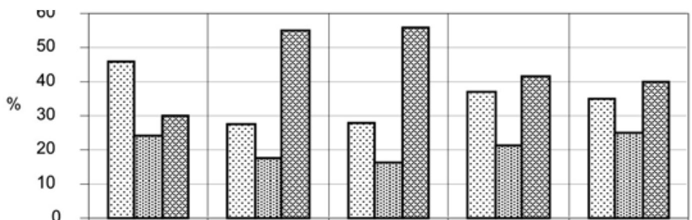
Data analysis results of the campaign carried out in April 2004 revealed that only in Cătina Pond bicarbonate anion was predominantly (Fig. 8). Most ponds were included in the mixed class: Sulphated-bicarbonate (Geaca) or Sulfated-bicarbonate (Ţaga Mare I and Ţaga Mare II). A situation occurred in Ştiucii Lake, which was included throughout the mixed class, but in the Sulphated-chloride group.



	Ştiucii	Cătina	Geaca I	Ţaga I	Ţaga II
Cl-	38,1	10,7	15,7	23,7	21,6
SO4--	34,9	38,7	39,3	45,4	48,3
HCO3-	26,9	50,5	45	30,9	30,1

Figure 9. Change in percentage values of anion concen-tration in water lakes in the Fizeş basin (April 2, 2004)

Taken cations by nature, Geaca and Cătina ponds were included in the class of magnesium and the remainder of the lakes in the mixed class with prevalence of magnesium (Ţaga I and Ţaga II) or sodium (Ştiucii Lake) (fig. 10).



	Ştiucii	Cătina	Geaca I	Ţaga I	Ţaga II
Na+ + K+	45,7	27,6	28	37	35,2
Ca++	24,1	17,5	16,3	21,3	25
Mg++	30,2	54,9	55,7	41,7	39,8

Figure 10. Change in percentage values of cation concentration in water lakes in the Fizeş basin (April 2, 2004)

The mixt character, that most lakes have, is explained by supply predominant consideration of the lakes by streams of water which has a mixed ionic structure, and disseminating high carbonate rocks and the rich content of sodium and magnesium sulphates, dissolved and transported by water surface and groundwater that supplies lakes.

Hydrochemistry common types is subject to renewal mixed volume of water in the lakes studied. While relatively high frequency of periods poor soil salinisation and training foster pluviometric eflorescenţelor which have a high percentage of sulphates, especially sodium, which drip water washed salts enrich the content of streams and lakes.

Research showed that seasonal variations of the mineralization and concentration of ions causes a change in the water quality and therefore the class or group in which they fall (fig. 11). Thus, in April 2004 we have identified several types of hydrochemistry, which ranged from pure magnesian bicarbonate (Catina) to Sulfated-magnesium bicarbonate mixed dominance (Ţaga Mare 1 and Taga Mare 2) and chloride-Sulfated mixed with sodium predominance (Lake Ştiucii).

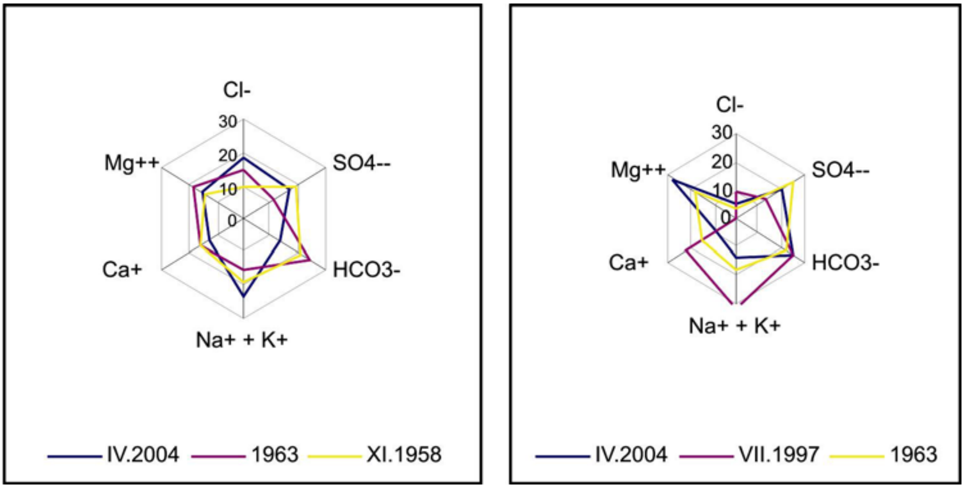


Figure 11. Changes in ion concentrations of lakes Ştiucii (A) and Cătina (B)

Gâştescu (1963) included the lakes in the studied region in several types of hydrochemistry, which ranged from pure calcium bicarbonate (the Zau de Campie 80% CA^{++} , 79% HCO_3^-) to sulfated magnesian mix (Catina 60% SO_4^{--} , 41%Mg^{++}).

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