HYDROCHEMICAL AND SPATIAL GROUPING OF GROUNDWATER OF SANTA ROSA VALLEY, CATAMARCA, ARGENTINA

Battistella, Romina (1) ; Ortega, Irene (1) & Morvillo, Mónica (2)

(1)Instituto Nacional del Agua/ Centro Regional de Agua Subterránea ; (2) Facultad de Ciencias Exactas Físicas y Naturales/ Universidad Nacional de San Juan

INTRODUCTION:

This work focuses on the chemical classification and characterization of the Santa Rosa Groundwater Basin located in the Province of Catamarca, Argentina (Fig.1). It is one of the most important aquifers of the region, currently pumped for irrigation, human consumption and livestock. The exploration of irrigation water suitable areas is based on the advancement of the agricultural frontier, and the significant duration of the low precipitation periods. Hence the need for studies aimed primarily to water resources quality, where the acquired scientific knowledge is conducive to improving the quality of life of the population and the conditions of the local environment in the basin.

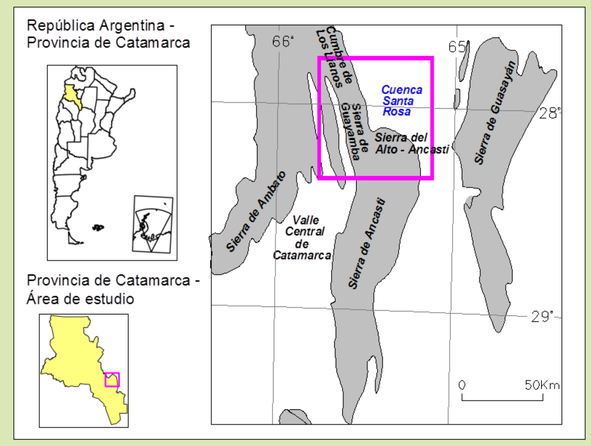
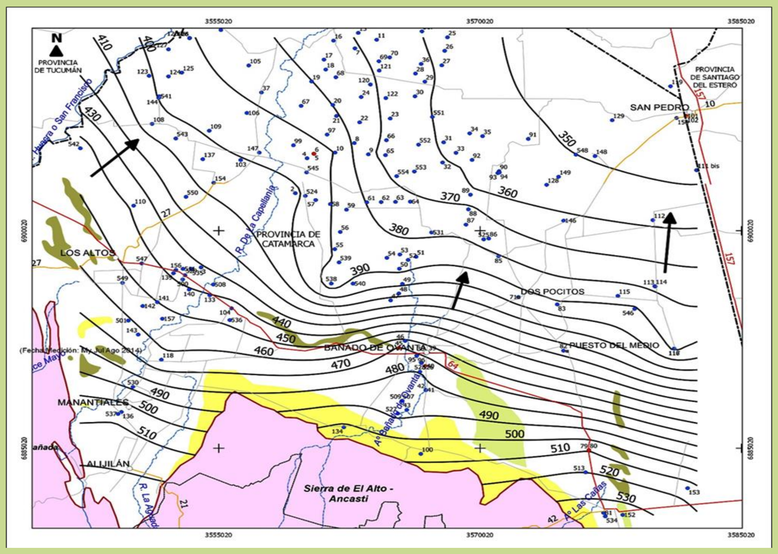


Fig.1: Study area.

METHODOLOGY:

- Groundwater surveys conducted during 2014.
- 72 wells, to a maximum depth of 250 m.
- Parameters: pH, Na +, Ca++, Mg ++,K +, HCO_3-, Cl-, SO_4 = ,SiO_2, B, NO3-, F-, As.
- Data analysis: Free Software R, version 3.3.1 R(2016).
- Statistical methods: Principal Components Analysis (PCA)- Cluster Analysis (CA).
- Hydrochemical characterization: based on Kurlov's Criterion.

HYDROGEOLOGY:



Legend	
	Cuaternary Rocks
	Tertiary Rocks
	Lower Paleozoic to Precambrian (Crystaline Basement) Rocks

Fig.2: Study area hidrogeology

RESULTS:

- PCA (Fig.3): The number of components taken into account are those that present variances greater than their standardized variables, i.e., greater than 1.
- PC 1: Na^{+}, $SO_4^{=}$, Cl^{-}, Ca^{++}, Mg^{++} and B; except B the variables are closely related to electric conductivity.
- PC2: With less entropy: As, HCO_3^{-}, F^{-}, pH.
- PC3: NO_3^{-} and SiO_2 on the less variable components.
- CP: Ward`s method was applied to the hierarchical cluster analysis. Resulting grouping chart shown in Figure 4, with wells classified into two group brackets: G1 (black) and G2 (red).

```
Standard deviations:
      PC1    PC2    PC3
   2.1581 1.6692 1.1865

Rotation:
         PC1    PC2    PC3
pH     0.119 -0.423  0.044
Ca..   0.363 -0.197 -0.087
Mg..   0.365 -0.085 -0.126
Na.    0.435  0.057  0.064
K.     0.187  0.128 -0.232
HCO3.  0.111  0.434 -0.119
SO4.   0.428 -0.013  0.065
Cl.    0.430 -0.020  0.052
SIO2  -0.050  0.317  0.541
F.     0.099  0.427 -0.267
B      0.321  0.104  0.368
NO3.   0.026  0.183 -0.605
As...  0.011  0.490  0.175
```

Fig.3: Variable coefficients used.

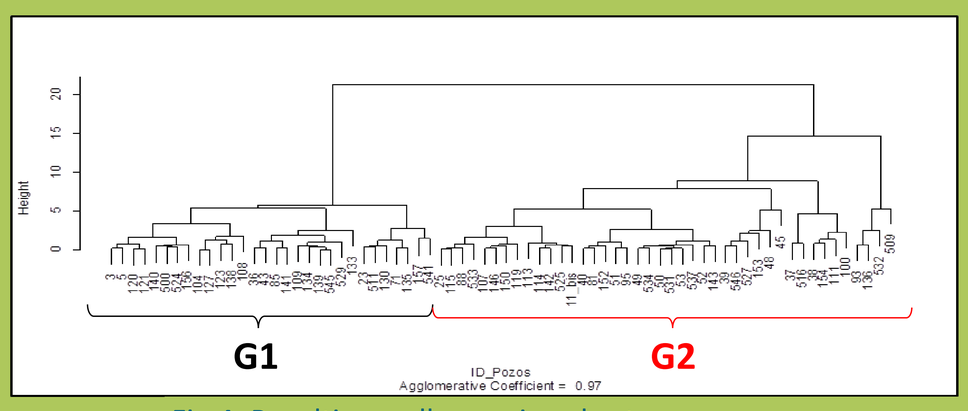


Fig.4: Resulting well grouping chart.

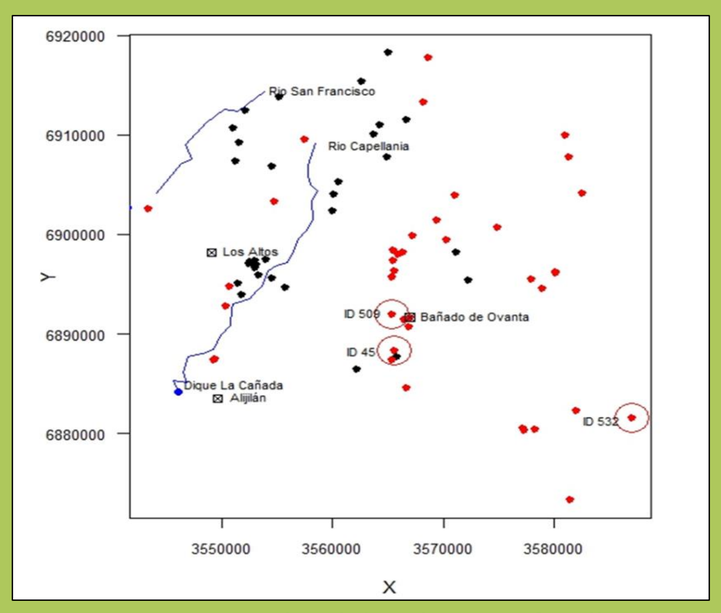


Fig.5: Geographical distribution of wells.

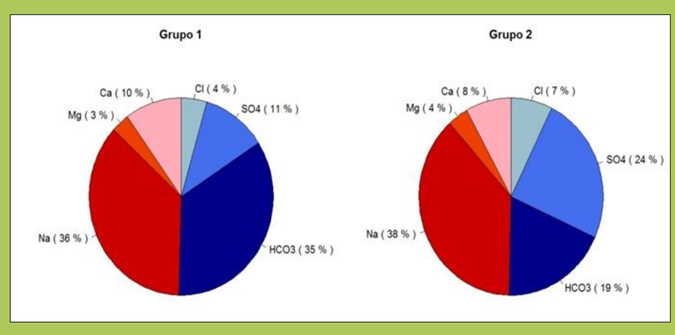


Fig.6: Water composition by group .

- Spatial groups geographical clustering (Fig.5) show: G1 to the northwest of the study region and G2 directly to the center and southeast.
- Using Kurlov's criterion, (Fig.6) the resulting water type composition by groups is: G1 sodium bicarbonate rich water type, and G2 sulfated sodium bicarbonate rich water type.

CONCLUSIONS:

Multivariate statistical analysis, in particular PCA, being an essentially descriptive method, together with cluster analysis, allows to adequately conduct spatial grouping of wells drilled into the Santa Rosa Basin by correlating the physical-chemical variables studied. The resulting analysis valuably increases the understanding of a complex hydrogeological system to improve its management.