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Geochemical and microclimatic characterization of water resources in the Copparo area (Ferrara)

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The Ferrara province (Fig.1) is located in the Po valley, a low plain surrounded by Alps and Apennine. This research was focused on Copparo area, which is characterized by closeness from the sea and by its continental climate . In this work we have used the isotopic element composition (δ^2H , $\delta^{18}O$) of the meteoric waters picked up in six choice stations (FIg.3), to verify the compositional variability on an extensive province area . The stations chosen for this study include several province sectors, therefore allowing to determine the isotopic range which characterizes the local meteoric waters.

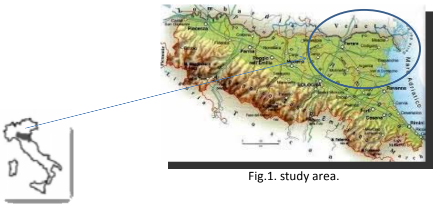

Fig.1. study area.

Fig.2 Six sities of microclimatic study

Fig.3 six sites of geochemical study's sampling on the meteoric waters

Microclimatic characterization

In the climatic study have been selected six pluviometric stations(Fig.2), to evaluate a possible regionalization of the pluviometric climate and verify any climatic differentiations in the zones placed immediately to North and South of Po river, data concerning the stations of Copparo, Codigoro and Guagnino for the Emilia Romagna area and from Rovigo, Adria and Chioggia for the Veneto Region. To the meteorological study is followed a geochemical study of the meteoric waters in a wide area (Fig.3). For the evaluation of the climatology of the undergoing area the study has been initially analysed the relative historical series of the precipitations(Fig.4). During the study of the historical series, have emerged a few more or less lasting survey gaps; they have been filled turning to statistical elementary methodologies (Arlery, 1973).

STATION	J	F	M	A	M	J	J	A	S	O	N	D	TOT
ADRIA	38	35	42	57	56	67	45	56	58	70	54	60	638
ROVIGO	48	41	53	66	62	66	66	60	47	61	74	54	698
CHIOGGIA	48	45	48	58	57	68	60	68	70	73	79	61	737
COPPARO	38	35	47	55	57	54	44	55	51	59	63	49	608
CODIGORO	42	34	44	52	57	51	49	62	56	60	64	48	620
GUAGNINO	43	39	47	51	52	51	43	67	61	66	70	56	647

Fig.4 Monthly average precipitations of the six stations

Even with slight differences between them, the rainfall patterns are representative of a clear continentally pluviometric area, the regime can be defined: padano external (Fazzini and Giuffrida, 2005) characterized by rainfall scarce in the complex but very well distributed during the year, in which the wettest season is Autumn and the drier the Winter. The medium rainfall recorded is quite uniform throughout and considered below media annual Italian by about 35% (640mm vs 990mm / year) (Fig.5).

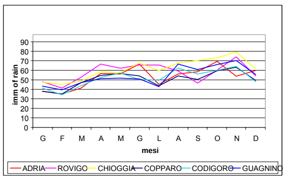

Fig.5 trend of the monthly changes in the pluviometric regime

"The index of Aridità" De Martonne is one of several climatic indices thermo-precipitation that can be used to define the climate of an area. It was decided to calculate the values for the station Codigoro highly representative of the normal climate. From the scatter plot (Fig.6), the calculated ratio between precipitation and temperature, shows a trend between 25 and 30. Referring to the table of degrees of dryness and humidity according to De Martonne, the climate of the area can be defined as sub-humid. There are no significant variations in the years, even in recent years, characterized by a marked increase in media annual temperatures, there is a drop in the index values that might suggest the beginnings of a process of drying up climatic

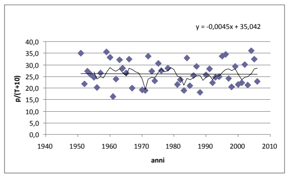

Fig.6 De Martonne index

Besides the calculation of the seasonal and annual trends, to understand any recent climate changes have been analysed data concerning the short and intense precipitations to 1h and 3h (Fig.7) the signal does not show significant variations; a clear sign that the atmospheric dynamics that determines storm conditions is absolutely not changed.. The evaluations of this parameter competes for a more precise comprehension of the modes of recharge of the aquiferous, ones especially in the summer season ,when events of this type are more frequent.

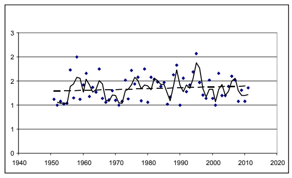

Fig.7 Relationship precipitation 3h / 1h. in the station of Codigoro.

Geochemical characterization.

The isotopes are subject to change in nature, they are subject to a process of isotopic fractionation, in which the proportions of the relative abundances of the various stable isotopes of the same element are not fixed, but change as a result of physical processes, biological and chemicals. From the chemical point of view this means that the lighter isotopes break chemical bonds more easily than the heavy isotopes and react faster than other, they focusing in the products, while the heavier isotopes are concentrated in the reagents. The meteoric waters have an isotopic composition different from ocean and always marked by negative delta values. The distribution of isotopic values along the Italian peninsula is a function of altitude, increasing latitude rainwaterδ18O values decrease. Another significant relationship is between local temperatures and significance of isotopic rainfall.

The concentrations of D and 18O in precipitation are closely connected by the relation:

$\delta D = 8.13 + 10.8$ ‰ $\delta 18O$ (GMWL, Global Meteoric Water Line)

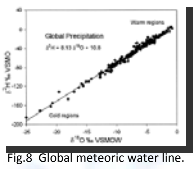

Fig.8 Global meteoric water line.

Studies have permission today to build straight meteoric referable to distinct geographical regions. For example, for northern Italy there is a line defined by Longinelli and Selmo (2003), whose coefficients will be slightly different.(Fig.9)

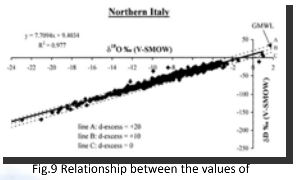

Fig.9 Relationship between the values of δ18O and δD calculated for North Italy. (Longinelli A., Selmo E.2003)

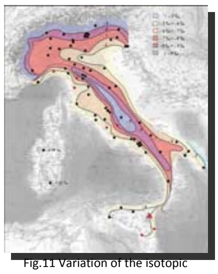

Fig.11 Variation of the isotopic composition of rainwater. (Longinelli and Selmo, 2003)

Station	Data			
Sant'Antonino	15/10/2012	29/10/2012	5/11/2012	12/11/2012
Ceccata	15/10/2012	22/10/2012	29/10/2012	12/11/2012
Baura	15/10/2012	22/10/2012	29/10/2012	12/11/2012
Ruffa	15/10/2012	22/10/2012	29/10/2012	5/11/2012 12/11/2012
Ferrara	15/10/2012	29/10/2012	5/11/2012	
Copparo		29/10/2012	5/11/2012	

Fig.10 Synthesis of the program of water sampling and correlated to the meteoric events .

6 stations (Fig.10) have been chosen to try to identify the average isotopic water composition in a reduced area, to be able to comparison between them and to verify the existence of possible variations on a local scale. In literature, the reference values for meteoric waters are estrapolated from the work of Longinello and Selmo(Fig.11) :

$\delta^{18}O$ (V-SMOW) = – 6,75

δ D (V-SMOW)= -42,4

Data obtained from the isotopic analyses (Fig.12) have allowed an isotope distribution quantification in the meteoric zone waters .

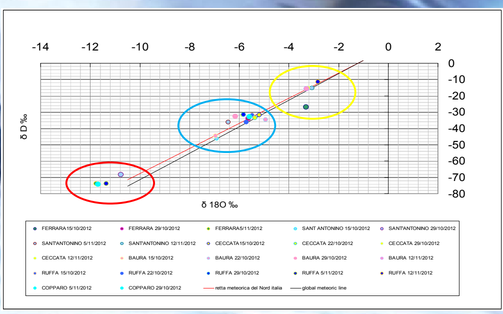

Fig.12 Designer of the events analysed referred to the monitoring stations.

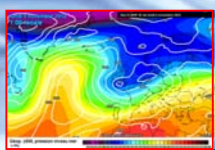

Fig.13

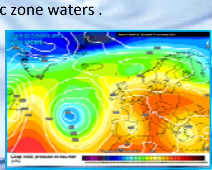

Fig.14

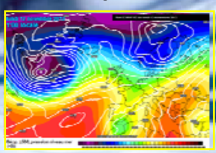

Fig.15

In the images perturbations concerning the three groups identified in the designer (Fig.12) are represented.
Picture 13 shows the origin of the disturbance which took place on November 5, 2012, from the image it is evident that the water masses have suffered isotopic fractionation that downloaded on the Tyrrhenian side of the light isotopes, arriving at the sampling zone very enriched in heavy isotopes.
Picture 14 is a picture related to the perturbation of the October 22, 2012, chosen as representative of the central group, this shows that the event source is local, the water masses are generated by evaporation and condensation of water vapor , producing an isotopic fingerprint typical of the area.
The picture 15 shows the origin of the disturbance of November 12, 2012, this was an event of short duration and high intensity, this has resulted in isotopic concentrations lower than other samples.

On the interest area rains change in a composizional interval of -6,95 and -5,19 for the $\delta^{18}O$, and a mean value between -46,21 e -31,82 for the δ D. , the short and intense events are marked by values which come from the seasonal average.
The application of the isotopic techniques outlined here, is a useful contribution for a bigger knowledge of the zone represents. The study provides a specific characterization of the relationship between precipitation and isotopic compositions, providing a stimulus for research to improve understanding between the isotopic characteristics and events that generated them.

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