



1 Hydrochemistry of groundwater samples from phreatic and multilayer aquifers of the Friuli Venezia Giulia plain, north-east Italy

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Determining the processes that control groundwater chemistry is essential for effective water resource management and protection. The Friuli Venezia Giulia Plain host a well developed phreatic aquifer and a series (up to 10) of artesian aquifers that have thicker clay and silt layers. The need for protecting of these important water sources has led the local government (ARPA FVG, Regional Environmental Protection Unit) to create a net of water chemistry monitoring. For this reason, water temperature, electrical conductivity, pH, anion (HCO_3 , NO_3 , Cl , SO_4) and cation (K, Na, Mg, Ca) concentrations as well as organic material is monthly monitored. The mean value of each concentration has been elaborated for this study with data from 2000 to 2006.

Groundwater samples collected from the phreatic and from the shallower artesian (up to 120 m) aquifers have mean concentrations that ranges from 25 mg/l to 41 mg/l for SO_4 , from 228 mg/l to 248 mg/l for HCO_3 , from 19 mg/l to 13 mg/l for NO_3 , and 5 mg/l for Cl. The deeper artesian aquifers have mean concentrations that decrease with increasing depth for Cl (from 4.5 to 1.3 mg/l for water collected at 200 m of depth), for NO_3 (from 12 mg/l to 1.3 mg/l for water collected at 200 m of depth) while no significant changes have been detected for SO_4 and HCO_3 . The cation concentration of

the water samples collected from the phreatic and from the shallower artesian aquifers indicates mean concentrations from 71 mg/l to 63 mg/l for Ca, from 19 mg/l to 23 mg/l for Mg, from 3.4 mg/l to 3.8 mg/l for Na and around 0.9 mg/l for K. The deeper artesian aquifers show decreasing cation concentrations with increasing depth for Ca (from 57 mg/l to 45 mg/l), whereas there are increasing mean values for Na (from 4.3 mg/l to 14 mg/l) for K (from 0.9 mg/l to 1.5 mg/l) and no significant changes for Mg. The electric conductivity measured on phreatic and from the shallower artesian aquifers have mean values recorded at 20°C of around 440 $\mu\text{S}/\text{cm}$ decreasing to 380 $\mu\text{S}/\text{cm}$ for deeper (200 m) confined artesian aquifers.

The elaboration of the maps of significant ion concentration has been done using ArcGis 9.1 and the Kriging statistical methods have been used for data interpolations. The isopleths of ion concentrations in the Region has indicated the presence of 7 different chemical provinces in the Friuli Venezia Giulia Plain. One province has a dominance of SO_4 waters due to the presence of the Tagliamento River which cross gypsum formations (Bellerophon Fm and formations dating back to Carnico). Two provinces are dominated by HCO_3 waters mainly due to local rivers that cross well developed carbonaceous massifs, while one province is Ca dominated.

The chemical studies of the deeper artesian waters have shown that they have different chemical signature to the shallower waters. This, together with the marked changes in isotopical signal of these deeper waters indicates that the hydrogeological settings are quite different and that the deepest and therefore oldest waters are separated to the recent ones with little water exchange.