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Geochemical groundwaters quality of a volcanic area: Mount Vulture (southern Italy)

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The main purpose of this work is to define the rock-water interaction processes that play an important rule on the drinking waters quality. The Mount Vulture area represent one of more important hydro-structures of Basilicata Region (southern Italy), having an area of about 230 Km^2. Mount Vulture is a isolated composite volcano located in the most external part of the Apennine orogene (southern Italy) almost at the edge of the Apulian foreland. The volcanic activity started at $\sim$ 0.75 Ma and continued, interrupted by long-lasting quiescence periods, up to $\sim$ 0.14 Ma. The studied area is characterized by the presence of many springs and wells and by the presence of two volcanic *maar* lakes, called Laghi di Monticchio, designed as Site of Community Importance (S.C.I. - Council Directive 92/43/EEC). The mineral waters are pumping for a drinkable purpose by many Companies and several groundwaters are employed by Public Local Authorities for drinking and irrigation use. In order that the survey and management of the quality and quantity waters are important.

Geologically, the study area can be divided into a volcanic domain, a fluvio-lacustrin domain and the domain of pre-volcanic sediments of the bedrock. The volcanic products are composed mainly of pyroclastic deposits and lava flow of tephritic phonolite, phono-foidite, foidite, melilite and carbonatite (Beccaluva *et al*., 2002). The second domain represents the fluvio-lacustrin deposits pre-sin and post volcanic made up by coarse-grained conglomerates with intercalations of sand, silt and clay and recent alluvial deposits (Principe and Giannandrea 2002). For the more there are the Oligocene-Miocene pre-volcanic flysch sediments of the bedrock (Boenzi *et al.*, 1987).

The groundwaters of a wide sector of the volcano are characterized by high salinity and high P_{CO2}values coming up from a deep magmatic source. The CO_2 deep origin was confirmed by the carbon isotopic ratio (Paternoster, 2005). The tectonic and structural discontinuities, that cross also the basement, act as deep preferential groundwater flow and promote the mineralization processes of these precious waters. From recent studies about the isotopic composition of the rain water and groundwater (Paternoster *et al.*, 2008) found out that the most of investigated water samples are meteoric in origin and that the mean altitude of the groundwater recharge area is about 1000 m.a.s.l.

In this study 48 water samples, taken at altitudes between 350 and 1200 meters, among springs and wells have been analyzed. The chemical-physical parameters (pH, electrical conductivity, temperature and Eh) were detected in situ. The major elements have been analyzed in laboratory by ion chromatograph. Silica and bicarbonates have been determined by titration. Other minor and a few trace elements (V, Al, As, B, Br, Cu, Fe, Mn, Ni, Pb, Rb, Se, Sn, Sr and Zn) have been determined by ICP-OES.

The temperatures of the sampled waters range from cold to hypothermal (10÷19,8 ˚C) while their pH ranges from mild acidic to slightly basic (5,4 ÷7,5). The increase in water acidity is principally due to the dissolution of CO_2 in the waters. The electric conductivity varies between 0,19 mS/cm and 17,97 mS/cm. A few spring are brackish waters type. Furthermore, a wide range of redox conditions have been measured. From chemical data the groundwaters have been classified in two hydrochemical facies: alkaline-earth-bicarbonate and alkaline-bicarbonate. The groundwaters of high and mean altitude, which circulate in the volcanic deposits, have a bicarbonate-calcium facies, characterized by low salinity, neutral pH or slightly acid pH. The springs and wells located at the bottom of the aquifer, and in some cases in contact with the domain of pre-volcanic sediments of the bedrock, are characterized by acid pH, temperature lightly higher and high salinity, belonging to bicarbonate-sodium-calcium facies or, in the extreme terms, to bicarbonate-sodium facies with high concentration of SO_4.

In the groundwaters with low salinity a few trace element concentrations are lower than the Maximum Admissible Concentrations (MAC) set by Drinking Water Directive (80/778 EEC) and by Italian Law (D/Lgs 152/1999). Therefore, some water samples show values below instrumental detected limit. Instead, in the waters with high salinity, the As, B, Mn, Pb and Se concentrations are higher than MAC and are correlated with the content of CO_2 dissolved. The NO_3 values are generally high but, always below the MAC.

The high concentrations of major, minor and trace elements in most of the investigated water samples of the Mount Vulture are naturally according and should therefore be

considered as a characteristic determined by the geological, petrological and hydrogeological features of volcanic area.

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