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# Fissured aquifer in north-western area of the como lake basin: permeability calculation and relationship with the springs (central western como lake - italy)

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This study aims at characterize the groundwater circulation of North-Western area of Lake Como, correlating the fracture systems of the rock-mass and the aquifer with the identification of the major permeable areas. This approach allows to determine the location of aquifer reservoir and represents a good instrument for the safeguard of the water resources.

The study area is located in Lombardy, Northern Italy. In detail, two zones have been chosen because of the presence of regional fault systems. The first zone is located in the area of Carlazzo, Grandola ed Uniti, Menaggio and Plesio (Menaggio area, Como) which is about 60 $Km^2$ wide, and it is controlled by the Grona fault system. The second zone is located near the Giovo pass-Jorio pass (GPJP area) with an extension of 20 $Km^2$ and it is controlled by the Tonale fault system.

The Menaggio area is located on the boundary between the pre-Alpine crystalline basement (pre-Westfalian, Perotti, 1987), constituted by micaschist and staurolite bearing gneiss (Liborio & Mottana, 1973), and muscovite orthogneiss (Gneiss Chiari: Boriani & Colombo, 1979), and the Permo-Mesozoic sedimentary cover constituted by conglomerates (e.g. *Verrucano-Servino*, Permian age), dolomite rocks and limestones (*S. Salvatore Dolomite*, *Cunardo Formation*, *Raibl Formation*, *Breccia di*

*Ligomena*, *Dolomia Principale*, Triassic age; Bertotti, 1991). The tectonic setting of this zone is strongly influenced by the Grona fault, oriented WNW-ESE, with a fault zone characterized by brittle and ductile-deformed rocks in the northern part, and by brittle deformed ones in the southern one (Bertotti G., 1991).

The GPJP area is constituted by amphibolite facies heterogeneous gneiss, highly deformed (Bertotti, 1991), composed of muscovite, garnet, staurolite and kyanite (Bocchio *et al*., 1980). The tectonic setting is influenced by the Tonale fault which is oriented E-W and has dextral strike-slip (Laubscher, 1983). In this area this fault is named Jorio-Tonale fault.

We have examined structural data from several representative outcrops located in these two zones and we have calculated the permeability for the two zones. For this calculation we have used a software (Pasqualino and Scesi, unpublished), which allows to identify the direction, the versus and the modulus of the permeability vector. Using the softwares Surfer 7 and Arcview 3.2, a surface permeability map have been elaborated.

In the Menaggio area, the calculated permeability value is between 4.071E-04 m $sec^{-1}$ (Stop 10S) and 6.023E-03 m $sec^{-1}$ (Stop 6S). Both outcrops are in crystalline rocks. These high values are explained by the strongly fracturation of the rocks subsequent to the Grona fault and the minor NE-SW Breglia fault. This area is divided in three parts due to different flow directions: two parts where the flow direction is concordant to the watersheds and where there is correspondence between the catchment basin and the hydrogeologic basin; one part where there is not correspondence between the two basins and this is in according to the springs abundance in Senagra Valley, located at the North of the watershed.

In the gneiss of the GPJP area the permeability value varies from 1.23E-04 m $sec^{-1}$ (Stop 8R) and 9.75E-03 m $sec^{-1}$ (Stop 3R). The permeability peaks are correlated with NW-SE lineaments which fracture the rock and with the strongly activity of the Tonale fault. In the Central part of the GPJP area the flow is directed towards the North and this is confirmed by the springs distribution and there is concordance between the catchment basin and the hydrogeologic basin.

In the both study areas we observed a tectonic regulation of the permeability values and the springs location done by the Grona and Tonale fault systems.

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