Geophysical Research Abstracts, Vol. 8, 06196, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06196

Assessment of hydrothermal circulation through faults: the Valdieri case (Argentera Massif, Maritime Alps, Northwestern Italy)

A. Baietto (1), P. Cadoppi (1), G. Martinotti (1), P. Perello (2), F.-D. Vuataz (3), P. Perrochet (4)

(1) Department of Earth Science, University of Turin, Italy, (2) SEA Consulting srl, Turin, Italy, (3) Centre for Geothermal Research (CREGE), Neuchâtel, Switzerland (4) Centre of Hydrogeology of Neuchâtel (CHYN), Switzerland

The Western Alps are a collision belt whose present-day activity is testified, in the southern sector (Maritime Alps), both by an intense seismicity (Larroque et al., 2001) and by the up-rise of low-enthalpy thermal waters (Perello et al., 2001). Several thermal springs emerge along re-activated alpine shear zones in the so-called Argentera Massifs, the southernmost among the external massifs. The thermal springs of Terme di Valdieri, outflowing at the core of the Argentera Massif, make the object of a multidisciplinary study aimed to assess the fault-related properties which control the hydrothermal circulation. An integration of hydrochemical and structural data provided the framework for the on-set of numerical models simulating the thermal water circulation through the faults present in the area. 3D numerical models were used in order to compare and validate different reference structural-geological models adopted to conceptually describe the hydrothermal circulation.

It is known that the thermal waters of Valdieri have a meteoric origin, but, whether the final emergence is confined along the borders of a sub-vertical striking fault zone (Perello et al., 2001), it is not clear where the waters infiltrate and circulate. In the Valdieri area, several NW-SE striking faults crosscut, with a partitioned strain, through migmatitic gneisses and granites, resulting in localised fractured zones in the former and broad fractured domains in the latter. This means that fluid infiltration and migration, potentially, can be concentrated along conduits (focussed fluid flow) or can be distributed across broad fracture networks (pervasive fluid flow). Scenarios which account for focussed or pervasive fluid flows have different implications not only in terms of fluid flow distribution but also in terms of rock-fluid heat transfer processes. In order to evaluate the influence of these patterns on the hydrothermal circulation of Valdieri, alternative numerical models were tested and their simulation outputs were compared with some measured spring parameters. Simulations of thermal fluid flows through a single fault acting as a permeable conduit pointed out that peaks in spring flow rates and temperatures may be obtained only for specific ranges of the country rock permeability (5 x 10^{-17} $<$k (m^2) $<$1 x 10^{-16}). These values turn to be in a good agreement with the permeabilities determined in a 1.2 km deep borehole (Darcy, 1997) located at about 15 km northwards of Valdieri and sited in migmatitic gneisses and granites showing structural features similar to those found in the Valdieri area. Moreover, it has been found that high spring temperatures and discharges might be promoted by the onset of convective circulation cells. In order to allow the convective cells to reach the best efficiency in conveying flow and heat towards the surface (e.g. at springs), tectonic activity must counteract self-sealing processes by keeping open circulation pathways along faults for at least 10 000 years.

Finally, it is proposed that multidisciplinary approaches combining hydrochemical, structural and numerical techniques may provide insights on the mechanisms driving hydrothermal circulations through faults as well as on the thermal state of tectonically active regions. An improved understanding of the interaction of groundwater flow and thermal regimes in mountain systems might constitute a potential in the perspective of thermal waters exploration and hazard forecasting in tunnel projects.

References

Darcy J., 1997. La nouvelle liaison routière Nice-Cuneo et le tunnel du Mercantour, Tunnels et ouvrages souterrains, 139, 46-50.

Larroque C., Betoux N., Calais E., Courboulex F., Deschamps A., Deverchere J., Stephan J.-F., Gilli E., 2001. Active and recent deformation at the Southern Alps-Ligurian Basin junction, Neth. Journ. of Geosc., 80, (3-4), 255-272.

Perello, P., Marini, L., Martinotti, G., Hunziker, J.C., 2001. The thermal circuits of the Argentera Massif (Western Alps, Italy): an example of low-enthalpy geothermal resources controlled by Neogene Alpine Tectonics, Eclogae geol. Helv., 94, 75-94.