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Groundwater vertical velocity from thermal data in aquifer recharge areas: first results on the Lanzo Fan (Piedmont, NW Italy)

Diego Barbero, Domenico Antonio De Luca, Maria Gabriella Forno, and Manuela Lasagna
Turin University, Earth Sciences Department, Turin, Italy (manuela.lasagna@unito.it)

The aim of this study is the evaluation of groundwater vertical velocity from thermal data in aquifer recharge areas. More specifically a particular solution of differential heat equation able to determine the groundwater velocity was applied. The vertical component of the velocity is an important parameter to estimate the time of the aquifer recharge of deep aquifer for drinking water supply. The used method is developed through a statistical analysis on the temperature measures collected in boreholes located in the Lanzo Fan, in the Piedmont Po Plain (NW Italy).

The Lanzo Fan is a terraced alluvial fan, with an extension of about 300 km^2, drained by the Stura di Lanzo River. It results as an important recharge area for the aquifer of the western Po Plain. An important water well field occurs in this fluvial fan: it represents one of main water sources for Turin supply.

The sedimentary succession consists of a very thick Villafranchian complex, referred to Piacenzian-Calabrian, that constitutes a multilayer aquifer. The Villafranchian complex is covered by thin fluvial middle Pleistocene deposits (about 15-20 m thick), consisting of gravel and sandy texture. The data were collected in the shallow aquifer hosted in the fluvial deposits. Groundwater flow is directed from the recharge area to the final receptor represented by Po River, flowing North of the Turin Hill. The piezometric surface of the shallow aquifer, that follows the topographic surface, shows hydraulic gradient varying from 1%, in the proximity of the apex of the fan, to 0.1%, in the distal areas.

The average depth of the boreholes used for temperature measures is from 30 up to 50 meters. The measures were obtained by the use of probes equipped with sensors of temperature and depth, with ± 0.01 degree Celsius sensitivity on temperature. The thermal logs profiles show a common trend characterized, in the first meters of depth, by temperature fluctuations linked to seasonal oscillations, and then become concave with a radius of curvature gradually more pronounced due to the aquifer supply.

The development of an hydrogeological and physical model of heat transfer in a porous and completely saturated sediments, using analytical equations of heat transport by conduction and advection with stationary boundary conditions, allows us to estimate the vertical component of the groundwater velocity. The statistical analysis of thermometric data, returns a vertical velocity of about 10^{-8} m/s.