Geophysical Research Abstracts
Vol. 14, EGU2012-11396, 2012
EGU General Assembly 2012

Coupled physical and chemical approach to improve understanding of transient flow in complex groundwater systems. The case of the "Forez" plain (France).

J. Ré-Bahuaud (1), D. Graillot (1), D. Mimoun (1), Y. Rossier (2), and C. Renac (3)

(1) Ecole Nationale Supérieure des Mines, Géosciences Environnement Department, CNRS : UMR 5600, EVS F-42023 Saint-EtienneFrance (re-bahuaud@emse.fr), (2) Laboratoire d'étude des Transferts en Hydrologie et Environnement, Grenoble, France, (3) Université Jean Monnet, CNRS: UMR 6524, F-42000 Saint-Etienne, France

The territory of the “Forez” plain in France is facing problems of groundwater resources management. These problems are related to dataset inaccuracies and the incomplete understanding of the hydrogeological dynamics.
Two different kinds of water resources are exploited:
The first one is provided by the shallow quaternary alluvium along the river Loire and old alluvium arranged in terraces overlooking the river. The thickness of these alluvial deposits not exceeds 15 meters. The low mineralization of water contained in the alluvium allows field irrigation and drinking water distribution.
The second one is provided by deep aquifers included in tertiary sediments underlying the alluvium. These sediments are mainly composed of sandy clay and have a maximum thickness of 500 meters. The deep aquifers levels are characterized by a significant water mineralization and are used for spa treatments or bottling.
The current state of hydrogeological knowledge does not consider the distribution of inflow into the shallow alluvium from the deep tertiary sediments and doesn't take into account the temporal and continuous variations of groundwater flow.

To deal with these problems, the work focuses on a coupled physical and chemical methodology. The physical approach is based on the observation of temporal data, on simplifying assumptions of the flow characteristics and on the implementation of a numerical groundwater model to identify physical conditions that explain piezometric variations. The chemical approach consists in acquisition, processing and interpretation of geochemical data in order to estimate a percentage of contribution of underlying sedimentary tertiary formation to the shallow alluvium.

Four 2D cross-section numerical models have been implemented into the shallow alluvium to simulate the influence of recharge from rainfall. These model results attempt to describe accurately the physical parameters of the aquifer, the boundary conditions and the transient nature of the flow.
Regardless the contributions of deep water, numerical models allow to describe piezometric variations which can be explained by the recharge from rainfall for confined and unconfined context.

Geochemical data were acquired at the same location than the monitoring piezometers. These geochemical data are mainly the isotopes 18O and 2H of the water molecule and the 13C and 14C isotopes of dissolved inorganic carbon. Whatever the hydrodynamic context, the geochemical analysis has revealed that only localized parts of shallow alluvium are supplied by deep water from tertiary sediments. The percentage of deep water can reach 70% and is very variable from one piezometer to another.

The coupled methodology showed that only a physical approach is not enough to characterize the constant flow coming from deep aquifers. The geochemical data are used to correct and improve the results given by the numerical model.
This methodology allows a better understanding of the functioning of complex aquifer systems and leads to identify the flow exchange between the geological layers.

A wider range of geochemical samples and the implementation of a regional-scale hydrogeological model should result in a decision support system for water resource management.