A hydrogeological and geochemical study was carried out in the Montioni area, a sector of the Colline Metallifere mining district (Tuscany, Italy) to distinguish the chemical facies of groundwater, to define their origin and flow systems, to identify the main geochemical processes ruling their chemical composition, as well as to evaluate the influence of human activities, such as landfill disposal of industrial waste (“gessi rossi”), on groundwater chemistry. The interest for the Montioni area was due to: (1) lack of knowledge of the hydrogeology and geochemistry of groundwater in the Colline Metallifere mining district; (2) geological and geo-structural complexity; (3) evidence of hydrothermal circulation that produced intense silicization and kaolinization, masses of alunite and small mercury mineralizations; (4) presence of human activities (landfills of industrial wastes such as “gessi rossi”) that could influence r chemistry and quality of groundwater. The Montioni area is characterized by a complex hydrogeological and hydrogeochemical system consisting of groundwater belonging to four hydrochemical facies: calcium-sulphate (Ca-SO4), calcium(sodium)-bicarbonate [Ca (Na)-HCO3], calcium-sulphate-bicarbonate (Ca-SO4-HCO3) and sodiumchloride(bicarbonate) [(Na-Cl(HCO3)]. The Ca-SO4 waters rise from the deep regional aquifer hosted by Triassic carbonate-
evaporite formations, through fractures and faults. The Ca(Na)-HCO₃ facies included waters characterized by surface circulation mainly within silicized carbonate rocks of the Group of calcareous-siliceous formations of the Tuscan Nappe and, to a lesser extent, clayey lithologies of the Scaglia Toscana Group. The Ca-SO₄-HCO₃ waters have a chemistry intermediate between the Ca-SO₄ and Ca(Na)-HCO₃ facies arising by mixing of deep Ca-SO₄ waters from the carbonate-evaporite aquifer and shallow HCO₃-Ca waters circulating in the calcareous-siliceous formations of the Tuscan Nappe. The Na-Cl(HCO₃) waters are characterized by a prevailing and prolonged circulation of meteoric waters in the clayey lithologies of the Scaglia Toscana Group. As the local hydraulic head increases, these waters have enrichment in chloride, sulphate, calcium and magnesium ions, probably due to contribution of fluids circulating within the stratigraphic horizons at the top of the metamorphic basement mainly consisting of anhydrite/gypsum and dolomite. The main processes determining the geochemical features of groundwater in the study area are: 1) carbonate dissolution (mainly calcite) in the surface recharge zone, as well as sulphate (gypsum and anhydrite) and carbonate (calcite and dolomite) dissolution in the deep aquifer hosted by Triassic carbonate-evaporite lithologies; 2) ion exchange reactions occurring in the surface water circulation system within clayey rocks of the Tuscan Nappe (Scaglia Toscana Group); 3) mixing of deep and shallow groundwater. Isotopes of hydrogen, oxygen and carbon were used to define the hydrogeological model and identify mixing of waters of different origin. The levels of tritium (3H) suggest: 1) long circulation times, even more than 50 years, for the Ca-SO₄, Ca-SO₄-HCO₃ and Na-Cl(HCO₃) waters; 2) mixing between fluids of deep and/or slow circulation and superficial and/or rapid circulation waters for Ca(Na)-HCO₃ waters. Furthermore, the variability of tritium levels, coupled with substantial constant contents of isotopes of oxygen (18O) and hydrogen (2H), indicates for Ca(Na)-HCO₃ waters the presence of two components circulating with different flow rate and/or along pathways at different depth, but receiving waters that have infiltrated at the same altitude. All groundwater of the Montioni area show no significant variations of the isotopic composition of the local meteoric water; therefore, liquid-solid isotopic exchange, evaporation during recharge and mixing with nonmeteoric waters must be excluded. In addition, isotopic data suggest that recharge altitudes of groundwater are between 180 and 250 m a.s.l., compatible with the hilly landscape of the north and north-east sectors of the Montioni area. This study also investigated the relationships between the groundwater of the Montioni area and the drainage waters of industrial waste ("gessi rossi"), stored in zones involved by past mining activities. The analytical data indicate that: 1) the chemical characteristics of drainage waters of "gessi rossi" are very different from those of the local groundwater as regards the concentration levels, the quantitative ratios and the distribution pattern of most of the major ions; 2) there was not a change of groundwater chemistry after the landfill disposal of "gessi rossi"; c) the levels of tritium in groundwater suggest a water circulation of at least 40-50 years. Therefore, it is possible to state that there is not a detectable influence of drainage water of the "gessi rossi" on chemistry and quality of groundwater in the Montioni area.

Localizzazioni e accesso

http://memoria.depositolegale.it/*/http://hdl.handle.net/11365/1009336