



Groundwater age determination and transfer properties of fractured aquifers using CFC measurements

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Chlorofluorocarbons (CFCs) are useful tracers in groundwater hydrogeology. As a matter of fact, their known atmospheric concentrations and relative chemical stability allow groundwater dating in continental areas. Few studies concern fractured media, because representativity (in global context) of the sampled water is the first uncertainty limiting analyses. Dating water by CFCs requires non-mixed water and well-characterized red-ox conditions (CFC degradation potential) of the analyzed water. Combining chemical data, physical and chemical logging, allows to characterize each level of incoming water (fracture) in the global hydrogeological context. Depending of the flow rate in fracture, pumping is not always the best solution because of induced mixing. Tubing sampler has been tested in order to sample representative water coming from specific fractures. Chemical data confirms the usefulness of this sampling methodology.

CFC have been measured on several sites in the whole Brittany (France) for groundwater datation. The studied sites have typical geology encountered in fractured aquifers elsewhere. Under a weathered zone of about 20 to 30 m depth, the highest flow rates are associated with large tectonic faults emphasizing local fracturation. Water is sampled by tubing sampler directly in front of main fractures and then analyzed for CFCs. Conductivity is also measured to easily control the representativity of sampled water in comparison with previous data.

The results show a ternary composition of water circulating in fractured crystalline basement rock aquifer of Brittany. First (1) in wetlands, reducing conditions disable

the opportunity of dating water : CFCs are more or less degraded and interpretation is often difficult. Moreover wetlands are preferential mixing zones due to groundwater discharge in the low-relief areas. (2) The weathered zone holds a “young” groundwater of about 15 to 20 years old. This level is influenced by landscape management and so by agricultural practices. Although close to the surface, the watershed shows no residence times lower than 15 years, which indicates a relative inertia of the hydrogeological system. (3) A Cl-rich water is often found in deeper parts of aquifers along fault zones. No CFCs are found, which implies an old water circulating for a long time in crystalline basement.