Geophysical Research Abstracts, Vol. 7, 11075, 2005
SRef-ID: 1607-7962/gra/EGU05-A-11075

Use of Chlorofluorocarbons in the study of groundwater flow in weathered- fractured basement rocks of Uganda

C. Tindimugaya (1), R. Taylor (2), T. Atkinson (2), K. Kulkarni (3), P. Aggarwal (3) and C. Gaye (3)

(1) Directorate of Water Development, P.O.Box 19 Entebbe, Uganda, (2) Geography Department, University College London, 26 Bedford Way, London, UK, (3) Hydrology Section, International Atomic Energy Agency, Vienna

Environmental tracers such as Chlorofluorocarbons (CFCs) can be used to determine groundwater residence times, which are useful in the determination of recharge rates, constraining hydrological models of groundwater systems and assessing vulnerability of groundwater to pollution. In Wobulenzi catchment of Uganda, CFCs have been used to determine groundwater residence times in order to understand flow in fractured basement rocks and to assess the vulnerability of groundwater resources to pollution. The CFC results indicate that the individual CFC species generate a range of inconsistent ages when interpreted as “single age” unmixed groundwater. The determined groundwater ages using individual CFCs vary between modern and 42 years. Groundwater ages derived from individual CFCs have been compared with those derived from Tritium. The results indicate that groundwater ages generated from Tritium are inconsistent with those obtained from individual CFC species when interpreted as unmixed piston flow water.

Tritium measured in groundwater samples and that predicted using CFCs were compared in order to verify the results of individual CFC species under non –mixing and mixing models. The results were also used to determine the mixing proportions of young and old groundwater, and groundwater residence times under a mixing model.

Interpretations of CFCs based on the non - mixing model result in big disagreements between the predicted and the measured tritium suggesting that the single age unmixed model is not appropriate for explaining the groundwater behavior in Wobulenzi. The

biggest disagreements between the predicted tritium and measured tritium were observed in old groundwaters while reasonable agreements were observed in relatively young groundwaters.

Interpretations of CFCs based on the mixing model result in reasonably good agreement between the predicted and the measured tritium. Best agreement between the predicted tritium and measured tritium was obtained in samples where the young component is either the biggest or is almost equivalent to that of the old water. The percentage of young water in the samples ranged between 11 and 73%. The results obtained using a mixing model indicate that the groundwater in the study area is less than 40 years old.

As noted by Clark and Fritz (1997) presence of a component of modern recharge is important because it indicates a hydraulic connection with an active flow system. Thus, groundwater with more than 50% of the young component can be considered as having a very short memory and is therefore vulnerable to pollution while groundwater with an old component greater than 50% can be considered as having a very long memory with a lot of mixing and thus not very vulnerable to pollution.

Based on the above analysis, it can be concluded that the mixing model better explains the behavior of the groundwater system in fractured basement rocks of Uganda than the singe age model. The data from the above analysis, whether predicted and measured tritium are in reasonable agreement or not, indicates that the groundwater in the study area is primarily less than 40 years old and is therefore young. The groundwater resources in this kind of environment are therefore vulnerable to pollution and need to be protected from any potential sources of pollution.

This approach where CFCs are used in combination with tritium offers a possibility to assess the mixing regime of groundwater and to determine the proportions of the different mixing components. Results of this study indicate that environmental tracers when used together offer an important tool for determining groundwater residence time and ages and for assessing the susceptibility of the fractured aquifers to pollution.