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Using Dissolved Organic Carbon Isotopes for Groundwater Age Dating in Southern Nevada, USA

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Dissolved organic carbon (DOC) 14C offers a method to calculate groundwater ages that is more straightforward than dissolved inorganic carbon (DIC) 14C. To obtain corrected DIC 14C groundwater ages requires models that account for chemical and physical processes that affect both 13C and 14C. This is especially true in carbonate-rock aquifers where a fair amount of dissolution and precipitation of carbonate minerals can occur. A first important step in calculating 14C DOC groundwater ages is to determine the initial 14C DOC (A0) values of the groundwater recharge. For this study, recharge area groundwater samples of DOC 14C, collected from 14 different sites, were used to determine the recharge DOC 14C values. These values ranged from 96 to 120 percent modern carbon (pmc), with an average value of 106.2 pmc. These 14C A0 values support the use of a 100 pmc 14C A0 pre-bomb value to calculate DOC 14C groundwater ages for southern Nevada. Several conditions to successfully use DOC 14C to date groundwater need to be met. First, soluble organic carbon content of aquifers needs to be low, so that little DOC is added to the groundwater as it flows from recharge areas down gradient in an aquifer. For this study, volcanic and carbonate aquifer outcrop rocks showed that these rocks contained low soluble organic carbon. Second, it is important that the DOC does not change character down a flow path, which could indicate transformation of DOC along a flow path and/or addition of DOC to the groundwater. Although specific DOC compounds could not be identified for samples collected at four sites, all four groundwater sample spectra show the same general shape over the duration of the HPLC run indicating that the DOC compound composition of groundwater does not significantly change from up-gradient to down-gradient. Third, another factor that could greatly affect DOC 14C groundwater age calculations is matrix diffusion/adsorption of DOC 14C. Laboratory experiments showed that matrix diffusion and/or adsorption of DOC 14C for southern Nevada aquifers was extremely low. Thus, the potential reduction in DOC 14C calculated ages by matrix diffusion, or DOC adsorption to aquifer mineral surfaces, is minimal. In summary, DOC 14C ages were thousands of years younger than DIC 14C ages in down gradient groundwaters, with DOC 14C ages ranging from 500 to 5400 years old as compared to DIC 14C ages that ranged from 6,000 to 20,900 years old. All of the processes evaluated in this study that could affect DOC 14C values would potentially reduce DOC 14C values in groundwater, so DOC 14C groundwater ages represent maximum groundwater ages.