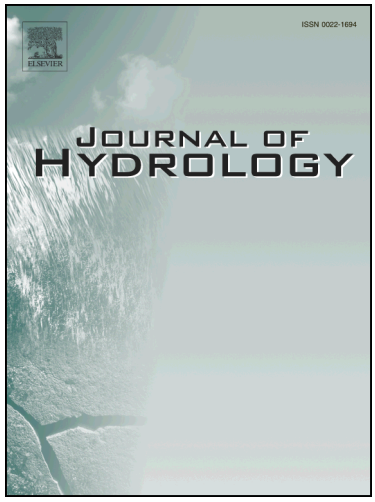

Research papers

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Geochemical Characterization and Modeling of Regional Groundwater Contributing to the Verde River, Arizona Between Mormon Pocket and the USGS Clarkdale Gage

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Abstract

We use synoptic surveys of stream discharge, stable isotopes, and dissolved noble gases to identify the source of groundwater discharge to the Verde River in central Arizona. The Verde River more than doubles in discharge in Mormon Pocket over a 1.4 km distance that includes three discrete locations of visible spring input to the river and other diffuse groundwater inputs. A detailed study of the Verde River between Mormon Pocket and the USGS Clarkdale Gage was conducted to better constrain the location of groundwater inputs, the geochemical signature and constrain the source of groundwater input. Discharge, water quality parameters (temperature, pH, specific conductance, and dissolved oxygen), stable isotopes ($\delta^{18}O$ and $\delta^{2}H$), noble gases (He, Ne, Ar, Kr and Xe), and radon (^{222}Rn) from river water were collected. Groundwater samples from springs and wells in the area were collected and analyzed for tracers measured in the stream along with some additional analytes (major ions, strontium isotopes ($^{87}Sr/^{86}Sr$), carbon-14, $\delta^{13}C$, and tritium). Groundwater isotopic signature is consistent with a regional groundwater source. Groundwater springs discharging to the river have a depleted stable isotopic signature indicating recharge source up to 1000 m higher than the discharge location in the Verde River and are significantly fresher than stream water. Spring water has a radiocarbon age of several thousand years and some areas have tritium less than the laboratory reporting level or low concentrations of tritium (1.5 TU). The strontium isotopes indicate groundwater interaction with tertiary volcanic rock and Paleozoic sedimentary rocks. Along the study reach with distance downstream, Verde stream water chemistry shows increased ^{222}Rn, freshening, increased ^{4}He, and isotopic depletion with distance downstream. We estimated total groundwater discharge by inverting a stream transport model against ^{222}Rn and discharge measured in the stream. The salinity, ^{4}He, and stable isotope composition of discharging groundwater was then estimated by fitting modeled values to observed in-stream values. Estimated groundwater inflow to the stream was well within the ranges observed in springs, indicating that the main source of streamflow is deep, regional groundwater. These results show that synoptic surveys of environmental