



The global volume and distribution of modern groundwater

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Groundwater is important for energy and food security, human health and ecosystems. The time since groundwater was recharged - or groundwater age - can be important for diverse geologic processes such as chemical weathering, ocean eutrophication and climate change. However, measured groundwater ages range from months to millions of years. The global volume and distribution of groundwater less than 50 years old - modern groundwater that is the most recently recharged and also the most vulnerable to global change - are unknown. Here we combine geochemical, geological, hydrologic and geospatial datasets with numerical simulations of groundwater flow and analyze tritium ages to show that less than 6% of the groundwater in the uppermost portion of Earth's landmass is modern. We find that the total groundwater volume in the upper 2 km of continental crust is approximately 22.6 million km³, of which 0.1 to 5.0 million km³ is less than 50 years old. Although modern groundwater represents a small percentage of the total groundwater on Earth, the volume of modern groundwater is equivalent to a body of water with a depth of about 3 m spread over the continents. This water resource dwarfs all other components of the active hydrologic cycle.