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Atom Trap, Krypton-81, and Global Groundwater¹

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The long-lived noble-gas isotope ^{81}Kr is the ideal tracer for old water and ice in the age range of $10^5 - 10^6$ years, a range beyond the reach of ^{14}C . ^{81}Kr -dating, a concept pursued in the past four decades by numerous laboratories employing a variety of techniques, is now available for the first time to the earth science community at large. This is made possible by the development of an atom counter based on the Atom Trap Trace Analysis (ATTA) method, in which individual atoms of the desired isotope are selectively captured and detected with a laser-based atom trap. ATTA possesses superior selectivity, and is thus far used to analyze the environmental radioactive isotopes ^{81}Kr , ^{85}Kr , and ^{39}Ar . These three isotopes have extremely low isotopic abundances in the range of 10^{-16} to 10^{-11} , and cover a wide range of ages and applications. In collaboration with earth scientists, we are dating groundwater and mapping its flow in some major aquifers around the world.

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