

Applications of Atom Trap Trace Analysis in the Earth Sciences

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With the successful development of the Atom Trap Trace Analysis (ATTA) method, radiokrypton dating has become available for the first time to the Earth science community at large. This novel tool, based on laser cooling and trapping and single atom counting of rare noble gas isotopes such as ^{81}Kr (230,000 yrs half-life) and ^{39}Ar (270 yrs), is enabling new research opportunities and improved understanding in the Earth sciences, with implications in studying climate change and in water resource management. Examples of applications of ATTA in the Earth sciences are: (1) ATTA measurements of ^{81}Kr in old underground water reservoirs such as the Nubian Aquifer of Africa, the Great Artesian Basin of Australia, and the Guarani Aquifer of South America to understand the long-term behavior of these large aquifer systems. ^{81}Kr dating with more extensive sampling will be carried out on major aquifer systems around the world. (2) The feasibility and accuracy of ^{81}Kr dating of old ice has been tested with the well-dated stratigraphy of Taylor Glacier in Antarctica. (3) A systematic survey of ^{39}Ar throughout the oceans, particularly when combined with ^{14}C data, will fill major gaps in our knowledge of deep ocean circulation and mixing, and will allow more accurate predictions of oceanic sequestration of atmospheric CO_2 .

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