



WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Field-Testing of Krypton-85 as an Emerging Tool for Age-Dating Groundwater

Duration of Project: September 1, 1997 to August 31, 1998

FY 1997 Federal Funds: \$36,885

FY 1997 Non-Federal Matching Fund Committed: \$110,926

Principal Investigators:

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Congressional District: Second

Statement of Critical Regional Water Problems:

The research proposed here addresses two identified research priorities for the Southeastern and Island Region: Water -Quality and Water Quantity. Specifically, we will provide new methods to study regional water problems such as water resource evaluation in the northern part of the Lower Mississippi Embayment, and contaminant transport at the Oak Ridge Reservation. The analytical technique that we here propose to put through its first field-testing will provide improved monitoring and assessment tools that can address a wide variety of problems involving the movement of groundwater by bringing on-line krypton-85 as a new tracer. Environmental tracers can play a major role in quantitative assessment of the hydrology of aquifer-aquitard systems. Krypton -85, tritium and CFCs are present at very low, but measurable levels in the atmosphere, and hence, in precipitation, due to release from anthropogenic sources such as the nuclear power cycle, atmospheric testing of thermonuclear devices and industrial or commercial activities. As precipitation containing these tracers infiltrates into the ground, it carries with it chemical or isotopic signatures related to atmospheric conditions at the time of recharge. The concentration of these tracers along a groundwater flow path will vary, (usually decreasing along the flow path) and measurement of concentrations can be used to determine groundwater age and infiltration rates. This type of direct measurement of infiltration rate is far more reliable than the conventional indirect methods which are usually based on measurements of hydraulic conductivity, hydraulic gradient, and porosity, all of which can vary greatly in the subsurface. Tracers can also be used to quantitatively investigate many other aspects of groundwater flow systems including:

discrimination between recharge and discharge zones, leakage through aquitards, measurement of dispersion or mixing rate between older and younger groundwaters, significance of fracture flow, investigation of groundwater-surface water interactions, and can act as a surrogate for assessing transport rates of contaminants. These factors can be critical in assessing the potential yield of an aquifer system, its influence on wetland/lake/river ecology, or its vulnerability to contamination, all of which are important issues in the Southeast/Island Region and throughout the nation.

Characteristics of an ideal groundwater tracer are: 1) its input concentration history should be known and not sensitive to local or seasonal variation; 2) it should be non-degradable or should decay at a known rate; 3) it should be unaffected by interaction with the aquifer and have no subsurface sources; 4) collection and analysis of samples should be practical, and 5) interpretation of results should be simple and unambiguous. Presently used tracers, tritium and CFCs, fail to meet several of these criteria. Krypton-85 promises to avoid many of the problems inherent in tritium and CFCs. The research proposed here will field-test krypton-85, which is only now becoming a viable tracer as new analytical techniques are reducing the required sample size to practical levels.

Research Results, Benefits and/or Information:

The proposed will address some of the major factors expected to influence the applicability of krypton-85 as an environmental tracer. This will include a study of sampling procedures to minimize changes or biases due to the sampling process, comparison of the krypton-85 method to conventional methods of determining groundwater age and recharge rate for an existing site in a well-characterized unconfined sand aquifer, and identification of a suitable major aquifer (for a follow-up study) for which krypton-85 data could provide unique, practical information for evaluating a significant groundwater resource. These steps are necessary to develop the sampling technology, to further test the theoretical and practical limitations of krypton-85 as a groundwater age dating tool and to gain acceptance of the RIS-based analytical method.

Initially, krypton-85 will primarily be a research tool until its applicability and limitations have been tested in a variety of hydrogeologic settings. The very first research measurements will be at an existing research site in a simple, well-characterized sand aquifer near Sturgeon Falls, Ontario. At the same time, preliminary investigations will be underway to identify an appropriate major aquifer system for testing its applicability in a more complex system that is impacted by human activities, including groundwater pumping. The first "practical" application will likely be in a sedimentary aquifer in the northern part of the Lower Mississippi Embayment, a region under active study by one of the CoPIs at the Ground Water Institute of the University of Memphis. Another likely user may be the US Geological Survey for their ongoing research on hydrology of aquifer systems, possibly at their existing research sites on the Delmarva peninsula. Other early users of the RIS-based krypton-85 analytical method will probably include the Department of Energy and related national laboratories for use in contaminant fate and transport studies at sites such as the Savannah River facility in South Carolina or the Oak Ridge Reservation in Tennessee. In the long term, RIS-based krypton-85 measurements

may become a widely used investigative tool for researchers and practitioners working on a variety of topics, including assessing aquifer or basin yields, and examining the integrity of clay-rich confining layers below contaminated sites. Because the RIS facility, which is the only such facility currently capable of processing krypton-85, is located in Tennessee, it will be more readily accessible to those in the southeast/island region and will provide a research and economic benefit to the region.