WATER RESOURCES RESEARCH GRANT PROPOSAL

PROPOSAL TO THE TENNESSEE WATER RESOURCES RESEARCH CENTER

FOR CONSIDERATION AS PART OF THE FY 1998 WRRIP

(1) Title: Field-Testing of Krypton-85 as an Emerging Tool for Age-Dating Groundwater, II

(2) Focus Categories: GW, HYDROL and MET

(3) Keywords: Groundwater Hydrology, Groundwater Movement, Age Dating, Groundwater Recharge, Solute transport, Contaminant Transport, Waste Disposal, Hydrogeology

(4) Duration of Project: September 1, 1998 to August 31, 1999

(5) FY 1998 Federal Funds: $49,165 $49,165 $ --0--

(Total) (Direct) (Indirect)

(6) FY 1998 Non-Federal Matching Funds Committed:

$98,402 $55,111 $43,291

(Total) (Direct) (Indirect)

(7) Principal Investigators:

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(8) Congressional District: Second

(9) 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 Department of Energy site in Oak Ridge, Tennessee by the use of a new environmental tracer. Environmental tracers can play a major role in quantitative assessment of the hydrology of aquifer-aquitard systems. Tritium, CFCs and krypton-85 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. Although tritium and CFCs have been used extensively in recent groundwater studies, krypton-85, due to the very large (120 to 250 liter) samples required by current analytical techniques, has seen almost no use. Having developed a new analytical technique for Kr-85 that can reduce the required sample by a factor of 10 to 100, we here propose to put it through its first field-testing, thereby bringing on-line krypton-85 as a new tracer. This will provide an improved monitoring and assessment tool that can address a wide variety of problems involving the movement of groundwater.

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 (*Quantity*) of an aquifer system, its influence on wetland/lake/river ecology, or its vulnerability to contamination, (*Quality*) all of which are important issues in the Southeast/Island Region and throughout the nation.

(10) Research Results, Benefits and/or Information:

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, Table 1. The proposed research will address some of the major factors expected to influence the applicability of krypton-85 as a tracer. This will include study of sampling procedures to minimize changes due to the sampling process, comparison of the Kr-85 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 new 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. Other early users will probably include the Department of Energy and related national laboratories for use in contaminant fate and transport studies at sites such as Savannah River or Oak Ridge. In the long term, 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. This facility, located in Tennessee and more readily accessible to those in the southeast and island region, is the only one currently capable of processing Kr-85, and hence will provide research and economic benefits to the region.