GRANTEE:

CALIFORNIA INSTITUTE OF TECHNOLOGY

Division of Geological and Planetary Sciences

Pasadena, CA 91125

DOE/ER/13851--73

GRANT:

DE-FG03-88ER13851

TITLE:

Isotope Tracer Studies of Diffusion in Silicates and of Geological Transport Processes in Aqueous Systems Using Actinide Elements

PRINCIPAL
INVESTIGATOR:

G. J. Wasserburg (626) 395-6139; FAX (626) 796-9823

E-mail: isotopes@gps.caltech.edu

Objectives: The initial aims of this project have not been modified.

Project Results: The research program has moved ahead with considerable success in several directions. Some of the work has been completed and published. Several manuscripts are near completion and one is completed and submitted. A list of papers and of abstracts is attached and copies of some of the key manuscripts are attached.

1) The isotopic composition of Os in sea water and in some rivers was directly determined for the first time (Sharma, Papanastassiou and Wasserburg, 1997).

2) The concentration of Os was first estimated in both sea water and some major rivers. The problem of tracer sample equilibration was identified but not fully solved. Recent works by Levasseur et al. (1998) and Sharma et al. (1998, 1999) have shown a possible means of obtaining equilibration.

3) The technical developments outlined in item #2 permitted determination of Os isotopic composition and concentration in the Ganges, Brahmaputra and Indus (Sharma et al. 1998, 1999). The results have direct application to the erosion of the Himalayas and the supply of Os to the oceans and to the transport of Os into the Columbia River Estuary (Porcelli et al. 1998).

4) A major effort was directed toward the transport of the U, Th series nuclides in the Kalix River watershed through organic rich mires in Sweden and into the estuary. Studies of the transport of these nuclides on detrital particles, Fe oxyhydroxide flow, colloids and in solution have been completed. The results are published in Andersson et al. (1998) and in manuscripts in preparation for publication (Porcelli et al., 1999 and Andersson et al., 1999).

5) A serious effort was directed at developing a model of transport of the U, Th series nuclides in aquifers. This theoretical treatment covers both weathering, nuclear recoil and chemical exchange with a substrata in the aquifer, and the basic hydrologic properties of an aquifer. This model appears to give a reasonable description of ^{234}U and

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

several other nuclides but cannot explain the high Rn emanation commonly observed. A summary report of these results has been submitted for publication by Tricca et al (1999).

6) A detailed study of ^{238}U - ^{230}Th dating of a speleothem (the Soreq cave) in Israel was carried out collaboratively. The results established a precise chronology for the detailed $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ stratigraphy covering the last 80,000 years. These results demonstrated a clear relationship with climate change, rainfall and transport of weathering products from soils. These results have been published (Kaufman et al., 1998) and are widely cited and demonstrate a means of studying climate change on the continents.

7) The Os-Re fractionation between silicate and sulfide melts were determined in MORB basalts and glasses and the isotopic composition of Os measured in the small sulfide samples with high concentrations. This approach permits determination of $^{107}\text{Os}/^{108}\text{Os}$ in basalts without the effects of sea water contamination. The correlation of basalt alteration uses boron isotopes as a monitor of sea water exchange and alteration (Roy-Barman et. al. 1998).

LIST OF APPENDED PAPERS

Andersson P.S., Porcelli D., Wasserburg GJ, and Ingri J. (1998) Particle transport of ^{234}U - ^{238}U in the Kalix River and in the Baltic Sea. *Geochim. Cosmochim. Acta* **62**:385-392.

Andersson P.S., Porcelli D., Gustaffson O., Ingri J., and Wasserburg G.J. (1998) Colloid and particle transport of U isotopes in the low salinity zone of a stable estuary (abst). 8th V. M. Goldschmidt conference, *Mineralogical Magazine* **62A**, 57-58.

Andersson P.S., Porcelli D., Gustaffson O., Ingri J., and Wasserburg G.J. (1999) The behaviour of uranium isotopes in the low salinity zone of a stable estuary. In preparation.

Kaufman A., Wasserburg G.J., Porcelli D., Bar-Matthews M., Ayalon A, and Halicz L. (1998) U-Th isotope systematics from the Soreq Cave, Israel and climatic correlations. *Earth Planet. Sci. Lett.* **156**:141-155.

Porcelli D., Sharma M., and Wasserburg G.J. (1998) A comparison of the behavior of Os, U, and Th isotopes in the Columbia River Estuary. (Abst.) *EOS* **79**:F426.

Porcelli D., Andersson P.S., Baskaran M., and Wasserburg G.J. (1999) The transport of U- and Th- series nuclides in a Baltic Shield watershed and the Baltic Sea. In preparation.

Roy-Barman M., Wasserburg G.J., Papanastassiou D.A., and Chaussidon M. (1998) Osmium isotopic compositions and Re-Os concentrations in sulfide globules from gasaltic glasses. *Earth Planet. Sci. Lett.* **139**:351-363.

- Sharma M., Papanastassiou D.A., and Wasserburg G.J. (1997) Os isotopic composition and concentration in the oceans: Terrestrial and extraterrestrial sources. *Geochim. Cosmochim. Acta* **61**:3287-3299.
- Sharma M. and Wasserburg G.J. (1997) Osmium in the rivers. *Geochim. Cosmochim. Acta* **61**:5411-5416.
- Sharma M. and Wasserburg G.J. (1997) Osmium and iridium in natural waters: Comparisons and consequences. (Abst.) International Conference on Isotopes in the Solar System, Ahmedabad, India.
- Sharma M. and Wasserburg G.J. (1998) The Osmium isotopic composition of the suspended and dissolved load in the Ganges: implications for the evolution of the seawater Os. (Abst.) EOS Supplement **79**:F519.
- Sharma M., Hofmann A., and Wasserburg G.J. (1998) Melt generation beneath ocean ridges: Re-Os isotopic evidence from the Polar Ural ophiolite. (Abst.) 8th V. M. Goldschmidt Conference, Mineralogical Magazine **62A**, 1375-1376.
- Sharma M., Wasserburg G.J., and Hofmann A. (1999) Os isotopes in hydrothermal fluids from the Juan de Fuca Ridge. (abst.) EUG, Strasbourg, France.
- Sharma M., Wasserburg G.J., Hofmann A., and Chakrapani G.J. (1999) Himalayan uplift and osmium isotopes in oceans and rivers. In preparation.
- Tricca A., Porcelli D., Wasserburg G.J., Baskaran M., and Naidu J. (1998) Transport of U- and Th-series radionuclides in groundwater. (abst.) 8th V.M. Goldschmidt Conference, Mineralogical Magazine **62A**, 1543-1544.
- Tricca A., Porcelli D., Wasserburg G.J., Baskaran M., and Naidu J. (1998) Development of a transport model of U-Th decay series nuclides in groundwater and its application to a sandy aquifer. EOS Supplement **79** (45):F354.
- Tricca A., Porcelli D., and Wasserburg G.J. (1999) Factors affecting the transport of U, Th, Ra and Rn in groundwaters. In K. Gopalan Festschrift, Indian Academy of Science.