APPENDIX D
IMPLEMENTING ARRANGEMENT #1
OF
THE U.S.DEPARTMENT OF ENERGY / RUSSIAN ACADEMY OF SCIENCES
MEMORANDUM OF UNDERSTANDING

URANIUM MASS TRANSPORT PHENOMENA IN FRACTURED WELDED TUFFS

Background:
The research into natural analogues presents an important element of national and international research programs aimed at the identification of radionuclide transport mechanisms in the geosphere. Such uranium-bearing occurrences as Poços de Caldas (Brazil), Tono (Japan), Oklo (Gabon), El Berrocal (Spain), and Peña Blanca (Mexico) are being studied as natural analogues of the proposed Yucca Mountain nuclear waste facility. Research has resulted in the acquisition of basic data characterizing the processes of uranium migration and accumulation under various natural conditions. However, the mineral-chemical composition of host rocks of several of these sites, except those of Peña Blanca (Mexico), differ from those at Yucca Mountain. The Mesozoic welded tuffs and felsites of volcanogenic strata, which have formed the Tulukuevskaya subsidence caldera in SE Siberia, provide additional natural analogues sites with similar characteristics to Yucca Mountain. These rocks contain hydrothermal uranium ores in various types of deposits, forming the Streltsovsky ore field, which is unique in its uranium resources. Research into these sites has resulted in the identification of the main factors governing the localization and formation of uranium ores of various grades ranging from rich vein-type to low grade impregnated ores.

Objectives:
The main objective of this proposal is to study the conditions for uranium migration and accumulation in horizons of welded tuffs (ignimbrites) and felsites of the Streltsovsky ore field, namely, Tulukuevskoe and Krasny Kamen deposits, SE Siberia. Field data will be used for better understanding actinide migration in rocks similar to the proposed Yucca Mountain repository in its post-closure period. In addition, data collected at the sites will be used to validate numerical models for actinide migration under oxidizing conditions in unsaturated fractured rock.

Benefit to DOE:
Increased understanding of vadose-zone migration of uranium will benefit DOE EM programs involving contaminant radionuclide transport within the DOE weapons complex (in addition to Yucca Mountain), particularly transport through fractured bedrock. Comparison of field data with model results will aid in model validation of flow and transport in fractured porous media within the vadose zone.

Workscope:
The Streltsovsky ore field (Tulukuevskoe and Krasny Kamen deposits) will be considered as natural analogues for radionuclide behavior in the near- and far-field of the proposed Yucca Mountain repository. Migration of radionuclides in fractured flow systems within the vadose

zone will be investigated. Studies of radionuclide migration in fractures will also serve as an analogue to long-term contaminant transport within the DOE weapons complex. It is proposed to conduct research in the following areas:

- Mineral and chemical composition and petrophysical characteristics of the radionuclide migration environment.
- Thermodynamic and hydrochemical conditions for radionuclide migration in fissures and pores in the unsaturated zone.
- Tectonic and physical-chemical conditions for the deposition of secondary minerals and the processes involved in radionuclide accumulation in fracture networks and rock matrix.

Key Milestones:

First Year:

1.1 .RAS: Collection of data, analysis, and summary of field work identifying processes for uranium migration and secondary ore deposition in fractured rock in the unsaturated zone at the Tulukuevskoe and Krasny Kamen deposits, Streltsovsky field. This will include the following:

- mineral and chemical composition of field samples of host rocks and ores;
- research into petrophysical characteristics of rocks and ores (density, permeability, pore space structure, etc.);
- X-radiography;
- research into sorption properties of rocks and mineral filling of fractures;
- hydrochemistry of underground waters.

Deliverable: A report that includes an overview of the geology, geochemistry, and mineralogy of the Tulukuevskoe and Krasny Kamen deposits, Streltsovsky field. The report will include mineral and chemical compositions determined during the first year, a summary of the petrophysical characteristics of the geologic units in these two deposits, and a summary of any additional results related to sorption studies, hydrochemistry or X-radiography.

Deliverable Date: 12 months after start date.

1.2.LANL: Assess methods to characterize fracture coating mineralogy using experience gained from similar studies performed for the Yucca Mountain Project. Investigate evidence for fracture-matrix interaction including matrix diffusion. Assess the need for obtaining isotopic data to constrain the conditions of uranium migration. LANL will act in an advisory and review role to RAS during the first year.

1.3.RAS & LANL: Hold workshop on results and accomplishments of work done during the first year and identify additional data needs required for modeling studies.

1.4.RAS: Presentation of initial progress on First Year Milestone results by one representative of the IGEM staff at an international conference to be determined.

Second Year:

2.1. Preparation for modeling processes involving uranium migration and accumulation at the Tulukuevskoe and Krasny Kamen deposits, Streltsovsky field, including the creation of databases containing physical and chemical site specific parameters and development of conceptual models involving fracture flow and fracture-matrix interaction.

Deliverable: A 3D database for each deposit containing the mineralogical and chemical data (as well as other data collected, such as petrophysical data, etc.) collected by IGEM during year one.

Participating Organizations:

Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemist-y (IGEM), Russian Academy of Sciences.
PPGKhO – Priargunsky Mining and Chemical Operations, Krasnokamensk, Chita Region.

Los Alamos National Laboratory of the U.S. Department of Energy, Los Alamos, NM.

Principal Investigators:

Dr. V.A. Petrov, IGEM RAS
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PROPOSED PERIOD OF PERFORMANCE AND PAYMENT SCHEDULE

This project will be conducted over the next 24 months. The beginning of the contract is October 1, 2000. The completion of the project is September 30, 2002. The total project cost is $ 296,000 USD. $266,000 USD will be paid to the Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemisry (IGEM) in the form of quarterly payments. $30,000 USD will be used to pay for international travel associated with workshop and conference attendance expenses. The payments will be made through standard DOE-EM procedures according to the following schedule:

Schedule	Payment	Deliverable
December 2000	$33,250	Progress Report and Presentation outlined in Milestone 1.4
March 2001	$33,250	Progress Report
June 2001	$33,250	Progress Report
September	$33,250	Project Report outlined in Milestone 1.1
December 200 1	$33,250	Progress Report
March 2002	$33,250	Project Report outlined in Milestone 2.1
June 2002	$33,250	Progress Report
September 2002	$33,250	Final Report outlined in Milestone 2.3

The responsibility of the parties for the violation of the terms of the Contract shall be determined by the Joint Coordinating Committee for Science and Technology.

LEGAL ADDRESS

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BANKING INFORMATION

Signed: