To help design the field experiment, a series of saturated crushed rock columns were conducted on the upper lithophysal (Tptpul) and the middle nonlithophysal (Tptpmn) units from the site. The experiments were designed to examine the effects of ionic strength (0.001 M and 0.01 M), rock type, pore size (78 - 155 mm and 155 -310 mm), injection rate (1 and 5 ml/hr), colloid size (44, 100, 190, and 500 nm), and colloid concentration on the transport of the microspheres to select the optimum parameters for the field test. Hydraulic data from the tracer experiments will be used to determine where and for how long to conduct the field experiment.

The columns (12" L x 2.5" D) were injected with a tracer solution of Lithium Bromide (LiBr) and carboxylate-modified polystyrene microspheres in a representative synthetic groundwater. The tracer was injected under steady-state condition for approximately three pore volumes followed by a water flush. The colloid size was significantly smaller than the pore size, such that the effects of microsphere diffusion and rock interactions could be studied without mechanical filtration. The data indicates that the colloid size must be optimized for the range of fracture apertures at the site and be sufficiently large such that transport is not dominated by diffusion. The experimental results also indicate that transport is sensitive to the flow rate and ionic strength. Therefore, for the field experiment, a higher flow rate with a low ionic strength solution is predicted to yield the best results. Additional information on the fluorescent properties of the microspheres will also be needed prior to the field experiment to minimize interference from natural colloidal material in the system.

H42A-03 1330h POSTER

CONCENTRATION AND DISTRIBUTION OF WELL DRILLING IN THE AMARGOSA DESERT AREA OF SOUTHERN NEVADA

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The earliest sources of fresh water supply in the Amargosa Desert area of Southern Nevada were the abundant, naturally occurring (cold) springs. They initially sustained the indigenous Native American populations and later, Euro-American miners, farmers, and ranchers. Prior to 1900, the many local springs and a few (mostly shallow) hand-dug wells were the principal sources of water supply. The first hand-dug well in the area was the Franklin well; it was dug in 1852 for workers performing a survey of the California-Nevada State line. The first mechanically bored wells were drilled for local railroads, along their respective alignments, sometime between 1905-07. About 1917, the first irrigation well in the Amargosa Desert area was drilled for an experimental farm operated by the Tonopah and Tidewater Railroad. In the late 1940s-early 1950s, permanent interest in the area was established, in large measure because of a Federally sponsored desert reclamation program.

For the period 1900-1999, a preliminary evaluation of publicly available information (collected principally by the State Engineer) indicates that more than 950 boreholes were drilled in the Amargosa Desert area. Almost half of these boreholes were drilled in the last 20 years. Forty-two percent of the boreholes were drilled to supply fresh drinking water; 26 percent were in support of irrigated agriculture; 21 percent of the wells were drilled for some non-water supply related purpose ground-water monitoring and testing; and 11 percent were drilled to supply water for commercial or unspecified applications.

Most of the well drilling has been concentrated in a parcel of land about 30-40 kilometers south of the proposed geologic repository at Yucca Mountain, Nevada. Most wells have been generally drilled to depths less than 30 meters (100 feet), although deeper wells are uncommon. The main reason is that drilling is expensive and the profitability of finding and extracting potable water, in sufficient quantity, generally declines with depth.

However, during the last two decades, there has been a general decline in drilling for irrigation. Designation of local aquifers in the area as protected in 1979 has favored new well-permitting for residential or commercial uses. Moreover, in the 1990s, local farmers were required to forfeit unused water rights and these rights have been reallocated to new, non-farming residents by the State Engineer in Nevadas Department of Conservation and Natural Resources. Nevertheless, the general decline in irrigation permitting for farming over the last several decades most likely has more to do with the physical and/or economic factors that have historically controlled local farming rather than with recent water availability issues.

H42A-04 1330h POSTER

255 Agreements, not 293 Unresolved Issues, on the Proposed High-Level Waste Repository at Yucca Mountain, Nevada.

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The U.S. Nuclear Regulatory Commission (NRC) is an independent regulatory agency whose mission is to ensure that public health, safety, and the environment are protected when nuclear materials are used. The Nuclear Waste Policy Act (NWPA) authorized NRC to develop licensing criteria for disposal of spent nuclear fuel and high-level radioactive waste in the proposed geologic repository at Yucca Mountain, Nevada. NRC is also required by the NWPA to interact with the U.S. Department of Energy (DOE), the potential license applicant, prior to the submission of a potential license application. Finally, the NWPA requires NRC to provide preliminary comments on "...the extent to which the at-depth site characterization analysis and waste form proposal for such site seem to be sufficient for inclusion in any application by the Secretary for licensing of such site as a repository" to DOE for inclusion in any DOE site recommendation.

In November 2001 NRC published the final licensing criteria and provided the Secretary of Energy with the NRC's preliminary comments regarding a possible geologic repository at Yucca Mountain. NRC's comments were subsequently included in a site recommendation made by the Secretary of Energy, and approved by the President, in February 2002. NRC's preliminary comments reflect many years of extensive pre-licensing interaction among the NRC staff, DOE, and various stakeholders. NRC staff engaged DOE in an issue resolution process on key technical issues and identified additional information that DOE would need to provide in any license application. As part of the issue resolution process NRC also obtained DOE's agreement to provide acceptable responses to the requests for information by the time of any license application.

The issue resolution agreements, which totaled 293, have been characterized as being unresolved issues. However, NRC's preliminary comments (these and NRC's issue resolution agreements with DOE are available at our website, noted below) and the text of the issue resolution agreements do not support this characterization. Approximately two-thirds of the 293 agreements were requests for documentation in a quality-assurance-approved document, of information that DOE already had, or had plans to obtain, but had not yet documented. As of March 1, 2002, 38 of the original 293 agreements have been completed. This means that the DOE has submitted the information they agreed to provide, NRC has reviewed the information and found that the information acceptably addresses the technical topic that required the additional information. The issue resolution process and representative agreements will be explained in the presentation.

URL: http://www.nrc.gov/waste/hlw-disposal.html

H42A-05 1330h POSTER

New Hampshire Apple Orchards as a Source of Arsenic Contamination

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Concern about high trace metal contamination in New Hampshire water supplies has focused attention on the fate of both natural and anthropogenic trace metals in the environment. We investigate apple orchards as a possible source of As in surface water and groundwater of New Hampshire. Lead arsenate sprays were widely used as fungicides and insecticides in apple orchards for more than a century and they represent the largest single anthropogenic input of arsenic into the environment. The applied As may 1) have remained in the surface soil, 2) have moved downward in the soil column and become stored in deeper soil horizons and/or regional groundwater system, or 3) have been transported as a result of overland surface runoff and/or erosion to surface reservoirs. We examine these pathways using two types of samples collected from a Southern New Hampshire apple orchard: soil profiles from apple orchards having different pesticide application (sprayed or not sprayed with lead arsenate) and land use (tilled or untilled) history, and stream sediment cores that may have accumulated sediments transported from nearby apple orchards.

Preliminary analyses provide the following observations. First, apple orchards which used lead arsenate pesticides contain significantly elevated As and Pb concentrations (up to 80g/g and 600g/g, and about 1 and 2 orders of magnitude above the background levels, respectively) in the surface soils. Second, As and Pb are generally limited to the upper 10-15 cm of soil, showing little evidence of downward transport. This suggests that As is largely chemically immobile in the soil environment and that the main mechanism for As removal from its source may be physical erosion. We hypothesize that, if left undisturbed, lead arsenate remains immobile in the soil column. However, any disturbances that increase physical erosion of the soil may mobilize the arsenic and lead and concentrate these metals in nearby stream and lake sediments. We test this hypothesis by comparing apple orchard sites with different land management history (tilled versus untilled) and by examining stream sediment samples potentially originating from As and Pb contaminated soils.

H42A-06 1330h POSTER

Using Concentration Measurements to Improve a Probabilistic Model of Prior Locations of Groundwater Contamination

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If contamination is observed in an aquifer, the source of contamination is often unknown. Receptor-based modeling is one method that can be used to identify the source of this contamination. In receptor-based models, transport is modeled backward in space and time, from the receptor to all possible sources, by solving the adjoint of the forward contaminant transport model. In the adjoint equation, the flow field is reversed, but dispersion is not. The results are probability distributions describing either the prior position of the observed contamination (backward location probability) or the travel time from a particular upgradient position to the observation location (backward travel time probability). The adjoint formulation of the receptor-based model only accounts for the location and time of the observation, ignoring the observed concentration. The relative concentration of two or more observations provides additional information that can be used to identify possible source locations and travel times. By using this concentration data, the variance of the probability distribution from the receptor-based model can be reduced. We present a new approach for incorporating concentration data. The theoretical probability distributions are validated with Monte-Carlo simulations. The results show that use of concentration measurements reduces the variance of the resulting probability distributions, thereby providing better information about the groundwater contamination source and travel time.

H42A-07 1330h POSTER

Environmental Geophysics of a limestone aquifer in Western Maryland

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Many geophysical methods have been employed in characterizing carbonate bedrock to assess potential engineering and hydrologic problems. Traditionally, microgravity and resistivity have been utilized with some success. While viable, these methods are prone to inaccuracies due to variability in operator and data acquisition techniques. Additionally, these methods are often expensive and labor intensive. In order to more effectively characterize such terrains while limiting cost and eliminating as many sample errors as possible, other means must be investigated. This study utilizes electromagnetic conductivity (EM) using the Geonics EM-34 unit to characterize the limestone aquifer surrounding a quarry area in Western Maryland (Garrett County, Hoyes Run Mine, Keystone Mining). Correlative methods of ground penetrating radar (GPR), resistivity and field reconnaissance were used. While

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