Ash redistribution following a potential volcanic eruption at Yucca Mountain

Jon Pelletier*, Steve DeLong**, Michael L. Cline**, Charles Harrington***, and Gordon Keating***

The redistribution of contaminated tephra by hillslope, fluvial, and pedologic processes is a poorly-constrained but important aspect of evaluating the radiological dose from an unlikely volcanic eruption at Yucca Mountain (YM). To better evaluate this hazard, we developed a spatially distributed, numerical model of tephra redistribution that integrates contaminated tephra from hill slopes and active channels, mixes it with clean sediment in the channel system, distributes it on the fan, and migrates it into the soil column. The model is coupled with an atmospheric dispersion model that predicts the deposition of radioactive waste-contaminated tephra at specified grid points. The redistribution model begins in the upper Fortymile Wash drainage basin where it integrates the tephra deposited on steep slopes and active channel beds within a GIS framework. The Fortymile Wash drainage basin is the focus of this model because tephra from only this basin reaches the Fortymile Wash alluvial fan by fluvial processes, and it is on this fan where the radiological dose to a hypothetical individual is compared to the regulatory standard (via additional biosphere models). The dilution effect of flood scour, mixing, and re-deposition within the upper basin is modeled using a dilution-mixing model widely used in the contaminant-transport literature. The accuracy of this model is established by comparing the model prediction with tephra concentrations measured in channels draining the Lathrop Wells volcanic center. The model combines the contaminated tephra transported from the upper basin with the tephra deposited directly on the fan as primary fallout. On the Fortymile Wash fan, channels and interchannel-divide areas are divided on the basis of soil-geomorphic mapping according to whether they are Holocene or Pleistocene in age. This approach allows the model to incorporate the effects of channel migration on the fan within the past 10,000 yr. The model treats the redistribution of radionuclides within the soil profile as a diffusion process in a stratified medium, a well-established model in the soil-physics literature. Samples were collected and analyzed from the fan to develop 137Cs profiles to determine rates of radionuclide migration in soils. Diffusivity values inferred from this analysis are lower on fan surfaces of greater age, most likely as a result of decreased permeability and infiltration rates on older surfaces. The model predicts surface and depth-averaged radionuclide concentrations through time on channels and interchannel divides of the Fortymile Wash fan. We report on model results for a range of possible eruption magnitudes, wind speeds, and wind directions.

* Department of Geology, University of Arizona
** Department of Geology, Unviersity of Arizona and Los Alamos National Laboratory
*** Los Alamos National Laboratory