Influence of Clastic Dikes on Vertical Migration of Contaminants in the Vadose Zone at Hanford

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Research Objectives

STCG # RL-SS29-S - Effect of Subsurface Heterogeneities on Chemical Reaction and Transport. Clastic dikes are vertically oriented subsurface heterogeneities that are common at the Hanford Site, including the subsurface sediments below the tank farms in the 200 West Area. Previous studies have suggested that clastic dikes may provide a fast path for transport of leaking fluid from the tanks through the vadose zone.

This research project will test the hypothesis that clastic dikes at the Hanford Site provide preferential pathways that enhance the vertical movement of moisture and contaminants through the vadose zone. Current flow and transport models of the vadose zone at the 200 Areas are based on relatively simple hydrogeologic models that assume horizontally layered sediments, with no preferential vertical flow paths. To address those scientific needs, our proposed research includes field and modeling studies of the spatial distribution of clastic dikes, the hydrologic properties within dikes, and the potential effect of clastic injection dikes on fluid flow through the vadose zone. The data and models of the clastic dike networks produced for this project should be directly applicable to fate and transport studies conducted at the 200 West Hanford Tank Farms.

Research Progress and Implications

This report summarizes progress after the first 5 months of a 3-yr project. The major accomplishment thus far has been mapping the spatial distribution of clastic dikes over an area of about 60 sq km using aerial imagery and a GIS system. The mapping was performed over an area of the Hanford Site south of the Tank Farms where cultural features and sand dunes are not present, and thus do not obscure the pattern of the clastic dikes. Analysis of the map data produced thus far includes statistical analysis of the length and orientation of the clastic dikes. The mapping and analysis has revealed several important properties of the clastic dike network at the Site. The most important is the apparent presence of trends in the size of the clastic dikes. These trends will be used to guide the placement of transects where detailed data will be recorded in the field. Based on previous work it is believed that differences in the length of dikes may be related to their width, and possibly to the grain size of the material making up the dikes. If those relationships are found to exist, they will be used to predict the transport properties of the dikes in the area of the Tank Farms, based on identification of the length of the dikes using subsurface geophysical methods. A related activity that took place in conjunction with the Vadose Zone Advanced Characterization Workshop at the Hanford Site in January was the recording of ground penetrating radar (GPR) data by investigators from Lawrence Berkeley National Laboratory over several clastic dikes that had been identified by the project. This preliminary work suggests that GPR will be suitable for mapping the presence of clastic dikes that do not breach the ground surface.

Planned Activities

Fractal analysis of the existing GIS mapping data will be performed in March of 2000. Detailed field work at the Hanford Site, including geological and geophysical measurements (GPR) along transects selected from the GIS data will be performed in April through June of 2000. This field work will also include application of advanced characterization methods, air-minipermeametry and IR imaging, to examine the distribution of hydrogeological properties within clastic dikes. Data from the field work will be analyzed during the last quarter of FY00 and the first quarter of FY01 using geostatistical methods. In tandem with that analysis, field work will be planned for spring 2001, which will include a field scale infiltration experiment over a clastic dike. The experimental site will be characterized and monitored during the infiltration experiment using advanced geophysical methods (GPR, TDR [time domain reflectometry], and ERT [electrical resistance tomography]). Geostatistical methods will be used in FY01-02 to provide numerical 3-D grids of the infiltration site for flow and transport modeling, and the resulting transport models will then be compared with the actual observations during the transport experiments.