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ABSTRACT TITLE:  River Water Intrusion and Related Contributions of Contaminant U During Springtime Runoff Events at the Hanford Site SFA

ABSTRACT:  The area near the Columbia River shore at the 300 Area is affected by large excursions in the elevation of the adjacent Columbia River. In the springtime, large, abrupt, and long-lasting fluctuations of as much as 3 m result from the influx of snowmelt from the large Columbia River catchment. These fluctuations in elevation cause proportional changes in the elevation of the water table, drive azimuthal fluctuations in the local groundwater gradient, and result in short-lived infiltration of river water into the aquifer and lower vadose zone. We used a combination of sediment analysis and daily groundwater sampling to test the hypothesis that the large springtime variation in groundwater elevation caused contaminant U, adsorbed to sediment in the lower vadose zone, to be added to the aquifer U plume. Groundwater sampling included the wells of the 300 Area IFRC well field, providing an estimate of lateral variation in U concentrations, river water infiltration, and site-specific variations in the hydrologic gradient and water table elevation. Well cuttings collected during well field construction were analyzed for bicarbonate extractable U (BCU), mineralogy, and porosity. Statistical analysis of the combined data was used to estimate the solid-phase inventory of U and its potential impact on the aquifer.

The regional north-northwest hydrologic gradient was perturbed by springtime rises in river elevation. At the IFRC (200 m from the river shore), the gradient reversed to north-northeast during elevation rise, and reverted to its normal heading during elevation fall. The extent of river water infiltration (as the fraction of river water mixed into the aquifer) was dependent on the magnitude of the river’s elevation rise and the rate of elevation change. If the rise was gradual, the regional gradient restricted the infiltration of river water; conversely, abrupt elevation rises resulted in infiltration of river water across the IFRC, to a river water fraction greater than 90%. Water table excursions into the vadose zone resulted in increased dissolved U, but the distribution was heterogeneous across the site. The timing and stratification of U concentrations indicated that the U was contributed immediately upon saturation of the lowermost vadose zone. Compositional stratification also indicated that the river water intruded along the top of the aquifer, and that the aquifer was homogenized after the gradient reversion. A geostatistical model that included BCU showed that the U source was heterogeneously distributed, consistent with the observed heterogeneous distribution of increased U concentrations.

The results showed intrusion of river water at distances of over 200 m from the Columbia River, indicating the presence of a very extensive hyporheic zone at this location. The addition of U during changes in water table elevation indicated that water table rise contributed U and other solutes to the aquifer (which have not been captured by previous modeling studies). The seasonal change in river elevation drove a significant compositional exchange between groundwater and surface water, and could represent unexplored impacts on surface ecology.