A Soil Geochemical Transect in Northern California: Links to Human Health

M.B, GOLDHABER, J.M. MORRISON, R.B. WANTY, D.B. SMITH AND G.S. PLUMLEE

U.S. Geological Survey, Denver Federal Center, Denver, CO 80225 ; (mgold@usgs.gov)

Soil may directly affect human health through its ingestion, inhalation, and dermal absorption. We studied soil samples in a latitudinal transect crossing northern California, USA, from Marin County north of San Francisco to the Nevada border. Potentially carcinogenic Cr (as Cr^{6+}) and Ni enrichments occur in soil derived from ultramafic belts. These constituents are toxic primarily via a respiratory pathway. We have chemically analyzed nearly 2000 soil samples from archives including 1300 surface soils in the central and eastern portion of the study area and 100 soil profiles across the transect. Chromium, Ni, and V in these samples display distinctive patterns reflecting the underlying geology. Elevated concentrations of soil Cr (up to 6000 ppm) and Ni (up to 3000 ppm) overlie ultramafic rocks in the foothills of the Sierra Nevada Mountains and are also associated with serpentinites in the Coast Ranges west of the Sacramento Valley. Chromium in these ultramafic soil samples is predominantly in a refractory form, presumabley as chromite ($FeCr_20_4$). Soils with Tertiary volcanic and granitic parent material, as well as alluvial soil in the eastern Sacramento Valley, have substantially lower Cr and Ni concentrations. Surprisingly, elevated Cr and Ni content (150-400 ppm and 60-300, respectively) occurs in Sacramento Valley soils west of the Sacramento River, which was derived in part from sediments transported from ultramafic rocks in the Coast Ranges to the west of the Sacramento Valley. Chromium in this geographic setting is in a less refractory form that is more easily mobilized from soil.

We are investigating a potential environmental link between soil geochemistry and human-health issues through 'bioaccessibility' (selective leach) studies and have subjected a subset of samples to selective leaching by water, simulated human lung and gastric fluid, and 'cell line fluid' (which may be a proxy for fluids characteristic of long-term exposure in the lung). These studies reveal the release of Cr and Ni to the solutions (0.01 -1 ppm and 0.06-150 ppm, respectively).

We have also obtained geochemical data from shallow groundwater and dust samples in the study area. Both media show elevated Cr and Ni content as well. Groundwater in the western Sacramento Valley has elevated Cr content (to 50 ppb), while groundwater samples from the east side of the valley contain less than 15 ppb Cr. Dust samples from near the cities of Sacramento and Stockton have elevated Cr content that is indicative of western Sacramento Valley soils, particularly in winter. We cannot infer a direct causal link between our data and specific health outcomes; however, the incidence of lung cancer is elevated in our study area, particularly for white females.