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The Chemistry of Serpentine Soils Developed Over A Podiform Chromite Deposit, Western Sierra Nevada, USA

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1 Abstract

The Chinese Camp mining district in the western Sierra Nevada of California, USA, contains a serpentinized, ultramafic dunite intrusion with podiform chromite deposits. Serpentine soils have developed over this intrusion, creating a unique ecosystem of endemic vegetation and soils characterized by low Ca/Mg ratios and high Ni and Cr contents. The vegetation and red coloration make it easy to visually distinguish between soils developed over intruded, serpentinized bedrock and unmineralized, adjacent andesite bedrock (Fig. 1).

Fig. 1. A landscape overview of the red colored serpentine soil in the Chinese Camp mining district, California USA. The buckbrush chaparral growing on the serpentine soil in the background stands in stark contrast to the open woodland/annual grass community developed on the adjacent andesite-derived soil, in the foreground.

The purpose of our study was to compare soil chemistry and vegetative parameters among 3 study-design levels: 1) undisturbed serpentine soil, 2) undisturbed background soil (non-serpentine, developed over andesite), and 3) serpentine soil disturbed by mining activities. Within each of these levels, 3 random locations were chosen where we established 3, 30-m transects (spaced 120-degrees apart). One soil sample was collected at a random location along each transect (0-15 cm depth after removing litter/O horizon). This scheme resulted in the collection of 9 replicate soil samples per study-design level.

Samples were analyzed for total metal content by ICP-AES/MS (inductively coupled plasma atomic emission spectroscopy/mass spectroscopy), pH, electrical conductivity, and total C/N/S. The vegetative parameter of % canopy cover was measured with a line-point intercept survey along each transect, using 0.6m intervals. Above-ground net primary productivity (ANPP) was estimated by harvesting all aboveground living plant material within a 0.5 m quadrant at 3 random locations along each transect, drying, and weighting the material.

Significant differences among design levels were observed for ANPP, canopy cover, total P, total N, and Ca/Mg, where the median values for these parameters decreased in the order undisturbed background> undisturbed serpentine > mining-disturbed serpentine. The highest concentrations of Cr and Ni were found in undisturbed serpentine (medians of 1960 ppm and 2529 ppm, respectively) followed by mining-disturbed serpentine (medians of 420 and 2120, respectively) then undisturbed non-serpentine (medians 47.0 and 32.2 ppm, respectively). Soil pH varied significantly among the design levels with a median 5.74 in undisturbed background, median 6.25 in undisturbed serpentine, and median of 7.17 in mining-disturbed serpentine.

These data document the distinct differences in soil chemistry and vegetation parameters between undisturbed serpentine soil and adjacent, undisturbed background soil. Efforts toward mining reclamation must recognize these differences and include the correct baseline conditions in the reclamation plan.

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