Digital Documentation and Evaluation of CPS Distribution in Soil Cores Following Injection for Hexavalent Chromium Fixation

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Background/Objectives. Hexavalent chromium (Cr(VI) is one contaminant being remediated at an industrial facility in Southern California. Suspected historical leakage from a former underground storage tank used to store spent etchant solutions resulted in localized, vertical distribution of Cr(VI) throughout a 13-meter (m) sand and overconsolidated silt-clay vadose zone. Calcium polysulfide (CPS) injection to fixate Cr(VI) through reduction to trivalent chromium hydroxide was first pilot tested and then upscaled for a larger area of remediation. Interim and confirmation soil borings were drilled and studied to assess the effectiveness and distribution of pressure-injected solutions of CPS in different soil types. A visual documentation method was standardized to support decision-making over dose and injection spacing during the remediation program to supplement laboratory analyses. The method also improved selection of soil samples for laboratory analysis to evaluate the representativeness of data. The following reaction describes the reaction of chromate with calcium polysulfide:

$$2CrO_4^{-2} + 3CaS_5 + 10H^+ \rightarrow 2Cr(OH)_3 + 15S^0 + 3Ca^{+2} + 2H_2O$$

The products of the reaction are insoluble non-toxic hydroxide compound, sulfur, calcium, and water. The sulfide to sulfur reaction is reducing, and results in color changes in oxidized clays and metals that is visible within the core. Accurately recording the color changes relative to reference borings and across sediment and soil textural patterns was the primary goal for the documentation.

Approach/Activities. Continuously-cored soil samples from each interim and confirmation boring were visually logged and digitally imaged to record distribution of CPS reducing reactions. Different color and soil texture indicators were selected and evaluated for the study. Use of Rhodamine dye tracer was also evaluated for performance. Digital cameras were used to attain overlapping images of cores after visual logging. Core alignment and orientation procedures were tested and improved between deployments. Different flagging methods were tested for tracking depth and sample collection points in the core images. Two commercially available software tools were used to combine images in post-production and produce continuous core images for reporting.

Results/Lessons Learned. Maintaining standard scale and image orientation was key to efficient post processing. Use of paper notes and tape scales had varying success. Rhodamine dye staining was blocked by the dark reductive colors where CPS had reacted. The method was useful for documenting exactly where laboratory samples were collected relative to reduction staining and CPS distribution evidence. The method has proven useful for documentation and communications to regulatory agency staff and provides a lasting record of remediation of soils.