geotech.org
World Headquarters
4945 South Routt Street
Littleton, CO 80127

geotech.org

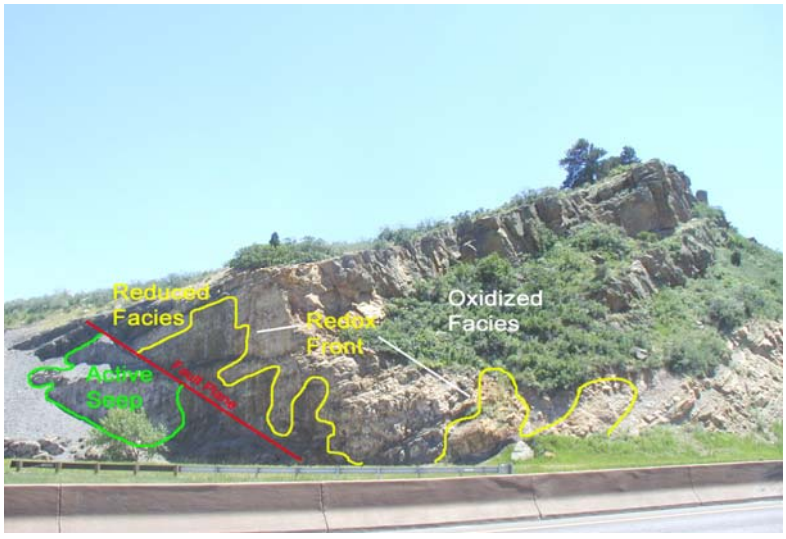
Hydrocarbon-Induced Geochemical Alteration at Turkey Creek Roadcut Denver, Colorado

Based on *"Hydrocarbon-Induced Mineralogic and Geochemical Alteration, Turkey Creek, Colorado, USA: Induced-Polarization Exploration Implications"* by Jeffrey Ried, Bruce Campbell, and Suzanne Ulrich.

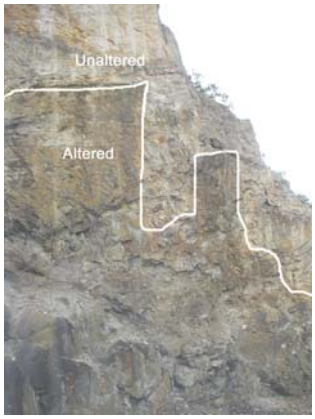
Turkey Creek roadcut is located in the Front Range west of Denver, Colorado and exhibits alteration and chemical conditions induced by seeping hydrocarbons. The site is an oxidation – reduction front which developed in the hogback section of the J sandstone interval, South Platte Fromation, Dakota Group, where hydrocarbons permeate the sandstone. Similar uranium bearing redox roll front deposits occur in south Texas, the Colorado Plateau, and Wyoming. Elevated concentrations of U, V, Mo, Se, As, S, and C are detected in rock cuttings at Turkey Creek as well as abundant pyrite.

Turkey Creek is a well exposed redox front controlled by an active oil seep. Degraded hydrocarbons pervade the chemically reduced part of the outcrop and are related to seepage from the abandoned Soda Lakes field located approximately 2500 feet east of the road cut. (Currently located under the Home Depot Store) Hydrocarbon seepage gives the outcrop a dark-yellow cast. Secondary pyrite coincides with degraded hydrocarbons saturating the sandstones and is concentrated preferentially along cross beds where greater porosity and permeability exist. Sulfuric acid coats large portion of the outcrop, particularly along the hydrocarbon seep. "Blooms" from sulfuric acid evaporation are also present.

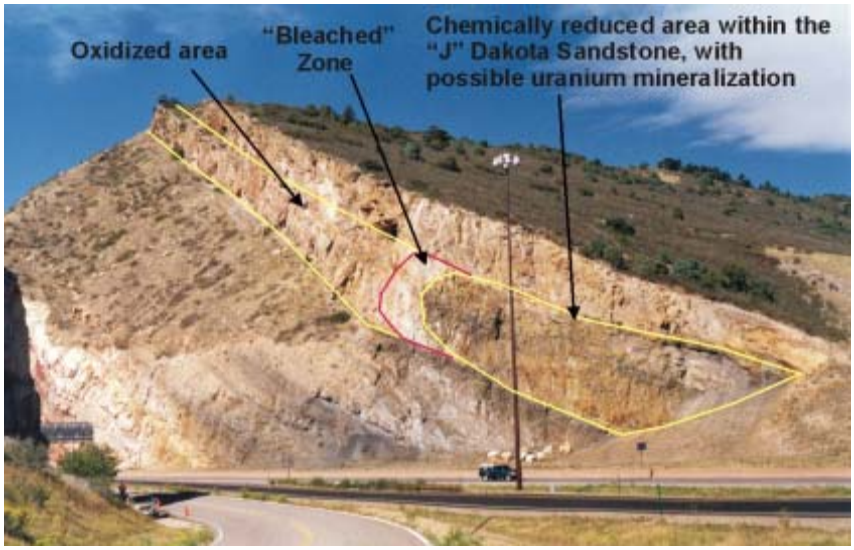
This type of alteration normally occurs in sandstone units containing either diagenetic disseminated coalified fossil plant fragments and pyrite, or sandstones that are epigenetically reduced



and sulfidized by infiltrating sour (H_2S-rich) natural gas. Three alteration facies have been designated to represent the geochemical changes at Turkey Creek. The updip oxidized facies is characterized by traces of hydrocarbons and secondary pyrite cement. The transition facies consists of uranium and molybdenum bearing sediments with the anomalous chemistry characteristic of a uranium roll-front deposit. This facies straddles a fault with minor apparent displacement. The active oil seep is located in this facies. The reduced facies is characterized by hydrocarbon saturated quartz sandstone containing pyrite. Hydrocarbon saturated sandstone is common downdip of the fault.



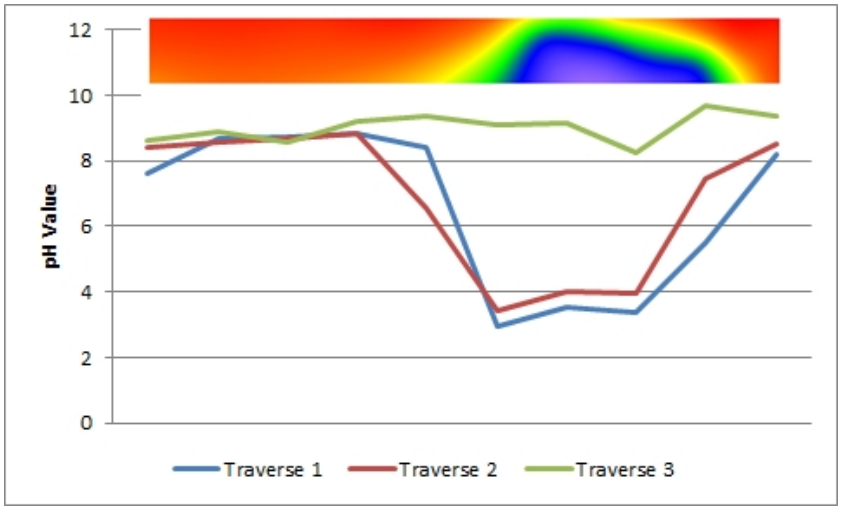
This case history is a uniquely well exposed location that shows how mineralogical and geochemical alteration can be related to hydrocarbon seepage. Many methods have been used to demonstrate detection of hydrocarbon seepage at the earth's surface.

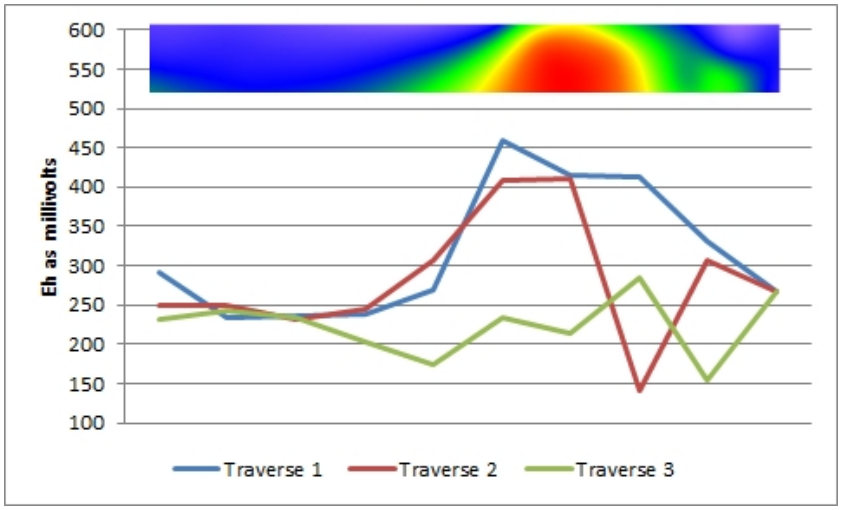


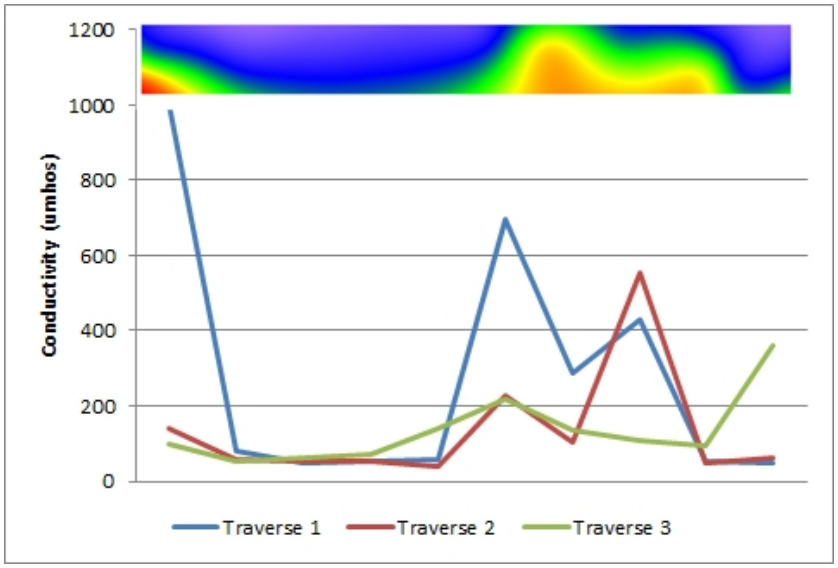
The picture is the north side of the Turkey Creek road cut. Similar alteration features can be seen here as well. The reduced, transition (bleached), and oxidized zones are present.

To further illustrate the affect that

seeping hydrocarbons have had on this area several geochemical data sets were prepared to demonstrate changes in soil bacterial, spectral color change, and hydrocarbon input.

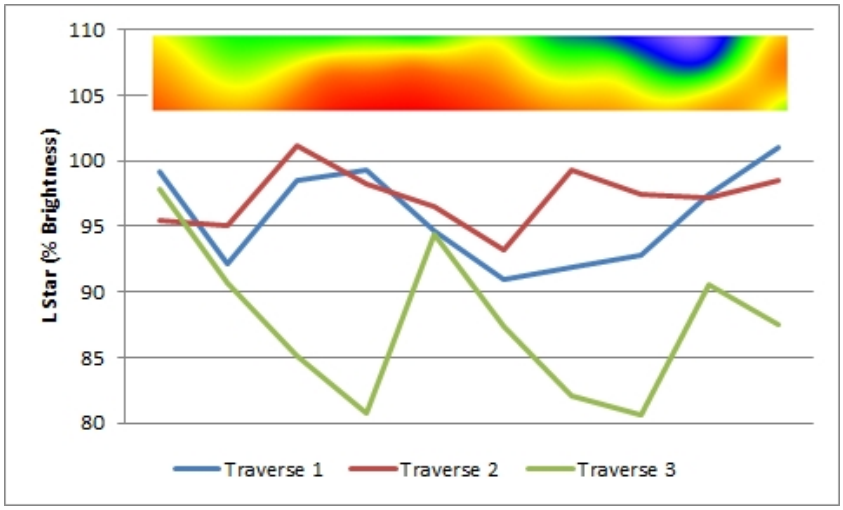


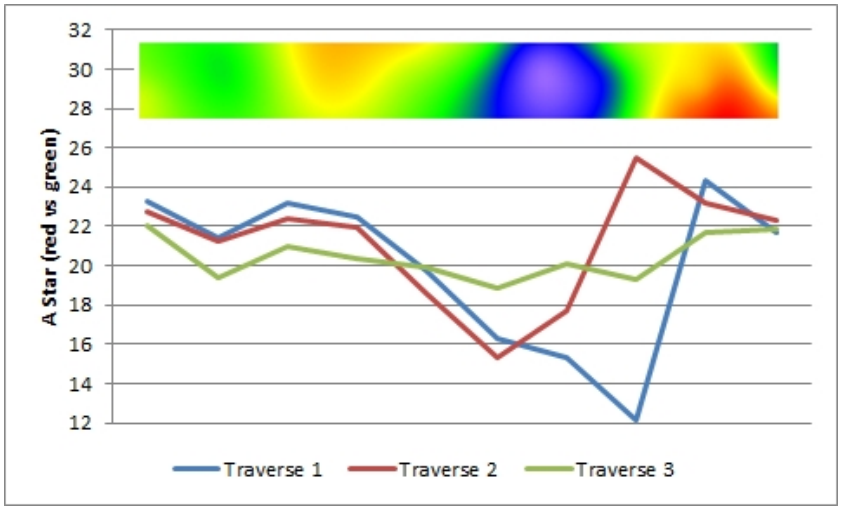


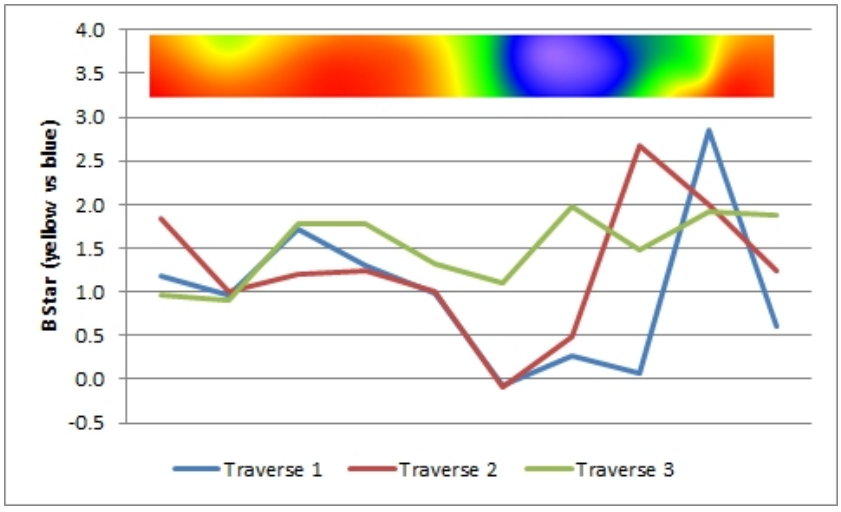


These are east to west traverses of the bulk soil chemical data pH (top), Eh (middle), and conductivity (bottom) along the Turkey Creek road cut. Notice the boundaries associated with the fault to the east and the edge of the reduced zone to the west. Here the bulk soil properties have less to do with the microbial aspect of hydrocarbon seepage, but the abiotic aspects. The high sulfur content has produced sulfuric acid and an excess of free ions therefore altering the Eh, pH, and conductivity of the area. The anomalous mineralization at Turkey Creek is related to hydrocarbon seepage and sulfur reactions resulting in carbon disulfide, hydrogen sulfide, and any number of uncontrolled reactions between the hydrocarbons and sulfur compounds.

The bulk pH, Eh, and conductivity measurements at the Turkey Creek road cut are somewhat misleading with regard to less exposed seepage anomalies. A more conventional anomaly would yield pH and conductivity highs, with Eh lows in the halo position. The sulfuric acid is not buffered where normally the precipitation of carbonate would buffer the signature.

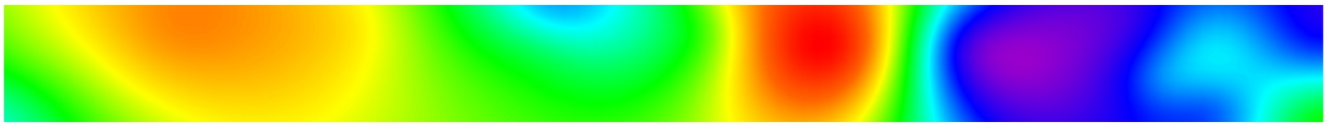






The High Resolution Soil Spectral Analysis shows the relationship between the red, green, yellow, and blue hues of the soil. The L Star data (top) picks up the bleached transition between the reduced and oxidized zones. The B Star data (bottom) reveals the altered sulfides in the soil. Note the traverse lines all yield a low at the fault. The HRSSA yields lows and highs near the hydrocarbon anomaly updip from the fault.

A microbial anomaly (below) is also present at the Turkey Creek road cut. The anomaly is present to the east of the fault with no signs of real activity in the oxidized zone. The fault is the bright spot towards the middle of the image.



The last data set is the hydrocarbons. The data set is from surface soils and analyzed as non-vapor hydrocarbons at 260 nm. Hydrocarbons are from the soluble fulvic acids present in the near surface organics. Note that the microbial and hydrocarbon data yield similar patterns with the highs and lows in the same positions though the stronger hydrocarbon anomaly is updip from the fault.