



Determining the Elemental Composition of Naturally Reduced Sediments at Old Rifle Aquifer

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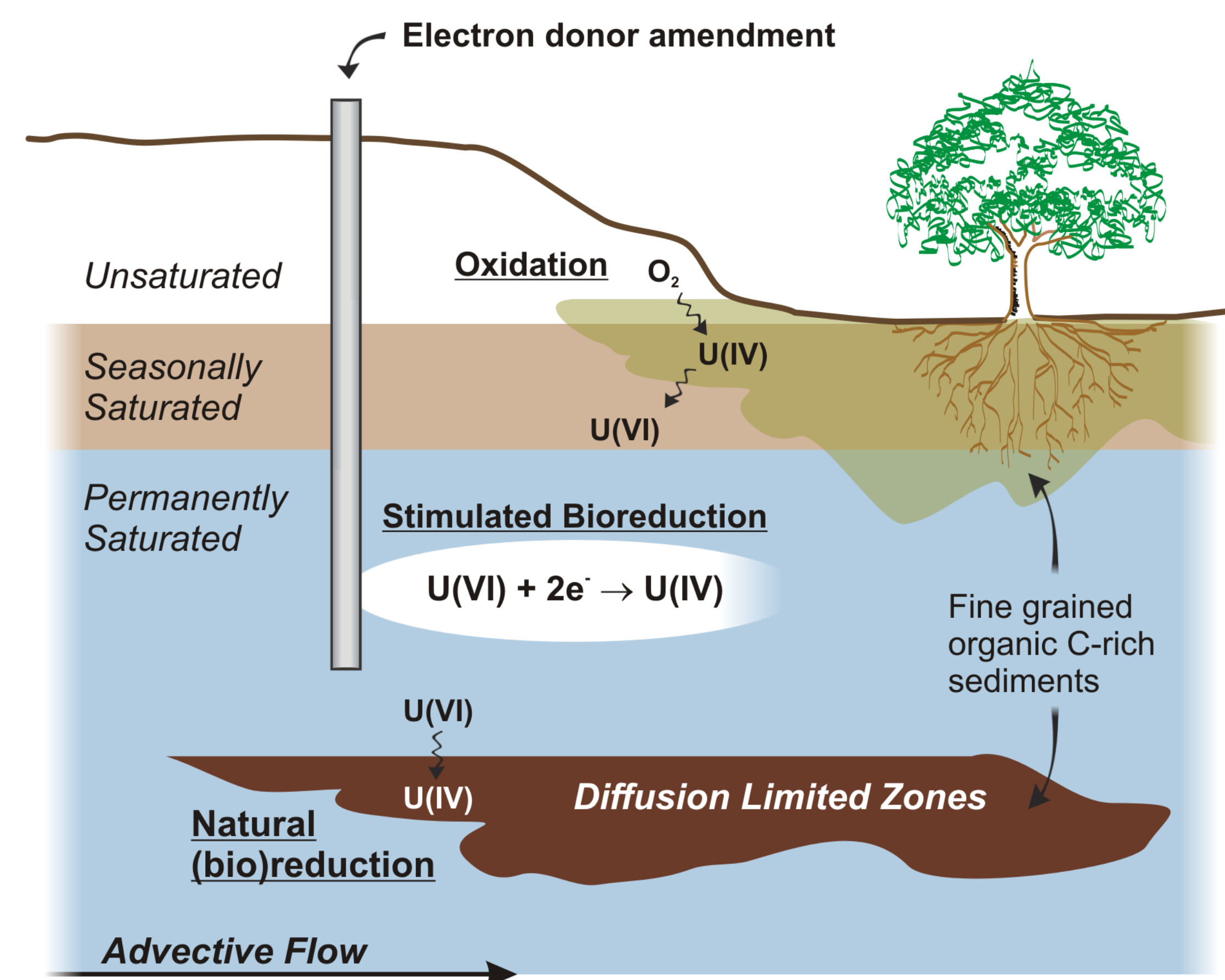
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OBJECTIVE:

- To determine the elemental composition of naturally reduced sediments in the aquifer at the Old Rifle site (Colorado), a former uranium mill.

INTRODUCTION:



- Large uranium plumes still persist in groundwater at legacy Department of Energy (DOE) due to past uranium extraction and processing.
- At Old Rifle, >34 million gallons of groundwater is contaminated with uranium.
- Naturally reduced zones (NRZ) are areas in the aquifer that contains highly reduced content.
- The mobility of uranium depends on its valence state: oxidized U(VI) is highly soluble and reduced U(IV) precipitates easily.

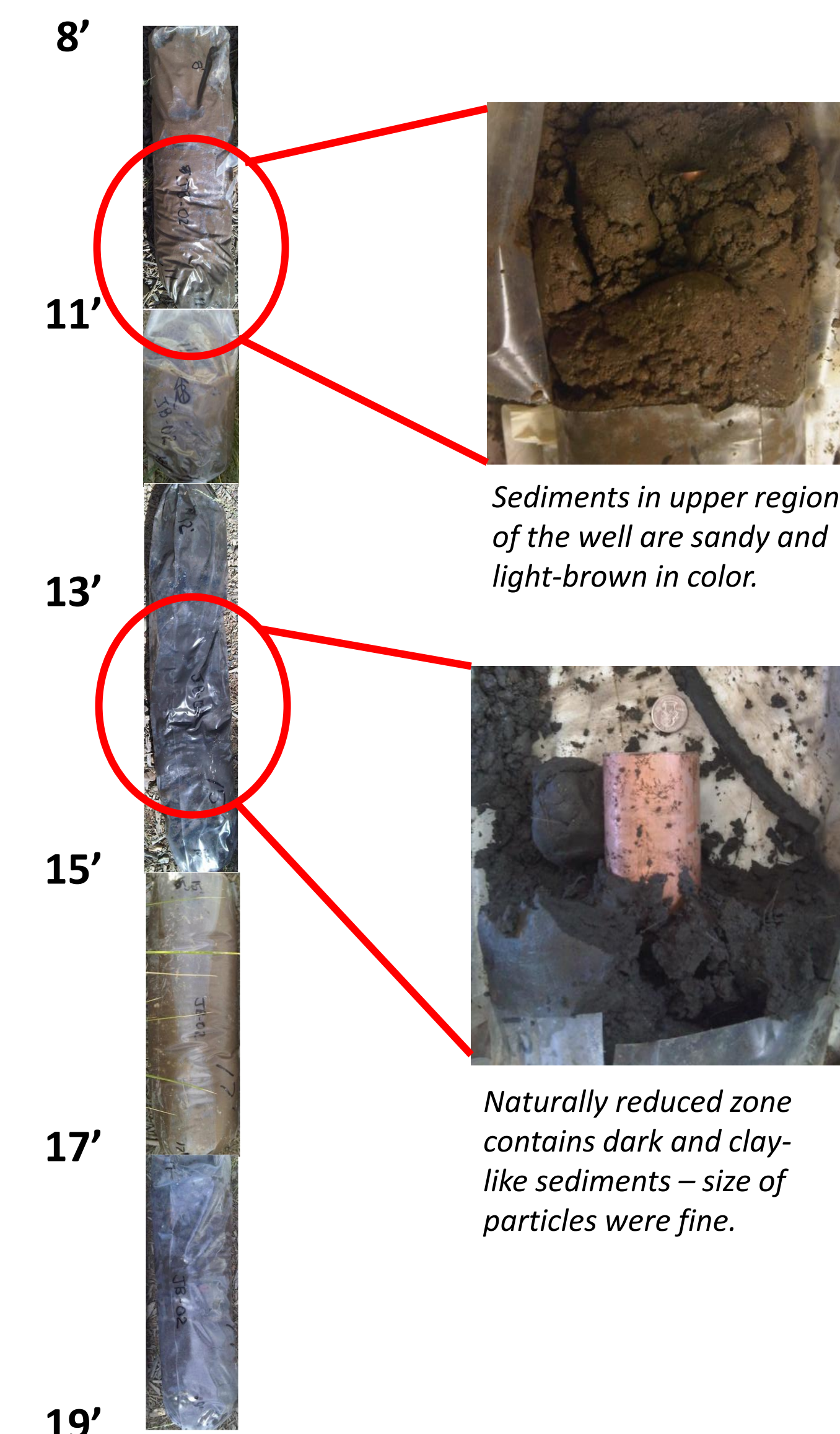
HYPOTHESES:

- NRZ will contain a higher concentrations of uranium(IV) and sulfide
- Higher concentration of U(IV) will be found in areas of low permeability (i.e. small sized particles).
- Higher concentration of U(IV) will be found in areas of higher concentration of organic carbon.

METHODS:

Collecting Samples

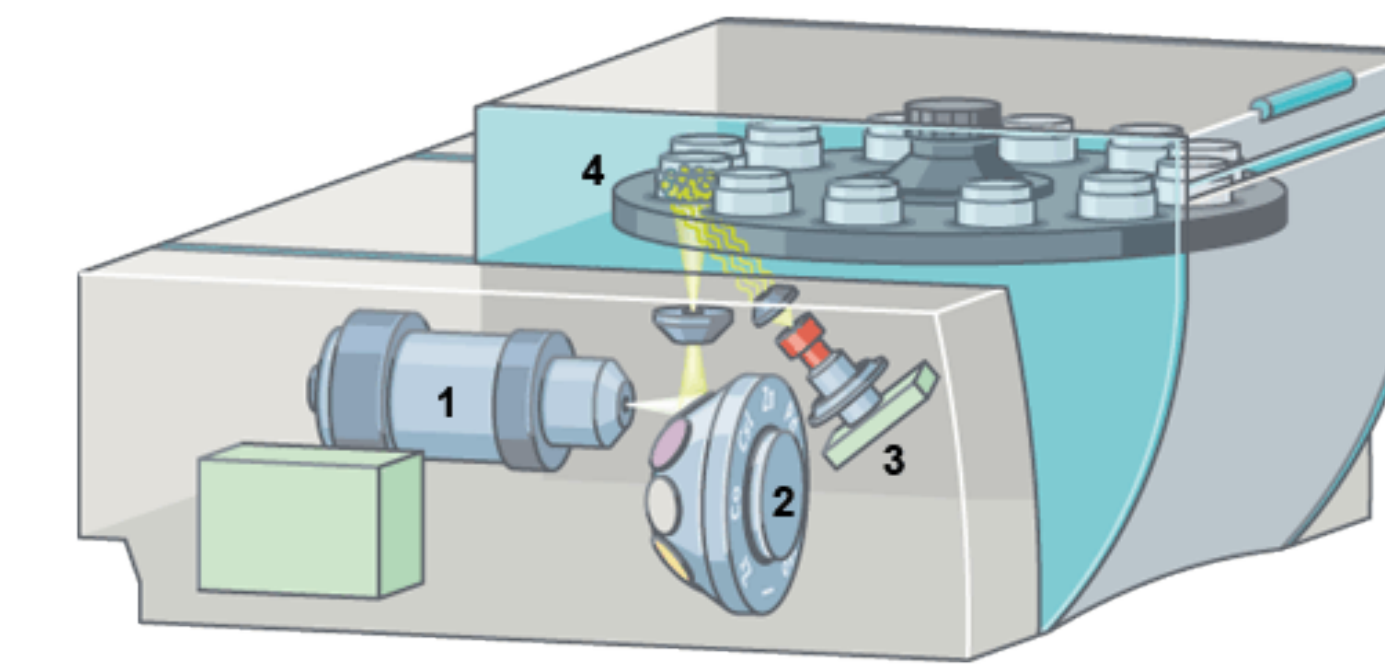
Sediments from a well were collected at half a foot intervals from 8' to 20' feet deep. Sediments were then grinded to a fine powder for analysis.



Analyzing Samples

X-Ray Fluorescence Spectrometer

- 1 - X-ray tube
- 2 - Target changer with up to 8 polarization and secondary targets
- 3 - SDD detection system
- 4 - Sample tray with samples



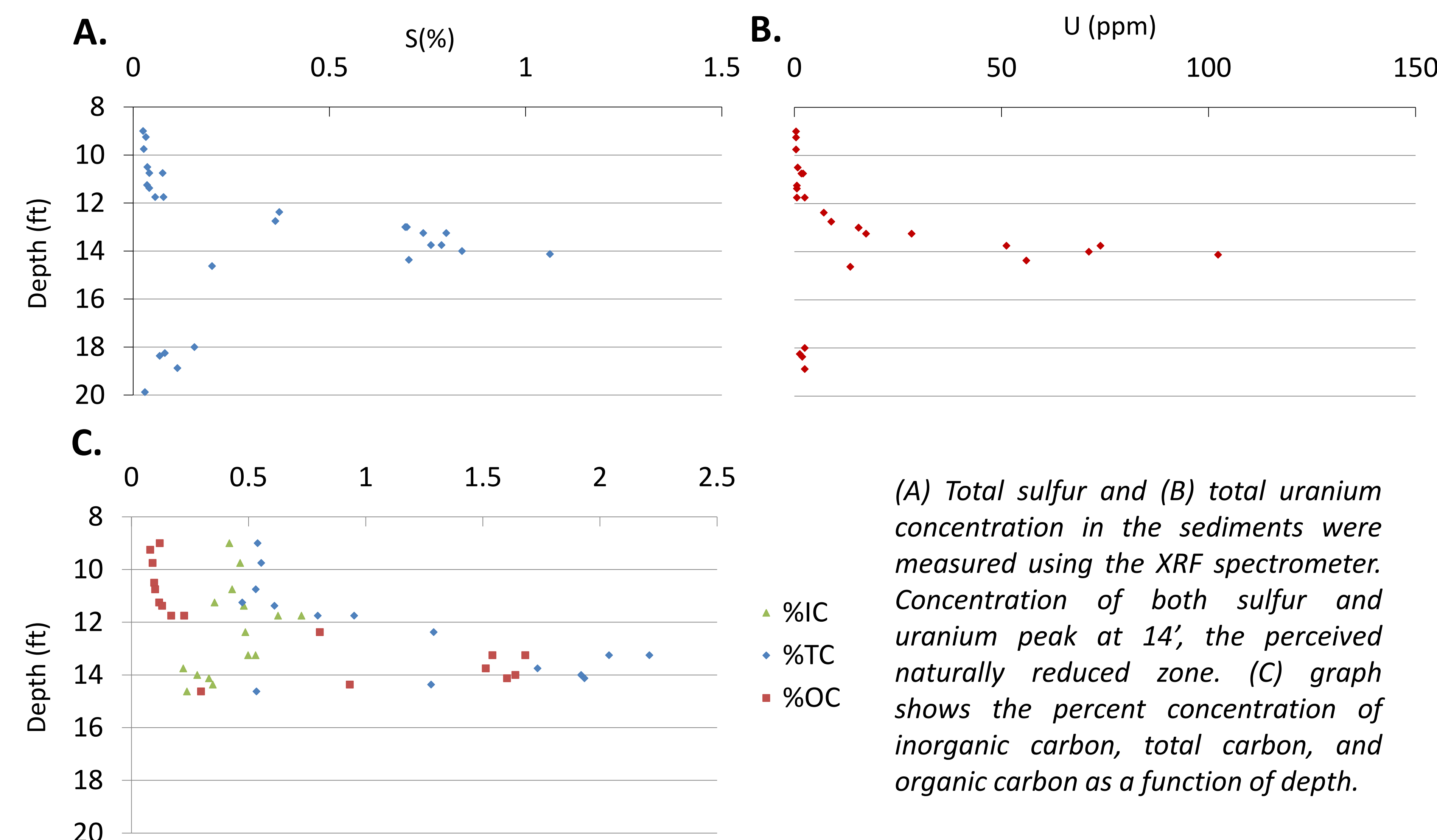
XRF spectrometer is used to determine the elemental composition of dry sediments.

Carbon/Nitrogen/Sulfur Analyzer

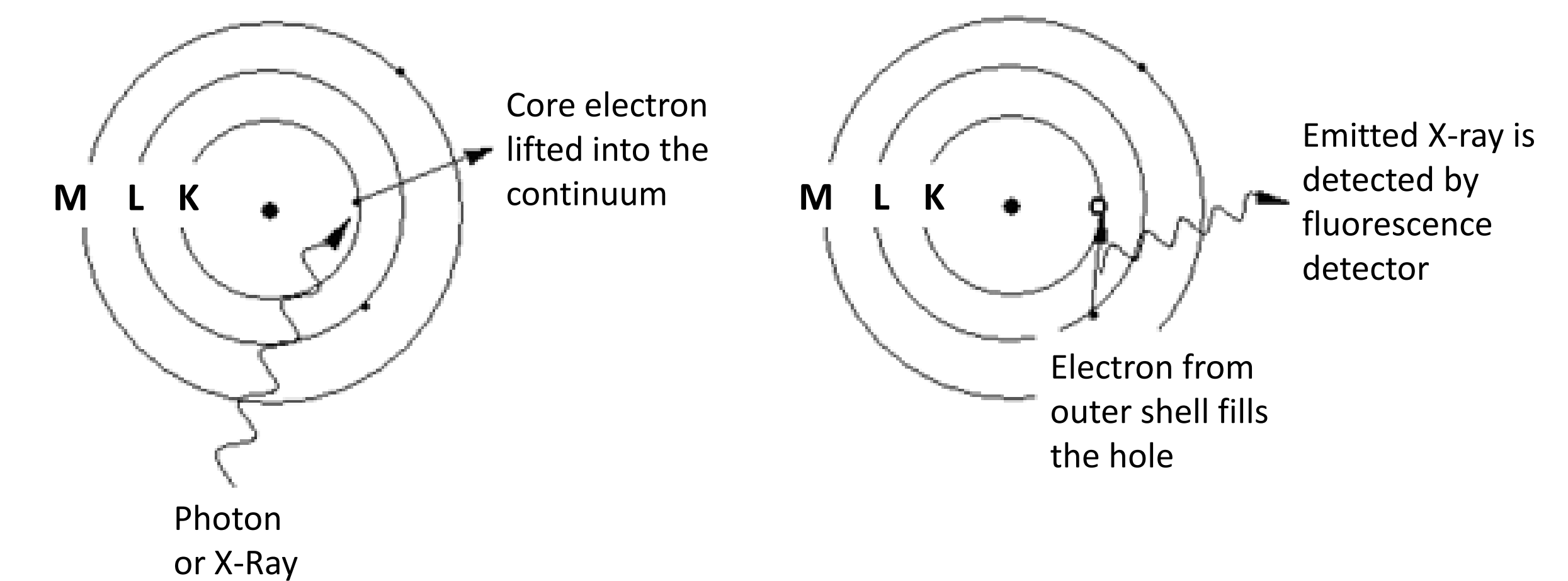


CNS analyzer measures the carbon, nitrogen, and sulfur content in a sample through flash combustion and gas chromatography.

RESULTS:



How X-Ray Fluorescence works:



Tungsten source emits high energy photons (X-ray), which ionize the target material and produce photons of a wide energy range. These photons then ionize the atoms in the sample and cause the elements to fluoresce. Silicon drift detector (SDD) detects the intensity of the fluorescence and calculates the concentration of each element.

CONCLUSIONS:

- Concentration of uranium, sulfur, and organic carbon are the highest at the naturally reduced region.
- Total sulfur, uranium and organic carbon are highly associated with one another.
- Organic carbon can be a potential factor in the reduction of uranium, U(IV).

FURTHER STUDIES:

- Determine the particle size of the sediments through size fractionation to see whether a correlation exists between particle size (i.e. permeability of sediment) and reduced uranium
- Determine the speciation of sulfur and uranium in naturally reduced sediments using X-ray absorption near edge spectroscopy (XANES) and EXAFS

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