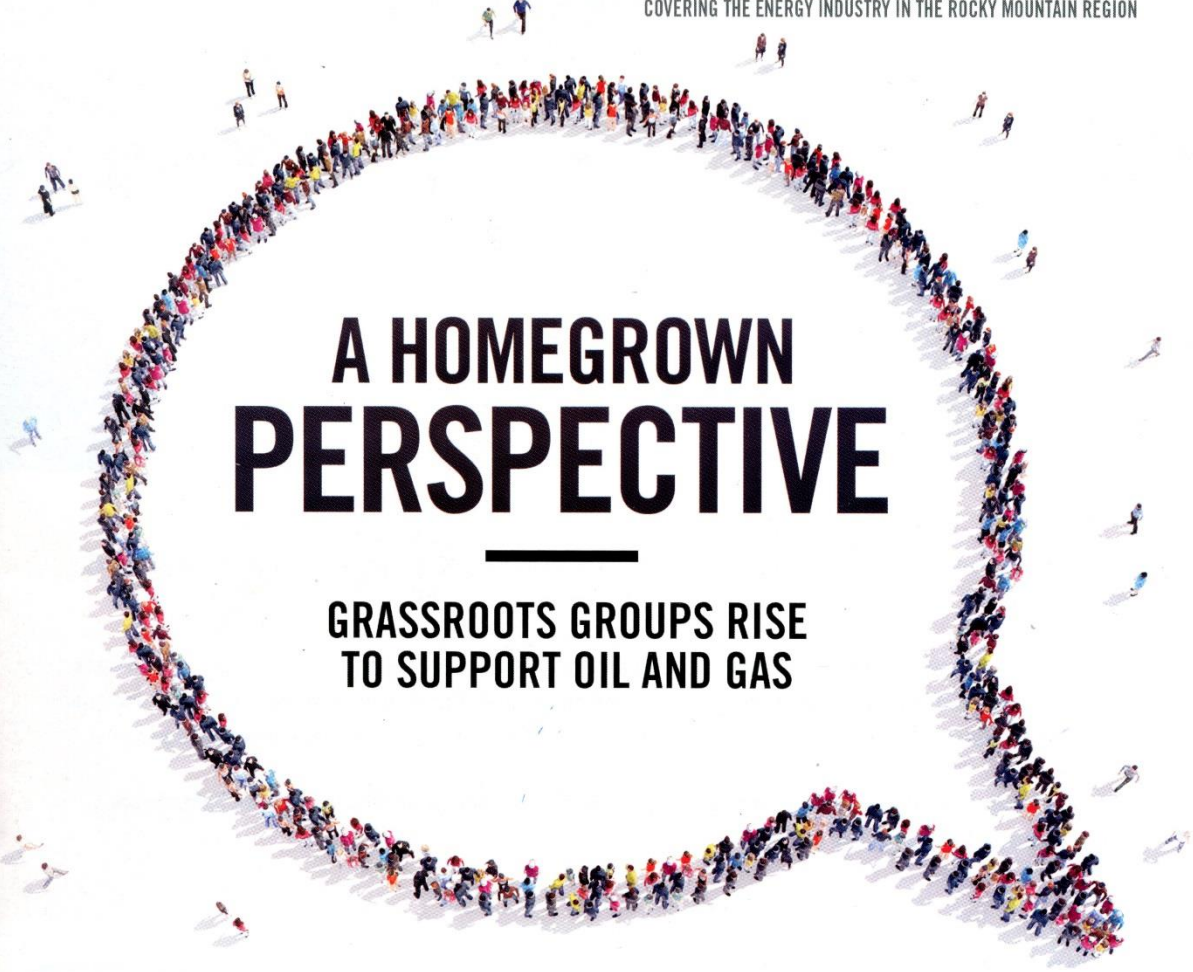




ENERGY PIPELINE

COVERING THE ENERGY INDUSTRY IN THE ROCKY MOUNTAIN REGION



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TECH TALK

IMAGES OF CHEMICAL CONCENTRATIONS IN SOILS USING INFRARED SPECTROSCOPY

BY GARY BEERS • FOR ENERGY PIPELINE

BEFORE DISCUSSING USE OF THIS TOOL in oilfields, a basic use of this tool is highlighted with a 2012 project conducted in Italy.

IMAGES OF SOIL COMPOSITION IN ITALIAN FOREST

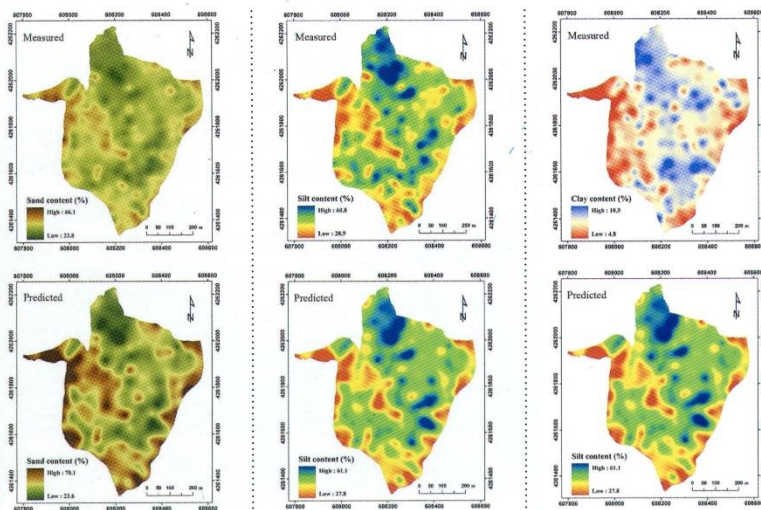
If you were assigned a project to map the percentages of clay, silt and sand for a large area of forest soils, you would likely collect many soil samples, perform particle size analyses, and use the results to develop percentage contours on a two-dimensional map. Certainly, this would be a

time-consuming and tedious effort. What if you could take a special photograph of this forest area and immediately produced the needed contour maps? Would the map based on the photograph be as accurate as the map based on actual soil samples?

A project comparing these two approaches was conducted in an Italian forest and described in a recent article ("Visible and near infrared spectroscopy for predicting texture in forest soil: an application in southern Italy," in the Italian Society of Silviculture and Forest Ecology, Volume 10, 2015). Comparisons of the contour maps are provided in the graphic. The information contained on maps based on infrared spectroscopy is essentially the same as



For over 50 years, **GARY BEERS**, has worked in numerous fields of environmental science as a consultant, regulator and educator. This career included senior management position with major consulting, nonprofit and public organizations. He has founded several successful firms to capture emerging resource management markets. One of his latest ventures, EnviroScienceINFO, provides content for public media.



the information based on actual field data (i.e., analyses of 235 soil samples).

IMAGES OF CHEMICAL CONCENTRATION IN OILFIELD SOILS

The above tool (which measures a soil sample's reflectance spectroscopy in the visible and near infrared spectral region) can be calibrated to provide an image of the soil area, with shaded areas corresponding to different concentrations of a specific chemical compound. The molecular-level vibrations generated by the bonds in each chemical compound generates a unique "fingerprint" that is used in calibration. The tool can be calibrated to detect variations in concentrations of various regulated compounds (i.e., benzene, methanol, phenol, naphthalene, and chrysene) and of typical organic chemicals in native soils (i.e., lignin, cellulose, and humic acids).

This fast, cost-effective, nondestructive approach to portraying a quantitative

snapshot chemical concentrations across a soil surface has an enormous potential for application in oilfields, especially related to environmental monitoring and remediation activities involving petroleum hydrocarbons. For long-term environmental monitoring, point-and-stare cameras could be pole-mounted to take time-lapse images of a soil area that may be at risk for petroleum releases. For periodic monitoring at various sites, hand-held cameras could provide images as many sites are inspected during a day. For soil remediation activities, initial images could provide a quick assessment of the extent of the problems and images taken during clean-up in the field could document the process, including attainment of end-point concentrations.

Advances in the use of this tool includes imaging of soil areas from drone-mounted cameras, as applied in precision agriculture.

OUTLOOK

The financial entry for using this tool is relatively low, especially when there is

repeated use - compared to traditional approaches involving soil sample collection, analyses, and data interpretation for mapping chemical contours. Consequently, there will be an initial wave of overwhelming amounts of environmental information which has to be incorporated into the decision-making processes for environmental management. Some period of time will be needed to understand the core value of this new information and how it is best utilized by these processes.

In the meantime, this tool will be invaluable as a means to rapidly monitor chemical status of key soil areas and, where a problem develops, a means to rapidly identify the size of a problem and document changes in soil chemicals as corrective actions are implemented. To comply with regulatory criteria, soil sample collection and analyses will have to be done in support of the use of this tool; however, this traditional data collection approach is expected to be reduced and confined to "ground-truthing" the chemical contours evident from visible and near infrared spectroscopy. ♦

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