# SURFACE HYDROCARBON DETECTION SHOWS PROMISE

**BOTTOM LINE**

Operators can use surface geochemical techniques for reservoir characterization, field development, and monitoring production patterns, as well as more established uses for high-grading leases, and prospects. Wider usage of surface geochemical exploration methods in mature basins also shows great promise.

## PROBLEM ADDRESSED

Hydrocarbon micro-seepage, which can be measured by various surface geochemical techniques, is common. Leaked hydrocarbons move predominantly in a vertical direction (with geological exceptions). Data confirm that oil and natural gas production levels respond quickly to changes in reservoir conditions. There are dependable pre-drilling methods available to quickly screen areas for oil and natural gas, such as surface geochemical prospecting technologies. These can be used in conjunction with other data to reduce exploration costs and increase success rates. After drilling, geochemical methods can be used to define the limits of production and identify bypassed hydrocarbons.

**KEY WORDS:**
Surface Hydrocarbon Detection
Geochemical Prospecting
Geochemical Methods
Hydrocarbon Leakage

## TECHNOLOGY OVERVIEW

Geochemical exploration surveys can establish the presence and distribution of hydrocarbons and relate them to specific exploration and exploitation needs. For reconnaissance surveys, seeps and micro-seeps are direct evidence that hydrocarbons were generated.

The composition of the seeps can indicate whether the geological play is most likely to contain natural gas or crude oil. The seepage data allow explorationists to quickly and economically screen large areas for targets of greatest interest. For example, reconnaissance surface geochemical surveys can be used to guide the location and extent of subsequent seismic coverage.

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**SPEAKERS:**

*Geochemical Technologies:*
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*Science & Statistics of Geochemistry:*
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*Data Integration:*
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*Prospecting Using Geochemistry:*
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*Canadian Hunter's Experience Using Geochemical Methods:*
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For evaluating exploration leads and prospects, geochemical surveys can identify areas associated with strong hydrocarbon anomalies. This allows operators to high-grade their prospects on the basis of hydrocarbon indicators. For development projects, detailed microseepage surveys can help evaluate infill or stepout drilling locations, delineate productive limits of under-developed fields, and identify bypassed pay or uncontacted reservoir compartments. Geochemical survey results add value to seismic data by identifying hydrocarbon-charged reservoir compartments.

The design and sampling of geochemical surveys are flexible—influenced by the exploration objectives, geological setting, and target size, among other considerations. For regional studies, data may be collected along seismic lines or designed to traverse across features of structural or geological significance.

Sample spacing for geochemical surveys may vary from 500 to 1,000 meters (m) at one extreme, to 50 to 100 m at the other. The use of sampling grids is recommended for small exploration targets. Whenever possible, operators should sample over a recent discovery to calibrate the data. In active fields, contours of microbial data may indicate low values adjacent to wells due to pressure depletion related to production. Bypassed production can be seen by isolated microbial anomalies ("highs").

## LESSONS LEARNED

1. Vertical micro-seepage of hydrocarbons (both oil and gas) is easily detected by surface geochemical methods. However, neither the depth of the reservoir(s) nor the amount of hydrocarbon present can be determined by geochemical prospecting.

2. Reconnaissance geochemical surveys used in conjunction with other data, such as 3-D seismic, provide an effective method to detect bypassed oil and determine the productive limits of a field.

3. Success with geochemical prospecting depends upon selecting the right method and using proper sample design and quality control. It also is necessary to have calibration to known oil and gas occurrences, and integration with other available surface and subsurface data.

4. The potential benefits of a successful geochemical exploration program include:

- Direct detection of hydrocarbons
- Documentation of source rock, hydrocarbon maturation, and migration
- Ability to high grade areas prior to purchasing leases or conducting seismic surveys
- Leads for further evaluation after running seismic surveys
- Geochemical data to constrain mapping of amplitude anomalies between seismic lines
- Evaluation of areas where seismic surveys may be ineffective
- Ability to locate traps poorly imaged with seismic

## FIELD RESULTS

Case histories document an excellent predictive capability for surface geochemical techniques. One study in the early 1980s in Kansas and Colorado used soil samples collected at 0.1-mile intervals within 0.5 miles of 49 proposed well locations. All geochemical analyses and interpretations were completed prior to drilling. Thirty-nine wells were subsequently drilled (ignoring the surface geochemical study), yielding three producing wells, three non-commercial wells, and 33 dry holes. The microbial survey correctly predicted all 33 dry holes, the three producing wells, and two of the three non-commercial wells. Additional case histories support surface geochemistry's ability to high-grade locations.

Case studies from a variety of petroleum provinces verify that integrating geochemical detection methods with 3-D seismic data can increase success rates, thus lowering oil and gas finding costs. Canadian Hunter increased its drilling success rate to 71% by combining geochemical techniques and 3-D seismic. This is more than double the drilling success rate of 34% using seismic data alone. By integrating geochemical data with 3-D seismic data, operators in South America achieved a 95% drilling success rate, and reduced their finding costs by 43%.

Within producing fields, geochemical methods can be used to define productive field limits and aid field development and management. Although the strategy cannot predict a project's economics, it can determine whether hydrocarbons are present in the target area.

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