

Managing Exploration Risks: Lessons Learned from Surface Geochemical Surveys and Post-Survey Drilling Results

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It has been long known and documented that most oil and gas accumulations leak, that this leakage is predominantly vertical (with some obvious geologic exceptions), and that this leakage can be detected and mapped using any of a number of direct and indirect methods. It has also been documented that the areal extent of the surface geochemical anomaly can approximate the productive limits of the reservoir(s) at depth. How reliably this can be done depends on the geologic setting, the choice of method, survey design and sample spacing.

Proponents of surface geochemical surveys contend that proper use of surface geochemistry -- and proper integration of geochemical results with conventional geologic and seismic data -- leads to better prospect evaluation and risk assessment. This may be true but the significance of surface geochemical anomalies in hydrocarbon exploration are not always readily apparent.

How can one quantify the value added by surface geochemical data when it is integrated with conventional exploration methods? One way to do so is to compare survey results with results of subsequent drilling. The results of such a comparison are summarized here for more than 1000 U.S. and International wells, all drilled on conventionally developed prospects after completion of surface geochemical surveys. The prospects are located in both frontier basins and mature basins, onshore and offshore, and occur in a wide variety of geologic settings. Targets ranged in depth from 300 meters to more than 4700 meters and covered the full spectrum of trap styles. Prospects were surveyed using a variety of geochemical exploration methods including free soil gas, sorbed soil gas, microbial, radiometrics, micromagnetics, etc.

Of all wells drilled, 52% resulted in commercial discoveries. However, **of wells drilled on prospects associated with positive geochemical anomalies 83% were completed as commercial discoveries. In contrast, only 13% of wells drilled in negative geochemical anomalies resulted in discoveries.** Had drilling decisions included consideration of the geochemical data, exploration success rates would have more than doubled!

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Pre-Drilling Geochemical Surveys and Post-Survey Drilling Results

Results of post-survey wells drilled on prospects associated with negative and positive geochemical anomalies. “Dry” means dry or non-commercial; “Discovery” means the well resulted in a commercial discovery.

<u>Location</u>	<u>Negative Anomalies</u>	<u>Positive Anomalies</u>
Amazon Basin, Brazil (Petrobras, microbial)	18/19 wells dry	6/16 wells discoveries
USA - CO, KS, NE (Barringer, microbial)	33/33 wells dry	3/6 wells discoveries
Western Canada (Can. Hunter, soil gas)	30/38 wells dry	10/14 wells discoveries
USA, Kansas Wildcats (Phillips, microbial)	55/68 wells dry	13/18 wells discoveries
USA, Williston Basin (Sun Oil, radiometrics)	43/54 wells dry	30/39 wells discoveries
USA and International (Santa Fe Min., soil gas)	42/43 wells dry	74/98 wells discoveries
Argentina, San Jorge Bsn. (Vintage Petro., soil gas)	0 wells drilled	155/164 wells discoveries
USA, Powder River Bsn (W. Curry, radiometrics)	18/31 wells dry	50/60 wells discoveries
USA – CO, WY, ND, IL (TPA, iodine)	53/58 wells dry	27/31 wells discoveries
Aberta, Canada (Topaz , micromagnetics)	8/11 wells dry	35/37 wells discoveries
USA, Texas (GMT, microbial)	7/8 wells dry	28/34 wells discoveries
Northwest Europe (Several companies, microbial)	112/117 wells dry	83/103 wells discoveries
SUMMARY of ABOVE	<u>419 of 480 wells dry</u> 87% dry; <u>13% discoveries</u>	<u>514 of 620 wells discoveries</u> 17% dry; <u>83% discoveries</u>

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