
Evolution of scientific surface geochemical exploration

The beginning of scientific surface geochemical exploration, that is, microseepage as opposed to macroseepage, took place in the 1920s at the prestigious Max Planck Institute in the work of Gunter Laubmeyer.

Laubmeyer was aware that gases could pass through metal, and he reasoned that gases under pressure could probably rise through the not impervious strata over an oil field. Laubmeyer needed to demonstrate that hydrocarbon concentrations in the air existed over an oil field, as contrasted with the near absence of hydrocarbons in the air away from the oil field. He created a technique, using microcalorimetry, to measure extremely small quantities of methane. Laubmeyer demonstrated that there was a critical contrast between methane in the air over an oil field and the near absence of hydrocarbons in the air away from an oil field.¹

Laubmeyer's demonstration of the vertical migration of hydrocarbons opened the door to a variety of different methods of surface geochemical exploration (e.g., direct hydrocarbon, radiometrics, geomicrobiology, radar, magnetic susceptibility, etc.) Laubmeyer's method was quickly embraced by V.A. Sokolov of the USSR Ministry of Geology, who advanced Laubmeyer's invention by developing a method of measuring ethane.² While methane may originate from many sources, the only known source of ethane in nature is petroleum. Sokolov, in 1936, was the first to observe that the ratio of methane content to heavier hydrocarbons at the surface could be used to distinguish between oil and gas at depth.³ Sokolov's work led to the widespread use of surface geochemical exploration in the former Soviet Union. Mogilevskii reported as early as 1935 that during that year there would be 13 active gas survey parties at work in the field.⁴ In his classic "History of Geophysical Prospecting," George Elliot Sweet wrote, "Russian enthusiasm has known no bounds and in the 1950s it was reported that the Soviets were maintaining as many as 300 geochemical crews in the field at one time."⁵

Blau's influence

The undisputed father of American surface geochemical exploration is Ludwig W. Blau of Humble Oil & Refining Co. (now ExxonMobil).

Blau read the published papers of Laubmeyer and Sokolov and developed a cheaper, easier (though merely qualitative) indicative technique. By Blau's own admission, his work in surface geochemical exploration was extremely simplistic, but he maintained that it successfully predicted many of Humble Oil's wildcat wells.⁶

Blau was aggressively opposed to reflection seismography and contended that many seismic highs were truly of a geochemical origin. He claimed that the vertical migration of hydrocarbons causes secondary mineralization of the strata above an accumulation which gives rise to higher velocity wave movements in the harder, mineralized strata; and that, in turn, is reflected as a seismic high.

During the annual research meetings of Standard Oil Co. (New Jersey) in the 1930s Blau reportedly would bang his fist on the table and proclaim, "Get rid of your seismic crews and geophysicists, all the oil that's been found could have been found using geochemistry without ever firing a single [seismic] shot."

Such statements tended to deeply antagonize geophysicists, especially since that was during the time when the great Gulf Coast oil fields were being found by reflection seismograph. Blau was prohibited from publishing, but his views became widely known and were tremendously counterproductive.⁷

Rosaire and McDermott

Two other eminent geophysicists, both pioneers in the introduction of seismography, pursued Blau's lead.

They were Eugene Rosaire, Blau's close personal friend, and Eugene McDermott, Rosaire's brother-in-law.

Rosaire was the president and one of the founders of the first and largest independent seismic contracting company, Independent Exploration Co. (IEC). He was convinced that the great future of oil exploration lay in surface geochemical exploration and not in seismic. Consequently, he sold his interest in IEC and started the first geochemical contracting company, Subterrex.

Having entered into a patent pooling agreement with Standard Oil Development Co. in 1935, Rosaire hired Leo Horvitz to perform further research in surface geochemical exploration.

McDermott, while still with the original Geophysical Service Inc. (GSI), through his relationship with Rosaire, became interested in surface geochemical exploration.

About 1939, GSI purchased an operating license from Subterrex and conducted a geochemical survey over half of Refugio County, Texas. GSI concluded that the geochemical method then available was not practical.

Shortly afterward, a meeting was held in the Houston offices of Humble Oil consisting of Blau, Rosaire, McDermott, and C.V.A. Pittman, McDermott's assistant. The purpose of the meeting was to inform Blau and Rosaire that the geochemical method then being employed by Subterrex needed further research.

On the drive back to Dallas with Pittman, McDermott hypothesized that the vertically migrating hydrocarbons might be creating a measurable soil alteration in the near surface that could be used to locate hydrocarbon accumulations.

Upon returning to Dallas, McDermott convinced his GSI associates, Everett DeGolyer and J.S. Karcher, to allocate \$1 million toward research aimed at finding surface soil alterations that he believed might be present over oil fields.

By 1940 the GSI geochemical division, headed by Ed Reagor and Jim Toomey, had investigated 13 different soil analysis methods. This involved creating a geochemical laboratory with a team of specialists operating 24 hr/day for a full year, not to mention several GSI field parties sampling soils in different kinds of geologic environments.⁸

In December 1941, GSI was purchased (for the sake of its oil producing properties) by a subsidiary of Standard Oil of Indiana with the provision that the seismograph division would revert back to Eugene McDermott, Bates Peacock, Cecil Green, and Eric Jonsson.

At the same time GSI sold its geochemical division to W.R. Ransone (another McDermott brother-in-law), Chal Pittman, Ed Reagor, and as a silent partner, Eugene McDermott. The company thus formed called itself Geochemical Surveys Inc., with Ransone as its president. Much later, in 1952, Rosaire joined the company and remained a senior partner until his death in 1959.⁹

The product of GSI's research was a unique carbonate caused by the oxidation of methane migrating from underlying petroleum accumulations. Carbon dioxide values were measured from near surface soil samples that were heated in the zone to 500-600° C. The technique was maintained as a trade secret, that is, a "black box," until shortly after McDermott's death in 1973.

Geochemical Survey's record

Geochemical Surveys Inc. operated primarily for its own account, largely because oil operators would not credit the company with the discoveries that came in behind its surface geochemical contracting.

GSI was an extremely successful company. In 1942-81, 174 geochemical anomalies were drilled resulting in 38 new field discoveries (of which 22 were stratigraphic traps) for a 22% new field discovery rate.¹⁰

About 1974 William Duchscherer purchased Geochemical Surveys Inc. but neither its oil producing properties nor its real estate. Duchscherer revealed the trade secret and called the indicator "Delta Carbonate." Geochemical Surveys Inc. went out of business with the death of Duchscherer in 1989.

Rosaire and Horvitz

From the start of their work Rosaire and Horvitz focused on the extraction of hydrocarbons adsorbed upon

soil particles. While the purpose was to achieve more reliable data, it also made possible the measurement of gases from soil in marshes as well as soil from the sea floor.

Initially the hydrocarbons were removed from the soil by heating the sample in a partial vacuum at temperatures below 100° C. When that proved inadequate Horvitz developed an acid extraction technique that released nearly all of the adsorbed hydrocarbons.

Until 1963, with the advent of the hydrogen flame gas chromatograph, Horvitz used a complex vacuum technique in analyzing the soil gases. Low temperature fractionation, in combination with sensitive McLeod gauges, were used to separate methane from the more significant ethane and heavier hydrocarbons and to measure both fractions.¹¹

It took about 5 years to perfect the Rosaire-Horvitz method, during which time Subterrex continued to do contract work for clients, with some success.

Overselling the method

By the late 1930s Subterrex was tending to oversell the capability of its surface hydrocarbon geochemistry. Difficulties relating to measurement and to the interpretation of results accounted for many dry holes.

Above all, there was the failure to appreciate the full significance of surface geochemistry's inability to determine the depth of an accumulation. This was particularly important in the Gulf Coast where the basement is very deep and where most of Subterrex's surveys were performed.

With World War II and the resulting falloff in exploration and with Horvitz called back to the University of Chicago to work on the atom bomb, Subterrex went out of business. After completing his work in Chicago, Horvitz founded Horvitz Research Laboratories in Houston, which he operated as a contracting company until his death in 1986.

In 1954 Horvitz reported a 59% new field discovery rate; 23 out of 39 prospects drilled.¹² Y.Y. Kuzmin of the USSR subsequently reported 26 out of 48 prospects drilled for a new field discovery rate of 54%.¹³

Horvitz's successes, just as those of Geochemical Surveys Inc., were not achieved on surface geochemistry alone but together with subsurface geology and-or seismic and in some cases with core drilling.

On where not to drill

In 1940 W.B. Lewis with Standard Oil (New Jersey), together with Rosaire and McDermott, reported on an especially important phenomenon: where not to drill a wildcat well. Thirty wells were drilled in areas condemned by the direct hydrocarbon soil analysis method, and 29 of the 30 negative predictions proved correct.¹⁴

In 1957 Horvitz reported on a 1944 hydrocarbon geochemical survey performed on the Gulf Coast for Crown Central Petroleum Corp.

At least 45 dry wildcat wells were drilled in the negative or condemned areas of that geochemical survey.¹⁵ As of 1994, 29 additional dry holes were drilled in the negative areas of that same survey.¹⁶

R.G. Behrman and J.P. Land in 1992 reported that in a Gulf of Mexico hydrocarbon geochemical survey area in which 89 anomalies were found, there were 160 dry holes drilled in the negative nonanomalous areas.¹⁷ Kuzman in 1983 wrote that of 19 areas not recommended for drilling and which were drilled anyway, 15 were dry holes.¹⁸

Cosden Petroleum Co. in 1951 ran a seismic survey over the approximately 18,000-acre Parkey Ranch in Baylor and Knox counties, Texas, and found several seismic prospects.

Subsequent to the seismic work, Horvitz performed a geochemical survey over the seismic prospects and predicted that all but the smallest seismic structure would be dry, and that one would become a producing field.

Four wildcat wells were drilled on the larger seismic prospects and the structures were found to be present but without porosity and hence without a reservoir. The smallest seismic prospect, which was also a hydrocarbon geochemical prospect, did have porosity and became Parkey (Caddo) field in Baylor County. The field has produced over half a million barrels of oil.¹⁹

Geochem on Destin Dome

In the 1970s Exxon and Mobil were looking for a partner to take a 17% interest in their Destin Dome block in the eastern Gulf of Mexico off the Florida Panhandle. It was a very large seismic structure with a significant bright spot anomaly.

Tenneco, Sun Oil, and Pogo (then a subsidiary of Pennzoil) hired Horvitz to do a seafloor surface geochemical survey of the prospect. Because he found no anomaly, none of those companies participated in the deal. Champlin Petroleum Co. did participate and reportedly dropped \$127 million on the unsuccessful prospect.²⁰

It would appear from these experiences that the best use of surface hydrocarbon geochemistry (when properly applied) is to determine where not to drill a wildcat well.

GSI's return

In 1956 McDermott, very much aware of Geochemical Surveys Inc.'s success, proceeded to put GSI into the contract geochemical survey business.

Don Saunders was chosen to set up a geochemical laboratory within GSI. Saunders reviewed and even improved upon Geochemical Surveys Inc.'s technology. Unlike Geochemical Surveys Inc., which could act as an independent oil operator, GSI was self-restricted to providing only contract surveys.

In 1960 Saunders attempted to sell GSI's geochemical surveys to 66 oil companies in Europe, Africa, and North America. Because GSI treated its method as a trade secret, only two sales were made, one of which was to Sinclair Oil Co.

Sinclair had spent some \$500,000 on a GSI seismic survey in Val Verde County, Texas, and was proceeding to drill a 15,000-ft test on the seismic prospect that was found.

Sinclair then decided to run GSI's surface geochemical survey over the entire seismic area at a cost of \$33,000. No anomaly was found over the seismic prospect, and the wildcat well was a dry hole. The seismic structure proved to be a velocity anomaly.

Immediately thereafter GSI shut down its geochemical operation based on the sound business principle that it was better to sell \$500,000 worth of seismic than to sell \$33,000 worth of geochemistry. GSI was clearly in the business of selling seismic; it was not in the business of finding oil.²¹

Twenty years later, in 1982, GSI once again entered the surface geochemical contracting business using the Rosaire-Horvitz acid extraction technique together with hydrogen flame gas chromatography. Surface geochemistry was sold as a reconnaissance tool to promote the subsequent sale of GSI's seismic services over any geochemical anomalies that might be found.

Texas Instruments sold its GSI subsidiary to Halliburton in 1988, and Halliburton in 1993 sold the surface geochemical division to its managers to continue to operate as GeoFrontiers Corp. F

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