SOUTHEASTERN E & P SERVICES, INC.
"Excellence in the Field"

GEO-Chemical Exploration Services

Southeastern E&P Services, Inc.
William Carlton, President
PO Box 682 Magee, MS 39111
601-849-9218 (Office) 601-849-5244 (Fax)
SoutheasternEandP.com

Introduction to Southeaster E&P

Southeastern E & P Services, Inc. was formed to provide quality geochemical services to oil & gas operators in the Southeast US. As an independent contractor for GRDC, Inc. of Lakewood Colorado, we endeavor to provide the absolute best in geochemical technology available. Southeastern E & P Services, Inc. provides services in Arkansas, Louisiana, Mississippi, Alabama, and Florida. For surveys in other areas, give Southeastern E & P Services, Inc. a call, and we will refer you to your nearest representative or give GRDC, Inc. a call directly.

Please review the information contained in this brochure carefully. If you are unfamiliar with geochem techniques, we hope you will come away with an understanding of the technology as it relates to hydrocarbon exploration and what it can do for your exploration program. Of course, if there are any technical questions, we would encourage you to contact Mr. Al Gallagher at GRDC, Inc. at 303-986-2783.

Thanks for taking the time to review this valuable information. We hope we can help reduce your dry hole risk for you and your investors.

Our Mission

"To provide the utmost quality in sample acquisition and customer service as mandated by GRDC and to ensure customer satisfaction with the services rendered."

Introduction to S.T.E.P

During the past thirty years, as geologists and geophysicists, we have evaluated four geophysical techniques (other than seismic), and over thirty elements and compounds, using various digestion and extraction methods. Bacteria and numerous hydrocarbon techniques work to some degree under varying circumstances. Our goal has always been to develop techniques that are:

1. Objective
2. Repeatable
3. Cost effective
4. Universally applicable to finding oil and gas

To our knowledge, no single **S**urface **T**echnique for the **E**xploration of **P**etroleum (STEP) can tell the "Operator" if an oil or gas accumulation is commercial, with appreciable objectivity. However, properly applied multiparameter STEP techniques should be able to demonstrate if a potential drill site will be dry or just have minor shows. This is irrespective of how good the geology and seismic pictures are. Accuracy in this area approaches 100%.

When STEP indicates that an area might contain hydrocarbons, it can often provide an indication of the type of fluid contained within the reservoir, (i.e., gas, gas condensate, light, medium, or heavy oil) and in many instances indicate the relative age of the reservoir fluid (i.e., Tertiary, Cretaceous, Pennsylvanian, Mississippian, etc.). In some areas where an adequate database has been established, more specific calls can be made. For example, in southeast Colorado, we can usually distinguish Marmaton from Morrow signatures.

We have endeavored to make STEP as practical, objective and easy to use as possible. This includes data reduction, interpretative software to satisfy not only the geochemical earth scientist, who thrives on raw data and sophisticated statistical analyses, and also the explorationist that simply wants to know: "Do I drill or do I walk away?" We have also learned through experience that sample density and areal extent are proportional to the degree of certainty of survey results.

> **QUESTION:**
> **IF YOU HAD A TOOL THAT COULD TELL YOU WITH CERTAINTY, WHETHER OR NOT A WELL YOU WERE ABOUT TO DRILL WOULD BE DRY, COULD YOU AFFORD NOT TO USE IT?**

For greater efficiency, we designed and built our sample acquisition systems, as well as customized the analytical procedures to make them not only accurate, but rapid and cost-effective. Are we saying that we have advanced oil finding technology? We believe we have. There is no longer any question that the STEP techniques as practiced by GRDC and SEEP, are now the most effective "tools" for finding new oil and gas reserves in onshore areas. We have made significant technological advances, developed a large experience factor, and are still learning.

Exploration Today

The modern STEP (**S**urface **T**echniques for the **E**xploration of **P**etroleum) approach developed by GRDC and used by SEEP for use in new exploratory areas, differs markedly from the classical, surface-remote sensing, subsurface, seismic exploration sequence. SEEP, using cost-efficient, rapid reconnaissance techniques (radiometric and/or remote-sensing and GRDC's hydrocarbons), locates oil and/or gas anomaly first, then works up the associated geology. This approach negates the necessity for large time-consuming detailed geologic subsurface studies. It permits the geologist to concentrate his efforts immediately on specific target areas that have already been shown to have a legitimate oil and/or gas potential. Using detailed STEP, the prospects are prioritized, and detailed subsurface geologic studies are completed over the prospects. At this time, if a potential prospect appears to involve a structural trap, some detailed seismic data might be acquired over that prospect area prior to drilling. Upon commencing exploratory work in a new area, the STEP approach permits the development of multiple, drillable prospects in a matter of weeks, thus minimizing the finding cost per barrel of oil.

Step Theory

All conventional oil or gas fields experience microseepage to one degree or another, irrespective of depth or the type of rock encountered from the reservoir to the surface. This micro-seepage forms a "geochemical chimney" effect from the reservoir to the surface. Within this chimney, the seeping hydrocarbons provide an easily obtainable food source for various microbes. These microbes within the chimney cause a decrease in the normal reduction/oxidation (Eh) potential and an increase in the pH. They also alter the electrical properties within the chimney. Depending upon the mineral composition of the rocks within the chimney, the microbes condition the chimney for the many chemical changes that may take place. These chemical changes form the basis for many of the indirect techniques used to locate anomalous areas of hydrocarbon microseepage on the surface.

The microseepage within the chimney has empirically been shown to be essentially vertical, irrespective of structural complications, such as faults, steep dips or strong hydrodynamic gradients. The strength of a surficial hydrocarbon microseepage signature related to an oil gas field at depth, appears to be a function of the **reservoir pressure**. Furthermore, the utilization of ratios between components within the surficial hydrocarbon microseepage signatures is an aid in determining various aspects of the potential reservoir.

GRDC has developed a field method of acquiring soil gas hydrocarbons that GRDC and SEEP believe is the simplest, most reliable and cost effective in the industry. We include with the hydrocarbon analyses, at no additional charge, pH, Eh and Conductivity measurements. These provide a confirmation role for the hydrocarbons as well as providing stand-alone information. In GRDC's opinion, hydrocarbons are the only STEP that can be used to pinpoint an actual drill site and accurately delineate a potential reservoir. The hydrocarbon technique, when properly applied, has no problem in defining stratigraphic traps and narrow hydrocarbon bearing channels.

Over potential drill sites that have been previously defined by geology and seismic, GRDC's hydrocarbon STEP is used to determine whether or not oil and/or gas is present. A standard drill site evaluation package is a grid laid out using a twenty five sample minimum on 330' x 330' sample pattern with sample 13 located at the well stake. GRDC ***recommends*** this pattern for proper evaluation and false fracture signature elimination.

Benefits of Integrated Technology

Each STEP technique develops tremendous amounts of data and yields useful information by itself. Collectively, they are the most powerful oil and gas exploration tools in existence. With the evolution in computer aided statistical analysis and multi-parameter STEP cross-correlation techniques, the ability to detect and evaluate hydrocarbons at the surface have been greatly enhanced.

GRDC was the first to use these new technologies collectively to locate potential oil and gas deposits. GRDC is unique in that it has statistically integrated several of these independent technologies, making it easy to use the STEP data with conventional geology and seismic data. Each detection technology may be thought of as a STEP. The more STEPs giving a positive indication, the greater the chances of finding commercial hydrocarbons.

Conversely, GRDC firmly believes that a negative indication from the utilization of STEP data will almost insure that a well drilled in that location will prove to be dry. Since its inception, only a small percentage of wildcat or semi-development locations condemned by GRDC has ever established commercial production, irrespective of how good the geology or seismic data appeared.

The Missing Link

By: A.V. Gallagher, GRDC

**used with permission by GRDC*

Since the late 1940's the seismic reflection method of exploration has been the primary exploration tool in use for the exploration for petroleum. It has been supplemented and aided to a small degree by subsurface geologic studies and to an even lesser degree by various rudimentary reconnaissance geochemical techniques. However, the seismic tool, even with today's most sophisticated 3-D technology is realistically only capable of objectivity defining the structural attitude of the sediments.

As any petroleum explorationist will readily acknowledge, we have all been taught that petroleum exploration requires three elements: source rock; a trapping mechanism; and reservoir rock. The seismic tool is the ultimate exploratory tool for the definition of a structural trap and determination of the orientation and magnitude of faulting. It cannot ascertain anything relative to source rock or, for practical purposes, reservoir rock. For many years this was adequate since there were many petroleum reservoirs that are contained in structural traps of one form or another such as: anticlinal traps, fault traps or unconformity traps.

Yet it is well known that many of the world's largest oil fields are found in stratigraphic traps and their discovery was not by seismic.

It has been known for many years that the tools of geochemistry are for practical purposes useless in the definition of the structural attitude of sediments and therefore are of no value in the attempt to locate structural traps. However, the tools of geochemistry are the most sensitive tools that we have for the identification of hydrocarbon microseepage. It has only been in the last ten to fifteen years that the principal of vertical migration of hydrocarbons from any depth, through any type of sediments has been recognized, documented and accepted, by those who have specialized in the subject, in the professional earth science community.

What does this mean in terms of oil and gas exploration? If we have vertical hydrocarbon microseepage then we should be able to locate the surface geographic limits of any oil and gas reservoir, at any depth, irrespective of the trapping mechanism. And if we have oil or gas microseepage then we must also have a source rock present otherwise we would have no hydrocarbon microseepage. Thus modern surface geochemistry as developed and practiced by GRDC directly addresses two of the three concerns of the explorationist, namely source rock and reservoir rock. The third concern, that of a trapping mechanism is indirectly addressed, in that you cannot have a hydrocarbon accumulation unless some type of trapping mechanism is in effect, be it structural or stratigraphic.

Thus from the theoretical standpoint of the explorationist, geochemistry satisfies all three requirements of the petroleum explorationist: source rock; reservoir rock and trapping mechanism. Seismic satisfies only the component identification of a structural trapping mechanism. ***The question is, would you rather find oil and gas or a structural trap?***

How does this translate into practical exploration practice? The field of exploration geochemistry has been around almost as long as seismic. Unfortunately, it remained stagnant for many years principally because of the reluctance to acknowledge and accept the principle of vertical migration. And confusion associated with halo and apical signatures form various tools of geochemical exploration. There have been many new geochemical tools developed in the past ten years that have enhanced our ability to locate areas of hydrocarbon microseepage. Most of these tools are what we would classify as reconnaissance techniques. That is they can define a geographic area of hydrocarbon microseepage, but that is as far as they can go.

GRDC, and its principals, have been actively engaged in the research and development of various tools of geochemical exploration for over twenty years. We developed the iodine technique (still in commercial use in some areas); the chelated metal suite interpretative approach; the lightly adsorbed hydrocarbon acquisition technique; the use of Eh, pH and soil electrical conductivity; the first use of large volume sodium iodine crystal detectors in digital acquisition of ground radiometric data; the development of hydrocarbon analytical procedures to permit high quality, routine economical analysis of hydrocarbon samples; the development of sophisticated statistical analytical procedures for the interpretation of hydrocarbons; and the development of a new gamma ray spectrometer to permit resolution of gamma ray data to the 1-1/2 Kev level with 2000 channels of data. GRDC is recognized in the industry as a leader in the field of geochemical exploration.

Would you rather find oil and gas or a structural trap?

GRDC's lightly adsorbed hydrocarbon acquisition system, in conjunction with its high quality analytical procedure and its hydrocarbon interpretative technique permits it to perform a reservoir characterization analysis on a petroleum reservoir from surface samples taken at a depth of approximately one meter. What is a reservoir characterization analysis? GRDC can provide the API gravity usually within +/- 2 degrees; a relative GOR (gas/oil ratio); determine whether the geochemical signature is emanating from a clastic or carbonate reservoir; and the relative geologic age of a geochemical microseepage signature. If the hydrocarbons are from a known productive horizon then the surface signature can often be used to identify the specific formation from which the signature is emanating. One of the most important developments of the new technology is the ability to analyze the hydrocarbon microseepage signature and determine whether it is emanating form one, two or three or more horizons. This eliminates one of the most significant problems encountered with other earlier geochemical technologies. Previously, when a strong anomalous geochemical signature was encountered, it was not possible to tell whether that signature originated in one stratigraphic horizon or was merely the summation of several good show intervals, none of which individually would be strong enough to represent a commercial reservoir.

GRDC with the utilization of the new technology, according to one of our clients on work performed for them, in the eastern United States, has achieved a mid 70-percentile commercial wildcat success rate over the past ten years. This success rate is from wildcat wells which have been drilled, not over surveys of existing fields which is relatively meaningless. To our knowledge, no other major oil company or private commercial geochemical contractor can even remotely approach the objectivity, definition and delineation achieved by GRDC and the application of its reservoir evaluation technology. Technology by itself is inadequate. Equally important is the experience gained over the years in the application and utilization of that technology to make it fully effective.

GRDC has several exploratory tools that it has developed, other than the new highly developed hydrocarbon technology that it uses depending on the status of a given exploratory project. Geochemistry, unlike seismic, can, and should be done in stages. Economical, reconnaissance techniques should be used initially to ascertain and localize an area of interest in most large-scale projects. This should then be followed up with the hydrocarbon techniques to confirm the reconnaissance work with a small initial program. If the small initial hydrocarbon program is successful, then the area of interest should be fully covered with a 100-meter grid of hydrocarbon samples over the apparent most favorable area to select a specific drill site for an exploratory well.

On dry land areas these techniques are at the very minimum as fully successful as the most sophisticated 3-D seismic in current usage at a fraction of the cost. GRDC has developed the sophisticated technology and in the development of that technology has gained the experience in how to use that methodology. GRDC is more than willing to share what it has learned relative to the technology that it has developed and how to apply that technology in the economic evaluation of large acreage tracts.

Techniques

Hydrocarbons

GRDC uses a nine-component hydrocarbon analysis including the saturated hydrocarbons Methane through Pentane, the unsaturated hydrocarbons Ethene and Propene, and the isoalkanes, isobutane and isopentane. The analysis is performed using standard gas chromatography.

Hydrocarbons seep naturally from the reservoir to the surface and are detected in minute amounts within the soil matrix, either as pore gas or as lightly held molecules on the soil grain surface. GRDC uses a bulk soil sample for analysis so that any free or loosely held hydrocarbons present would be captured in the sample " ***headspace*** " upon sample preparation. Tightly held " ***occluded*** " hydrocarbons are not removed in the sampling or preparation process and are not available for analysis. Therefore, the signature obtained will be " ***apical*** " or coincident with the hydrocarbons at depth instead of a " ***halo*** " configuration where the anomalies would be associated with the periphery of the reservoir at depth.

GRDC uses a three **STEP** (**S**urface **T**echniques for the **E**xploration of **P**etroleum) exploration program when running surveys. The primary role of surface geochemical exploration is anomaly detection. Is a statistically valid signature present? A reconnaissance survey is used for this purpose and can be either a sample traverse or loose sample grid. Once an anomaly is located a detailed survey is run to delineate aerial extent and verify the source of the hydrocarbons as being either ***biogenic*** or thermogenic. This step is accomplished through high-density sampling and multivariate data processing procedures. Characterization of the anomaly is the final step. Comparison of compositional ratios with known analogs allows estimates of reservoir age, maturity and fluids to be made. This can be very diagnostic when integrated with existing geology and geophysics.

> GRDC USES A THREE STEP EXPLORATION PROGRAM WHEN RUNNING SURVEYS.

Great strides have been made in surface geochemical surveying. Exploration now spans any number of techniques or combination of methods. GRDC always recommends a multi-parameter approach and provides several ***indirect*** methods in conjunction with the hydrocarbon surveys, which allows for a complete evaluation of a prospect.

Eh, pH, and Conductivity

The study of oxidation-reduction processes in soils began in the early 1900's and has since been applied to biological, limnological, and geochemical systems. Early petroleum related studies concerned the redox characteristics of sediments, the preservation of organic material, and the ultimate generation of petroleum. Ground water investigations showed that water with hydrocarbon gases are distinguished by low redox potentials. Other subsurface studies proposed the use of a redox-logging tool. Early near surface oil exploration studies started with the Hilbig Oil Field and have led to the development of electrode arrays for the in-situ analysis of near surface redox potentials.

Two models have been proposed which would explain the presence of redox phenomena in near surface soils over oil fields. The first model promotes the mineralogical oxidation of the vertically seeping hydrocarbons are the primary cause of redox lows detected in the near surface. Early theories suggest that natural zeolites in the reservoir seal initiate the cracking of large aliphatic hydrocarbons in smaller molecules which result in a net negative charge within the area of hydrocarbon microseepage. The adjacent oxidizing areas establish a path of electrical flow from the electron generating oil reservoir. The current theory relies on hydrocarbon, rock, and water interactions that produce organic acids and acid anions (OAA's). For instance, iron oxides react with hydrocarbons to produce pyrite, oxygenated organic compounds, and CO2.

The second model states that the redox anomalies associated with oil fields are related to microbial oxidation of the vertically seeping hydrocarbons, and not to the hydrocarbons themselves. Low molecular weight hydrocarbons, which are most often associated with near surface direct hydrocarbon techniques, have a very low reactivity caused by their saturated bonding. These bonds can only be broken under strenuously reactive conditions. By oxidizing the hydrocarbons, the microbes mediate changes in available reactive chemical species that can take up liberated electrons, thereby changing the mineralogy above hydrocarbon deposits. GRDC provides the Eh and pH methods as a suite free of charge with the hydrocarbon analysis or as a quick reconnaissance exploration tool using near surface soil.

Radiometrics

The purpose of gamma-ray spectrometry is to provide information about the distribution of the three radioactive elements, uranium, thorium, and potassium. The distribution of these elements with regard to hydrocarbon exploration is significant. As with many other elements, uranium, thorium, and potassium, and their isotopes, are affected by the alteration effects of hydrocarbon microseepage. Radiometrics is a term applied to the measurement of the gamma ray spectrum at three specific windows where emissions for uranium, thorium, and potassium are located. Bismuth 214 represents the Uranium window at 1760 Kev (thousand electron volts), Thallium 208 represents the Thorium window at 2620 Kev, and Potassium which has a single emission energy at 1460 Kev. A standard interpretation for hydrocarbon exploration consists of looking for decreases in gamma emissions from all of these windows, except thorium or a decrease in the total count. Changes in radiometric response can also be attributed to road surface changes, outcrops, drainages, road cuts, and road fill. Keen observation is the key to culling the false anomalies from the seepage anomalies.

Radiometric survey's can be run as a continuous profile or as discrete points. Traverses run as continuous data can yield a considerable amount of detail with regard to signal character by showing the location of faults and fractures, radiation halos, and traditional seepage anomalies. Though the character of the signature is missing, the discrete points yield a more visual interpretation of the spatial extent of the radiometric highs and lows. As with any survey, the greater the sample density the better the interpretation.

Radiometrics is a first wave culling tool for reconnaissance geochemical surveys. It should be used to delineate anomalies that can be tested for the presence of hydrocarbons using other surface geochemical techniques.

A gamma ray spectrometer is a device that separates gamma radiation into two or more energy components. Spectrometers require a detector and a device to analyze the signal. The detector, normally a sodium iodine crystal, absorbs the gamma radiation and converts it to a light flash or scintillation. The light is received by a photomultiplier tube which converts the light flash to a voltage proportional to the intensity of the light flash. The counting device then separates the voltage into a number of magnitude dependent classes which represents the energy spectrum of the incident gamma rays.

Most of the useful gamma emissions, for petroleum exploration, are located in the low energy range of the spectrum below Potassium 40.

Acquisition of radiometric data does require a knowledge of the variables that can affect the gamma ray signal. In addition to the normal variables of geometry and physical property contrasts, it is necessary to consider the size and the efficiency of the detector, the speed at which the detector moves, the effects of meteorological variables, topography, and cultural influences.

Large detector crystal volume of 112 cubic inches minimum, is the most important aspect of radiometric surveying, The larger the volume the higher the number of gamma counts that can be collected. This equates to the greater sensitivity that is required to detect the secondary alteration of near surface microseepage anomalies.

The count observed during any specified period of time in any particular radiation environment is directly proportional to the volume of the crystal detector and the minimum speed of the vehicle.

Moisture content in the soil or air may cause variations in the gamma ray readings. Standing water or snow will yield strong lows due to absorption. Small crystal volumes require a recovery time of about 3 hours after a rain storm, though such affects are negligible when using large detector volumes.

Depending on the source of the radiation, barometric pressure might be a variable. Radon can influence radiometric readings such that high pressure might suppress gamma counts or low pressure might enhance the number of counts.

Ideally radiometric surveys should be run over flat featureless terrain or areas with few outcrops or lithologic changes. Difficulty of interpretation is proportional to the ruggedness of the topography making it harder to discern seepage anomalies from those related to lithology. Changes in radiometric response can also be attributed to road surface changes, outcrops, drainages, road cuts, and road fill. Keen observation is the key to culling the false anomalies from the seepage anomalies.

Radiometric surveys can be run as a continuous profile or as discrete points. Traverses run as continuous data can yield a considerable amount of detail with regard to signal character by showing the location of faults and fractures, radiation halos, and traditional seepage anomalies. Though the character of the signature is missing, the discrete points yield a more visual interpretation of the spatial extent of the radiometric high and lows. As with any survey, the greater the sample density the better the interpretation.

Radiometrics is a first wave culling tool for reconnaissance geochemical surveys. It should be used to delineate anomalies that can be tested for the presence of hydrocarbons using other surface geochemical techniques.

Bacteria

Bacteria are ubiquitous in the environment but will concentrate where a food source is available. Hydrocarbon microseepage from oil and gas reservoirs provide this food source. Microbial activity provides a catalyst for the various “redox” chemical reactions that occur within a live seepage anomaly. Oxidation of the hydrocarbons provides an electron rich environment for these reactions.

Bacteria are available that use specific substrates such as ethane, propane, or butane. GRDC uses a method that is non-specific and primarily looks at aerobic bacteria that live in very near surface soils which can oxidize any number of organic substrates. The culturing is fairly rapid (36 to 48 hours) and results in a color change that is equivalent to the microbial concentration.

Iodine

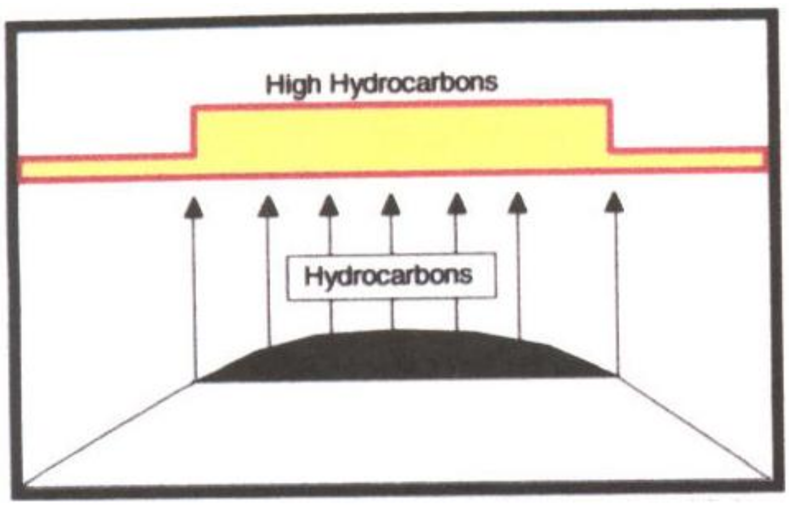
Iodine is one of the halogens, the most reactive group of elements in the periodic table. This group includes fluorine, chlorine, bromine, and iodine. The halogens are prominent anions in the environment, forming largely ionic molecules. They are powerful oxidizers as neutral atom free radicals. The halogens form diatomic molecules that are gases at normal temperatures and pressures and therefore are mobile and play significant roles in the atmosphere, hydrosphere, and biosphere.

Iodine, as a halogen, needs an electron to complete its octet. The size, weight, and electron density of iodine produces weak chemical bonds. All of the natural halogens can and do replace iodine from almost any molecule. Iodine is continually losing its shared electron and is forced out as either the gaseous/solid mobile diatomic molecule or the reactive free radical. Iodine ends up at the interfaces, aqueous/sediment and gaseous/solid, seeking an electron with little hope of ever maintaining it once it is acquired.

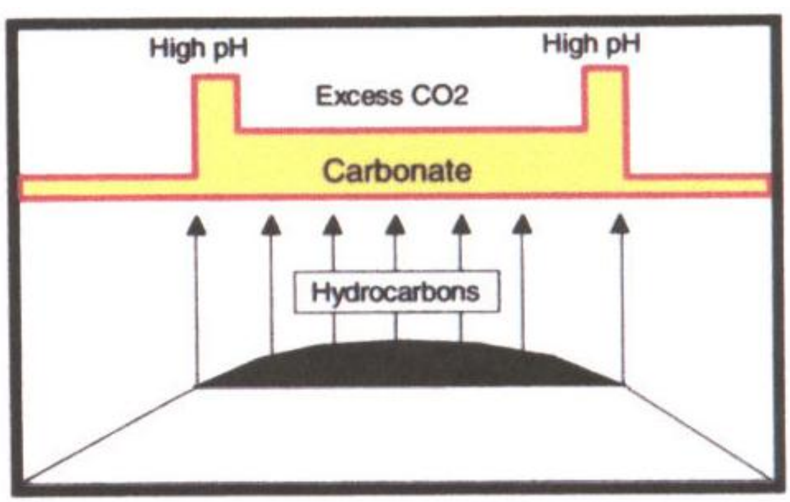
Recent research indicates most or all of the iodine in the soil is related to hydrocarbons. These compounds are a complex mixture of iodoorganics ranging from iodomethane to humic-iodine.

Soil iodine enrichments and light hydrocarbon seepage have been directly correlated. Iodine enrichments over hydrocarbon seepage sometimes exceed 10 times the average background. When iodine is organically bound to hydrogen, the hydrocarbons become immobile. The iodine then congregates at this source of electrons. If the hydrocarbons stop, the iodine disperses continuing its search for another electron source.

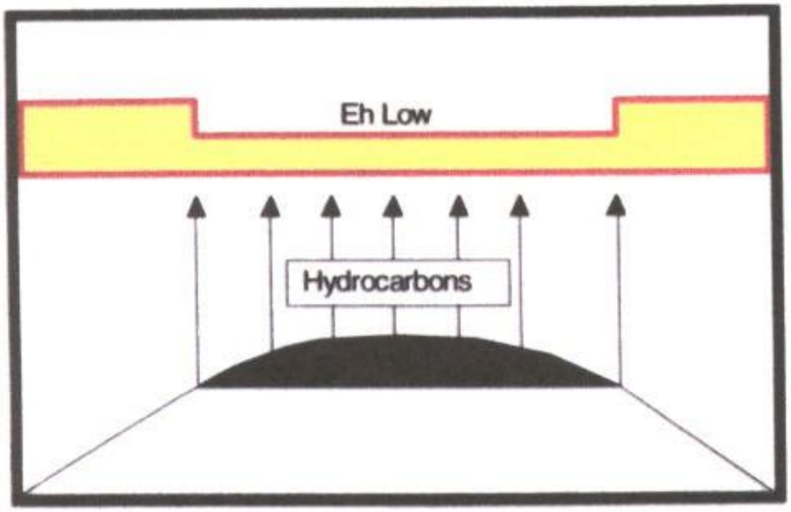
Anomaly Signatures



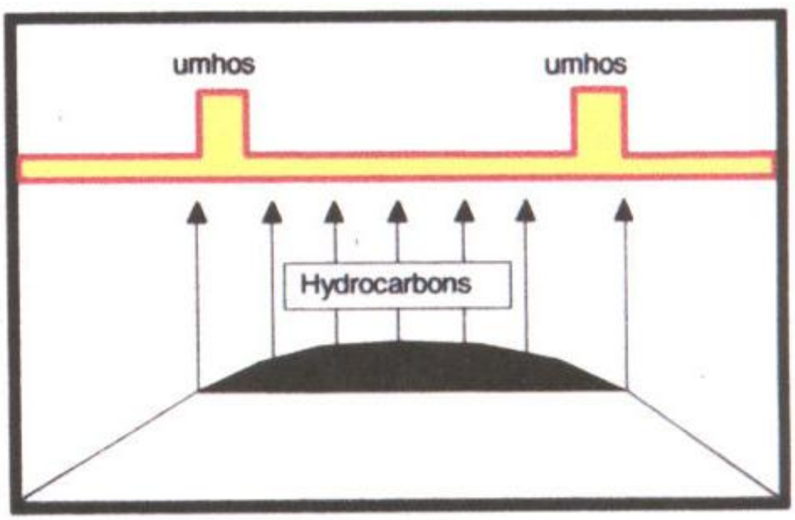
Apical hydrocarbon anomaly. The hydrocarbon highs are coincident with the reservoir at depth.



pH halo. The high pH values occur at the edge of the microseepage anomaly. The precipitation of the calcium carbonate causes a slight pH increase over the microseepage area.



Apical Eh or redox anomaly. Eh values decrease over hydrocarbon microseeps. This is often referred to as the "geochemical chimney". Low Eh values are often associated with moderate to high pH measurements.



Conductivity halo anomaly. Conductivity anomalies are associated with salts or ionic material in near surface soils. The salts accumulate in the higher pH regime at the edge of the microseepage anomalies.

Hydrocarbon Ration Explanation:

M1 = P/M x 10^3 **M2 = M/E** **M3 = %M**

Standard interpretive rations where M is methane, E is ethane, and P is propane. These values fall into specific windows which indicate the presence of oil, gas-condensate, or gas.

	GAS	GAS/CON	OIL
M1	2-200	2-15	60-500
M2	200-20	20-10	10-4
M3	100-90	90-75	75-45

%W

The wetness factor is an estimate of wet gas content, which in turn is an estimate of the degree of catagenesis. During catagenesis two zones are formed, the oil zone and the wet gas zone.

% WETNESS	
OIL	15-30
GAS-CON	5-15
DRY GAS	0-5

Ra, Rb

Ra is used to determine significant outliers which are outside the apparent background and may have been affected by reservoir depletion, bacterial degradation, water action, or are not within the productive region. When Rb exceeds unity bacterial attack is indicated. These ratios are a measure of various combinations of isoalkanes to normal alkanes. Bacteria tend to prefer normal alkanes relative to isoalkanes. The ratios should increase as the bacteria consume the normal alkanes.

Q1, Q2

Q1 values decrease from unity with maturity. This value indicates where the samples are located within the oil or gas generating windows and does not necessarily reflect the presence of hydrocarbons. Unity approximately corresponds to the early wet gas zone (R_o =0.35). When the value is less than 0.8 the gas is dissolved in oil, extracted from oil, or is or was in contact with oil. When the value is greater than 0.8 then the gas was never in contact with oil, i.e. is there an absence of oil or insufficient maturation to generate oi?

Increases in Q2 indicate a greater maturity while decreases in Q2 indicate a lower maturity.

(Q1 is the ratio of isobutene to normal butane.)
(Q2 is the ratio of total light alkanes to total alkanes without a methane influence.)

GOR 1, GOR 2

GOR 1 values greater than 1.9 indicate a very high GOR, values of 1.6 indicate an intermediate GOR, and values of 1.4 and lower indicate a low GOR. High GOR 2 values indicate a dryer more mature gas. Low GOR 2 values indicate an immature early wet gas. Values > 50 may indicate methanogenesis.

(GOR 1 is a measure of light alkanes with a methane influence.)
(GOR 2 is a measure of methane to the sum of the light alkanes.)

A1, A2

A1 and A2 can be used to indicate the type of reservoir from which the hydrocarbons are leaking.

	A1	A2
LS	0-0.12	0-12
LS/SS	0.12-0.15	12-20
SS	0.15-.0.20	20-36

BH

Bh is the ratio o flight to heavy hydrocarbons and is intended to give an approximation of hydrocarbon gravity. The larger the value the light the oil present.

CH

CH will yield an estimate of oil associated gas. Values less than 0.5 when BH is greater than 10 indicates the presence of oil associated gas.

C2C2, C3C3

C2C2 is the ratio of ethane to ethane and C3C3 is the ratio of propane / propene. Because reservoir hydrocarbons do not contain unsaturated hydrocarbons these ratios can be a measure of the percentage of the signal that is related to microseepage. Values greater than unity may indicate seepage.

PREDICTION RESULTS

In 1985, GRDC introduced the STEP technique for predicting the outcome of wells. This technique includes the nine component hydrocarbon, Eh, pH, and conductivity. In 1993, GRDC predicted the results on six wildcat wells using the 25 sample, five by five grid on 330' spacing, the results were as follows.

4 dry holes predicted	**4 dry holes drilled**
2 commercial wells were predicted	**2 commercial wells were completed**

There were 16 wildcat wells surveyed from October 1994 through June of 1996, the results are as follows:

8 dry holes predicted	**8 dry holes were drilled**
8 commercial wells were predicted	**5 commercial wells were completed** **3 wells were unsuccessful.**

Mr. Rick Reeves, an independent petroleum geologist based in Ohio, has been a client since 1986 and has compiled the following results on wildcat prospects that he surveyed in Ohio. These predictions were made from 1986 through 1998. 28 wildcat predictions were made, out of which:

5 dry holes were predicted	**5 dry holes were drilled**
6 "risky" predictions were made	**5 marginal wells were completed** **1 dry hole was drilled**
17 commercial wells were predicted	**16 commercial wells were completed** **1 well was unsuccessful.**

These numbers do not reflect developmental projects, infill drilling or reconnaissance surveys. They only include rank wildcats that were predicted using the 25 sample minimum on 330' grid spacing. These numbers do not include predictions made last year due to the fact that some of the operators have not informed GRDC of their results. Obviously, the dry hole predictions are running 100% accurate, and the commercial predictions are running 86% accurate, with a combined accuracy of 90%. (The wells in the "risky" group are not included in these figures). As these figures show, other technologies and techniques would be hard pressed to generate these results, including 3-D seismic. This also proves the viability of the GRDC STEP technique, which is far more economic than even the most inexpensive 2-D seismic. Please consider applying this technology prior to spending a large sum of money on a dry hole. Give Southeastern E&P Services, Inc. a call on your next exploration project so that we can help you reduce your dry hole risk.

RESUMES

William Carlton

William has over 32 years of experience in the oil and gas industry in the southeast. He has an extensive background in oil and gas production and natural gas processing. He formed Southeastern GeoChem, Inc. (SEGC) which was merged into Southeastern E & P Inc. (SEEP) to serve oil and gas operators in the southeast with the technology developed by GRDC.

A. V. (Alton) Gallagher

Alton received a Master of Science Degree in geology from Michigan State University, East Lansing, Michigan, in 1957.

After graduation he worked at Chevron for ten years as a geologist / geophysicist. Other companies and positions include Assistant to the Vice President at Signal Oil and Gas Co. (Aminoil), Vice President of Exploration at Oceanic Exploration, Vice President of Exploration at Trend Exploration, Ltd., and President of Petro-Mineral Exploration, Inc.

He is founder and President of GRDC, Inc. and is currently investigating the use of the total radiometric spectrum for applications in oil and gas exploration.

Gallagher, A.V. 1995. ***Radiometrics for the Petroleum Explorationist.*** APGE Special Publication 3, Radiometric Surveys in Petroleum Exploration, Editor Roger M. McCoy.

Gallagher, A.V. 1996. ***Radiometric Surveying Applied to an Evaluation of Sorrento Field, Cheyenne County, Colorado.*** AAPG Bulletin, v. 80, no. 6, p. 970, June (Abstract Only)

J.M. Fausnaugh

James received a Bachelor of Science Degree form Fort Lewis College in geology in 1978. Following graduation he worked on the NURE Project in northeastern Nevada, acquiring water and stream sediment samples for chemical analysis. This was followed by a year at Skyline Laboratories and Golden Labs, where he performed chemical analyses for numerous elements. In 1980, he joined Petro-Labs, Inc. as Field Operations Manager.

The following year he joined GRDC, Inc. He has been instrumental in developing and refining new and existing geochemical techniques for the exploration of petroleum. In addition he has developed and applied modern statistical analytical techniques to the interpretation of surface geochemical data.

He is a member of the American Association of Petroleum Geologists, and member and past President of the Rocky Mountain Chapter of the Association of Petroleum Geochemical Explorationists. Jim has since formed his own company, Geotech of Littleton, Colorado and has continued to be active and promote the use of geo-chem techniques.

Allexan, S., Fausnaugh, J., Goudge, C., and Tedesco, S., 1986. ***The Use of Iodine in Geochemical Exploration for Hydrocarbons.*** APGE Bulletin v.2, no.1, p.71-93, December.

Tedesco, S., Goudge, C., Fausnaugh, J., Allexan, S., 1987. ***Iodine - An Exploration Tool for Oil and Gas.*** Oil and Gas Journal, v.85, no. 26, p. 74-77, June 29.

Fausnaugh, J. M., 1989. ***The Effect of High Soil Conductivity on Headspace Gas Sampling Techniques .*** APGE Bulletin, v.5, no.1, pp.96-115, December.

Fausnaugh, J.M. 1994. ***The pH-Eh Relationship in the Detection of Near Surface Hydrocarbons.*** AAPG Hedberg Research Conference, Near Surface Expressions of Hydrocarbon Migration, April 24-28, 1994, Vancouver, British Columbia, Canada.

Fausnaugh, J.M., Tedesco, S., Gallagher, A.V. and Goudge, C.K., ***Advanced Surface Geochemical Techniques for Petroleum Exploration.*** Short course presented June 11, 1994, Denver, Colorado.

Fausnaugh, J.M., 1995. ***Advanced Hydrocarbon Interpretation Using Modified Pixler Plots and Multvariate Statistics.*** AAPG Convention, Houston, March 3-5, v. 4, p. 28A. (Abstract Only).

Fausnaugh, J.M., 1995. ***Statistical Analysis of Geochemical Spatial Point Patterns.*** AAPG Bulletin, v. 79, no. 6, p. 917, June (Abstract Only).

Fausnaugh, J. M., 1996. ***Reservoir Characterization Using Surface Geochemistry, Sorrento Field, Cheyenne County, Colorado.*** AAPG Bulletin, v. 80, no.6, p. 969, June (Abstract Only).

Fausnaugh, J.M., 1996. ***Methods for Testing the Validity of Surface Geochemical Anomalies.*** AAPG Bulletin, v. 80, no. 9, p. 1501, September (Abstract Only).

Fausnaugh, J.M., 1996. ***Survey Design and Data Integration When Using Surface Geochemistry.*** AAPG Bulletin, v. 80, no. 9, p. 1523, September (Abstract Only).

Fausnaugh, J.M., 1996***. Techniques Characterize Reservoirs.*** Lakewood, Colorado: American Oil and Gas Reporter, November, pp. 75-82.

Fausnaugh, J.M., 1999. ***Field-Based Spectral Analysis.*** Hart Oil and Gas World, March, pp. 25-26.

Some of GRDC, Inc's Customers

Amoco
Hunt Mining & Exploration
Michigan Oil Co.
Fancher Oil Co.
Patrick Petroleum Corporation
Belden and Blake
U.S. Energy Corporation
National Fuels
Mack Oil
Mack Energy
Anadarko Exploration
Gibraltar Energy Co.
Oilfinders, Inc.
Stanley Oil Co.
Tumbleweed Oil Co.
Enrich Oil & Gas
Bettis, Boyle, and Stovall
Winslow Resources
MFC Drilling Co.
Harper Oil Co.
Longleaf Energy Co.
Denver-Alaska Oil Co.
Consumers Gas Corporation
Colorado School of Mines
Viking Petroleum
David Shafer Oil Producers
Marshall and Winston Exploration
Long Petroleum
Sabel Corporation
Gully and Ridge Oil Co.
Nova Petroleum
Jubilee Energy Inc.
White-Tail Exploration, LLC
O'Brien Energy
Trophy Petroleum
Junction City Oil Co.

Charges For Surveys and Services

The following rates are offered as a guide in estimating the cost for a given survey under average conditions. The actual costs may vary depending upon terrain, ease of access, and size of survey. Sample acquisition, field crew expense, data processing, interpretation, and report are included in these rates where applicable. Travel costs are not included.

Soil Gas Hydrocarbons
Basic Hydrocarbons

Includes:
- Sample acquisition of samples from a depth of 32” to 36”.
- Analysis of nine component hydrocarbon analysis, Eh, pH, and conductivity.
- Interpretation and mapping.

The following charges apply to 25 or more samples per area:

100’ thru 330’ spacing, cost / sample	$110.00
331’ thru 660’ spacing, cost / sample	$115.00
661’ thru 1320’ spacing, cost / sample	$125.00
Survey setup and layout (per survey)	$200.00

Hydrocarbons Plus

Includes:
- Sample acquisition of samples from a depth of 36” to 42”.
- Analysis of nine component hydrocarbon analysis, Eh, pH, conductivity, Bacteria, and UV reflectance.
- Interpretation and mapping.

Discounted analytical rate per sample	$150.00
Less than 25 samples, additional cost / survey	$50.00
Integration of two or more surveys	$75.00

For surveys greater than 100 samples apply a 10% discount.

Reconnaissance Methods

Silver Option

Includes:
- Analysis of Eh, pH, conductivity, and Spectrosense.
- Interpretation and mapping.

Analysis, cost / sample	$40.00

Gold Option
Includes:
- Analysis of Eh, pH, conductivity, Iodine, and Bacteria
- Interpretation and mapping.

Analysis, cost / sample $50.00

Platinum Option
Includes:
- Analysis of UV reflectance, Eh, pH, conductivity, Iodine, and Bacteria
- Interpretation and mapping

Analysis, cost / sample $60.00

Eh
Includes:
- Analysis of Eh by electrode, interpretation, and mapping.

Analysis, cost/sample $15.00

pH
Includes:
- Analysis of pH by electrode, interpretation, and mapping.

Analysis, cost/sample $15.00

Conductivity
Includes:
- Analysis of conductivity electrode, interpretation, and mapping.

Analysis, cost/ sample $15.00

Spectrosense
Includes:
- Analysis of tungsten source reflectance, interpretation, and mapping.

Analysis, cost / sample $15.00

Soil Alkalinity Index (SAI)
Includes:
- Analysis, interpretation, and mapping

Analysis, cost / sample $15.00

Loss on Ignition (LOI)
Includes:

- Gravimetric analysis, interpretation, and mapping

Analysis, cost / sample $15.00

Iodine
Includes:

- Analysis of iodine by titration, interpretation, and mapping.

Analysis, cost / sample $15.00

Bacteria
Includes:

- Analysis of bacteria by color change, interpretation, and mapping.

Analysis, cost / sample $20.00

UV reflectance
Includes:

- Analysis of UV source reflectance, interpretation, and mapping.

Analysis, cost / sample $25.00
Sample acquisition by SEEP $15.00
Integration of two or more surveys $75.00
For surveys greater than 300 samples apply a 10% discount.

DAFSR (Digitally Acquired Full Spectrum Radiometrics)
Acquisition by All Terrain Vehicle, cost / mile $150.00
Mobilization/Demobilization $1,800.00
Low level airborne surveys, cost / mile $30.00*
**plus cost of helicopter with coverage at 40 miles per hour.*

Magnetics
Micro magnetics for fault identification. All stations are corrected for diurnal variations.
100' stations, cost / mile $250.00

Travel Costs
Includes field crew and ALL survey expenses.
Cost / mile $2.00

Consulting

Per hour (expenses not included)	$75.00

Drafting

Per hour (includes printing and copies)	$50.00

Payment for Services

All invoices are due and payable upon receipt. Payments not received by SEEP within thirty days of invoice date interest will accrue at the rate of 1.5% per month.

General

SEEP maintains Liability insurance coverage for its operation. A certificate of insurance may be obtained upon request.

SEEP will provide a quote on any project, domestic or international, with no obligation. Our staff is always available for consultation in planning your exploration program.

Effective 10/1/09