Final Report
PANGAEA RESOURCES
Block 788 South, AUSTRALIA
Hydrocarbon Microseepage Survey
Microbial Oil Survey Technique (MOST)
Sorbed Soil Gas Analysis

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Executive Summary

We have completed the microbial analysis (Microbial Oil Survey Technique-"MOST") of 521 soil samples and 141 Sorbed Soil Gas "SSG" analysis from Pangaea Block 788 South. Pangaea Resources, with the cooperation of GMT, developed the survey design and sampling pattern used for this microseepage survey. The soil samples were collected at +/- 250m intervals along 17 north-south lines with some samples spaced at +/- 500m intervals in a near grid pattern and along selected seismic lines. Fieldwork was conducted from March 11 thru March 16, 2007 and covered approximately 100 sq km. The principal objectives of this ***reconnaissance*** hydrocarbon microseepage survey are (1) to determine the presence and location of significant hydrocarbon microseepage anomalies, (2) to determine the composition of the hydrocarbons, (3) to identify areas that warrant additional geological, geophysical, or geochemical evaluation based on these microseepage results.

The analytical MOST results from PEL 788 South locates several high microbial anomalous trends which are consistent in size and intensity with the other three nearby Pangaea survey areas. The microbial average for PEL 788S is 25 with a standard deviation of 16. Likewise, the Pangaea microbial values compare favorably to previous extensive GMT surveys in similar environments (Cooper Basin, Australia; western USA; Bolivian Chaco; etc.), **The MOST data documents (1) the presence of north-south trending microseepage anomalies grouped mainly along the western margin of the block, (2) a smaller north-south trend of anomalies in the north central part of the block, (3) numerous smaller anomalies scattered in the eastern portion of the block separated by an extensive low background area in the south central region, and (4) no strong microseepage anomalies located in the three out of four previously drilled dry hole areas. The limited and reliable Sorbed Soil Gas data characterize the hydrocarbon seepage as thermogenic with a compositional preference primarily from an oil source.** It is possible that some of the clusters of anomalous samples be related to fault leakage. We encourage PANGAEA to closely examine the relationship between these microseepage anomalies and the available surface structural geology elements. ***This report is a stand-alone hydrocarbon microseepage evaluation only.***

Summary of Field Work for Pangaea Resources, Australia

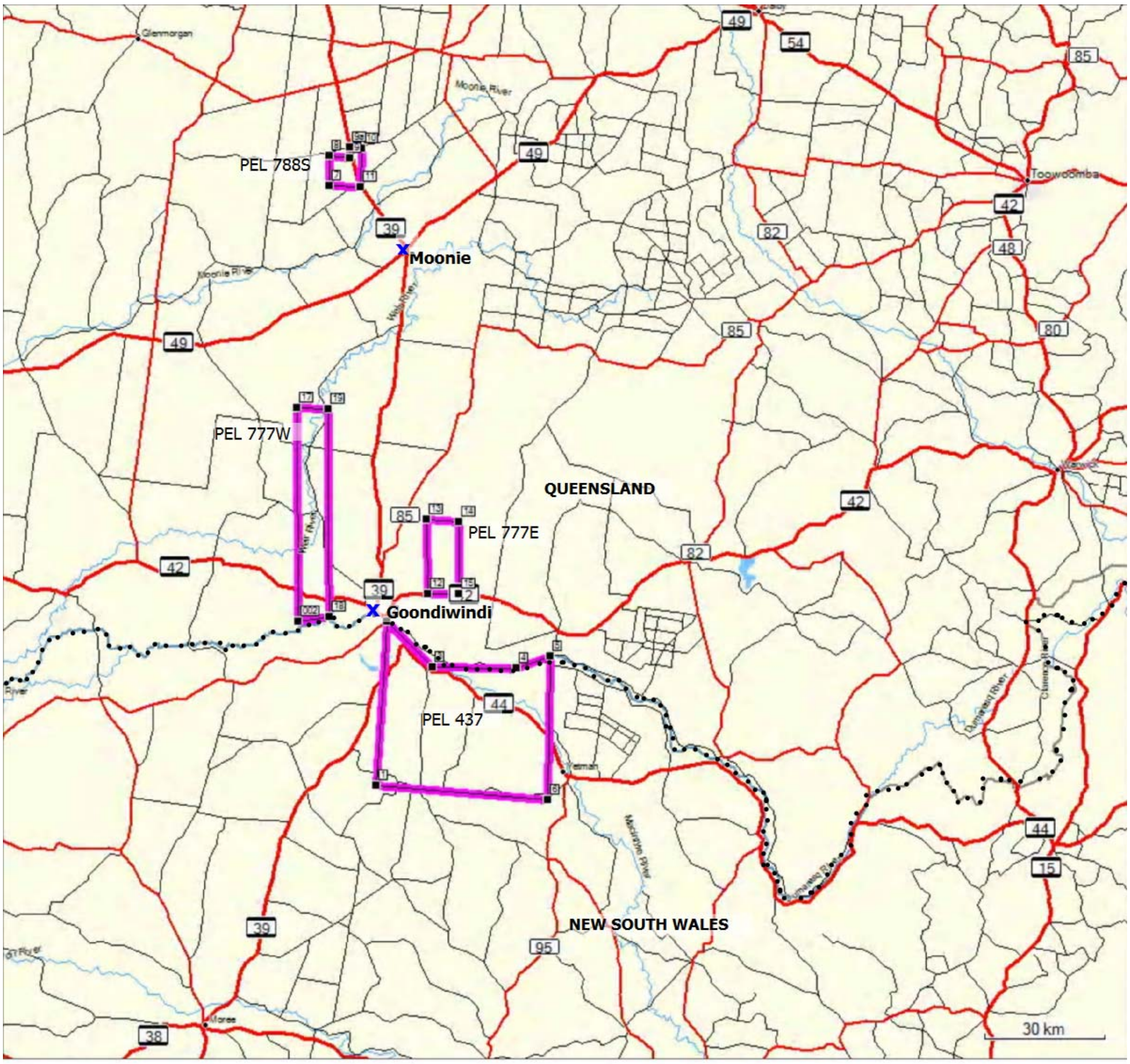
This following is a brief description of the survey field work executed for Pangaea Resources in four blocks: PEL 788S, PEL 777W, PEL 777W, and PEL 437, located in Queensland and New South Wales, Australia.

Before field mobilization, there were three office days spent in Sydney, Australia to prepare the survey maps and grids (March 8 to 10, 2007).The field survey was executed from March 11 to May 2, 2007, with the assistance of a service company (Walcott & Associates PTY. Ltd.) and under the supervision of four GMT officers lead by Luigi Clavareau (Director of International Operations for Geo-Microbial Technologies).

During the field work schedule as many as six (6) crews were formed-- each one composed of a minimum of three people: a crew leader (GMT officer or a trained local), a driver, and a digger. Each crew had its own vehicle with GPS, tools, radios, etc. The first base camp headquarters was established in Moonie, Queensland for field work for PEL 788S. For the sample collection in PEL 777E, PEL 777W and PEL 437, the base camp was moved to Goondiwindi, Queensland, 90 km south of Moonie.

The field work was executed according to the following itinerary:

March 6-7	GMT personal arrives Australia .
March 8-10	Office work in Sidney preparing maps.
March 11	Travelling to the field (Moonie).
March 12-16	Survey Block 788S. 613 samples collected.
March 16-23	Survey Block 777E. 1374 samples collected.
March 24 - April 5	Survey Block 777W. 2124 samples collected.
April 6 - May 1	Survey Block 437. 6974 samples collected.
May 2	End of field work. Demobilization from the field.



PEL 788S, PEL 777E, PEL 777W, AND PEL 437 LOCATION MAP. PANGAEA RESOURCES.
QUEENSLAND AND NEW SOUTH WALES - AUSTRALIA

x	Town, City
▬	Exploration block limit
• • • • •	State limit
▬	Roads, Higways
▬	Rivers

A few gas samples were also collected by using a field made gas separator. Two or three samples were collected in each oil well located in the field.

Block name: PEL 788S
Approximated area 100 Km^2
Location: Queensland, 22 Km. North of Moonie on Highway 39
Survey design: Grid formed by 17 Lines oriented North –South spaced 500 m with samples every 250m.
Surveying days 6 from March 11 to march 16
Crews used: 2 - 3 crews
Samples collected 521 MOST and 141 SSG Samples analyzed 521 MOST and 141 SSG

GeoMicrobial Tech
Field Report

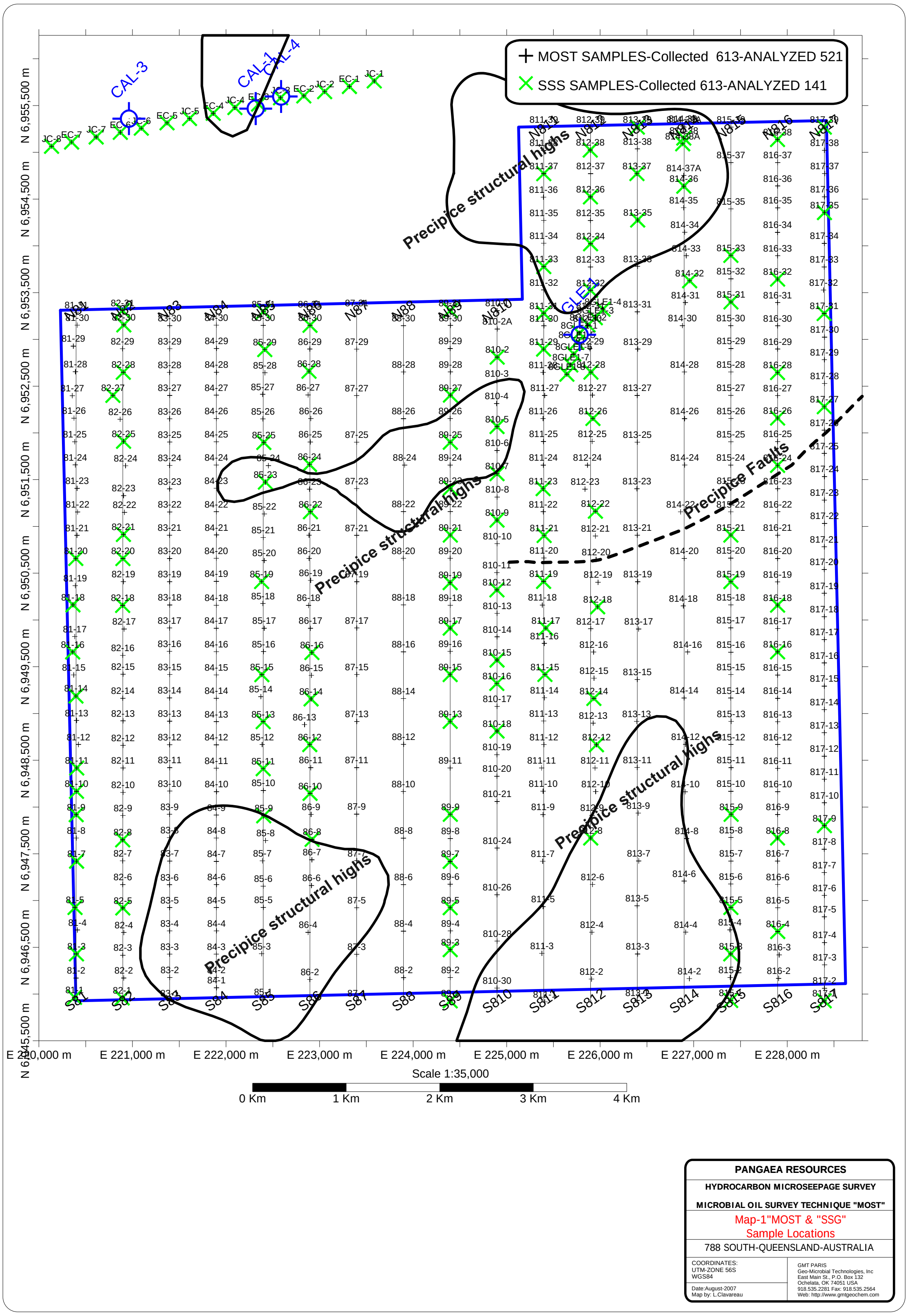
Date: MARCH-5 thru 15-07

Survey 788SOUTH
Client PANGAEA
Country AUSTRALIA
Client contact
GMT Contact Luigi **SAT-PHONE +881631522922** luigi.c@gmtgeochem.com Australian cell phone +61 415169122
Field Camp MOONIE/CROSS ROADS MOTEL

				CREWSLSAMPLES/DAY					
Field/Day	**Date**	**Description**	**Sampling sites**	**JS**	**EL**	**LC**	**James/Al**	**Vehicles/DRIVERS**	**Diggers**
1	5-Mar	MOB TO AUSTRALIA	0						
2	6-Mar	MOB TO AUSTRALIA	0						
3	7-Mar	MOB TO AUSTRALIA	0						
4	8-Mar	PANGAEA OFFICE	0						
5	9-Mar	PANGAEA OFFICE	0						
6	10-Mar	MOB TO FIELD	0						
7	11-Mar	RECOM-SAMPLING-788S	21	11	10	0		3	3
8	12-Mar	SAMPLING	152	62	60	30		3	3
9	13-Mar	John,Ed sampling, luigi&Mike tracking roads-777w-e	124	62	62			3	4
10	14-Mar	John,Ed sampling, luigi&clinton tracking roads-777w-e	100	60	40			3	3
11	15-Mar	3 GMT in the field-Luigi finishing training James & Al	197	70	59	50	18	3	5
12	16-Mar	John sampling/Luigi&Ed packing.MOB to Goond+samplin	19	11			8	3	
Cumulative	**Totals**		**613**	**276**	**231**	**80**		**18**	**18**
	Date	**Description**	**Sampling sites**	**JS**	**EL**	**LC**	**James/Al**	**Vehicles/DRIVERS**	**Diggers**

MOST" and shallow "SSG" samples were collected from 20cm deep holes. The sampling was done along lines guided by GPS system. Selected "SSG" samples came from 80cm-100cm deep holes

Map-1 Sample locations



Methods and Data Analysis

Microbial Oil Survey Technique (MOST): This microbial method was developed more than 30 years ago by Phillips Petroleum and since 1985 has been available to industry from GMT. MOST **soil samples** are collected at a depth of 20 centimeters and, after overnight dehydration, are shipped to our Oklahoma laboratory to be analyzed for the presence of hydrocarbon-oxidizing microbes. There is a direct positive relationship between the light hydrocarbon concentration in soils and these microbial populations, a relationship that is easily measurable and reproducible. MOST samples are routinely processed to identify the presence of butane-oxidizing microbes; however, samples can be processed to detect methane-oxidizers if necessary. Microbial anomalies have been proven to be reliable indicators of oil and thermogPangaeac gas in the subsurface (Beghtel et al., 1987; Lopez et al., 1994; Tucker and Hitzman, 1994; Hitzman et al., 2002) and the method has been widely used in throughout the world.

In processing the samples, twenty-five (25) grams of the collected soil were analyzed from each sample location. The 25 grams of soil were diluted and plated three times with agar gel and n-butanol. The butanol is the only utilizable organic carbon source for these microorganisms. Only those microorganisms already capable of light hydrocarbon metabolism survive in this selective growth medium. After one week of incubation, the microorganisms grow into colonies visible to the naked eye. These colonies were counted and the Microbial Value for each sample was calculated as the average of the three agar plates.

Sorbed Soil Gas (SSG): The sorbed soil gas method used by GMT, first developed by Horvitz (1939, 1985) and later modified by Phillips Petroleum, is also known in the industry as adsorbed gas, Horvitz adsorbed gas, acid-extracted gas, bound gas, or desorption gas. This exploration technology is based on the observation that light hydrocarbon gases migrating upward from buried reservoirs become sorbed onto clays or incorporated into carbonate cements in near-surface soils and sediments. Areas of microseepage are detected by observing the concentration and composition of light hydrocarbons extracted from these soils and sediments. There is often a direct relationship between the subsurface hydrocarbon accumulation and the concentration of these sorbed soil gases in the near-surface.

The modified Phillips Petroleum/Horvitz method is a quantitative determination of methane (C_1), ethane (C_2), propane (C_3), butane (C_4), and heavy components (C_{5+}) sorbed to soil particles or within soil cements. In processing the samples, fifty (50) grams of sample are placed under partial vacuum to remove any free gases, which would dilute the extracted light hydrocarbons. The sample is then digested with heated 2N hydrochloric acid for 30 minutes. All liberated gases pass through a 30% potassium hydroxide solution to scrub any carbon dioxide generated during digestion. The scrubbed, liberated gases are collected and analyzed by flame ionization detector (FID) gas chromatography to determine light hydrocarbon concentrations in the parts per million (PPM) range.

Results and Observations

Faults, Fracture Zones, and Lineaments: The surface expression of faults, fracture zones, and/or other structural boundaries can also have a geochemical expression since such fractures may provide hydrocarbon migration pathways to the surface, and this leakage can be detected with closely spaced geochemical samples. Such leakage may be expressed geochemically as (1) a single high-value sample, (2) as a high value-low value sample pair, or (3) as a series of highs separated from a series of lower values at the location of the inferred fracture or structural boundary. Most of the 788S samples were collected at distances of 250m apart. Unless samples are collected within 50-100m of the fault trace, one may not see it reflected in the surface geochemical data. Pangaea should investigate if there are outcropping faults, or if there are faults in the subsurface (vertical or non-vertical faults). It is always possible that some of the microbial surface anomalies may be the surface expression from previously unidentified faults at depth.

Microbial Data: The results of the 521 microbial analyses from BLOCK 788S are summarized on the accompanying tables, figures, and maps. Map 1 (previous page) shows the MOST sample locations for the survey.

The analytical MOST results from PEL 788S locates two high microbial anomalous trends which are consistent in size and intensity with the other three nearby Pangaea survey areas. These Pangaea microbial values compare favorably to previous extensive GMT surveys in similar environments (Cooper Basin, Australia; western USA; Bolivian Chaco; etc.). The MOST data documents (1) the presence of north-south trending microseepage anomalies grouped mainly along the western margin of the block, (2) a smaller north-south trend of anomalies in the north central part of the block, (3) numerous smaller anomalies scattered in the eastern portion of the block separated by an extensive low background area in the south central region, and (4) no strong microseepage anomalies located in the three out of four previously drilled dry hole areas. The limited and reliable Sorbed Soil Gas data characterize the hydrocarbon seepage as thermogenic with a compositional preference for an oil source. It is possible that some of the clusters of anomalous samples be related to fault leakage. We encourage PANGAEA to closely examine the relationship between these microseepage anomalies and the available surface structural geology elements.

Table 1 lists the **Microbial Values** for each sample, and Figure 1 summarizes the statistical characteristics (i.e., population mean, standard deviation, etc.) of the 788S microbial data set. All samples were analyzed for the presence of butane-oxidizing microbes.

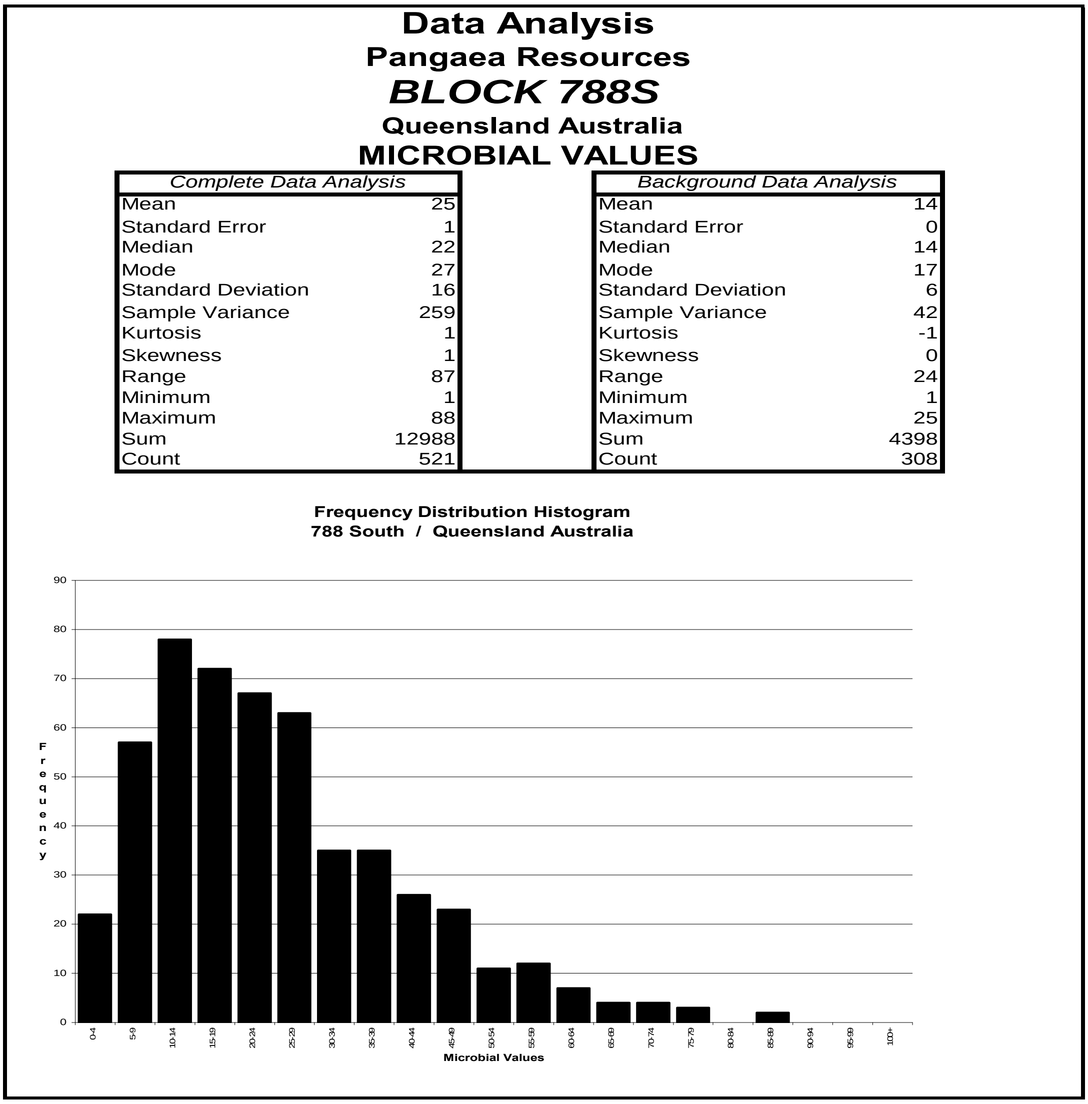
Figure 1 (see next page) displays the **Statistical Data Analysis** and the **Frequency Distribution Histogram** of the Microbial Values for the survey area. The frequency histogram illustrates the magnitude and skewness of the microbial data sets in the survey area. A histogram's skewness and mean can indicate the relative potential of the area under investigation. In an exploration area, a *non-productive* survey area is usually represented by a histogram of normal frequency distribution, i.e., a normal bell-shaped curve. For *productive* areas or prospects, the frequency distribution indicates dual populations or, more commonly, is skewed to the right. The frequency distribution for the BLOCK 788S survey combined microbial data is strongly right-skewed indicating very good potential for production, especially beyond the microbial value of 55 where there is definite break in the distribution downward slope. Also, sample values >35 (another break in distribution slope) all appear to stretch the normal distribution slope further to the right. In Australia and similar environmental regions, experience dictates that microbial values of 50 or greater are often good indicators of positive microseepage. Microbial values of >70 can be very good microseepage indicators depending upon the overall background of the data set. However, more important than the shape of the distribution is whether the data contain groupings of elevated (or depressed) microbial values. It is these clusters of high microbial values that reflect leakage from an accumulation or along a migration pathway or faults. The results of the analysis from all of the samples are summarized in Table 1.

For this 788S data set, microbial values of 35 or greater (approximately 3 SD above background mean) should be indicative of significant hydrocarbon microseepage and are highlighted in red, orange, and yellow colors on the accompanying "bubble" maps. Extremely low values (<8) have been highlighted in blue color, because these very low values can also form geologically meaningful patterns.

In the **Microbial Value Map** (Map 2), the highest values have been highlighted in red, orange and yellow colors. The lowest values are highlighted in blue. Map 3, **Smoothed Microbial Value Image**, presents the raw microbial values as a contour image based on an edited contour interpretation using the Surfer program's Krieging contour algorithm. All maps have also been reduced to page-size for easy report reference.

Microbial values of the combined survey area (Figure-1) range from 1 - 88 with an overall mean value of 25 and a standard deviation of 16. Statistical analysis of the data (Figure-1) suggests that the background population for the combined survey area has a mean value of 14 and a standard deviation (SD) of 6.

Figure-1



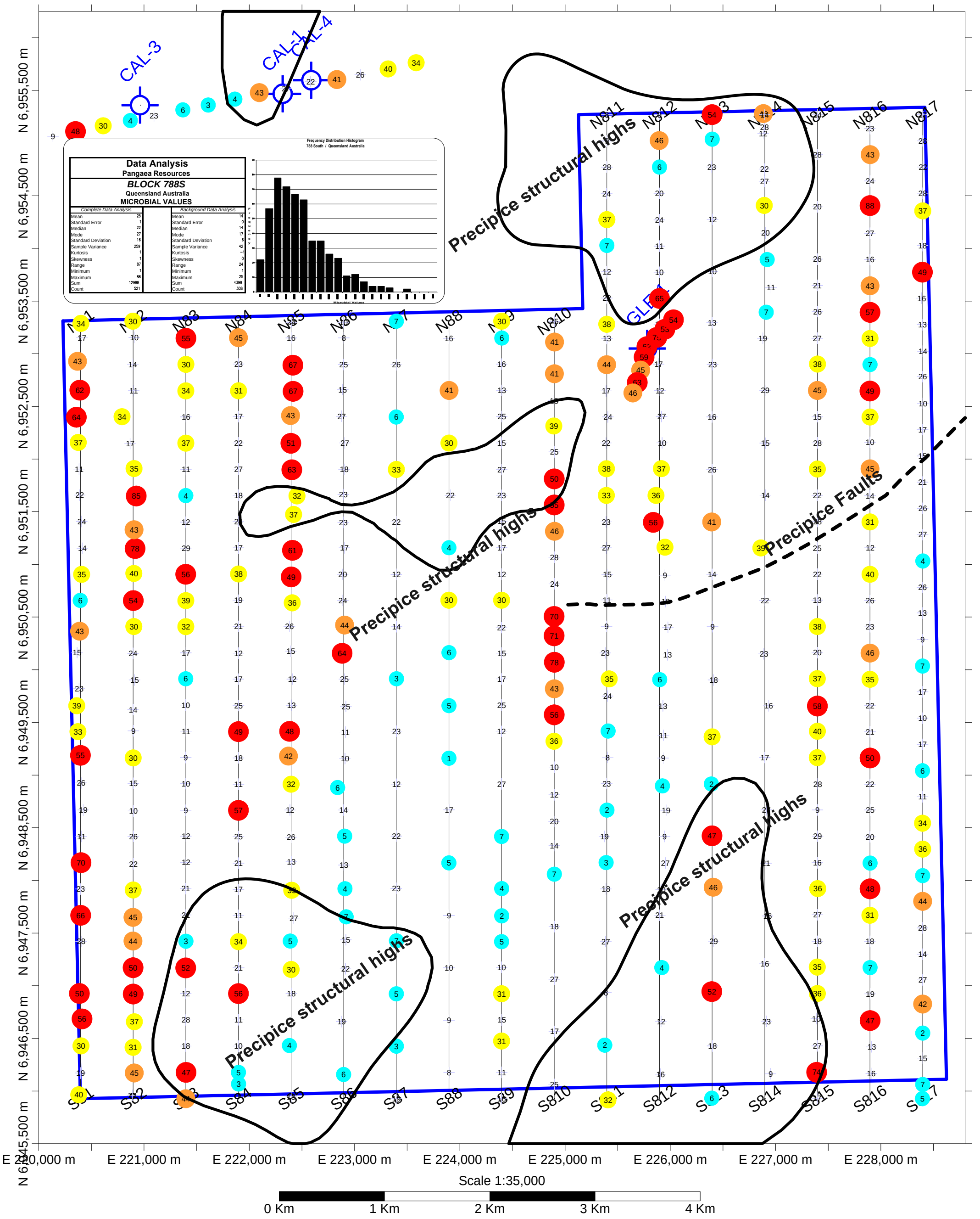
Data Analysis
Pangaea Resources
BLOCK 788S
Queensland Australia
MICROBIAL VALUES

Complete Data Analysis	
Mean	25
Standard Error	1
Median	22
Mode	27
Standard Deviation	16
Sample Variance	259
Kurtosis	1
Skewness	1
Range	87
Minimum	1
Maximum	88
Sum	12988
Count	521

Background Data Analysis	
Mean	14
Standard Error	0
Median	14
Mode	17
Standard Deviation	6
Sample Variance	42
Kurtosis	-1
Skewness	0
Range	24
Minimum	1
Maximum	25
Sum	4398
Count	308

Frequency Distribution Histogram
788 South / Queensland Australia

Map-2 Microbial Values-MV



Microbial Values Thresholds

●	47- to 88-	5 and more standard deviations above the background mean
●	41- to 46-	4-5 standard deviations above the background mean
●	30- to 40-	2.5-4.0 standard deviations above the background mean
+	8- to 29-	Background
●	0- to 7-	Below background mean

PANGAEA RESOURCES

HYDROCARBON MICROSEEPAGE SURVEY

MICROBIAL OIL SURVEY TECHNIQUE "MOST"

Map-2 Microbial Values-MV

788 SOUTH-QUEENSLAND-AUSTRALIA

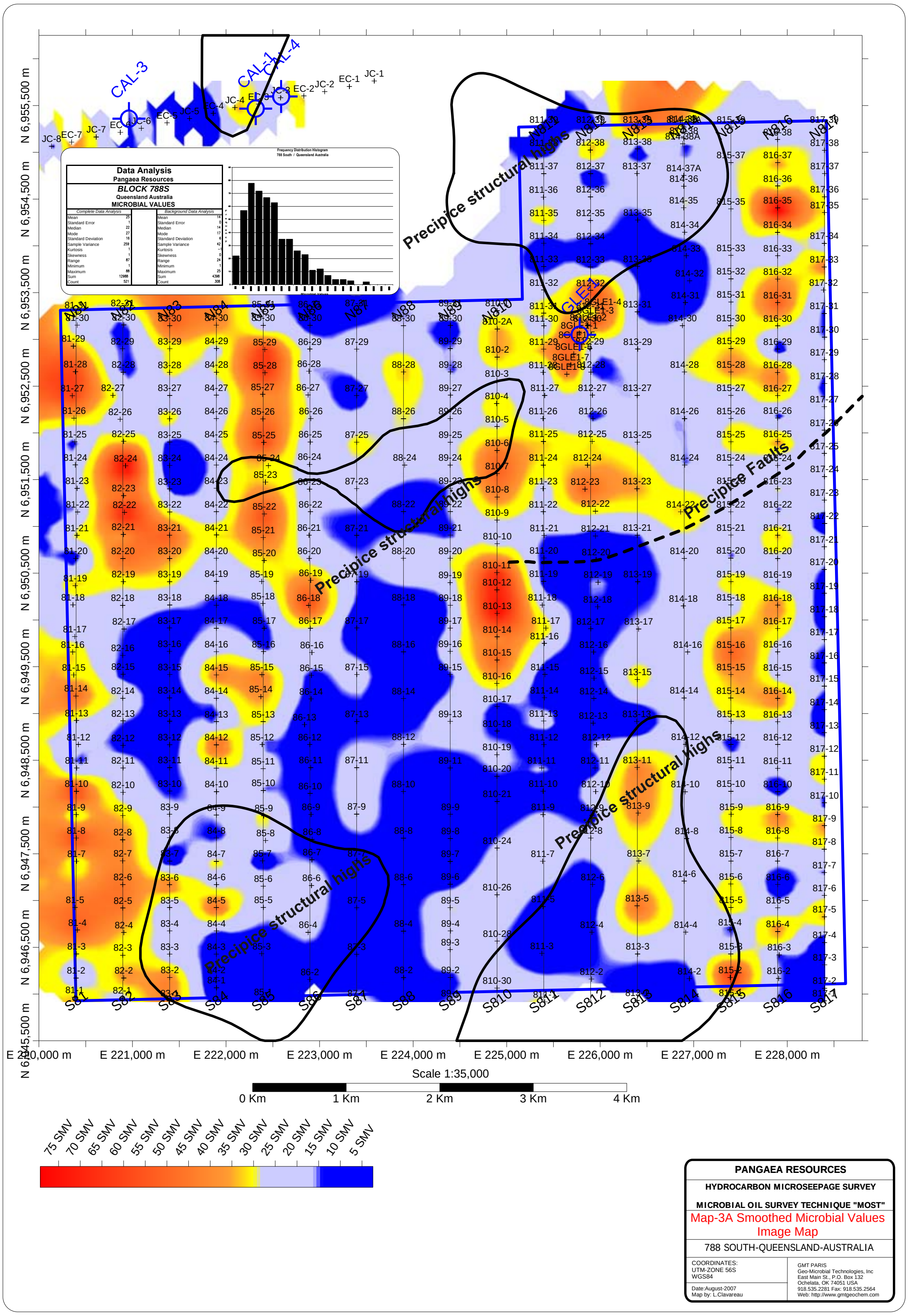
COORDINATES:
UTM-ZONE 56S
WGS84

Date:August-2007
Map by: L.Clavareau

GMT PARIS
Geo-Microbial Technologies, Inc
East Main St., P.O. Box 132
Ochelata, OK 74051 USA
918.535.2281 Fax: 918.535.2564
Web: http://www.gmtgeochem.com

Both Maps 2 and 3 show significant groupings of anomalous MOST values. The majority of the anomalous groupings are clustered along the western portion of the survey area in what appears to be north-south trends but this may be due to the north-south alignment of sample lines and sample spacings. A large anomaly – approximately 10 sq. kilometers in size – is found in the northwestern portion of the survey area but does have a center heterogeneous gap of low values. Microbial anomalies are *not* halo anomalies. An area of grouped anomalies also is found in the north central part of 788S ending with the GLEN-1 location. Smaller eastern anomalies are more widely scattered and less intense. A significantly large area of low and background values separates the western from the eastern parts of the block. The size and intensity of the western and north central area anomalies are very good indicators for oil and gas accumulations at depth. Confidence for the survey results is increased by the observation that three out of four of the dry hole locations within the 788S area would **not** have been recommended by these microbial results. The GLEN-1 location does have a strong overlapping MOST signature.

Map-3 Smooth Microbial Values-SMV-IMAGE MAP



Data Analysis
Pangaea Resources
BLOCK 788S
Queensland Australia
MICROBIAL VALUES

Complete Data Analysis		*Background Data Analysis*	
Mean	25	Mean	14
Standard Error	1	Standard Error	0
Median	22	Median	14
Mode	27	Mode	17
Standard Deviation	16	Standard Deviation	6
Sample Variance	259	Sample Variance	42
Kurtosis	1	Kurtosis	-1
Skewness	1	Skewness	0
Range	87	Range	24
Minimum	1	Minimum	1
Maximum	88	Maximum	25
Sum	12988	Sum	4398
Count	521	Count	308

PANGAEA RESOURCES

HYDROCARBON MICROSEEPAGE SURVEY

MICROBIAL OIL SURVEY TECHNIQUE "MOST"

Map-3A Smoothed Microbial Values
Image Map

788 SOUTH-QUEENSLAND-AUSTRALIA

COORDINATES:
UTM-ZONE 56S
WGS84

Date:August-2007
Map by: L.Clavareau

GMT PARIS
Geo-Microbial Technologies, Inc
East Main St., P.O. Box 132
Ochelata, OK 74051 USA
918.535.2281 Fax: 918.535.2564
Web: http://www.gmtgeochem.com

Sorbed Soil Gas "SSG" Data: SSG Table 2 lists the individual values for 5 of the light hydrocarbon gases to be considered: **methane (C_1), ethane (C_2), propane (C_3), butane (C_4), and C_{5+}.** The sample gas values are measured in parts per million (ppm). SSG Table 2 also lists several key gas ratios used in determining the gas source characterization and identifying the reservoir's predominant signature source – either gas, oil, or gas condensate. GMT's SSG analyses are primarily utilized for hydrocarbon characterization purposes while the MOST results are used for locating seepage anomalies. The extremely low values for the 788S SSG analyses create an interpretational difficulty. The reliable soil gas characterization of 788S points to an oil reservoir source rather than a gas or gas condensate source.

Methane: The statistical characteristics of the SSG data are summarized in Figure 2. SSG methane values range from a minimum of 0.00 ppm to a maximum of 2.58 ppm. The total methane sample population has a mean of 1.78 ppm. Statistical analysis of the methane data suggests that the background population has a mean of 1.60 ppm and a standard deviation of 0.66.

Ethane: SSG ethane values ranged from a minimum of 0.00 ppm to a maximum of 1.20 ppm. The total ethane sample population has a mean of 0.21 ppm. Statistical analysis of the ethane data suggests that the background population has a mean of 0.02 ppm and a standard deviation of 0.05.

C_2 – C_4: The sum of ethane through butane values ranged from a minimum of 0.00 ppm to a maximum of 1.96 ppm. The total C_2-C_4 sample population has a mean of 0.27 ppm. Statistical analysis of the C_2-C_4 data suggests that the background population has a mean of 0.05 ppm and a standard deviation of 0.08.

The relative soil gas values of some of these samples are extremely low and their significance is tested more as ratios than as individual sample values. One must keep in mind that 141 samples collected from such a large area may not be thoroughly representative, but this is the best SSG sampling pattern of the four survey areas. Frequency distribution histograms and the location map of the reliable SSG data are included in this report. The results of the SSG analyses from BLOCK 788S are summarized on the accompanying Table 2, and Figures 2, 2A, 2B thru 5.

Figure-2

Data Analysis

Pangaea

788S South

Queensland Australia

Methane Data Analysis

Complete Data Analysis	
Mean	2.58
Standard Error	0.15
Median	2.54
Mode	1.04
Standard Deviatior	1.78
Sample Variance	3.16
Kurtosis	41.33
Skewness	4.90
Range	18.15
Minimum	0.00
Maximum	18.15
Sum	364.28
Count	141

Background Data Analysis	
Mean	1.60
Standard Error	0.08
Median	1.66
Mode	1.04
Standard Deviation	0.66
Sample Variance	0.43
Kurtosis	-1.12
Skewness	-0.11
Range	2.58
Minimum	0.00
Maximum	2.58
Sum	121.45
Count	76

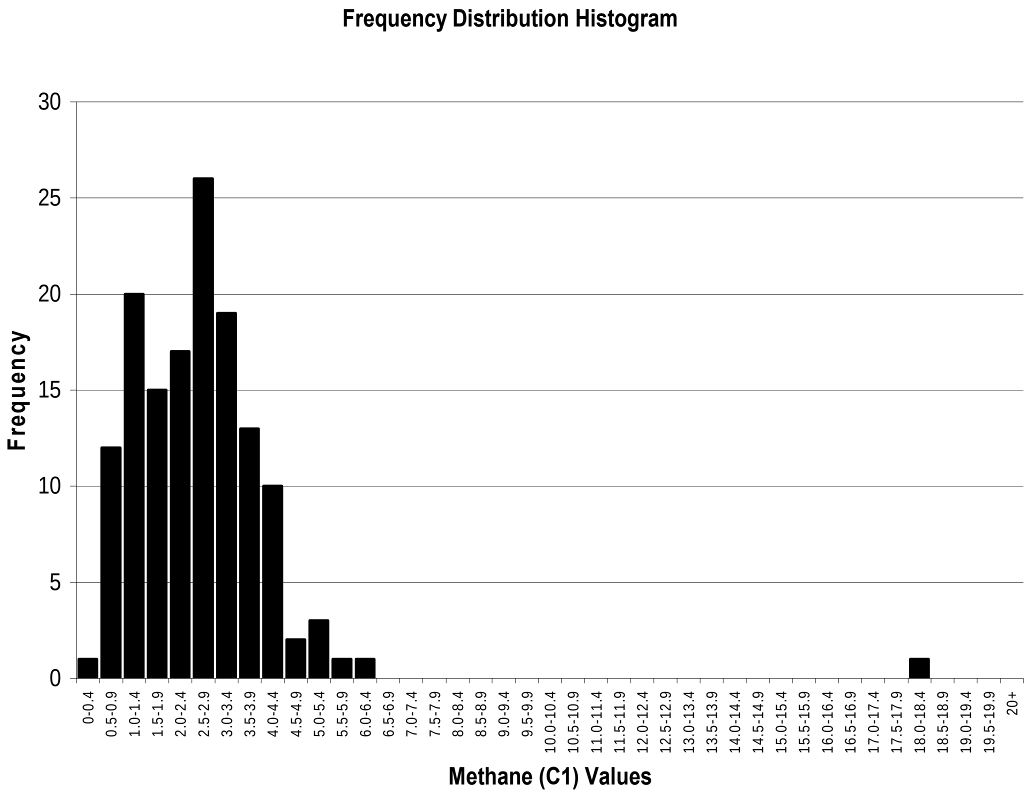

Frequency Distribution Histogram

Figure-2A

Data Analysis

Pangaea

788S South

Queensland Australia

Ethane Data Analysis

Complete Data Analysis	
Mean	0.21
Standard Error	0.02
Median	0.13
Mode	0.00
Standard Deviation	0.25
Sample Variance	0.06
Kurtosis	0.94
Skewness	1.09
Range	1.20
Minimum	0.00
Maximum	1.20
Sum	30.15
Count	141

Background Data Analysis	
Mean	0.02
Standard Error	0.01
Median	0.00
Mode	0.00
Standard Deviation	0.05
Sample Variance	0.00
Kurtosis	5.56
Skewness	2.61
Range	0.21
Minimum	0.00
Maximum	0.21
Sum	1.52
Count	77

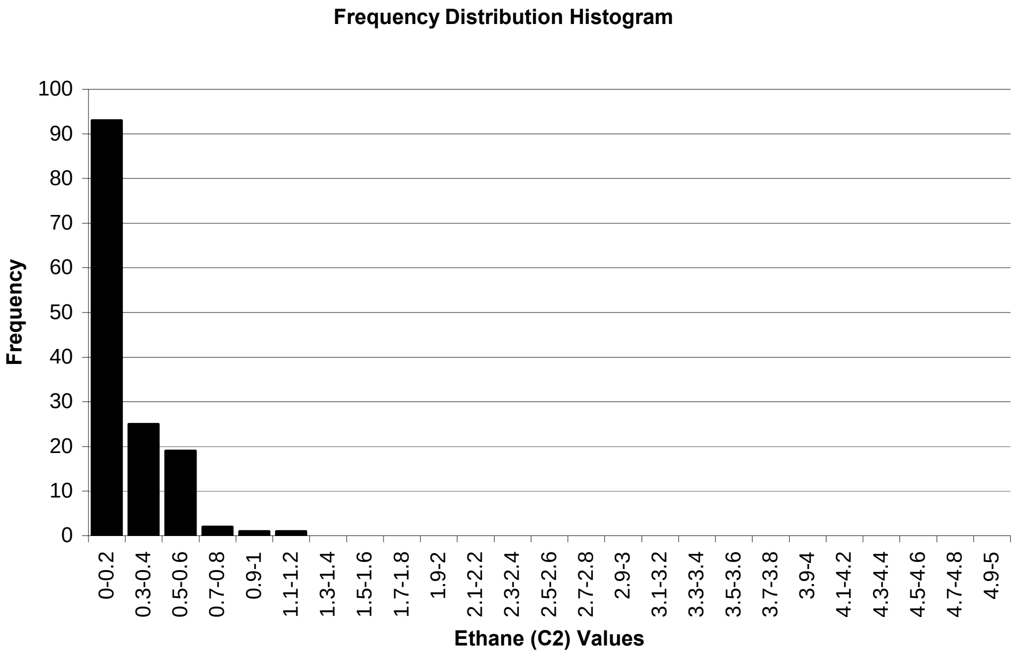


Figure-2B

Data Analysis

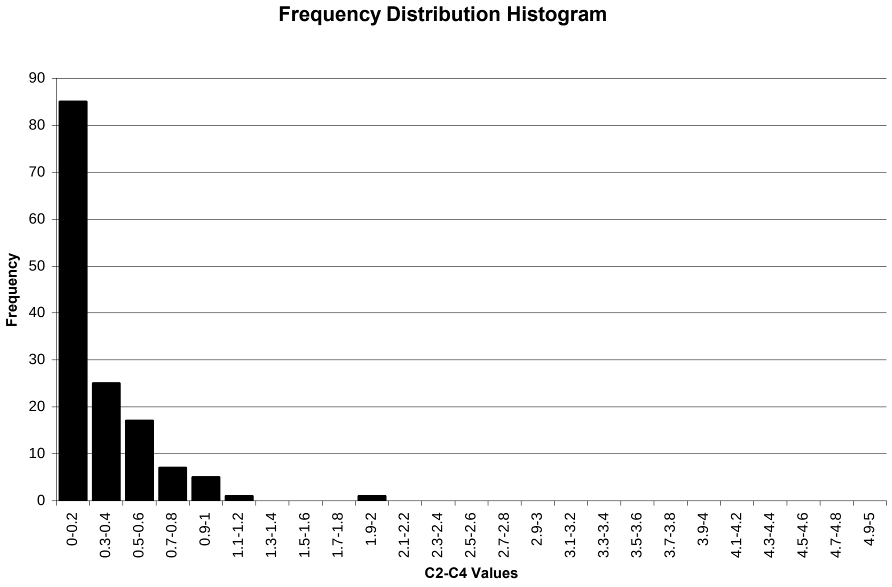
788S South

Queensland Australia

SUM C2 - C4

Complete Data Analysis	
Mean	0.27
Standard Error	0.03
Median	0.16
Mode	0.00
Standard Deviation	0.32
Sample Variance	0.10
Kurtosis	4.44
Skewness	1.67
Range	1.96
Minimum	0.00
Maximum	1.96
Sum	37.78
Count	141

Background Data Analysis	
Mean	0.05
Standard Error	0.01
Median	0.00
Mode	0.00
Standard Deviation	0.08
Sample Variance	0.01
Kurtosis	1.16
Skewness	1.58
Range	0.27
Minimum	0.00
Maximum	0.27
Sum	4.23
Count	83



Hydrocarbon Composition and Origin

Genetically, near-surface hydrocarbon gases can be bacterial, early diagenetic, thermogenic, or of mixed origin. They may be generated in shallow sediments and soils, or at the greater depths associated with oil and gas generation. Additionally, soil moisture, soil mineralogy, and microbiological activities can variously affect different soil gas survey methods. Consequently, near-surface gases may have changed from their original geochemical characteristics since their time of generation. Despite these diverse origins and possible modifications to the composition of near-surface gases, geochemical surveys and research studies have documented that the composition of soil gases reliably reflects the composition of reservoir gases in the survey area (Jones and Drozd, 1983; Klusman, 1993).

How can we differentiate between dry biogenic gas and thermogenic dry gas? We discriminate the two origins by looking at gas isotopes and by the presence and abundance of ethane and higher light hydrocarbons in the gas. A pure biogenic gas is 99+% methane with very minor ethane, propane, etc. Its methane–to-ethane ratio for example is 100's to >1000, as compared to 5-50 typical of thermogenic gas. Isotopically, the carbon in biogenic methane is more negative than –60, and –70's are common; thermogenic methane typically is in the range of –55 to –30. The ratio of ethane to ethylene is <1 in biogenic gas, >1 in thermogenic gas. The ratio of isobutane to normal butane tends to be >1 in biogenic gas and <1 in thermogenic gas. These are but a few of the criteria available to discriminate biogenic from thermogenic gases, and these same criteria are applicable to soil gas.

Composition of Soil Gas Hydrocarbons: The composition of migrating (or reservoired) hydrocarbons can be inferred from selected light hydrocarbon ratios and crossplots. Jones and Drozd (1983) published some empirical soil gas ratios based on thousands of measurements from several areas in the United States and Canada. These ratios are useful for establishing qualitative cutoffs between an oil-producing region (or prospect) and a mixed oil/gas region or a gas-prone region. Exact values of the qualitative boundaries will vary between regions due to local geology, source type and maturity, reservoir pressures, etc. The interpretation guidelines we recommend are listed below, along with the ratios for some specific samples and microseepage anomalies in the survey area.

As is evident from the **Composition of Soil Gas Hydrocarbons** table below, , and Figures 3 thru 5, soil gas data from the 788S survey area shows a variety of compositions, ranging from oil to oil or condensate associated with thermogenic gases.

Hydrocarbon Composition					
	C1/C2	C1/C3	C1/C4	C1/∑(C1-C4)	C2/C3
0IL	4-10	10-20	15-40	0.55-0.75	1.0-2.5
O/G. COND	10-20	20-50	40-100	0.75-0.95	2.5-4.0
THERMAL GAS	20-50	50-100	100-	0.95-1.00	4-6
BIOGENIC GAS	>100	>>100	>>200	0.99-1.00	>6.0
Sorbed Soil Gas					
Average Block Samples	12.84	60.32	92.98	0.94	5.24
Average GLEN-1 Samples	10.11	22.76	71.52	0.95	1.08
Average CALwells area	4.85	24.53	32.52	0.77	5.04
	C1/C2	C1/C3	C1/C4	C1/∑(C1-C4)	C2/C3

The soil gas crossplots, Figures 3 thru 5**,** show weak positive correlation with a large amount of scatter in the data, reflective of low analytical values and indicative of microbial degradation of the soil gases.

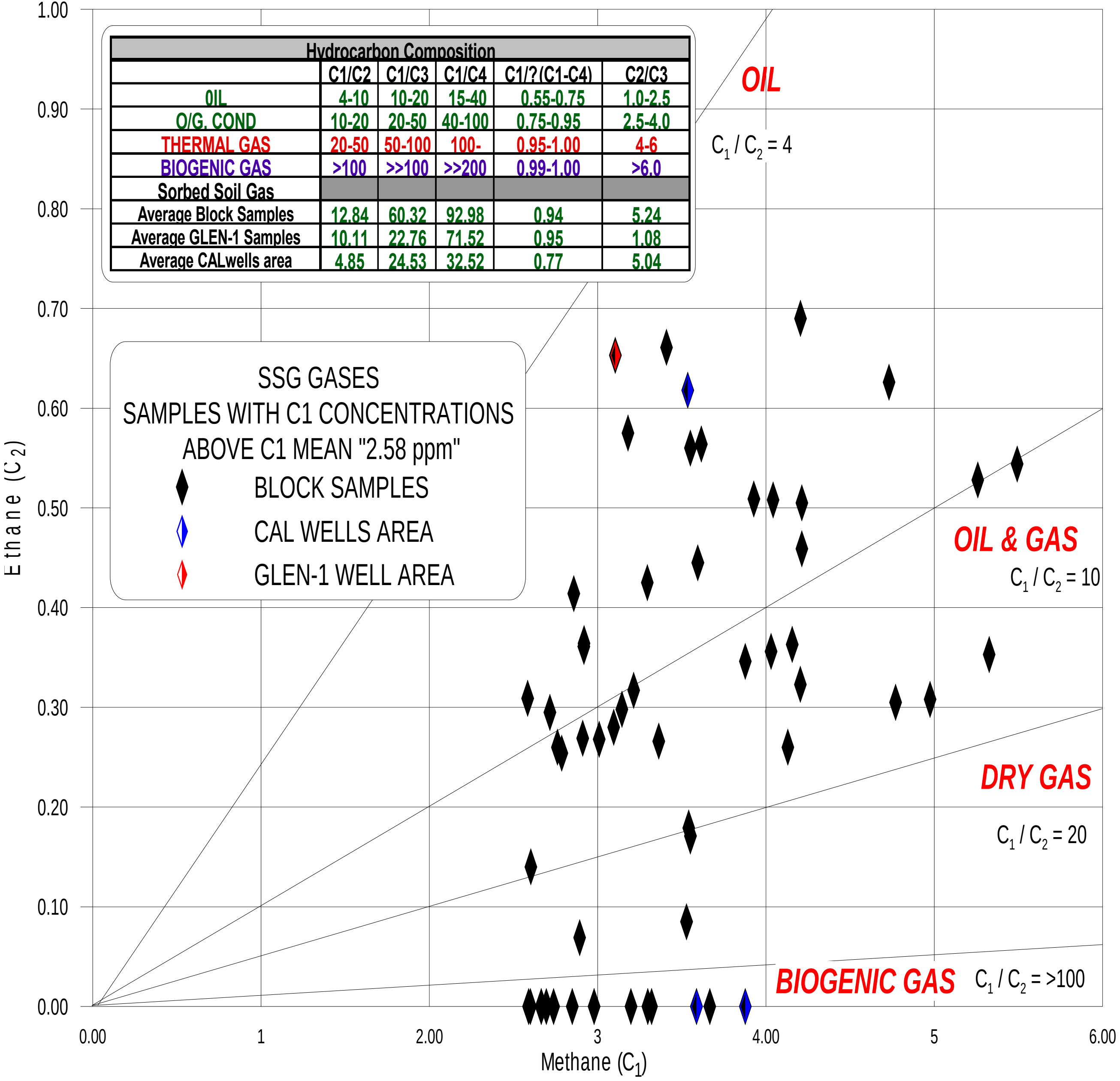
SSG Figure 3 shows a comparison of methane to ethane for the purpose of determining if a nearly linear relationship exists between the two gases. If the relationship is approximately linear then it is recognized that ***thermogenic methane*** tracks ***thermogenic ethane***, and therefore the gas source is predominantly thermogenic, not biogenic methane. This case study ratio demonstrates a loosely linear relationship. However, the most reliable SSG sample values appear to cluster closer along the oil and oil & gas ratio and therefore points to a ***thermogenic*** source. There are several biogenic samples in this data set. SSG Figure 3 also characterizes whether the gas source is predominatly dry gas, oil & gas, or oil in its origin. For this data set the methane v. ethane ratio tracks primarily along oil boundaries compared to hydrocarbon reservoirs from around the world.

Figure-3

Pangaea

788 South Queensland Australia

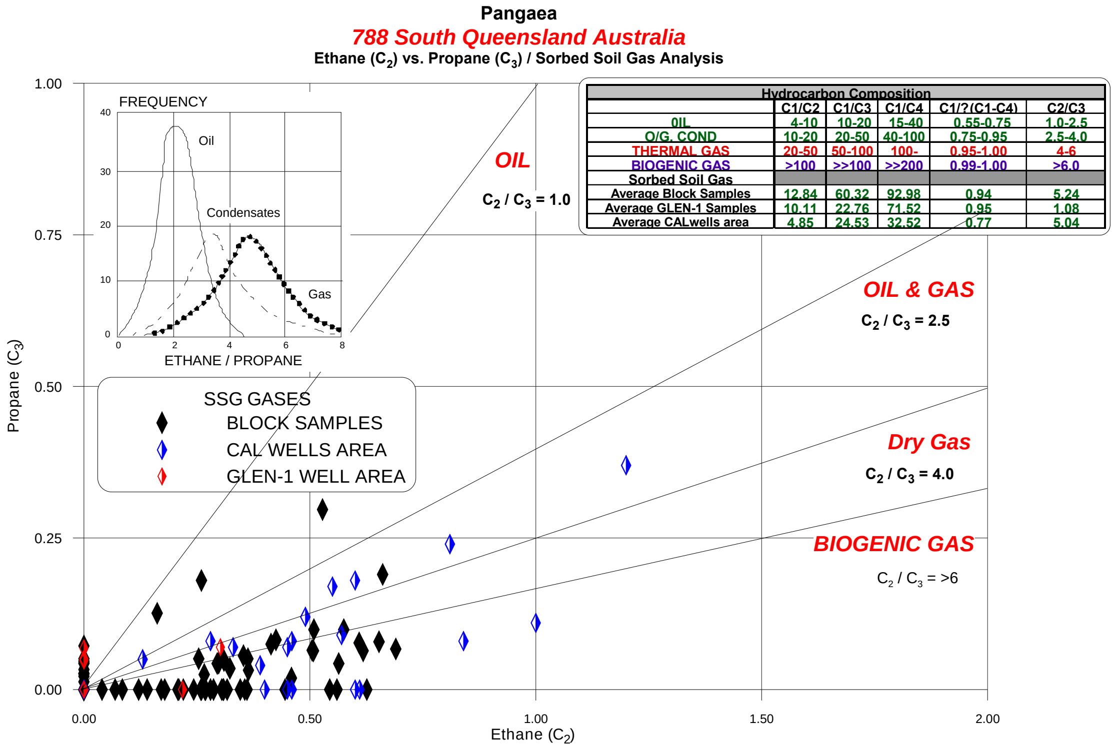
Methane (C_1) vs. Ethane (C_2) / Sorbed Soil Gas Analysis



Hydrocarbon Composition					
	C1/C2	C1/C3	C1/C4	C1/?(C1-C4)	C2/C3
OIL	4-10	10-20	15-40	0.55-0.75	1.0-2.5
O/G. COND	10-20	20-50	40-100	0.75-0.95	2.5-4.0
THERMAL GAS	20-50	50-100	100-	0.95-1.00	4-6
BIOGENIC GAS	>100	>>100	>>200	0.99-1.00	>6.0
Sorbed Soil Gas					
Average Block Samples	12.84	60.32	92.98	0.94	5.24
Average GLEN-1 Samples	10.11	22.76	71.52	0.95	1.08
Average CALwells area	4.85	24.53	32.52	0.77	5.04

The SSG C_2/C_3 plot, Figure 4, shows a cluster of mostly dry and biogenic gas samples, with a few samples registering in the oil and condensate ranges. The extremely low C_2 and C_3 values of this data set create this interpretational difficulty. Regardless, this 788S area appears to be more gas prone than the other Pangaea survey areas.

Figure-4



Hydrocarbon Composition					
	C1/C2	C1/C3	C1/C4	C1/?(C1-C4)	C2/C3
0IL	4-10	10-20	15-40	0.55-0.75	1.0-2.5
O/G. COND	10-20	20-50	40-100	0.75-0.95	2.5-4.0
THERMAL GAS	20-50	50-100	100-	0.95-1.00	4-6
BIOGENIC GAS	>100	>>100	>>200	0.99-1.00	>6.0
Sorbed Soil Gas					
Average Block Samples	12.84	60.32	92.98	0.94	5.24
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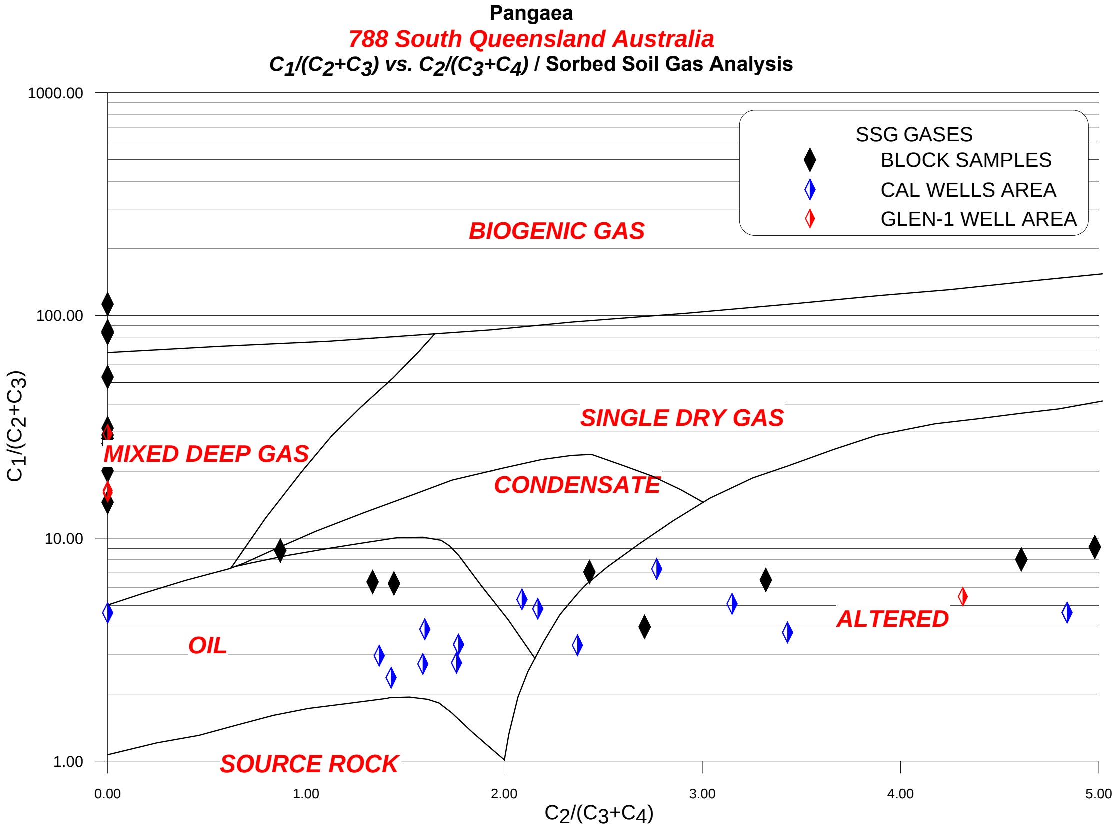
The difference between the possible composition of the hydrocarbon source recorded in Figures 3 & 4, is not unusual -- normally methane is not adsorbed as readily as ethane, propane, and higher hydrocarbon gases. Consequently, the SSG ratios involving C_2 and higher tend to appear oilier than they migrating gas probably is. In this case, the overall low values allow the ethane values to drive the ratios towards the lighter compositions. This is why we rely on the more complex ratio comparison of all four gases found in Figure 5.

Figure 5 presents a more complex set of ratios which include C_1 – C_4 gases and "maps" the ratio values into various gas source windows as determined from conventional soil gas geochemistry of hydrocarbon reservoirs from around the world. These ratios are more inclusive and rely on gas values of significant quantity. In looking at Figure 5 one can see that the tightest grouping of *reliable* samples are found in the window representing an light oil source signature. Three samples are found in the condensate window. Many samples are found in the altered and along the extreme left hand margin. The samples with an "altered" signature are generally unreliable due to their low absolute values and certain environmental factors. Samples with low methane values combined with high ethylene ratios often indicate microbially-altered samples and may not be reliable for SSG analyses. This is a common occurrence with shallow soil gas collection and subsequent analyses. This soil gas restriction is why microbial MOST results prove more reproducible and effective than soil gas testing and why only a selective subset of the microbial samples were chosen for SSG analyses and not the whole data set. It must be emphasized that SSG analyses are used primarily for light hydrocarbon source ***characterization***.

If we have the chemical composition of produced gas from nearby productive wells or fields, we could calculate the standard ratios for those gases and see how those values compare with the SSG values.

Figure-5


Pangaea
788 South Queensland Australia
C1/(C2+C3) vs. C2/(C3+C4) / Sorbed Soil Gas Analysis
SSG GASES
BLOCK SAMPLES
CAL WELLS AREA
GLEN-1 WELL AREA
BIOGENIC GAS
SINGLE DRY GAS
MIXED DEEP GAS
CONDENSATE
OIL
ALTERED
SOURCE ROCK
1000.00
100.00
10.00
1.00
C1/(C2+C3)
0.00
1.00
2.00
3.00
4.00
5.00
C2/(C3+C4)

Conclusions and Recommendations

Survey Design and Sample Collection: The sampling pattern and variable sample densities were adequate to evaluate the 788S area as part of a **reconnaissance** microseepage survey. The sample collection was completed without incident utilizing efficient GMT methodologies and productive collection crews.

Microbial Values: The results of the microbial analysis document the presence of large and strong groupings of samples with high microbial values representing the surface expression of microseepage anomalies. The size and intensity of these anomalies and their alignment into trends make for intriguing prospect possibilities. The western – especially the northwest -- portion of 788S is most favorable for further exploration studies. Also, a very strong MOST anomaly trends north-south in the north central part of 788S ending at the GLEN-1 drillsite. Lesser intense and scattered anomalies characterize the eastern margin of Block 788S. A large background area separates the eastern and western portions of the block. The correlation of low microbial and background values associated with the three out of four dry hole areas of 788S provides additional confidence. The CAL prospects would have been condemned by this microbial survey. The GLEN-1 location is on the edge of a strong MOST signature.

Faults: Naturally, it is possible that some of the clusters of anomalous samples may be related to fault leakage similar to macroseepage environments. Thorough integration of geochemical and geological and geophysical data is imperative for complete understanding of hydrocarbon traps and subsequent seepage signatures. The possibility of small stratigraphic features and their microseepage expression should never be overlooked.

Sorbed Soil Gas (hydrocarbon composition): A better effort of 141 samples were analyzed for SSG. The reliable SSG C_1/C_2 ratio data indicates that the hydrocarbon source is definitely thermogenic and is most likely light oil in composition. There are some samples with a biogenic source. The limited SSG $C_1/(C_2+C_3)$ v. $C_2/(C_3+C_4)$ ratio has more scatter in the data. However, it also suggests that the hydrocarbon source of the microseepage gases has a composition associated with primarily an oil source.

RECOMMENDATIONS: The integration of mapped microseepage signatures with geological and geophysical data sets is imperative. Infill and tighter density MOST sampling in the western and particularly in the northwestern parts of 788S may further define specific prospect locations as indicated by reconnaissance anomalous signatures. The MOST anomaly located just south of the GLEN-1 drillsite should be scrutinized with additional samples.

Interpretation Guidelines

Introduction

The successful application of surface and near-surface geochemical techniques in petroleum exploration requires careful acquisition, interpretation, and integration of surface and subsurface data (Jones and Drozd, 1983; Horvitz, 1985; Klusman, 1993; Lopez et al., 1994; Schumacher and Abrams, 1996; Schumacher, 1999; Schumacher and LeSchack, 2002). Hydrocarbon microseepage data, such as the microbial data of this report, can provide the explorationist with the means to screen large areas -- or individual leads and prospects -- rapidly, economically, and qualitatively for their overall hydrocarbon potential. Microbial and soil gas data can help establish favorable trends or fairways of potential production by delineating zones of active hydrocarbon microseepage associated with migration pathways and/or individual accumulations. Such data can high grade areas for future seismic acquisition, as well as high grading individual leads and prospects on the basis of their probable hydrocarbon charge. Surface exploration data cannot replace conventional exploration methods, but their hydrocarbon detection ability makes them a potentially powerful complement to them. **Geochemical and microbial data have found their greatest utility when used in conjunction with available geological and geophysical information. The need for such an integrated approach cannot be overemphasized.** Properly applied, the combination of surface and subsurface data can reduce exploration risk by focusing on the areas with greatest petroleum potential.

A soil microbial or gas anomaly at the surface **represents the end of a petroleum migration pathway**. The increased microseepage within these anomalies may reflect hydrocarbon migration from an accumulation, or merely leakage from a carrier bed or other migration pathway. The large clusters of samples of very high (or very low) hydrocarbon values may indicate the location of discrete structural or stratigraphic targets within the survey area. **If this is a basin characterized by predominantly vertical microseepage, then the correlation of a strong soil gas or microbial anomaly at the surface with a possible trap at depth suggests that the trap is charged with hydrocarbons.** Conversely, if the trap is not associated with a positive soil gas or microbial anomaly the assumption is that the trap is not charged with hydrocarbons. If the structural or geologic setting of this basin suggests that microseepage may be predominantly lateral, such as along dipping stratigraphic surfaces and unconformities, the interpretation will be more difficult since microbial and soil gas anomalies may then not be located vertically above a trap. Which of these migration scenarios is more likely in ***Block 788S*?** What is the expected relationship of the microseepage anomalies to outcrop and subcrop geology, mapped stratigraphic traps or structural closures, individual faults or fault zones, basement highs, seismic amplitude anomalies, or other features of geologic interest?

When evaluating the potential significance of a particular microseepage anomaly, always refer back to the microbial value map (Map 2) to see the actual distribution and abundance of anomalous samples. Due to the smoothing process, a single high-value sample can inflate the smoothed microbial value of 3-4 nearby samples and thereby increase the apparent size of the anomaly portrayed on the smoothed map.

Fault or lineament indicators may appear as a pronounced single sample anomaly, or be associated with a high value-low value microbial sample pair, or occur at the boundary between a series of low values and a grouping of high to very high values.

Not every sample within a microbial anomaly will be anomalous; due to the noisy nature of surface geochemical data, it is not uncommon to have up to 20% non-anomalous samples within a microseepage anomaly. The strongest microseepage anomalies will not only include a higher proportion of anomalous samples, but those samples will be tend to be clustered or closely grouped together and surrounded by non-anomalous (i.e., background) samples.

APPENDIX A

Background Information About Geochemical Exploration for Oil and Gas

Description of Geochemical Survey Methods

Introduction

The successful application of surface and near-surface geochemical techniques in petroleum exploration requires careful acquisition, interpretation and integration of surface and subsurface data (Jones and Drozd, 1983; Horvitz, 1985; Klusman, 1993; Lopez et al., 1994; Schumacher and Abrams, 1996; Schumacher, 1999; Schumacher and LeSchack, 2002). Hydrocarbon microseepage data, such as the soil geochemical data of this report, can provide the explorationist with the means to screen large areas -- or individual leads and prospects -- rapidly, economically, and qualitatively for their overall hydrocarbon potential. Microbial and soil gas data can help establish favorable trends or fairways of potential production by delineating zones of active hydrocarbon microseepage associated with migration pathways and/or individual accumulations. Such data can facilitate high grading of individual leads and prospects on the basis of their probable hydrocarbon charge. Surface exploration data cannot replace conventional exploration methods, but their hydrocarbon detection ability makes them a potentially powerful complement to them. **Geochemical and microbial data have found their greatest utility when used in conjunction with available geological and geophysical information. The need for such an integrated approach cannot be overemphasized.** Properly applied, the combination of surface and subsurface data can reduce exploration risk by focusing on the areas with greatest petroleum potential.

Assumptions, Uncertainties, and Limitations

The underlying assumption of all near-surface geochemical exploration techniques is that hydrocarbons are generated and/or trapped at depth and leak in varying but detectable quantities to the surface. This has long been shown to be an established fact, and the close association of surface geochemical anomalies with faults and fractures is well known. It is further assumed, or at least implied, that the anomaly at the surface can be reliably related to a petroleum accumulation at depth. **The success with which this can be done is greatest in areas of relatively simple geology and becomes increasingly difficult as the geology becomes more complex.** The geochemical anomaly at the surface represents the end of a petroleum migration pathway, a pathway that can range from short distance vertical migration at one end of the spectrum to long distance lateral migration at the other extreme (Thrasher and others, 1996). Relationships between surface geochemical anomalies and subsurface accumulations can be complex; proper interpretation requires integration of seepage data with geological, geophysical, and hydrologic data. Understanding geology, and hence petroleum dynamics, of a basin is the key to using seepage data in exploration.

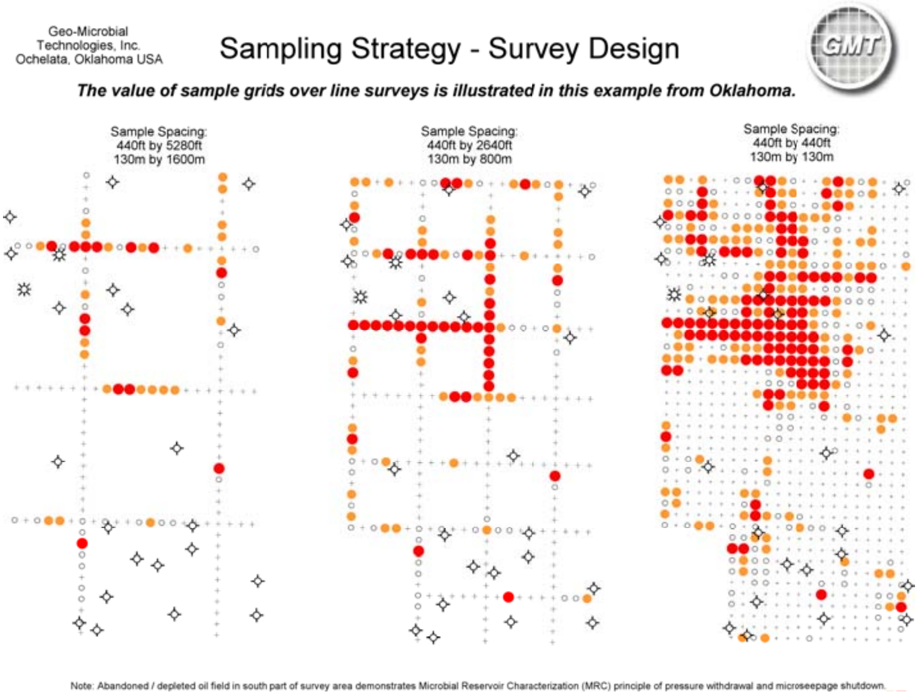
Macroseepage versus Microseepage: *Macroseeps* represent visible oil and gas seeps; very localized areas containing large concentrations of light hydrocarbons as well as, if available, high molecular weight hydrocarbons. Macroseeps are localized at the termination of faults, fractures, and outcropping carrier beds. *Microseepage* is defined as high concentrations of chemically detectable light hydrocarbons in soils, sediments, or waters. These are invisible seeps recognized only by the presence of anomalous concentrations of light hydrocarbons (principally C_1-C_5), volatile or semivolatile high molecular weight hydrocarbons (such as 2-ring to 4-ring aromatics), hydrocarbon-oxidizing microbes, or hydrocarbon-induced alteration products. Most surface geochemical methods, including the microbial method employed in this survey, are designed to detect microseepage. Hydrocarbon migration in microseeps is a pressure-driven, or buoyancy-driven, process and is predominantly vertical (Klusman and Saeed, 1996). In geologically and structurally complex areas, microseeps and macroseeps will tend to follow the same migration pathways. **Hydrocarbon microseepage is dynamic; migration rates in microseeps range from less than one foot per day to tens of feet per day** (Klusman and Saeed, 1996; Jones and Burtell, 1996; Brown, 2000).

Seepage Activity: Seepage activity refers to the relative rate of hydrocarbon seepage. It may range from active seepage at one end of the spectrum, to passive seepage at the other (Abrams, 1992; Schumacher, 1999). The term *active seepage* refers to areas where subsurface hydrocarbons seep in large concentrations into shallow sediments and into the overlying water column. Such active seeps often display acoustic anomalies on conventional or high resolution seismic profiles and can be detected geochemically by most sampling methods. Areas where subsurface hydrocarbons are not actively seeping are referred to as characterized by *passive seepage*. Such seeps usually contain light hydrocarbons above background levels, but may only be detectable in deeper samples or near major leak points. **For soil gas and microbial methods to be effective, light hydrocarbons must be seeping at a rate greater than the rate of destruction or dissipation.** Reservoirs that are significantly underpressured, or contain heavy oil with little or no associated light hydrocarbons, may display little or no active hydrocarbon microseepage.

Anomaly Recognition: Hydrocarbon microseepage data, whether soil gas or microbial or other indirect measurements, are inherently noisy data and require adequate sample density to distinguish between anomalous and background areas. Matthews (1996) has reviewed the importance of sampling design and sampling density in target recognition, and states that undersampling is probably the major cause of ambiguity and interpretation failures involving surface geochemical studies.

To optimize the recognition of an anomaly, the sampling pattern and sample number must take into consideration the objectives of the survey, the expected size and shape of the anomaly (or geologic target), the expected natural variation in surface measurements, and the probable signal-to-noise ratio (Matthews, 1996). Defining background values adequately is an essential part of anomaly recognition and delineation; Matthews suggests that as many as 80% of the samples collected be obtained outside the area of interest. We concur with these recommendations for reconnaissance and prospect evaluation surveys; however, for field development surveys optimum results are obtained when numerous samples are collected in a closely spaced grid pattern over the feature of interest. Sample spacing in that case is routinely 100-160 meters or less.

Grid designs keep the spatial density of sampling approximately constant and enable more direct correlation with subsurface data, an essential objective in field development or production applications. The advantages of grid data for anomaly definition are illustrated in the example below.



Geo-Microbial
Technologies, Inc.
Ochelata, Oklahoma USA

Sampling Strategy - Survey Design

The value of sample grids over line surveys is illustrated in this example from Oklahoma.

Sample Spacing:
440ft by 5280ft
130m by 1600m

Sample Spacing:
440ft by 2640ft
130m by 800m

Sample Spacing:
440ft by 440ft
130m by 130m

Note: Abandoned / depleted oil field in south part of survey area demonstrates Microbial Reservoir Characterization (MRC) principle of pressure withdrawal and microseepage shutdown.

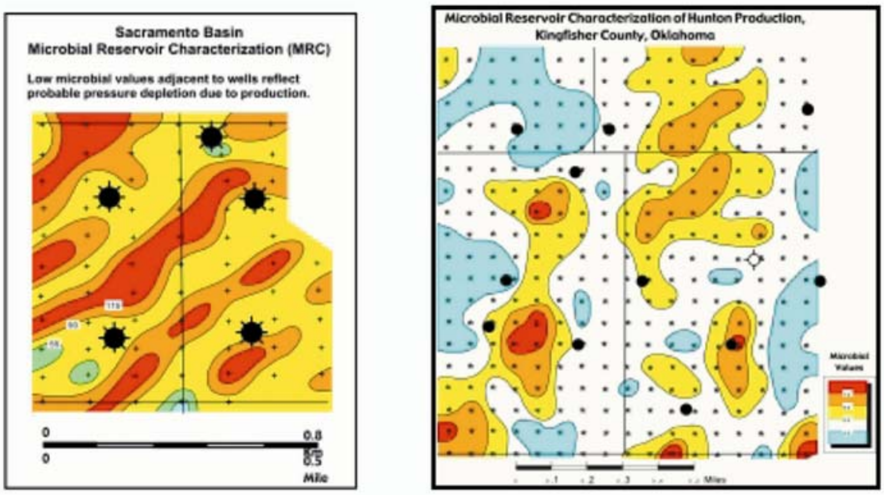
Microseepage Response over Producing Fields

Microbial Reservoir Characterization (MRC) evaluations are an interpretive modification of the MOST technology. Detailed geochemical and geomicrobiological surveys and research studies have documented that hydrocarbon microseepage is a dynamic and predominantly vertical process which responds quickly to changes in reservoir conditions (Tucker and Hitzman, 1994; Schumacher and Abrams, 1996; Schumacher et al., 1997; Hitzman et al., 2002). These characteristics create a new suite of applications for geochemical surveys, including field development and the search for by-passed oil, etc.

Because hydrocarbon microseepage is nearly vertical, the extent of an anomaly at the surface can approximate the productive limits of the reservoir at depth. Furthermore, the pattern of microseepage over a field can reflect reservoir heterogeneity and distinguish hydrocarbon-charged compartments from drained or uncharged compartments. Additionally, since hydrocarbon microseepage is dynamic, seepage patterns can change rapidly in response to production-induced changes. Seismic data will remain unsurpassed for imaging trap and reservoir geometry, but in many geologic settings only microbial and soil gas surveys can image hydrocarbon microseepage from those same reservoirs.

Microbial Reservoir Characterization (MRC) theory assumes that the pattern of hydrocarbon-oxidizing microbial populations on the surface can be directly related to pressure regimes within a subsurface reservoir. Samples for a MRC survey are collected in a tight grid pattern (every 100m or less). MRC evaluations anticipate **reduced microbial populations above portions of the reservoir in direct communication with a producing well**. This phenomenon of apparent reduced hydrocarbon microseepage over producing fields is thought to be due to a decline in reservoir pressure, as well as changes in the drive mechanism controlling microseepage. When a well is brought into production, the drive changes from a vertically migrating buoyancy force to horizontal gas streaming to low pressure sinks created around producing wells. When this occurs, microseepage ends and microbial populations decline rapidly. These changes in drive mechanism and microbial response can help define reservoir drainage directions, radii and heterogeneity around existing wells in producing fields.

In MRC evaluations of fields under primary production, areas of elevated microbial populations represent (1) microseepage from areas *not* in pressure communication with surrounding producers, or (2) represent undrained portions of the reservoir, or (3) seepage from a reservoir not perforated by the producing wells. Clusters of low microbial counts may indicate (1) depressured regions of the reservoir in communication with the surrounding producers, (2) areas without significant hydrocarbon accumulation, or (3) areas from which reservoir facies are absent. An example of the complex seepage patterns that are observed over producing fields is shown below.



MRC examples from Sacramento Basin, California and Kingfisher County, Oklahoma

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