GULF OF MEXICO
gPVT STUDY

REGIONAL PETROLEUM GEOCHEMISTRY AND PVT ANALYSIS COMPARISON OF CRUDE OIL SAMPLES FROM THE GULF OF MEXICO

GEOMARK
RESEARCH, INC.

PROSPECTUS

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EXECUTIVE SUMMARY

GeoMark Research has completed a crude quality study to establish ranges of oil quality for the different oil types found in the Gulf of Mexico. Average ranges of quality parameters have been determined for different source types, levels of thermal maturity, degrees of biodegradation, and percentage of oil family mixing. The study was accomplished by statistically comparing oil quality parameters in GeoMark's GOMOIL™ database (e.g., %S, ppm Ni & V, API gravity, SARA, GC wax factor) with selected engineering-based oil quality measurements (i.e., viscosity, API gravity, bubble point, cloud point, GOR ratio, and SARA analysis).

This unique study has established statistical ranges of crude oil quality for all the oil families or types in the Gulf of Mexico Basin. Participants are able to accurately predict the quality ranges of oils in new or unexplored regions, or can predict oil quality from cuttings or sidewall core extracts. Although we classified each of the oil groups found in the Gulf of Mexico we concentrated on the offshore, and especially on the deep-water region.

Specifically, this study accomplished the following:

- Determined the statistical ranges of oil parameter indices found in the Gulf of Mexico. This includes different oil families, mixtures of these families, thermal maturation differences, degrees of biodegradation, and presence of second pulse light hydrocarbon (polyhistory oils).
- Established a database of PVT for Gulf of Mexico oil samples, concentrating on the offshore region.
- Performed the standard geochemical analytical program on the 134 dead oil samples that were submitted with corresponding PVT results.
- Correlated PVT results to the matrix of parameter averages established for oil types in the Gulf of Mexico.
- Constructed a matrix table that provides a complete set of quality ranges for all the significant oil quality parameters for each of the oil types.

GeoMark is inviting interested companies to participate in this study. The cost of participation is (US) $32,500.00. The study is completed and available for immediate delivery.

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INTRODUCTION

The relative quality of newly discovered petroleum is an important variable with regard to the ultimate quantity produced from a reservoir, the type and maintenance of production/transport facilities, the net price that can be obtained for the oil, and environmental costs associated with petroleum production. Discovery of “low” quality crude is certainly less desirable than crude of “higher” value, and in some regions can determine economic viability (i.e., deep-water environments). Oil quality evaluations are increasingly being employed in exploration risk analysis. The volume of oil generated from a potential source rock is often estimated in risk analysis. If the quality can also be predicted more precisely, economic forecasts can be more accurate. This is especially important during times of reduced profit margins.

A ‘low’ or ‘high’ quality crude oil is determined by numerous physiochemical properties of the oil, which are, in turn, governed by various geochemical/geological processes. The three principal geochemical/geological processes that determine the quality/value of a particular crude oil are 1) source rock type, 2) thermal maturity, and 3) post-emplacement issues such as extent of biodegradation or mixing of different crude types. GeoMark’s previous studies have been focused on the molecular composition of crude oils, predicting the depositional environment of the oils’ source, and determining the thermal history of the source rocks from which the oils were derived. The analytical program used in these studies also addresses oil quality parameters.

All of the 1000 oil samples used in GeoMark’s Gulf of Mexico Oil Study and its GOMOIL™ database have been typed for origin, thermal maturity, degree of biodegradation, and mixing. In addition, each oil sample has been evaluated for the full range of oil quality parameters. This makes GeoMark’s database an exceptional tool for establishing the quality ranges for each of the oil types present in the basin.

GeoMark used its GOMOIL™ database to calculate the average oil quality parameters for each oil type in the Gulf of Mexico. In addition, as part of this study GeoMark analyzed a collection of 134 samples previously analyzed for PVT parameters. These new oils were classified by type, maturity, biodegradation, and mixing. Once this was completed, we were able to calculate the average PVT ranges for each oil class, and provide the participants with the tools needed to accurately predict oil quality in the Gulf.

The results of this study permit participants to predict, with confidence, the quality of a) any oil in the Gulf, b) the quality characteristics of the oils in a new region (geographic or stratigraphic), and c) the expected quality of an oil from a small sample test, extracted side-wall core, or extracted cuttings sample.

METHODOLOGY

GeoMark Research has built a digital library of crude oil analyses for the greater Gulf of Mexico (GOMOIL™). The oils in the GOMOIL™ database came from GeoMark's Gulf of Mexico Oil Study, in which geology and geochemistry were integrated to determine the corresponding source rock type, age, thermal history, and degree of biodegradation of each oil. This was accomplished primarily using GC/MS biomarker and carbon isotopic analyses. Bulk data pertaining to oil quality issues were also obtained for each oil sample. API gravity, SARA analyses (% saturate, aromatic, resins, and asphaltenes), % sulfur, and ppm Ni & V were routinely measured on the 1000 oils in the GOMOIL™ sample set. Additionally, whole crude gas chromatograhic parameters related to oil quality were acquired. These data are useful for determining the wax content and degree of alteration of the oils. GeoMark has aliquots of the oils permitting additional quality testing procedures, as required.

GeoMark has conducted a study to establish the ranges of oil quality for all the oil types found in the Gulf of Mexico. By establishing the relationships between GeoMark's geochemical analyses and fluid properties parameters, we have provided the quality ranges for standard fluid property indices.

This study evaluates each of the 11 petroleum systems (particular oil families with known geographic extents) identified in the in the greater Gulf of Mexico Basin, and will focus on the deep-water region. We compared oil quality and fluid properties data collected from samples representing each of the "family" classifications established from our previous geochemical studies. We addressed each of the five issues relating geochemistry and oil quality, namely:

1. Exploration risk as regards to expected oil quality
2. Production engineering
3. Transportation
4. Refinery problems
5. Environmental problems

Additional analyses were performed on a few select samples from the GOMOIL™ database including high temperature gas chromatography to determine C70+ waxes, cross polarized microscopy with variable temperature stage (CPM) to determine the wax appearance temperature (WAT), total acid number (TAN), and heat capacity.

OBJECTIVES

This two-phase study accomplished the following objectives:

Objective 1 - The first objective of this study was to determine oil quality parameter averages and ranges for the matrix squares shown in Table I. This was accomplished using GeoMark's Gulf of Mexico Oil Study and GOMOIL™ database of over 1000 GOM oils. Our past work in the basin indicated that we needed to establish ranges for 11 distinct oil families having 3 levels of thermal maturity and 2 degrees of biodegradation. In addition, 3 families of degraded oils that have been recharged with a nondegraded light oil or condensate were also studied (polyhistory oils). We determined the average parameter ranges for mixed compositions of Cretaceous and Tithonian oils (Family SE1). The mixed oils were determined at 100/0, 75/25, 50/50, 25/75 and 0/100 mixtures for each of the possible end members.

Table I. GOM family designations and compositional matrix classes.

Parameter averages for % Sulfur, API gravity, asphaltene content, resin content, aromatic content, ppm Ni, ppm V, and wax content were calculated for each matrix class.

Oil Family	M1	M2	M3	M1B1	M1B2	M2B1	M2B2	M3B1	M3B2	M1B2*	M2B2*
A											
B											
C2											
D											
C1											
SE1 Mix											
SE2											
F1											
F3											
F2											
T2/AJB											

M1: low maturity B1: slightly/moderatly biodegraded
M2: moderate maturity B2: severly biodegraded
M3: high maturity *=polyhistory oil (+light end charge)

GeoMark's sample collection has a population of samples for most matrix classes ensuring that a statistical average for each class will be established. This process provided a mathematical range of index parameters for oil types produced in the Gulf of Mexico Basin. This classification will allow participating companies to generate quality estimates of fluid properties for any type of oil sample (drill stem test, formation test, extracted side wall core, extracted cuttings, etc.). Several of the matrix squares were not calculated because the oil type represented by this class has not been identified. The ranges will be calculated if these oils are later discovered.

Objective 2 - The second objective of this study was to couple PVT fluid property data with GeoMark geochemical data so the matrix classifications in Table I could be assigned PVT ranges. GeoMark collected 134 PVT analyses along with corresponding dead oil samples (Figure 1). The oil samples were analyzed by GeoMark (assuming they were not in the original studies) so that we could compare the oil quality and geochemical data for each sample. Specifically, we calculated matrix averages for each of the following parameters, appropriately qualified as necessary for pressure and temperature:

- Density - API gravity
- Viscosity - often determined at reservoir temperatures and pressures
- GOR - the relative abundance of gas in crude oils
- Bubble point - saturation pressure
- Asphaltene content
- Phase behavior of asphaltene under different pressure/temperature regimes

- Cloud point - the temperature where wax precipitates from a crude
- Sulfur content
- Nickel and vanadium content

Since the "new" oil samples (those samples with corresponding PVT data) could be interpreted and "classed" in the matrix Table I, we were able to establish the PVT ranges for each oil type.

All this information, along with the matrix classifications and written interpretation is supplied to the participating companies.

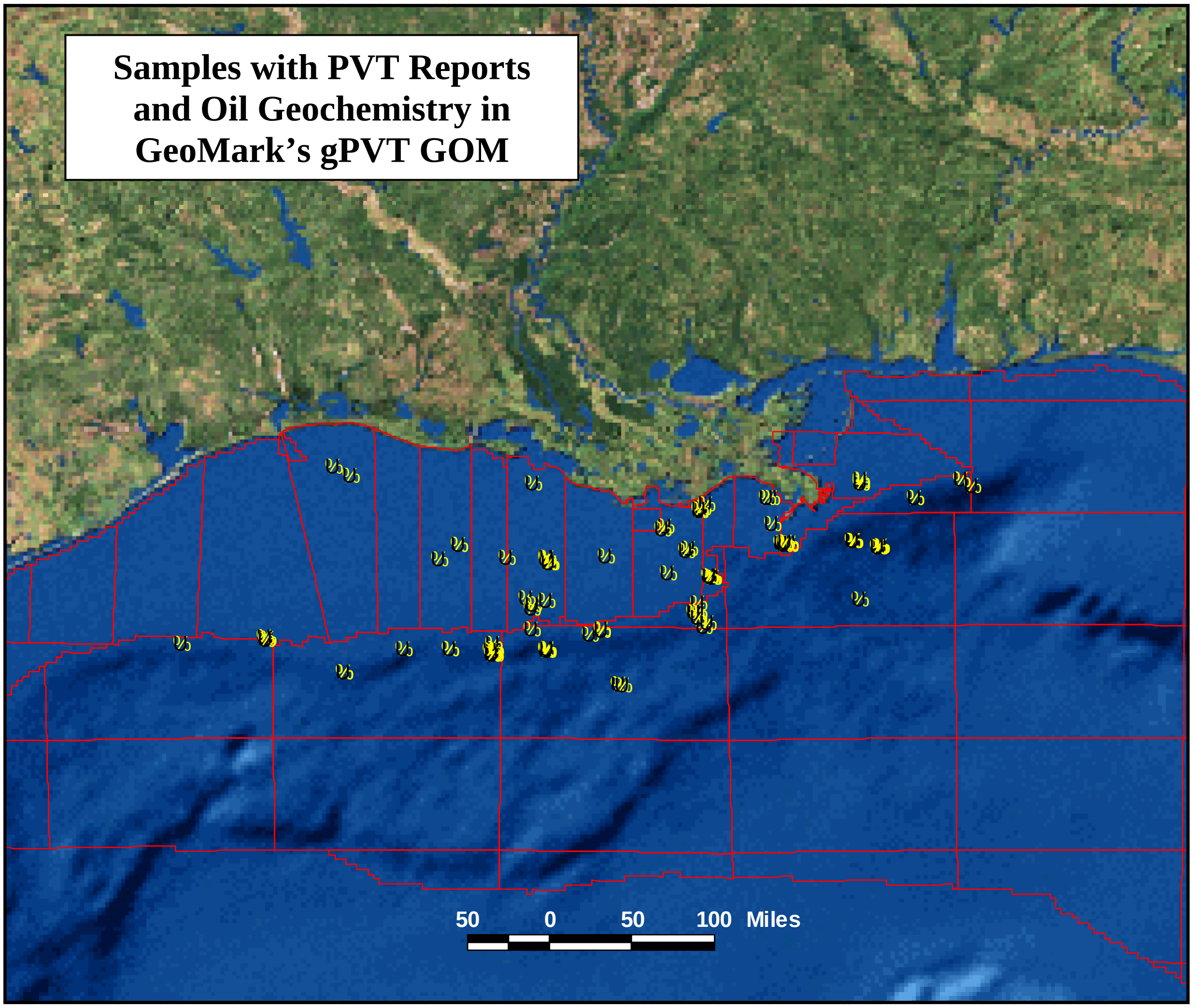

Figure 1. Location map showing distribution of samples included in this study.

PARTICIPATION

The complete study is available at a cost of (US) $32,500.00.

TIMING

The study is completed and available for immediate delivery.

FOR ADDITIONAL INFORMATION CONTACT:

Mr. Stephen W. Brown
GeoMark Research, Inc.
9748 Whithorn Drive
Houston, TX 77095

Telephone: (281) 856-9333
Fax: (281) 856-2987
e-mail: sbrown@geomarkresearch.com

TABLE I

PVT Reports and Oil Samples Analyzed for this Report

SampleID	Field	Well	Depth ft	Formation Sand	Lat	Long
LA104	EI330	A-2	4,752		28.232553	-91.689156
LA119	GC60	1	5,671		27.900469	-91.140015
LA320	GC6	OCSG-06987 A-8			27.946052	-91.646524
LA329	EW1006				27.97	-90.14
LA488	GC18	A-2			27.95	-91.03
LA490	GC18	A-4			27.94	-91.03
LA912	VK697	1 OCS-G-13059	11,212	Tex W	29.283206	-87.868283
LA913	VK697	1 OCS-G-13059	10,904	Tex W	29.283206	-87.868283
LA914	Baldpate (GB260)	A-1 OCS-G-7462	16,767	Big	27.737	-91.997785
LA915	Baldpate (GB260)	A-2 OCS-G-7462	17,625	Big	27.72815	-91.977017
LA916	Baldpate (GB260)	A-3 OCS-G-7462	16,778	Twins	27.734753	-91.99271
LA917	Baldpate (GB260)	A-4 OCS-G-7462	17,579	Twins	27.736361	-92.001199
LA918	Baldpate (GB260)	A-5 OCS-G-7462	16,684	Big	27.740873	-91.99647
LA919	Baldpate (GB260)	A-6 OCS-G-7462	16,965	Twins	27.748962	-91.997574
LA920	Baldpate (GB216)	2	14,389	U. Lentic 1	27.772324	-91.968711
LA921	Baldpate (GB216)	2	14,906	U. Lentic 2	27.772324	-91.968711
LA922	Baldpate (GB216)	2	15,921	Basal Lentic	27.772324	-91.968711
LA923	ST287	2 ST 1 OCS-G-15343	13,583	1350 ft	28.180743	-90.188826
LA924	Baldpate (GB260)	4 ST 1	16,684	Big	27.736361	-92.001199
LA925	Baldpate (GB260)	4 ST 1	16,931	U. Twin	27.736361	-92.001199
LA926	Baldpate (GB216)	3 OCS-G-14224	17,551	Disc A	27.771959	-91.980252
LA927	Enchalda (GB172)	1 OCS-G-14221	11,772	Lentic	27.818157	-91.987847
LA928	Baldpate (GB215)	2	15,515	Basal Lentic 3	27.762217	-92.001622
LA929	Baldpate (GB259)	1 ST 1 OCS-G-7461	17,476	Basal Nebraskan 5		
LA930	Baldpate (GB260)	1 ST 1	18,238	U. Twin	27.74464	-91.988206
LA931	Baldpate (GB259)	1 ST 1 OCS-G-7461	17,568	U. Twin		
LA932	Baldpate (GB260)	1 OCS-G-7462	16,749	L. Twin	27.74464	-91.988206
LA933	Baldpate (GB260)	1 ST 1 OCS-G-7462	18,207	L. Twin	27.74464	-91.988206
LA934	VK740	1	10,124	U. Vig		
LA935	VK740	1	10,815	Tex W		
LA936	Ladybug (GB409)	1	6,450		27.56464	-93.293959
LA937	Ladybug (GB409)	1	6,483		27.56464	-93.293959
LA938	Ladybug (GB409)	3	5,738		27.564607	-93.294089
LA939	McKinley (GC416)	1				
LA940	Fuji 2 (GC505)	1 OCS-G-8879	14,782	Pink	27.459866	-90.884894
LA941	Fuji 2 (GC505)	1 OCS-G-8879	17,134	U. Leiv	27.459866	-90.884894
LA942	Fuji 2 (GC505)	1 OCS-G-8879	17,612	Magenta	27.459866	-90.884894
LA943	Fuji 2 (GC505)	1 OCS-G-8879	17,899	Magenta	27.459866	-90.884894
LA944	Fuji 1 (GC506)	1 OCS-G-8880	19,690	Magenta	27.456434	-90.84975
LA945	Fuji 3 (GC506)	2 OCS-G-8880	18,208	L. Leiv	27.460001	-90.884953
LA946	Fuji 3 (GC506)	2 OCS-G-8880	19,095	Magenta	27.460001	-90.884953
LA948	Gemini 2 (MC291)	1	14,293	Dean	28.677594	-88.58818
LA949	Gemini 2 (MC291)	1	14,712	Luis	28.696145	-88.57906
LA950	Gemini 2 (MC291)	1	18,336		28.696145	-88.57906
LA951	Gemini 2 (MC291)	1	18,410	Marilyn	28.696145	-88.57906
LA952	Gemini 3 (MC291)	2	11,456		28.68085	-88.610409

LA953	Gemini 1 (MC292)	1	13,770	Dean	28.68085	-88.610409
LA954	Triton (MC722)	1	12,927		28.221735	-88.766152
LA955	Petronius (VK786)	1	10,274		29.2291	-87.78104
LA956	Oudinot (VK864)	1	7,999		29.123481	-88.275699
LA957	Oudinot (VK864)	1	8,333		29.123481	-88.275699
LA974	Matterhorn (MC243)	2 OCS-G-19931	6,108		28.746704	-88.816173
LA975	Matterhorn (MC243)	3 OCS-G-19931	7,694		28.737227	-88.824041
LA976	Baldpate (GB259)	A-7 OCS-G-4712	16,620	Basal Lentic 3	27.733371	-91.993635
LA977	Matterhorn (MC243)	1 ST1 OCS-G-19931	8,464		28.742245	-88.825614
LA978	Matterhorn (MC243)	1 ST2 OCS-G-19931	7,808		28.742245	-88.825614
LA979	Matterhorn (MC243)	1 ST1 OCS-G-19931	8,322		28.742245	-88.825614
LA980	Matterhorn (MC243)	1 ST2 OCS-G-19931	7,272		28.742245	-88.825614
LA981	Matterhorn (MC243)	1 OCS-G-19931	6,496		28.742245	-88.825614
LA992	Baldpate (GB259)	A-7 OCS-G-4712		D. Tamalis Sand	27.733371	-91.993635
LA993	GB208	1 OCS-G-8222	7,205		27.77758	-92.363228
LA994	GB208	1 OCS-G-8222	7,205		27.77758	-92.363228
LA995	EB157	2 OCS-G-11412	5,000		27.822525	-94.725359
LA996	GB208	1 ST2 OCS-G-8222	7,037		27.777541	-92.366696
LA997	GI102	6 ST3 OCS-G-5662	15,900		28.419234	-90.069459
LA998	GI102	7 OCS-G-5662	13,180		28.415749	-90.060623
LA999	GI102	B-1 OCS-G-5662	11,980		28.427236	-90.088239
LA1000	GI102	B-2 OCS-G-5662	13,550		28.432659	-90.078334
LA1001	GB200	3 OCS-G-15852	12,932		27.782532	-92.76858
LA1003	EI224	A6	13,586	Aqua		
LA1034	EW873	A2	13,287		28.097024	-90.188427
LA1035	EW873	A3	10,348		28.103821	-90.211292
LA1036	EW873	A17			28.102218	-90.187615
LA1037	EW873	A18			28.102541	-90.215846
LA1038	EW917	1	11,161		28.061089	-90.188405
LA1039	EW963	A2			28.006735	-90.101471
LA1040	EW1008	1	13,065			
LA1041	Jolliet (GC184)	A1	8,983	KE-1, KE-2, KI	27.769134	-91.520293
LA1042	Jolliet (GC184)	A3	9,490	KE-2	27.775146	-91.515975
LA1043	Jolliet (GC184)	A8	8,480	KE-1, KE-2	27.777759	-91.510539
LA1044	Jolliet (GC184)	A10-D		ID#4, IF#4	27.760363	-91.515609
LA1045	Jolliet (GC184)	A10	10,430	IG #4	27.760363	-91.515609
LA1046	Jolliet (GC184)	A11-D	7,387	HJ#1, HM#1	27.761529	-91.522762
LA1047	Jolliet (GC184)	A16-D	7,034	HO, AI, IB	27.774425	-91.515431
LA1048	Jolliet (GC184)	A17		HG	27.770035	-91.510381
LA1049	Jolliet (GC184)	A19	6,925	IA#7, IB#7	27.775781	-91.51265
LA1065	SP86	2 OCS-G-5687	16,539		28.721436	-89.385369
LA1066	WD79	B-1 OCS-G-4243	9,271		28.889431	-89.528803
LA1067	SP87	4 OCS-G-7799	18,346		28.712891	-89.447878
LA1068	SP87	4 OCS-G-7799	18,346		28.712891	-89.447878
LA1069	SP87	4 OCS-G-7799	18,346		28.712891	-89.447878
LA1070	SP86C	C-1 OCS-G-1618		U-1/5	28.710535	-89.384148
LA1071	SP86C	C-2 OCS-G-5687?(1618)		U-1/5	28.721436	-89.385369
LA1072	SP87	3 OCS-G-7799	17,694		28.72915	-89.421845
LA1073	SP87	4 OCS-G-7799	18,346		28.712891	-89.447878
LA1074	SP87	5 OCS-G-7799	18,282	U Series	28.707667	-89.424148
LA1075	SP87	5 ST1 OCS-G-7799	18,428	U Series	28.719963	-89.430722
LA1076	SP87	3 OCS-G-7799	17,611		28.72915	-89.421845
LA1077	SM78	B-1 OCS-G-1210	13,793	C3A	28.594826	-91.870212

LA1078	SS182	E-9 OCS-G-1019	14,390	E-3	28.600879	-90.995404
LA1079	WC168	2 OCS-G-5283	12,903		29.400265	-93.387093
LA1080	WC198	C-1 OCS-G-3265	15,194	MN-3	29.326508	-93.23384
LA1081	BM2	EE-14 OCS-G-0386	9,211	J	29.013748	-90.168698
LA1082	BM State Lease 1366	66	6,268	H		
LA1083	Bay Marchand Field	CG-71 OCS-G-0369	7,652		29.03639	-90.147202
LA1084	BM2	EE-13 OCS-G-0386	8,780	J	29.017689	-90.170883
LA1085	BM State Lease 1365	81	8,300	RASU		
LA1086	BM3	SG-38 OCS-G-0390		7500 FF Sand	29.062078	-90.115492
LA1087	BM2	EE-15 OCS-G-0386	8,494	J	29.020582	-90.171519
LA1088	EI52	4 OCS-G-3148	10,390		29.247371	-91.631625
LA1089	EI230	7 OCS-G-0979	12,517		28.585373	-91.518591
LA1090	EI353	D-6 OCS-G-3410			28.136563	-91.648575
LA1091	EI352	B-5 OCS-G-3410			28.169686	-91.641294
LA1092	EI237	3 OCS-G-0981	9,479	D-4	28.541676	-91.489438
LA1093	EI237	K-7 OCS-G-0981	8,870	C-15 FB-K1 Sand	28.544146	-91.49155
LA1094	EI229	1 OCS-G-5505	12,353	14 Sand	28.580784	-91.522373
LA1095	EI230	CD-8 OCS-G-0979	13,482	14 Sand	28.585325	-91.505592
LA1096	EI341	A-14 OCS-G-2914	12,353	5400 FB A-14	28.207786	-91.523751
LA1097	EI237	K-1D OCS-G-0981	8,870	D-1	28.541843	-91.492328
LA1098	ST135	X-3 OCS-G-0498	16,412	J-7 Sand	28.676039	-90.268719
LA1099	ST135	5 OCS-G-0462	16,405		28.647422	-90.288487
LA1100	ST203	B-2 OCS-G-1269			28.454513	-90.456254
LA1101	ST52	7 ST OCS-G-1241	11,008	10700 FT Sand	28.872265	-90.474577
LA1102	ST52	8 ST1 OCS-G-1241	12,044	10800 FT 'B' Sand	28.849471	-90.502118
LA1103	WD27A	A-9D OCS-G-4773	9,840	C-5	29.126703	-89.542428
LA1104	WD28	14 OCS-G-0384			29.120084	-89.579152
LA1105	VR214	C-2 OCS-G-2076	12,656		28.706103	-92.28566
LA1106	VR214	C-2 OCS-G-2076	13,815		28.706103	-92.28566
LA1107	VR245	F-4 OCS-G-1146	10,322		28.580455	-92.455138
LA1108	MP299	11 OCS-G-1316	1,275		29.253011	-88.757273
LA1109	MP299	AA2 OCS-G-1316		7200 FT A Sand	29.278799	-88.750212
LA1110	MP299	AA3 OCS-G-1316			29.282939	-88.751495
LA1111	MP299	DA3 OCS-G-1316	2,153		29.257462	-88.750227
TX173	HIA-596	#D-08A OCS-G-2722	6,246		27.870716	-93.975388
TX176	HIA-595	#D-10 OCS-G-2221	6,600		27.876959	-93.996147
TX179	HIA-595	#D-02 OCS-G-2722	13,663		27.857712	-93.980873