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NATURAL GAS ANALYSES FROM OFFSHORE GULF OF MEXICO

By

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This report summarizes analyses of natural gas collected from 116 wells representing 55 different fields in offshore Louisiana and Texas. Samples were collected from the entire productive trend from the Mississippi delta in eastern Louisiana westward to the Brazos area in Texas (fig. 1). Because samples were taken primarily from gas fields, most of the samples are located offshore of western Louisiana and Texas because of the dominance of gas fields in those areas.

Gas samples were analyzed by thermal-conductivity gas chromatography. Volume percent of the constituents methane (C_1), ethane (C_2), propane (C_3), butanes and pentanes (C_4+), carbon dioxide (CO_2), and nitrogen and air (N_2-air) are reported. The methane peak was quantitatively collected and converted to CO_2 in a vacuum combustion system. Stable carbon isotope ratios were measured on a Neir-McKinney type mass spectrometer and are reported in the δ-notation in parts per thousand ($^o/oo$) deviations, relative to Pedee belemnite (PDB) marine carbonate standard.

Analyses of gas samples are summarized in table 1. The volume percentage of selected components is reported, together with the proportion of methane in the hydrocarbon fraction (C_1/C_{1-5}) and the stable carbon isotope ratio ($\delta^{13}C$) of the methane component. The samples are arranged by area (west to east) and by field/block (increasing number).

The interpretation of data is presented in a paper by Rice (1980) and is briefly summarized below. The gases display a trend of becoming isotopically heavier ($\delta^{13}C_1$ values range from -70 to -35 $^o/oo$) with increasing depth and age of producing reservoir. The mechanisms responsible for this fractionation are biogenic enrichment of $^{12}C_1$, thermal cracking, and mixing. Separate trends are present in Texas and Louisiana which confirm the existence of a higher geothermal gradient in offshore Texas. There is considerable scatter along the trend because gases generated from deeper,thermally mature source rocks have commonly migrated to shallower immature reservoirs.

The province is primarily a gas-producing area for three reasons. Many gas fields, particularly those of Pleistocene age, are of apparent biogenic origin. This gas is characterized by enrichment of the light isotope ^{12}C in methane ($\delta^{13}C_1$ values lighter than -55 $^o/oo$) and by large amounts of methane (C_1/C_{1-5} >0.99). Miocene gas accumulations in the western part of the province are the result of early stages of thermal cracking of heavier hydrocarbons, including oil, because of a higher geothermal gradient. This gas is wetter than biogenic gas (C_1/C_{1-5} >0.94) and isotopically heavy ($\delta^{13}C_1$ values are heavier than -40 $^o/oo$). Many gas fields in reservoirs of all ages are the result of "separation-migration" in which the gas phase was physically segregated from a petroleum accumulation. These gases are similar in composition to gas associated with petroleum.

ACKNOWLEDGMENTS

The Gulf of Mexico OCS Operations Office, Minerals Management Service greatly assisted in collecting the gas samples and provided data on the sampled wells which we gratefully acknowledge. We also thank the many oil and gas companies for their permission and assistance in collecting the gas samples.

REFERENCE CITED

Rice, D. D., 1980, Chemical and isotopic evidence of the origins of natural gases in offshore Gulf of Mexico: Transactions of Gulf Coast Association of Geological Societies, v. 30, p. 203-213.

Table 1.--Chemical and isotopic composition of natural gas from selected wells in the Gulf of Mexico OCS

Area	Field/ block	OCS number	Well number	Depth to producing interval (m)	Age of producing interval	Type of gas	N_2 and (or) air	C_1	CO_2	C_2	C_3	iC_4	nC_4	iC_5	nC_5	C_1/C_{1-5}	$\delta^{13}C_1$(°/oo)
Brazos	A1	G1723	A1U	2056	Miocene	Nonassoc.	3.490	90.20	0.377	2.270	1.720	0.818	0.507	0.403	0.203	0.938	-55.9
Do	A1	G1723	A4U	1986	---do---	---do---	3.800	89.96	.366	2.180	1.740	.840	.524	.391	.191	.939	-56.7
Do	A70	G2663	A4	2907	---do---	---do---	2.670	93.44	1.090	1.960	0.470	.110	.090	.050	.030	.971	-35.5
Do	A70	G2663	A9	2970	---do---	---do---	0.960	94.98	1.640	1.610	.440	.110	.090	.050	.040	.975	-35.1
Do	A76	G1752	A1	2826	---do---	---do---	3.230	91.79	.865	2.280	.979	.385	.227	.139	.089	.957	-43.5
Do	A76	G1752	A6	2899	---do---	---do---	3.390	90.88	2.480	2.230	.556	.233	.117	.070	.038	.965	-40.6
Do	A105	G1754	A1	3083	---do---	---do---	3.900	87.64	.932	3.780	2.000	.691	.545	.332	.181	.921	-39.2
Do	A105	G1757	A2	2780	---do---	---do---	3.040	93.17	.787	1.670	.694	.258	.178	.120	.072	.969	-36.2
Do	A133	G2665	A3	2856	---do---	---do---	2.880	91.89	.930	1.970	.950	.380	.310	.280	.180	.955	-34.8
Do	A133	G2665	A5	2846	---do---	---do---	1.950	94.74	.380	1.520	.530	.160	.180	.090	.080	.970	-34.6
Do	A133	G2665	A6	2889	---do---	---do---	1.940	94.74	.860	1.310	.490	.210	.140	.120	.120	.975	-34.7
Do	A133	G2665	A9	2949	---do---	---do---	2.580	92.13	.820	2.110	1.000	.530	.310	.270	.150	.954	-36.0
Galveston	255	G1772	A5	2778	Miocene	Associated	3.300	85.78	0.457	6.300	2.360	0.757	0.556	0.296	0.172	0.891	-43.9
Do	255	G1777	A8	2755	---do---	---do---	2.350	89.84	.790	1.990	3.330	1.020	.730	.420	.260	.928	-43.7
Do	288	0709	A6	2261	---do---	---do---	3.530	89.48	1.450	3.390	1.140	.435	.277	.187	.105	.942	-40.6
Do	288	0709	A14	2587	---do---	---do---	3.450	89.21	1.230	3.870	1.220	.501	.244	.184	.098	.936	-42.8
Do	288	0709	B5L	2613	---do---	---do---	3.130	90.14	1.320	3.240	1.170	.417	.286	.191	.109	.943	-40.2
Do	288	0714	B11L	2658	---do---	---do---	3.180	90.18	1.230	3.270	1.160	.420	.254	.190	.105	.943	-40.0
High Island	52	0740	A6	2420	Miocene	Associated	2.280	92.09	0.430	3.520	1.000	0.272	0.227	0.118	0.074	0.946	-39.4
Do	111	G2353	A4	3873	---do---	Nonassoc.	.910	95.63	1.790	1.270	.260	.060	.070	.010	Trace	.983	-35.8
Do	111	G2353	A5	2723	---do---	---do---	2.120	91.65	.310	3.520	1.310	.490	.300	.190	.120	.939	-41.1
Do	111	G2353	A6	3725	---do---	---do---	1.740	91.60	1.430	3.520	.940	.330	.170	.100	.070	.946	-39.2
Do	111	G2353	A8	3234	---do---	---do---	1.040	94.01	.850	2.760	.710	.250	.140	.090	.050	.958	-38.6
Do	111	G2354	A3	3754	---do---	---do---	1.000	92.19	1.630	3.520	.920	.312	.200	.090	.060	.947	-39.4
Do	111	G2354	A7	3745	---do---	---do---	2.350	91.05	1.440	3.510	.950	.280	.170	.130	.070	.946	-39.3
Do	129	G1848	5	2782	---do---	---do---	1.740	93.05	.740	2.940	.860	.310	.150	.100	.090	.954	-42.0
Do	129	G1848	6	2774	---do---	---do---	1.590	93.34	.410	2.990	.860	.300	.150	.080	.070	.952	-41.6
Do	140	0518	A1U	2290	---do---	---do---	3.320	92.26	.389	2.700	.769	.283	.145	.088	.050	.958	-41.1
Do	140	0518	C1	1995	---do---	---do---	2.320	93.30	.360	2.700	.752	.257	.139	.108	.059	.959	-41.6
Do	154	G2357	1	3110	---do---	---do---	2.610	89.78	.380	4.800	1.470	.370	.210	.070	.040	.926	-44.3
Do	154	G2357	5	3168	---do---	---do---	2.620	88.98	.890	5.100	1.410	.500	.230	.140	.080	.931	-43.9
Do	154	G3115	1	2888	---do---	---do---	15.030	78.08	.720	4.110	1.170	.410	.190	.110	.070	.927	-44.3
Do	154	G3115	2	3155	---do---	---do---	4.330	83.30	1.040	6.110	2.590	1.150	.660	.390	.240	.880	-43.9

Table 1.--Chemical and isotopic composition of natural gas from selected wells in the Gulf of Mexico OCS--continued

Area	Field/ block	OCS number	Well number	Depth to producing interval (m)	Age of producing interval	Type of gas	N_2 and (or) air	C_1	CO_2	C_2	C_3	iC_4	nC_4	iC_5	nC_5	C_1/C_{1-5}	$\delta^{13}C_1$(°/oo)
High Island----------	160	0743	1	2617	Miocene	Nonassoc.	3.750	91.92	0.997	2.330	0.605	0.219	0.099	0.047	0.033	0.965	-39.8
Do----------	160	0744	7L	2473	---do---	---do---	3.060	92.12	.995	2.330	.610	.369	.270	.095	.046	.960	-39.8
Do----------	206	G1831	A7	1796	---do---	Associated	1.430	93.96	.090	3.100	.790	.220	.150	.070	.050	.954	-42.6
Do----------	206	G1831	A9	2413	---do---	---do---	1.890	92.18	.380	3.810	1.070	.300	.180	.080	.060	.943	-40.9
High Island----------	A302	G2732	A1	2721	Pleistocene	Nonassoc.	2.490	97.14	0.060	0.240	0	0	0	0	0	0.997	-61.7
Do----------	A302	G2733	A10	2786	---do---	---do---	2.700	96.97	.220	.040	.010	0	0	0	0	.999	-65.1
Do----------	A309	G2735	A1	2208	---do---	---do---	10.200	88.25	.260	.650	.320	.120	.090	.060	.040	.986	-61.5
Do----------	A309	G2735	A8	1337	---do---	---do---	2.410	95.70	.170	1.070	.560	.040	0	0	0	.982	-57.4
Do----------	A323	G2414	A1	1505	---do---	---do---	2.580	94.22	.164	2.080	.814	.045	.083	.001	.007	.969	-54.0
Do----------	A323	G2414	A6	1457	---do---	---do---	4.730	69.86	.492	7.860	8.130	3.120	3.250	1.500	1.030	.737	-55.1
Do----------	A327	G2418	A12D	1313	---do---	Associated	2.440	89.83	.290	4.590	1.550	.430	.410	.280	.190	.924	-45.8
Do----------	A327	G2418	A18D	586	---do---	---do---	2.520	94.94	.630	.520	.850	.100	.100	.040	0	.980	-52.6
Do----------	A330	G2557	A5	2430	---do---	Nonassoc.	2.910	96.76	.060	.070	.020	.020	0	0	0	.997	-64.5
Do----------	A330	G2557	A5D	1456	---do---	---do---	2.250	97.43	.030	.040	.030	.140	0	0	0	.997	-66.5
Do----------	A334	G2423	A4	1512	---do---	---do---	2.270	93.48	.130	2.520	.990	.170	.230	.070	.070	.958	-50.9
Do----------	A334	G2423	A7	865	---do---	---do---	2.480	97.25	.020	.030	.050	.090	0	0	0	.997	-60.8
Do----------	A343	G2425	B8	1916	---do---	---do---	1.990	97.72	.090	.070	.020	0	0	0	0	.998	-66.8
Do----------	A343	G2740	B3	1879	---do---	---do---	2.790	96.99	.060	.040	0	0	0	0	0	.998	-67.0
Do----------	A343	G2741	A1	1799	---do---	---do---	1.620	98.18	.090	.087	.014	0	0	0	0	.999	-67.1
Do----------	A343	G2741	A2	1829	---do---	---do---	2.280	97.56	.050	0	0	0	0	0	0	.999	-67.0
Do----------	A343	G2741	A3	1839	---do---	---do---	2.900	96.89	.040	.090	0	0	0	0	0	.998	-66.9
Do----------	A370	G2428	A3	2393	---do---	---do---	3.150	96.61	.070	.030	.080	.040	.020	0	0	.998	-65.3
Do----------	A370	G2428	A11	2293	---do---	---do---	2.400	97.20	.060	.040	.080	.030	.020	.020	0	.997	-65.3
Do----------	A370	G2734	A3	1270	---do---	---do---	2.610	96.86	.080	.160	.140	.050	.040	.030	.020	0.995	-63.9
Do----------	A370	G2734	A7	2279	---do---	---do---	2.570	93.50	.070	1.240	.950	.550	.440	.320	.260	.960	-60.6
Do----------	A520	G2378	A3U	629	---do---	Associated	1.070	98.72	.152	.003	0	0	0	0	0	.999	-50.7
Do----------	A520	G2378	A4	1225	---do---	---do---	1.700	93.85	.933	2.510	.789	.070	.105	.015	.021	.964	-48.6

Table 1.--Chemical and isotopic composition of matural gas from selected wells in the Gulf of Mexico OCS--continued

Area	Field/ block	OCS number	Well number	Depth to producing interval (m)	Age of producing interval	Type of gas	N_2 and (or) air	C_1	CO_2	C_2	C_3	iC_4	nC_4	iC_5	nC_5	C_1/C_{1-5}	$\delta^{13}C_1$(°/oo)
West Cameron----------	40	0224	5	3256	Miocene	Nonassoc.	1.040	93.78	0.900	3.330	0.668	0.125	0.071	0.056	0.025	0.956	-42.0
Do----------	71	0244	D4	3288	---do---	Associated	1.070	91.74	1.050	3.760	1.340	.440	.214	.247	.130	.937	-44.6
Do----------	71	0245	D10D	3301	---do---	---do---	1.170	91.56	1.030	3.800	1.320	.457	.209	.242	.156	.937	-44.6
Do----------	229	G0902	A2	2078	---do---	Nonassoc.	3.710	94.49	.290	.980	.290	.111	.590	.051	.025	.976	-49.5
Do----------	280	G0911	7	2395	Pliocene	---do---	.850	97.60	.209	.842	.180	.075	.044	.059	.111	.987	-51.3
Do----------	280	G0911	7D	2319	---do---	---do---	.843	97.70	.199	.848	.181	.063	.051	.054	.060	.987	-50.9
Do----------	513	G2007	B1	2312	Pleistocene	---do---	.958	96.18	.124	1.080	.823	.297	.185	.242	.106	.972	-56.9
Do----------	513	G2007	B2	2224	---do---	---do---	1.000	98.56	.119	.225	.010	Trace	0	0	0	.997	-57.2
Do----------	533	G2226	A1D	917	---do---	---do---	5.670	94.18	.100	.040	.010	0	0	0	0	.999	-64.3
Do----------	543	G2010	A8	2573	---do---	---do---	1.490	96.36	.140	1.190	.408	.116	.096	.110	.084	.980	-57.0
Do----------	543	G2011	A10	2498	---do---	---do---	.970	97.03	.153	1.210	.436	.141	.116	.140	.104	.978	-56.7
Do----------	587	G2021	A2D	1355	---do---	---do---	.944	97.05	.102	1.330	.486	.014	.036	0	Trace	.981	-58.7
Do----------	587	G2021	A8	1562	---do---	---do---	.927	97.05	.131	1.370	.499	.005	.019	0	0	.981	-58.1
Do----------	639	G2027	A5	1511	---do---	---do---	.813	98.38	.042	.348	Trace	0	0	0	0	.996	-63.2
Do----------	639	G2027	A16	1414	---do---	---do---	.978	97.49	.097	1.170	.258	.006	.007	0	0	.985	-57.9
Do----------	643	G2240	A8	1399	---do---	---do---	.744	96.60	.100	1.920	.565	.033	.028	0	0	.974	-55.3
Do----------	643	G2241	A2	1391	---do---	---do---	.847	96.46	.151	1.880	.577	.043	.037	0	0	.974	-55.4
East Cameron----------	222	G2037	A4	2858	---do---	---do---	4.270	92.41	.262	1.350	0.418	0.458	0.247	0.087	0.145	0.972	-42.3
Do----------	222	G2037	A6	2897	---do---	---do---	30.570	67.64	.244	1.000	.310	.092	.072	.041	.023	.978	-41.9
Do----------	224	G0966	A11	1636	Pliocene	---do---	5.130	92.75	.150	1.330	.420	.106	.074	.036	.009	.979	-44.2
Do----------	245	G0970	A3D	458	Pleistocene	---do---	.707	99.17	.115	.011	0	0	0	0	0	.999	-69.4
Do----------	245	G0970	A6D	983	---do---	---do---	1.310	98.46	.117	.108	0	0	0	0	0	.999	-65.9
Vermillion----------	218	G1141	A2	2792	Pleistocene	Associated	15.860	79.00	0.362	3.110	0.986	0.226	0.174	0.185	0.093	0.943	-50.4
Do----------	218	G1141	A2D	2342	---do---	---do---	.942	93.38	.221	3.100	1.290	.351	.270	.259	.156	.945	-50.4
Do----------	320	G2087	A1Z	1772	---do---	---do---	.807	95.42	.266	2.030	.737	.231	.199	.151	.100	.965	-45.6
Do----------	320	G2087	A2	1950	---do---	---do---	.859	87.63	.266	1.860	.740	.253	.202	.172	.104	.963	-45.3
South Marsh Island-----	66	G1196	B2	3496	---do---	---do---	2.210	95.60	0.485	1.170	0.314	0.071	0.063	0.054	0.029	0.983	-39.7
Do----------	66	G1196	B4	3548	---do---	---do---	.739	97.01	.408	1.240	.348	.076	.074	.063	.042	.981	-39.2

Table 1.--Chemical and isotopic composition of natural gas from selected wells in the Gulf of Mexico OCS--continued

Area	Field/ block	OCS number	Well number	Depth to producing interval (m)	Age of producing interval	Type of gas	N_2 and (or) air	C_1	CO_2	C_2	C_3	iC_4	nC_4	iC_5	nC_5	C_1/C_{1-5}	$\delta^{13}C_1$ (‰)
Eugene Island----------	266	0792	D1	980	Pleistocene	Nonassoc.	2.060	96.89	0.142	0.887	Trace	0	0	0	0	0.991	-53.9
Do----------	266	0792	D7	1321	---do---	---do---	.911	98.30	.112	.666	Trace	0	0	0	0	.993	-56.9
Do----------	198	0437	1	3948	---do---	Associated	1.470	93.82	.835	2.280	.818	.223	.201	.206	.140	.960	-45.1
Do----------	198	0437	A11	3988	---do---	---do---	1.480	93.47	.869	2.330	.867	.262	.262	.242	.192	.957	-44.9
Do----------	296	G2105	A1	2305	---do---	---do---	.870	93.00	.165	3.560	1.260	.274	.333	.236	.260	.940	-43.0
Do----------	296	G2105	A7	1279	---do---	---do---	.809	98.35	.097	.562	.005	.035	.061	0	Trace	.993	-51.7
Do----------	306	G2109	A10	3130	---do---	---do---	.891	93.81	.214	3.390	.960	.220	.214	.182	.117	.949	-41.8
Do----------	306	G2109	A17	1289	---do---	---do---	.847	98.39	.317	.296	.075	Trace	Trace	0	0	.996	-48.5
Ship Shoal----------	CNPT	G1441	7	4383	Miocene	---do---	0.924	92.28	0.801	3.500	1.290	0.349	0.312	0.276	0.204	0.940	-50.6
Do----------	CNPT	G1868	4D	4895	---do---	---do---	.893	90.36	1.500	4.180	1.650	.414	.366	.400	.238	.926	-46.0
Do----------	159	0817	2	1768	Pleistocene	---do---	1.760	95.01	.178	2.250	.552	.035	.095	0	.084	.969	-49.3
Do----------	159	0817	3	1786	---do---	---do---	1.260	95.30	.177	2.480	.649	.031	.084	0	Trace	.967	-49.0
Do----------	208	0827	G4D	2512	Pliocene	Associated	.962	93.76	.204	2.690	1.130	.323	.328	.331	.254	.949	-49.3
Do----------	208	0827	J7A	2330	Pleistocene	---do---	1.060	94.77	.468	2.410	.670	.178	.163	.174	.099	.962	-37.5
Do----------	271	G1038	7	1876	---do---	Nonassoc.	.861	97.37	.404	.770	.285	.062	.099	.009	.075	.987	-59.9
Do----------	271	G1038	8	1818	---do---	---do---	.849	97.54	.447	.707	.253	.037	.064	.006	.027	.989	-56.9
Do----------	274	G1039	13	2557	---do---	Associated	1.420	89.56	.167	3.140	2.210	.670	.984	.885	.863	.911	-58.0
Do----------	274	G1043	4A	2438	---do---	---do---	1.000	92.49	.174	2.970	1.680	.378	.504	.415	.395	.936	-57.5
South Timbalier--------	172	G1251	A1D	2045	---do---	Associated	1.340	95.88	0.167	1.700	0.521	0.123	0.107	0.090	0.061	0.974	-49.8
Do----------	172	G1251	A3D	2024	---do---	---do---	.990	96.45	.142	1.720	.436	.090	.093	.039	.035	.976	-48.4
Grand Isle----------	41	0129	A1	3038	Miocene	Associated	0.986	94.25	0.196	2.640	1.010	0.286	0.239	0.244	0.153	0.954	-53.0
Do----------	47	0133	H9	1207	---do---	---do---	1.160	98.28	.075	.378	Trace	Trace	Trace	0	0	.996	-60.3
Do----------	76	G2161	A3	1547	Pleistocene	Nonassoc.	.855	95.15	.083	3.010	.877	.061	0	0	0	.960	-42.9
Do----------	76	G2161	A5	1712	Pliocene	---do---	1.230	94.53	.173	3.010	.877	.055	.084	Trace	Trace	.959	-57.0
West Delta----------	133	G1107	D4	3299	Pliocene	Associated	0.977	93.87	0.310	3.380	0.960	0.197	0.154	0.103	0.049	0.951	-56.8
South Pass----------	62	G1294	A11A	2345	Pliocene	Associated	2.270	84.49	0.354	6.580	3.910	0.662	0.884	0.515	0.331	0.868	-53.6
Do----------	62	G1294	A20	2331	---do---	---do---	41.970	47.80	.226	4.600	3.050	.585	.872	.484	.364	.828	-51.3
Main Pass----------	290	G1666	B10	1605	Miocene	Associated	0.961	96.88	0.135	1.540	0.241	0.069	0.081	0.023	0.040	0.980	-53.5