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COOPER BASIN

SOURCE ROCK STUDIES

REPORTS AND DATA

Submitted by

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1995

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DIVISION OF FOSSIL FUELS

GEOCHEMICAL PROSPECTING FOR NATURAL GAS IN THE COOPER BASIN, SOUTH AUSTRALIA 1980.

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JANUARY 1983.

1. INTRODUCTION

In a previous report (RIR 1215R) a summary was given of the results obtained from a geochemical prospecting survey in the Cooper Basin in 1979. That survey showed that it was possible to determine hydrocarbon concentrations of soil samples in the field by gas chromatography and surface anomalies could be detected.

In the present survey a new sampling technique was used that enabled the gas chromatograph to be located at a central campsite rather than being mobile in a vehicle. It was felt that this would improve analysis and sampling efficiency. This survey was again carried out in collaboration with the South Australian Department of Mines and Energy and we duly acknowledge all the valuable help and assistance given by the department.

2. METHODS AND TECHNIQUES

Equipment

The drilling and analytical equipment were basically the same as in 1979 as described in RIR 1215R. A two man motorized hand-held auger was used for the first half of the survey because the drilling vehicle's engine became unserviceable before the survey began. The gas chromatograph and integrator were the same units as used before but were mounted in the laboratory caravan in the camp. The soil gas sampling prove was replaced by 2 metre lengths of 1/8inch o.d. copper tubing terminated on the tops with swagelok fittings which fitted the traps. The sampling vehicle had the generator and vacuum pump fitted for the 1979 survey.

Surveying and Drilling

The survey used a 1 km x 1 km seismic line grid which had been bulldozed for the Strzelecki development seismic survey (Woolkannie Seismic Survey). Samples were taken at ½ kilometre spacing. The sample points between line intersections and on the ends of lines were measured out using the vehicle's odometer. Where the ½ km grid was completed with a central point the sampling position was located using an optical square and the vehicle odometer (e.g. 1b, 1c, 1d etc.). The surveyed sample point numbers are shown on Figure 1.

Immediately after drilling the holes to a depth of 1.7 metres, a copper sampling tube was lowered into the hole and the hole was backfilled with cuttings. A trap similar to that described in the first survey was attached to the top of the sampling tube and the free air in the tube and trap was drawn out by pumping the hole for 30 seconds. This was achieved by attaching the trap to the vacuum pump system on the vehicle using a flexible tube and needle valve. The trap was finally capped using a solid male plug and marked with flagging tape for easy relocation. The sampling tubes were then left undisturbed for 48 hours to allow the soil gases time to re-establish equilibrium.

The Sampling Method

A dewar flask containing lqiuid nitrogen was placed under the trap and the trap was cooled for 30 seconds. The solid metal plug was removed and the open end of the trap was attached to a needle valve connected to the vacuum pump by flexible tubing. The valve was opened and 400 mls of soil gas were pumped through the cooled trap. The vacuum line and the tube were removed in turn from the trap and the open ends were sealed with solid metal plugs marked with the number of the sample. The trap was then completely immersed in the liquid nitorgen until analysis.

During sampling there was usually a gradual slowing down of the rate of flow through the trap due to icing up. After analysis this water was removed by passing helium through the traps which were connected in series and kept in the oven of the G.C. overnight at 160°C.

To ascertain the volume of gas pumped through the trap, the volume of the exhaust gas from the vacuum pump was measured by displacement of water.

To test for data reproducibility, 20 sample tubes were left in the ground after the first sampling round and then resampled eighteen days later. As a further test of the validity of these data, two close-spaced hexagonal patterns were established, using 7 sampling sites, each 10 metres from adjacent sites. These sites were located on two different lines midway between two sample points. One site was on a sand flat, the other on a claypan.

RESULTS

The results of the 1980 survey are plotted on Figures 2 to 5 and are listed in Appendix 1.

A comparison of these results with the 1979 survey carried out over the same area showed few if any meaningful comparisons between the two sets of results. The test to determine reproducibility also showed that this was poor. This lack of reproducibility and in-ability to compare results from previous surveys highlights some of the problems with this type of survey described in a recent review, 1 (Philp and Crisp, 1982).

The detection of the sources of natural gas seepages in the Cooper Basin Region is complicated by the effect of aquifers on the gas flow. In the Strzelecki area the two main Eromanga Basin aquifers are the Namur Sandstone Member and the Hutton Sandstone. In this region their combined thickness is approximately 300 metres. Water velocities in the aquifers in the South Australian part of the Eromanaga Basin have been estimated at 0.2 - 0.4 m per year (Bowering, 1982). From Smith et al. (1971), it is possible to work out a formula for the diffusion rate of gases through an aquifer. Methane has the fastest diffusion rate. The velocity of the vertical diffusion rate V for depth D (m) for methane is:

$$V = \frac{1392}{1400} \text{ cm/1000 yrs} = \text{approx 1 cm/1000 yrs}$$
$$\text{or 1 metre in } 100\cancel{0},000 \text{ years.}$$

Therefore the minimum time required for the methane gas to vertically traverse a 200 metre thick aquifer is 20,000,000 years. If the slowest-flowing water is moving horizontally at 0.2 metres/year, this means the leaking methane will exit from the aquifer 4,000 kilometres downstream from the entry point. Note that this value is a best case for only one of the two main Eromanga aquifers. However natural gas seepages for the Strzelecki area could have been sourced from the Coorikiana Sandstone which lies well above the artesian aquifers.

CONCLUSIONS

Overall it cannot be concluded that this survey was an outstanding success. Reasons that can be advanced from this include the fact that the sample holes might have been too shallow, no allowance was made for changes in soil type (i.e. sand vs clay); gases might have leaked from traps or gas chromatograph during analysis.

In order for the type of survey to be successful a fairly large commitment of finance is necessary. It requires several vehicles, mobile drill rigs, experienced operators and various other types of logistical support. We were attempting the survey on a shoe-string budget and this in many ways could have contributed to the lack of success of these surveys.

On the results of the surveys run to date it would be difficult to completely dismiss the soil-gas field sampling method. Before testing this method further it will be necessary to make the analytical technique operator-proof by replacing plugs in the traps with needle valves. Secondly, the long-term monitoring of a number of sample points of different depths and soil types will be necessary. This may demonstrate with certainty the optimum sampling depth, optimum waiting time between drilling and sampling and also reveal the stability or otherwise of an anomaly over time. Thirdly, for experiments of this type a geologically simpler area should be chosen, preferably with only one hydrocarbon entrapping horizon and no thick aquifers above the accumulation.

ACKNOWLEDGEMENTS

We wish to acknowledge all the help and assistance provided by the Department of Mines and Energy, South Australia, in particular Mr. D. Vinall. Furthermore we wish to acknowledge the fact that Figs. 1 - 5 are reproduced, with permission, from a report written by the Department of Mines and Energy on the same survey.

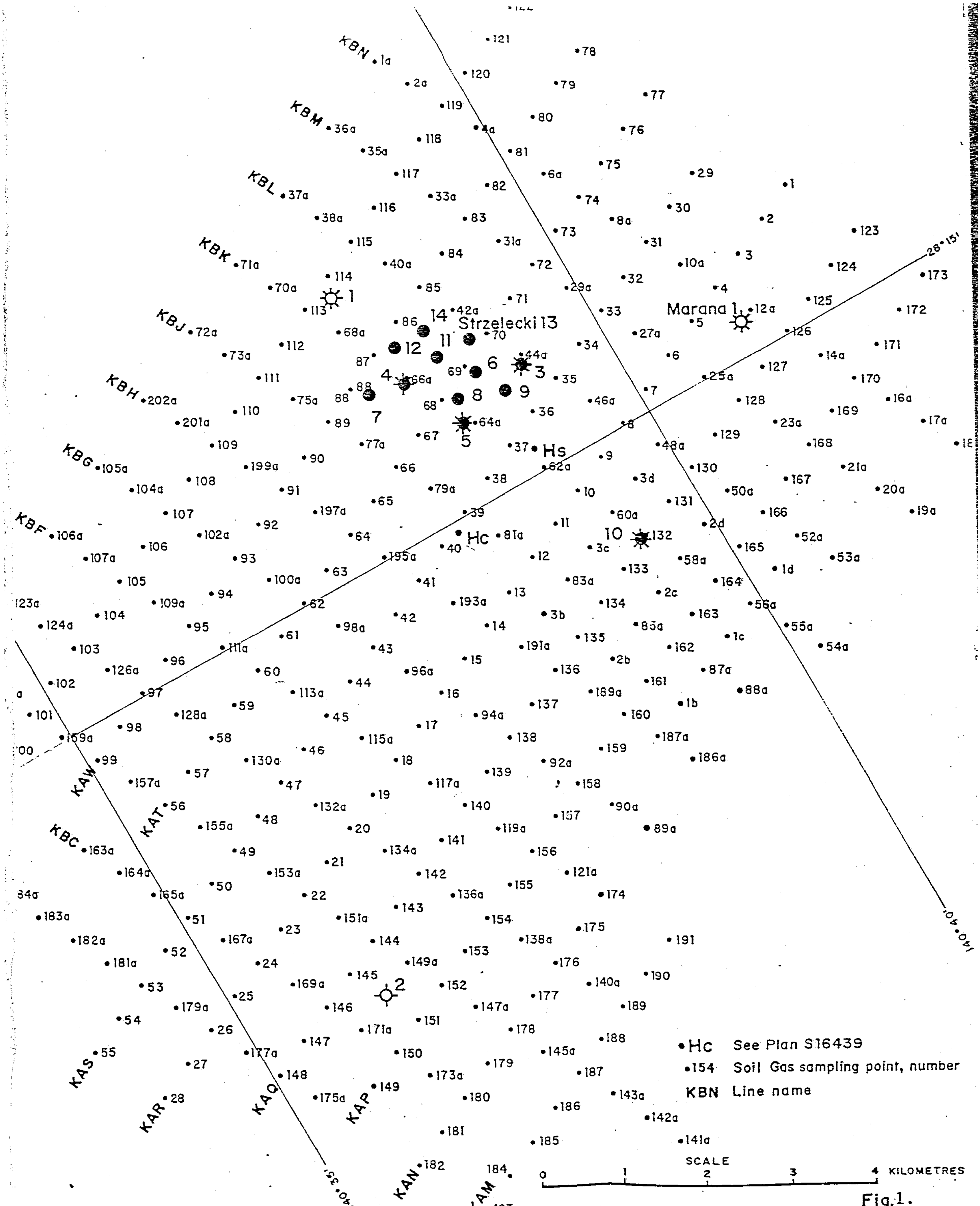


Fig.1.

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

SOIL GAS SURVEY
COOPER BASIN, 1980
SOIL GAS SAMPLE LOCATIONS

COMPILED D.V.	CDO 18-11-82 DATE	
DRAWN M.B.	SCALE 1: 60 000	
DATE Sept. '82	PLAN NUMBER	
CHECKED	S16415	

7/87

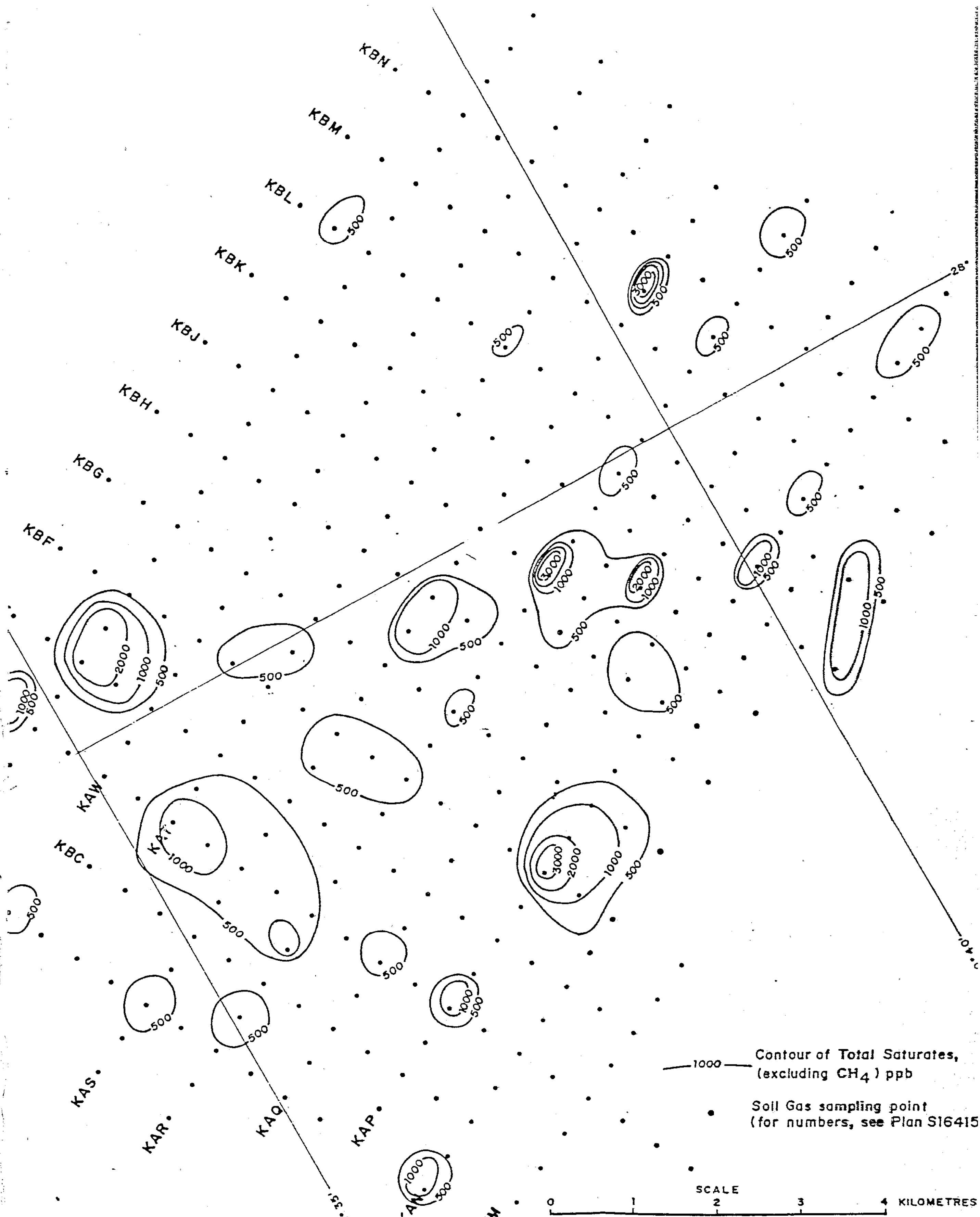


Fig. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

SOIL GAS SURVEY
COOPER BASIN, 1980
TOTAL SATURATES EXCLUDING CH_4

COMPILED D.V.	CDO	DATE 18-11-82
DRAWN M.B.	SCALE 1:60 000	
DATE Sept. '82	PLAN NUMBER	
CHECKED	S16424	

2872

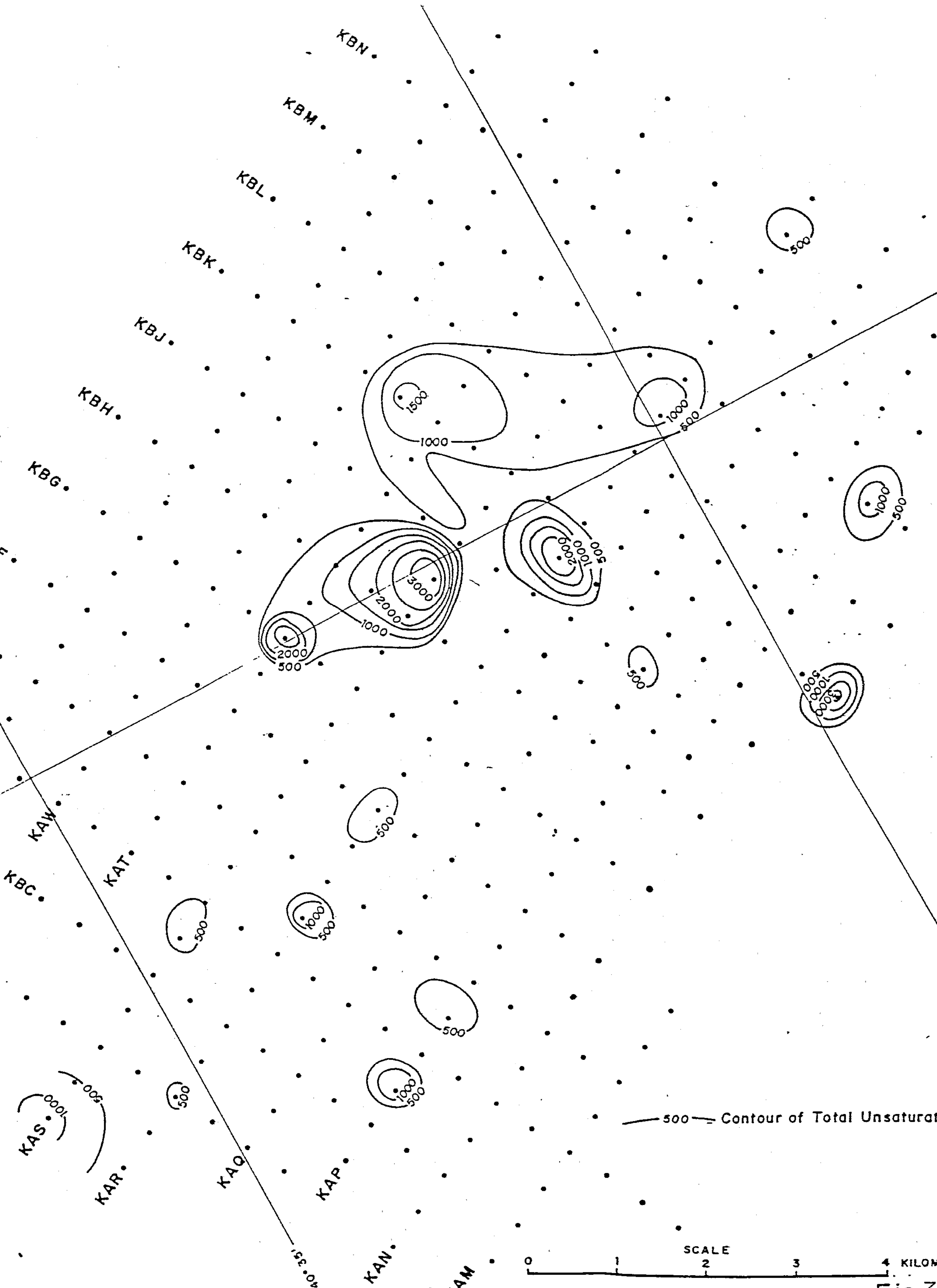
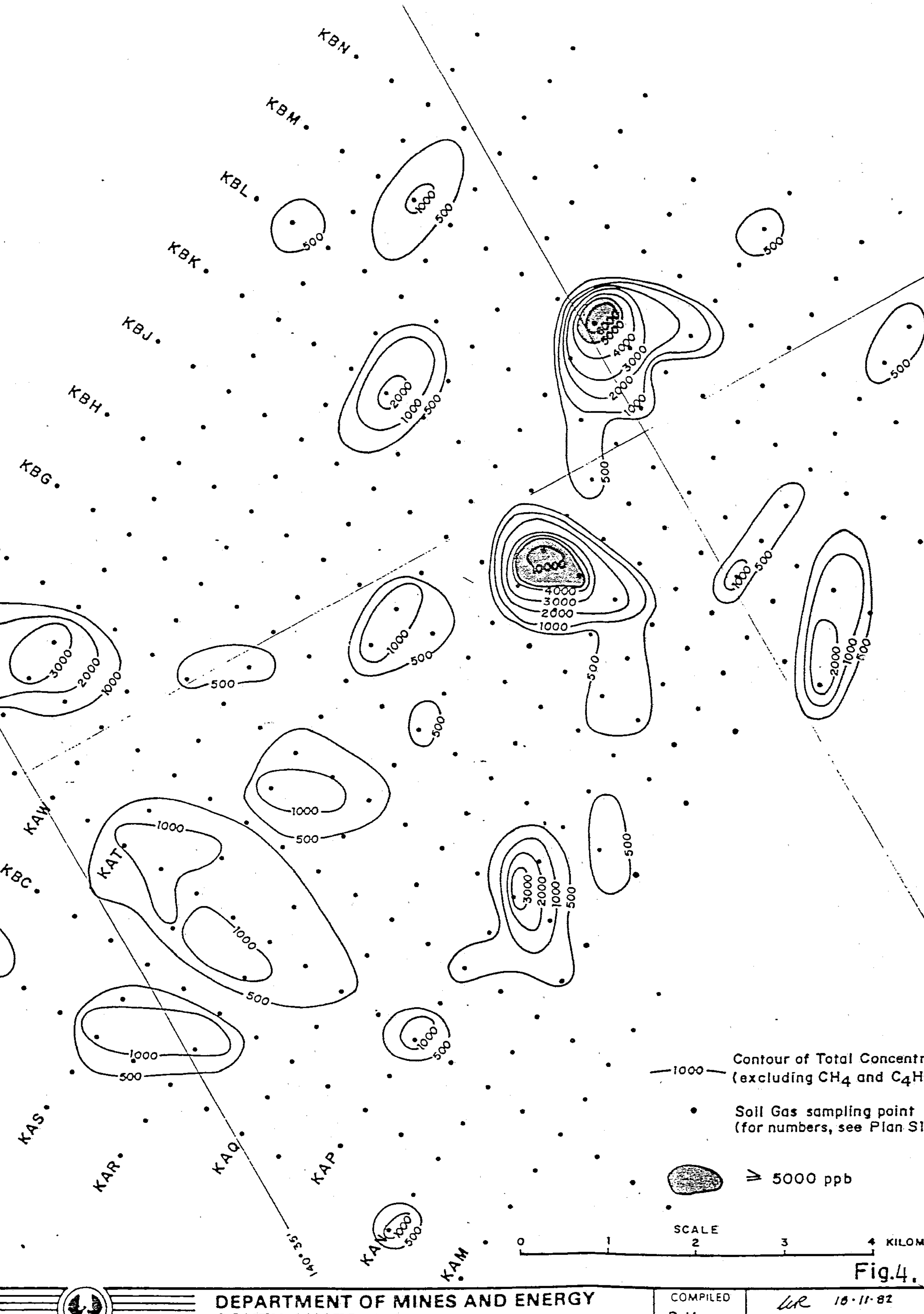


Fig. 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

SOIL GAS SURVEY
COOPER BASIN, 1980
TOTAL UNSATURATES

COMPILED	D.V.	CDO	DATE 18-11-82
DRAWN	M.B.	SCALE 1: 60 000	
DATE	Sept. '82	PLAN NUMBER	
CHECKED		S16426	



—1000— Contour of Total Concentr
(excluding CH_4 and C_4H

• Soil Gas sampling point
(for numbers, see Plan S1

≥ 5000 ppb

SCALE
0 1 2 3 4 KILOM

Fig.4.

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

SOIL GAS SURVEY

COOPER BASIN, 1980

TOTAL CONCENTRATION EXCLUDING CH_4 AND C_4H_8

COMPILED	D.V.	CDO	18·11·82 DATE
DRAWN	M.B.	SCALE 1 : 60 000	
DATE	Sept. '82	PLAN NUMBER	
CHECKED		S16423	

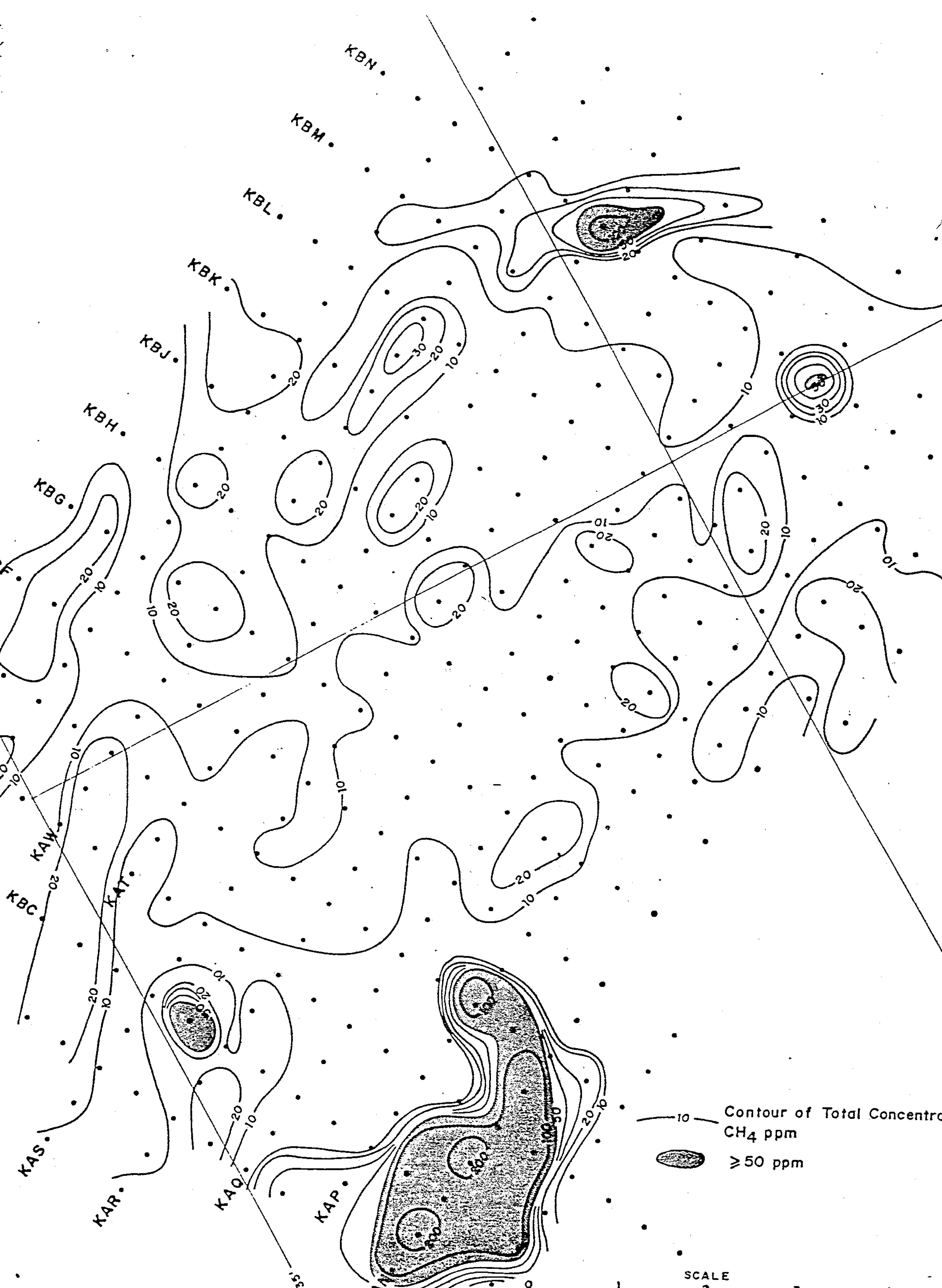


Fig. 5.

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

SOIL GAS SURVEY

COOPER BASIN, 1980

TOTAL CONCENTRATION CH_4

COMPILED D.V.	18-11-82 CDO DATE
DRAWN M. B.	SCALE 1: 60 000
DATE Sept. '82	PLAN NUMBER
CHECKED	S16425

1980 Hydrcarbon Values (PPM)

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KAR 1	15.9	0.150	0	0.15
2	8.9	0.500	0.650	0.56
3	0.32	0.113	0.004	0.117
4	17.1	0.120	0.420	0.21
5	24.1	0.770	0.250	1.02
6	16.9	0.160	0.600	0.38
7	10.9	0.460	1.370	0.75
8	3.1	0.130	0	0.13
9	3.8	0.5773	0.0125	0.581
10	18.49	8.880	2.430	11.25
12	15.6	3.000	0.320	3.23
13	13.62	0.074	0	0.074
14	13.84	0.281	0.010	0.2904
15	15.80	0.074	0.006	0.078
16	2.6	0.920	0.330	0.950
17	26.8	0	0.170	0.50
18	16.7	0.540	0.660	0.940
19	-	-	-	-
20	29.0	0.250	0.300	0.29
21	11.9	0.360	1.080	0.63
22	8.17	0.568	0.080	0.593
23	14.78	1.240	0	1.24
24	8.74	0.089	0.017	0.106
25	19.6	1.000	0.250	1.060
26	10.5	0.280	0.510	0.370
27	8.6	0.120	0.150	0.13
28	10.8	0.110	0.340	0.16
KAS 29	24.5	0	0	0
30	6.6	0	0	0
31	15.4	0.100	0.260	0.13

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KAS 32	17.7	3.270	3.020	5.030
33	-	-	-	-
34	-	-	-	-
35	-	-	-	-
36	-	-	-	-
37	-	-	-	-
38	5.9	0.140	0.140	0.17
39	20.6	0.090	0.490	0.26
40	31.5	0.070	3.570	0.26
41	9.2?	34.73?	2.210	35.140
42	33.82	1.012	0.080	1.091
43	3.95	0.401	0.010	0.411
44	9.9	0.25	0.260	0.33
45	2.24	0.855	0.062	0.917
46	13.95	0.944	0.119	1.059
47	2.4	0.130	0.360	0.40
48	45.54	0.932	0.019	0.948
49	5.4	0.830	0.490	0.870
50	5.0	0.980	0.600	0.98
51	-	-	-	-
52	2.6	0	0	0
53	8.7	0.979	0.154	1.128
54	12.1	0.160	0.490	0.350
55	9.0	0.290	1.100	1.230
KAT 56	3.3	1.240	0.117	1.321
57	1.24	0.523	0.016	0.534
58	15.13	0.260	0.160	0.360
59	7.46	0.180	0.120	0.24
60	9.0	0.014	0	0.014
61	7.36	0.539	0.006	0.545
62	11.95	0.230	2.740	0.370
63	7.05	0.330	0.890	0.62
64	4.32	0	0	0
65	5.7	0	0	0

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KAT 66	24.6	0	0	0
67	23.6	0.130	0.600	0.130
68	9.5	0	0	0
69	8.3	0.02	0	0
70	4.0	0.500	0.500	0.70
71	1.00	0.092	0.011	0.103
72	10.8	0.030	0.020	0.040
73	1.1	0.010	0.020	0.03
74	106.97	0.076	0	0.076
75	-	-	-	-
76	18.49	0.083	0.104	0.132
77	4.7	0.020	0.090	0.04
KAW 78	4.0	0	0	0
79	1.38	0	0	0
80	5.92	0.450	0	0.45
81	26.5	0.024	0.006	0.025
82	31.6	0.020	0.0012	0.021
83	16.7	0.013	0.003	0.013
84	1.89	0	0	0
85	29.14	0.075	0.091	0.162
86	34.9	0.190	0.149	0.269
87	21.03	0.180	0.310	0.196
88	20.16	0.186	0.008	0.188
89	20.91	0.047	0.009	0.055
90	27.88	0.080	0.005	0.083
91	10.20	0.040	0.008	0.0483
92	13.22	0.102	0.085	0.153
93	30.79	0	0.002	0
94	16.31	0.017	0.002	0.019
95	0.11	0	0	0
96	18.05	0.051	0.166	0.053
97	25.85	0.022	0.027	0.049
98	38.7	0.043	0.424	0.445
99	6.96	0.013	0.041	0.014

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KAX100	16.3	0.071	0.187	0.212
101	24.3	0.005	0	0.006
102	18.84	0.095	0.100	0.145
103	19.54	2.958	0.051	3.009
104	19.24	2.227	0.032	2.2593
105	-	-	-	-
106	8.94	0.159	0.005	0.159
107	2.84	0	0	0
108	6.31	0.169	0.595	0.757
109	37.1	0.024	0.089	0.091
110	17.68	0.014	0.004	0.014
111	-	-	-	-
112	29.38	0	0.013	0.002
113	25.36	0	0.029	0.016
114	39.44	0.021	0.0003	0.021
115	24.72	0.073	0.049	0.109
116	20.45	0	0	0
117	25.7	0.107	0.216	0.287
118	0.53	0	0	0
119	13.9	0.138	0.019	0.149
120	0.5	0	0	0
121	1	0	0	0
122	150.07	0	0	0
KAQ123	26.6	0.036	0.076	0.112
124	2.26	0	0	0
125	1.76	0	0	0
126	54.85	0.004	0.002	0.011
127	5.97	0.0036	0	0.0036
128	17.46	0.093	0.022	0.115
129	28.9	0	0	0
130	4.57	0.072	0.036	0.101
131	19.08	0	0	0
132	3.28	0.347	0.020	0.367

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KAQ133	9.99	2.270	0.0002	2.270
134	17.27	0.191	0.020	0.211
135	17.37	0.160	0.012	0.172
136	-	-	-	-
137	-	-	-	-
138	11.02	0	0	0
139	14.88	0.085	0.010	0.089
140	8.94	0.055	0.014	0.069
141	-	-	-	-
142	1.96	0.078	0.012	0.082
143	1.48	0.021	0.004	0.021
144	2.12	0.601	0.013	0.606
145	2.85	0	0	0
146	2.48	0.142	0.057	0.166
147	-	-	-	-
148	2.68	0.296	0.057	0.32
KAP149	-	-	-	-
150	3.5	0.017	0.007	0.019
151	3.21	0.007	1.007	0.028
152	1.69	1.309	0.014	1.313
153	3.94	0.014	0.828	0.052
154	132.2	0.298	0.250	0.548
155	2.78	0.072	0.036	0.101
156	1.27	3.280	0.035	3.297
157	3.41	1.364	0.050	1.399
158	14.4	0	0.0005	0.0005
159	0.29	0.322	0.006	0.327
160	2.08	0.068	0.006	0.072
161	8.65	0.764	0.015	0.776
162	1.76	0.111	0.027	0.122
163	4.38	0.096	0.004	0.10
164	2.27	0	0.009	0.009

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KAP165	0.98	1.595	0.027	1.622
166	3.13	0.489	0.023	0.509
167	2.29	0.934	0.015	0.949
168	3.19	0	0	0
169	6.77	0	0	0
170	1.75	0.152	0.198	0.35
171	2.90	0.571	0.020	0.591
172	14.26	0.953	0.004	0.956
173	-	-	-	-
KAN174	2.90	0.049	0.006	0.055
175	14.26	0.481	0.274	0.699
176	-	-	-	-
177	135.59	0	0	0
178	93.55	0.049	0.032	0.059
179	233.94	0.032	0.038	0.057
180	134.8	0.082	0.022	0.104
181	219.8	0.118	0.073	0.16
182	115.0	1.367	0.124	1.462
KAM183	7.13	0.042	0.029	0.071
184	6.41	0	0	0
185	122.0	0.114	0	0.114
186	-	-	-	-
187	1.76	0	0	0
188	5.95	0.071	0.115	0.11
189	4.88	0.033	0.289	0.054
KBN 1a	-	-	-	-
2a	2.9	0.011	0.045	0.023
4a	4.2	0.055	0.034	0.082
6a	2.9	0	0	0
8a	13.4	0.023	0.003	0.023
10a	-	-	-	-
12a	3.19	0.036	0.005	0.041
14a	3.51	0.006	0.289	0.041

Line No.		Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KBN	16a	3.16	0	0	0
	17a	11.10	0.036	0.001	0.037
	18a	3.73	0	0	0
KBM	19a	0	0.030	0	0.030
	20a	-	-	-	-
	21a	0	0.027	0.022	0.036
	23a	2.81	0	0	0
	25a	8.08	0.004	0.003	0.007
	27a	2.74	0	0	0
	29a	19.9	0.071	0.044	0.095
	31a	30.72	0.104	0.047	0.151
	33a	27.6	0.205	0.948	1.125
	35a	29.51	0.120	0.024	0.144
	36a	11.6	0.054	0.003	0.057
KBL	37a	3.79	0	0	0
	38a	8.78	0.599	0.017	0.613
	40a	0.11	0.119	0.031	0.130
	42a	12.1	0.126	0.013	0.130
	44a	-	-	-	-
	46a	8.6	0	0.800	0.8
	48a	16.4	0.034	0.034	0.068
	50a	26.85	0.041	0.005	0.046
	52a	50.23	0.074	0.044	0.116
	53a	21.48	1.685	0.026	1.711
KDK	54a	31.35	0	3.000	2.11
	55a	0.807	0	0.010	0.102
	56a	13.3	0.006	0.006	0.108
	58a	2.02	0.150	0	0.15
	60a	21.4	0.185	0.020	0.201
	62a	2.97	0	0	0
	64a	5.02	0	0	0
	66a	0.26	0.610	1.500	2.11
	68a	1.24	0.038	0.004	0.041

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KDK 70a	16.7	0.001	0.006	0.006
71a	29.4	0.056	0.111	0.137
KBJ 72a	0.83	0	0	0
73a	30.6	0.057	0.007	0.064
75a	18.9	0.071	0.035	0.101
77a	1.52	0.065	0.006	0.070
79a	4.6	0	0	0
81a	7.85	0.060	0.002	0.062
83a	-	-	-	-
85a	48.8	0.404	0.537	0.843
87a	17.4	0.063	0.090	0.149
88a	8.7	0.148	0.074	0.208
KBG 89a	-	-	-	-
90a	6.88	0.845	0.003	0.843
92a	29.1	0.082	0.006	0.087
94a	-	-	-	-
96a	19.7	0.047	0.054	0.084
98a	7.2	0.048	0.021	0.054
100a	7.05	0.293	0.113	0.390
102a	23.96	0.036	0.037	
104a	25.9	0.054	0.005	0.059
105a	4.9	0	0	0
KBF106a	14.79	0.099	0.003	0.101
107a	26.88	0.021	0.004	0.025
109a	3.78	0.083	0.008	0.088
111a	4.31	0.687	0.004	0.688
113a	26.03	0.036	0.005	0.04
115a	-	-	-	-
117a	7.65	0.236	0.011	0.238
119a	15.35	0.115	0.003	0.116
121a	3.13	0	0	0
KBE123a	9.58	0.098	0.086	0.159
124a	19.19	0.014	0.006	0.015
126a	4.35	1.212	0.030	1.242
128a	17.77	0.127	0.083	0.174

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KBE130a	37.37	0.013	0.023	0.028
132a	-	-	-	-
134a	-	-	-	-
136a	5.28	0.047	0.006	0.052
138a	82.78	0.036	0.040	0.076
140a	26.2	0	0.002	0.002
KBD141a	22.6	0.058	0.086	0.137
142a	18.0	0.013	0.002	0.016
143a	27.95	0.033	0.011	0.042
145a	162.96	0.128	0.025	0.138
147a	6.62	0.145	0.012	0.154
149a	8.29	0.046	0.028	0.070
151a	2.10	0.030	0.016	0.039
153a	3.37	0	0	0
155a	13.76	0	0	0
157a	32.03	0.012	0	0.012
159a	1.22	0	0	0
161a	6.3	1.198	0.082	1.259
162a	25.77	0	0	0
KBC163a	25.16	0.039	0.181	0.215
164a	33.26	0.364	0.031	0.381
165a	6.19	0.056	0.016	0.072
167a	57.32	0.020	0.018	0.037
169a	17.3	0.065	0.008	0.069
171a	0.74	0	0	0
173a	112.48	0.024	0.038	0.062
KBB175a	35.28	0.022	0.001	0.022
177a	24.62	0.065	0.013	0.066
179a	-	-	-	-
181a	28.46	0.120	0.002	0.121
18a	28.27	0.135	0.004	0.138
183a	0.75	0	0	0
184a	24.64	0.985	0.078	0.998
KBH186a	5.39	0	0	0

Line No.	Methane	Saturates Excluding Methane	Unsaturates	Total Excluding Methane & Butene
KBH187a	3.02	0	0	0
189a	2.60	0	0	0
191a	-	-	-	-
193a	17.7	0.709	0.021	0.73
195a	-	-	-	-
197a	-	-	-	-
199a	0.06	0	0	0
201a	0.905	0.179	0.007	0.186
202a	4.69	0	0	0
No line names				
1a	2.53	0.089	0.002	0.089
2b	0.611	0.702	0.112	0.706
3b	9.10	0.704	0	0.704
1c	1.83	0.232	0.006	0.239
2c	2.97	0	0	0
3c	2.40	0	0	0
1d	3.26	0.167	0.003	0.170
2d	1.72	0	0	0
3d	10.34	0.103	0.068	0.171