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SOIL GAS SURVEY

PEL 19

SOUTH AUSTRALIA

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SUMMARY

Anomalous concentrations of light hydrocarbon gases have been detected in three samples from the central portion of a domal structure located near Mernmerna homestead some 25 km NNW of Hawker, South Australia. These samples confirm the presence of anomalous concentrations of hydrocarbon gases in the atmosphere above the dome which were detected during a previous airborne gas sensor survey.

The ratios of methane to ethane and propane contents of anomalous samples is greater than 15, suggesting a dry gas rather than oil source for the hydrocarbons in the soil gas.

The areal extent of the anomalous samples is small, suggesting the presence of only a small gas accumulation in the dome - but this can be confirmed only by drilling.

There may be potential for other, larger structures known in the region to host economic concentrations of petroleum.

1. INTRODUCTION

Following an airborne hydrocarbon gas sensor survey, which detected anomalous gas concentrations in the near-surface atmosphere over a domal structure in the south-east corner of PEL 19 Base Mines Ltd. was commissioned to carry out a soil gas survey to define the petroleum prospectivity of the structure.

2. SURVEY METHODS

2.1 INTRODUCTION

Although microseeps of both gaseous and liquid hydrocarbons, which are recognised by smell or sight, have led to the discovery of numerous commercial petroleum field, the potential of microseeps, which cannot be recognised with unaided human senses, has not been appreciated. Despite many tests being carried out above known gaseous or liquid hydrocarbon reservoirs no convincing case histories showing the presence of light hydrocarbon species in soil gas or in the atmosphere have been published. This has led to scepticism of the use of geochemical methods for petroleum exploration. However, many previous geochemical surveys were inconclusive as they employed insensitive analytical methods which were incapable of detecting nanogram quantities of light hydrocarbon gases. Furthermore, many previous surveys encountered serious problems with sample collection and transport to the laboratory of soil gas containing very dilute, readily diffusable hydrocarbon species.

There remains in the petroleum exploration industry a general disbelief that significant quantities of light hydrocarbons do excape from gas and/or oil reservoirs at depth and can be detected directly above or peripheral to the reservoirs. Nevertheless, there is a growing body of evidence which attests to the migration of gaseous hydrocarbons taking place, but the mechanisms of migration have not been resolved.

During the past two years in Australia, Base Mines Ltd. has carried out orientation surveys over some fifteen known gas and/or oil reservoirs and has assembled case histories which show the presence of detectable light hydrocarbon gases (methane through butane) in both soil pore spaces (Termed "soil gas") and in the near-surface atmosphere. Many of the problems associated with the field and laboratory procedures have been satisfactorily overcome to permit limited conclusions to be drawn from the results.

The case studies compiled by Base Mines Ltd. demonstrate that a flux of light hydrocarbon gases is present above at least some moderately deep petroleum reservoirs and that this can be detected in soil gas or in the near-surface atmosphere.

From results of soil gas analyses over known petroleum reservoirs it is observed that samples having less than anomalous concentrations of one or more of C1 to C4 are commonly present. Therefore, results from individual samples are of subordinate importance to those from groups of samples. Clusters of anomalous samples are of special significance to the interpretation of soil gas surveys.

2.2 SOIL GAS SURVEY

Soil gas surveys are conducted as follow-up to gas sensor surveys or as independent surveys in areas where geological deduction or previous seismic surveys have defined fairways or leads. The number of samples collected depends on many factors, including the predicted areal extent of the reservoirs to be detected, as well as on financial and time constraints. Access and the presence of suitable soils for sampling are also important considerations. Generally, not less than 100 samples are required to characterise a gas sensor anomaly or a seismic lead.

At each station a soil gas sample is carefully collected from an undisturbed site using a probe and pre-prepared microsyringes. Sampling depth is typically 0.5m - 1m, but in stony soil profiles only shallower samples can be collected.

After collection, samples are immediately sealed in air-tight containers and are returned to the laboratory for analysis. The soil gas samples are analysed for the light hydrocarbon gases methane through butane (C1 to C4) by conventional hydrogen flame gas chromatography.

Because of differences in the proportion of oil and gas from reservoir to reservoir, and in the composition of the oil and gas phases, together with differences in reservoir parameters and in soil characteristics from region to region, an attempt is always made to carry out orientation surveys over known reservoirs as close as possible to the survey area.

By comparing results from the survey area with those from the known reservoir an estimate can be made of the type of hydrocarbons giving rise to the microseeps detected in the survey area. Estimates of the size of the hydrocarbon reservoir in the survey area are difficult to establish and can only be attempted within areas having closely similar reservoir and soil characteristics. This is because the magnitude of an anomaly may be determined by the ease of the migration of gases from the reservoir, rather than by the volume of gas in the reservoir.

The parameters which govern the amount and type of hydrocarbon gases present in near-surface environments are only imperfectly understood but include the following:-

(i) Reservoir characteristics relating to the form of the reservoir, the integrity of its seal, the proportion of gas and the pressure under which it is constrained.

(ii) Soil properties, particularly the clay content, degree of compaction and moisture content of the soil.

(iii) Atmospheric variables, particularly atmospheric pressure, ambient temperature and rainfall.

3. OPERATIONS

A Bell Longranger helicopter, operated by Lloyd Helicopters of Adelaide, was employed for transport to the survey area and to sample sites. No problems were encountered during the survey, which was accomplished in one day (29th March).

The anomalous structure has the form of an elevated, elongate dome which stands out from the flat, sandy desert country to the west, and from a prominent, broad valley to the east. Vehicle access is possible through the northern part of the structure by a track leading from Mernmerna homestead. There is no vehicular access to the southern half of the structure, which is more rugged.

To the west of the structure soils are unconsolidated re-brown sands, but over the structure they are thin skeletal types with little profile development. Some of the creek banks are characterised by thick accumulations of alluvium.

Adequate penetration of the sampling probes could be obtained at all sites. Sampling depth was generally greater than 400 mm.

Samples were collected from two lines across the axis of the structure, with additional samples from along the axis (Figure 1). Sample spacing away from the structure ranged from 1 to 4km, but within the structure spacing ranged from 300 to 500 m.

A total of 24 samples were collected, and two syringes of a gas of known composition were filled before collection of sample 2 and after collection of sample 24, and stored with the other samples for transport to our Sydney laboratory for analysis. This procedure permits corrections to be made to analytical results which may be low due to escape of some of the hydrocarbon gases during transport.

4. RESULTS

The methane (C1), ethane (C2) and propane (C3) contents of the soil gas samples are listed in Table 1. Butane (C4) was not detected in any sample.

Inspection of the results shows mostly only low concentrations of C1, C2 and C3, but near the central part of the structure moderate concentrations of the light hydrocarbon gases are present.

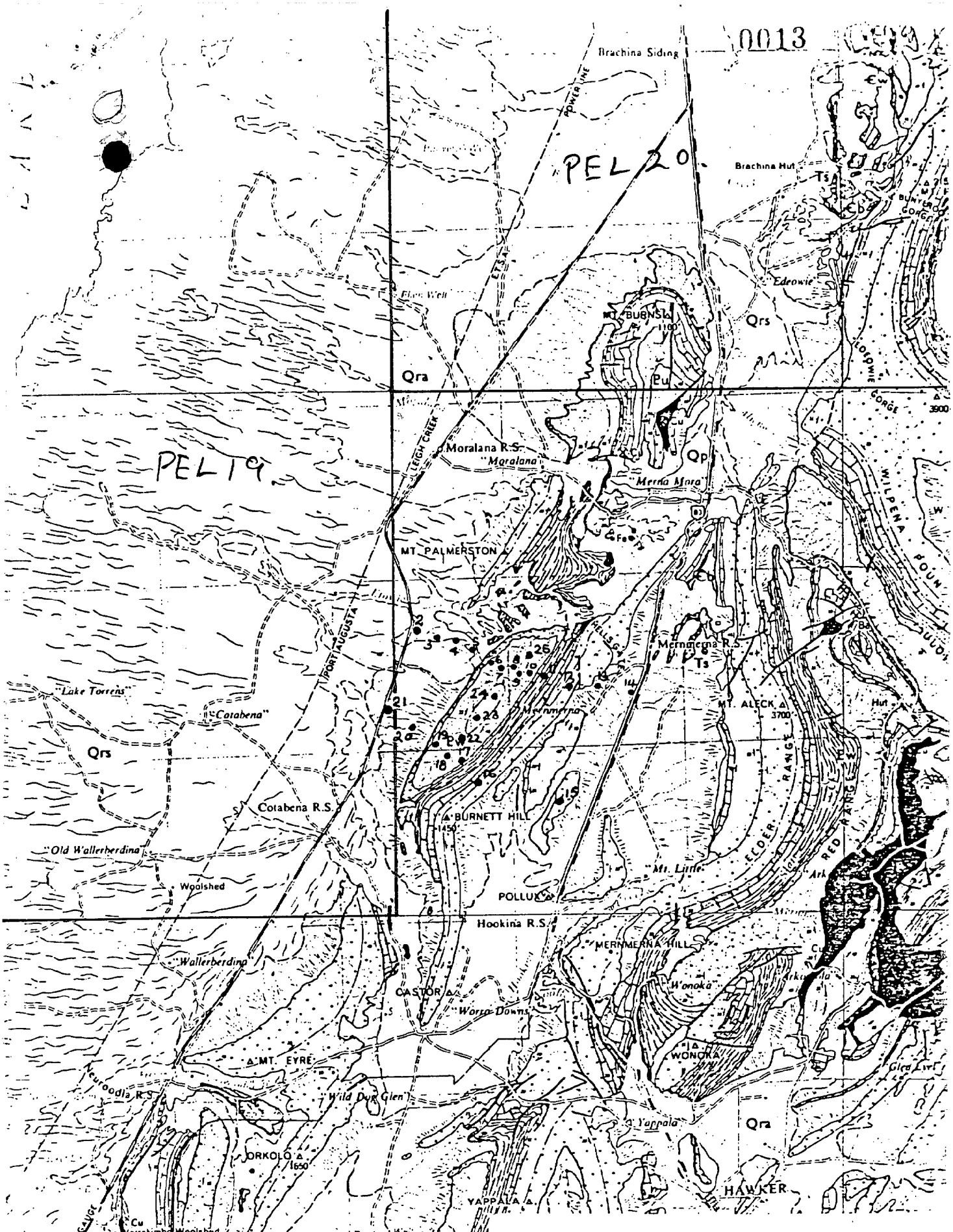
The ratios of methane to the heavier gases (Table 1) are generally very high (i.e. C1:C2 greater than 20) indicating a dry gas source for the hydrocarbons detected in the soil gas. Samples 21, 22 and 23 have lower ratios, indicating a "wetter" source, but the C1:C2 ratios of 15 to 18 continue to indicate a dry gas source.

5. CONCLUSIONS

Soil gas samples from the central part of the domal structure located near Mernmerna homestead, contain moderately anomalous concentrations of the light hydrocarbon gases methane, ethane and propane. Ratios of the concentrations of methane to the heavier hydrocarbons suggest a dry gas, rather than an oil source for the anomalous hydrocarbon gases in the soil gas.

The areal distribution of the anomalous soil gas samples, and the ratios of their methane to heavier hydrocarbon gases indicate the presence of a small reservoir of dry gas, but these samples cannot define the quantity of gas in the structure.

The absence of known petroleum fields in the region prevents their characterisation by soil gas surveys, and subsequent comparison of their signature with the results obtained in the present survey.



SOIL GAS SAMPLE SITES

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Scale 1 : 250 000 Figure 1

TABLE 1. Methane, ethane and propane contents of soil gas samples, PEL 19 South Australia.

SAMPLE POINT	C1	C2	C3	C4	$\frac{C1}{C1+C2+C3+C4}$	$\frac{C1}{C2}$
2	3.70	.05	.05	.00	.97	74.00
3	7.90	.23	.06	.00	.96	34.35
4	9.80	.29	.08	.00	.96	33.79
5	7.20	.24	.05	.00	.96	30.00
6	11.00	.50	.09	.00	.95	22.00
7	9.40	.36	.11	.00	.95	26.11
8	10.60	.37	.09	.00	.96	28.65
9	9.70	.40	.07	.00	.95	24.25
10	6.70	.28	.07	.00	.95	23.93
11	15.60	1.06	.21	.00	.92	14.72
12	7.90	.25	.06	.00	.96	31.60
13	2.90	.08	.05	.00	.96	36.25
14	6.70	.09	.05	.00	.98	74.44
15	4.60	.10	.05	.00	.97	46.00
16	7.90	.10	.05	.00	.98	79.00
17	7.70	.24	.06	.00	.96	32.08
18	8.90	.40	.05	.00	.95	22.25
19	6.60	.18	.05	.00	.97	36.67
20	8.90	.38	.09	.00	.95	23.42
21	7.00	.31	.06	.00	.95	22.58
22	21.60	1.20	.42	.00	.93	18.00
23	22.80	1.32	.40	.00	.93	17.27
24	26.40	1.68	.56	.00	.92	15.71
25	10.40	.29	.05	.00	.97	35.86