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RECON
EXPLORATION

AIRBORNE HYDROCARBON SENSING SURVEY

EP-20, NORTHERN TERRITORY, AUSTRALIA

For:

INDIGO OIL PROPRIETARY LTD.
Adelaide Airport
South Australia 5000

October 1988

ABSTRACT

RECON Exploration Pty. Ltd. was retained by Indigo Oil Proprietary Ltd. to perform an airborne hydrocarbon sensing survey over selected target leads in EP-20, Northern Territory, Australia. The leads were defined by a satellite photo analysis of the central and western portions of EP-20 in the Amadeus Basin (RECON Exploration, Inc., "Satellite phote analysis: EP-20",1988).

Data collection was done during the period of September 25 through September 29, 1988 with flights conducted out of a base of operations at Wallera Ranch, Northern Territory, Australia. The survey was concentrated on structural leads along anticlinal trends and over selected geomorphic indications of possible concealed structures.

A total of nine significant strength hydrocarbon microseepage anomalies were detected along with seven microseepage anomalies of moderate strength and two minor intensity anomalies. It is planned to validate and characterize selected airborne anomalies by combined interstitial soil gas hydrocarbon and soil magnetic susceptibility measurements. These results will be integrated with data from previous programs in the area.

INTRODUCTION

The helicopter-borne gas sensor system is a direct detector of the presence of hydrocarbon gases escaping at the surface of the earth (Thompson, 1981, 1984; Thompson and Burson, 1984). The following model has been presented to explain the phenomenon (Thompson, 1981): The transmitter sends out radio pulses of specific frequency from a rotating antenna. A portion of the transmissions is absorbed by the hydrocarbon gas molecules which move to a higher energy state. In the time between the emitted pulses, the exited gas molecules return to their original energy state emitting energy with a different frequency from the incident exciting frequency. A receiver is tuned to detect this characteristic signature or echo from the gases. The source and relative intensity of the return signal is displayed during the survey on a cathode ray tube video screen and recorded on maps of the surveyed area.

The airborne gas sensor is capable of evaluating approximately thirty thousand acres per day, and is flown at low altitudes in all open fields and cleared areas.

The purpose of this airborne hydrocarbon sensor survey was to determine the location, intensity and extent of hydrocarbon microseepage anomalies over selected photogeologic and geomorphic leads reported previously (RECON Exploration, Inc., 1988). These leads were based on interpretation of high-resolution Russian satellite photos.

SURVEY CONDITIONS AND HYDROCARBON MICROSEEPAGE ANOMALIES

Data collection began September 25, 1988 with flights conducted from a base of operations at Wallera Ranch, Northern Territory. The survey included five days of flying through September 29, 1988.

Flight conditions were near perfect with no rain or strong winds. Atmospheric pressure ranged from 1010 to 1019 millibars. Terrain varied from flat in the southern regions to extremely rough in the mountainous regions to the north. Tree cover varied from clear to dense desert oak. The southern portion of the survey area contained patches of dense desert oak which prevented complete survey coverage. Photographs selected to illustrate the terrain and culture of the survey area and pertinent field notes are included in the APPENDIX to this report.

The survey pattern consisted nominally of East-West flightlines modified to fit terrain conditions where necessary. Survey coverage was generally concentrated on flights along anticlinal axes and over defined lead areas (See RECON Exploration, Inc., 1988).

Anomalies were recorded by the instrument operator on 1:100,000 scale topographic maps during the flights. Subsequently these were summarized at 1:250,000 scale for comparison with the photogeologic and geomorphic leads (See maps accompanying this report). Anomalous levels have been shaded in color as follows: Significant = Green; Moderate = Dark Yellow; and Minor = Light Yellow.

Flights over the "benchmark" fields disclosed significant strength anomalies over Mereenie and Palm Valley Fields, and a moderate strength anomaly over Dingo Field. In all three cases, the areal extent of the anomalies was in agreement with the apparent production limits. These observations are in agreement with conclusions drawn from previous tests of RECON's methods in the Amadeus and Cooper Basins (Vinall, 1983).

Anomaly Descriptions

Significant Strength Anomalies

S-1. Walker Gorge Prospect - First of four Significant anomalies associated with the Mereenie AND West Walker anticlinal trend (A-A'). Located on the west end of trend between Walker Gorge and Mt. Lewis.
S-2. McMinn Prospect - Found on the south flank of inferred anticlinal trend (A-A') adjacent to McMinn Creek.
S-3. Mount Holder Prospect - Largest significant strength anomaly in the area. Located on the north flank of inferred anticlinal trend A-A'.
S-4. Maloney Prospect - Located east of Maloney Creek on the South flank of the inferred anticlinal trend.
S-5. Mount Ormerod Prospect - West part associated with an apparent synclinal depression which might be an impact structure based on its geomorphic expression. East part on the north flank of the Seymour Range anticlinal trend, E-E'.
S-6. Middle Range Prospect - Possible stratigraphic pinchout on the south flank of the Middle Range syncline.
S-7. Merrick Gully Prospect - West end of apparent anticlinal anomaly in the James Range trend, B-B'.
S-8. Henbury Southwest Prospect - Located south of Meteorite Craters.
S-9. Mill Ridge Prospect - Located on the crest of Mill Ridge anticline.

Moderate Strength Anomalies

M-1. Tempe Downs Prospect - Located on the crest of the A-A' axis.
M-2. Orange Prospect - Situated on the east end of the projected A-A' axis.
M-3. Petermann Prospect - Located on the north side of Petermann Creek at the east end of anticlinal lead #14 on the C-C' axis.
M-4. White Horse Gap Prospect - Found on anticlinal lead #16 on the C-C' axis.
M-5. Wallera Ranch Prospect - Positive geomorphic anomaly lead # 17 on inferred anticlinal axis D-D'.
M-6. Wallera Prospect - Located south of Wallera Ranch.
M-7. Calvary Prospect - On crest of projected F-F' anticlinal axis where it plunges under cover.

Minor Strength Anomalies

W-1. Illara Creek Prospect - Located on synclinal geomorphic lead #3.
W-2. Areyonga Valley Prospect - Situated on the north flank of James Range anticline.

RECOMMENDATIONS FOR FURTHER WORK

General

It is recommended that the more promising airborne anomalies in EP-20 be validated, i.e., confirmed by combined interstitial soil gas measurements and soil magnetic susceptibility studies. Using this approach with RECON's Advanced Statistical Data Evaluation allows comparison of the data to RECON's extensive data base to insure extraction of maximum information including:

1.) Characterization of background levels and variations of each soil gas component and the magnetic susceptibility along each profile,
2.) Identification of significantly anomalous concentrations of hydrocarbon components and diagenetic magnetic minerals along each profile,
3.) Quantitative evaluation of the validity of each anomaly,
4.) Indications of oil-prone and gas-prone areas, and
5.) Identification of possible fault or fracture-related seepages.

Interstitial Soil Gas Hydrocarbon Measurements

Soil gas hydrocarbon analyses have been used in petroleum prospecting for many years, and developments in this area have been reviewed by several authors including Philp and Crisp (1982), Davidson (1984), and Price (1986). This type of study provides quantitative and truly direct evidence of petroleum at depth.

Reconnaissance soil gas sampling is done along profiles over each selected anomaly with a sample spacing of 0.1 miles. Profiles are sampled also over any nearby benchmark fields for comparison. For more detailed mapping of the extent of microseepage anomalies, grid patterns of samples may be employed. Sample site locations are shown on 1:24,000 scale topographic maps.

Samples are obtained by probe from a depth of about 30 inches. Thompson (1984) and Thompson and Burson (1984) have described the patented probe collection unit equipped with an integral slide hammer that drives it into the soil. When it reaches the desired depth a special valve is opened on the tip of the probe and a gas sample is drawn through the probe into a hypodermic syringe. The tip of the needle is sealed with a silicone rubber stopper and the syringe is placed in a metallized envelope for protection. At intervals during the survey, samples are taken to a nearby field laboratory and analyzed by sensitive hydrogen flame ionization gas chromatography. Having this equipment near the sampling sites makes it possible to perform preliminary data evaluations and provide more efficient quality control of sampling and analytical operations.

The samples are analyzed for six hydrocarbon constituents: methane, ethane, ethylene, propane, propylene, and butanes at sub-part-per-million levels.

Soil Magnetic Susceptibility Measurements

Soil magnetic susceptibility is a relatively new tool which was developed originally by RECON to validate aeromagnetic "micromagnetic" anomalies and prove the presence of anomalous amounts of diagenetic magnetic materials in shallow-depth soils and rocks over petroleum accumulations. It has proved useful in conjunction with soil gas hydrocarbon measurements in validating airborne hydrocarbon sensing anomalies.

Several investigators have reported shallow-depth aeromagnetic anomalies over oil and gas fields (Donovan, 1981; Donovan, et al., 1979, 1984, 1986; Foote, 1984; Saunders and Terry, 1985). These "micromagnetic" anomalies are attributed to diagenetic magnetic iron minerals in the near-surface rocks and soils. These are believed to be formed by chemical reactions of sedimentary iron minerals with traces of hydrogen sulfide produced by sulfate-reducing bacteria during their consumption of hydrocarbon gases seeping upward from petroleum deposits (Ferguson, 1979; Price, 1986; Oehler and Sternberg, 1984). Thus, the shallow-depth (short-wavelength/high-frequency) magnetic anomalies provide the possible basis for a "semi-direct" petroleum detection technique.

A principal problem with airborne "micromagnetics" prospecting methods has been difficulty in separating significant petroleum-indicating anomalies from "cultural" anomalies due to pipelines, tanks, casings, and other iron or steel objects. Results of recent studies demonstrate that magnetic susceptibility measurements on soil (or well-cuttings) samples can be used to search for diagenetic magnetic minerals without interference from cultural magnetic sources.

Saunders, Burson and Thompson (1988) reported preliminary tests over eleven oil and gas fields and one gas storage area which compared soil magnetic susceptibility anomalies and soil gas hydrocarbon anomalies using samples collected along the same profiles. A grass-roots-depth soil sample was collected near each soil gas sample location and was analyzed for its magnetic susceptibility. The two data sets were found to complement one another by filling in the gaps in each other's anomalies, thus providing more complete guidance to the productive areas than could be derived from either data set alone.

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APPENDIX

AIRBORNE FIELD NOTES

SELECTED TERRAIN PHOTOS

FIELD (ATMOSPHERIC) NOTES

RECON EXPLORATION (AUSTRALIA) PTY. LTD.
JOB NUMBER 88-1001
INDIGO OIL PTY. LTD.
EP-20

SUNDAY, SEPTEMBER 25, 1988

8:30 AM	B.P.	1019 mb
	Temp.	68 ° F
	Wind	300 degrees, 5-10 knots
5:25 PM	B.P.	1019 mb
	Temp.	80 ° F
	Wind	300 degrees, 5-15 knots

MONDAY, SEPTEMBER 26, 1988

8:55 AM	B.P.	1014 mb
	Temp.	70 ° F
	Wind	CALM
4:30 PM	B.P.	1015 mb
	Temp.	82 ° F
	Wind	280 degrees, 10 knots

TUESDAY, SEPTEMBER 27, 1988

8:40 AM	B.P.	1016 mb
	Temp.	70 ° F
	Wind	100 degrees, 7 knots
5:05 PM	B.P.	1015 mb
	Temp.	90 ° F
	Wind	CALM

WEDNESDAY, SEPTEMBER 28, 1988

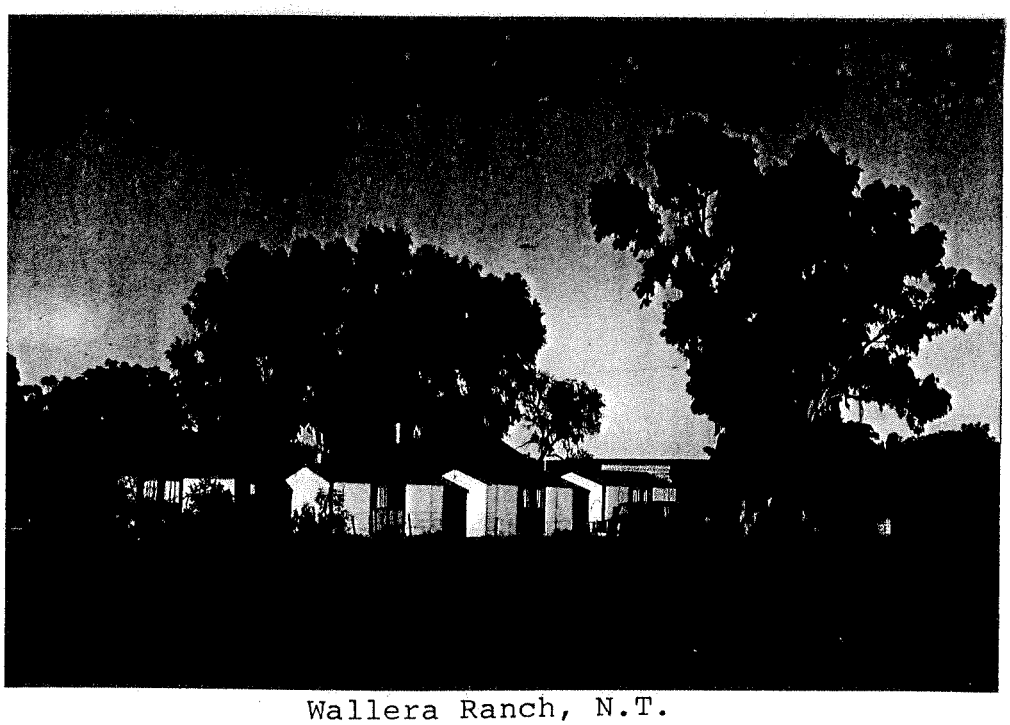
8:05 AM	B.P.	1012 mb
	Temp.	68 ° F
	Wind	220 degrees, 5 knots
5:15 PM	B.P.	1010 mb
	Temp.	94 ° F
	Wind	300 degrees, 12-20 knots (gusts)

THURSDAY, SEPTEMBER 29, 1988

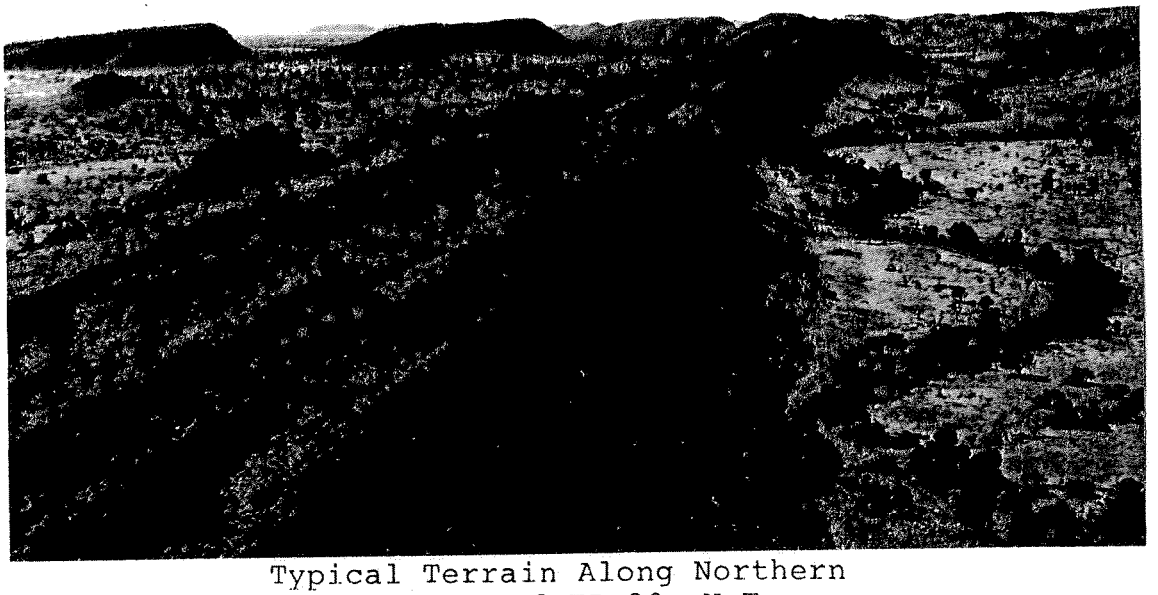
9:10 AM	B.P.	1012 mb
	Temp.	78 ° F
	Wind	70 degrees, 10 knots
11:30 AM	B.P.	1012 mb
	Temp.	82 ° F
	Wind	70 degrees, 10 knots

INDIGO OIL PTY. LTD.

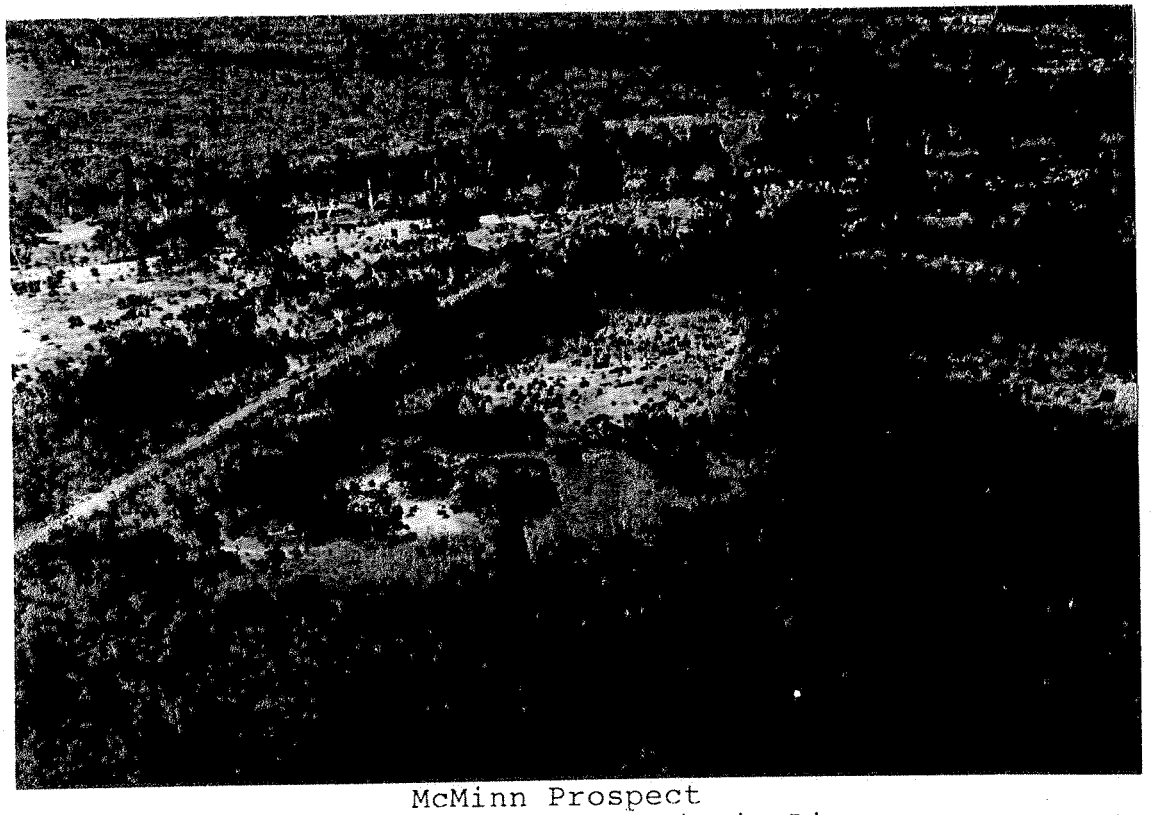
RECON Airborne Gas Sensor
at Wallera Ranch, N.T.



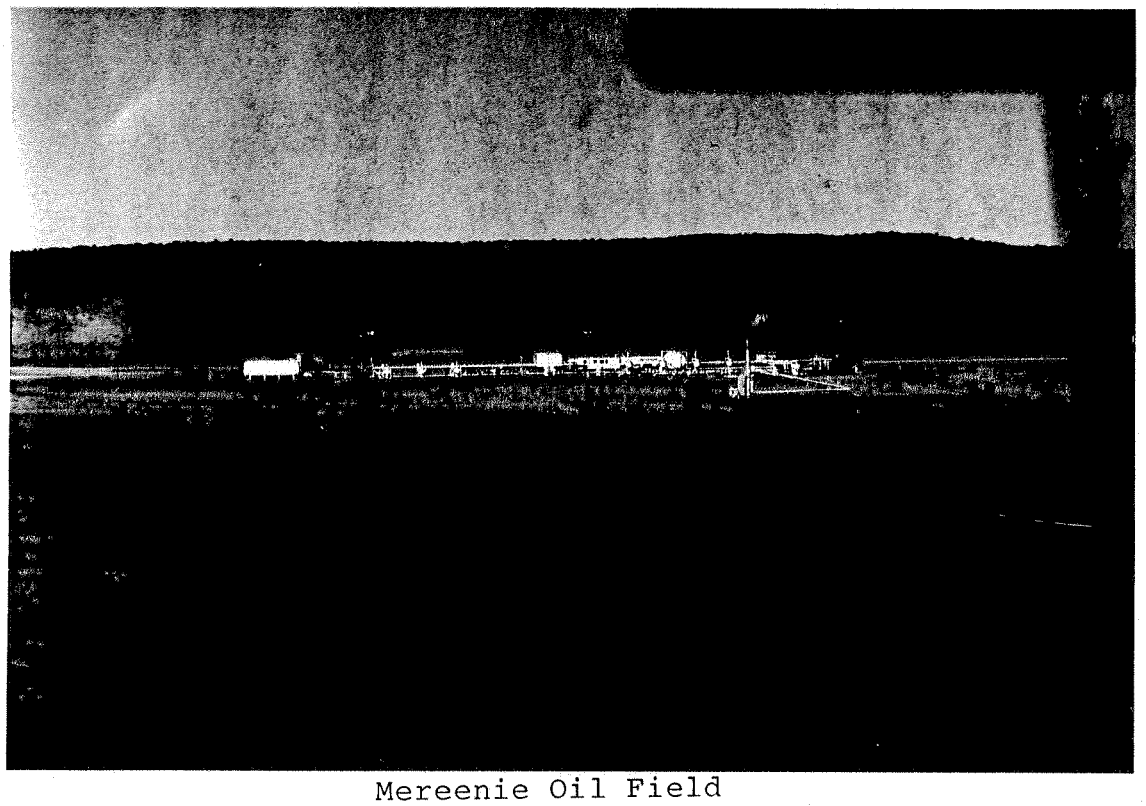
Wallera Ranch, N.T.
Survey Crew Accommodations



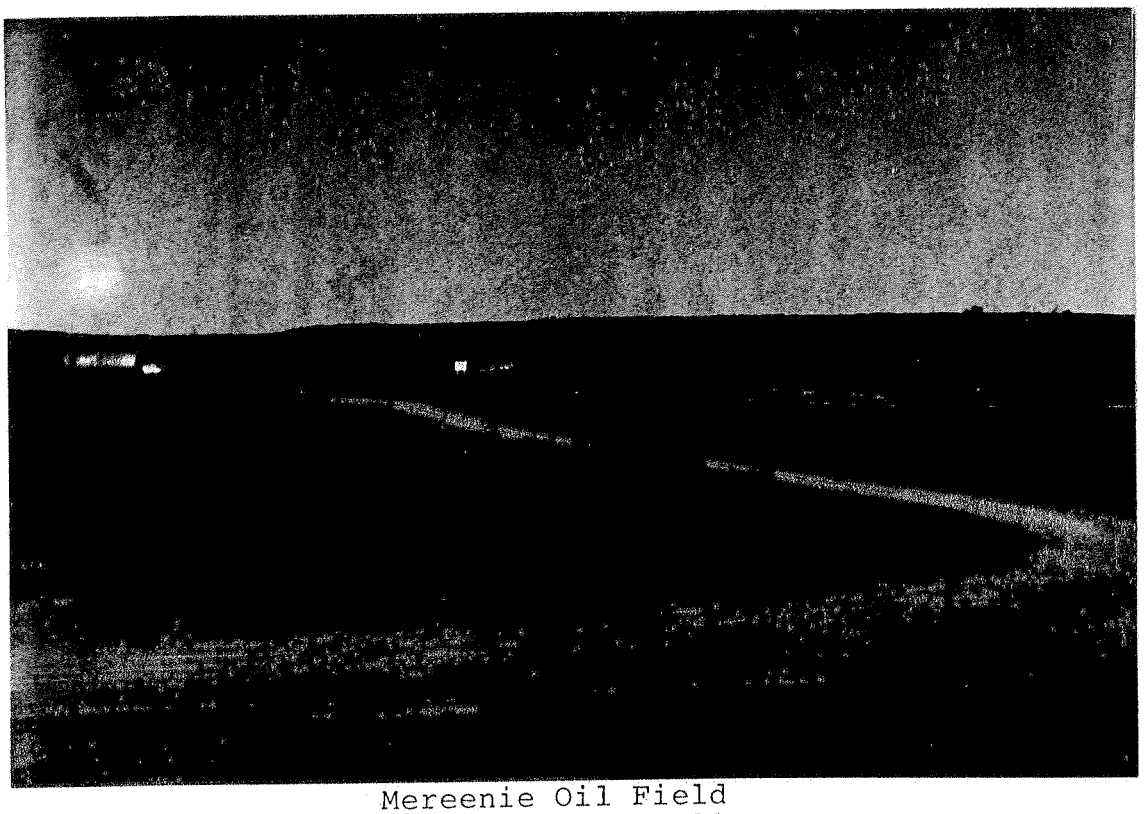
Typical Terrain Along Northern
Boundary of EP-20, N.T.



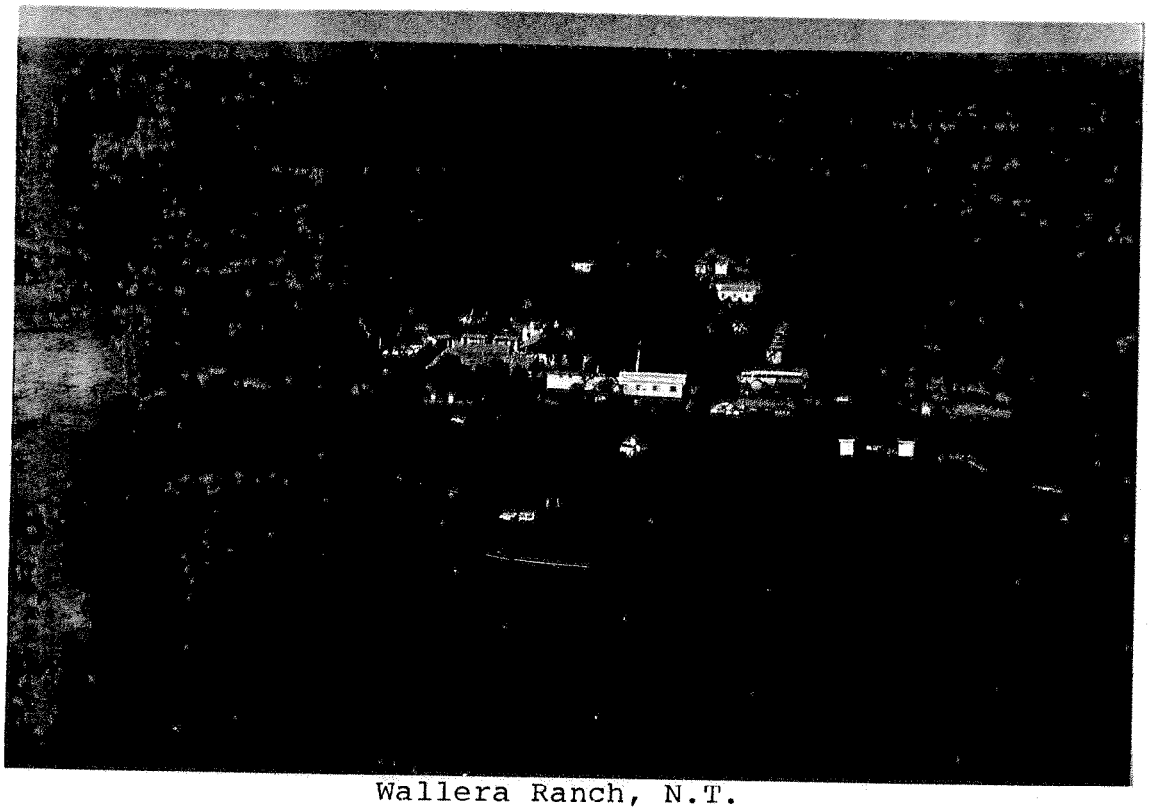
McMinn Prospect
Bleached Soil Along Seismic Line
East End of Anomaly



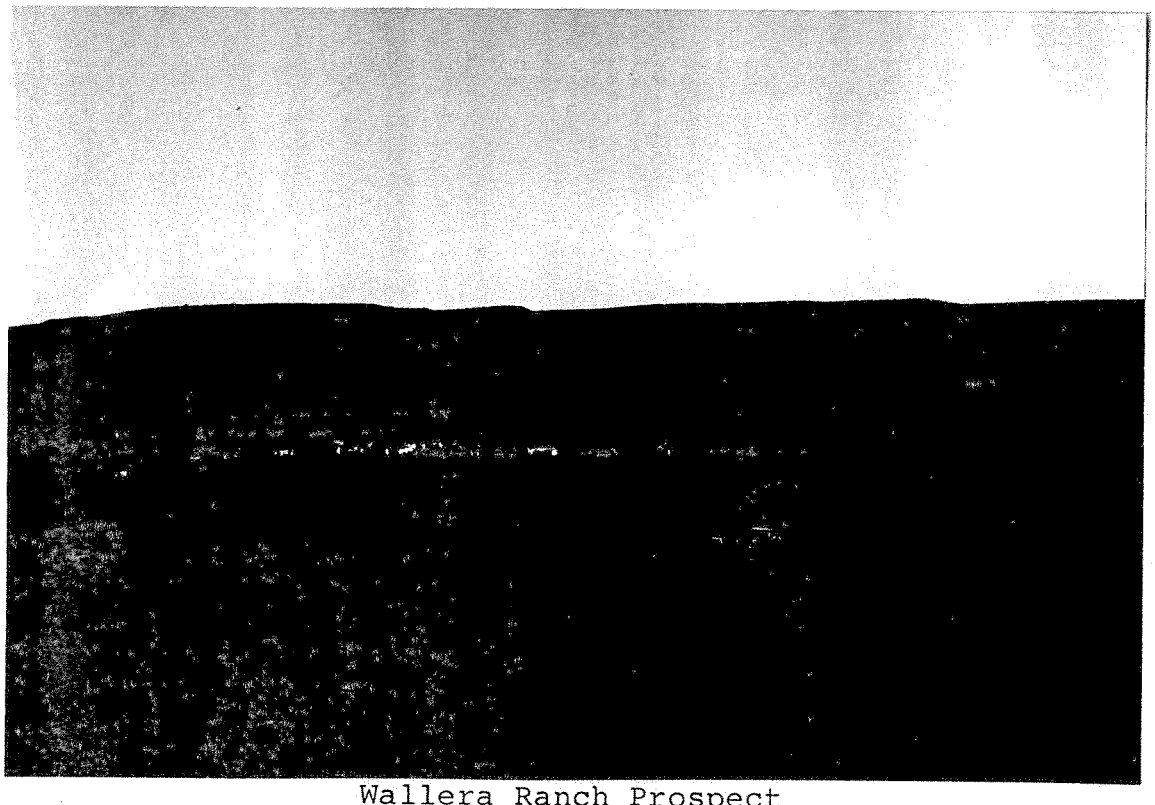
Mereenie Oil Field
Gas Processing Plant



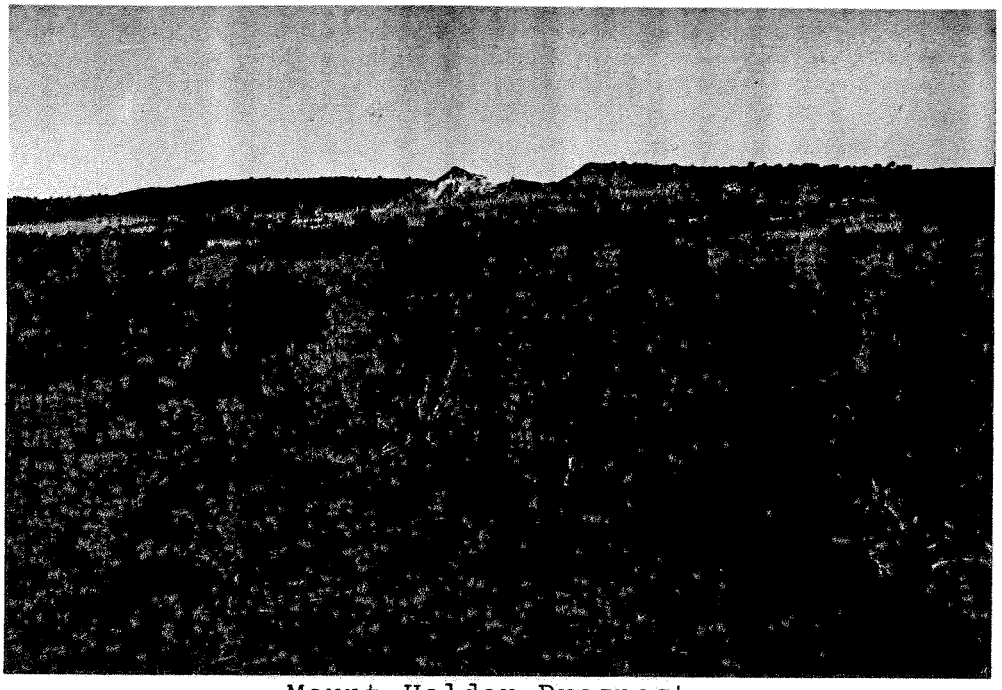
Mereenie Oil Field
Typical Field Well



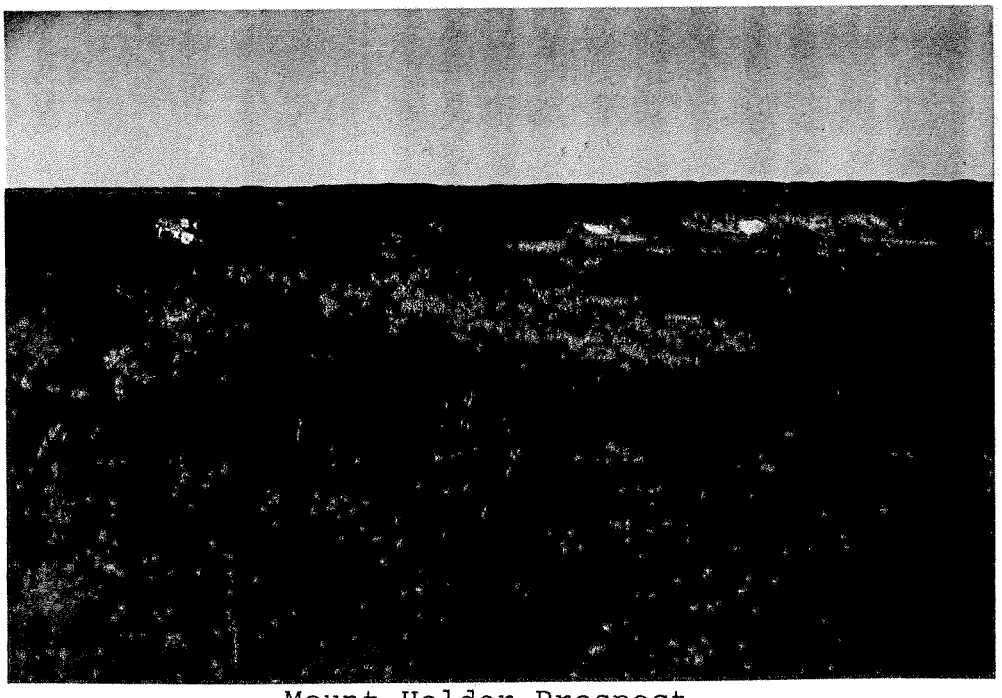
Wallera Ranch, N.T.
Base of Survey Operations



Wallera Ranch Prospect
North View of Anomaly
Desert Oaks in Foreground



Mount Holder Prospect
Bleached Soil
West End of Anomaly



Mount Holder Prospect

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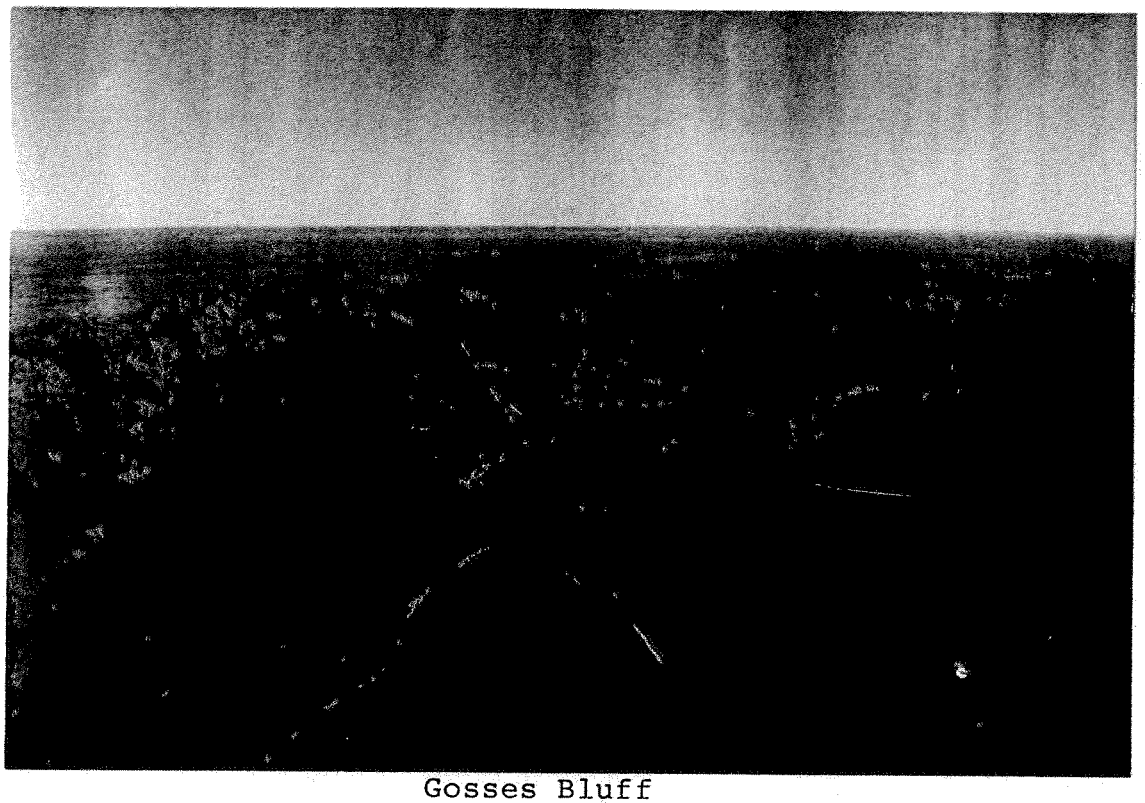
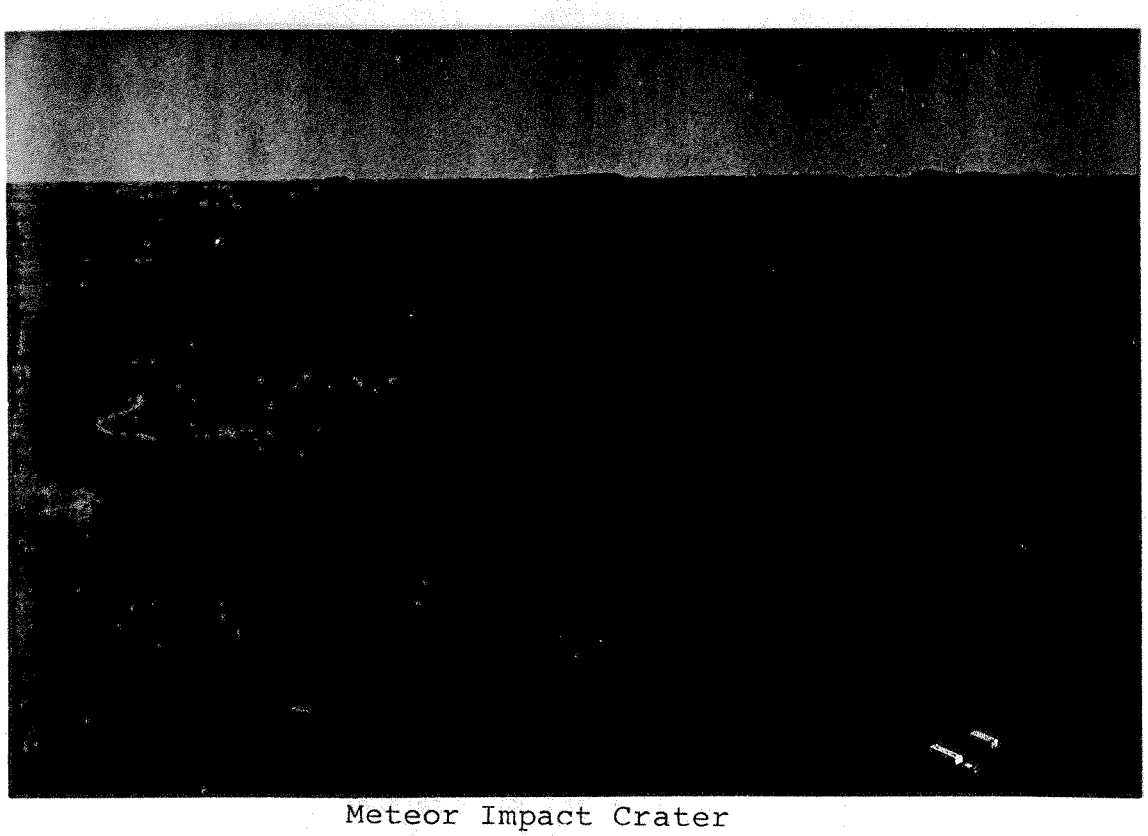


Gosses Bluff
Meteor Impact Crater
Wildcat Well Currently Drilling 10/88



Meteor Impact Crater
Near Henbury, N.T.