PHOTOGEOLOGICAL STRUCTURAL MAPPING OF PART OF EP11, SANDOVER RIVER AREA, N.T.

Undertaken for

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ABSTRACT

Photogeological structural mapping which relied on the benefit (in flat country) of the very marked exaggeration of stereoscopic relief afforded by superwide angle aerial photography (scale 1:83,000) enabled a number of anticlines to be recognised that had previously not been mapped. Some of the larger ones having discernable axial lengths more than 8-10km may represent drilling targets during petroleum exploration.

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1. INTRODUCTION

1.2. Aims and Objectives

The aim of the study was to capitalise on the stereoscopic exaggeration of relief provided by aerial photographs to produce as much structural information as possible from within part of EP11 in Northern Territory, to aid oil exploration. (See location diagram, Fig. 1). In specific terms the object was to attempt to identify antiforms, particularly large four-way anticlinal closures that might represent drilling targets.

1.2. Stratigraphy, Deformation and Landforms

Apart from the possibility of narrow dykes in fractures, the study area is exclusively undelain by Paleozoic sedimentary rocks. These include Cambrian to Ordovician dolomites, dolarenites, sandstones and cherts of the Georgina Basin. Undifferentiated Mezozoic terrigenous beds rest unconformably on the older rocks and Quaternary to recent sand and alluvium blanket large areas.

Significant hydrocarbon potential has been demonstrated by Pacific Oil and Gas to exist within the Georgina Basin strata and these were the focus of attention. The thin-bedded nature of most of the sediments and the relatively slight undulatory deformation they have undergone exacerbates the problem of structural mapping in an area that is remarkably

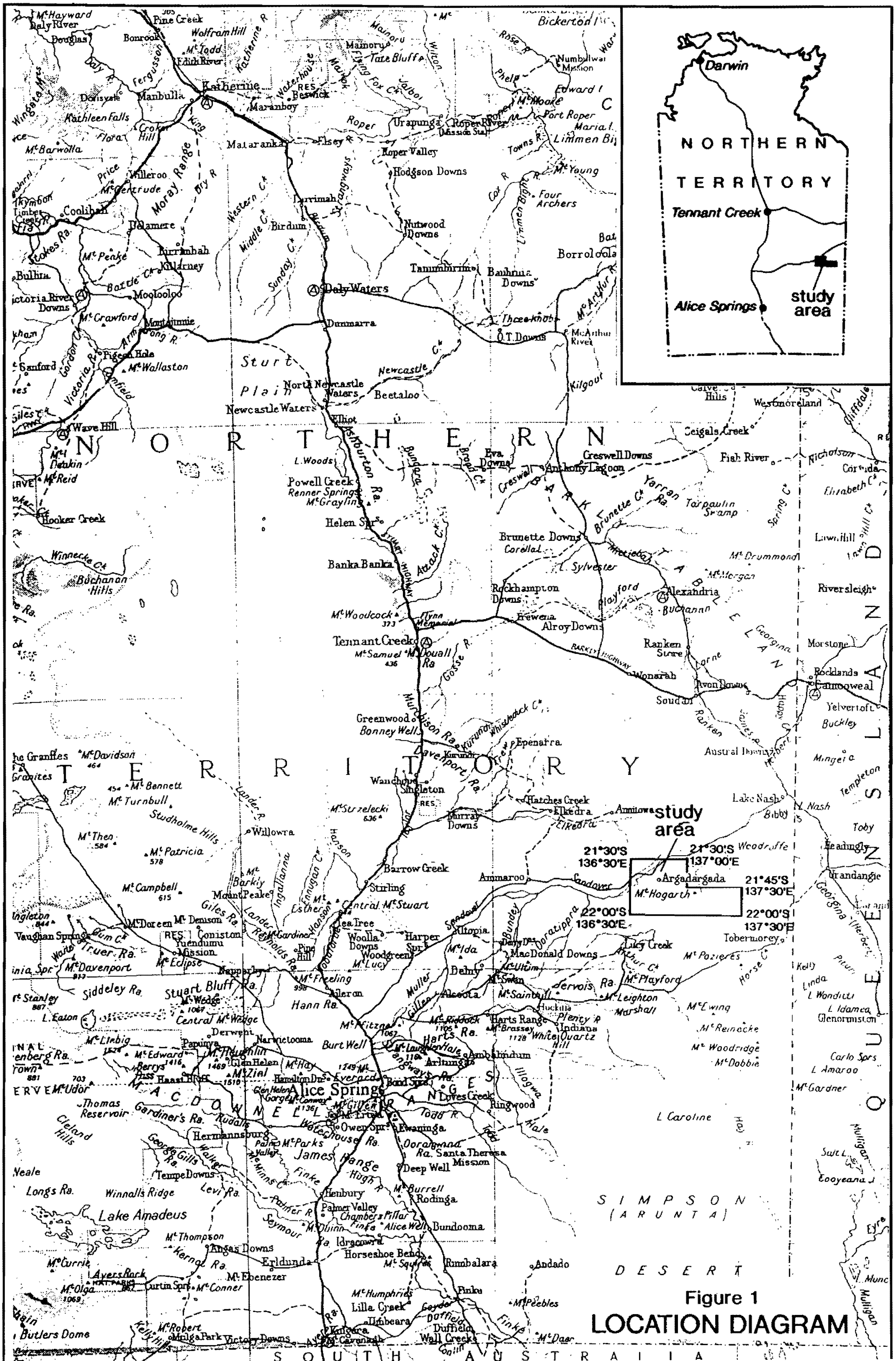

Figure 1
LOCATION DIAGRAM

flat and lacking incision by erosion. Outcrops are low, broken and rubbly, attesting to rapid mechanical disintegration of bedding at the surface and in sub-outcrop. In the field it is difficult if not impossible to obtain meaningful measurements of dip-planes and strike directions, and it is seldom possible to recognise individual folds.

1.3. Use of Aerial Photographs

Under the steroscope during structural mapping in flat country, aerial photographs have the distinct advantage of producing an exaggerated image of relief and dips. The Appendix details the airphotos that were utilised during the study. These were chosen in preference to larger scale photography for two reasons:

i. The short focal length of the RC9 camera produces super-wide angle photography which has the attribute of very greatly increasing the stereoscopic relief.

ii. The wide field of view of individual airphotos (owing to the small scale, 1:83,000) makes recognition of major folds easier.

False colour Landsat TM images were available for reference. Details are in the Appendix.

1.4. Premises and Concepts

It was known that detailed mapping of structure in the Georgina Basin would be difficult, and without any guarantee of success, notwithstanding the airphoto advantage mentioned above. Accordingly, the project was formulated in two stages, the first being a rapid, reconnaissance mapping stage, Stage I, intended to be followed if justified by results, by a detailed mapping stage, Stage II.

It was surmised that (any) incised watercourses and active alluvial channels might permit the indirect recognition of anticlines, owing to the common tendency for breached anticlines to erode more rapidly than synclines. For this reason current watercourses were mapped during the annotation of the aerial photographs.

It was not initially considered necessary or feasible to attempt to map stratigraphic units, either Palaeozoic or Mezozoic. As the project progressed the geologists suspected otherwise and the linework and interpretation effort was then significantly increased in the attempt to use the pattern of distribution of stratigraphic units as an additional guide to the recognition of large antiformal targets. To the extent that the original intention was to map only stratification, dips, and active drainage, the final maps represent a significant expansion of the photogeological work load within the budget. Unfortunately the extra work did not prove fruitful.

2. PROCEDURE

At the time the work was proposed it was anticipated but not proved that recognition of unmapped structural information would lead to the definition of target anticlines. The first stage of reconnaissance photogeological mapping was thus undertaken to determine what detail could be discerned, to familiarise the geologist with the landforms and attendant problems, to recognise anticlines if possible, and to indicate whether more intense and detailed annotation (once the geologist "had his eye in"), would be likely to yield useful targets. This Stage I phase was sufficiently successful to justify Stage II but a significant amount of dip and fold information was amended and discarded once Stage II was in progress.

Stage I work utilised x3 as well as a small component of x6 binocular stereo-magnification of the airphoto images, whereas Stage II relied largely on intense study of the photographs under x6 magnification as well as on maximum exaggeration of stereosopic relief to enable subtle changes of dip to be discerned and vague stratification to be mapped.

Linework was done on clear-film overlays of individual aerial photographs and compiled to a base map. At the initial Stage I, map compilation onto enlarged and retraced quadrants of the published 1:250,000-scale topographic map was deemed adequate. When Stage II commenced, owing to the possibility that the mapped area might be extended at some time in the forseeable future, the more accurate "line compilations" (scale 1:100,000) available from AUSLIG were used as the control maps.

At the scale (1:83,000) of the "RC9" aerial photographs that were used some of the annotated detail was so fine that it defied compilation except at an enlarged scale. Consequently the compilation control sheets i.e. drainage bases, were enlarged photographically to 1:60,000-scale, and the photo-overlays likewise but by photocopy machine, and the annotated detail was then compiled into a map by tracing the overlays. Finally, the draughted map sheets at the scale of 1:60,000 were photographically reduced to the scale of 1:100,000 for presentation purposes.

During both Stage I and Stage II of the study interim maps were made available to Pacific Oil and Gas as work-sheets. These were prepared by mosaicking paper photocopies of the annotated overlays.

3. RESULTS

3.1. General

The photogeological map in two sheets at the scale of 1:100,000 represents the major outcome of the study.

Scattered remnants of a formerly widespread Mesozoic sand and pebble mantle were mapped as outliers on the Paleozoic Georgina Basin strata throughout the mapped area except in the extreme NW sector where Quaternary and recent colluvium and alluvium predominate. The Georgina Basin sediments are very gently flexured and warped rather than folded and the SE two-thirds of the tenement is characterised by strongly jointed subhorizontal Georgina Basin rocks. Only some of the joints have been mapped. They all strike NE and, judged by their rectilinearity, are vertical. Intersecting joints are rare and their parallelism is remarkable. No evidence of any joint-controlled dykes or other igneous intrusion exists, but some of the erosion-widened joints in the far E are similar to joints seen elsewhere in Australia which do contain narrow dykes. The sand mantle in the NW is not as featureless as published maps tend to indicate and active alluvial wash-channels were recognised.

3.2. Drainage as a Guide to Target Anticlines

The supposition that active drainages on gently deformed strata in this flat landscape may etch out anticlinal folds in particular, proved to be wrong. Notwithstanding the additional drainage content of the photogeological maps, it is evident that the overall character is dendritic and uncontrolled by underlying bedrock structure. Even in the far E of the mapped area where jointing is ubiquitous, the broad dendritic pattern prevails, suggesting that the drainage is superimposed and not reponsive to bedrock deformation.

An indirect guide to the recognition of anticlines in this area by means of drainage "anomalies" therefore appears not to exist. (The method has been successfully used in the Eromanga Basin). The mapped drainage routes are certainly at a much broader scale of dendritic character than could be responsive to or indicative of the anticlines that have been recognised. The broad scale inhibits subjective target selection even in an area the size of the study area. (But one is tempted to speculate on the significance of the fan-shaped alluvial channels S of Argardargada homestead. Is there a possibility here of a very gentle dome (or basin?) some 30km in diameter?

3.3. Target Anticlines

The mapped anticlines considered worthy of mention may be chosen only on the basis of relative size, i.e. the discernable length of individual axes.

There are 7 recognised anticlines which have axial lengths greater than 8-10km, and a number of lesser ones. There is no definite pattern or association: at best it might be said that an E-W axial trend is not uncommon but that three or four of the longest anticlinal axes do not follow this trend and instead are aligned NNE (in the extreme SW), ENE (centre S of tenement), and NW (in the jointed strata in the E). The larger anticlines seen on the aerial photographs are the following ones

i. 40km SSW of Argardargada homestead.
This fold axis actually lies 5km W of the SW corner of the Argardargada 1:100,000 sheet area, i.e. just beyond the limit of the compiled map. The mapped axial length is about 10km and the axis strikes NNE. A double plunge appears to be present, but details of outward dips on the E flank are scarce and a NS lineament may truncate the bedding. The recent drill hole "Ross-1" in the extreme SW of the study area is 5km E of this large fold.

ii. 16km ESE of Argardargada.
The mapped axis is roughly EW and is mildly convex towards the N. The length is about 9km. The W end is revealed by plunging strata but the E end is not evidenced by outward dips, so a potential trap-culmination is not proved.

iii. 18km SE of (ii) and 34km ESE of Argardargada.
A 9km-long SW-NE trending axis, also without proof of closure at its NE termination.

iv. 6km SW of of (iii) and 30km SE of Argardargada.

An E-W axis 8km long, not proved to close at the E end.

v. 5-10km W of the cluster of tributary headwaters of Imbordjuju Creek, in the E part of the mapped area.

A possible large fold in (relative terms) with a 20km-long axis which trends NW. The inferred SE termination may be a fold closure but the NW limit is undefined. The closure in the NW may be hidden beneath sand, or the entire fold may be lacking 4-way closure. On the other hand, Imbordjuju Creek to the SE is coaligned with the axis of this fold and rare dips may possibly permit the SE prolongation of the axis. If this case is argued, then the abovementioned "fold closure" at the "SE termination" may in fact be a local domal culmination. If so, the interplay of NW- and ENE-aligned anticlines may be responsible (see below).

vi & vii. Two anticlines crossed by the headwaters of Imbordjuju Creek

These are situated E of the abovementioned large fold. The axes trend E-W in the case of the northern one which has a length of 9km, and slightly E of N in the case of the other which has an axis suspected to be more than 10km long. It is possible that the last-mentioned "fold" may in fact represent outward dipping tilt-blocks between joints or fractures, rather than a true fold closure. The tenuous curving eastwards prolongation of the mapped axis, to join up with a NW trending axis followed by a creek just beyond the extreme E part of the mapped area, is suspect.

There are 4 other smaller anticlines on the map which are of less interest.

All of the abovementioned folds were previously unmapped and are unrecognisable on the Landsat images. Each was critically examined and confirmed under the stereoscope by three experienced photogeologists.

4. DISCUSSION

Although relatively few good target structures were recognised within the study area the relevance of photogeological mapping is that there is no easier or less expensive way to find direct targets in this landscape, or to indicate, if not prove, their absence. Blanket seismic traversing would be prohibitive cost-wise at the present stage of perceived prospectivity. The importance of the tremendous exaggeration of stereoscopic relief in enabling gentle dips to be differentiated and mapped, and the essential need for the photogeologist to become entirely familiar with the landscape (i.e. to "get his eye in") cannot be stressed enough. During the progress of the work it became evident that the interpreters' abilities to discern meaningful detail including stratigraphic divisions peaked during Stage II only some weeks after commencing the photostudy, owing to the difficulty inherent in the landscape.

5. CONCLUSIONS

1. Of anticlines recognised during the photogeological mapping to have axial lengths of more than 8km, only one, located just beyond the extreme SW of the map, has indicated 4-way closure. This appears to be a prospective drilling target, subject to tenement constraints.

2. Subject to proof of "closure" forthcoming from field work the anticlines numbered ii-vii above may represent drilling targets.

3. Those anticlines in the east of the tenement may well be compartmentalised by parallel NE striking fractures.

4. The active drainage system displays a dendritic character on a grand scale that is unrelated to the folding recognised which is undulatory and non-substantive. The predictive value of drainage analysis for recognition of anticlinal targets is thus discounted (unless over a much wider region megafolds 30-40km across might be seen to influence the broad-scale drainage in a way that the mapped folds cannot).

5. The available Landsat images proved of limited use. This is in part a function of their small scale, but also largely a problem brought about by the flat landscape and thinly bedded undulating sediments, which combine to provide fine landscape features beyond the limits of resolution of the (two dimensional) satellite images.

APPENDICES

(i) Aerial Photographs Utilised

Type : Black and White Super-wide angle prints; f = 88mm
Scale : Approximately 1:83,000
Overlap : 80% forward and aft
Format : 23 x 23cm
Quality : Good
Source : Commonwealth Government of Australia

Film no.	Run	Print nos.	Date	No. of prints
CAG 4104	5	0039-0056	1971	18
CAG 4103	6	0278-0294	1971	17
CAG 4107	7	0132-0163	1971	32
CAG 4103	8	0113-0144	1971	32
				99

(ii) Landsat Images Available for Reference

Four Landsat Thematic Mapper colour composite paper prints at the scale of 1:250,000 as follows:

	WRS	Date acquired	Channels	Title
(a)	100-75	24 Oct. '86	2,4,7=B,G,R	SANDOVER RIVER
(b)	99-76	1 Oct. '86	2,4,7=B,G,R	MT. WHELAN
(c)	99-75	1 Oct. '86	2,4,7=B,G,R	URANDANGI
(d)	101-75	29 Sept. '86	2,4,7=B,G,R	ELKEDRA