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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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AIRBORNE REMOTE SENSING PROJECT WESTERN AUSTRALIA 1970

by

E.P. Shelley and C.J. Simpson

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SUMMARY

An airborne remote sensing survey over two areas in the Goldfields region of Western Australia from 15 September to 3 October 1970 was done to assess the value of geologic data obtainable from airborne techniques, and to evaluate different types of aerial photography.

Detailed magnetic and radiometric data, and colour, colour infrared, black-and-white infrared, and panchromatic photography were obtained for each area, and filtered panchromatic photography for part of one area. Evaluation of results was carried out in stages to allow the contributions of various interpretations to be assessed. Relevant published geology was incorporated in the final results to produce interpreted geological maps. No field checking has been done to date, and the maps are subject to confirmation.

The study showed that in the environments studied (i.e. complex geology, deep weathering, and extensive superficial mantle), photogeological interpretation without supporting data is of little value. The photogeological and airborne geophysical techniques produced some complementary information, and combined evaluation of data resulted in a more useful geologic interpretation than those derived from either method independently. The availability of even limited published ground data considerably upgraded the interpretations, and ground checking in the project areas is recommended to test the interpretations.

Despite the absence of ground checking the geologic information obtained is significant enough for the authors to recommend that combined airborne geophysical (detailed magnetic and radiometric) and photogeological studies should be undertaken in advance of field mapping in all areas where the rock types possess a wide range of magnetic susceptibility contrasts.

Colour photography was the most useful of the photographic types evaluated and it is recommended that if further experimentation with panchromatic multi-spectial photography is attempted it should be undertaken with a single-film, multi-lens camera.

1. INTRODUCTION

The idea of carrying out a detailed aeromagnetic survey over a test area in part of the Western Australian greenstone belt was initiated by geophysicist G.A. Young in 1969, following his investigations of regional aeromagnetic results (Young, 1971). At the time Young was investigating new techniques for interpreting structure from airborne magnetic data.

Proposed flying of the test area offered the opportunity to try different aerial photographic techniques. It was then decided that the investigations should be undertaken as a remote sensing test project to evaluate: (1) the extent of geological information that could be interpreted from data collected by airborne magnetometer, gamma-ray spectrometer, and aerial camera instrumentation; (2) the relative geological usefulness of various types of aerial photography in the environment studied. Although the concept of using airborne magnetometer results combined with photogeological interpretation as a rapid reconnaissance technique for geological data collection is not new, it had not been previously evaluated by the Bureau of Mineral Resources (BMR).

Test Area 1 (Fig. 1), of 211 sq. km, lies within the North Coolgardie Goldfield and was selected from the regional magnetic results (Young & Tipper, 1966) which indicated that it comprises greenstone rocks which may have been partly assimilated by granite or gneiss. Outcrop for photointerpretation purposes was poor, and the only published geology (Talbot, 1912) showed the area to be granite.

Test Area 2, of 340 sq. km, was selected after air-photograph inspection indicated that it had a higher percentage of outcrop than Area 1. Interpretation of geophysical data (Tipper & Gerdes, 1971) revealed strong south-southeast structural features which defined a belt of greenstones with included granite and metasediments.

Area 2 lies within the Mount Margaret Goldfield, and relevant geological data have been published by Gibson (1906), Clarke (1925), Hobson & Miles (1950), and Hobson, Miles & Matheson (1952). The geology as published by Hobson et al. (1952) is summarized in Plate 11.

Evaluation of the remote sensing project was carried out in stages as shown in Figure 2. Project results at various stages are shown in the accompanying plates. Variations between different stages can be assessed by comparison of plates, and discussion has been minimized.

Environment of test areas

Both test areas are within a semiarid to arid environment. Annual rainfall is 20-22 cm, the bulk of which falls during the winter.

Hobson & Miles (1950) note that the vegetation types reflect the underlying geology. The Margaret Series maintains stunted mulga, alluvial areas maintain a more vigorous growth of mulga, and in the vicinity of some larger creeks medium-sized eucalypts are found. Granite or gneiss areas maintain principally spinifex with stunted mallees.

2. STAGE ONE

Collection of airborne data

Survey operations took place between 15 September and 3 October 1970. Details of the geophysical operations are listed in Appendix 1.

The magnetic data are presented as contours of total magnetic intensity in Plates 3 and 4. Stacked profiles were produced only as an aid to interpretation, and are not presented here.

After the return of the survey party to Canberra in October 1970, certain malfunctions of the gamma-ray spectrometer recorders were discovered. These were not apparent at the time of the survey. Consequently a low degree of realiability was placed on the gamma-ray spectrometer data and they have not been presented as contours or profiles.

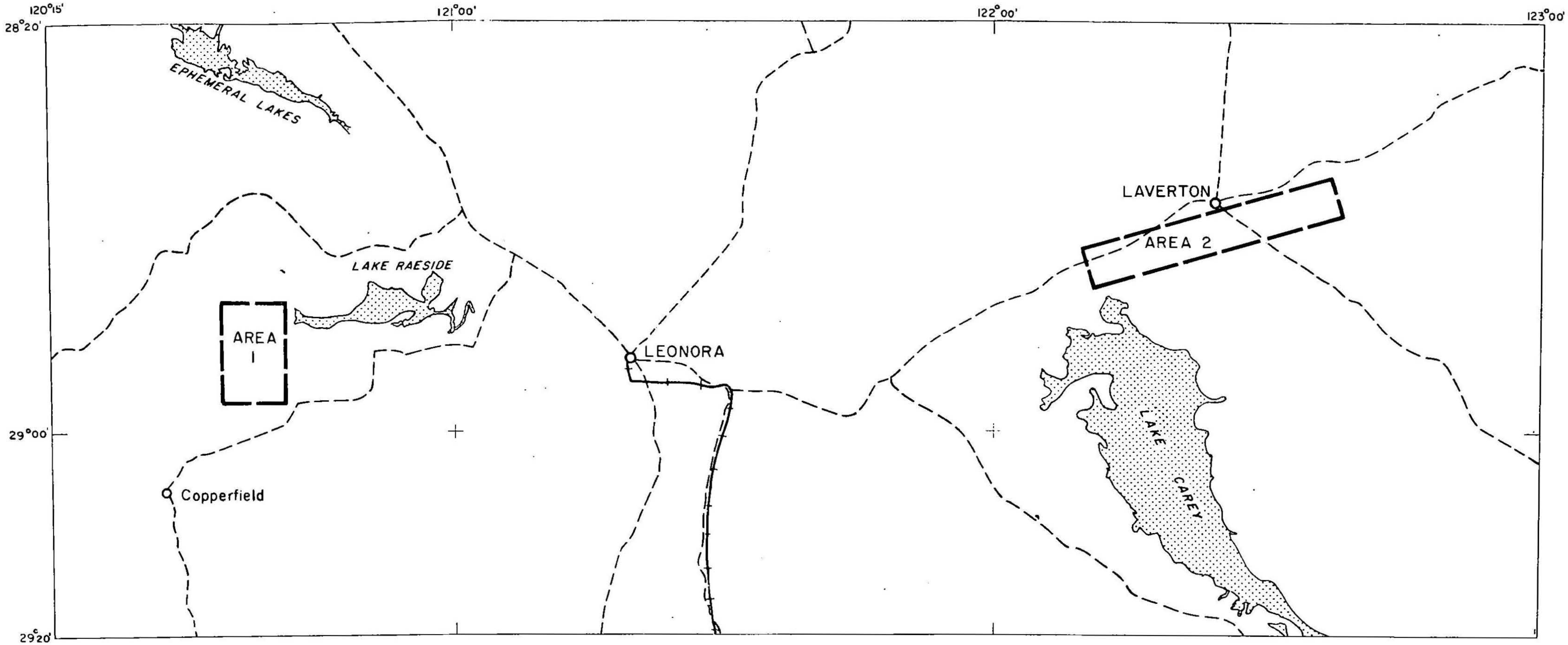
Colour, colour infrared, black-and-white infrared, and panchromatic films were exposed over both areas. Aerial photography details are listed in Appendix 2. Variously filtered panchromatic films were exposed in additional test flights over the central portion of Area 2.

3. STAGE TWO

PHOTOGEOLOGICAL INTERPRETATION

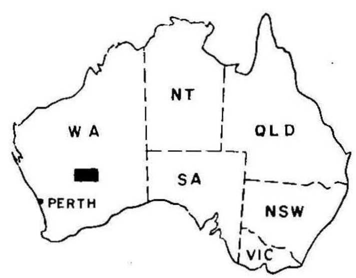
Procedure

Before reference was made to any published or unpublished geological data, systematic photogeological interpretations were prepared for both areas. These were made on the 1:31 000 scale W.A. Lands Department photographs (Appendix 2) with the aid of a Wild mirror stereoscope and 3x binocular attachment. The photo-interpreted geology was then compiled into the respective maps at photoscale to serve as bases for all subsequent interpretations. All



AIRBORNE REMOTE SENSING SURVEY, WESTERN AUSTRALIA, 1970

LOCALITY MAP



Survey boundary

10 0 10 20 30 40 50 60 70 80 KILOMETRES

5 0 10 20 30 40 MILES

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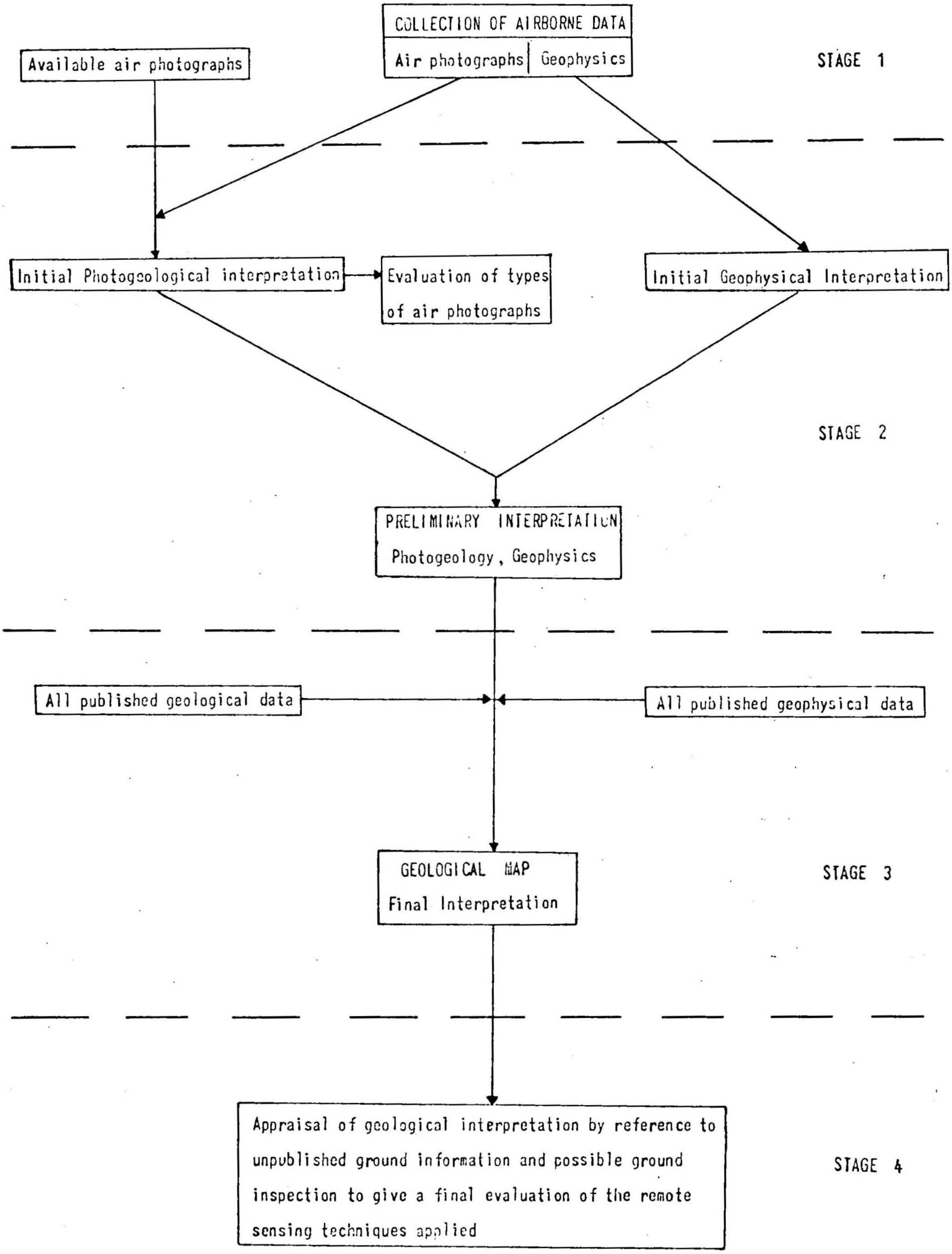
Figure 1

Figure 2

PROJECT EVALUATION PROGRAM



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geological maps in this Record are at a smaller scale than the original and therefore show less detail than can be interpreted or plotted at photo-scale.

An examination of the 1:86 000 scale Commonwealth air photography over both areas was then undertaken, and any relevant data not detected on the W.A. State photography was incorporated into the interpretations.

Interpretation and comparison of the BMR photography was then carried out in the following order: the various filtered panchromatic films, the black-and-white infrared, the colour, then the colour infrared. All films were processed to negative products and examination of both the original 70-mm negatives and selected runs of positive contact prints was undertaken for each type of film. Evaluation was primarily undertaken on positive prints since they are the normal medium used by the field geologist. Film and prints were examined with the aid of a pocket stereoscope, and a binocular stereoscope (with 5½x magnification) specially designed in BMR for the purpose of stereoscopically viewing 70-mm film in uncut rolls. The special viewer (BMR Technical drawing VO7-1) was mounted on a 'Brookeades' parallel guidance traversing mechanism.

Any additional relevant data resulting from the examination of the BMR photography were incorporated into the original photo-interpretation maps to produce the Initial Photogeological Interpretation (Plates 1 and 2) for STAGE 2.

Initial photogeological interpretation

Early in Stage 2 it became obvious that detailed examination of the airphoto characteristics of known rock types would be necessary before any meaningful subdivision by photo-interpretation could be achieved.

Attempted subdivision and/or correlation of Archaean outcrops on photo data alone was hindered by extensive surficial cover and deep weathering effects. Different rock types could be recognized but even correlation along strike was dubious in many places because weathering tended to produce similar appearance in different rock types.

Apart from structural information the initial photogeology maps (Plates 1, 2) are basically maps of Cainozoic superficial material and pre-Cainozoic rock outcrop.

Cainozoic

Alluvium. Alluvium (Qa) has been differentiated only on Area 1 and represents both recent and older alluvium of Lake Raeside. Sand deposits within the lake and which are too small to separate out have been shown as alluvium.

Alluvial occurrences in area 2 are more restricted and have not been differentiated.

Sand. Areas of sand (Czs) have been differentiated in Area 1. These areas appear to contain thick accumulations of both alluvial and aeolian sand.

Travertine. Travertine (Czt) has been identified in Area 2. The main outcrops are related to lakes in the low-lying country on the west of the test area. A smaller area of what may be derived from travertine is indicated to the east of Mount Barnicoat.

Undifferentiated Cainozoic. The Cainozoic surficial material has not been extensively subdivided and has been left as undifferentiated (Cz). All aeolian and alluvial sand (with the exception of Czs in Area 1), alluvium, colluvium, and soil have been included in this unit. In many instances the undifferentiated material is shown mantling another unit (e.g. Cz over f). Although sufficient photo data are generally available to allow differentiation of the underlying unit, it is expected that in most instances only the superficial material would be observed in the field.

Laterite. In both areas two different deep weathering mantles of laterite or ferruginous material of different ages have been recognized.

Remnants of the older laterite (Old f of Area 1, f of Area 2) are all that remain of an old subhorizontal erosion surface. The younger laterite (f of Area 1, f_1 of Area 2) occurs at a lower topographic level, and on steeper slopes, than the older. It is not possible to determine conclusively by photo-interpretation whether the younger laterite is the result of a more recent episode of deep weathering or whether it is a mantle of ferruginous material resulting from weathering and transportation of the older laterite.

Archaean

The outcrops of pre-Cainozoic (Archaean) rock have been grouped under A (greenstones, paragneiss) for Area 1 and A and Ag (granite? rocks) for Area 2. Surficial cover and weathering effects, as previously discussed, prohibit any further meaningful subdivision at this stage.

Area 1 (Plate 1). The amount of pre-Cainozoic outcrop identifiable on air-photographs is limited. Strike trends can be identified both in outcrop and as vegetation alignments in areas of superficial cover.

A comparatively hard rock comprising a series of linear NNE-trending strike ridges which crop out in the east has the appearance of quartzite and is considered to be different from the other pre-Cainozoic rocks of the area. The strike ridges are interpreted as dipping steeply westward.

Near the centre of the area the rocks dip to the east at a low angle which suggests a north-trending asymmetrical syncline in the east of the area. Lack of outcrop prohibits positioning of the inferred fold axis.

In the southeast of the area another syncline is inferred from converging bedding trends and a steep westerly dip of the eastern limb.

The dominant airphoto lineaments trend northeast in the south of the area, east in the centre, and southeast in the north. There is insufficient evidence to identify the lineaments as being due to either faults or fractures. No displacements have been recognized along the lineaments.

Area 2 (Plate 2). Two main rock types have been differentiated: greenstones and paragneiss (A) and ?granitic (Ag).

Bedded and banded rocks which generally maintain a northerly strike are classified as greenstone and paragneiss (A). The only instance of a main change of strike was noted in the southwest corner of the area.

The main topographic peaks of the area, Mounts Ajax, Jumbo, and Enniskillen, occur on prominent strike ridges of hard, erosion-resistant beds. It has not been possible at Stage 2 to determine whether the consistent easterly dip of the beds represents a continuous succession or whether the hard ridges are fold repetitions of one bed. If the latter is the case the folds are comparatively tight and overturned with axes dipping to the east.

Northwest of the strike ridge through Mount Ajax the rock has been differentiated as ?granitic (Ag). Outcrops do not have continuous strike trends throughout. Some trends are apparent but they appear to be related to discontinuous bodies of darker rock within larger areas of light toned rock. The topography of the area does not reflect the general north-south trends of the bedded rocks to the east, and is indicative of a more homogeneous rock type. It has thus been labelled ?granitic.

Numerous dykes have been mapped in Area 2; most crop out west of the hard rock unit extending through Mount Jumbo. Most mines appear to be located on or near dykes. At least two types of dykes are present - light toned (?siliceous) and dark toned (?basic).

The dominant photo lineaments mapped trend northeast. In some instances minor horizontal displacements appear to occur on either side of lineaments, but in general transcurrent faulting appears to be minimal.

AERIAL PHOTOGRAPHY EVALUATION PROJECT

The program of aerial photography was aimed at evaluating colour, colour-infrared, and black-and-white infrared, and multispectral photographs as aids to geological mapping.

Multispectral photography is the technique of exposing panchromatic film to particular wavelengths of the visible and/or near-infrared bands of the electromagnetic spectrum. The various filters used to select wavelengths are listed in Appendix 2 and the transmittance ranges are shown in Figure 3.

The main filters evaluated in the project - numbers 58, 25A, and 32 - primarily transmit the green, red, and blue & red wavelengths respectively. Filters 58 and 25A are standard colour separation filters, and these in conjunction with 32 were chosen since they would give the best separation of the dominant wavelengths expected.

Available photography

The first photogeological interpretation carried out on the W.A. Lands Department photographs at 1:31 000 scale was amended after consulting the Commonwealth 1:86 000 scale photographs.

The latter allowed more precise differentation of the older and younger laterites. This may have been due, in part, to a difference in print quality. The only 1:31 000 scale prints available were slightly over-exposed and had lower contrast than those at 1:86 000.

Lineaments were more obvious on the 1:86 000 scale photographs because of the greater areal view available for examination.

Determinations of dip directions in low outcrops was more reliable on the 1:86 000 scale photographs. The 80% overlap on consecutive photographs permitted viewing at wider air base separations to increase the vertical exaggeration of the stereoscopic image.

TRANSMITTANCE OF PHOTOGRAPHIC FILTERS

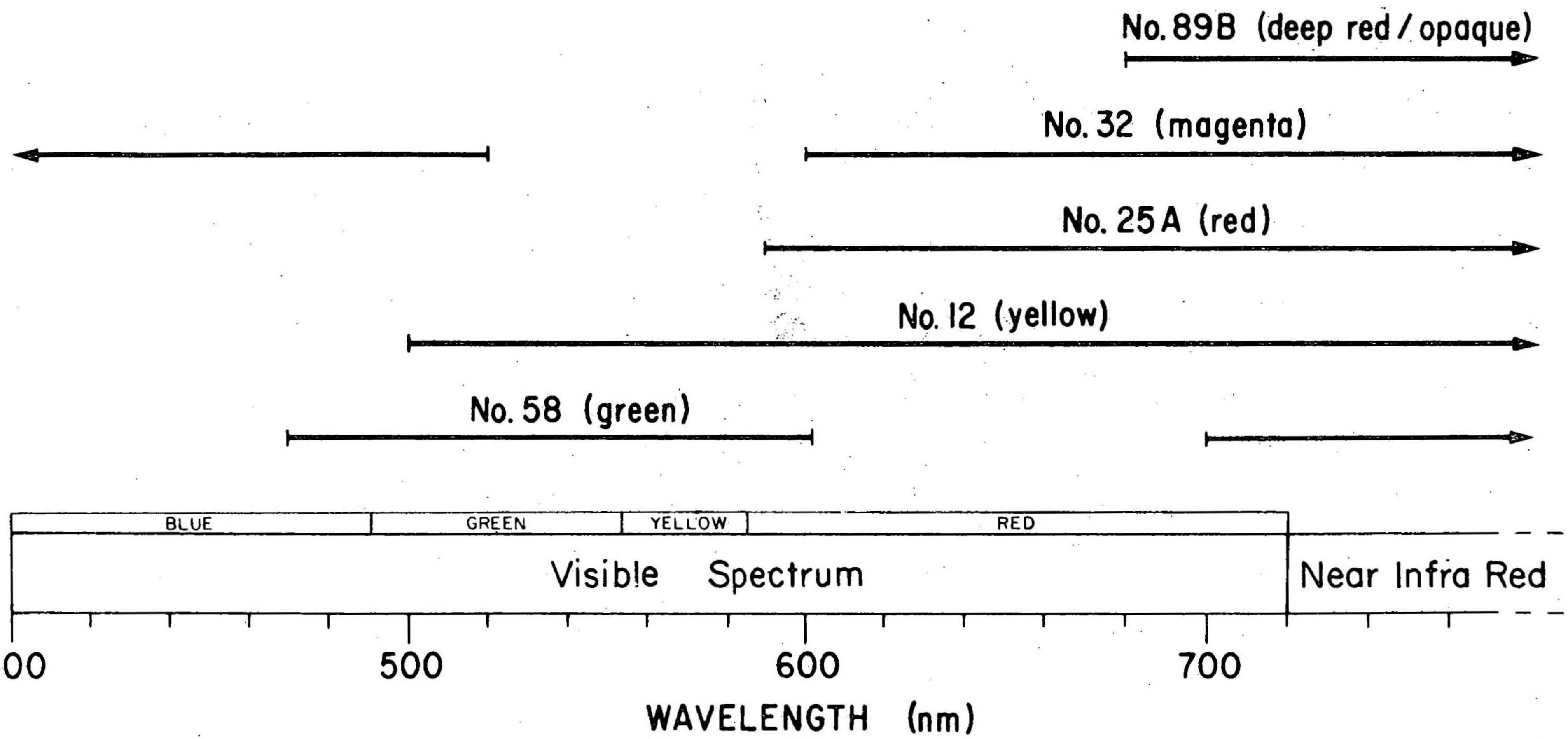

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Figure 3

Colour and colour infrared photography

The following observations were noted during examination of the colour and colour infrared photography:

(a) Outcrop - more obvious on colour prints.

(b) Sediments in dry salt lakes - best differentiated on colour infrared negatives.

(c) Bare ground - more obvious on colour infrared prints.

(d) Travertine - distinctive colour on colour infrared prints, but without the aid of colour (or panchromatic) could not be initially identified.

(e) Archaean - more readily differentiated on colour prints.

(f) Mines - generally more obvious on colour infrared prints.

(g) Soil - more readily subdivided on colour prints.

(h) Cloud shadow areas - virtually no detailed image on colour infrared whereas colour allows moderate identification of topography etc.

(i) Dykes - better identification on colour prints.

The normal colour positive prints provided more geological data and were easier to interpret than colour infrared negative and positive prints, or colour negative. They also provided more geological data (particularly with respect to soils) than any of the panchromatic photographs examined.

Black-and-white infrared photography

During the photographic mission with this film there was a camera malfunction which resulted in some double exposure. Some positive prints from the film were examined and these indicated that dykes and laterite areas are more readily identified on this film than on prints from filtered panchromatic film.

Panchromatic multi-spectral photography

Although the exposure of panchromatic film through different filters resulted in either the enhancement or subdual of certail geological features, a comparative visual examination of the photography did not reveal any relevant geological data that had not been initially interpreted on the 1:31 000 and 1:86 000 scale photographs.

The following general observations were noted on the BMR filtered panchromatic photography:

Observation	Dominant light recorded	Filter Number
best overall contrast	green	58
enhancement of mine dumps	red	25A
subdual of mine dumps	green	58
enhancement of Archaean outcrops	red	25A
enhancement of lithological trends	red	25A
subdual of lateritic boundaries	red	25A
enhancement of laterite and lateritic soil	green	58
enhancement of different soil boundaries	red & blue	32
enhancement of dykes	green	58

From such observations it is clear that filters could be used effectively for selective enhancement of certain features. However, no one filter can be used to enhance all airphoto data necessary for useful geological interpretation (e.g., filter 25A enhances Archaean outcrops but subdues laterite boundaries).

The unfiltered panchromatic showed marginally better tonal contrast than the panchromatic exposed through a number 12 filter. This result was unexpected since the number 12 filter is generally used for haze penetration in normal aerial photography. The difference may have been due to printing differences (see below).

Printing. After exposure of the aerial films they were processed and printed by commercial firms specializing in such work.

Prints were evaluated as received; i.e. without any specific tonal enhancement.

Subsequent tests were made to examine the effect on tonal values of varying printing exposure time. The tests demonstrated that unless stringent control is exercised on processing and printing, the tonal variations that can be introduced during these processes can be as significant as the differences produced by filtering. Therefore the general observations listed above about filter effects may be valid only for the prints examined.

The separate camera and film approach to such multi-spectral panchromatic photography is unsound since the tones displayed on the final prints may be controlled by factors other than exposure by the filtered wavelengths.

To achieve truly representative print displays of spectral separation it would be necessary to use films from the same production batch which had been stored, exposed, and printed under identical conditions. Such control would be difficult to achieve.

To exercise the maximum control over the variables concerned, it is preferable to undertake multispectral photography with a multi-lens camera imaging onto separate areas of one film.

General comments. Visual examination and comparison of the filtered photography proved to be more time-consuming than the initial photo-interpretation on both 1:31 000 and 1:86 000 scale photography over the same area. The panchromatic multi-spectral techniques employed on this project provided no additional geological data and are not recommended.

No equipment was available to evaluate projection colour reconstitution techniques on the negatives obtained. Even if equipment had been available it could not have been used since the duplicated photographic overflights did not photograph exactly the same areas (Plate 16). With a duel camera system it would be virtually impossible to duplicate overflights to the precision required for multi-projection techniques.

GEOPHYSICAL INTERPRETATION

Magnetic interpretation

The magnetic data were interpreted in terms of rock type and geological structure. The two magnetic criteria used to delineate rock units were anomaly amphitude and linearity. Five rock types were interpreted as described in the following table.

	Magnetic criteria	Interpreted rock type
1.	linear anomalies with average amplitude greater than 200 gammas	banded iron formations, ultrabasic rocks, basalt, dolerite
2.	linear anomalies with average amplitude in range 50 to 200 gammas	basalt, dolerite
3.	linear regions with average amplitude less than 50 gammas, usually occurring between anomalies of types 1 or 2	sedimentary rocks
4.	broad regions of anomalies generally less than 50 gammas with poor or no linearity	granite, gneiss
5.	linear anomalies with average amplitude less than 50 gammas occurring in 4.	partly assimilated greenstones forming gneissic bands within the granite.

Fold axes, faults, and lineations were interpreted from the profile and contour patterns.

Area 1 (Plate 5). The southeast and central east parts of the area have been interpreted as granite and gneiss. The northern boundary of the granite appears to be faulted against the older rocks. Several elongated regions of partly assimilated greenstone lie within the granite.

Folded basic and sedimentary rocks have been interpreted west of the granite. A cross-fold has been interpreted from the divergence of the north-striking fold trends.

A magnetic lineation 11 km long appears to displace one greenstone belt and a fold axis, but elsewhere along it there is no evidence of further faulting.

Area 2 (Plate 6). A broad region of granite and gneiss has been interpreted in the west of this area. Several partly assimilated greenstone belts are postulated within this granite, and the symmetry of anomalies suggests that these greenstones were folded about a north-striking axis located 1 km west of Mount Gooses. This axis is also supported by the marked northward divergence of interpreted greenstone belts east and west of the granite.

The rest of the area consists of folded basic and sedimentary sequences with strikes ranging from north-northwest to north-northeast.

Radiometric interpretation

Because of the malfunction of the gamma-ray spectrometer system as described earlier, a detailed interpretation of the radiometric data was not made. Regions of radioactivity significantly greater than 'geological background' were delineated in each area. The gamma-radiation in these regions was as follows:

total count channel	- greater than		100	counts/second
potassium channel	- "	"	25	"
uranium channel	- "	"	20	"
thorium channel	- "	"	10	"

The Compton scattering coefficients used in the interpretation of the gamma-ray data were those derived by Grasty & Darnley (1971) for comparable equipment.

Area 1 (Plate 7). Two regions were delineated. Region 1 extends over parts of Lake Raeside, and strong count rates were recorded in the potassium channel (up to 150 counts/s) and the uranium channel (up to 80 counts/s). The thorium count rate was less than 10 counts/s. These values suggest that the radiation is due to uranium and potassium in approximately equal proportions.

In region 2 the maximum count rates recorded were 40 counts/s (potassium channel), 30 counts/s (uranium) and 30 counts/s (thorium). This indicates that most of the radiation is due to thorium.

Area 2 (Plate 8). Three regions of strong gamma-radiation count were delineated. Region 1 near Mount Gooses lies within a broad area interpreted as granite from the magnetic data. The count rates in the potassium, uranium, and thorium channels were approximately the same, suggesting that the radiation was due to thorium.

Region 2 gave rise to average count rates of 60 counts/s (potassium channel) and 20 counts/s (uranium and thorium channels). Region 3 has the same characteristics. The measurements indicate the radiation is due to potassium with some thorium. This suggests a granitic source.

PRELIMINARY GEOLOGICAL INTERPRETATION

Results of the independent photogeological and geophysical interpretations were jointly considered and after any necessary reinterpretation were combined to produce the Preliminary Geological Interpretations for both areas.

Area 1 (Plate 9). Pre-Cainozoic rock outcrops originally shown as greenstones and paragneiss (A) from photo-interpretation have been subdivided on the basis of the rock types interpreted from magnetic data (Plate 5).

Magnetic data indicate a major rock boundary trending north-northeast in the east of the area. The discontinuous strike ridge discussed earlier occurs to the east of this boundary. The magnetic results do not provide data on the identity of the rock comprising the ridge, which appears to be quartzite and may represent a major fault zone. East of the magnetic boundary, granite or gneiss with partly assimilated greenstones are interpreted. To the west, north-striking interbedded sediments have been differentiated.

Over the southern two-thirds of the area there is good agreement between the numbers of folds interpreted independently from magnetic results and aerial photographs. The combination of results allows the folds, and positions of fold axes, to be identified.

In the southwest of the area two faults indicated from magnetic interpretation (Plate 5) have the same general trend as the mapped airphoto lineaments. Two sets of airphoto lineaments north of Turkey Well may be related to the interpreted cross-fold. They tend to converge towards the eastern end of the axis. The position and spacing of the lineaments suggests that they may represent major joints (rather than faults) on the flanks of the fold. Thus it is possible that another east-trending cross-fold axis occurs in the vicinity of Turkey Well.

A main east-northeast-trending fault through Lake Raeside, and a northeast-trending lineament interpreted from the magnetic data, do not appear to have any identifiable surface expression. Both underlie areas of extensive surficial material (Qa, Cz, Czs).

Radiometric region number 2 (Plate 7) probably relates to a granitic source. It corresponds to an area interpreted as older laterite overlain by superficial material, and it has not been possible to determine whether the high count rate originates from radioactive material transported from a source outside the project area or whether the source is under the indicated anomalous region.

<u>Area 2</u> (Plate 10). Pre-Cainozoic rock outcrops shown as greenstones and paragneiss (A), and ?granitic (Ag) from photo-interpretation (Plate 2) have been subdivided on the basis of rock types indicated from magnetic data (Plate 6).

From airphoto data a main north-trending rock boundary was interpreted through Mount Ajax, whereas magnetic data indicated that the boundary lies between 1½ and 2 km to the west. Re-examination of the photographs showed discontinuous narrow linear outcrops in the position indicated by the magnetics, and these have been interpreted as banded iron formations, ultrabasic rocks, basalts, or dolerites (greenstones).

The main outcrops to the west of the Mount Ajax magnetic zone are interpreted as granite or gneiss with partly assimilated greenstones. There is general agreement on this interpretation between both the photo and magnetic data.

Another north-trending zone of granite or gneiss between 5 and 8 km east of Mount Barnicoat has been interpreted from radiometric data (region 2 in Plate 8). It corresponds in part to an area of extensive superficial cover, and only limited ground outcrop is expected.

The remainder of the Archaean outcrops east of the Mount Ajax zone have been divided into three rock types as indicated by the magnetic data (Plate 6). Similar northwest-trending rock types are interpreted under the extensive Cainozoic-covered plain to the west of the granite and gneiss outcrops around Mount Gooses. The magnetic trends are confirmed by strike ridges in the southwest corner of the area.

Several fold axes are interpreted from magnetic data. The consistent easterly dip of the strata prevents identification of the folds and allows various structural interpretations.

Radiometric region 3 (Plate 8) is interpreted as relating to a granite source. It corresponds to an area interpreted as older laterite.

4. STAGE THREE

All available published geological and geophysical data were examined at this stage, and useful information was used for reinterpretation of the Stage 2 results.

In the course of normal photo-interpretation or geophysical projects, the published data would normally be examined, possibly in conjunction with reconnaissance field investigations, early in Stage 2.

For the purpose of this remote sensing evaluation, the published data are regarded as a substitute for ground inspection.

The project has been primarily oriented to interpretation of the pre-Cainozoic geology in areas of extensive surficial mantling material. Because of this, the surficial materials have not been considered in detail. The importance of differentiation of older and younger lateritic areas etc. is recognized in relation to such investigations as palaeogeomorphic studies to assist in the interpretation of geology. For more detailed information on the surficial materials the reader is referred to the recent publication of Mulcahy, Bettenay & Hingston (1972).

Area 1

The only geological report relating to Project Area 1 is that by Talbot (1912), in which he shows the whole area to be granite. Since the project area lies just within the eastern side of Talbot's map it is unlikely that he traversed the area studied.

It is considered, therefore, that there is no relevant published information with which to compare or upgrade the Preliminary Geological Interpretation of Stage 2 (Plate 9), and no Stage 3 geological map has been produced for Area 1.

A geological interpretation of Area 1, based on a combination of photogeological and geophysical interpretation, is shown in Plate 13.

Area 2

In his investigations of the Leonora-Duketon district in 1917-1918, Clarke (1925) recorded geological observations over part of Area 2.

During the period 1937 to 1941, intermittent investigations by R.A. Hobson and K.R. Miles included mapping within the region selected for test Area 2. Results of the field work were published as a W.A. Geological Survey Bulletin (Hobson & Miles, 1950; Hobson, Miles & Matheson, 1952) and the geology is summarized in Plate 11.

Although there are often contradictory data in the above reports, they contain valuable information on ground geology, and relevant data were incorporated into a reinterpretation of the Stage 2 Preliminary Geological Interpretation (Plate 10) to produce the Stage 3 Geology (Plate 12).

It is interesting to note that in some instances the final map produced (Plate 12) tends to support the geology of Clarke (1925) rather than the more comprehensive work of Hobson & Miles (1950). This applies particularly to the region around Mount Gooses, where Clarke (1925) records more extensive granite and contemporaneous porphyry and porphyry dykes than are shown by Hobson & Miles (1950). Although Hobson & Miles do not differentiate the Mount Gooses region from the area to the east, the authors feel that the granite and gneiss with partly assimilated greenstones, as shown in Plate 10, is a valid differentiation.

Detailed airphoto examination of outcrops inspected and identified by Hobson & Miles (1950) has allowed subdivision into six units.

In many instances subdivision was achieved by extrapolation along strike from good exposures outside the project area. Extrapolation was carried out on the 1969 Commonwealth aerial photography at 1:86 000 scale (Appendix 2), and the total surrounds were examined for at least 15 km beyond the border of the project area.

The best example of this is illustrated by excellent exposures of granite, with assimilated greenstones, to the north of the anomalous radiometric region 2. The granite was mapped by Hobson & Miles (1950) and can be extrapolated into project Area 2, where it coincides with the radiometric region 2 (Plate 8). Within the project area, extensive superficial cover prevents airphoto identification or differentiation of the granite.

The Precambrian of Area 2 has been divided into seven units as shown in Plate 12, namely porphyry and aplite intrusives; basic lavas and agglomerates; jaspilite; schists and metasediments; gneissic granite; undivided Precambrian and granitized sediments with assimilated greenstones.

Porphyry, aplite. These were annotated on the photographs using data from Clarke (1925) and Hobson et al. (1952). Outcrops generally occur in the north-trending zone between Mount Ajax and Mount Jumbo, and they are interpreted as being more abundant than indicated by previous workers. Dykes appear to be more numerous in this region, and they have a similar photo appearance to the light-toned dykes. The similar appearance, combined with the position of outcrop, suggests an intrusive origin.

There is no indication of the porphyry or aplite on either magnetic or radiometric data; this suggests that the outcrops are of different age from the gneissic granite, which does produce magnetic and radiometric anomalies.

Jaspilite. Within the limits of available ground data, all the magnetic anomalies greater than 200 gammas correspond to the 'Jasper Bars', jaspilites, and related rocks of Hobson et al. (1952). Some of the known jaspilites also occur within regions where the magnetic anomalies are less than 200 gammas, but marked variations in the amplitudes of anomalies are a common feature of jaspilites. Hobson & Miles (1950) note that the jaspilites and related rocks can be divided into either ferruginous or siliceous types. Both types are subject to gradational compositional changes along strike. It is assumed that the strongly ferruginous jaspilites cause the high magnetic anomalies.

Re-examination of the aerial photographs in the light of the magnetic anomaly pattern indicates jaspilite ridges that have not been mapped previously. Compositional variations rule out any meaningful correlation between individual outcrops of jasper beds using magnetic data.

Basic lavas and agglomerates; schists and metasediments. The subdivision of these two groups as shown in Plate 12 is based almost totally on photo-interpretation after reference to Hobson et al. (1952). The reliability of the subdivision by airphoto interpretation is directly related to the amount of outcrop. The extent of interpreted Archaean outcrop is shown in Plate 14.

Granitized sediments; gneissic granite. Interpretation of granitized sediments in the region west of Mount Ajax has been discussed under Stage 2. The term granitized sediments has been applied, as granitic rocks with assimilated greenstones have been interpreted from magnetics. No such subdivision was recognized by Hobson & Miles (1950).

Unlike the granitized sediments, the interpreted zone of gneissic granite to the east of Mount Barnicoat gives rise to a radiometric anomaly, which suggests an intrusive origin. The magnetic data (and photo data beyond the test area) indicate sedimentary-type banding, or foliation. The shape of the gneissic granite outcrop - in places transgressing the regional strike - supports an intrusive origin.

Structure. No major faulting is recorded in published reports or indicated from the remote sensing results.

Hobson & Miles (1950) interpret two major folds, the Margaret Anticline and the Laverton Syncline (Plate 11).

The Stage 3 remote sensing geological interpretation (Plate 12) contains data which allow various structural interpretations. The cross-section (Plate 15) has been constructed on the assumption that the fold axis in the region of Mount Ajax is synclinal. There are no data to allow identification of the fold, and if it is anticlinal the folds as interpreted should be reversed accordingly.

5. STAGE FOUR

The final evaluation of the remote sensing techniques is a comparison of the results with unpublished ground information or field investigations, or both. This has not yet been undertaken.

The results of Stage 1, 2, and 3 have been compiled to release the findings to date. Officers of the W.A. Geological Survey are currently mapping the 1:250 000 Sheet areas which cover the project areas. It is proposed that Stage 4 results will be released as a separate Record when the data from the W.A. Geological Survey become available.

6. CONCLUSIONS

In the project areas the most reliable photogeological interpretation was achieved from the colour positive prints in conjunction with 1:86 000 panchromatic prints.

Dual-camera, separate-film techniques are not suitable for panchromatic multi-spectral photographic projects.

Because of increased evaluation time, the interpretation and comparison of large quantities of panchromatic prints obtained with a multi-lens camera is probably not justified.

In the environment studied, photogeological interpretation unsupported by ground data is of little value in differentiation of rock types in unmantled outcrop.

Airborne geophysical techniques allowed delineation of regions of similar physical properties, and interpretation of rock type and structure.

In both project areas the independent photogeological and geophysical interpretations gave results that were largely complementary.

A combined evaluation of both photogeological and geophysical data produced a more useful geologic interpretation than was obtained from either method independently.

In Area 1, which has extensive superficial deposits, the remote sensing techniques produced considerable geologic information.

In Area 2, the ground data, though limited, considerably upgraded the interpretations of the remote sensing results. As no field checking has been done, the final geological maps (Plates 9 and 12) are subject to confirmation.

Although ground checking has yet to be done, the results demonstrate that the remote sensing techniques applied can provide useful geologic information.

7. RECOMMENDATIONS

Panchromatic multi-spectral photographic projects should be undertaken with a multi-lens camera imaging onto separate areas of one film.

Ground checking should be undertaken in the project areas to test the validity of the final interpretations and thus to fully evaluate the techniques studied.

Before field mapping commences in areas where the rock types prossess a wide range of magnetic susceptibility contrasts, airborne geophysical surveys incorporating detailed magnetics and radiometric methods and, if necessary, photographic surveys should be undertaken, and the resultant data interpreted.

8. ACKNOWLEDGMENTS

We wish to thank Mr D. Carneggie, formerly attached to the Department of Agronomy, of the University of Western Australia, for the loan of photographic equipment, and Mr C. Totterdell of the CSIRO Division of Plant Industry for helpful discussions on photographic techniques.

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APPENDIX 1

DETAILS OF GEOPHYSICAL OPERATIONS

Aircraft

Aero Commander 500U (VH-BMR)

Airborne magnetometer

Type:	Proton precession MNS-1 of BMR design with towed 'bird' detector
Recorder:	Moseley 7100B
Sensitivities:	40 and 400 gammas/cm
Chart speed:	5 cm/min

Base-station magnetometer

Type:	Proton precession MNS-1 (prototype)
Recorder:	Esterline Angus
Sensitivity:	8.5 gammas/cm
Chart speed:	15 cm/h

Gamma-ray spectrometer

Detectors:	Two 15 cm x 10 cm NaI (Tl) crystals
Electronics:	Hamner modules
Stabilization:	Cesium-137
Energy windows:	Channel 1 - total count above 1.0 MeV
	Channel 2 - 1.3 to 1.6 MeV (potassium)
	Channel 3 - 1.6 to 1.9 MeV ('uranium')
	Channel 4 - 2.4 to 2.8 MeV ('thorium')
Recorders:	Two Speedomax Mk II, 3-channel
Sensitivities:	Channel 1 - 50 counts/s/cm
	Channel 2 - 20 counts/s/cm
	Channel 3 - 10 counts/s/cm
	Channel 4 - 10 counts/s/cm
Time constant:	2 s (all channels)

Radio-altimeter

Type:	Bonzer TRN-70
Recorder:	Output to one channel on each of the Speedomax Mk II recorders
Sensitivity:	600 m full scale (non-linear)

Tracking camera

Type:	Vinten 35-mm single-frame with 'fish-eye' lens

Surveying details

Line spacing and direction:	400 m east-west (Area 1) and ENE-WSW (Area 2); 1600 m north-south (Area 1) and NNW-SSE (Area 2).
Altitude:	80 m above ground level
Speed:	Approx. 200 km/h

Staff

Party Leader:	E.P. Shelley
Technical Officer:	H.J. Alexander
Technical Assistant:	J.W. Williams
Pilot (TAA):	First Officer B.N. Joel

APPENDIX 2

AERIAL PHOTOGRAPHY DATA

Available Air Photography (Panchromatic only)

AREA 1

W.A. State Lands Department photography

Flying height 4828 m (15,840 ft)
Lens focal length 152 mm (6 in)
Nominal photo scale 1:31 000

Negative No.	Run	Frame Nos.	Date flown
WA 564	19	5024-5027	27-9-59
WA 563 Z	20	5300-5303	26-9-59
WA 561	21	5086-5089	23-9-59
WA 561 Z	22	5024-5027	23-9-59

Commonwealth aerial photography

Flying height 7620 m (25,000 ft)
Lens focal length 88.45 mm (3½ in)
Nominal photo scale 1:86 000

Negative No.	Run	Frame Nos.	Date flown
CAF 4093	7	0230-0234	28-8-69
" "	8	0174-0178	"

AREA 2

W.A. State Lands Department photography

Flying height 4828 m (15,840 ft)
Lens focal length 152 mm (6 in)
Nominal photo scale 1:31 000

Negative No.	Run	Frame Nos.	Date flown
WA 579 Z	14	5277-5278	2-11-59
WA 579	15	5191-5198	11-3-59
WA 579 Z	16	5146-5156	2-11-59
WA 579	17	5081-5088	1-11-59
"	18	5026-5028	1-11-59

Commonwealth air photography

Flying height 7620 m (25,000 ft)
Lens focal length 88.45 m (3½ in)
Nominal photo scale 1:86 000

Negative No.	Run	Frame Nos.	Date flown
CAF 4099	5	0230-0240	21-9-69
"	6	0190-0200	21-9-69
"	7	0241-0231	3-9-69

BMR PROJECT PHOTOGRAPHY

Cameras: Two Vinten Type 492 (70-mm film format) with electronically synchronized shutter control.

Lens focal length: 76 mm

Flying altitude: 3050 m (10 000 ft) above sea level)
2600 m (8500 ft) above mean terrain level

Average photo scale: 1:34 000

Filters Used: Kodak Wratten gelatine film filters
Numbers 12, 25A, 89B as film mounted between optical glass plates.
Numbers 32, 58 as lacquered film slices held in front of the lens by an optical glass plate.

Shutter speed: 0.002 s

Film	Filter	Aperature	Test Area	Runs Flown	Film No.	Date Flown
Kodak Ektachrome	-	f 5.6	1	8	3	24-9-70
MS Aerographic 2448	-	f 8	2	6	7	30-9-70
Kodak Ektachrome	12	f 5.6	1	8	4	24-9-70
Infrared Aero 8443	12	f 8	2	6	8	30-9-70
(Colour)						
Kodak Infrared	89B	f 11	1	8	2	23-9-70
Aerographic 5424	89B	f 11	2	2	6	29-9-70
	89B	f 8	2	4	6	"
Ilford FP3						
Aerial (Panchromatic)	-	f 8	1	8	1	23-9-70
	-	f 8	2	6	5	24-9-70
	32	f 5.6	2	2	9	30-9-70
	12	f 8	2	2	10	"
	58	f 5.6	2	2	11	"
	25A	f 5.6	2	2	12	"

FLIGHT-LINE AND FILM DETAILS

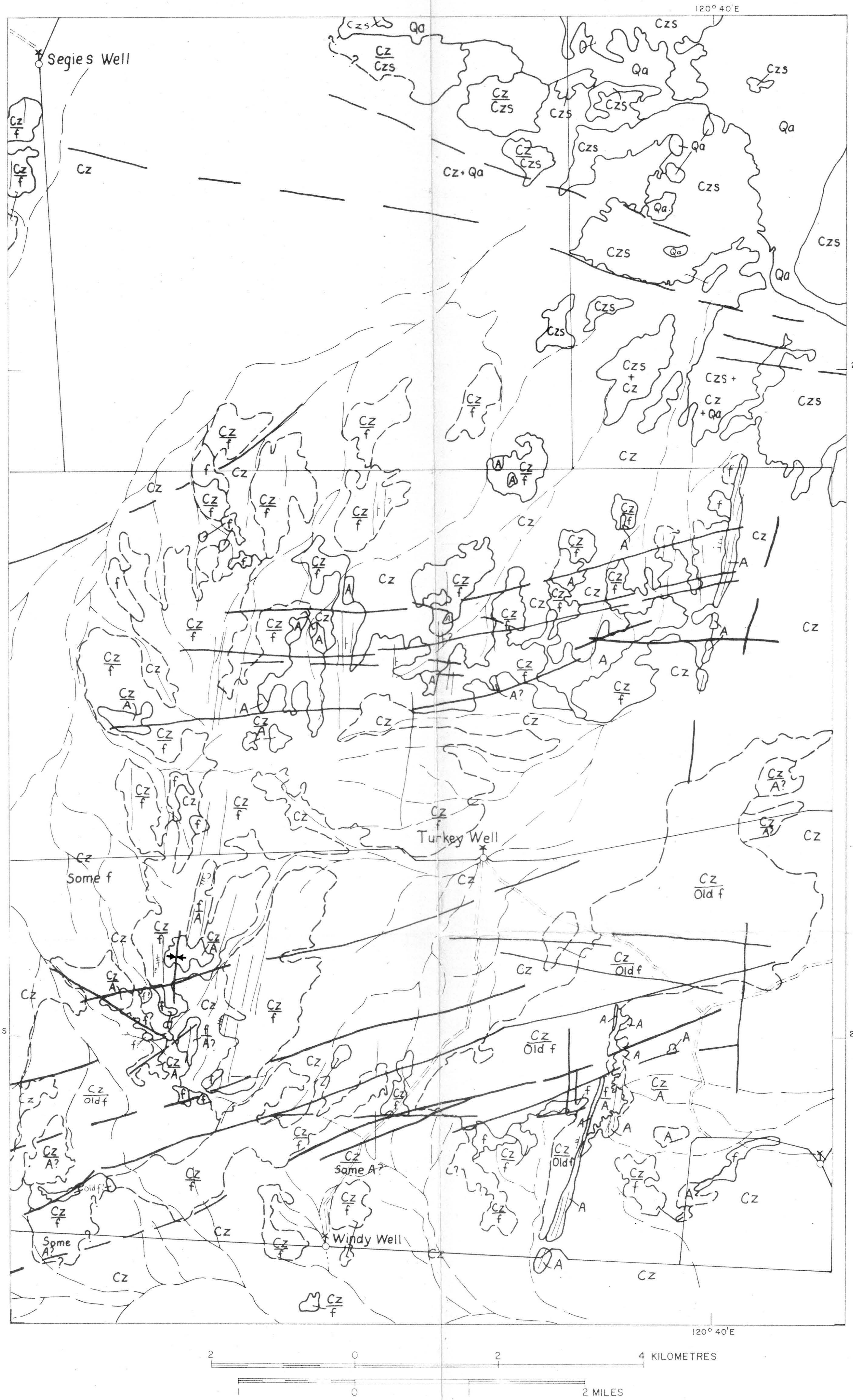
AREA 1

Flight Line	Frame No.	Flight Direction (from-to)	Film Nos.
A	234-263	S-N	1,2
B	232-205	N-S	"
C	178-203	S-N	"
D	147-176	N-S	"
E	104-131	N-S	"
F	074-102	S-N	"
G	046-073	N-S	"
H	007-041	S-N	"
A*	241-272	N-S	3,4
B*	209-239	S-N	"
C*	178-208	N-S	"
D*	147-177	S-N	"
E*	119-146	N-S	"
F*	087-118	S-N	"
G*	056-085	N-S	"
H*	023-054	S-N	"

AREA 2

Flight Line	Frame No.	Flight Direction (from-to)	Film Nos.
1	011-085	W-E	5,6
2	097-163	E-W	"
3	011-085	W-E	"
4	087-160	E-W	"
5	162-231	W-E	"
6	232-303	E-W	"
1*	012-085	W-E	7,8
2*	086-152	E-W	"
3*	153-223	W-E	"
4*	232-298	E-W	"
5*	300-363	W-E	"
6*	365-431	E-W	"
3*	010-073	W-E	9,10
4*	076-042	E-W	"
3*	155-218	W-E	11,12
4*	221-282	E-W	"

* flight-lines plotted in Plate 16



Fold axis (syncline)

Lineament

Trend line

Dip 0°–10°

Dip 10°–45°

Dip 45°–90°

Vertical

CAINOZOIC

Qa	Alluvium
Cz	Undifferentiated sand, soil, alluvium
Czs	Sand
f	Laterite
Old f	Old laterite

ARCHAEAN

A	

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

STAGE 2 – INITIAL PHOTOGEOLOGICAL INTERPRETATION AREA I

To Accompany Record No. 1972/131

H51/B1-115

PLATE 2

2 0 2 4 KILOMETRES

1 0 1 2 MILES

CAINOZOIC

Cz	*Undifferentiated soil, alluvium, etc*
Czt	*Travertine*
f'	*Laterite (young)*
f	*Laterite (old)*

ARCHAEAN

Ag	*? Granitic rock*
A	*Greenstone, paragneiss, jasper, etc.*

Boundary

Lineament

Trend

Dyke

Dip 10°-45°

Dip 45°-90°

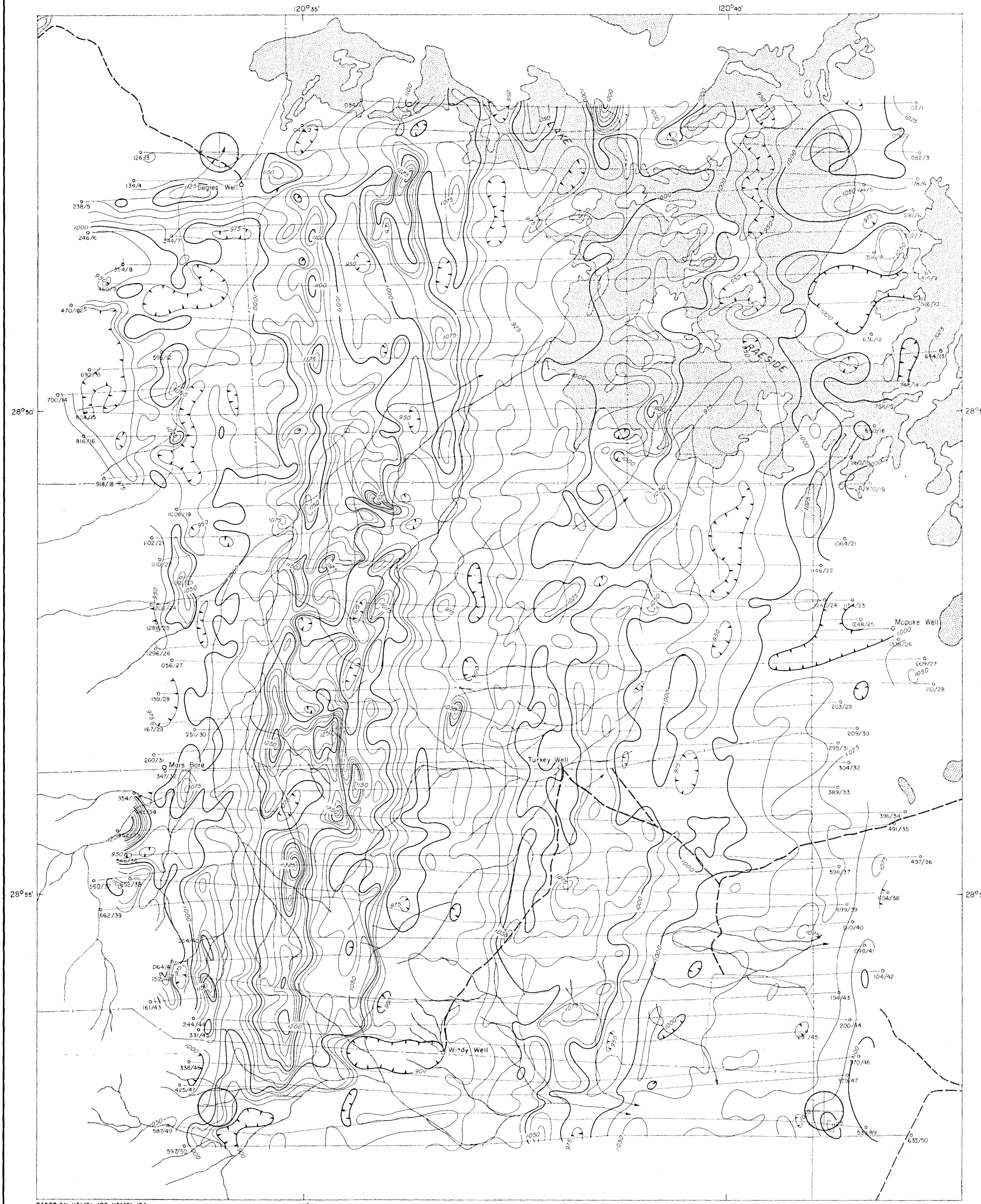
Vertical

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

STAGE 2 - INITIAL PHOTOGEOLOGICAL INTERPRETATION AREA 2

To Accompany Record No. 1972/131

H51/B1-116



BASED ON H51/B1-100, H51/B1-104

GEOPHYSICAL LEGEND

- Magnetic contours
- Magnetic "low"

EXPLANATORY NOTE

This survey was flown at a nominal altitude of 80 metres above ground level along lines spaced 400 metres apart.

The magnetic contours have been corrected for the regional gradient in the Earth's magnetic field.

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

TOTAL MAGNETIC INTENSITY

AREA I

KILOMETRES 2 0 2 4 KILOMETRES

MILES 1 0 1 2 MILES

CONTOUR INTERVAL 25 GAMMAS

TOPOGRAPHICAL LEGEND

- River or creek
- Road or track
- Telegraph line
- Mine
- Fence
- Hill feature
- Lake or claypan
- Corner registration mark for geology plates

Topography after 1:31,680 photo-scale compilation by Dept. of Lands W.A. (1959 photography)

To Accompany Record No 1972/131

H51/B1-109

To Accompany Record No 1972/131

PLATE 4

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

TOTAL MAGNETIC INTENSITY

AREA 2

2 0 2 4 KILOMETRES

1 0 1 2 MILES

CONTOUR INTERVAL 25 GAMMAS

TOPOGRAPHICAL LEGEND

River or creek
Road or track
Telegraph line
Mine
Fence
Hill feature
Lake or claypan
Corner registration mark for geology plates

Topography after 1:31,680 photo-scale compilation by Dept. of Lands WA. (1959 photography)

GEOPHYSICAL LEGEND

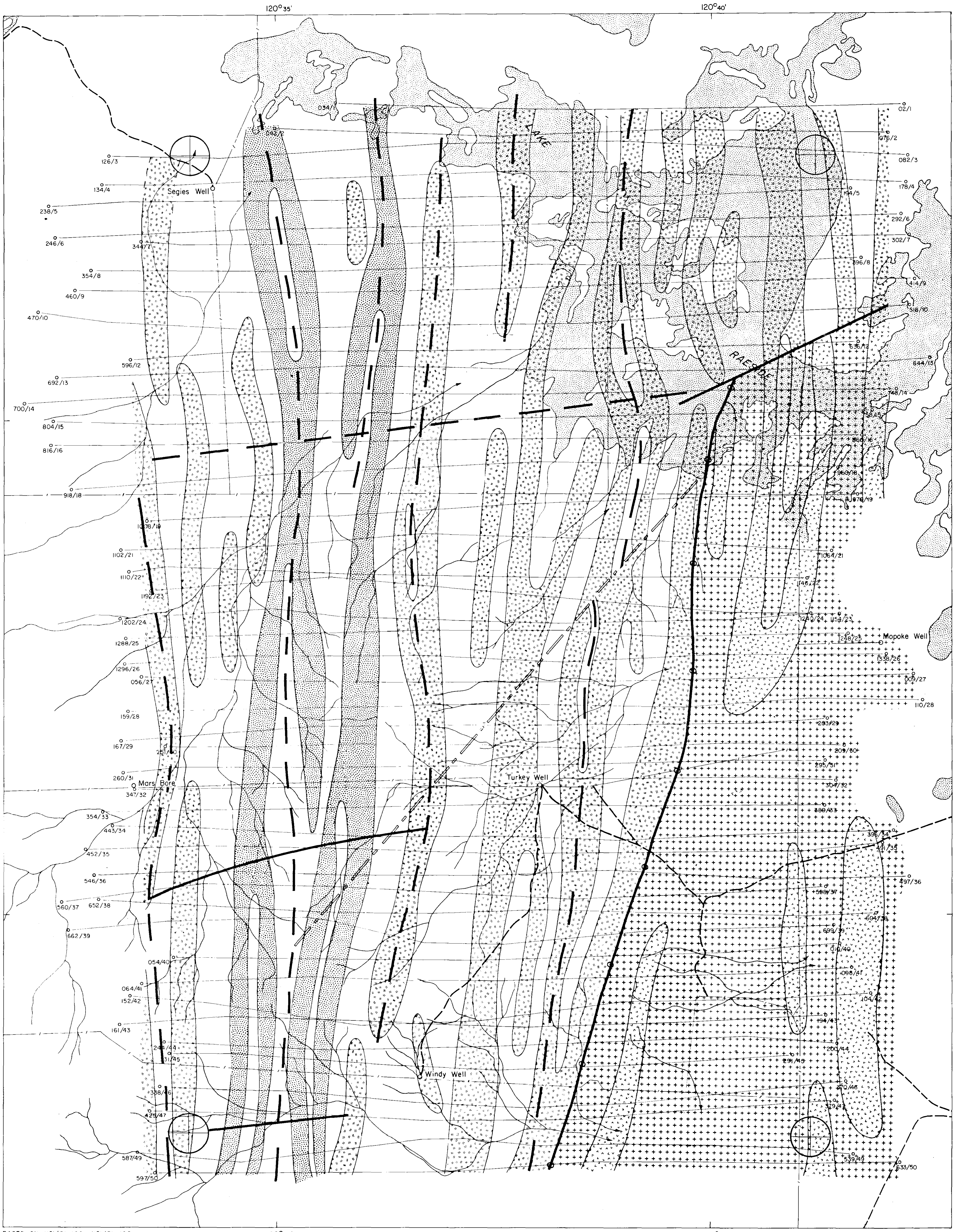
Magnetic contours
Magnetic "low"

EXPLANATORY NOTE

This survey was flown at a nominal altitude of 80 metres above ground level along lines spaced 400 metres apart.

The magnetic contours have been corrected for the regional gradient in the Earth's magnetic field.

H51/B1-110



GEOPHYSICAL LEGEND

- Banded iron formation, ultra-basic rocks, basalt, dolerite (greenstones)
- Basalt, dolerite (greenstones)
- Sedimentary rocks (whitestones)
- Granite, gneiss
- Partly assimilated greenstones
- Fold axis
- Fault
- Magnetic lineation
- Magor geological boundary
- Flight-line with fiducial point and line number
- Corner registration mark for geology plates

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

MAGNETIC INTERPRETATION

AREA I

KILOMETRES 2 0 2 4 KILOMETRES

MILES 1 0 1 2 MILES

TOPOGRAPHICAL LEGEND

- River or creek
- Road or track
- Telegraph line
- Mine
- Fence
- Hill feature
- Lake or claypan

Topography after 1:31,680 photo-scale compilation by Dept of Lands WA (1959 photography)

To Accompany Record No. 1972/131

H51/B1-113

PLATE 6

To Accompany Record No 1972/131

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

MAGNETIC INTERPRETATION

AREA 2

2 0 2 4 KILOMETRES

1 0 1 2 MILES

Approximate True North

GEOPHYSICAL LEGEND

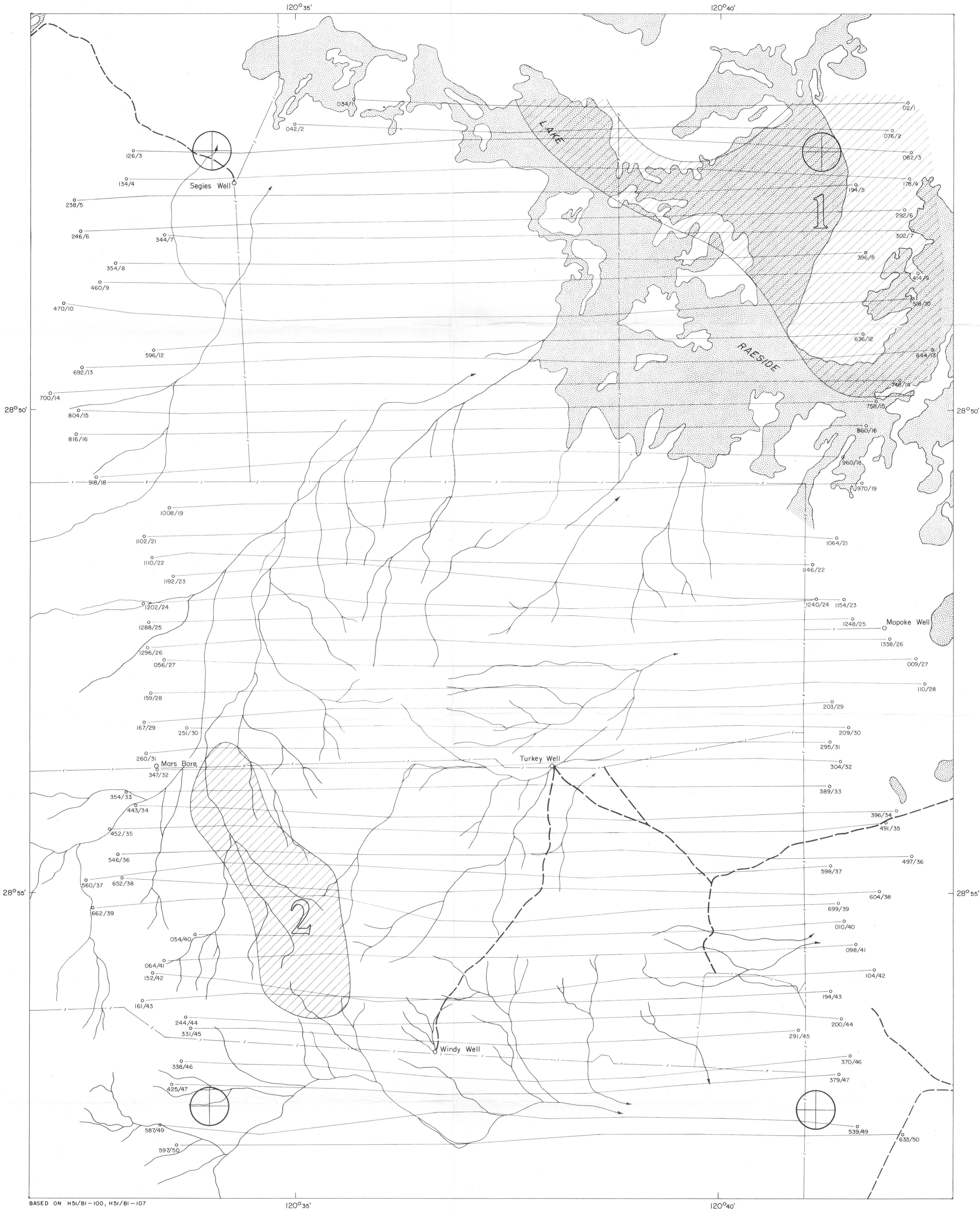
- Banded iron formation, ultra-basic rocks, basalt, dolerite (greenstones)
- Basalt, dolerite (greenstones)
- Sedimentary rocks (whitestones)
- Granite, gneiss
- Partly assimilated greenstones
- Fold axis
- Fault
- Magnetic lineation
- Major geological boundary
- 468/123 Flight-line with fiducial point and line number
- Corner registration mark for geology plates

TOPOGRAPHICAL LEGEND

- River or creek
- Road or track
- Telegraph line
- Mine
- Fence
- Hill feature
- Lake or claypan

Topography after 1:31,680 photo-scale compilation by Dept of Lands WA (1959 photography)

H51/B1-114



GEOPHYSICAL LEGEND

Region of radioactivity greater than "geological background"

2 Total count channel > 100 counts/s
Potassium " > 25 "
Uranium " > 20 "
Thorium " > 10 "

Region numbered for text reference

Corner registration mark for geology plates

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

RADIOMETRIC INTERPRETATION

AREA I

KILOMETRES 2 0 2 4 KILOMETRES

MILES 1 0 1 2 MILES

TOPOGRAPHICAL LEGEND

River or creek
Road or track
Telegraph line
Mine
Fence
Hill feature
Lake or claypan

Topography after 1:31,680 photo-scale compilation by Dept of Lands WA (1959 photography)

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

RADIOMETRIC INTERPRETATION

AREA 2

2 0 2 4 KILOMETRES

1 0 1 2 MILES

Approximate True North

GEOPHYSICAL LEGEND

Region of radioactivity greater *than "geological background"*

Total count channel	>100 counts/s
Potassium "	> 25 "
Uranium "	> 20 "
Thorium "	> 10 "

Region numbered for text reference

Corner registration mark for geology plates

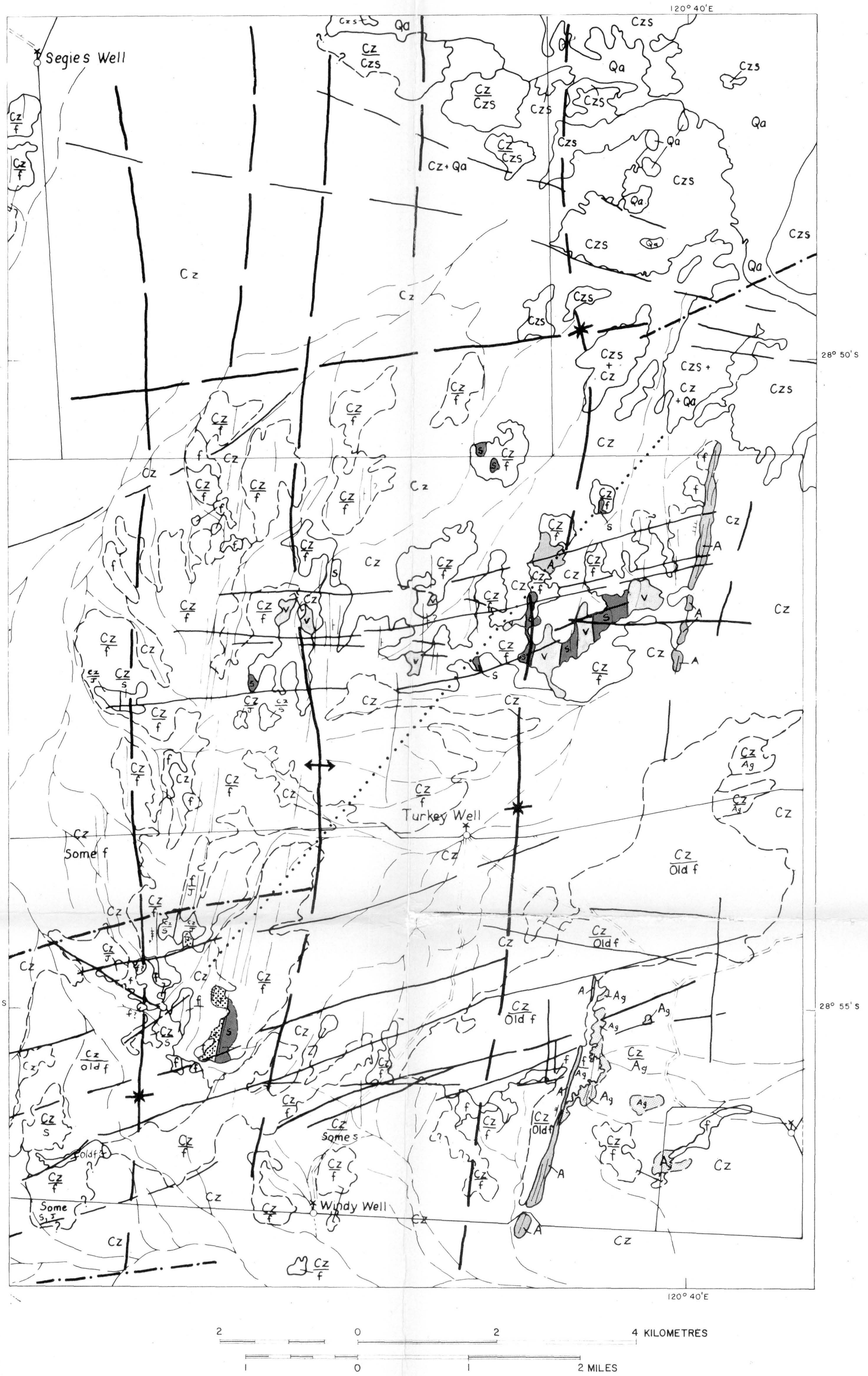
TOPOGRAPHICAL LEGEND

River or creek
Road or track
Telegraph line
Mine
Fence
Hill feature
Lake or claypan

Topography after 1:31,680 photo-scale compilation by Dept of Lands WA (1959 photography)

To Accompany Record No. 1972/131

H51/B1-112



CAINOZOIC	Qa	*Alluvium*
	Cz	*Undifferentiated sand, soil, alluvium*
	Czs	*Sand*
	f	*Laterite*
	Old f	*Old laterite*
ARCHAEAN		*Banded iron formation, ultra-basic rocks, basalt, dolerite (greenstones)*
	V	*Basalt, dolerite (greenstones)*
	S	*Sedimentary rocks (whitestones)*
	Ag	*Granite, gneiss with assimilated greenstones*
	A	*Quartzite ?*

Lineament — *airphoto*; *magnetic*

Trend line

Dip 0°–10°

Dip 10°–45°

Dip 45°–90°

Vertical

Fold axis

Fault

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

STAGE 2 – PRELIMINARY GEOLOGICAL INTERPRETATION AREA I

(combined Photogeological and Geophysical Interpretations)

To Accompany Record No. 1972/131

H51/B1-117

PLATE 10

2 0 2 4 KILOMETRES

0 2 MILES

CAINOZOIC	Cz	*Undifferentiated soil, alluvium, etc*
	Czt	*Travertine*
	f'	*Laterite (young)*
	f	*Laterite (old)*
ARCHAEAN		*Banded iron formation ultra-basic rocks, basalt, dolerite (greenstones)*
	V	*Basalt, dolerite (greenstones)*
	S	*Sedimentary rocks (whitestones)*
	Ag	*Granite, gneiss with assimilated greenstones*

Boundary
Lineament
Trend
Dyke
Dip 10°-45°
Dip 45°-90°
Vertical
Fold axis

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

STAGE 2 – PRELIMINARY GEOLOGICAL INTERPRETATION AREA 2

(combined Photogeological and Geophysical Interpretations)

To Accompany Record No. 1972/131

H51/B1-118

PLATE II

2 0 2 4 KILOMETRES

1 0 1 2 MILES

RECENT	Qa	*Alluvium*
PRECAMBRIAN MARGARET SYSTEM	G	*Metamorphosed basaltic and andesitic lavas, sediments, basic and ultrabasic rocks*
		"Jasper Bars," jaspilite, and related rocks
INTRUSIVES	Gr	*Granite*

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

AREA 2 — PUBLISHED GEOLOGY — After Hobson, Miles and Matheson, 1952 GSWA Bull. 103.

To Accompany Record No. 1972/131

H51/B1-119

2 0 2 4 KILOMETRES
1 0 1 2 MILES

CAINOZOIC

- Cz — Undifferentiated soil, alluvium, etc
- Czt — Travertine
- f' — Laterite (young)
- f — Laterite (old)

PRECAMBRIAN

- P — Porphyry, aplite - intrusives

MARGARET SYSTEM

- L — Basic lavas, agglomerate
- J — Jaspilite
- S — Schist, meta-sediments
- G — Gneissic granite
- A — Undivided

- Ag — Granitized sediments with assimilated greenstones

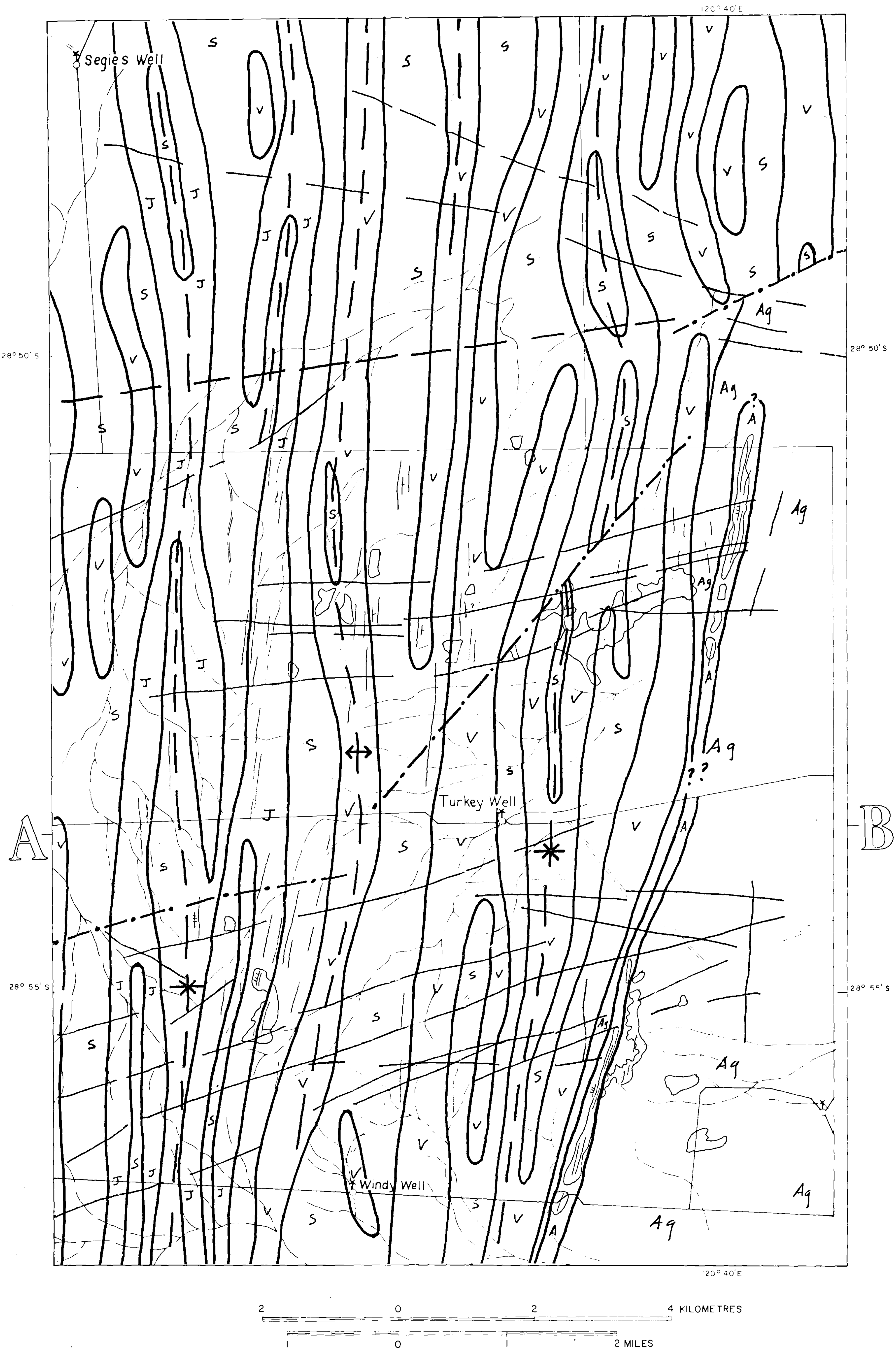
- Boundary
- Lineament
- Trend
- Dyke
- Dip 10°-45°
- Dip 45°-90°
- Vertical
- Fold axis

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

STAGE 3 - GEOLOGY AREA 2

To Accompany Record No. 1972/131

H51/B1-120



ARCHAEAN

J	Banded iron formation, ultra-basic rocks, basalt, dolerite (greenstones)
V	Basalt, dolerite (greenstones)
S	Sedimentary rocks (whitestones)
Ag	Granite, gneiss with assimilated greenstones
A	Quartzite ?

Rock boundary

Outcrop boundary

Lineament

Trend line

Dip 0° – 10°

Dip 10° – 45°

Dip 45° – 90°

Vertical

Fold axis

Fault

A-B Section shown on Plate 15

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

ARCHAEAN SOLID GEOLOGY INTERPRETATION AREA 1

PLATE 14

ARCHAEAN SOLID GEOLOGY INTERPRETATION AREA 2

2 0 2 4 KILOMETRES

1 0 1 2 MILES

PRECAMBRIAN

MARGARET SYSTEM

P	*Porphyry, aplite - intrusives*
L	*Basic lavas, agglomerate*
J	*Jaspilite*
S	*Schist, meta-sediments*
G	*Gneissic granite with assimilated greenstones*
A	*Undivided*
Ag	*Granitized sediments with assimilated greenstones*

Outcrop boundary

Rock boundary

Fault

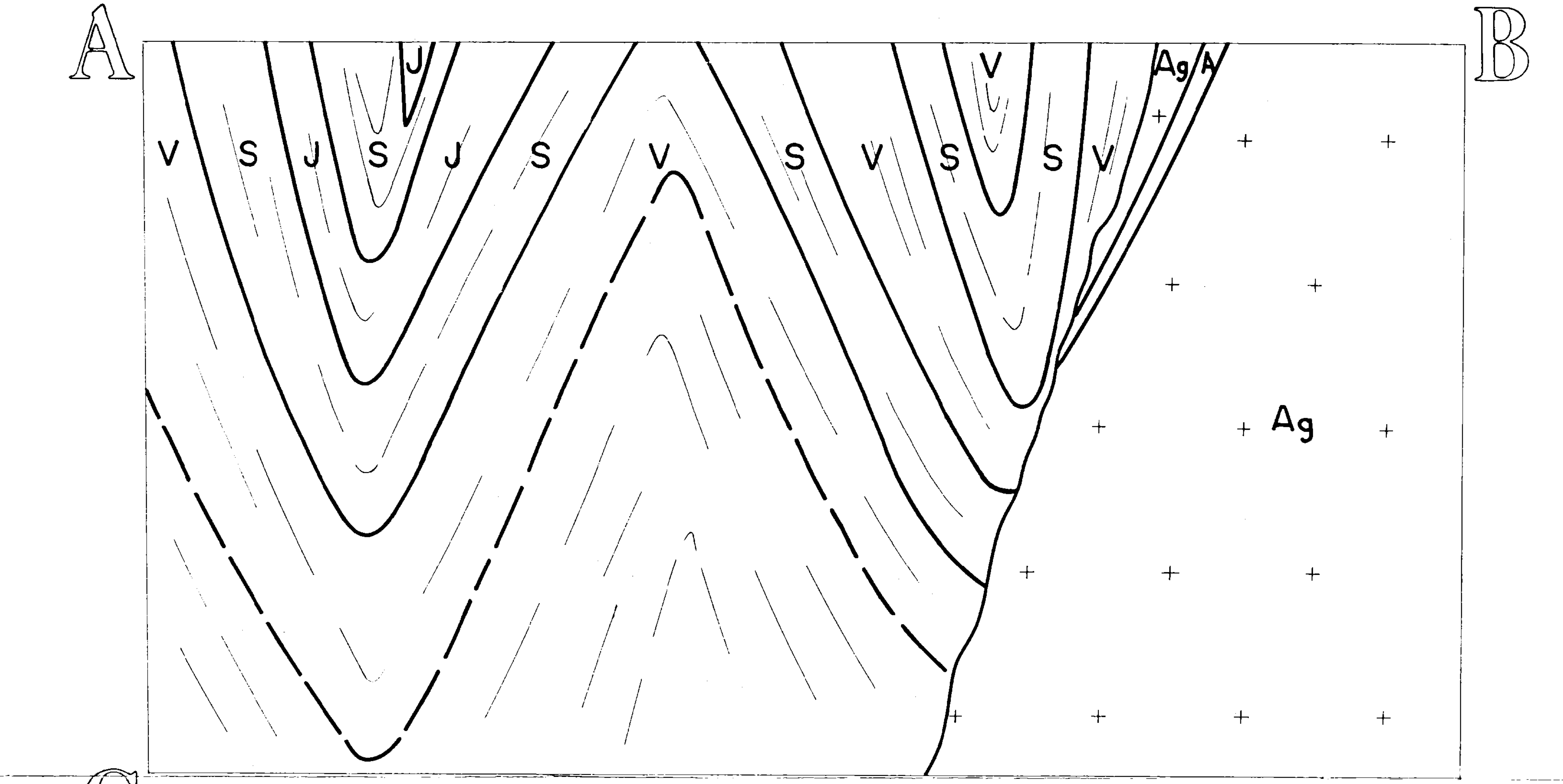
Fold axis

C-D *Section shown on Plate 15*

To Accompany Record No. 1972/131

H51/B1-122

A — B



CROSS-SECTION A-B
LEGEND

ARCHAEAN

J	*Banded iron formation, ultra-basic rocks, basalt, dolerite (greenstones)*
V	*Basalt, dolerite (greenstones)*
S	*Sedimentary rocks (whitestones)*
+ Ag	*Granite, gneiss with assimilated greenstones*
A	*Quartzite ?*

Rock boundary

Form line

CROSS-SECTION C-D
LEGEND

PRECAMBRIAN — MARGARET SYSTEM

L	*Basic lavas, agglomerate*
J	*Jaspilite*
S	*Schist, meta-sediments*
+ G	*Gneissic granite with assimilated greenstones*
A	*Undivided*
+ Ag	*Granitized sediments with assimilated greenstones*

Rock boundary

Form line

REMOTE SENSING SURVEY, WESTERN AUSTRALIA 1970

CROSS-SECTION INTERPRETATIONS

HORIZONTAL SCALE

KILOMETRES 2 0 2 4 KILOMETRES

MILES 1 0 1 2 MILES

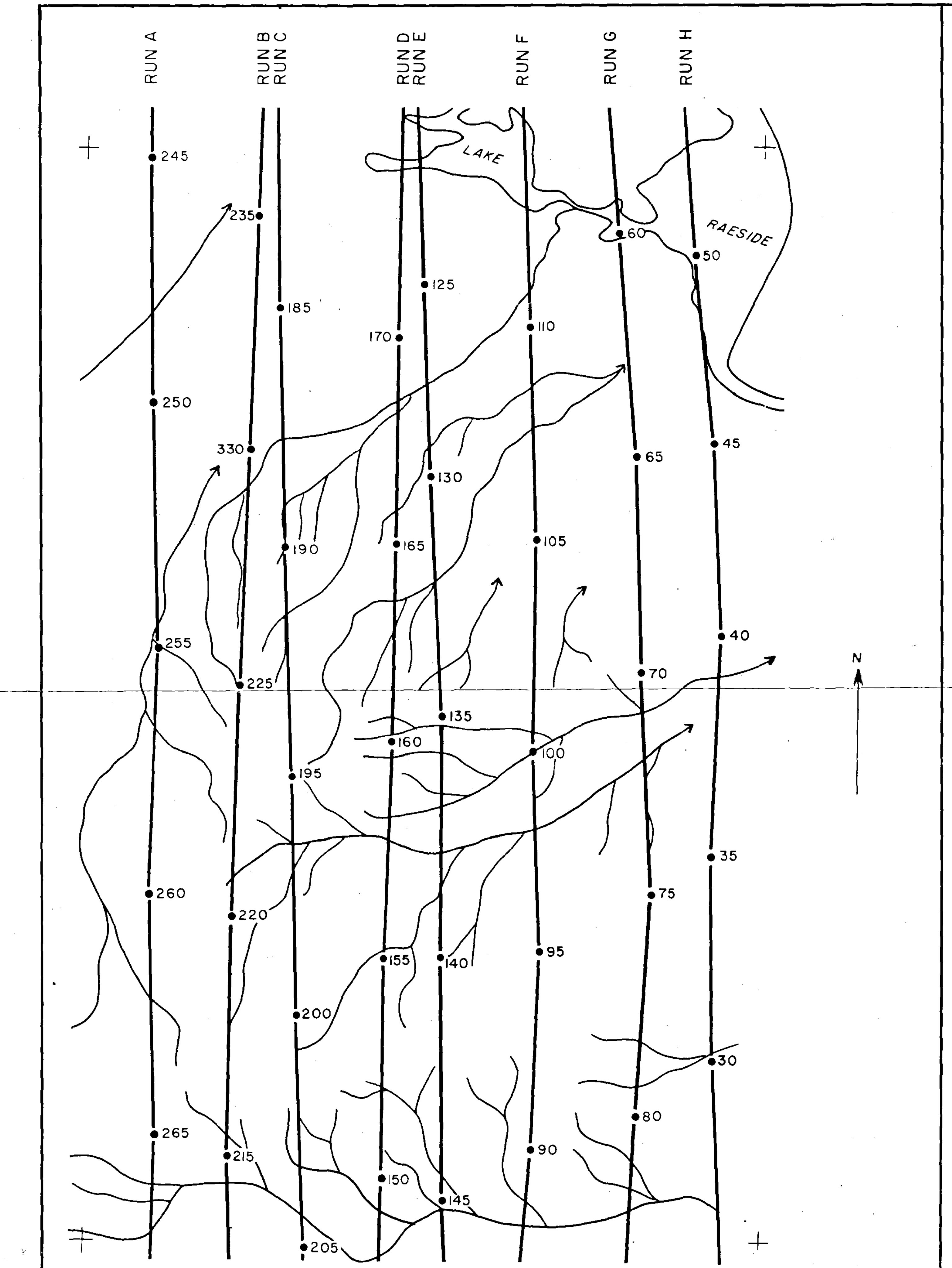
VERTICAL SCALE NOT APPLICABLE

Cross-section A-B is taken from Area 1 and is positioned on Plate 13 (H51/B1-121)
" " C-D " " " " 2 " " " " " 14 (H51/B1-122)

C — D

To Accompany Record No. 1972/131

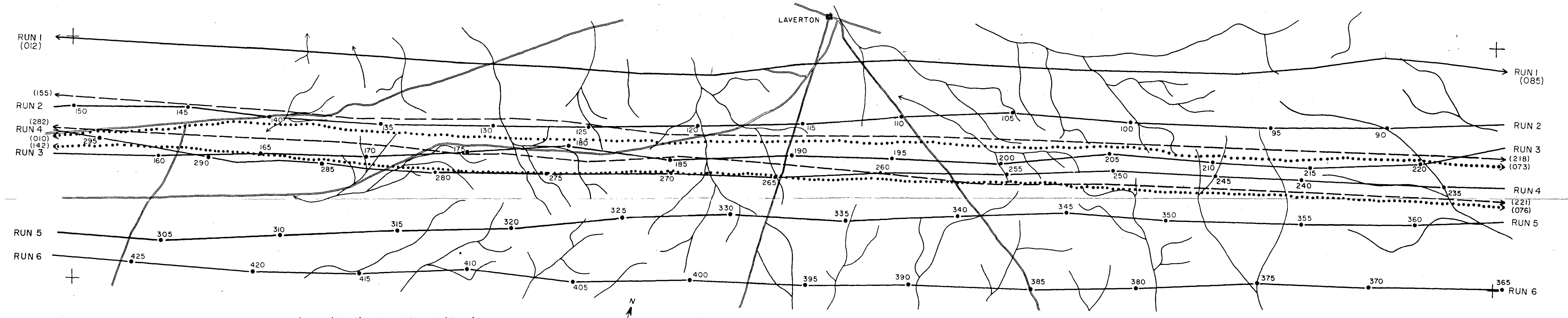
PLATE 16



SCALE 1:80,300

FLIGHT PLOT B M R AREA 1 (LEONORA, W.A.)

Colour (film 3) and colour IR (film 4)



Colour (film 7) colour infra red (film 8) Runs 1-6

Panchromatic films 11, 12

Panchromatic films 9, 10

SCALE 1:80,700

FLIGHT PLOT B M R AREA 2 (LAVERTON, W.A.)

To Accompany Record No. 1972/131

H 51/B1-124