MAP READING, INCLUDING ELEMENTARY AERIAL NAVIGATION

Object of Map Reading

This is to render possible the clear and accurate visualization of the ground, so that this knowledge can be used for whatever task comes to hand. To reach this standard the student must understand the following :-

* The information shown in the margin of the map.
* The names by which features are known, and technical terms used in mapping.
* Scales, protracting bearings.
* Map symbols.
* How to visualize relief from contours.
* The difference between truo, magnetic and grid north.
* Australian map grids.
* The use and reading of Crid (or Map) References).

It must be remembered that few, if any, maps can be perfectly accurate owing to the time lag between the original aerial photography and the first printing. Although the terrain has been mapped accurately from the photography constant alterations and additions to the man-made detail in well populated areas soon renders the best work out of date.

Understanding maps

(a) Marginal information. This varies with the scale of the map, and its purpose. It also varies slightly with the publishing authority. The information on the margins of the two scales of maps at present generally used in the field is as follows :-

(i) ICAO 1:1,000,000.
Name and number of the area.
Scale.
Elevation unit (ft), and elevation conversion scale (metres)
Projection.
Hypsometric (Elevation) Tint code.
Topographic base reliability diagram.
Scales, Nautical miles, Statute miles, Kilometres.
Edition number, compiled by, drawn by, and printed by,
Date of Aeronautical, Topographical, and Isogonic (Mag. Dec) Inf.

In addition, much information is printed on the back of the ICAO. This includes symbols for the type of aerodromes, air navigation lights and beacons, marine lights and code, also miscellaneous information such as, Isogonic lines, radio masts heights, prohibited or restricted areas, etc. These are printed in dark blue on the face of the map. Hydrographic symbols (pale blue on the map), relief contours or hatchuring (brown on map) and mapping symbols (black on map), are also shown.

(ii) The 1:250,000 map series will probably be the one most used for field work in Australia for some years. The following information will be found in the margin :-

Map name, number, series and edition.
Scales in stutute miles, nautical miles and kilometres.
Method elevations shown, and datum.
Projection and horizontal datum.
Details of TM grid, zone and spheroid.
Method of giving a map reference.
Magnetic declination information.
Map reliability diagram, and map sheet location diagram.
Map symbol legend.
Date of aerial photography and compilation.
Authority responsible for compilation and printer.

Two important factors to notice about the 1:250,000 map series; firstly that some map areas have been compiled by different authorities making for some slight differences in layout and style, and secondly, on these maps the Australian National Grid, in yards and using the Clarke 1858 Spheroid, is still in use. As the new 1:100,000 series is compiled, so also will be the new 1:250,000 series based on the metric Australian Map Grid and the Australain Geodetic Datum. The Universal Transverse Mercator Projection is used.

(iii) Marginal information on the 1:100,000 map series is similar to the 1:250,000 series, but enlarges on it along the following lines :-

Road classification shown.
True, Magnetic and Grid North shown in diagramatic form.
Information about contour intervals.
Conversion table, metres to feet, (to convert metric heights to ft).
More specific information about accuracy of horizontal control.

(b) Names by which features are known and technical mapping terms.

Basin A small area of level ground surrounded or nearly surrounded by hills. Or a district drained by a river and its tributaries.

Saddle A neck or ridge of land connecting two mountains or hills. It is lower than the points it connects and higher than the surrounding plains and valleys.

Crest The general line formed by joining the summits of the main ridge of a chain of mountains. Or the top of a mountain, or hill.

Dune A hill or ridge of sand formed by the wind.

Estuary The tidal mouth of a river.

Escarpment An extended line of cliffs or bluffs.

Foreshore That portion of the shore between high and low water at maximum spring tides.

Gorge A rugged and deep ravine.

Knoll A low detached hill.

Main Feature Those important features such as ridges, drainage systems, etc., which determine the shape of the terrain.

Pass Narrow passage through mountains or hills.

Plateau An elevated plain.

Re-entrant (or Gully) These occur where the hillside is curved inwards towards the main feature. They are always found between two spurs.

Spur A projection from the side of a hill or mountain, generally with a decreasing gradient.

Undulationg ground Ground which alternatively rises and falls gently.

Watercourse The line defining the lowest part of a valley, whether occupied by a stream or not.

Watershed A ridge of land separating drainage systems; the summit of land from which water divides and flows.

This list does not profess to be exhaustive. There are many common words such as hill, mountain, river plain, island cliff or ravine, etc., which it is not necessary to define.

Technical mapping terms :-

Bearing True bearing is the clockwise angle from the true north line to the point observed.
Magnetic bearing is the clockwise angle from the magnetic north line to the point observed.
Grid bearing is the clockwise angle from the grid north line to the point observed.

Contour This is an imaginary line on the surface of the ground at the same height above sea level throughout its length.

Contour Interval The difference in level between two adjacent contours.

Datum Level The level to which altitudes are referred.

Detail All minor natural or artificial features.

Fixed Point A point which has been joined to one or more of the main control points by traverse intersection resection, etc.

Form Line An approximate contour; a sketch contour.

Grid A system of East-West, and North-South parallel lines which represent progressive distances east and north of a fixed point of origin.

Grid North The Central Meridian of a Map Zone points both true north and grid north. Within that Map Zone any line drawn parallel to the Central Meridian points grid north. The greater the distance east or west of the Central Meridian, the larger the convervence from the true bearing. This is known as Grid Convergence.

Hachuring A Method of representing hill features by shading in short disconnected lines drawn directly down the slopes in the direction of the flow of water from the slopes.

Horizontal Datum The datum to which the horizontal control is related.

Latitude The Latitude of a place is expressed in degrees, minutes and seconds, east or west from the Meridian of Greenwich, as the case may be.

Magnetic declination The amount Magnetic North declines from True North, at any place. It is called East or West declination according to whether magnetic north is East or West of true north from that place.

Orienting a map When a map, sketch, air photo or plan is placed so that its true north line points true north, the map is said to be "oriented".

Plotting The process of recording on a map or plan, the field observations and measurements.

Resection A method of fixing the position of the observer by drawing lines to or observing bearings to at least two previously fixed points.

True North This is the direction of the North Pole from the observer.

Vertical Interval This is the vertical distance between two contours.

(c) Scales

The word "scale" means the proportion which the length between two points on a map bears to the horizontal distance between the same two points on the ground; thus if the distance between two houses on the map is one inch and the horizontal distance on the ground is one mile, the scale of the map is one inch to one mile. This can also be expressed as a Representative Fraction. This expresses the denominator of the fraction in the same unit as the numerator; thus the R.F. for one inch to one mile is expressed 1:63,360, there being 63,360 inches per mile, As the metric system comes more into use, more scales will be expressed as a Representative Fraction.

(d) Protracting bearings from a map

Where approximate bearings are required from a map, i.e. the 1/250,000 series, the grid lines, rather than the faint Latitude and Longitude graticules, are the most convenient, from which to protract the bearings. This does introduce a small error, if the map sheet happens to be close to the Map Zone boundary. However, taking into account the general accuracy of the compass, it would only in rare cases be worth while to rule true meridians from the Longitude graticules, from which to protract bearings.

To obtain the magnetic bearing of a line, from the map, the true bearing is protracted, then the magnetic declination added or subtracted from that true bearing, to give the magnetic bearings.

When declination is East :- Subtract from true bearing.
When declination is West :- Add to true bearing.

Example :-	True bearing	265°
	Declination East	- 5°
	Magnetic Bearing	260°

To obtain the true bearing from the magnetic bearing, the rule is reversed:-

When declination is East :- Add to magnetic bearing.
When declination is West :- Subtract from magnetic bearing.

Probably the best way of obtaining magnetic bearing from a map is to set the protractor so that it is oriented with 0° along the line to Magetic North. Proceed as follows :-

Set centre mark of the protractor over the point from which bearings are to be read. Orient to true north by keeping parallel to the grid lines.

Then mark with pencil the angle of declination as shown on the map margin, i.e. declination 5° East, mark 5° to the east of North.

Turn north point of protractor to co-incide with the 5° mark.

Magnetic bearings can now be read directly from the map.

(e) Map Symbols (Conventional Signs)

For ease of recognition, these are suggestive of the object represented. Thus the sign for a windmill could scarcely be taken for anything else as also a cross for a church and an aeroplane for an airstrip. The scale of the map governs the space available, therefore a set of map symbols is designed for each map scale. However, little trouble is experienced in understanding the variations encountered.

(f) How to visualize relief from contours

Relief is mostly shown on the 1:250,000 maps by hill-shading owing to the lack of vertical control in most areas. However maps of the more developed areas are contoured at 250 ft intervals with layer tinting as an adjunct.

Form lines are approximate contours and are used when insufficient vertical control is available for contouring. They show the elevation in the same manner but are not reliable for exact information.

With the increased vertical control becoming available, the new 1:100,000 maps will be contoured in metres. Some have already been published, the contour interval being 40 metres with 20 metre auxillary contours in selected areas.

The contour lines have their height printed at various places along the actual line and these contour lines, with the actual drainage pattern give the map reader the picture of relief, As can be imagined, un-numbered contours of a knoll without any drainage pattern could also be interpreted as a depression. It should also be noted that the closer the contour interval, the better the picture of relief.

Figure 1 below, shows a contour plan of a knoll and section through the same. As previously mentioned, unless some other information such as heights against each contour, drainage pattern, spot heights, etc., is provided, this plan could just as easily be that of a depression. Turn the page upside down and see.

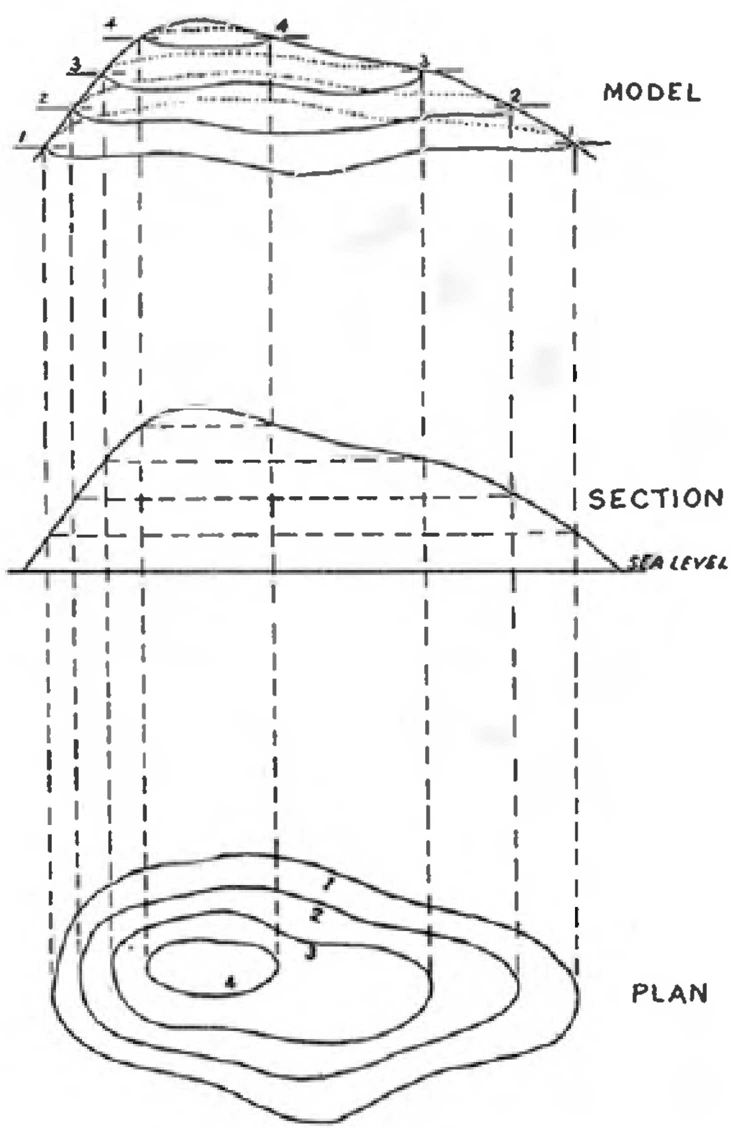


Figure 1

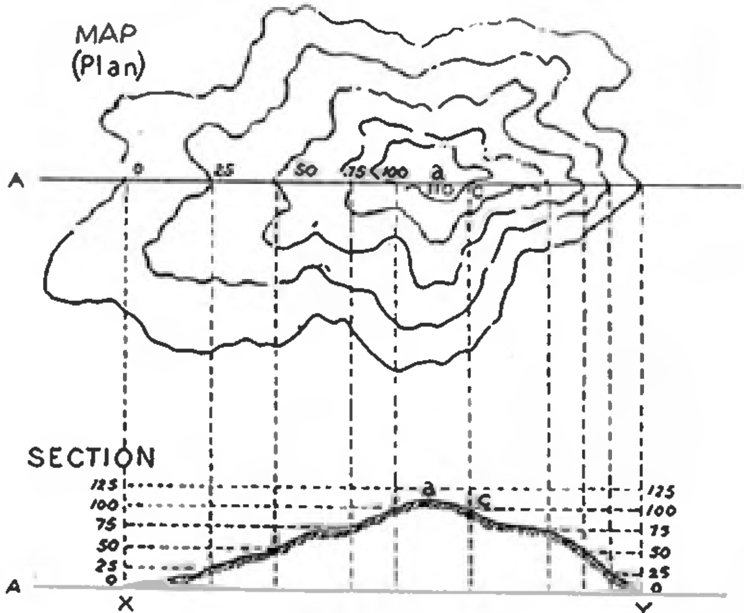


Figure 2

The contours of a definite knoll with a section through the same

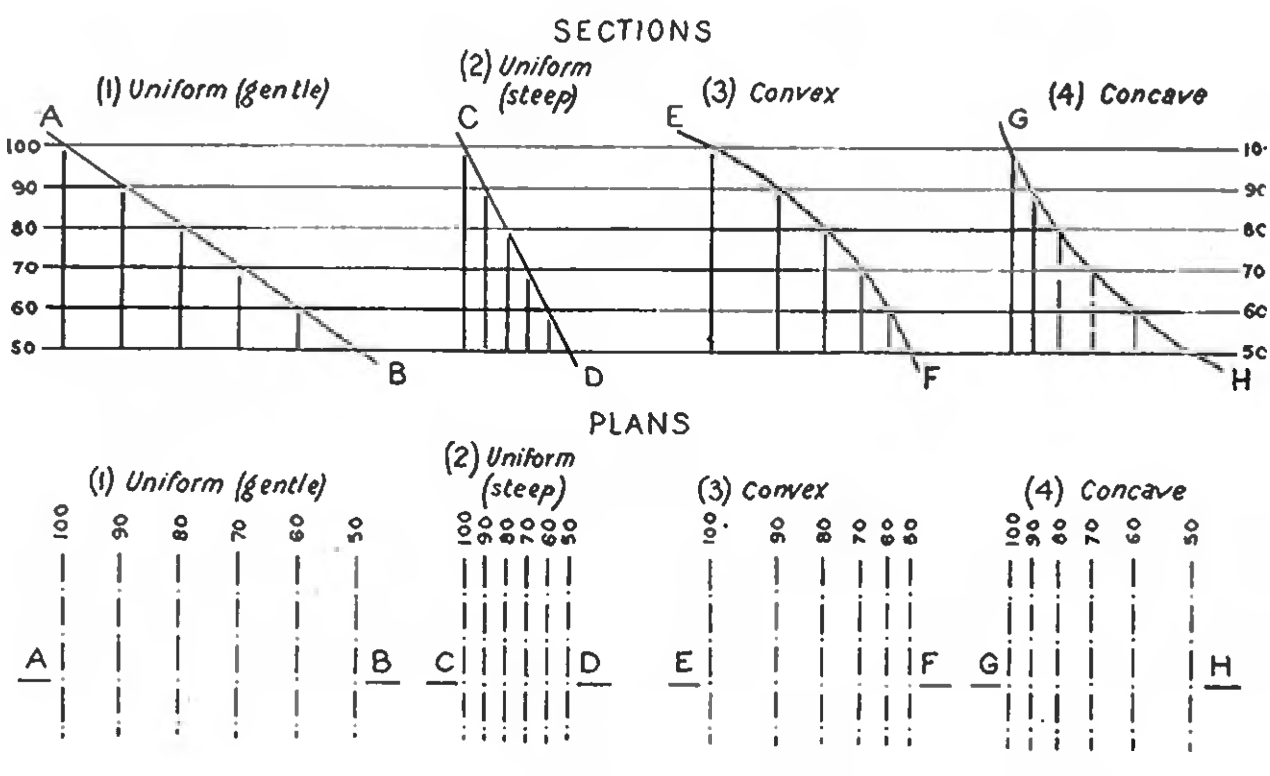


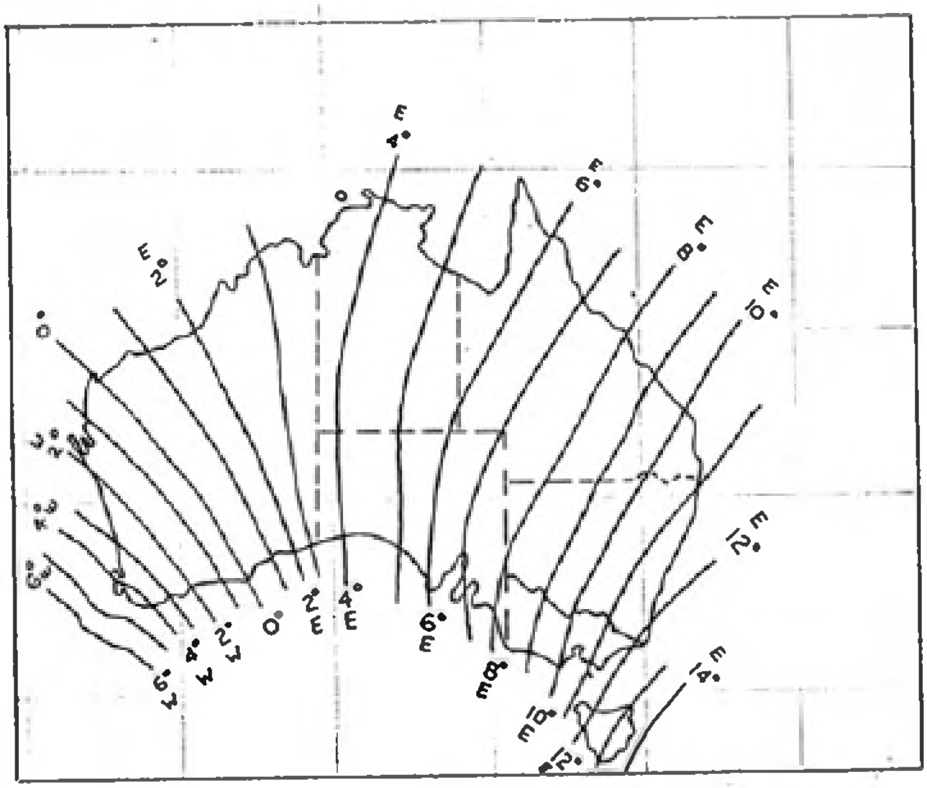
Figure 3

Sections drawn from contours to show slopes. The drawing of such sections taken from various maps, is good practise for the visualising of terrain from contours.

(g) <u>The difference between true, magnetic and grid north</u>

True north means the direction of the north pole from the observer, and the direction of true north from the observers position is called the True Meridian. As the earth is spherical in shape, it follows that the meridian of any point, East or West of the observers position will meet the true meridian of the observers position at the north pole.

Magnetic north is the direction of the magnetic pole from the observers position. The difference between the magnetic and true meridians is known as the Magnetic Declination of that position. Magnetic Declination varies from place to place throughout the world. Figure 4 shows the general pattern of magnetic declination over the Australian continent. Lines joining places of equal magnetic declination are known as Isogonic Lines. Owing to the slight annual movement of the magnetic pole the magnetic declination of a place varies slightly from year to year.



Isogonic Chart of Australia
Figure 4

Grid north Map grids will be explained in the next section. For a definition of grid north it is sufficient to say that grids are rectangular and only one grid line coincides with a true meridian therefore it is only along this meridian (called the Central Meridian) that the grid points to true north. All other vertical grid lines are drawn parallel to this Central Meridian and do not point to true north, but in each case point to an imaginary point called "Grid North". The angle between True and Grid north is called Grid Convergence and increases as the distance from the Central Meridian increases.

(h) <u>Australian Map Grids</u> In the early 1930's the Australian National Grid on the Transverse Mercator Projection, and in yards, was adopted for Australian maps and maps produced until the completion of the provisional and 1st Edition of the 1:250,000 maps about 1966 use this grid. Any revising to these 1:250,000 map will be only overprints in magenta to show changes of road and track patterns. built up areas, development , etc. This grid is based on Clarkes 1858 Figure of the Earth, and the Astonomical Co-ordinates of the Sydney Observatory were used as the origin. Eight zones, each 5° wide plus ½° common overlap were laid out to cover from Longitude 111°E to 154°E.

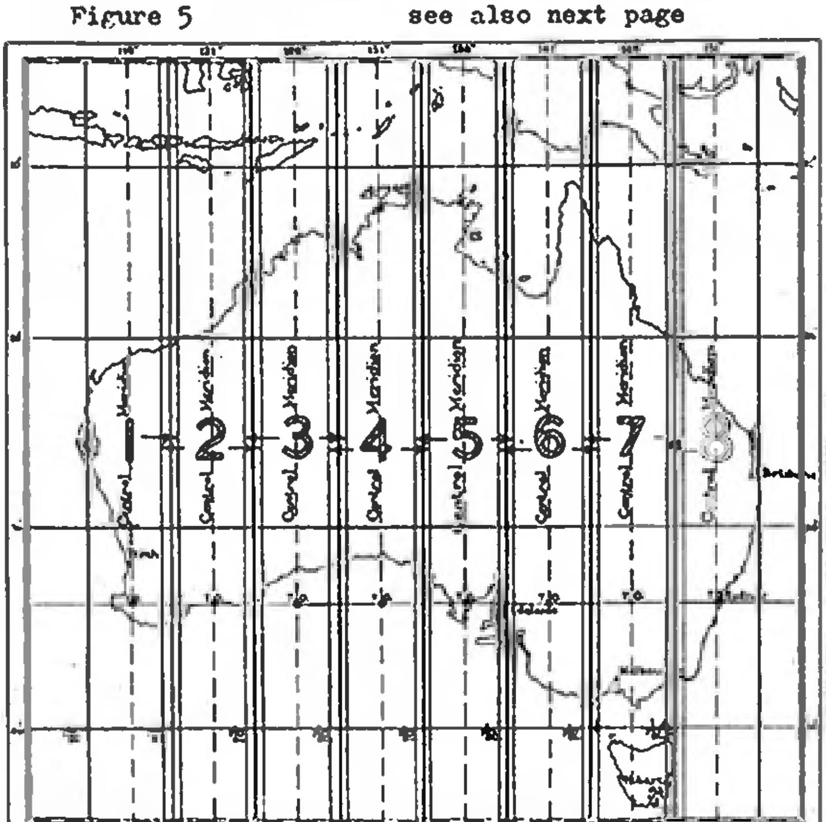
The True Origin of the co-ordinates of each zone in the grid isthe junction of Latitude 34°S and the Central Meridian of the zone. The False Origin for each zone, with zero co-ordinates is 400,000 <u>yards west</u> and 800,000 <u>yards south</u> of True Origin. This is to ensure that co-ordinates for all points within the zone will be positive.

In 1965, the Australian National Mapping Council adopted a new grid, the <u>Australian Map Grid</u>. It is a metric grid based on the Universal Transverse Mercator Projection and the Australian Geodetic Datum. Twelve zones 6° wide plus ½° common overlay are used to cover the Australian continent and Territories under its control.

True Origins re the junction of the Central Meridian of each zone with the Equator. False Origins are 500,000 <u>metres west</u> and 10,000,000 <u>metres</u> south of the True Origin.

Figure 5 shows the layout of the map zones under both the Australian National Grid and the Australian Map Grid.

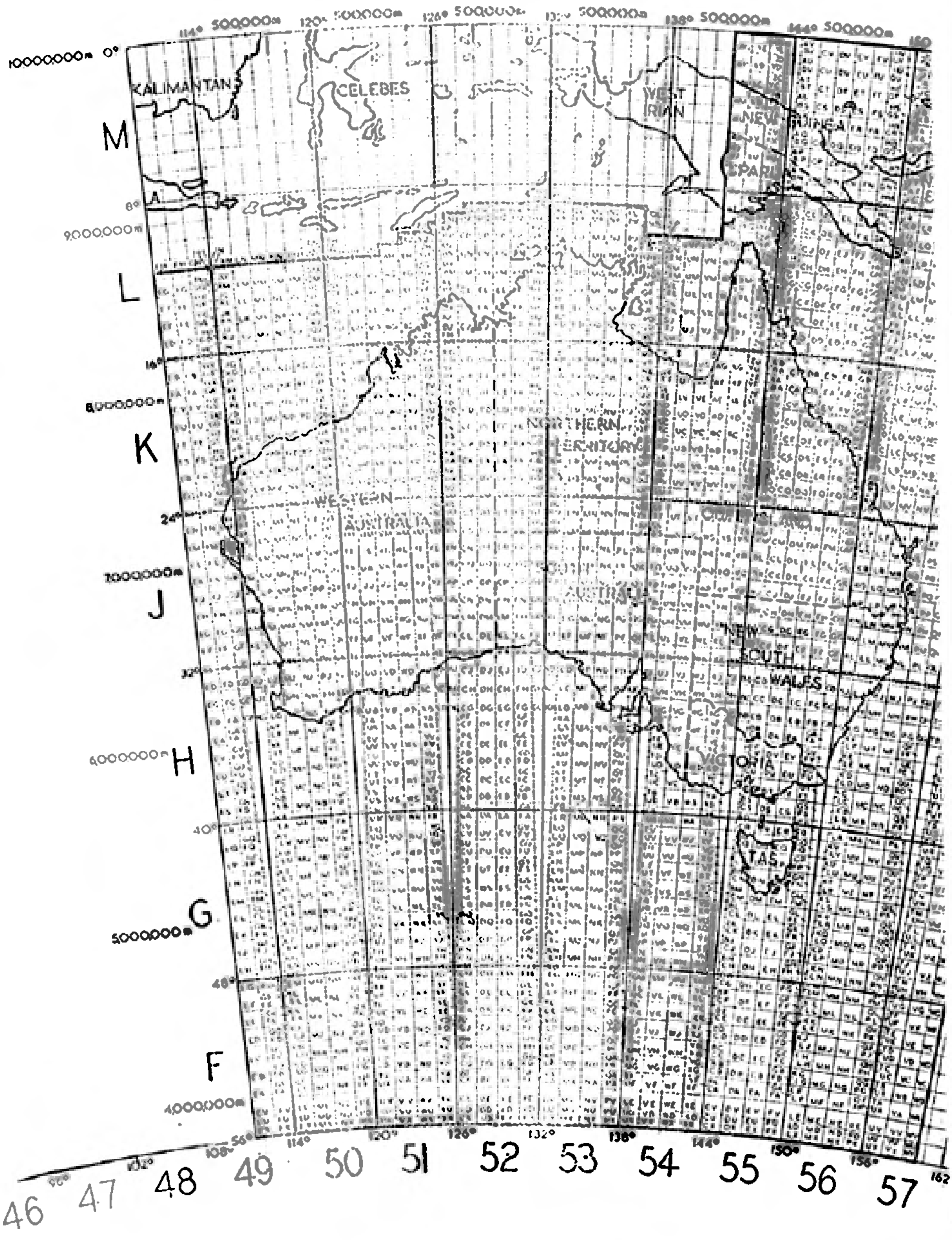
TRANSVERSE MERCATOR ZONES
Australian National Grid
Figure 5 see also next page



T.O. True Origin
F.O. False Origin 400 000 yds W., 800 000 yds S. of True Origin

Zones overlap ½° on each side

100.000 METRE SQUARE IDENTIFICATION OF THE AUSTRALIAN MAP GRID AREA



(i) The use and reading of Grid (or Map) References

(i) The 1:250,000 Australian National Grid (yards) It will be some years before this series will be republished on the Australian Map Grid (metric), and as these maps are the basic map for current field work any grid references used will still be in yards. However, this is no problem as all maps incorporate a panel in the margin giving an explanation and an example. The black numbered grid lines indicate 10,000 yard intervals, and the Grid Reference of a point is given to the nearest tenth of this interval i.e. 1,000 yards. Each grid line is numbered with two figures, the 100,000 and the 10,000. Thus the three figures for the Easting reference come from the two printed figures on the nearest line west of the station with the third figure representing the number of tenths the point is estimated to be east of that line.

It follows that the three figures for the Northing reference come from the two printed figures on the first grid line immediately south of the point, with the third figure representing the number of tenths the point is estimated to be north of this line.

(ii) The 1:100,000 Australian Map Grid (metric). As these maps will gradually become available an explanation of the giving of Grid References on these maps, is warranted. The black numbered grid lines indicate 1,000 metre intervals. By estimating the tenths of these intervals in the same manner as in (i) above, a Grid Reference to the nearest 100 metres is obtained.

From the margin and the Grid information panel ascertain within which 100,000 metre square the point lies, and prefix the six figure reference with the two letters nominating that 100,000 metre square.

Hints on Map Reading

Once a good knowledge of the amount and variety of information obtainable from the map has been assimulated, map reading itself is mainly a matter of having plenty of practise at following maps under field conditions. The following hints have been found useful :-

(a) Always check the date of the air photography, map compilation and latest amendments. These will give an idea of the reliance to be placed on that particular map.

(b) Always have a prismatic compass, protractor, and scale handy. If no scale is available make one along the edge of a piece of blank paper.

(c) Always keep the map orientated.

(d) Always use a soft lead pencil (not a ball-point) to draw in bearings or make notes of directions and milaages. It is a great help to be able to quickly plot one's position, particularly when on reconnaissance. When this is done in pencil the map can be cleaned up later and the required data only, plotted permanently in ink. Also always have a notebook handy for more elaborate notes.

(e) When "feeling the way" in poorly mapped country or along tracks not shown on the map, always keep a speedo and magnetic bearing log. At the end of the day correct bearings to true and plot the days travel as accurately as possible on the map. The information gained is often necessary to help prove lines, plan the next days moves, or to update the published map.

ELEMENTARY AERIAL NAVIGATION

(a) Standard required in the field

The main requirement is to navigate a light plane on reconnaissance or Aerodist flights; or a helicopter to establish or visit Mapping Control Points.

Therefore ability to follow terrain mainly from the 1:250,000 map and air photo's is needed rather than any knowledge of radio beacons, application of "drift" to courses, flight plans, etc, which can safely be left to the pilot.

(b) At times it may be necessary to use the ICAO maps, but where possible the 1:250,000 series should be used. A protractor and scale (or set of dividers), are necessary.

The pilot will estimate drift, wind speed, etc. He will apply the drift so as to keep the correct course, altering it when necessary during flight, and will estimate his speed over the ground, in knots. From this point on, ground speed should be converted to flying time in minutes and this should be the basis of all Aerial Navigation. Usually the pilot will be a good navigator, however the passenger will need to follow his own maps so as to perform his various technical tasks.

(c) Prior to the commencement of the flight, plot the course to be followed on the map and mark off the points as they will be reached, in time intervals.

Once the flight commences, mark the time each point is reached with a soft pencil thus enabling a close estimate of the time of arrival at the next point of detail.

Concentration is the main keynote; if in doubt of the aircraft's position never worry about detail already passed, watch the terrain ahead and concentrate on locating some point which will positively identify your position. If on a low level flight and in doubt, immediately take the aircraft higher; it is amazing how much easier locating the position becomes at 3,000 feet above ground level.

(d) If the final approach to a point is to be made on air photo's mark the boundary of the area covered by the photo's on to the map and once the aircraft reaches that boundary, follow the photographs exclusively.

(e) The 1:250,000 maps give a fair amount of natural detail even in many un-promising areas. Probably the drainage pattern gives the best navigation aid. Even in endless sandridge country a clear pattern is there to be followed by a keen-eyed navigator who can really concentrate.

(f) Most difficulty will be experienced in flat, featureless areas with no drainage pattern, or man made detail such as earth tanks, fences, tracks, etc.

Often a long flight across such terrain is necessary to site, or visit, a mapping control point. In this case initial preparation should ensure wide aerial photo coverage of the area. The aircraft's course should be plotted to the most easily identified point on these photo's, with a short separate course to the mapping control point. Once the identifiable point is located there is no doubt of one's position thus giving a better chance of locating the control point at the first attempt.