

MAPPING DATA AND THE NATIONAL MAPPING PROGRAMME

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In response to increasing interest in aerial photography and related products and in map compilation material available prior to the map being published, this paper aims to provide information on basic mapping data, aerial photos and map control, with a general description of their uses in the national topographic map series programme. Examples are presented to give some idea to potential users what they can get for their money.

Aerial Photography

These days the value of aerial photographs which provide information about a portion of the earth's surface at a particular time is so well known that discussion is largely unnecessary. However, it may be of interest to note one of the advantages stressed by an early enthusiast, about 40 years ago: '...being able to see both sides of the mountain at once and thus avoid that tedious climb and descent so necessary in ground survey'. No doubt this attracted many customers and still does !

Apart from basic data for standard mapping, aerial photographs are widely used in minerals exploration, planning, land use, environment studies and whenever a 'birds eye view' is helpful. Demand continues to grow; for example, some quantities of the more popular photographic products supplied during the past 4 years are :-

<u>Year</u>	<u>Film Negs.</u> <u>Issued</u>	<u>Contact</u> <u>Prints</u>	<u>Colour</u> <u>Prints</u>	<u>Diapositives</u>	<u>Enlargements</u>
1971	8,002	187,845	1,052	18,869	2,105
1972	8,940	264,904	2,499	17,710	2,841
1973	8,789	328,937	7,815	11,632	4,197
1974	6,436	222,530	12,894	9,428	4,447
TOTALS	32,187	1,004,216	25,260	57,639	13,590

The drop in production of some items over the past year is due mainly to bad weather for aerial photography. This printing has involved the handling of some 32,000 rolls of film negatives from the storage vaults and return. Many old films on nitrate base are stored at Commonwealth Archives, Brighton, and these are progressively being duplicated onto safety base film. The State Governments also have large libraries of aerial photographs and it is likely that similar quantities of photos are produced.

The recently distributed, January 1975, Edition 1, Air Photographs brochure by the Division of National Mapping shows the progress of the superwide-angle photo coverage as 95% complete for the mainland. This programme was started in 1960 using the 230 x 230 mm format and 88.5 mm focal length, superwide-angle camera exposed from a height of 7,600 metres giving a photoscale of approximately 1:84,000. This is the photography mostly used for the 1:100,000 mapping programme and it has the advantage of needing only one third the number of photos to cover an area compared with the older 1:50,000 scale 230 x 230/152 mm wide-angle photography, also exposed from 7,600 metres. The 1:50,000 photography comprised the bulk of the photos available post-war and was used for most of the 1:250,000 scale R502 Series mapping. A disadvantage of the superwide-angle photography is that photo-interpretation is more difficult due to the smaller scale.

As well as the black and white photography, colour aerial photography, usually 230 x 230/152 mm at approximately 1:25,000 scale is being obtained of selected areas for resources mapping. It is also being used, where available, for assisting in the photointerpretation of 1:100,000 map detail. Some superwide-angle colour photography has been obtained in the Prince Charles Mountains area of Antarctica.

Apart from the systematic mapping photography, other photography is obtained for special purposes, such as the supplementary photography usually at 1:30,000 scale which is taken when necessary to position alterations and additions to map detail during the field checking of map compilations. This varies from spot photos to runs of photos depending on the amount of development and time elapsed since the mapping photos were flown. Photography using infra-red film is being used in coastal areas at times of high and low tide for interpretation and delineation of the coastline and mean low water for mapping purposes.

An interesting addition to the imagery available of Australia is that derived from the four channel multi-spectral scanning (MSS) equipment carried by the NASA Earth Resources Technology Satellite, ERTS-1, now called LANDSAT 1. Copies of the 70 mm images were given to Australia by the United States Government. Instead of cameras, special electronic sensors record the sun's energy reflected from the earth in certain wavelength bands, which cover the green-yellow, red and two infra-red bands of the spectrum. These are referred to as bands 4, 5, 6 and 7. The satellite orbit is about 900 km above the earth and the area covered by the 70 mm image is about 185 x 185 km at a scale of 1:3,369,000. There is 10% overlap along track and the across track overlap varies from 14% at the equator to 34% at 40° and 85% at 80° latitude. Repetitive images are available for some scenes at multiples of 18 days. Enlargements and false colour composite prints are available. 1:250,000 scale enlargements of LANDSAT images have been used to produce mosaics and preliminary small scale map compilations of Antarctica. Some use has been made of the imagery for locating underwater features particularly in the Great Barrier Reef and as an

aid in regional land use mapping.

A small amount of SKYLAB photography has been received from NASA, covering a strip from Alice Springs to the south coast of N.S.W. near Eden. Unfortunately, there is a lot of cloud in the middle section of the strip. Photographs are available from two cameras :-

S 190 A, 57 x 57 mm on 70 mm film,
 152 mm focal length,
 Photoscale : 1:2,900,000
 6 film types, 2 B & W panchromatic
 2 B & W infra-red
 1 false colour (IR)
 1 colour

S 190 B, 115 x 115 mm format
 460 mm focal length
 Photoscale : 1:945,000
 The film used is high resolution SO-242 colour
 film.

A flight diagram is available. There are a few very good photos over the Snowy Mountains - Lake Eucumbene area. This gives a remarkable range of imagery available covering that area from scales of 1:40,000 flown in 1944 to Skylab and LANDSAT 1 at 1:1 Million and 1:3.4 Million in 1972/74.

From the Photos to the Map

While a single aerial photograph can yield some information and an overlapping pair of photographs viewed stereoscopically can yield much more, it is necessary in order to make accurate maps from aerial photos to have at least three control points, not in a straight line, identified on each overlap or model, as it is known. Two of these points control the model for scale and azimuth and, as three points determine a plane, this enables the model to be levelled to the three points and controlled for height. The model control points may be obtained from field survey or as is more usual, from a combination of field survey and extension by graphical or numerical photogrammetric methods which usually provide at least six points per model.

The photos forming the overlap are set up in a stereoplottting instrument and the resultant model is tipped, tilted and has the scale changed until it best fits the control points. With the model now oriented to control, the map detail can be plotted using the floating index mark to trace out the required detail and by setting the mark at certain levels in the model space, contours may be drawn by keeping the mark in contact with the model. It is usual to plot planimetric detail, model by model, on the base compilation sheet which shows the control and plot the contours and vegetation on separate overlays registered to the planimetric sheet.

Map Control

Horizontal: More than 12,000 permanently marked survey stations throughout Australia form a network of points fixed by triangulation, traverse or trilateration. Even in the remote areas the density of control is not less than a $1^{\circ} \times 1^{\circ}$ pattern. Geographical co-ordinates, latitudes and longitudes of these stations have been computed in terms of a homogeneous horizontal control datum, the Australian Geodetic Datum (AGD) which was established in 1966. Relevant information for each station is recorded on a Control Station Summary, including the Australian Map Grid (AMG) co-ordinates, easting and northing which have been converted from the AGD longitude and latitude. The AMG co-ordinates provide the framework for the horizontal positioning of topographic map detail in Australia. This means that mapping can be started anywhere in Australia and eventually, when adjoining map sheet areas are done the detail will join without gaps, duplication, displacement or distortion.

A full explanation of the AMG is given in National Mapping Council Publication No. 7 - The Australian Map Grid Technical Manual.

The writer recalls the difficulties experienced before AMG when using whatever mapping control was available (and being glad of it) to compile some of the 1:250,000 R502 series maps with control based on various systems such as; Clarke 1858 Figure of the Earth and Sydney Datum, Everest/Perth, astronomical fixes, Townsville etc. Under these conditions fitting 'the last brick in the wall' had its problems.

Vertical: The basic vertical control is supplied by more than 45,000 permanent bench marks determined by differential levelling. These heights are based on the Australian Height Datum (AHD) which was established in 1971 from the adjustment of a network of levelling sections tied to mean sea level at 30 tide gauges - see Division of National Mapping, Technical Report 12. Information concerning the AHD values and location of these bench marks may be obtained from the Surveyor General in the particular State or Territory. Additional vertical control data needed for contouring is being obtained by airborne laser profiling along the sidelap of the mapping photography. The profiles are adjusted between bench marks in the AHD levelling network. Horizontal and vertical control overlay diagrams to the 1:1 Million maps are available for planning mapping projects.

Topographic Mapping Programme

Progress of topographic mapping is shown on the 'Maps of Australia' brochure by the Division of National Mapping. Maps published usually at the larger scales by State Governments are shown in similar brochures available from the Surveyor General of the particular State. Few topographic maps are available at 1:25,000 scale. Maps available at smaller scales are :

	<u>On Australian Map Grid</u>	<u>On Old 5° Wide Yard Grid</u> (Non-metric)
1:50,000	83	201
1:100,000	605	10
1:100,000 OPM's	125	NIL
1:250,000	3	541 All

There are about 3,060 maps to be compiled in the 1:100,000 series. Of these, some 1,430 covering inland areas are unlikely to be published at 1:100,000 unless specially required. In addition to the 605 maps published, many are being compiled and progress reports are available from the Division for line map compilations and orthophotomapping. Compilations or orthophotomaps should be available for the whole of Australia by 1978. Increasing numbers of orthophotomaps are becoming available and they are proving to be very useful particularly at large scales and also at smaller scales where there is little detail that can be shown by the conventional map symbols.

Orthophotomaps are produced by mosaicing orthophotographs which are photos with the image detail in the correct map position. In hilly areas the orthophotographs are made from pairs of overlapping photos using differential rectification scanning equipment. In areas of relatively flat terrain single photo rectification is used. Contours are usually produced on conventional stereoplotting equipment but where profiles are scanned automatically and horizontal and vertical co-ordinates are recorded along the profiles, contours can be produced by computer and drawn by an automatic drafting machine. Some editing is usually required. In the less developed areas OPM's can be converted to line maps using fairly simple photogrammetric methods. These OPM/line map sheets can be reduced from 1:100,000 to provide line base compilations for the 1:250,000 series.

Bathymetric Mapping

Two maps have been published in the new Bathymetric Map Series. A programme to map the continental shelf at a scale of 1:250,000 commenced in 1971. The outermost limit for collection of bathymetric data is the 300 metre depth mark. Lines of soundings are generally run at right angles from the coastline at intervals of 1,500 or 3,000 metres, depending on the nature of the seabed topography. Initially, bathymetric maps are compiled at 1:150,000 scale and show depths along each sounding line at approximately 1,000 metres spacing. The maps are produced in two colours - blue and black - and follow basically the same sheet lines and format as the 1:250,000 scale National topographic map series - see Cartography Vol. 8, No. 3, January 1974 for further details.

Surveys and Mapping - General Organisation and Co-ordination

The Australian Government is responsible for mapping Australia at the 1:100,000 scale as well as mapping at various scales in Northern Territory and portions of Antarctica. The Division of National Mapping, Department of Minerals and Energy, carries out part of the Australian mapping programme and arranges for parts to be carried out by the Department of Defence (Royal Australian Survey Corps), State Authorities on a partial reimbursement basis and by private enterprise under contract.

As the State Governments also have fairly large organisations engaged on surveys and mapping, a National Mapping Council has been constituted with the approval of the Commonwealth and State Governments. The members are :-

Director, National Mapping (Chairman), Department of Minerals and Energy

Director of Military Survey, Department of Defence

Surveyor General for Australia, Department of Services and Property

Hydrographer, R.A.N.

Director of Mapping, N.S.W.

Surveyor General, Queensland.

Surveyor General, South Australia

Surveyor General, Tasmania

Surveyor General, Victoria

Surveyor General, Western Australia

The Council has provided a very effective means of Commonwealth/State co-operation in the geodetic survey and topographic mapping fields. It has brought about complete geodetic and levelling surveys of Australia which permit the co-ordination of survey data by various agencies so that it can be used for mapping operations, or other survey activity. It has enabled complete air photography coverage of Australia and the uncounted mapping of the country at 1:250,000 scale. A national contoured map coverage is now underway at scales between 1:25,000 and 1:250,000.

The Australian poet, John Manifold in the opening verse of his poem, 'Travellers Tales' writes, possibly after an unfortunate wartime experience with emergency mapping :-

'The standard map admits it does not know,
The hinterland, you see, is barely tinted,
Not contoured in; besides this sheet was printed

For eyewash sake, in peacetime years ago'.

There should be published contoured maps of Australia, including the hinterland, within 4 to 5 years time.-