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**BMR Gravity, Latitude and Longitude Conversion
from Eastings and Northings**

by

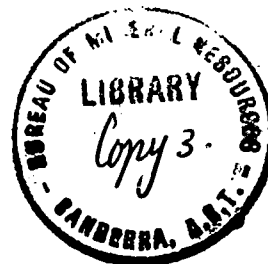
D. G. Townsend

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CONVERSION FROM EASTINGS AND NORTHINGS**

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CONTENTS

	<u>Page</u>
SUMMARY	
1. INTRODUCTION	1
2. PROGRAMME MAGLAT	2
3. CARD ORDER FOR PROGRAMME MAGLAT	3
4. PROGRAMME TMCOORD	4
5. CARD ORDER FOR PROGRAMME TMCOORD	5
6. REFERENCES	7

SUMMARY

This Record describes a specialized version of TMCOORD programme as used in the BMR Gravity Group. The programme TMCOORD was kindly made available to the BMR by Mr A. Bomford of the Division of National Mapping. The specialized version, called MAGLAT, is designed to convert eastings and northings, on a number of grids used in Australia, to latitudes and longitudes on the Australian Geodetic Datum. MAGLAT can also be used to store station numbers, latitudes, longitudes, and other relevant data such as height and gravity on magnetic tape, thus extending the scope of the gravity data storage system on magnetic tape.

For convenience a short description of TMCOORD, its capabilities and its card deck structure, are also included. Both programmes are designed for a CDC 3600 computer, as used by CSIRO in Canberra.

1. INTRODUCTION

Ultimately, the Regional Gravity Group of the Bureau of Mineral Resources, Geology & Geophysics (BMR) intends to have available on magnetic tape, principal facts for all gravity surveys of interest, particularly those in Australia and on its continental shelves which are capable of scale and datum adjustment and subsequent inclusion in a unified gravity map. The principal facts include:

- (a) An eight-figure identification number for all gravity stations.
- (b) Station latitude and longitude.
- (c) Station height and observed gravity.

Such a storage system affords ready access for all types of interpretational work based on Bouguer or free-air anomalies.

Since on some surveys it has been found convenient to use eastings and northings instead of latitudes and longitudes, a programme such as TMCOORD, developed by the Division of National Mapping was needed for a quick conversion. It has been found desirable to modify TMCOORD for two reasons: (a) to enable latitudes and longitudes to be written onto magnetic tape in the same programme 'run' as the conversion from eastings and northings; (b) to simplify the card-deck structure, since only one of the several facilities of TMCOORD is being constantly used.

2. PROGRAMME MAGLAT

Maglat accepts as input the grid specified, the hemisphere worked in, and distance units used, all on the first card. Station number, eastings, northings, height, and gravity follow on the second and subsequent cards forming the main data block.

The programme will then convert the eastings and northings to latitudes and longitudes, and also will write principal facts, as previously defined, onto magnetic tape if required.

There are five grids available for computation:

- (a) ANS: The Australian Map Grid on the Australian National Spheroid.
- (b) ACT: The Australian Capital Territory grid on the Australian National Spheroid.
- (c) MMBW: Melbourne Metropolitan Board of Works grid on the Australian National Spheroid.
- (d) INT: Universal Transverse Mercator grid on the International Spheroid.
- (e) C58: The 'Old Australian Yard Grid' on the Clark 1858 Spheroid.

Eastings and northings may be presented in yards, feet, or metres. The ensuing calculation uses Redfearn's formulae in full, as given in TMCOORD, ensuring a high order of accuracy.

If the northern hemisphere is not specified, then the programme will assume that calculations are to be made applicable for the southern hemisphere only. If the distance units are not specified, the programme assumes metres for the eastings and northings.

The 'data block' limit is 2000 cards, that is 2000 stations within the same area. These are sorted numerically before being stored on magnetic tape.

Theoretically any number of areas may be treated sequentially in the one programme run; but in practice the computer time available is a limiting factor.

When any one survey involving eastings and northings, is computed with a view to storing principal facts on magnetic tape, the latitudes and longitudes should be written onto magnetic tape before the rest of the principal facts are included, using other programme of the gravity storage system.

If a completely new magnetic tape is to be started using MAGLAT then the Survey Area File header and ENDSAF marker must be placed on the tape, with programme NAME; otherwise MAGLAT will not operate.

3. CARD ORDER FOR PROGRAMME MAGLAT

Card 1. Title card, area title or description (a full 80 characters may be used)

Card 2. Grid card, giving any one of the five grids mentioned, length units, and hemisphere of operation. e.g.

(a) ACT in columns 7-9
FT " " 18-19
N " " 22

Calculation will be made for points in the northern hemisphere.

(b) MMBW in columns 7-10
blank for distance unit
blank for hemisphere

In which case metres will be used for calculations made in the southern hemisphere.

Card 3. The data cards are in such a format that the programme will accept TMCOORD '7' cards with eight-figure station numbers punched in columns 17-25, e.g.

6712.1131 in columns 17-25
1 in column 29, that is zone 1
30-43 easting format F14.5
44-57 northing format F14.5
721.12 in columns 60-67 elevation format F8.2
861.3 in columns 68-76 observed gravity format F8.2

Elevation and observed gravity inclusions are optional; however, if observed gravity is included, the value should be in milligals relative to 978,000.00, and the elevation, if used, should be in feet.

- Card 4. This card acts as a marker for the end of the data block and consists of '99' in columns one and two.
- Card 5. If the latitudes and longitudes are to be recorded on magnetic tape then CREATE in columns one to six is used, otherwise an EOF marker will conclude programme operations.
- Card 6. This is used only in conjunction with card 5 and gives a free field of eighty characters in which to write the area name, which is to go on magnetic tape as title for the block of data being computed.
- Card 7. For a programme run dealing only with one block of data under the one area name, card 7 will be an EOF marker. However, if more than one area is being dealt with in the one programme run, cards 1 to 6 may be repeated indefinitely.

4. PROGRAMME TMCOORD

(Programmer: A. Bomford)

Programme TMCOORD can convert eastings and northings to latitudes and longitudes and the reverse, giving meridian distance and convergence of the grid used in the process. The programme can also calculate sheet-orner co-ordinates and make zone-to-zone conversions.

Computations made involve Redfearn's formulae (Empire Survey Review 1948 No. 69) for lat-long conversion, and the standard formula for meridian distance.

Data cards are numbered 1-7 in the second column for various options which the programme provides, but every data deck must start with a 1-card.

A. Latitude and Longitude conversion, i.e. conversion from or to eastings and northings.

There are three standard grids available: ANS the Australian Map grid; INT, the Universal Transverse Mercator grid; and C58, the Clarke 1858 spheroid and 'Old Australian Yard' grid.

Eastings and northings may be presented in any distance units; but the parameter a, the semi major axis of the spheroid, must be in the same units.

For non-standard grids, two extra data cards are included, giving false easting, false northing, central scale factor, zone width, central meridian, and flattening factor f.

On the MMBW grid, co-ordinates are specifically required to be in zone O. This is achieved by increasing the central meridian of the MMBW grid by a zone width of 6 degrees, and using a mythical central grid of zone 1. The cards which may be involved in this section number 1, 2, 3, 6, & 7 for non-standard grids, and 1,6 & 7 for standard grids.

B. Sheet-Corner Co-ordinates

Sheet-corner co-ordinates can be produced for any size within a rectangular area. Areas which are not rectangular must be split into rectangles and dealt with separately. Eastings and northings will be computed for all points on or within the limiting meridians and parallels at the specified intervals. Cards 1 & 4 are used in this section.

C. Zone-to-Zone Conversions

For points within half a degree of a zone boundary, if the eastings and northings are given as in section A, not only are the latitudes and longitudes computed, but the eastings and northings of these points are given on the adjacent zone. Thus the programme can be used for zone-to-zone conversion in the zone overlap region. Cards used are 1, 2, 3, & 7.

5. CARD ORDER FOR PROGRAMME TMCOORD

As mentioned, the data deck always starts with a 1-card. Cards 2 and 3 are included only for non - standard grids. The remaining cards 4-7 each used for different types of computation, may be mixed in any order. The card identification number is always in column 2. On all cards, if the N/S or E/W boxes are left blank, latitudes are assumed south and longitudes east.

Card 1

Columns 3-77 may be used for details of the job in hand. Columns 78-80 are left available for entering one of the three standard grids, and are otherwise left blank.

If a standard grid is used, then cards 2 and 3 are omitted.

Card 2

This card is used in conjunction with card 3. The spheroid used is given in cols. 4-43, format 5A8.

Distance units used for co-ordinates, cols. 45 - 46, format A2.
 Radius a of spheroid is given in cols. 48 - 59, format F13.4
 Inverse of flattening factor f, cols. 60 - 67, format F 8.4

Card 3

False eastings, cols. 3 - 13, (decimal in column 10)
 False northing, cols. 14 - 27, (decimal in column 24)

N, or S in col. 29 defines the hemisphere worked in.

Scale factor, cols. 30-37, decimal point in col. 31; if scale factor is omitted, unit scale factor is used.

Zone width, cols. 38 - 42 in degrees, format F5
 cols. 43 - 45 for minutes, format F3
 W or E in col. 50 defines the central meridian
 Central meridian, cols. 51 - 54 in degrees, format F4
 cols. 55 - 57 in mins, format F3
 cols. 58 - 65 in secs, format F8.4

Card 4

Required for sheet-corner computations only.

N/S col. 4
 North limit cols. 5 - 15 degs., mins. and secs.
 in format - F3, F5.2
 Latitude increment cols. 16 - 25, degrees, mins. and secs.
 in format - F2, F3, F5.2
 N/S col. 26
 South limit cols. 27 - 37, degs., mins. and secs. -
 2F3, F5.2
 E/W col. 40
 West limit cols. 41 - 52, degs., mins. and secs. -
 F4, F3, F5.2
 Longitude increment
 cols. 53 - 62, " " " " F2, F3,
 F5.2
 E/W col. 63
 East limit cols. 64 - 75 " " " " - F4, F3,
 F5.2

Card 5 5 - cards are punched automatically by programme
VARYCORD (Nat. Map.), and convert adjusted geographicals
to rectangulars.

Card 6 For lat - long conversion to eastings and northings.
Station space in cols. 3 - 26 format 3A8

N or S in	col. 27	format A1
Latitude in	cols. 28 - 41,	degs., mins. and secs. format 2F3, F8.4
E or W in	col. 44	format A1
Longitude in	cols. 45 - 59,	degs., mins. and secs. format F4, F3, F8.4
Optional height in	cols. 62 - 70,	format A8, A1
Height units in	cols. 71 - 72,	format A2

Card 7 For eastings and northings to lats. and longs.
Station space, cols. 3 - 26, format 3A8
Zone, cols. 27 - 29, format F3
Easting, cols. 30 - 43, format F14.5
N, or S hemisphere, col. 45 format A1
Optional height, cols. 48 - 56, format A8, A1
Height units, cols. 58 - 59, format A2

End card The data deck is finalized by an EOF card.

6. REFERENCE

REDFEARN, J.C.B., 1948 - Transverse Mercator formulae. Emp. Svy. Rev.
69, pp 318-22.