GIS, Imagery, and Digital Map production

ERTH 6401: Earth Sciences and Geology Honours Foundation Course

1) Map Datums and Projections; Geological/GIS database principles
   - 9-11am, Thurs May 6

2) Current scope, availability, cost, etc of satellite imagery and associated data and digital map products, and current trends in image processing for geological purposes
   - Sylvia Michael/Mike Peters, Geoimage Pty Ltd
   - 9-11am, Thurs May 13 [Options: 1) minibus: meet at 8.50am behind Steele Bldg
     2) make your own way to Geoimage*

3) Digital Map Presentation using MapInfo

   9-11 am, Thurs May 20

4) Hand in assignment by Friday June 4

*
13/180 Moggill Road, Taringa
geoimage@geoimage.com.au

Computer-aided mapping & visualisation

Departmental software:

- Database preparation: Excel; Access; MapInfo
- Image processing: ER-Mapper
- Image viewers: MapInfo; ERViewer (free download)
- GIS/digital map prep: MapInfo
- 3-D visualisation: Fractal Graphics; (MapInfo; ER-Mapper)
- 3-D modelling/drawing: Fractal Graphics (latest versions)
- Mine/block modelling: None (e.g. Surpac; Datamine; Vulcan)
- Balanced section modelling: None (e.g. GeoSec)
- Forward 2-D/3-D section modelling: None (e.g. GeoSec)

Module Assignment

Due: Friday June 4

Prepare a GIS set of data and an A3 mock-up of a final map suitable for publication. The map can be quite hypothetical, and not very complex, but must look professional, and contain the following key elements:

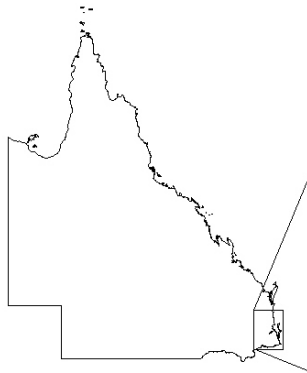
- A background scanned map image that has been registered into an appropriate datum and projection. Can be your own project data or images supplied for the Moreton/Gympie area;
- Some digitized boundaries and units from this background map. The units (polygon fills) must contain at least one mutual boundary, one "island", and one "lake" such that it demonstrates proficiency in object clipping and erasing;
- A GIS table, derived originally from an Excel spreadsheet, containing some point data within the area of interest. Can be your own data or from age & geochem data sets supplied
  - 'Create Points' from the data in this Table, and then use the located data to create a shaded 'thematic map' (that is, a shaded pseudocontour map of the data)
- A labelled map grid of easting/northings or lat/longs
- An annotated scale bar
- A legend (for the digitised boundaries/units and the thematic map)
- An inset diagram showing a graph of some aspect of the data used for the thematic map from a selected spatial subset of the data
- An inset map showing your thematic map overlain with the data pts used to make it
- An Inset map of Queensland showing a location rectangle
- A title, including your name, and a statement at the bottom about the map datum and projection. The information in this latter must be accurate with respect to your chosen Projection/datum

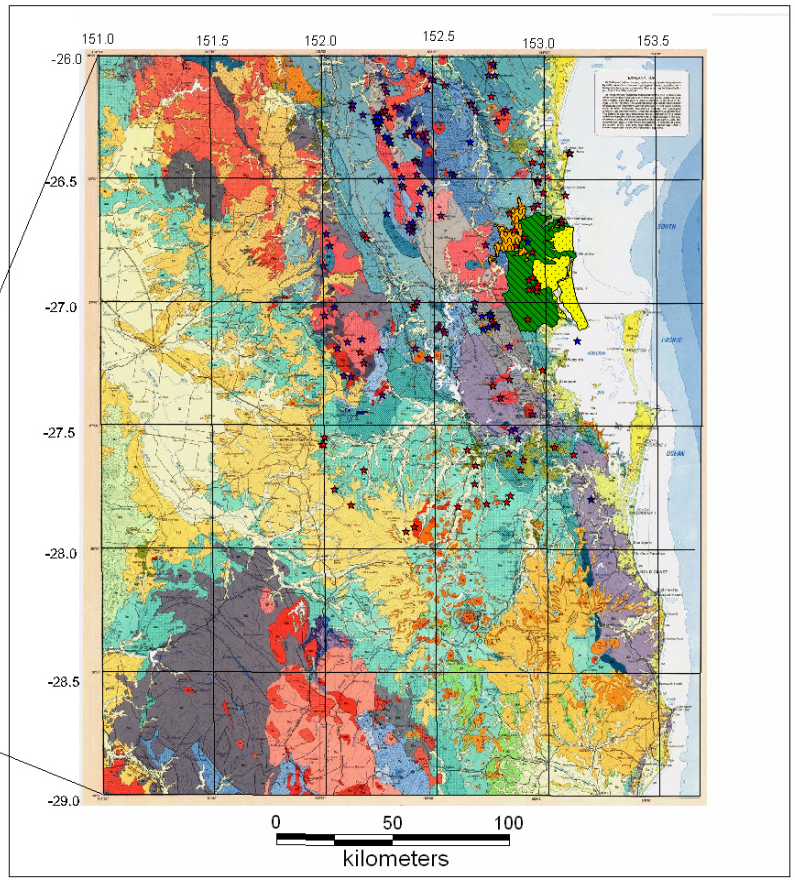
Assignment Example

Digital Mapping/GIS Exercise
Moreton Area

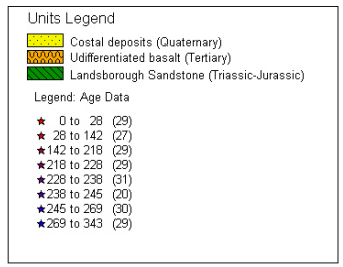
Joseph Blow

Map Location





Title
Name
Registered image
Digitised units
Including mutual boundaries, 'lakes', 'islands'
Thematic map
Legend of units and thematic map



Annotated Grid
Scale bar
Inset location map
Projection and grid details

Map projection: (UTM) AMG66, Zone 56
Grid: Latitude/Longitude in AGD 66 Datum

Assignment Submittal

Finally:

1 Save your Layout as a Workspace in the same directory containing your various Tables.

2 Start a new directory using your name under the GIS Foundation Course Directory on Studata4

3 Copy **all** your Tables and the Workspace that recreates your Layout to this named directory

4 Notify me by email that you are done.

WorkGroup/Domain: Student:

Topaz…Studata4…erth6401 Foundation course GIS

Insert a new folder labelled using your name

Copy your Assignment Tables and Workspace into this new folder

Department File and Computer Structure

WorkGroup/domain: ***Earth***

Computer: ***Topaz***

Share: ***Studata4***

MapInfo General Map Data

Contains lots of useful MapInfo Tables (streams, coastline, towns, Australia, map, etc). Eg:

Scalebars

student-drawn bars for different areas. Drag them to where you need them.

Also contains Mapbasic tools that can be run as tools from within MapInfo. Eg.:

GeoMapSymbol

Draws structural symbols (e.g. strike and dip) in map windows

Foundation Course GIS raw data

Contains Tables that can be used in the assignment

Computer: ***Quartz***

Share: ***Studata2***

erth6401 Foundation course GIS

This is where you will create a directory (your name) and lodge your completed maps

Your name

new directory created by you. Copy your Assignment Layout here

- (You may wish to temporarily transfer the general Table files to a subdirectory under your own work area. This makes your Workspaces more portable as they then use relative path names rather than absolute path descriptions)

Databases

- **Consist of:**
  - One or more Tables of basic data
    - spreadsheet-like Fields (columns) and Records (rows)
    - structured and populated following database ‘rules’
    - e.g. Relational Databases:
      - each Record can be uniquely identified within any one Table
      - each Field contains the same Type of data (numeric, alphanumeric, date, object, etc)
      - Tables containing at least one of the same data columns can be linked to one another as if they were a single large table
        - » Uses Relationship ‘rules’ between the linked Tables
  - Queries: structured views of of the data using selected fields chosen from one or more Tables linked together using the relationships between the overlapping fields

Excel spreadsheet databases

- 'Flat' databases - Can only show 1:1 relationships
- Therefore need to include fields for all possibilities
- Thus get loads of empty space

E.g.:

FieldNum	Easting	Northing	AMGZone	Location	Rocktype1	Rocktype2	Rocktype3	BeddingDip
1	336456	7769234	56	Lynd Hwy 50m N of Peach Rd intersection	sandstone	rhyolite dyke		23
2	336456	7769234		etc	sandstone			-
2a	336456	7769234		etc	siltstone	minor ss	minor cgl	56
3	336456	7769234		etc	sltst	ss		
4	336456	7769234		etc	ss			78

Do not mix numbers and characters in locns (can't sort data easily)

Remember somewhere to indicate datums and UTM zones

Be consistent with spelling within fields: else can't query efficiently

BeddingDirn	CleavageDip	CleavDirn	Joint1Dip	Joint1dirn	Joint2Dip	Joint2dirn	Joint3Dip	Joint3dirn	Sample1	Sample2
123			45	56						
?										
234										
342	45	145							RH234	

Don't put non-numeric characters into numeric fields: interferes with sorting and processing

Use sample numbers that identify the owner

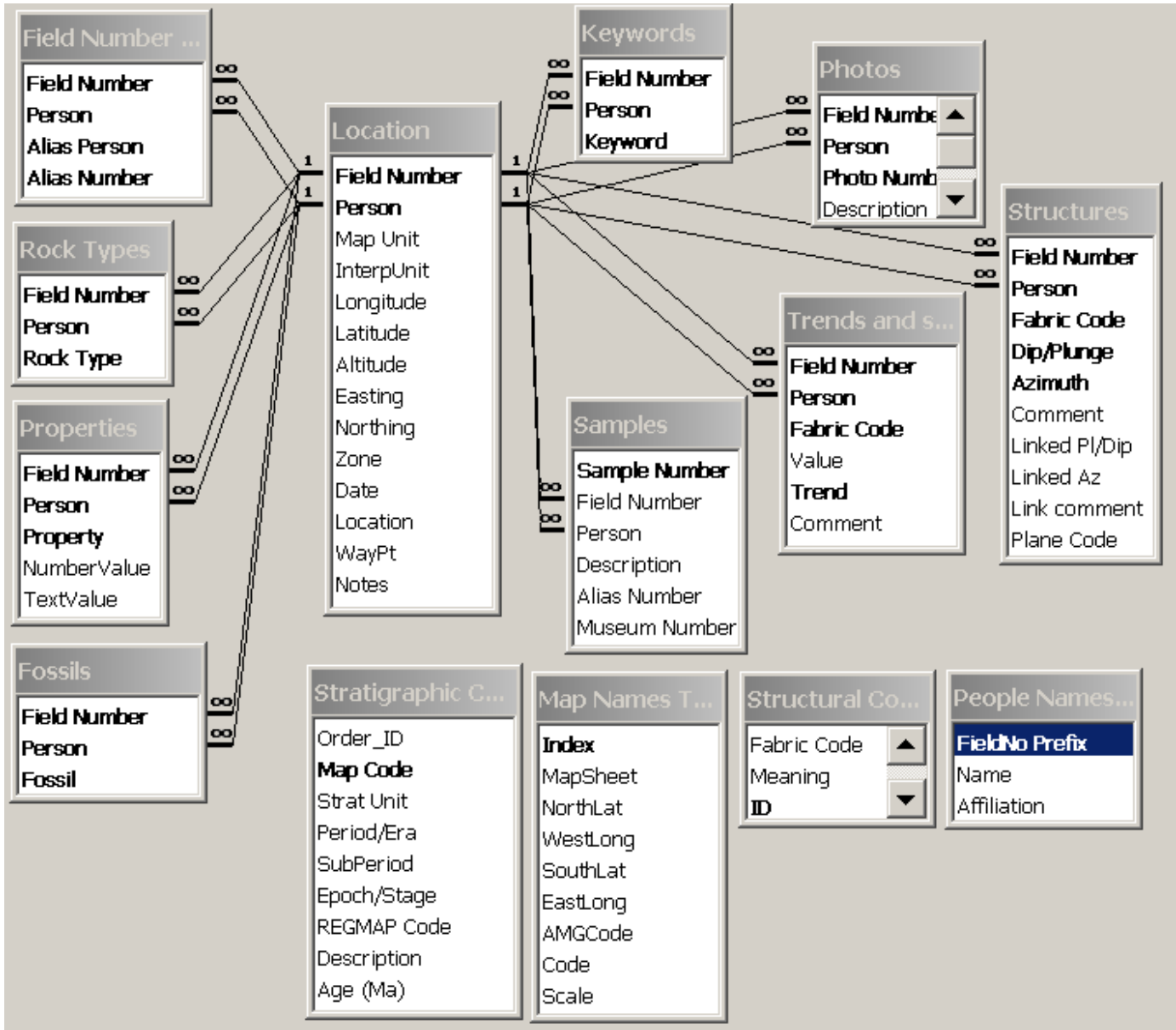
Database design

- Poor design, even for a simple database, can lead to unwarranted cleaning-up at a later stage
- Think carefully about how you are going to Query your database - after all that's why you are doing it
- Only include those fields that will be involved in subsequent queries. The more fields you have, the more time-consuming it is to enter data.
  - In general, don't try to produce all-inclusive databases
  - databases tend to have a life that is limited to the project for which they were designed and hence extra effort may be wasted

Relational databases

- E.g. Microsoft Access
- Multiple tables (spreadsheets) for every 1-to-many relationship
- Every Table has a Key field(s)
  - Unique value (number or characters)
  - May combine more than one field to form the Key
- Tables can be linked by their Key values in Queries

Relational Database Structure



Geographic Information Systems (GIS)

- GIS = Spatial relational databases
  - i.e exactly the same as any other relational database except that at least some of the Tables consist of entities with a geographic location
    - Data can be displayed as a map as well as a spreadsheet-like table
  - Separate Tables can be overlayed in map view as if they were a single map
    - This is the heart of a digital map system

- Commonly used GIS software:
  - ArcInfo; ArcView; MapInfo

GIS - Spatial Relational Database

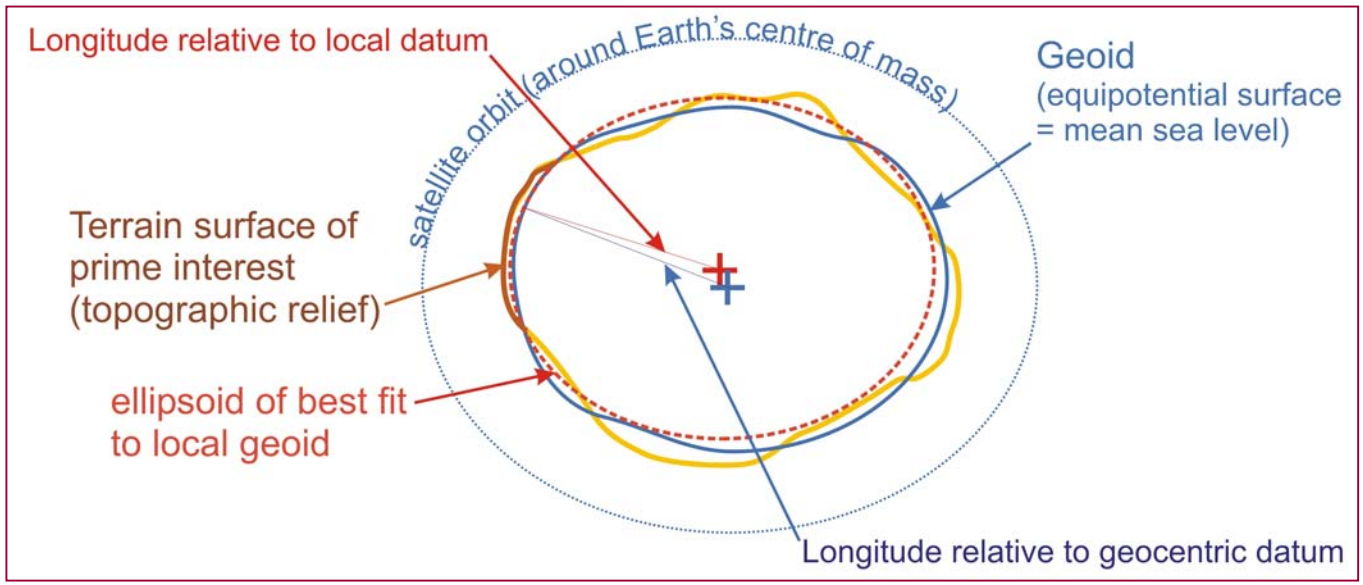
- E.g. MapInfo, ArcView, ArcInfo
- In addition to normal fields, Tables can have an extra field (commonly hidden) that contains geographic information about Geographic objects in the Table
  - *Point, Line, Arc, Polyline, Polygon, Region, etc*

- Geographic Information:
  - Point location or Centroid location (if a polygon object)
  - Perimeter
  - Area
  - Object contained on the left/right side of line
  - Etc

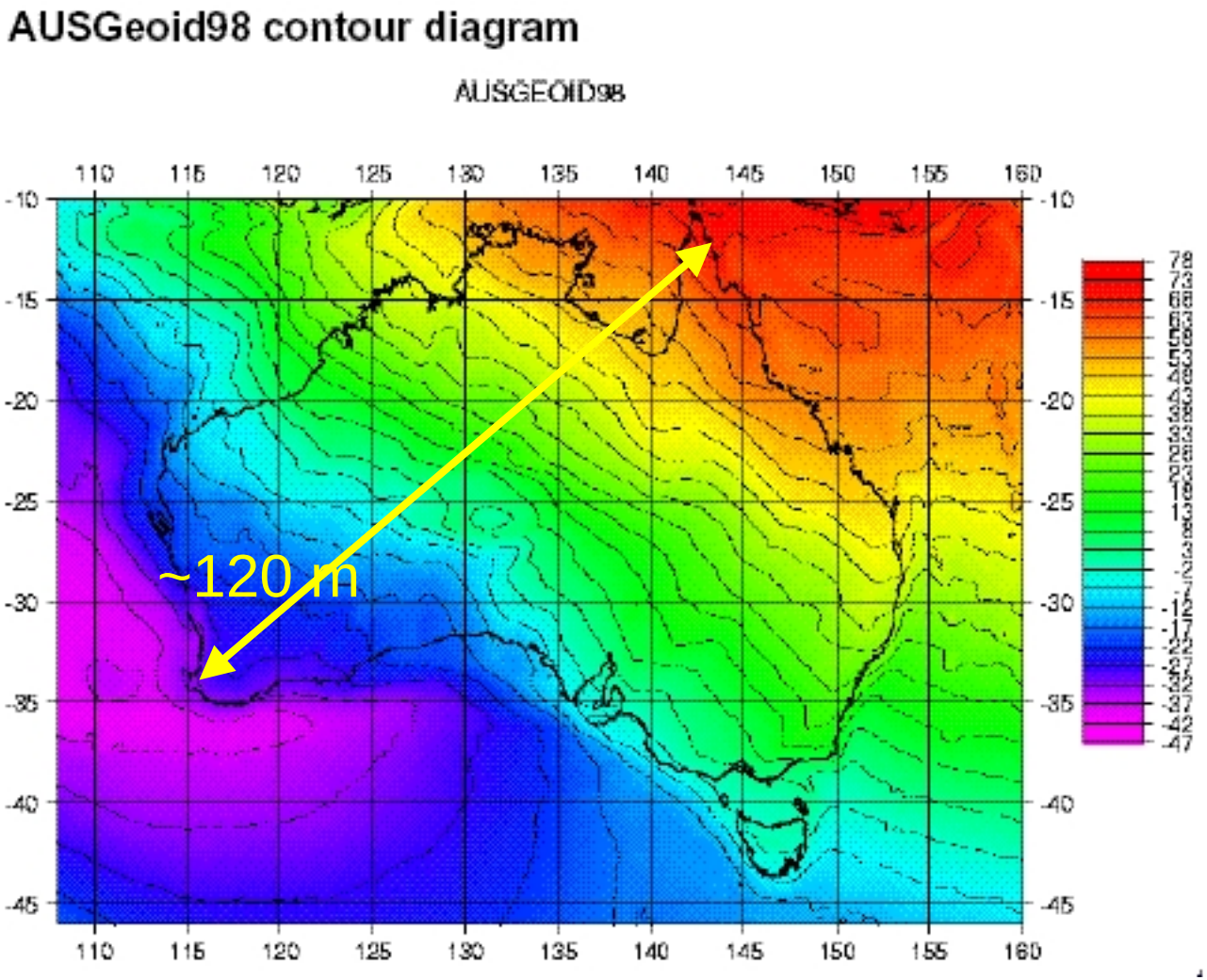
- Location information is dependent on Datums and Projections

Map Datums

Earth is neither a sphere or a true ellipsoid



Shape of Australian Geoid



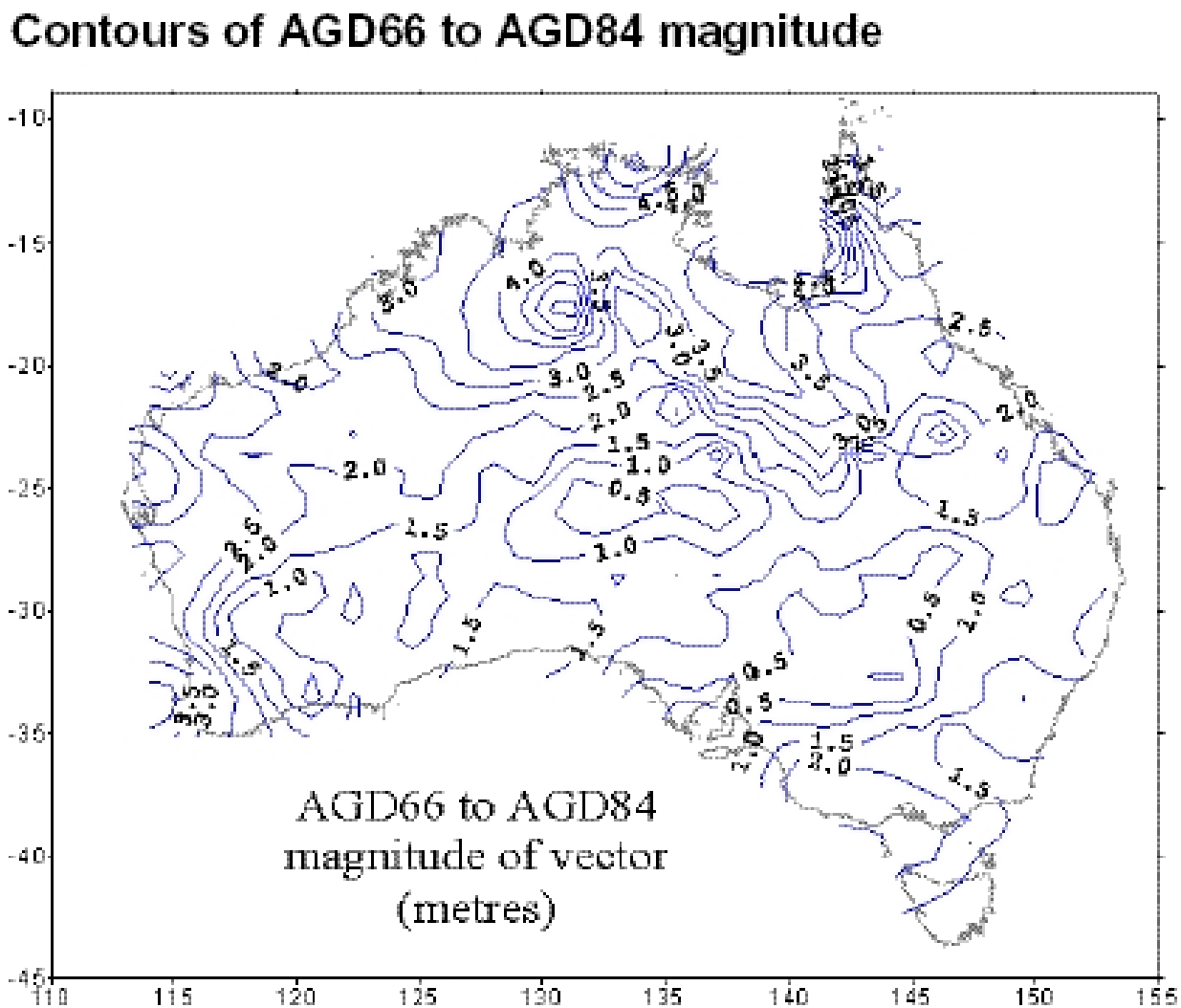
Australian and International Datums

- Australian
  - Older imperial maps
    - Clarke ellipsoid
  - Modern metric maps
    - AGD66
    - AGD84
    - GDA94
      - based on WGS84
- International
  - >50 datums in local use
  - e.g. USA
    - NAD27

•Global geocentric datum WGS84

AGD66/AGD84 comparison

- Maximum spatial difference is about 3 metres

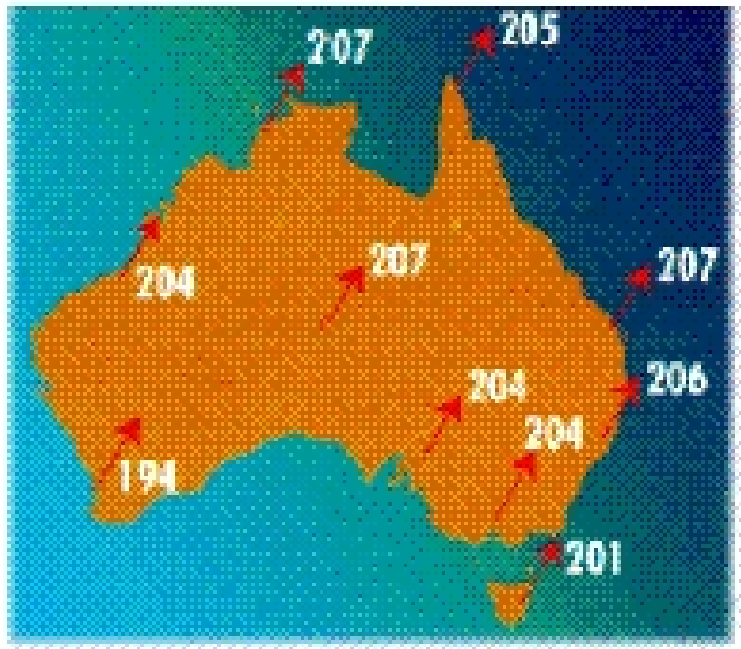


GDA to AGD comparison

GDA and AGD

ITRF92, on which GDA is based, was realised using Very Long Baseline Interferometry (VLBI), GPS and Satellite Laser Ranging (SLR) observations at 287 globally distributed stations (Boucher, 1993). However, the coordinates for Johnston, the origin station for the Australian Geodetic Datum (AGD), were based on a selection of 275 astro-geodetic stations distributed over most of Australia (Bomford, 1967). The adoption of this origin and the best fitting local ellipsoid, the Australian National Spheroid (ANS), meant that the centre of the ANS did not coincide with the centre of mass of the earth, but lay about 200 metres from it. Hence, the GDA94 coordinates of a point appear to be about 200 metres north east of the AGD coordinates of the same point.

The precise size and orientation of the difference will vary from place to place. More detailed information, including methods of transformation, is available in chapter 7.



- Maximum spatial difference is about 200 metres

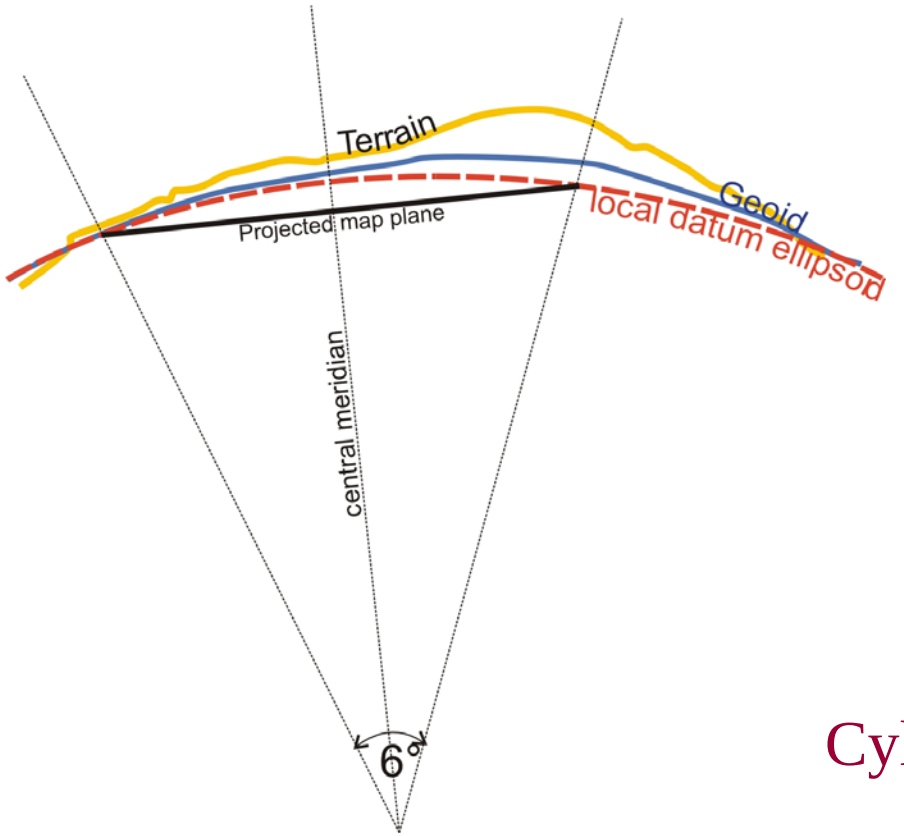
Projections

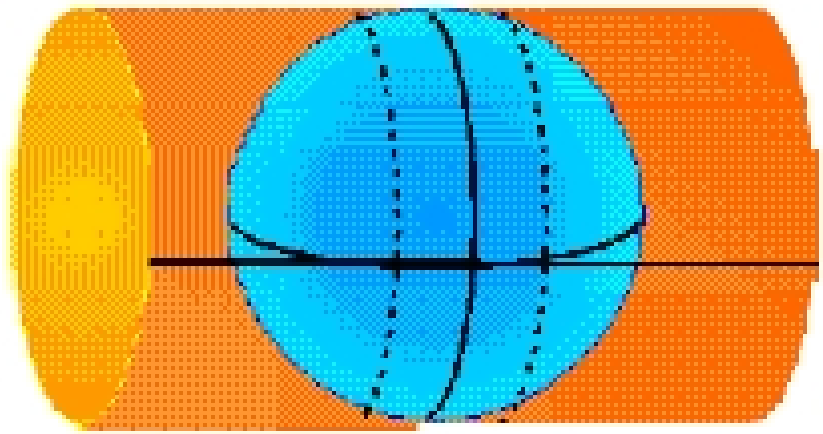
- The algorithm used to project map data that has been projected from the terrain onto the datum ellipsoid onto a 2D flat surface
  - e.g polar stereographic projections
    - e.g. as used for continental wander path reconstructions

- Most common map projection:
  - Universal transverse mercator (UTM)
- Others
  - conic, polyconic, gauss-kruger, etc...

UTM projection

- Projection onto a cylinder tangent to the ellipsoid equator





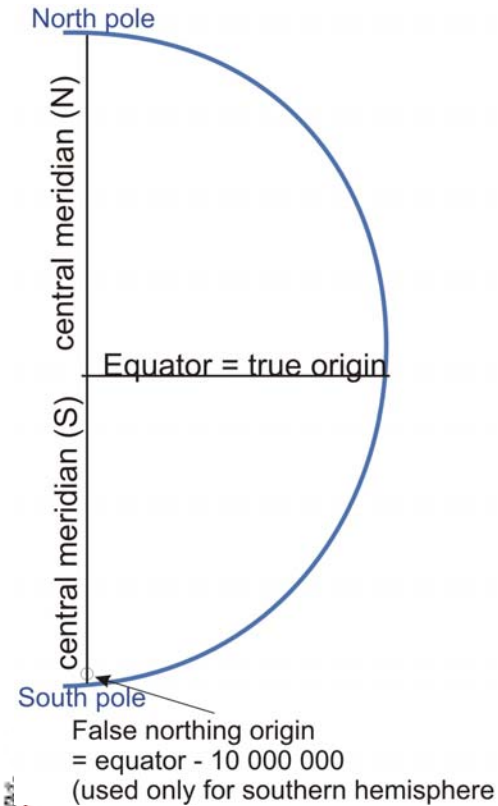
Cylinder is unrolled to give 2D map

UTM zones

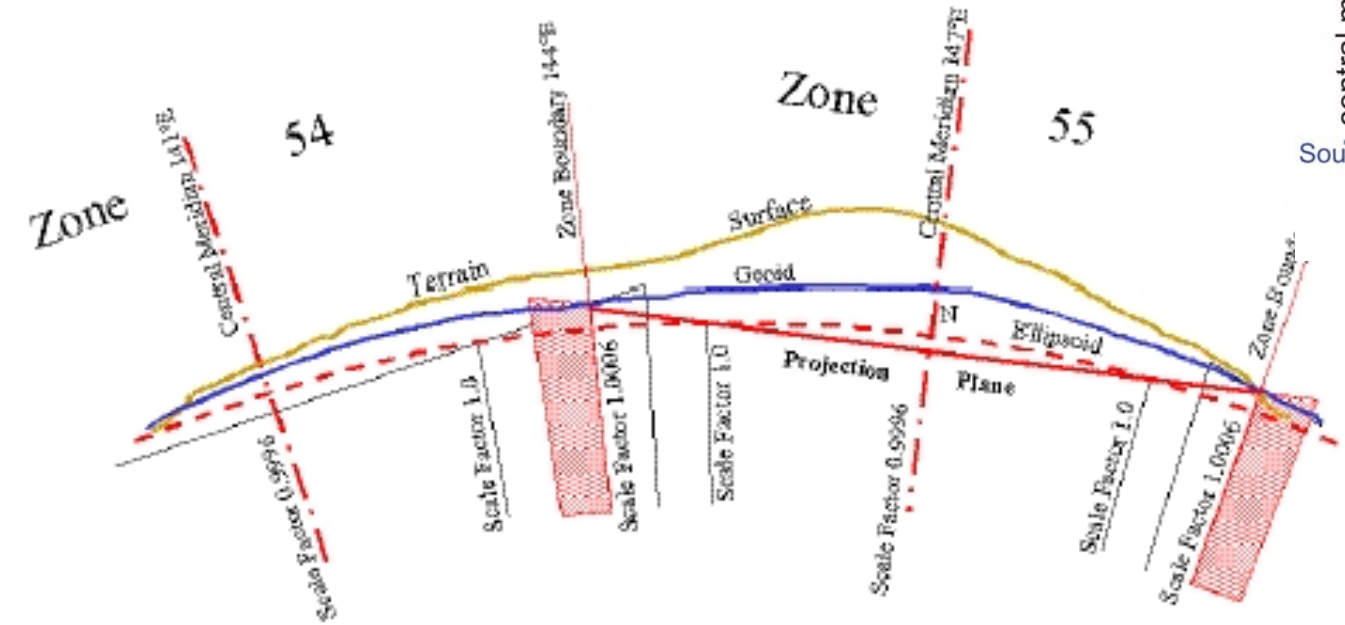
–60 northern and southern zones

Definition of UTM zones

Longitude of initial central meridian (Zone 1)	177° W
Zone width	6°
Central Scale Factor	0.9996
False easting	500 000 m
False Northing (S hemisphere)	10 000 000 m



Cross section through two MGA zones



Australian map grids (projections)

- Yard grid
  - Clarke ellipsoid
  - e.g. Gympie 1:250000 sheet
- Modern metric maps
  - AMG66
    - AGD66
  - AMG84
    - AGD84
  - MGA94
    - GDA94
      - based on WGS84

Australian UTM zones