VIEPS GIS Shortcourse

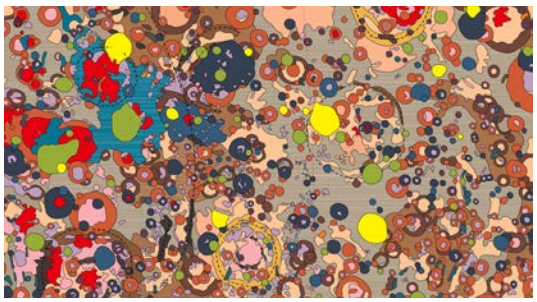
Lecture 1: What is GIS?

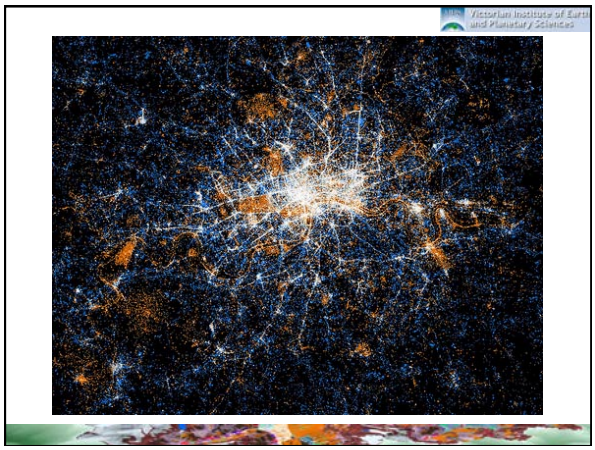
What is GIS?

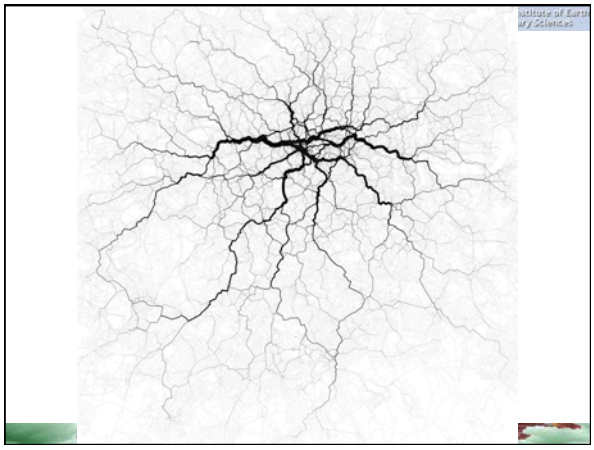
- What is GIS?

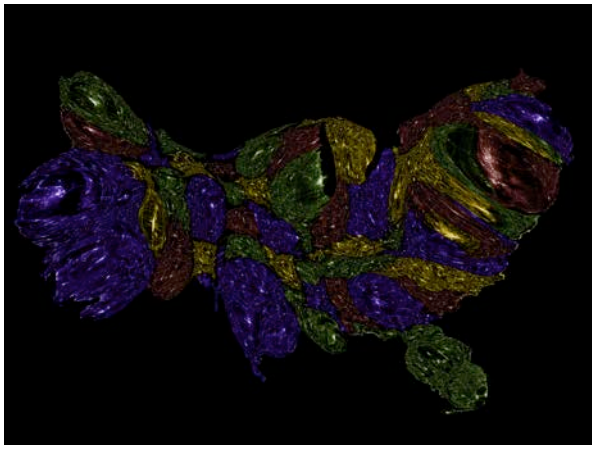
What is GIS?

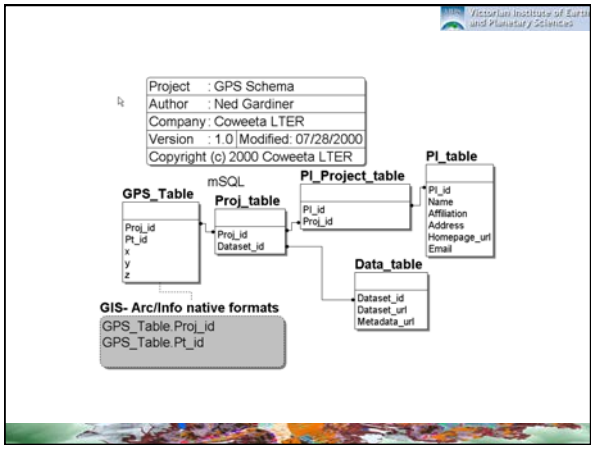
- **Geographic**
  - Deals with maps or other spatial information
  - 2D or 3D (or 4D)
  - Earth system
  - Spatial raltionships
- **Information**
  - Incorporates any other digital information
  - text, numbers, images, tables, sounds, animations, movies
  - Processed data – added value
- **System**
  - Complex system defined by rules – solar system
  - Computer software (data entry, storage, manipulation and display)
  - Computer hardware (data acquisition, entry, display)










Project : GPS Schema
Author : Ned Gardiner
Company : Coweeta LTER
Version : 1.0 Modified: 07/28/2000
Copyright (c) 2000 Coweeta LTER
mSQL
GPS_Table
Proj_id
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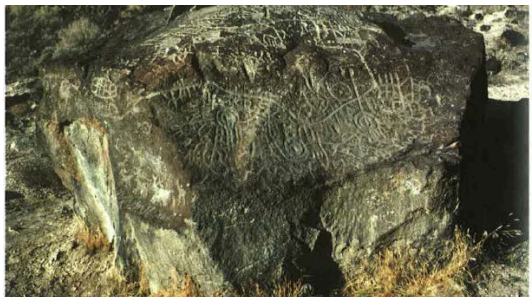
GIS- Arc/Info native formats
GPS_Table.Proj_id
GPS_Table.Pt_id


The first GIS?

Maybe, maybe not…

Or…



"A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying **spatial data** from the real world."

Burroughs 1986 (*Principles of Geographical Information Systems for Land Resources Assessment)*

"A decision support system involving the integration of **spatially referenced data** in a problem solving environment."

Cowen 1988 (*Photogrammetric Engineering and Remote Sensing 54:1551-4*)

"An information system that is designed to work with **data referenced by spatial or geographic coordinates**. In other words, a GIS is both a database system with specific capabilities for spatially-referenced data, as well as a set of operations for working with the data."

Estes & Star (in Clarke 2001, *Getting Started with Geographic Information Systems*)

GIS

- A GIS is a special type of database, designed to be used with **spatially or geographically-referenced objects**
- A GIS incorporates tools for working with spatial data
  - Database - sorting, selecting, querying, etc.
  - Geographic - projections, coordinates, scales, etc.)
- A GIS serves a wide variety of purposes
  - Storage
  - Display
  - Analysis

What is the purpose of GIS?

- Organisation
- Visualisation
- Spatial query
- Combination
- Analysis
- Prediction

Geoscience applications

- Hazard mapping
  - Slope stability
  - Flooding
  - Pollution
- Site selection
  - Waste disposal
  - Pipelines
  - Infrastructure
- Resource evaluation
- Environmental cause and effect
  - Disease etc
- Research
  - Spatial and geochemical relationships between granite types

What GIS is not.

- **A computer based cartography**
  - GIS data is often displayed as a map
  - You need to understand maps to use GIS
  - It is important to remember that a GIS does a lot more than make pretty maps
- **GPS**
  - GPS can be used to geo-spatially reference information
  - coordinates, without other data, don't constitute a GIS.

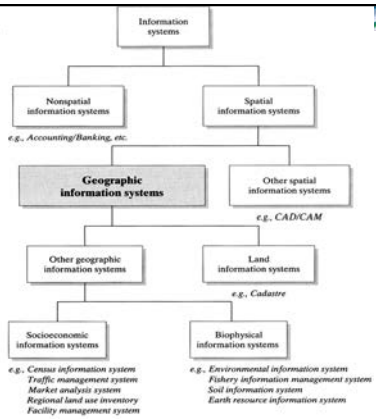
Geospatial Information Technology

- GIS
- GPS/surveying
- Remote Sensing
- Computer Cartography
- CAD technologies
- DBMS

GIS is only a part of the big picture!

Power of GIS

- Spatial information - maps
- Tabulated data – text, numerical
- Integration or connection of the two data



GIS componenets

- Data
- Technology
- Application
- People

What is Data?

- Facts and figures
- Places, people, things
  - Represented as
    - Numbers
    - Characters
    - Symbols
    - Signals

Data

- Geospatial data
  - Locations and characteristics of natural features or human activities at or near the earths surface
  - Or under!
  - Geodetic control network
  - Topographic base
  - Graphical overlay

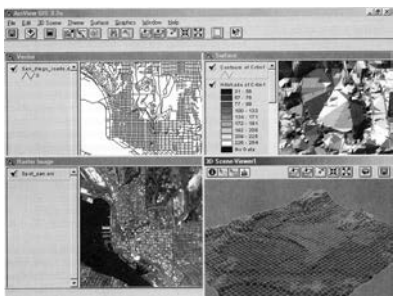
Geospatial Data

- Geographic space
  - Geographic coordinate systems
  - Cross referencing
- Geographic scale
  - Measured at small scale
  - Symbolised, generalised, themed

Data

- Geospatial data can be represented by:
  - Vector
    - Discreet points, lines and polygons
    - Best for features that can be individually identified
  - Raster
    - Grid cells with attributes
    - Good for spatial analysis
    - Selected points or continuous lines of equal value
    - 2D or 3D
    - Best for changing values
  - Surface
    - 3D data
    - 2D or 3D display

Data



Data

- Older systems
  - One data type
  - Separate files of layers
    - Caused interoperability issues
- New systems
  - Geodatabases
    - Aggregate data types
    - OGC 1999
    - Enable interoperability

Technology

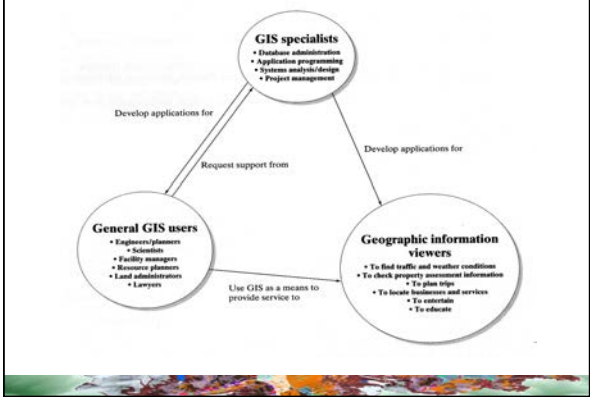
- Hardware and software
  - Hardware
    - Computer system
    - Server
    - Network
    - Storage
    - Internet
    - Peripherals
  - Software
    - GUI
    - Geodatabase
    - Toolbox
    - Scripting
    - Modules

Application Component

- Diverse usage
- 3 aspects
  - Area of application
  - Nature of application
  - Approach of application
- Depends on the sector
  - Eg academic, business, government, industry, military…

People Component

- Profile is changing
  - Once only expert users and developers
  - Now anyone can use GIS



History of GIS

- 1960's – 1980's
  - Mainframe computers
  - Proprietary software
  - Raster data
  - Government
  - Research
  - Military
  - Land and resource management
  - Surveying
  - CGIS – Canadian GIS – designed in the 60's –

History of GIS

- 1980's – 1990's
  - Corlett (1979)
    - Topology – adjancency – connectivity – containment
  - Mini-computers
  - ArcINFO – ESRI
    - First to use georelational data models
      - Graphical data – topological
      - Text data – relational

History of GIS

- 1980's – 1990's
  - Georelational data structure
  - GUI
  - Business
  - Market analysis
  - Logistics
  - Integration with other data
  - Transition from data management to decision support

History of GIS

- 1990's – now
  - Workstations and PC's
  - Network and internet interface
  - Data integration
    - Multimedia etc
  - Object oriented datastructures
  - Geodatabase
  - Mobile
  - Public
  - Location based services
  - Geographic data browsing

Location Based Services - LBS

- Safety – EPIRB
- Information – Internet maps
- Enterprise – asset tracking, logistics
- Consumer portal – location based information
- Telematics – GPS navigation
- Triggered Location – location advertising, billing

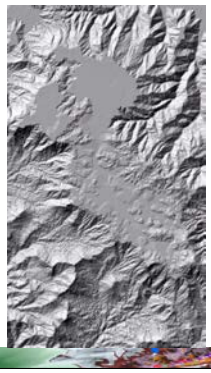
Common GIS applications

- Arc/INFO 7 /ArcGIS (ESRI)
  - http://www.esri.com/software/arcgis/
- MGE (Intergraph Corp.)
  - http://imgs.intergraph.com/mge/
- Autodesk Map (Autodesk Inc.)
  - http://www.autodesk.com.au/
- IDRISI (Clark Labs)
  - http://www.clarklabs.org/
- MapInfo (Pitney Bowes.)
  - http://www.mapinfo.com/
- Maptitude (Caliper Corp.)
  - http://www.caliper.com/maptovu.htm

Open source GIS

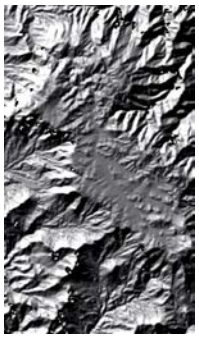
- GRASS (Baylor University)
  - http://grass.baylor.edu/index.php
- QuantumGIS
  - www.qgis.org
- SAGA
  - www.saga.org

GIS in geoscience - Geohazards in Peru



- Contour 1:100,000 Discharge Monitoring Report

Geohazards in Peru

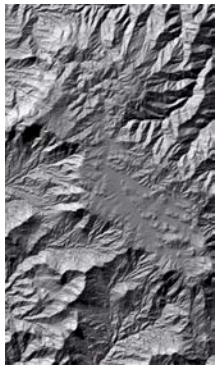


- SRTM DMR Pixel Size 90 m

Geohazards in Peru

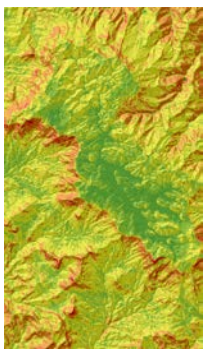
Depressionless DEM Derived from SRTM (2)
Pixel size 25 m

Geohazards in Peru



- Shaded Relief Pixel Size 25 m

Geohazards in Peru

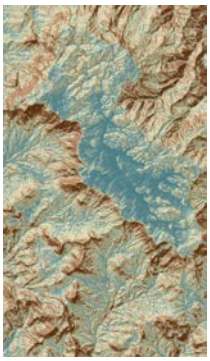


- Slope map

Geohazards in Peru

- Slice DEM

Geohazards in Peru

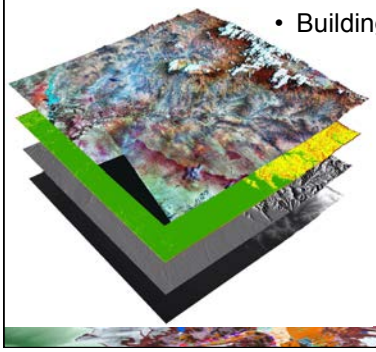


- Flow direction

Geohazards in Peru

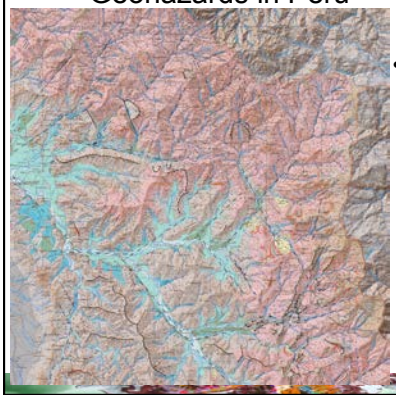
- Flow Accumulation

Geohazards in Peru



- Building a Geodatabase

Geohazards in Peru



- Final output

GIS in geoscience - example

- Mineral exploration scenario
  - Multistage and multiscale
    - Regional assessment to target identification
    - Small scale – region selection
    - Medium scale – prespective regions identified for follow up
    - Large scale – target selection
  - Multiple and varied data sources
    - Light table - GIS

GIS in geoscience - example

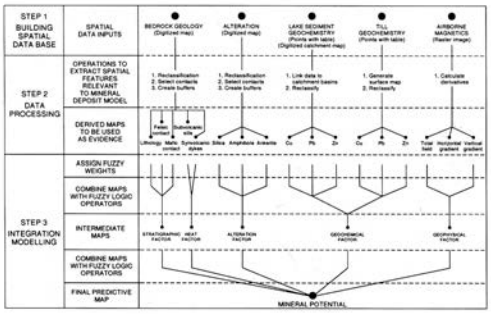
- Example
  - VMS (volcanic massive sulfide)
  - Manitoba Canada
- Mineral deposit model
  - Conceptual model
  - Guides GIS development
    - Data selection
    - Modelling
    - weighting

GIS in geoscience - example

- VMS deposits
  - Seafloor volcanic vents
  - Occur with thick sequences of volcanics
    - Mainly felsic
    - Close to contact
  - Volcanics associated with large felsic intrusives
    - Heat source
    - Seawater in hydrothermal system
  - Vents associated with dykes and vertical fractures
  - Hydrothermal alteration and silicification of volcanic rocks
  - Deposits weathered and eroded
    - Geochemical halo in young sediments
  - Volcanics are often distinguishable in magnetics
  - EM and magnetic signature of deposits

GIS in geoscience - example

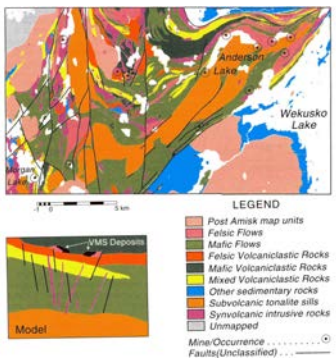
GIS in geoscience - example



GIS in geoscience - example

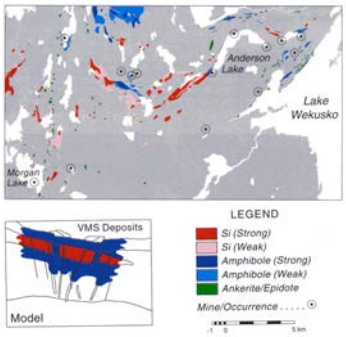
- Step 1
  - Spatial extents
  - Projections
  - Data aquisistion
  - Digitisation / registration
  - Drainage basin designation
  - Geophysics image processing

GIS in geoscience - example



- Regional geology map
  - Digitised from a paper
  - Cross section is schematic

GIS in geoscience - example

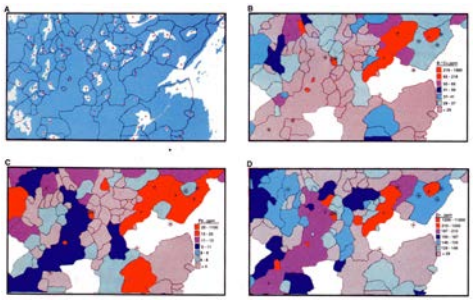


- Alteration map
  - Digitised

GIS in geoscience - example

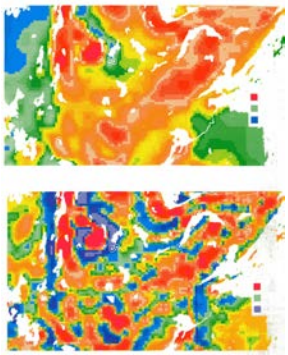
- Step 2
  - Evidence for prediction
  - Create classes of significant information
  - Proximity maps
    - Buffers
  - Geophysics derivative images

GIS in geoscience - example



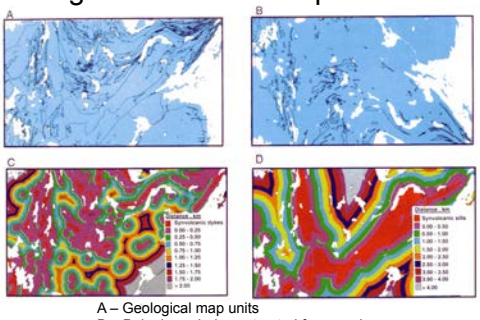
Geochemistry maps (A) sample locations and catchments (B) Cu (C) Pb (D) Zn

GIS in geoscience - example



Potential field data – TMI and 1VD

GIS in geoscience - example

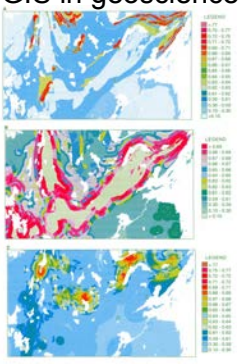


A – Geological map units
B – Dyke boundaries extracted from geology map
C – buffer on dykes
D – tonalite sills buffered

GIS in geoscience - example

- Step 3
  - Creation of maps providing evidence of mineralisation
  - Predictive map
  - Alternative maps
    - Assumption changes

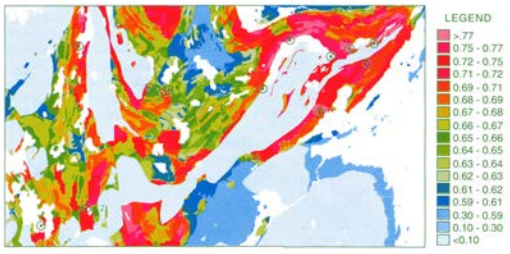
GIS in geoscience - example



Intermediate factors generated

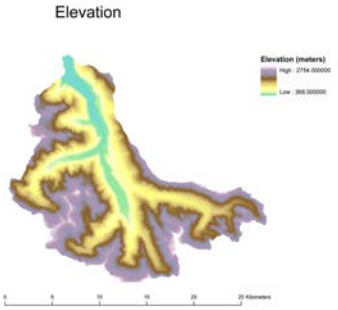
- stratigraphic factor
  - good lithologies close to good contacts
- heat factor
  - proximity to dykes and sills
- alteration factor
  - favorable rock types and proximity to alteration zones

GIS in geoscience - example



VMS favourability map – integrated intermediate maps

Soils of Thunder Creek Watershed, North Cascades



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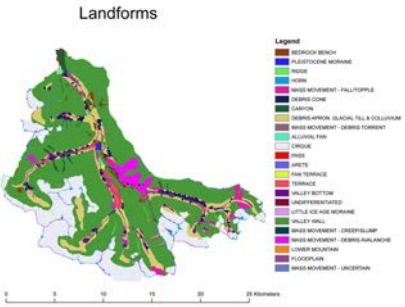

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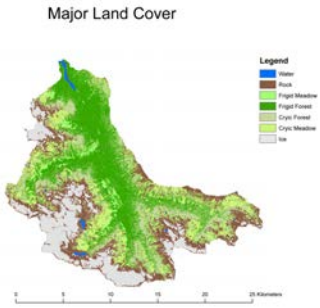

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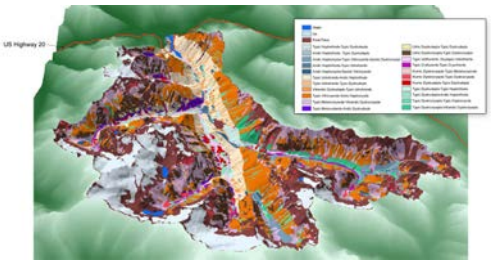

Diamondiferous Kimberlite Potential of Namibia

Fluvial contaminant dispersal

Los Alimos – radionuclide contamination

Fluvial contaminant dispersal