GIS in geology: overview and future trends

G. Bonham-Carter
Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8, Canada

Geographic Information Systems (GIS) are computer systems for the capture, storage, manipulation, analysis, retrieval and display of spatial information. This talk examines the geological (as opposed to geographical) roots of GIS, as indicated by publications mostly in the field of computer geology. The present capabilities of GIS are reviewed, and some future trends are postulated.

From the moment commercially available mainframe computers appeared in the early 1960s, computers began to be used for mapping applications in geology. Methods of trend surface analysis, automatic contouring, geostatistics and numerical modelling of fluid flow and sedimentation were published in the 1960s, often with digital pen plotter output. During the 1970s, colour raster plotting of grid and vector data became popular, and digital databases of well logs and surface modelling software were widely used in the oil industry. The early 1980s saw enormous changes due to computer graphics and PCs. The need to analyze satellite imagery catalyzed the development of raster image processing, and CAD systems made rapid advances for manipulation of vector data.

The modern commercial GIS, characterized by the graphical interface, the ability to handle both raster and topological vector data structures, with linkages to a relational database and ability to carry out map modelling operations, did not appear until the mid to late 1980s. This brought about rapid changes in the practice of map production, field data capture, and the visualization and manipulation of map data of all types. Commercial 3-D GIS systems were developed mainly for use by the oil industry, who needed to manipulate and visualize sedimentary basin data, or deposit-scale models for use by the mining industry.

Future trends in GIS will improve the ability to (1) represent and analyze the effects of uncertainty in spatial data, (2) combine 2-d and 3-d functionality, as for example in merging seismic interpretations with geological constraints, (3) permit multiple data views to be manipulated dynamically, (4) automatically generate and track provenance information with each data layer, (5) provide much closer coupling of GIS to statistical and geostatistical analysis packages, and (6) apply new methods of analysis not restricted to traditional spatial statistics. It is to be hoped that improved standards for spatial data formats will be developed by international bodies, rather than by commercial GIS companies. Freedom of access to spatial data generated by government agencies is likely to be crippled by pricing policies in most countries except the United States. The movement of spatial data via the Internet will have a profound impact on the usage of data that is distributed at no cost.