Surface Modeling with GIS

By

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For

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CRP 514: Introduction to GIS

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Outline

- Introduction
- Objective
- Griding technique
- Model structures with GIS
- Surface Model Creation Workflow
- 3D models visualization using GIS-ArcScene
- Conclusion

Introduction

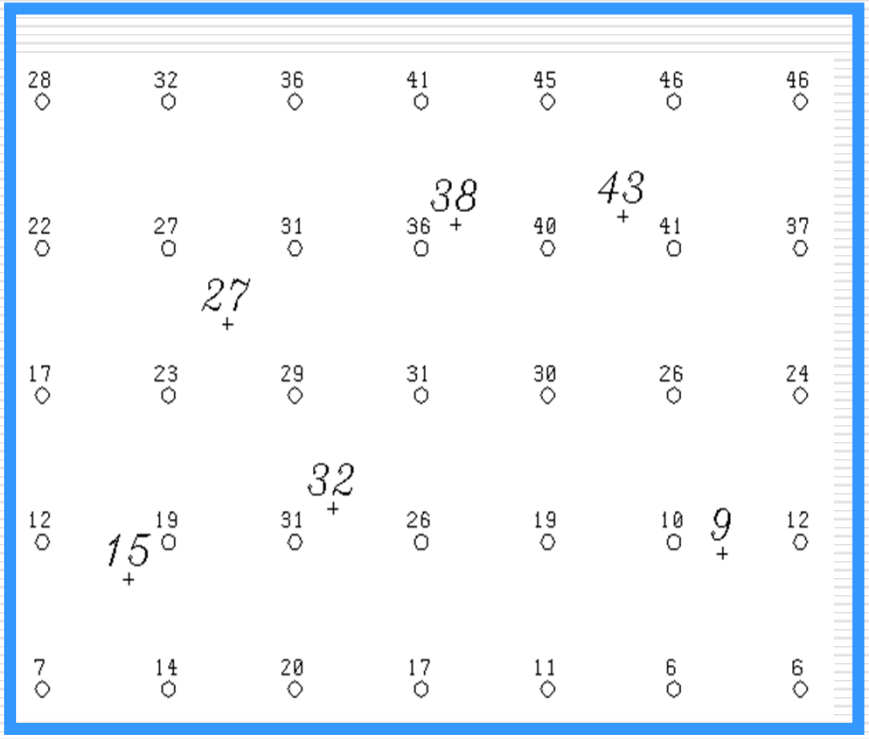
- Surface geologic modeling is a complex task for GIS. However, the spatial nature of geo-objects always drives GIS to be part of modeling systems.
- The spatial analysis extension provides the ability to generate grids and contours with a variety of data-interpolation method.

Objective

- To provide an introduction to surface modeling and griding techniques with GIS and also how to visualize structural models as 3D display using GIS-ArcScene.

Griding Technique

- A surface model (or grid) is a set of points that are regularly distributed estimates of some attribute over an area.



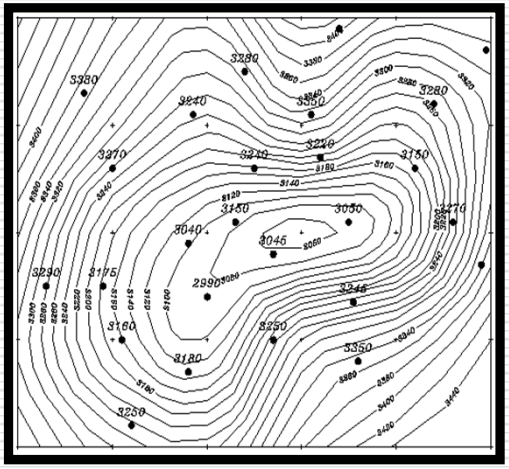
Grid with control points data.

The purpose of griding

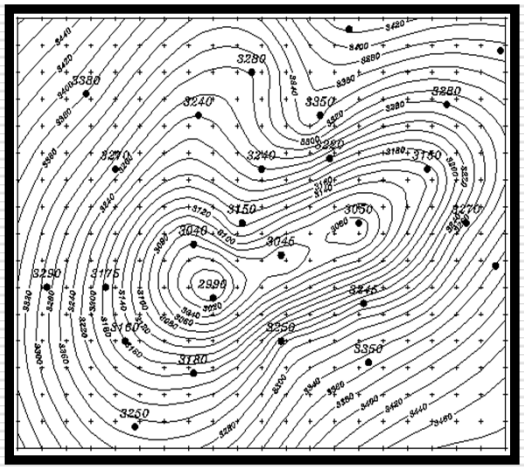
- Grids are produced in order to achieve an even distribution of points. Some examples of functionality that depend on the even distribution of points includes:
  - Generating contours on a map.
  - Producing perspective (3D) display.
  - Drawing grid profiles (cross section), Performing grid operation.

The effect cell size

- Map-1 Establishes The trend, Grid does not honor data points.
- Map-2 Honors individual data points & Preserves trend.
- Map-3 Honors the original data points very well. Loses trend in void data areas and forms artificial closures around data points.



Grid-Inc 200



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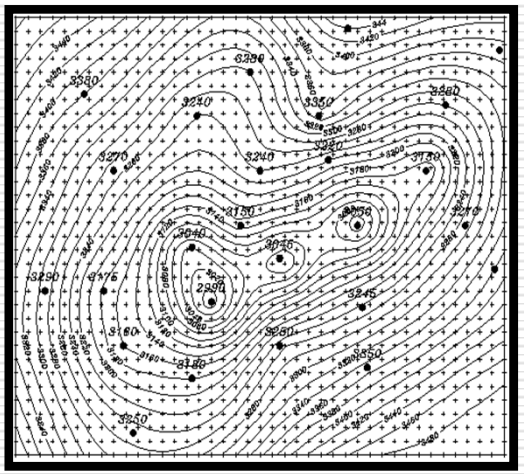
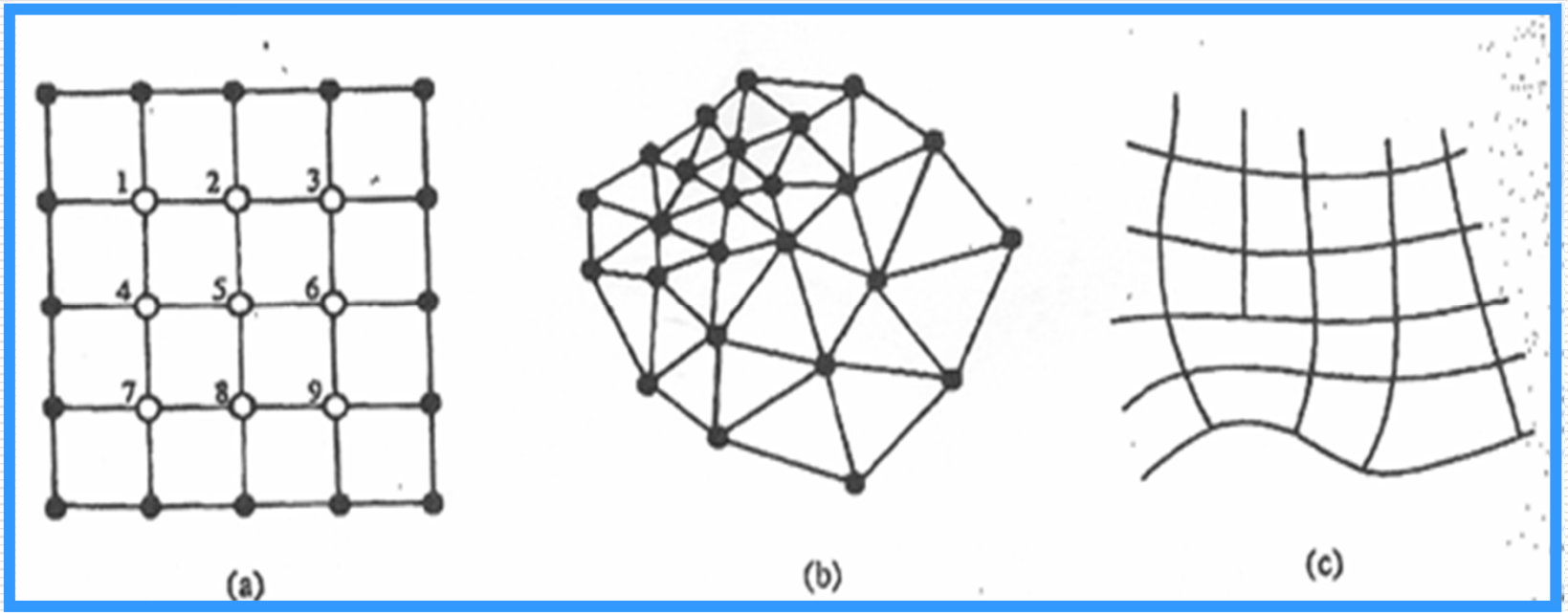


Grid-Inc 25

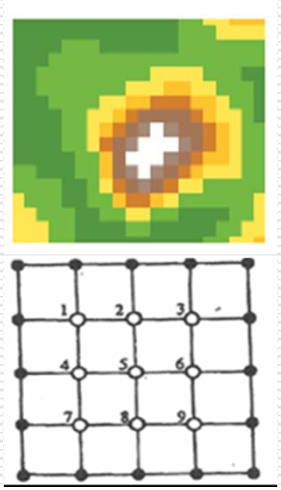
Models Structures with GIS



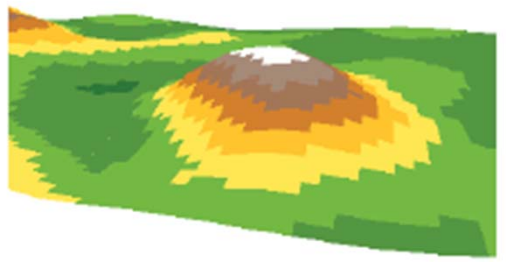
Raster Model | Triangulated Irregular Network (TIN) | Vector Model

Raster Model

- Raster surfaces are in Grid or pixels format.
- Grids identified by row & column.
- Grid cells are usually square in shape.
- Raster is the most widely used.
- Fitting plane is generated to estimate grid cell by regression or projection.
- The advantage of raster is that complex surface model algorithms are better suited for continuous array of evenly spaced data.



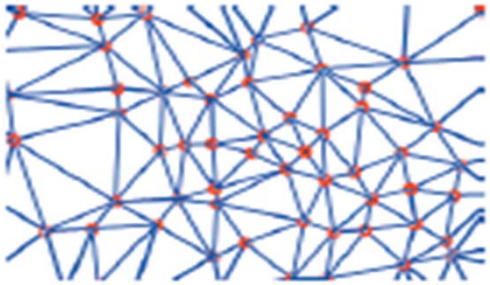
Raster Model



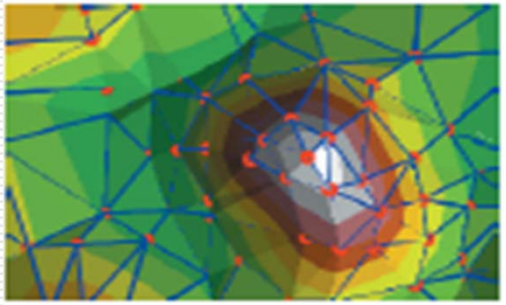
Raster Grid in perspective view

TIN Model

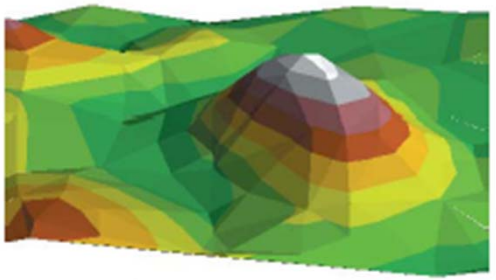
- Stands for Triangulated Irregular Network.
- Is an alternative to raster for representing complex surfaces.
- Elevations are calculated based on linear regression between control points.
- Contours are drawn across the sides of the connected triangular plates.
- The two advantages with TIN are: it does not interpolate beyond the data and the model is forced to fit the data.



Nodes and edges of a TIN



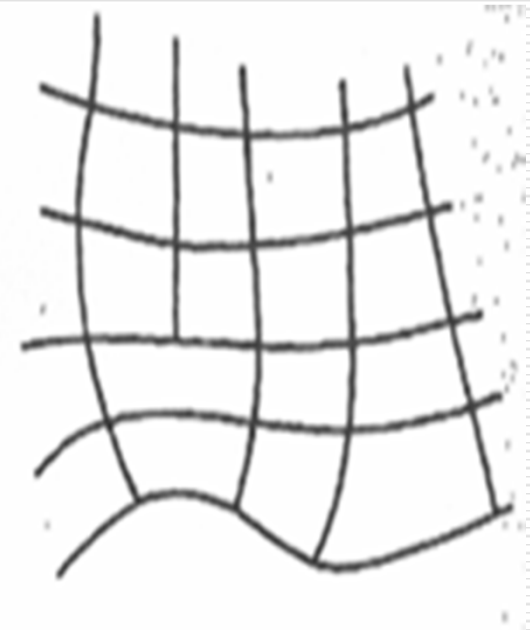
Nodes, edges, and faces



TIN in perspective view

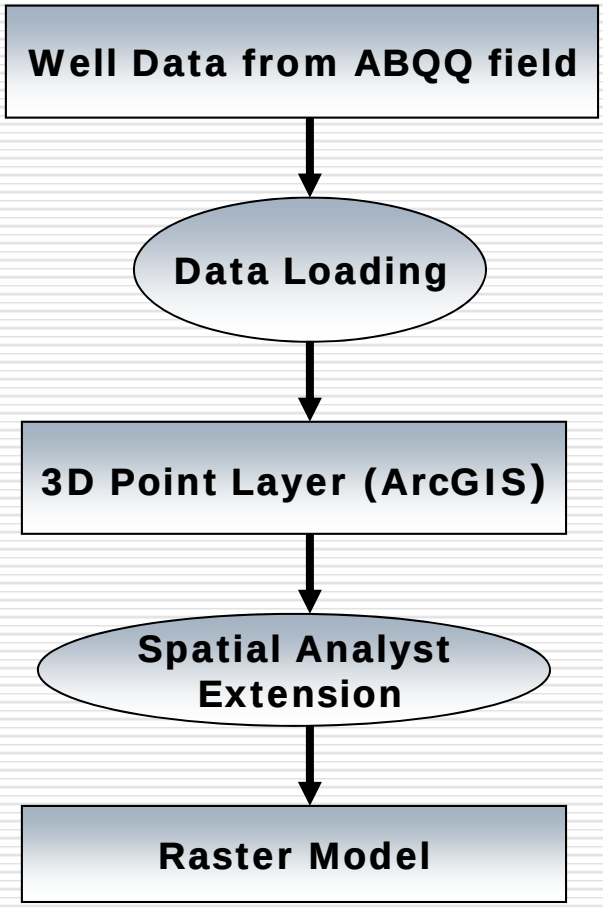
Vector Model

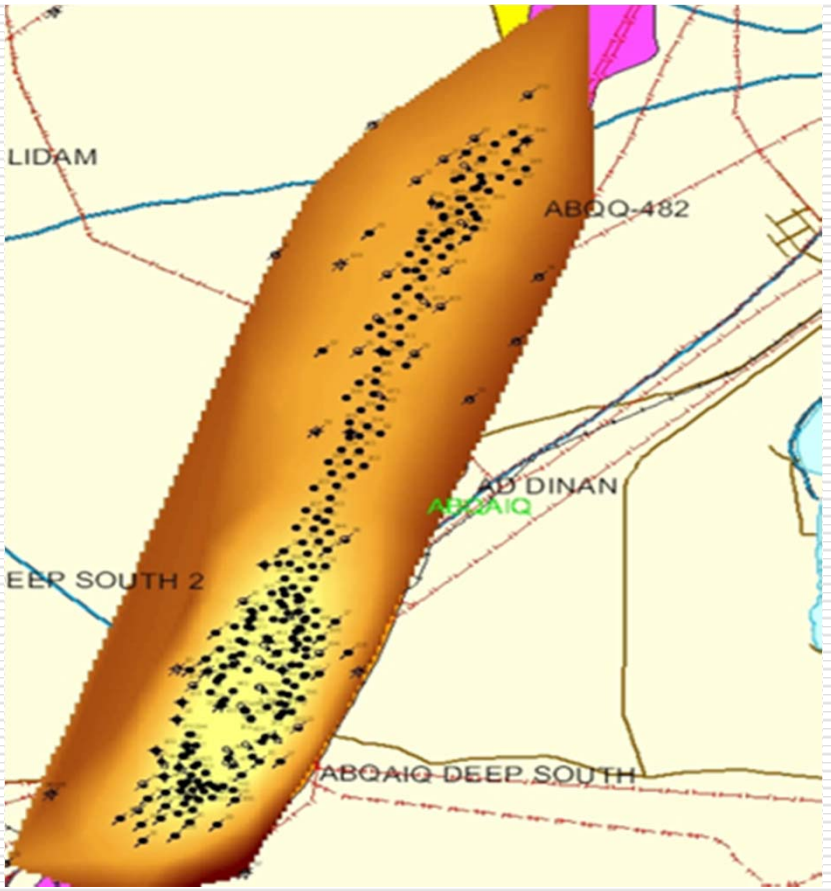
- Vector or contour – based methods consists of digitized contour lines and are stored as digital line graphs (DLGs) in the form of x, y.
- Vector model can be used to subdivide an area into irregular polygons bounded by adjacent contour lines and adjacent streamlines.
- Vector model is used in all administrative boundaries, roads, pipelines, power lines, flight paths and transportation routes.



Vector Model

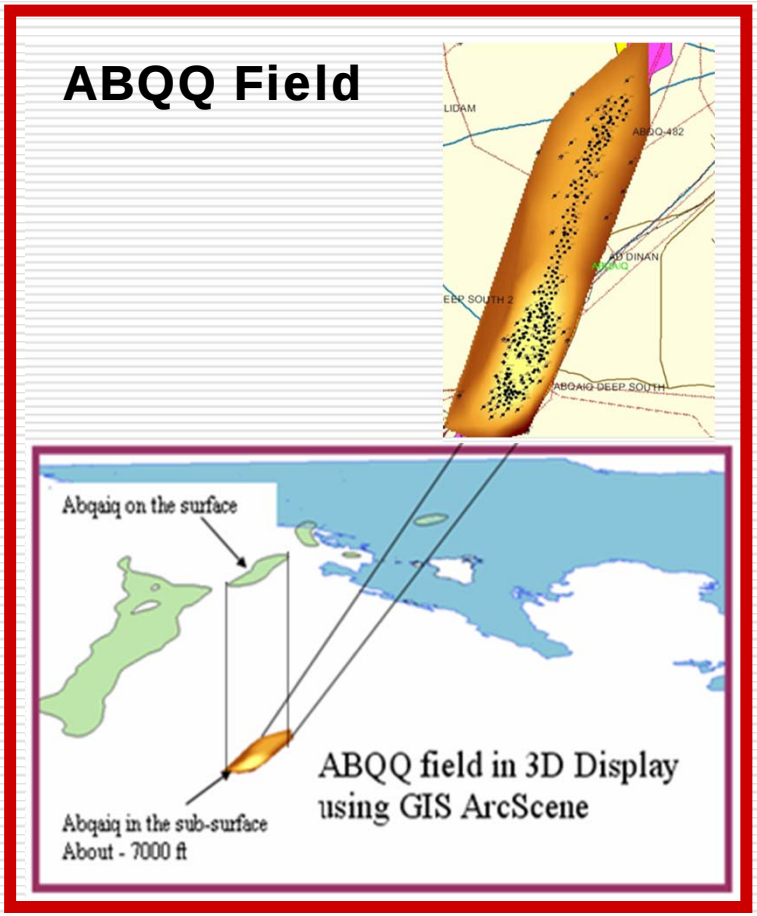
Surface Model Creation Workflow





3D Model Visualization with GIS-ArcScene

- ArcScene, 3D viewing application that is part of ArcGIS 3D Analyst extension.
- Allows earth scientist to visualize structural models in 3D.
- ArcScene helps geologists to find the structure of the reservoir below surface and in planning proposed wells, drilling operation and fluid flow direction.



Conclusion

- Geographic Information System is used to display and map both surface & subsurface data.
- The main methods of creating surface models are by interpolation and triangulation.
- None of the contouring can work with randomly control-point datasets; the datasets must always be grided first.

- The most widely used data structures consists of square grid networks because of their ease of computer implementation and computational efficiency.

- The flexibility of assigning Z-values from various sources makes ArcScene a powerful tool for anyone who needs to show the quantitative variations in three dimensional data.


Thank You
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