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Topological Properties of Geographic Surfaces: Applications in Computer Cartography (1978)

Objective

Expose topological structures and their potential use in computer-cartographic applications including

-Contouring

-Profile Searches

-Surface Generalization

Geographic Surfaces

- Continuous
- Single –Valued Function of 2 Variables (horizontal and vertical)
- Variables denote position in geographic space

- Assumed to be contained within a single “closed contour”

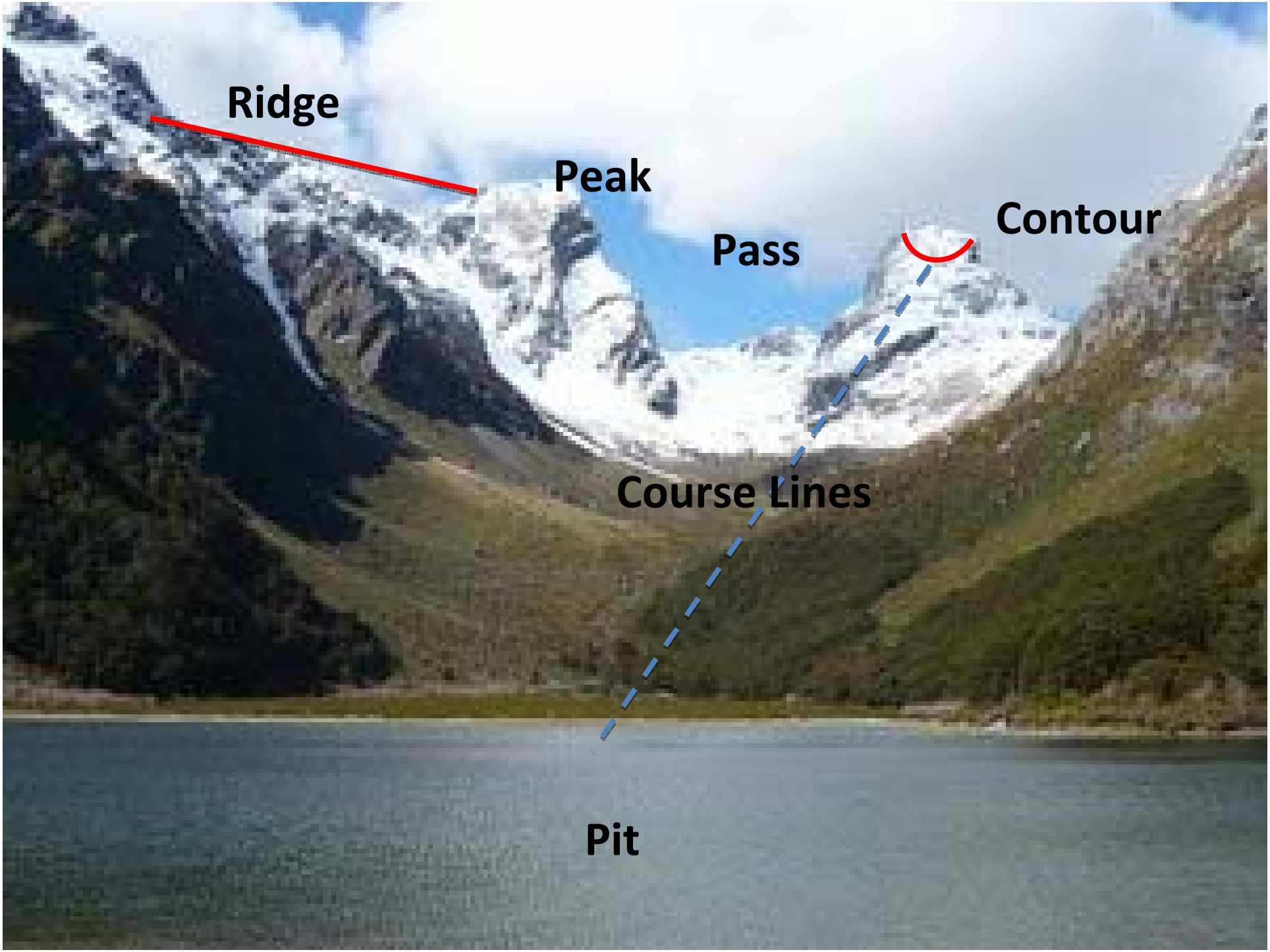
Topography is one example of a geographic surface

The Contouring Problem

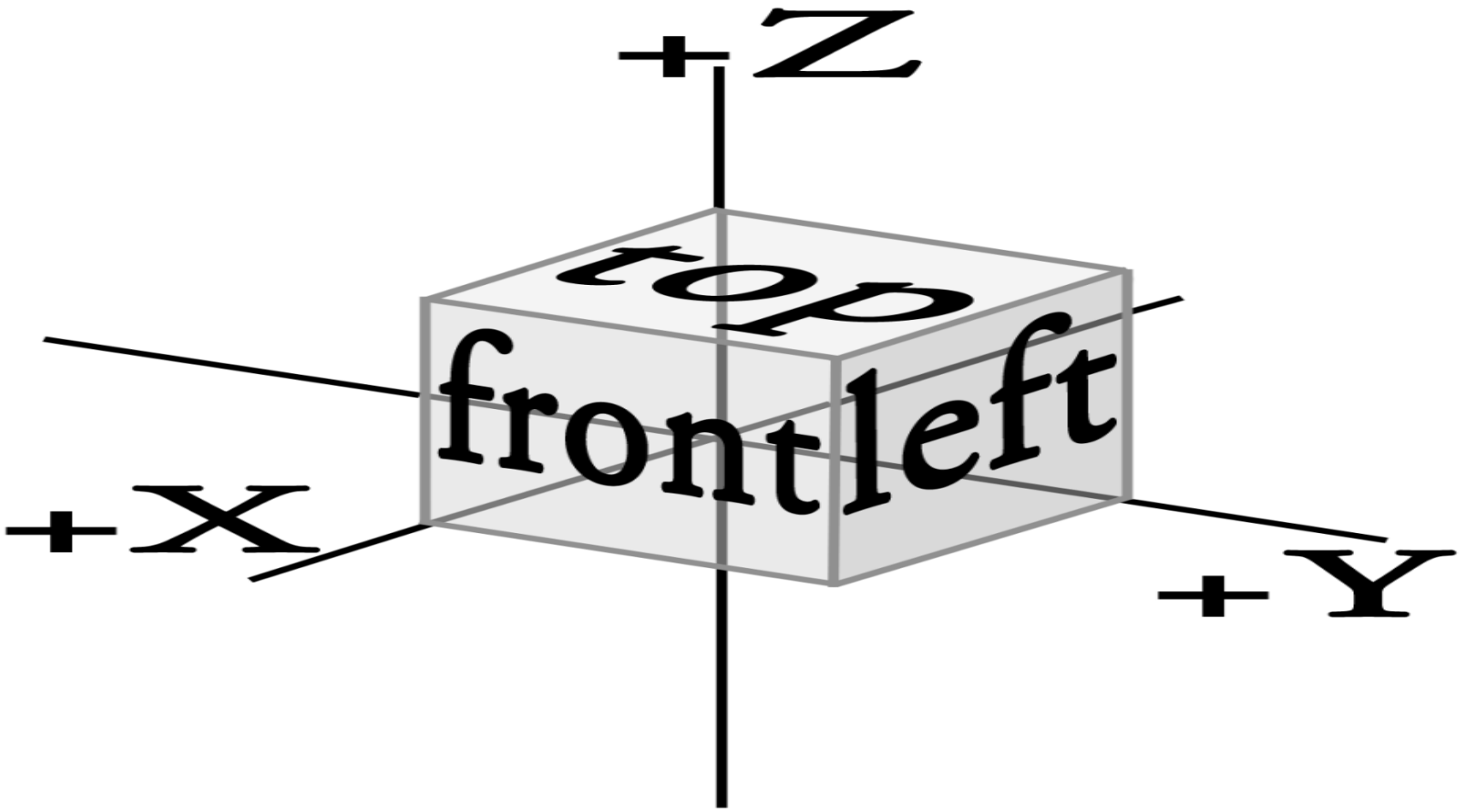
- We have the ability to have numerous discrete “sample points” to determine a geographic surface
- The Challenge lies in connecting these points into a CONTINUOUS smooth geographic surface network that accurately depict and model the “true” topography

Critical Points on a Closed Surface

- Peaks = Local Maxima
- Pits = Local Minima
- Passes = Mixed Equilibrium Saddle Points


Ridge
Peak
Pass
Contour
Course Lines
Pit

Cartesian Coordinate System



Wharntz Network of representing a geographic surface

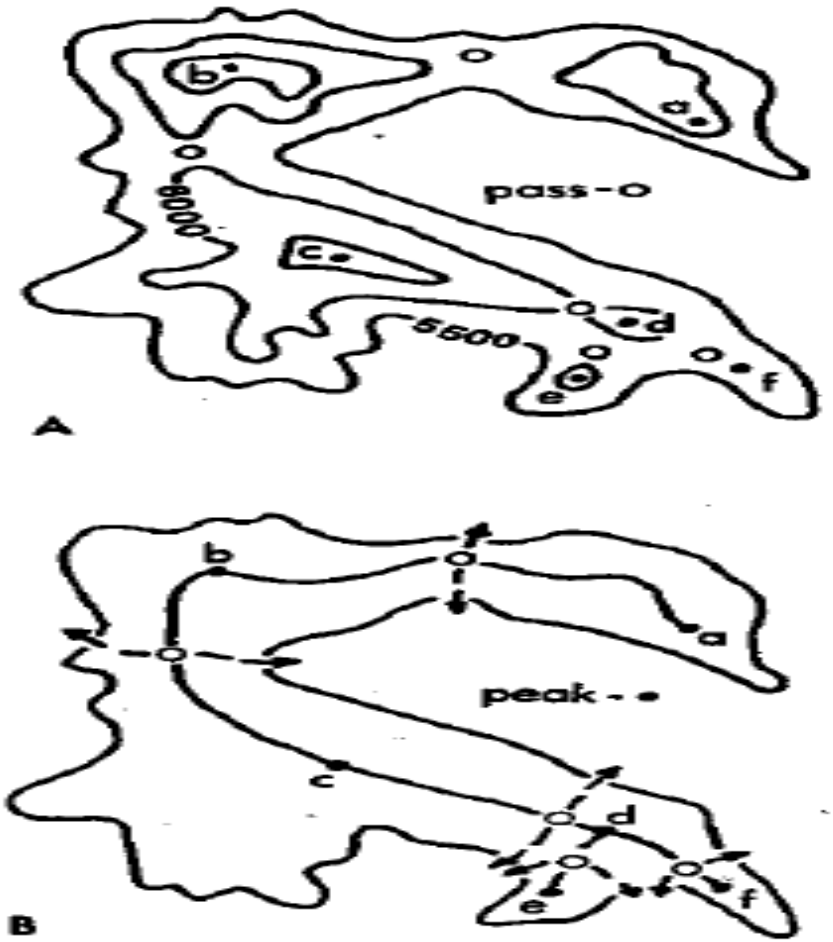


Figure 1 -- A) Simplified Contour Map of a Hilltop with Critical Points Shown

B) Critical Lines Forming the Warntz Network of the Surface

Note: Ridge lines are solid; course lines are dashed; all lead to some pit or pits outside the boundary contour.

A contour tree is another way to representing a geographic surface
And depicts the adjacency relationships between a set of contour loops

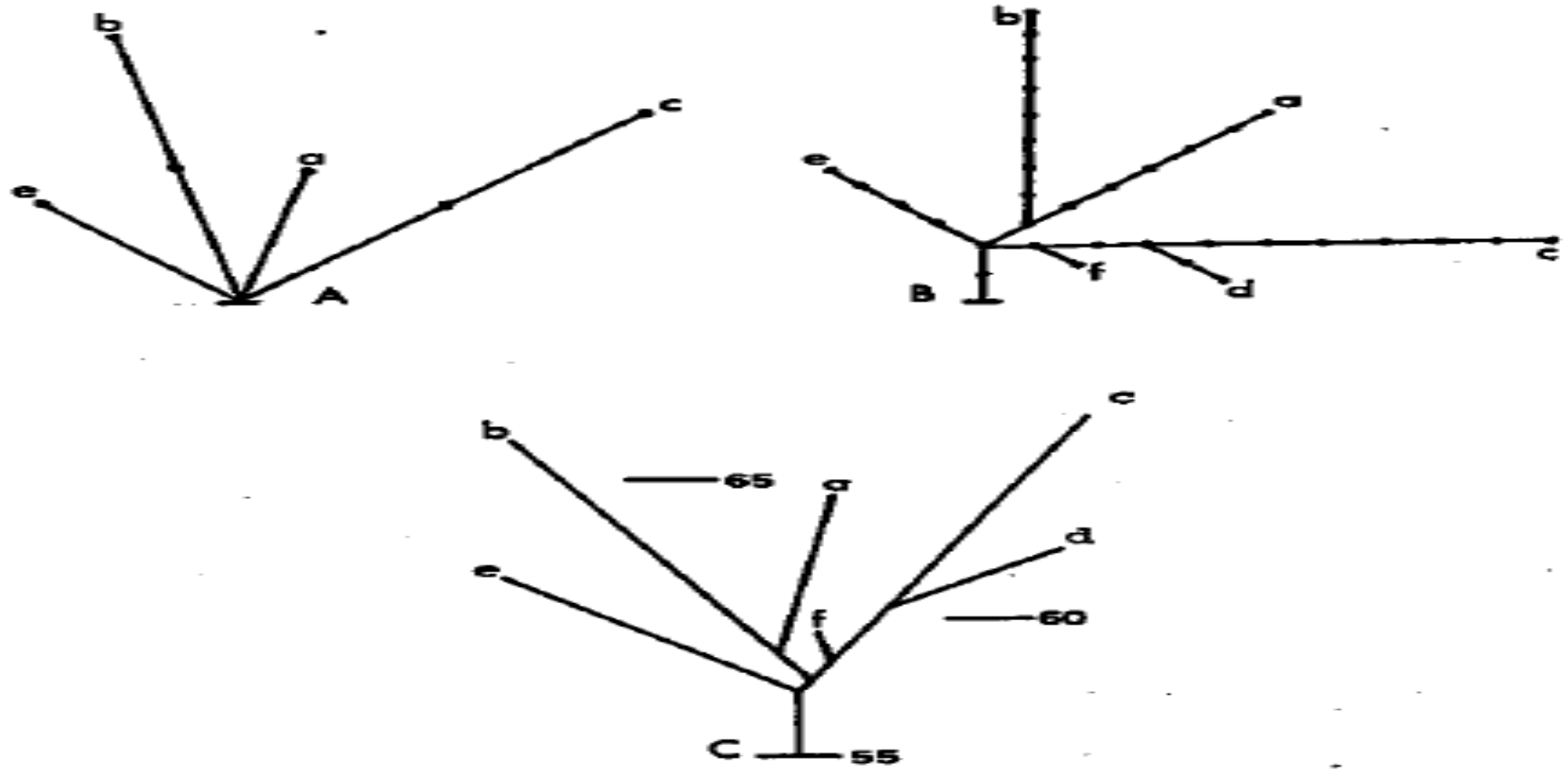


Figure 2 -- A: Contour Enclosure Tree for the Area Depicted in Figure 1

B: As in A, but with a 100-Unit Contour Interval

C: The Surface Tree of the Area with Elevations of Critical Points Plotted to Scale

Note:
Figures are in hundreds of units.

The lower-case letters indicate the correspondence with Figure 1.

How do we represent the physical topography of the world around us and what factors are important

- Relationships between adjoining points (this area is higher in elevation than that area)
- Position of a particular point in regards to other points

Surface Generalization: Where do we draw the line?
To Include
or
To Not Include

- What is the application the model is being created for and is it important to preserve fine spatial details?

Generalization Procedure

Procedure to remove item without destroying relationship between points

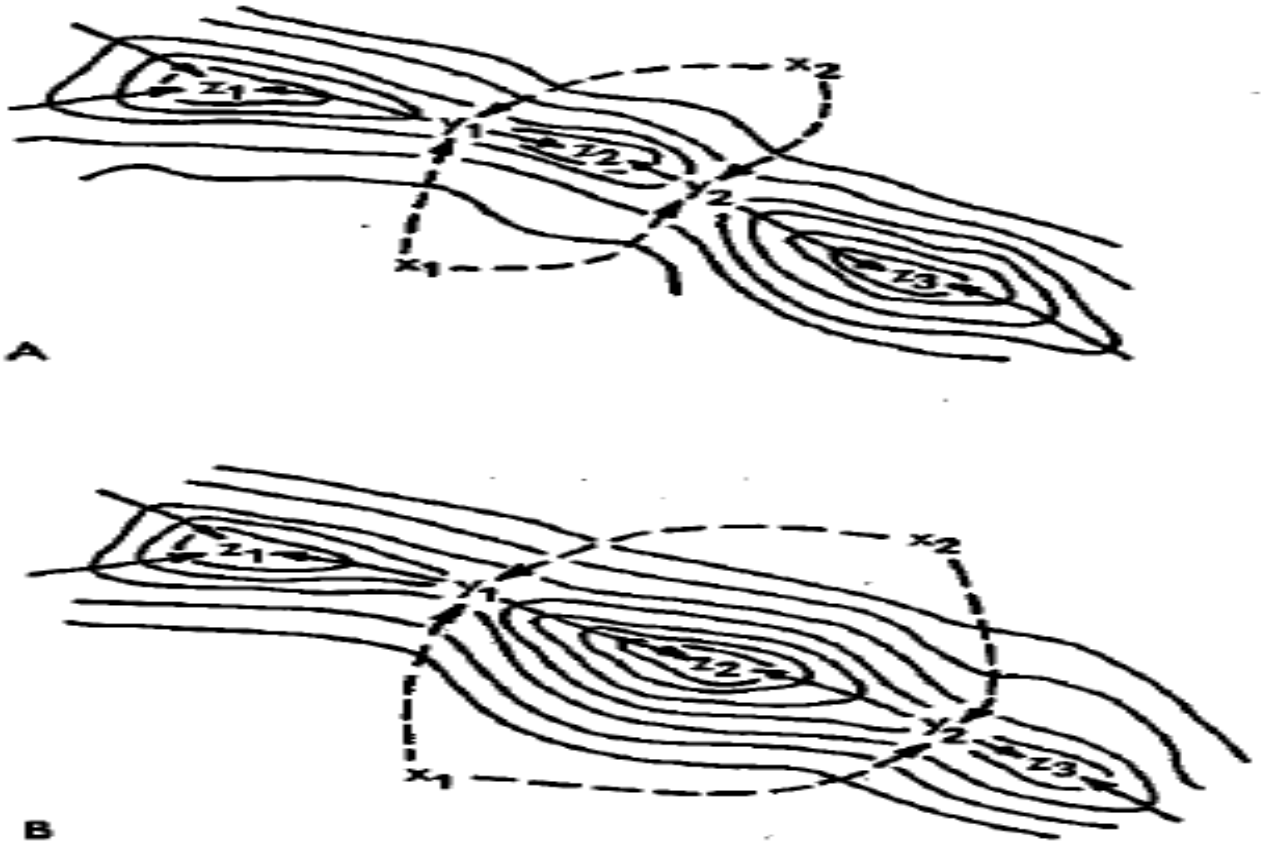


Figure 3 -- A generalization procedure proposed by Pfaltz (1976) would delete pass Y_1 and peak Z_2 in each case; this would be appropriate in A (Pfaltz's example) but not in B.

Conclusions

- Computer cartography problems such as surface generalization and surface networks
- Determining surface networks for DTM's and finding the necessary storage space to process will pay off in savings in model analysis
- Operational programs based on these concepts and approaches are needed