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MAXIMA: software to determine local maxima from gridded data

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Abstract

MAXIMA is a Geosoft GX implementation of a method of identifying local maxima from gridded data described by Blakely and Simpson (1986). The routine determines local maxima in 1, 2, 3, or 4 directions. The position of the local maximum value is calculated from 9 local grid cells and is an improvement on methods using grid cell centres as the position of the maxima. Local maxima can be discriminated by a user supplied minimum input grid value. The output maxima are written to a Geosoft GDB file.

TABLE OF CONTENTS

LIST OF FIGURES

1. Introduction

MAXIMA is a Geosoft GX implementation of a method of identifying local maxima described Blakely and Simpson (1986). It is based on original FORTRAN code written by Walter Roest (unpublished). This routine can be used to delineate magnetic domains based on maxima in the horizontal gradient of pseudo-gravity, analytic signal or other filters designed for edge detection.

2. MAXIMA GX

Various edge detection techniques (horizontal gradient maxima, analytic signal maxima etc.) require a method of identifying local maxima in gridded data. Blakely and Simpson (1986) developed a method that locates and provides a measure of the quality of the maxima. Their automated method of locating maxima from a data grid involves comparing each grid cell to its eight nearest neighbours (Fig.1) and determining if the central grid cell value is a local maximum in each of the four directions. The grid cell is assigned a value (N) between 0 and 4, signifying the number of directions in which the cell is a local maximum. An N value of 0 indicates that the point is not a local maximum in any direction. N values of 4 are isolated maxima, which are of minimal geological interest and probably represent noise when based on a single grid cell. N values of 2 and 3 represent local maxima that have lateral continuity and tend to define boundaries or linear features.

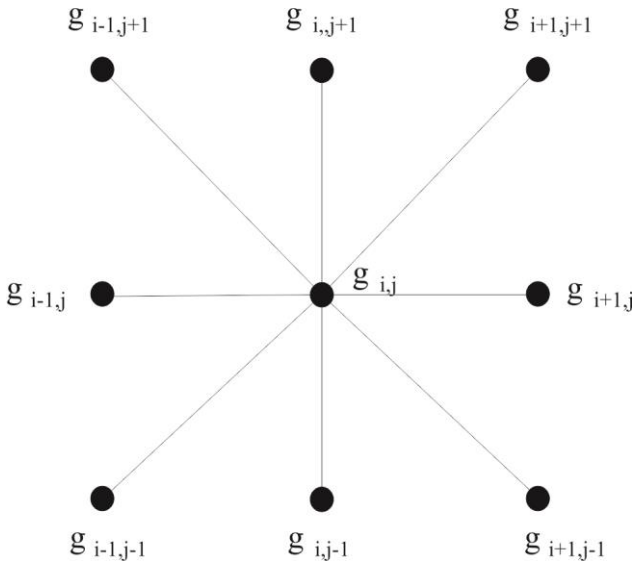


Figure 1. Eight nearest grid cell neighbours to $g_{i,j}$ and the four directions in which local maxima are tested. (after Blakely and Simpson, 1986).

As the grid represents a continuous surface at discrete points, the actual maxima may not fall on grid cell centres. The positions of the maxima are calculated from the grid cell and its eight nearest neighbours. For example, in the x direction:

$$x_{max} = -\frac{bd}{2a}$$

where

$$a = \tfrac{1}{2} (g_{i-1,j} 2g_{i,j} + g_{i+1,j})$$

$$b = \tfrac{1}{2} (g_{i+1,j} - g_{i-1,j})$$

and *d* is the grid cell size. The value of the grid at this point can be used as an acceptance criterion and is calculated by;

$$g_{max} = ax^2_{max} + bx_{max} + g_{i,j}$$

For each grid cell inspected, the highest value of g_{max} is used as the acceptance criterion. Local maxima can be discriminated by the number of directions in which the grid cell is a maximum and by the amplitude of the maximum.

2.1. Input Parameters

MAXIMA accepts the following input parameters:

Input Grid:
Specify the name of the grid for which local maxima will be determined.

Number of passes of smoothing filter:
Specify the number of passes of a Hanning filter to smooth the input data. Enter 0 for no smoothing.

Minimum value for local maxima:
Specify the minimum acceptable value of the input grid for all local maxima.

Index value for local maxima:
The index defines the nature of the output local maxima.

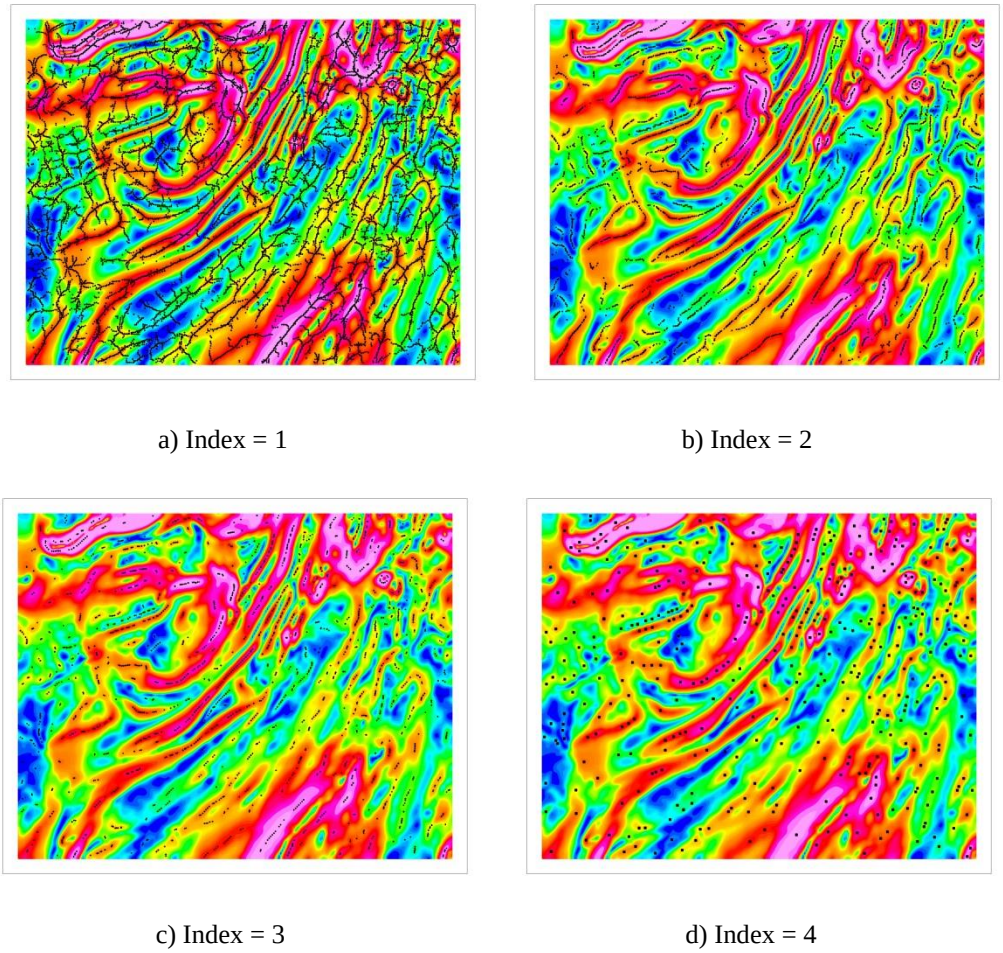
1 – local maxima in one direction – all maxima
2 – local maxima in two directions
3 – local maxima in three directions
4 – local maxima in four directions – isolated maxima

Index values of 1 represent local maxima in at least one direction. Index values of 2 and 3 represent local maxima that have lateral continuity and tend to define boundaries or linear features. Index values of 4 are isolated maxima, which are of minimal geological interest and may represent noise when based on a single grid cell.

Output GDB file:

Specify the name of the output GDB file to contain the local maxima.

3. Example - Figure 2 shows the local maxima of the horizontal gradient of pseudo-gravity using index values of 1, 2, 3, and 4.



a) Index = 1 b) Index = 2

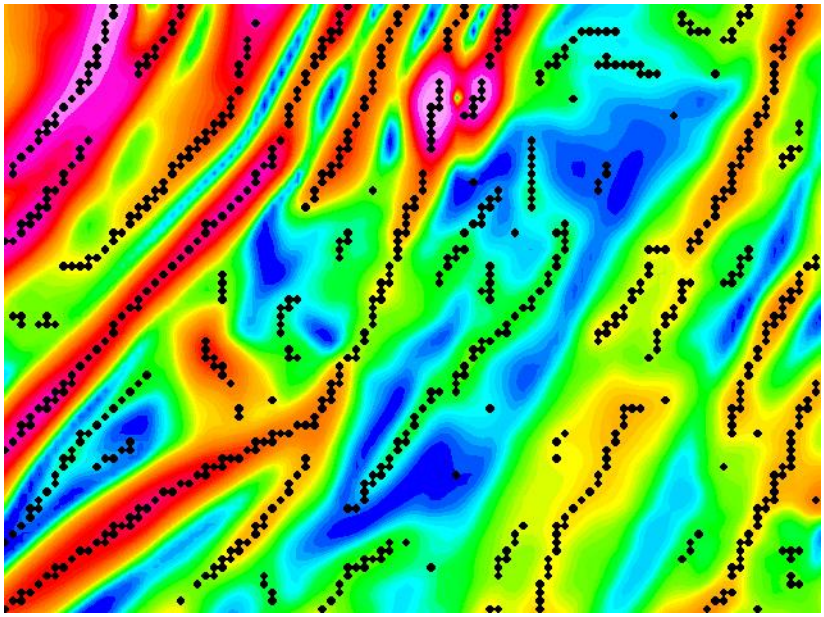
c) Index = 3 d) Index = 4

Figure 2. Local maxima (black dots) of the horizontal gradient of pseudo-gravity; a) Index = 1, b) Index = 2, c) Index = 3, and d) Index = 4.

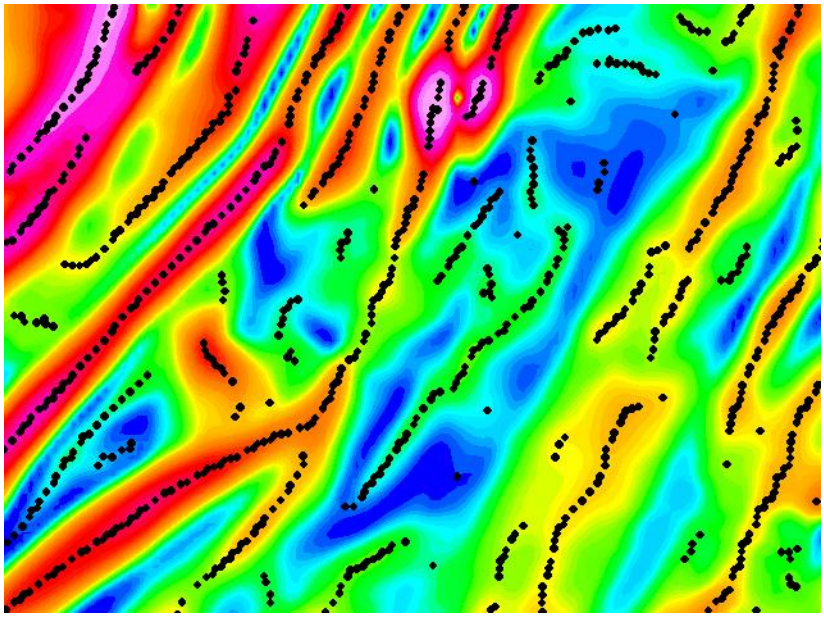
The local maxima in Figure 2a were generated with an index value of 1. This represents all local maxima regardless of the number of directions in which the point is a local maximum. Figures 2b and 2c represent local maxima in, respectively, two or three directions. These maxima have neighbours that are also local maxima and clearly define

linear features. Figure 2d represents local maxima in all four directions. As a result, only isolated local maxima are identified.

The GX determines the actual position of maxima, not merely the grid cell position of a maximum. As a result, the linear features defined by the GX are smoothly varying and not dictated by the grid interval (Figure 3).



a)



b)

Figure 3. a) local grid peaks based on grid cell centres b) actual local maxima.

4. Conclusion

MAXIMA GX finds local maxima based on the number of directions in which the local anomaly achieves a maximum value. The position of actual local maximum value is calculated from the current grid value and its eight surrounding grid values. These maxima better describe boundaries and linear features than similar techniques based on grid cell positions only.

References

Blakely, R.J., and Simpson, R.W., 1986. Approximating edges of source bodies from magnetic or gravity anomalies. Geophysics, **51**, No. 7, 1494-1498.