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Forsmark site investigation

Interpretation of topographic lineaments 2002

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April 2003

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Contents

1 Introduction

SKB performs site investigations for localization of a deep repository for high level radioactive waste. The site investigations are performed in two municipalities; Östhammar and Oskarshamn. The Forsmark investigation area is situated in Östhammar, close to the Forsmark nuclear power plant.

This document reports the interpretation of topographic lineaments carried out during 2002 in the Forsmark area.

The work was carried out according to activity plan AP PF 400-02-11 (SKB internal controlling document) by GeoVista AB (Hans Isaksson).

2 Objective and scope

The purpose of interpretation of lineaments from topographic data is to identify linear features (lineaments), which may correspond to deformation zones in the bedrock. The data will be combined with interpretations of lineaments from airborne geophysical data in order to produce an integrated lineament interpretation for the Forsmark area. This integrated interpretation will be combined with geological data in order to establish a bedrock geological map of the Forsmark area.

The area for the lineament interpretation is the same as that selected for the bedrock mapping activities during 2002, i.e. the land area around Forsmark.

3 Equipment

3.1 Description of equipment

All work has been completed using Windows-based computers and software. The following software's have been used:

Software	Trademark	Activity
Geomatica	PCI	Terrain modelling Image processing and "on screen" interpretation
Surfer	Golden Software Inc.	Grid processing
Oasis	Geosoft Inc.	Grid filtering
MapInfo	MapInfo	Documentation of characteristicsMap production
ArcView	ESRI	Delivery format

4 Execution

The work has been carried out according to the procedures and methodology described in "Metodbeskrivning för lineamentstolkning baserad på topografiska data" (SKB MD 120.001, v 1.0). However, some changes have been made regarding the attributes given for a lineament. The structure and content of the attribute table for lineaments has been altered by the data administrator for the SKB database, Sicada.

No field work has been carried out in this study.

4.1 Input data

New topographic data were produced during 2001 from aerial photographs taken from 2300 m altitude /1/. The following basic data have been used in the interpretation of lineaments based on topographic data:

- Elevation grid, 10 m spatial resolution /1/.
- Elevation contours, 1 m equidistance /1/.
- Infrared orthophoto data, 0.2 m spatial resolution /1/.
- Geographic data, cadastral map.

4.2 Data processing

The 10 m elevation grid has been resampled to a 50 m grid, to provide a basis for the identification of regionally more significant topographic lineaments. The infrared orthophoto grid has been resampled to 0.8 m spatial resolution and the contrast enhanced in order to provide a better colour distribution in the image.

The following terrain modelling has subsequently been performed on the elevation grids:

- Slope
- Aspect
- Drainage

The following image enhancements have been performed on the 10 m elevation grid:

- Laplacian. Generates sharp edge definition (slopes) of a grid.
- Edge sharpening filtering by combining subtractive smoothing and edge enhancement is often used as a basis for image segmentation. Good results can often be obtained by applying a vertical derivative filer, commonly used for potential field data.

- Sobel filter. This filter enhances edges (sharp changes in slope values) and provide similar information as Slope.

For lineament interpretation purposes, a combination of the slope, the edge sharpening and the original elevation grid datasets, together with the elevation contours, have shown to be most useful.

4.3 Lineament interpretation

The lineament interpretation has been carried out by visual identification, delineation and characterization, using image analysis and GIS-techniques. The identified lineaments have been stored as vectors in four layers according to character and method:

- Minima (valleys) identified in 10 m elevation grids and 1 m contours.
- Edges (slopes) identified in 10 m elevation grids and 1 m contours.
- Minima (valleys) identified in 50 m elevation grids (but not in 10 m grids).
- Edges (slopes) identified in 50 m elevation grids (but not in 10 m grids).

At this stage, the vectors are only 2-dimensional. However, it is a rather simple procedure to attach an elevation value to each node in the lineament vectors. This work can be carried out at a later stage.

Some topographic depressions have been displayed as surfaces. These areas are expressed by a very flat landscape, with little or no topographic relief. Topographic lineaments are very difficult to identify in these areas, which mostly represent lakes, bogs and marshes. The sea area has not been outlined. It should be noted that also the industrial area around the Forsmark power plants is very flat due to extensive landfill. However, this feature is regarded as artificial and therefore not included. The extension of the industrial area can, if needed, be expressed from cadastral map data.

During the characterization phase the identified lineaments have been checked against the infrared orthophoto and the cadastral map data. The grade of uncertainty for each lineament has been judged in relation to possible artificial causes such as power lines, roads etc. Supporting features have also been noted, such as very narrow valleys, narrow occurrences of deciduous forest, wetlands and bogs, etc. In some cases, the lineament extension has been adjusted according to features occurring in the infrared orthophoto. Finally, some obvious, additional lineaments, identified solely in the infrared orthophoto data, have been outlined in a separate vector layer.

Detailed information on the lineament characterization can be found in Table 1. A flow chart for the whole work is presented in Figure 4-1.

The shortest length identified for a topographic lineament in this study is generally around 100 m. However, a few shorter lineaments have been outlined. Work in more detailed scales can probably also reveal shorter topographic lineaments, with a length in the order of 20 – 100 m. This is especially valid for the high resolution, infrared, orthophoto data. Such studies are preferably carried out over a smaller target area.

Table 4-1. Attribute table for lineament characterization

Field name	Name	Description	Attribute used in this work
Id_t	Identity	Identity given to the lineament. Can only be obtained from the data administrator of the SKB database SICADA.	Not assigned in this work
Origin_t	Origin	Major type of basic data	Topography
Method_t	Method	The data in which the lineament is identified	Elevation model, 10 m gridElevation model, 50 m gridElevation model, 1 m contourInfrared orthophoto, 0.8 m grid
Char_t	Character	Character of the lineament	Minima (valley) or Edge (Slope) for DEM-dataLineament for orthophoto
Uncert_t	Uncertainty	Gradation of identification, in terms of uncertainty	Low, Medium, High
Class_t	Classification	Classification of a lineament	Not assigned in this work
Comment_t	Comment	Specific comments, e.g. cause of uncertainty	Commonly; road, power line, narrow valley etc
Process_t	Processing	Data processing performed	DEM, Edge sharpening, Slope (Sobel), 1 m contours, drainage, image visualisation
Date_d	Date	Point of time for interpretation	20020902, 20030110
Scale_t	Scale	Scale of interpretation	5000–10000
Platform_t	Platform	Measuring platform for the basic data	All data originate from aerial photographs, 2300 m altitude
Width_n	Width	Width on average	Not assigned in this work
Precis_n	Precision	Spatial uncertainty of position	10–100 m, 20 m in general
Sign_t	Signature	Work performed by:initials and organisation	hi (Hans Isaksson), GeoVista AB

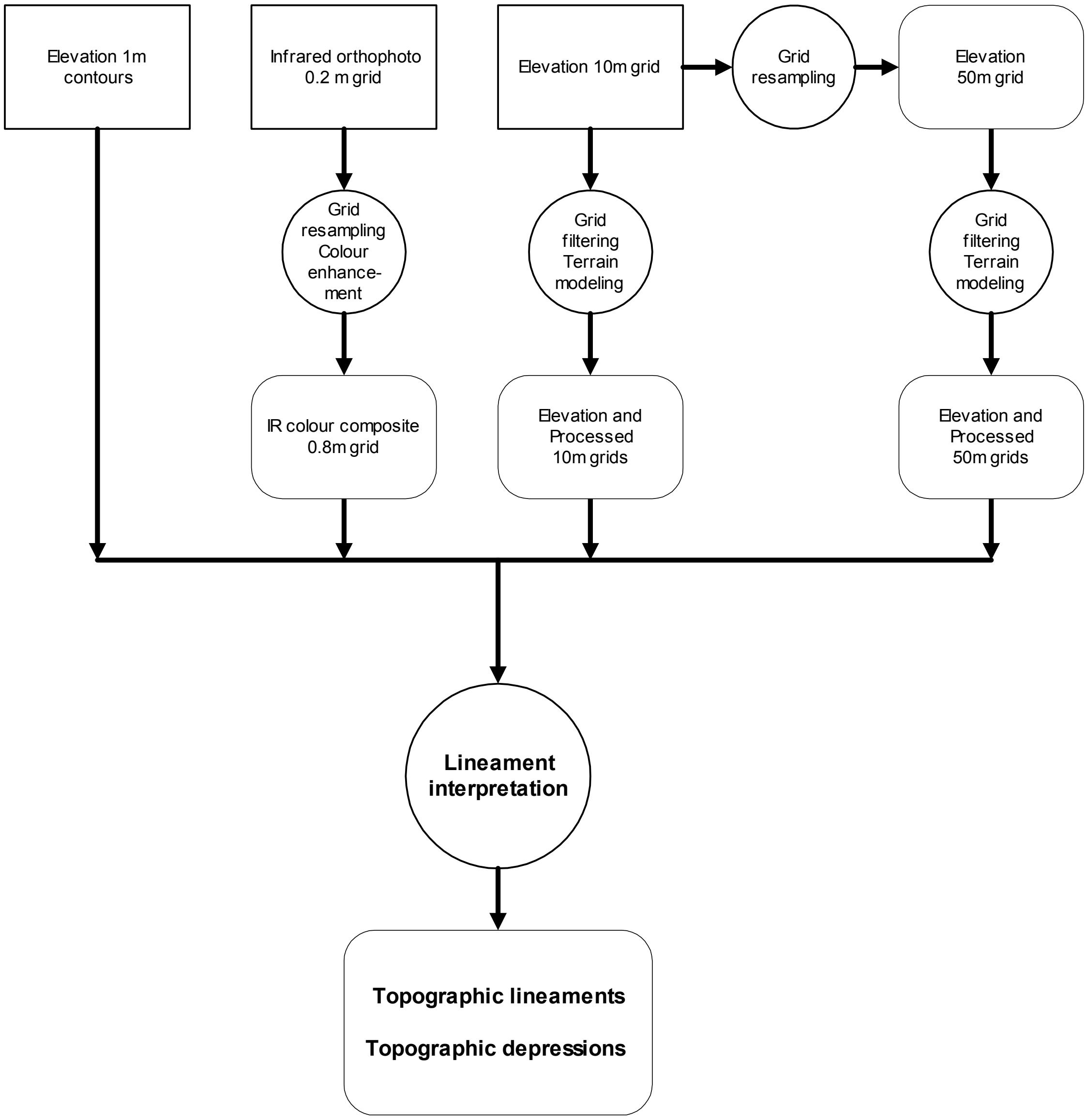

Figure 4-1. Flow chart for topographic lineament interpretation.

5 Results

The interpretation of topographic lineaments, see Figure 5-1, has in total identified 1017 lineaments, divided in method and character as follows:

	Minima	Minima and orthophoto lineament	Edge	Edge and orthophoto lineament	Orthophoto lineament
10 m elevation grid and 1m contours	579	233	53	46	N/A
50 m elevation grid and 1m contours	26	24	8	0	N/A
Infrared orthophoto	N/A	N/A	N/A	N/A	48
(N/A, not applicable)					

Uncertainty estimates are distributed as follow:

- 270 occurrences. Low uncertainty.
- 676 occurrences. Medium uncertainty.
- 71 occurrences. High uncertainty.

In addition to the lineaments, 11 topographic depression areas have been outlined.

The results of the interpretation have been delivered to SKB in ArcView format, and the data can be extracted from SKB's GIS database. The file names are:

Topographic depressions: GV_FM_GEO_1304

Topographic lineaments: GV_FM_GEO_1305

The SICADA reference to the activity is Field note No. 74.

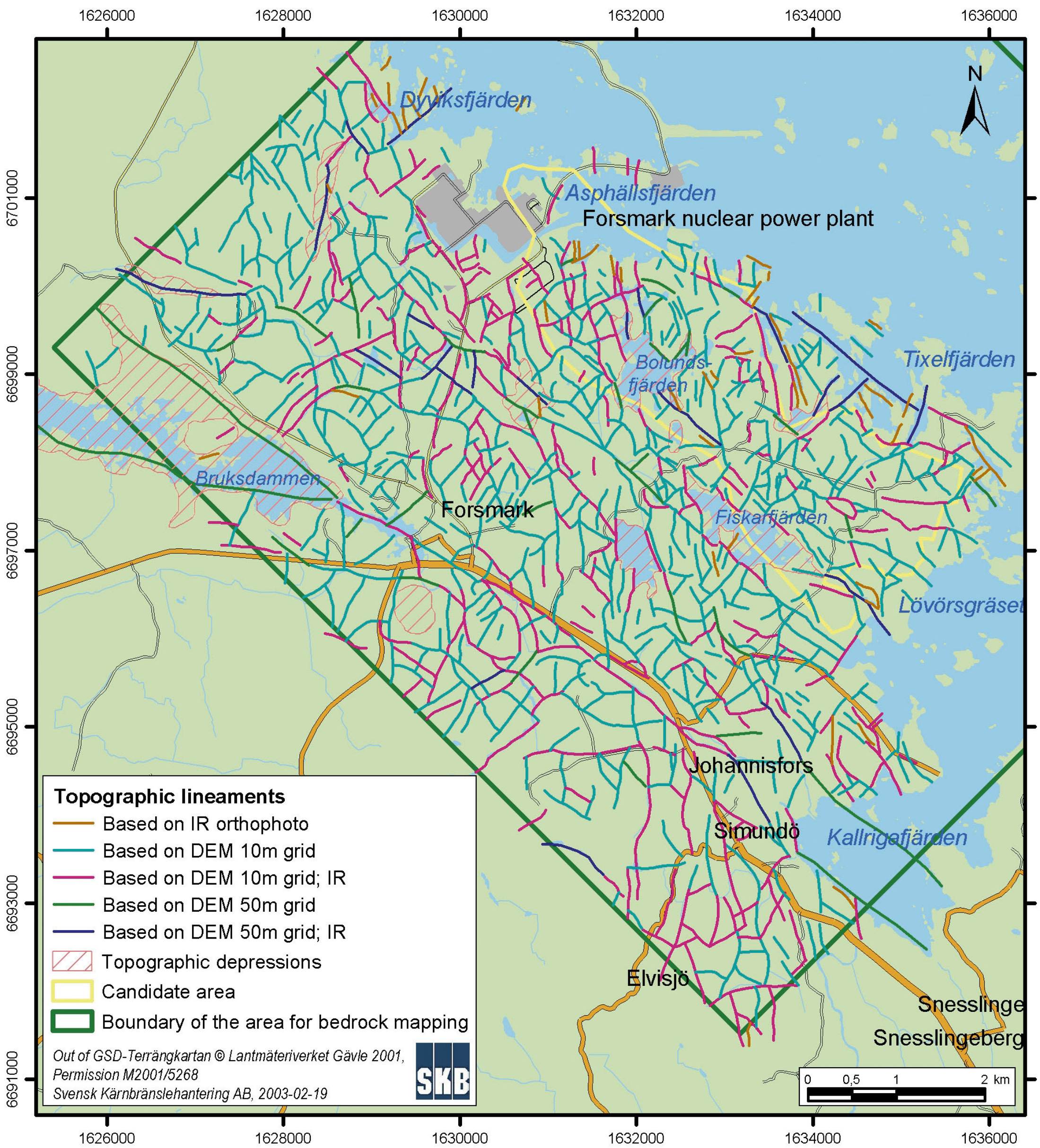

***Figure 5-1.** Topographic lineaments identified in the present study.*

6 Reference

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