P-04-49

Oskarshamn site investigation

Joint interpretation of lineaments

Carl-Axel Triumf, GeoVista AB

April 2004

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-04-49

Oskarshamn site investigation

Joint interpretation of lineaments

Carl-Axel Triumf, GeoVista AB

April 2004

Keywords: Lineament, Simpevarp, Laxemar, Oskarshamn, Topographical data, Elevation data, Digital elevation model, Fracture zones, Deformation, Helicopter borne geophysics, Airborne geophysical survey data, Bathymetry, Uncertainty.

Abstract

This document reports the results gained from the joint interpretation of lineaments within the Simpevarp regional model area. The joint interpretation strives to homogenize the earlier identified lineaments from different data sets, such as a new digital terrain model, results from helicopter borne geophysics and marine gelogical investigations. The final result is a homogenised group of lineaments (called "linked lineaments") where every single lineament has been assigned a number of parameters describing the origin and character of the linked lineament.

The linked lineaments will be further evaluated in order to control whether they represent deformation zones or not, some of them with geological field control and some by means of geophysics and drilling. This means that a lineament remains to be a linear structure only, until the source to the feature has been identified and classified.

Sammanfattning

Föreliggande rapport presenterar resultaten från en samtolkning av lineament inom det regionala modellområdet i Simpevarp. Målet med samtolkningen är att skapa en homogen grupp av lineament ur alla de som identifierats i samband med tolkning av en digital terrängmodell, data från flyg- och helikopterburen geofysisk mätning samt detaljerad maringeologisk undersökning. Slutresultatet utgörs av s k linked lineaments där varje lineament beskrivs med parametrar som belyser lineamentets ursprung och karaktär.

Gruppen av lineament (linked lineaments) som denna samtolkning resulterat i är ej att betrakta som annat än linjära objekt på kartan. Flera av dem är förvisso deformationszoner men även andra förklaringar kan finnas. Det är först genom geologiska fältkontroller, geofysiska mätningar, borrning eller annan information och kunskap som man kan avgöra om ett lineament representerar en deformationszon. Lineamentkartan får därför inte sammanblandas med den karta över deformationszoner som kommer att tas fram i SKBs fortsatta arbete.

Contents

1 Introduction

This document reports the results gained in the activity “Joint interpretation of lineaments”. It is one of the activities performed within the site investigation at Oskarshamn.

The work was carried out by GeoVista AB during the winter of 2004 mainly following the instructions and guidelines from SKB (activity plan AP PS 400-04-004 and method description SKB MD 120.001, SKB internal controlling documents) under the supervision of Peter Hultgren, SKB. The personal communication with the work group of Forsmark, which has carried out a similar activity regarding joint interpretation of lineaments in the Forsmark area, has also been an important complement to the guidelines.

At an early stage of the site investigation at Oskarshamn, an identification of lineaments in the Simpevarp area was carried out through the interpretation of topographical data /1/. In parallel, data from the airborne geophysical surveys of 1986 and 2002 were interpreted; one of the key tasks was the identification of possible lineaments /2/. These preceding activities resulted in the identification of more than 5,000 lineaments of different character. Altogether these lineaments formed quite a heterogeneous group which without refinement, would be complicated to investigate further and to invoke in geological models.

In a second step, “Joint interpretation of lineaments in the eastern part of the site descriptive model area”, the topographical and geophysical lineaments in the eastern part were unified into a more homogeneous group /3/. This activity formed the first step of two in the joint interpretation of lineaments and covered a small area at and around the Simpevarp peninsula.

This present activity “Joint interpretation of lineaments” also strives to homogenise earlier gathered lineaments, primarily west of the area for the activity described above. As data from the marine geological survey became available during the joint interpretation, they also had to be implemented into the process. This resulted in a re-evaluation of the near coastal linked lineaments already presented in /3/. Furthermore some of the linked lineaments on land also had to be re-evaluated. This means that the result from the present joint interpretation activity covers almost the entire regional model area where new data are available from the helicopter borne survey /4/, the air photo survey /5/ and the marine geological survey /6/. The result presented from the “Joint interpretation of lineaments in the eastern part of the site descriptive model area” /3/ are thus superseded by the present activity.

The final result of this activity “Joint interpretation of lineaments” is a homogenised group of lineaments (called “linked lineaments”). The linked lineaments will be further evaluated in order to control whether they represent deformation zones or not, some of them with geological field control and some by means of geophysics and drilling. This means that a lineament remains to be a linear structure only, until the source to the feature has been identified and classified.

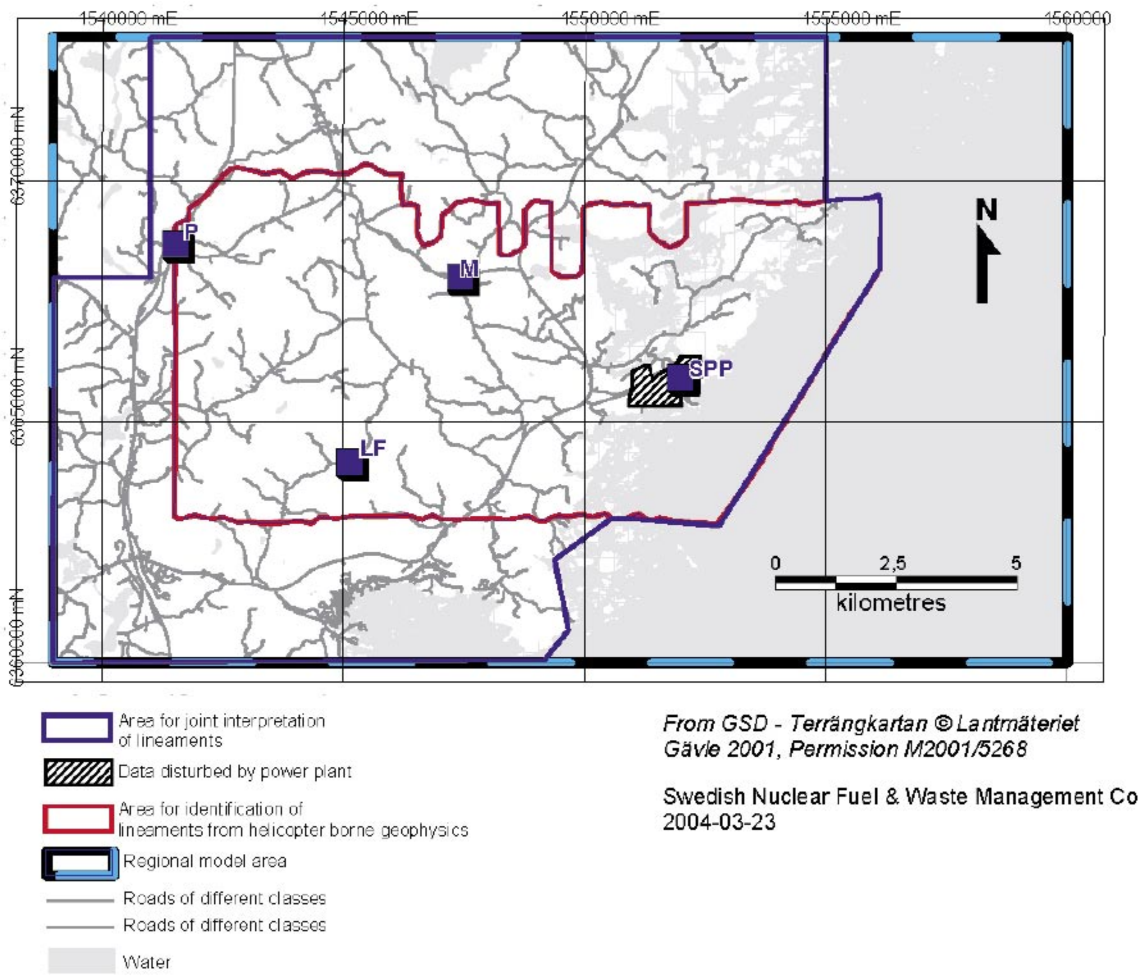

Figure 1-1. *The area that is covered by the joint interpretation is shown together with the Simpevarp regional model area and the area where lineaments were identified from helicopter borne geophysics. The marked area around the Simpevarp nuclear power plant (SPP) shows where data from the helicopter borne survey and topography are degraded in quality or missing. P = Plittorp, M = Mederhult, LF = Lilla Fjälltorpet.*

2 Objective and scope

The activity "Joint interpretation of lineaments" strives to uniform lineaments previously identified from different data sets. The joint interpretation is thus expected to result in a homogeneous group of lineaments both regarding the view of their location and the description of their character. In this group called "linked lineaments", which is a purely technical term without any connection to geology, the character of each lineament can more easily be evaluated both in the perspective of planning further field investigations and in the construction of a structural model for the area. The objective of the joint interpretation is to identify linked lineaments longer than 1 kilometre.

The final result of the joint interpretation reported here is gathered in a GIS shape file where every identified lineament is called a linked lineament. From the shape file all parameters connected to the specific linked lineament can easily be extracted. Every linked lineament however, is built up from one or more so-called "co-ordinated lineaments" picked from another GIS shape file. The shape file with "co-ordinated lineaments" forms the other product from this joint interpretation activity. The term "co-ordinated lineament" is also purely technical.

In summary the result of the joint interpretation of lineaments will be delivered to SKB as two shape files and presented in this report.

3 Equipment

3.1 Description of equipment

The joint interpretation is a pure desktop study using computers with appropriate software. The softwares used for interpretation and presentation of results were MapInfo (MapInfo Corp) and ArcView (ESRI). The calculations of directions were made with Discover (Encom Technology).

4 Execution

4.1 Definitions

A *lineament* is a linear anomaly on the Earth's surface, straight or gently curved, which has been interpreted on the basis of a 2-dimensional data set, such as a topographic map, a digital terrain model (DTM), an air photo mosaic, or an aeromagnetic map /7/.

A *method specific lineament* is a technical term meaning a lineament defined from a single and specific type of data set. The data set comes from one type of an investigation method such as topography (essentially a digital terrain model either based on airborne photographs or bathymetry), airborne magnetics or airborne EM (coil-coil frequency domain system or VLF), see also Figure 4-1.

A *co-ordinated lineament* is a technical term meaning a single lineament that represents all method specific lineaments that are supposed to indicate the same length section of an actual lineament, see also Figure 4-1.

A *linked lineament* is a technical term meaning a lineament that is composed of one or several co-ordinated lineaments.

Method specific, co-ordinated and *linked lineaments* are all supposed to represent a *lineament* according to the general definition explained above. The prefix is used only due to reasons of communication and quality assurance where the names are supposed to associate the reader to a specific interval in the process of defining and describing lineaments.

4.2 Overview of the joint interpretation process

The process of joint interpretation consists of:

- preparatory work,
- construction of co-ordinated lineaments from method specific lineaments (see Figure 4-1),
- parametrization of the co-ordinated lineaments,
- construction of linked lineaments from co-ordinated lineaments (see Figure 4-1),
- parametrization of the linked lineaments.

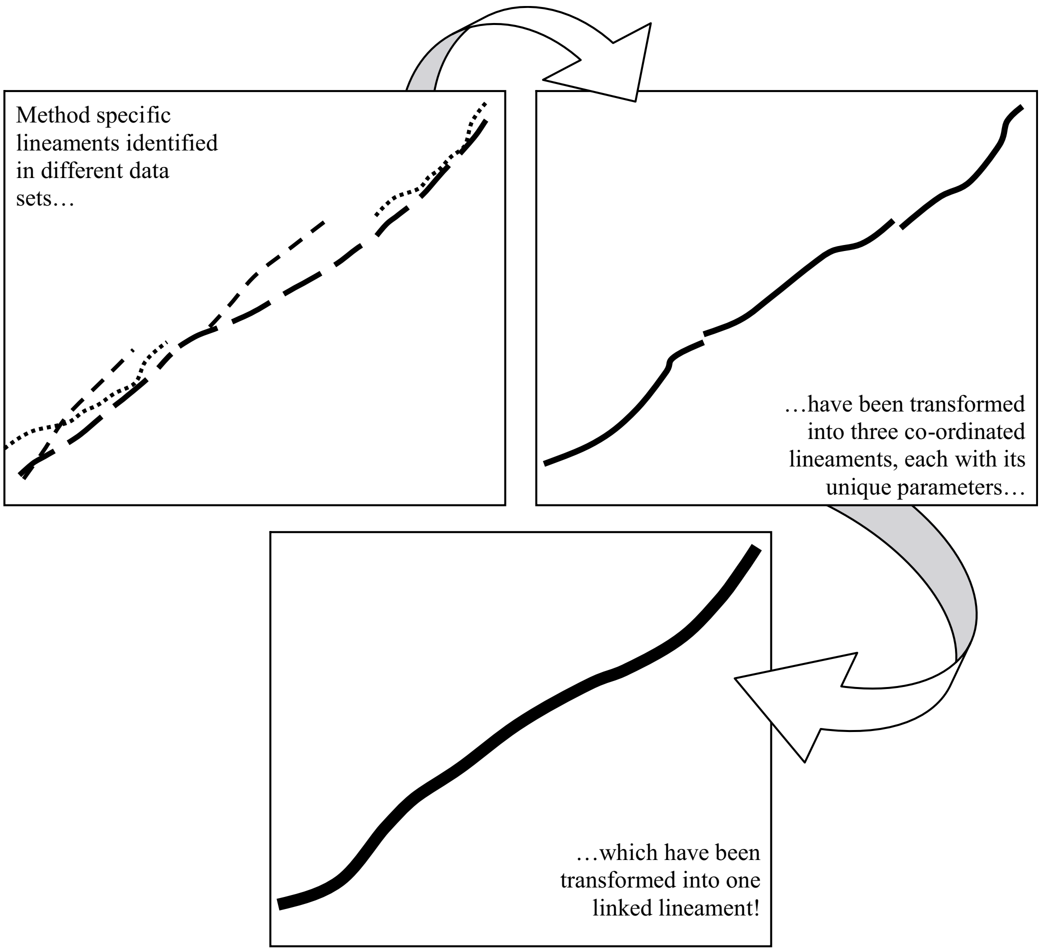

Figure 4-1. *Condensed explanation of the joint interpretation process.*

4.3 Preparatory work

The preparatory work includes gathering and preparation of:

- files with method specific lineaments /1/, /2/,
- GIS files that were used in the identification of method specific lineaments /1/, /2/,
- other relevant information such as the structural part of the site descriptive model version 0 /8/.

4.4 Method specific lineaments to co-ordinated lineaments

If in an area, several more or less coinciding method specific lineaments are supposed to indicate one unique lineament, all the method specific lineaments can instead be represented by one single lineament. This single lineament is called a "co-ordinated lineament". In the joint interpretation process the first step carried out is to construct such co-ordinated lineaments that are representing several spatially more or less coinciding method specific lineaments. Every co-ordinated lineament is then assigned a number of parameters. The parameters inform in which data sets the origin to the co-ordinated lineament were visible, which is the judged level of uncertainty in the visibility of the co-ordinated lineament etc. The list of parameters describing every co-ordinated lineament is given in Table 4-1.

In the list of parameters the T_N is supposed to inform if the co-ordinated lineament has been detected in data revealing morphology. Such data could be topography or a digital elevation model (DEM). A DEM can be constructed from detailed air photographs or bathymetry and reflections seismics from boat. In this case however also helicopter borne EM data have revealed the water depth, at least to some degree. If a linear structure has been identified in EM data – through an indication of thickening of the sea water layer – then the lineament has been assigned a number of 1 for the parameter of T_N and not in the parameter EV_N as could be expected. It means that the EM survey has detected a morphological lineament. The linear structure is however not directly detected by the EM system as a linear conductor in the ground, but rather as a depression in the sea bottom.

The parameter UNCERT_N reflects the level of uncertainty in the detection and/or delineation of the co-ordinated lineament. It is a parameter that is partly inherited from the classification of uncertainties of the individual method specific lineaments constituting the co-ordinated lineament. There is however no strict mathematical formula applied to calculate this parameter, it is merely a result of personal weighting of the visibility of method specific lineaments in the different data sets.

In some areas it has been obvious that the earlier identified method specific lineaments could have been located otherwise. In such areas the joint interpretation has resulted in co-ordinated lineaments that are free from any connection to earlier interpretation results.

At a late stage of the joint interpretation process the interpretation results from the marine geological survey carried out by SGU /6/ also became available. The lineaments that could be identified in the data sets from the marine geological survey had to be implemented into the joint interpretation process. This was made in a pragmatic manner not based on a preceding identification of method specific lineaments in the marine data. Instead lineaments possible to identify in marine geological data were directly invoked into the group of co-ordinated lineaments.

Table 4-1. List of parameters assigned to every "co-ordinated lineament".

Name of attribute	Values in this activity	Comment
ID_T	n.a.	Identities have not been assigned to the individual lineaments.
ORIGIN_T	method specific lineaments	
CLASS_T	n.a.	The individual co-ordinated lineaments have not been classified according to their length.
METHOD_T	see PLATFORM_T below	
EV_N	0 or 1	Conductivity (EM and/or VLF). 0 if not detected 1 if detected in data revealing the conductivity of the ground.
M_N	0 or 1	Magnetization. 0 if not detected 1 if detected in data revealing the magnetization of the ground.
T_N	0 or 1	Morphological (Topography/DEM, bathymetry or EM water depth) 0 if not detected, 1 if detected in data revealing the morphology of the ground.
PROPERTY_N	1, 2 or 3	Number of properties (conductivity, magnetization, morphology) where the lineament has been identified.
WEIGHT_N	1, 2, 3, 4, 5	According to a weighting function involving number of properties (np) and level of uncertainty (lu) np = 3, lu = 1 eq. weight = 5 np = 3, lu = 2 eq. weight = 4 np = 3, lu = 3 eq. weight = 3 np = 2, lu = 1 eq. weight = 4 np = 2, lu = 2 eq. weight = 3 np = 2, lu = 3 eq. weight = 2 np = 1, lu = 1 eq. weight = 3 np = 1, lu = 2 eq. weight = 2 np = 1, lu = 3 eq. weight = 1
CHAR_T	co-ordinated lineament	
UNCERT_N	1, 2, 3	Level of uncertainty in visibility/existence 1 = low, 2 = medium, 3 = high
COMMENT_T		Free text
PROCESS_T	Image analysis	
DATE_D	20030810	Date when the last change was made in the individual co-ordinated lineament.
SCALE_T	10,000	Typical scale in which the identification of a lineament has been carried out.
PLATFORM_T	airborne photo, airborne geophysics, marine charts, topography	
WIDTH_N	0	Has not been specified.
PRECIS_N	0	Has not been specified.
SIGN_T	Carl-Axel Triumf/GeoVista AB	Interpreted by Carl-Axel Triumf, GeoVista AB.
DIRECT_N	–90 degrees to +90 degrees, in relation to north (+clockvise)	Calculated mean direction in MapInfo.
LENGTH_N	in meter	Calculated length in MapInfo.
COUNT_N	1	By default = 1.

4.5 Co-ordinated lineaments to linked lineaments

If several co-ordinated lineaments are considered to build up one lineament longer than 1 kilometre, they have been linked to each other to represent the longer lineament. This resulting longer lineament is called a "linked lineament". The threshold value is set to 1 kilometre, i.e. a linked lineament with a length of less than 1 kilometre will not be included.

Every linked lineament is assigned a number of parameters describing the lineament. The list of parameters is given in Table 4-2.

In the list of parameters the identity ID_T uses nine positions, where XSM means a lineament in the Simpevarp area, while ZSM means a fracture zone in the Simpevarp area. The two last positions are used to indicate that also a linked lineament can be sub-divided into several sections. This flexibility is needed to describe situations where the same linked lineament may be divided into two or more branches. It is also possible in the two last positions to describe a change in the data set that has been used for the identification of the linked lineament. If the letters B or C are involved then it indicates that the area where the lineament is found is either covered by water or only by aerial photography respectively, se Figure 4-2 for examples.

In the list of parameters the CLASS_T indicates the dignity of the linked lineament based on the length. A linked lineament with a length of more than 10 kilometres is classified as "Regional" while linked lineaments with a length between 1 and 10 kilometres are classified as "Local major". Some of the linked lineaments classified as "Regional" may have had to be classified on the basis of their continuation outside the interpreted area. It means that a linked lineament identified in this joint interpretation may have been traced outside the area of this joint interpretation by following its continuation in the site descriptive model version 0 /8/. As an example a linked lineament classified as "Regional" with a length of 7 kilometres identified in this joint interpretation must have been traced for at least 3 more kilometres in the site descriptive model version 0.

Table 4-2. List of parameters assigned to every "linked lineament".

Name of attribute	Values in this activity	Comment
ID_T	XSM0003A0	Identity of the identified linked lineament.
ORIGIN_T	co-ordinated	
CLASS_T	regional, local major	Regional > 10 km Local major 1–10 km
METHOD_T	See PLATFORM_T below	Combined data set used in the identification work.
EV_N	0–1	Proportion of the length of the linked lineament where increased conductivity is indicated from VLF or helicopter borne EM
M_N	0–1	Proportion of the length of the linked lineament where magnetic properties indicates it's existence (airborne surveys).
T_N	0–1	Proportion of the length of the linked lineament indicated in morphology (Topography/DEM, bathymetry, marine seismics or EM water depth/ bedrock morphology).
PROPERTY_N	1–3	Property (linked_lineament) = length(lin1)* property (lin(1))+length(lin(2))* property(lin(2))+…+lenght(lin(n))*property(lin(n))/ ((lenght(lin(1)+(lenght(lin(2)+.. (lenght(lin(n)).
WEIGHT_N	1–5	Weight (linked_lineament) = (length(lin(1))*weight (lin(1))+length(lin(2))*weight(lin(2))+… +lenght(lin(n))*weight(lin(n)))/((lenght(lin(1)+ (lenght(lin(2)+.. (lenght(lin(n))).
CHAR_T	linked lineament	
UNCERT_N	1–3	Uncert (linked_lineament) = ((length(lin1)* uncert (lin(1))+length(lin(2))*uncert(lin(2))+… +lenght(lin(n))*uncert(lin(n)))/((lenght(lin(1)+ (lenght(lin(2)+.. (lenght(lin(n))).
COMMENT_T		Free text.
PROCESS_T	Image analysis	
DATE_D	20030810	Date when the last change was made in the individual linked lineament.
SCALE_T	10,000	Typical scale in which the identification of a lnked lineament has been carried out.
PLATFORM_T	air photo, hcp survey OR air photo OR marine chart, hcp survey OR air photo, marine chart, hcp survey	Describes data set available in the area where the lineament occurs (hcp = abbreviation of helicopter).
WIDTH_N	0	Has not been assigned, by default 0.
PRECIS_N	0	Has not been assigned, by default 0.
SIGN_T	Carl-Axel Triumf/GeoVista AB	Interpreted by Carl-Axel Triumf, GeoVista AB
DIRECT_N	–90 degrees to +90 degrees, in relation to north (+clockvise)	Calculated mean direction of the linked lineament in MapInfo.
LENGTH_N	in meter	Calculated length of the linked lineament in MapInfo.
COUNT_N	3	Number of co-ordinated lineaments resulting in the linked lineament. 1 or more.

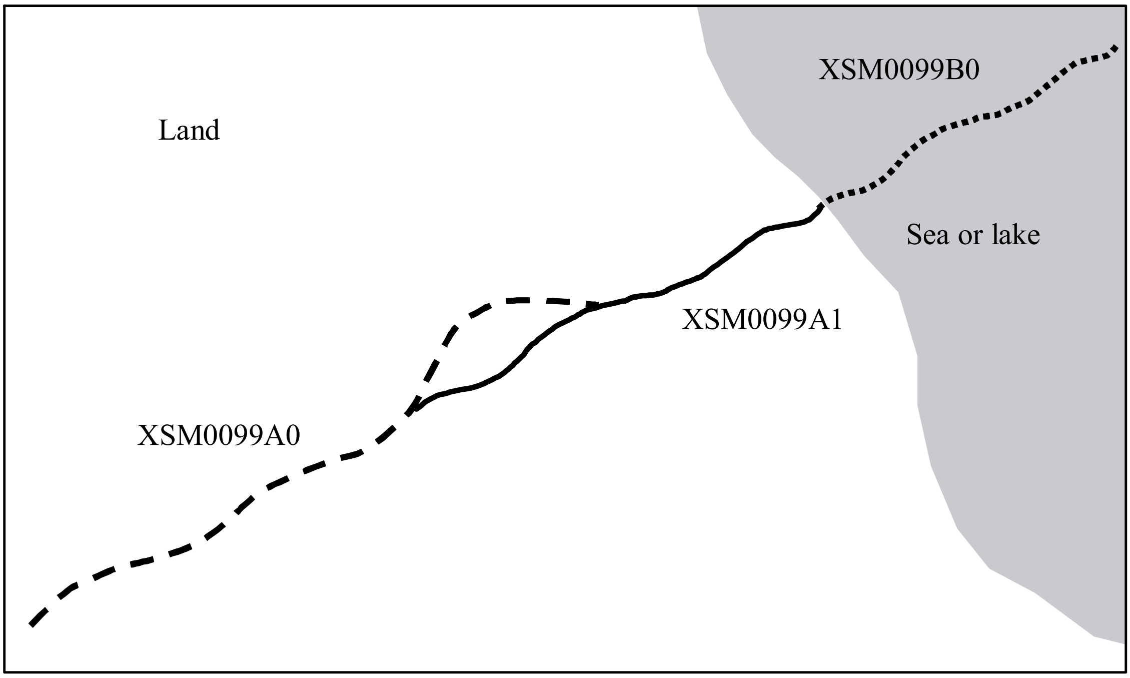

Figure 4-2. *A linked lineament XSM0099A0 splays into it's continuation in XSM0099A1. The linked lineament continues in the sea or lake where digital elevations model may be lacking. This is indicated in the name by the use of letter "B". In areas where only aerial photos are available the letter "C" has been used.*

5 Results

5.1 Storing of results

Performance data of this joint interpretation activity will be stored in SICADA. The results from this activity will however be stored in two sets of GIS-files; one covers the co-ordinated lineaments and the other the linked lineaments. The GIS-files are stored in SKB's GIS database of the site investigation at Oskarshamn.

The SICADA and GIS reference to the present activity is field note no 293.

5.2 Co-ordinated lineaments

The co-ordinated lineaments are delivered in a GIS file adapted for the ArcView format and named "XSM_Co-ordinated_lineament_polyline.*". All the co-ordinated lineaments that have been used as a starting point for the linking into linked lineaments are shown in Figure 5-1. From Figure 5-1 it is obvious that the density of lineaments around the Simpevarp nuclear power plant is slightly lower as compared to it's surroundings. This is due to the lack of data or degraded data quality in the digital elevation model and the helicopter borne survey data at and around the power plant.

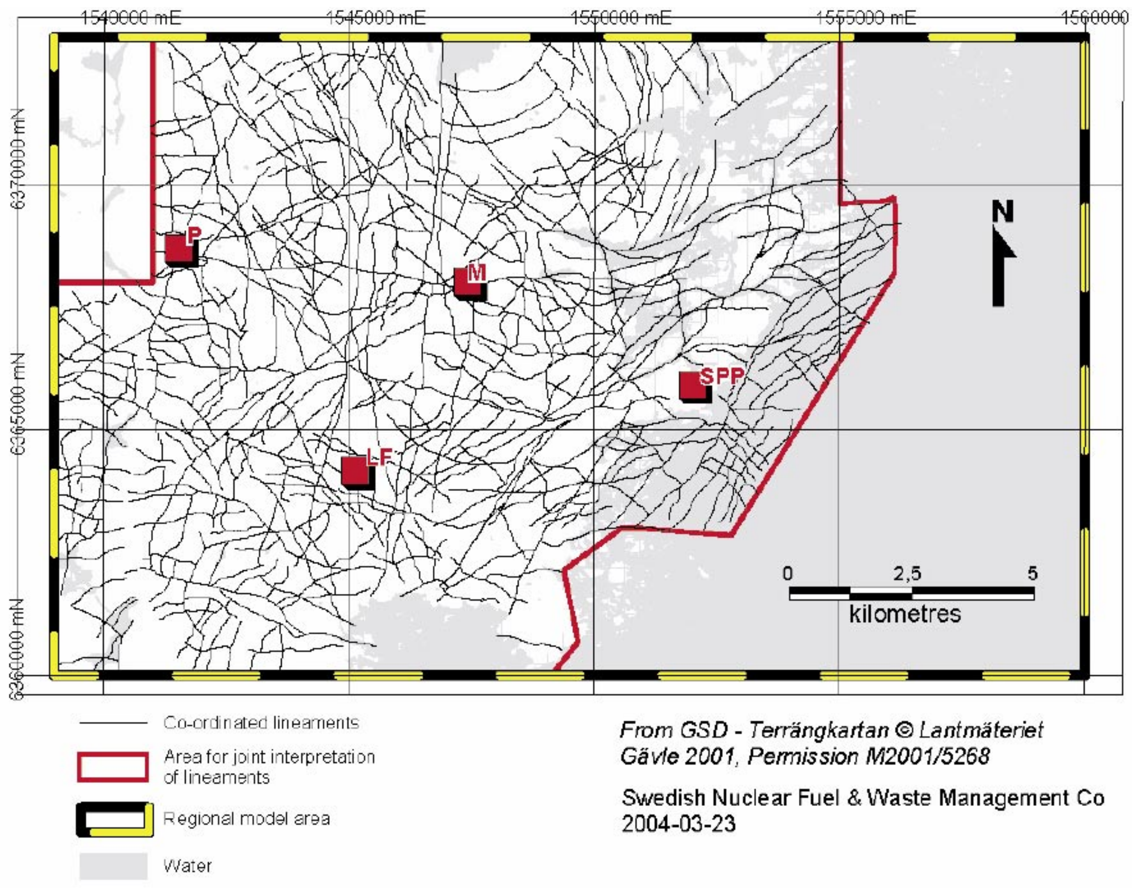

Figure 5-1. *Co-ordinated lineaments have served as the starting point in the joint interpretation process for the linking into linked lineaments. P = Plittorp, M = Mederhult, LF = Lilla Fjälltorpet, SPP = Simpevarp Power Plant.*

5.3 Linked lineaments

The linked lineaments are delivered in a GIS file adapted for the ArcView format and named "XSM_Linked_lineament_polyline.*. The linked lineaments are presented in Figure 5-2. The figure shows the linked lineaments in the perspective of their interpreted belonging to either "Regional" or "Local major" and also to the grade of uncertainty in their detection and delineation. In Figure 5-2 the level of uncertainty has been divided into three groups; below 1.5, 1.5–2.5 and above 2.5. A low value means that the lineament is comparatively easy to identify in the data sets as compared to a lineament with a high value in the uncertainty.

The linked lineaments classified as "Local major" show larger variations in their weighted uncertainty as compared to the "Regional" linked lineaments. This is not very surprising, as some of the shorter lineaments can be quite difficult to identify.

From Figure 5-2 it is obvious that the density of lineaments around the Simpevarp nuclear power plant is slightly lower as compared to it's surroundings. This is due to the lack of data, or degraded data quality in both the digital elevation model and the helicopter borne survey data, at and around the power plant. Also other factors such as large valleys and vast areas with low magnetic susceptibility will influence the possibility of identifying lineaments. These factors will be commented further in section 5.5 below.

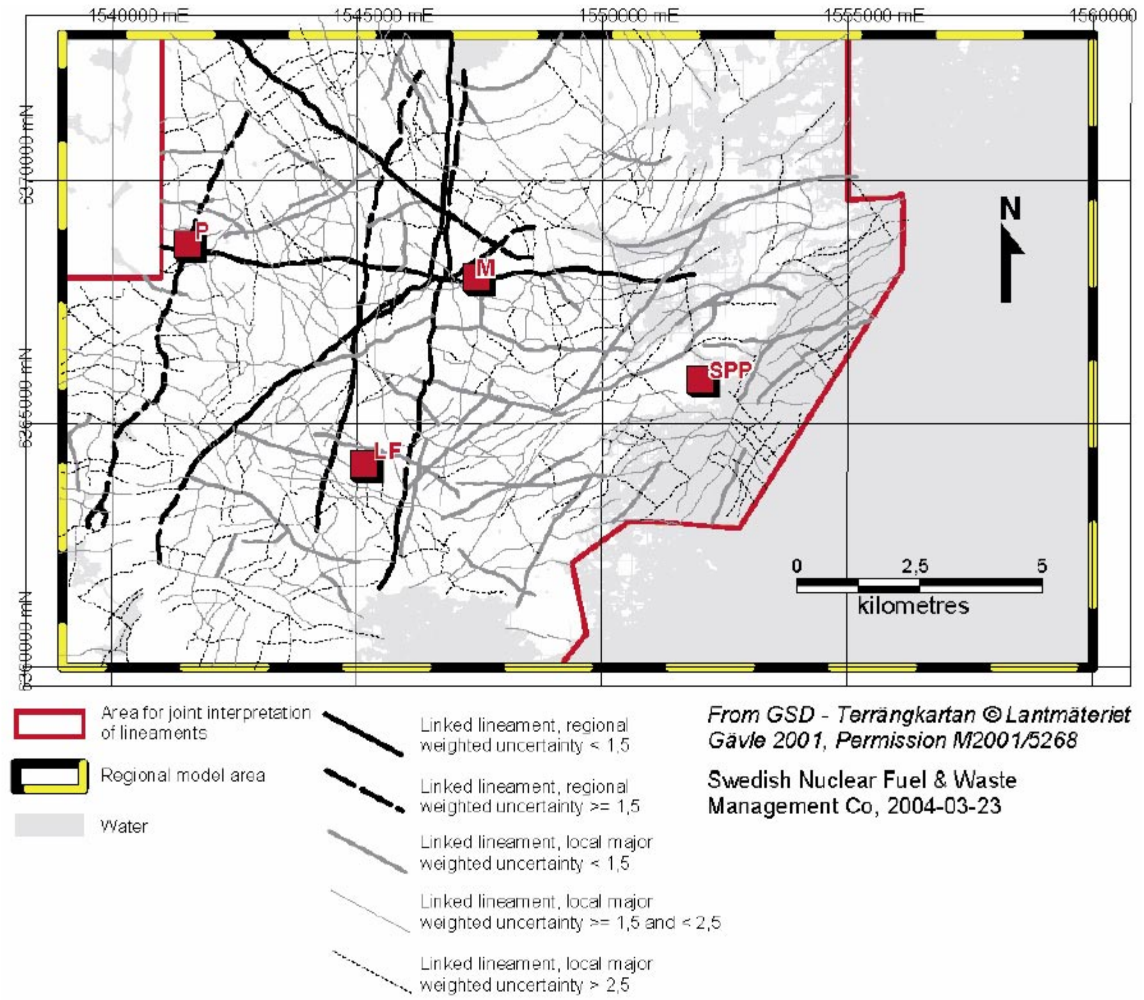

Figure 5-2. *Linked lineaments presented as to reflect their different class (regional or local major) and different level of uncertainty. P = Plittorp, M = Mederhult, LF = Lilla Fjälltorpet, SPP = Simpevarp Power Plant.*

5.4 Comparison with the site descriptive model version 0

In Figure 5-3 the structural part of the site descriptive model and the linked lineaments are possible to compare. In general the agreement is quite good though some discrepancies occur. The differences will however not be commented in detail.

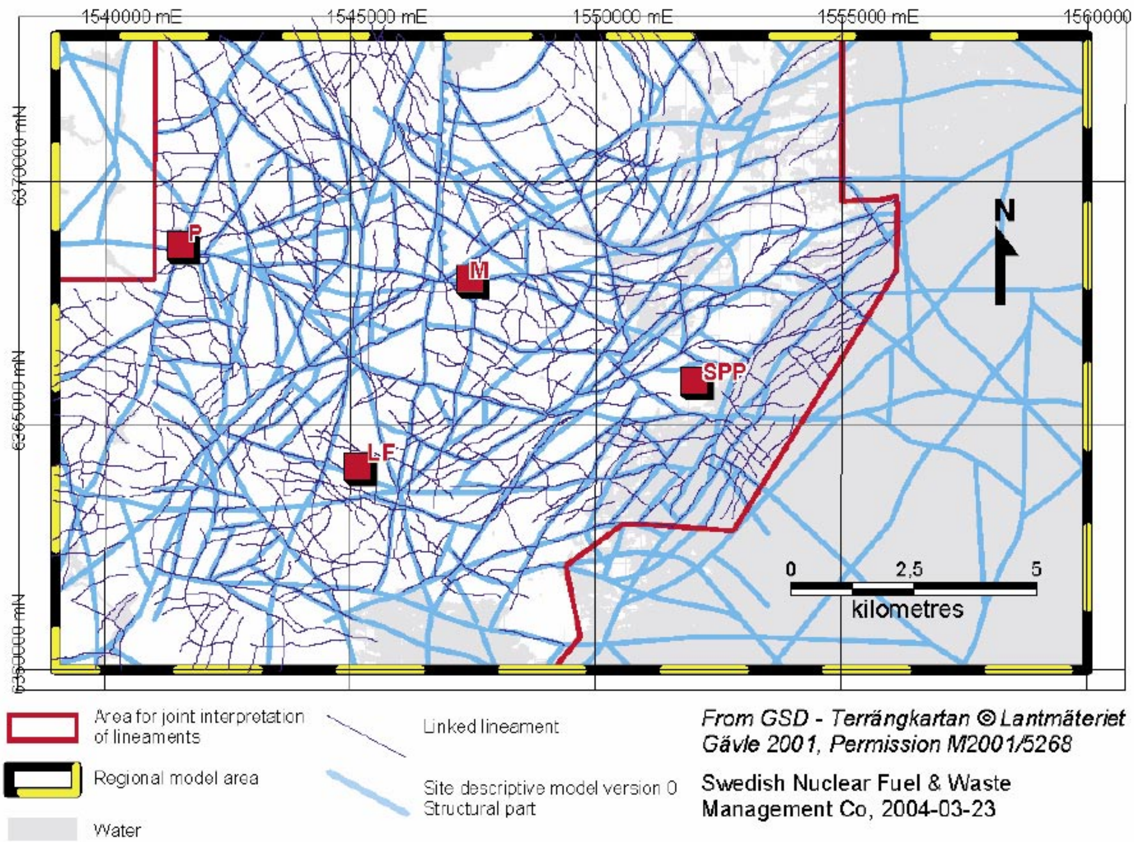

***Figure 5-3.** Comparison of linked lineaments and the structural part of the Simpevarp site descriptive model version 0. P = Plittorp, M = Mederhult, LF = Lilla Fjälltorpet, SPP = Simpevarp Power Plant.*

5.5 Discussion

It appears to be quite clear that some of the époques in the tectonical history may be more evident in one data set as compared to another. Such an example from the Simpevarp area is the Äspö shear zone, which manifests itself clearly in data of the magnetic total field, whilst it is only partly visible in topographical data. This fact must be taken into consideration when making the joint interpretation in order not to introduce unnecessary errors. An example of such an erroneous action would be to force two nearby method specific lineaments into one co-ordinated lineament though in the reality both method specific lineaments are representing different tectonical processes. The correct behaviour in such a case would be to maintain the two individual method specific lineaments and transfer them into two separate co-ordinated lineaments. These judgements are however very difficult and certainly such errors may have been introduced during the joint interpretation process. If follow-up work on linked lineaments will result in equivocal results, the best action will probably be to control the method specific lineaments in the specific area of interest, and compare them with the original data sets from aerial photography, marine geology and helicopter borne geophysics.

In the joint interpretation process lineaments identified in different and mostly new data sets are brought together into a synthesis. The coverage of new data, i.e. data which have been collected after the feasibility study, is however heterogeneous over the interpreted area. It means that in some areas only topographical data have been available. Of course this could lead to a result where fewer lineaments are identified as compared to areas where several new data sets are available.

From the results it is also obvious that the density of lineaments around the Simpevarp nuclear power plant is slightly lower as compared to it's surroundings. This is due to the lack of data or degraded data quality in the digital elevation model and the helicopter borne survey data at and around the power plant. This affects the diagnose level of the area. In some areas also other factors are influencing the number of lineaments possible to identify. In flat topographical depressions it is difficult to pinpoint the location of a single lineament, and equally difficult to judge whether the depression is a result of one or several different lineaments. A corresponding problem occurs where the magnetic susceptibility is low over large areas. A practical manner to illustrate the problem is to show the linked lineaments on a background of identified large topographical depressions and areas with low magnetic susceptibility, see Figure 5-4.

At a late stage of the joint interpretation process the interpretation results from the marine geological survey carried out by SGU /6/ also became available. The lineaments that could be identified in the data sets from the marine geological survey had to be implemented into the joint interpretation process. This was made in a pragmatic manner and resulted in a re-evaluation of the near coastal area outside the Simpevarp peninsula and the island Ävrö where changes had to be made to linked lineaments earlier presented /3/.

It appears as if the lineaments striking north west are suppressed in the interpretation and hence occur at lower density as could be expected when studying the images of topographical and geophysical data. The reason is that they occur in very short sections, quite often near each other and parallel. Furthermore there can be quite long distances between the individual lineament sections which makes it very difficult to identify which sections could belong to the same lineament.

A slight change in the directions of the lineaments at the western part of the interpreted area is possible to observe. Whether the reason is the esker or not is difficult to judge. It is however possible that the corresponding accumulations of non-magnetic sediments could cause low-magnetic features, which falsely could be interpreted to indicate low magnetic zones in the bedrock.

Some of the linked lineaments that have resulted from this joint interpretation may continue outside the interpreted area. The length of the lineament outside the interpreted area however also has to be accounted for in the classification of linked lineaments into "Regional" and "Local major". This means that the interpreter also has to consider the lineaments and fracture zones presented in the site descriptive model version 0. We have however observed that some of the structures in the model version 0 could be re-interpreted regarding their spatial location and continuation. In some cases it is also probable that structures in the model version 0 have to be removed. This implies that also the extrapolation of linked lineaments based on the model version 0 will introduce some degree of uncertainty. Furthermore this fact will introduce a problem with new identities on structures already named in version 0. It is believed to be very difficult if not impossible to maintain an unequivocal heritage of identities from the model version 0 to this result of linked lineaments.

It is important to note that the lineament map only presents linear objects on the map, and has not to be regarded as deformation zones. The linked lineaments resulting from the joint interpretation will be further evaluated in order to control whether they represent deformation zones, some of them with geological field control and some by means of geophysics and drilling.

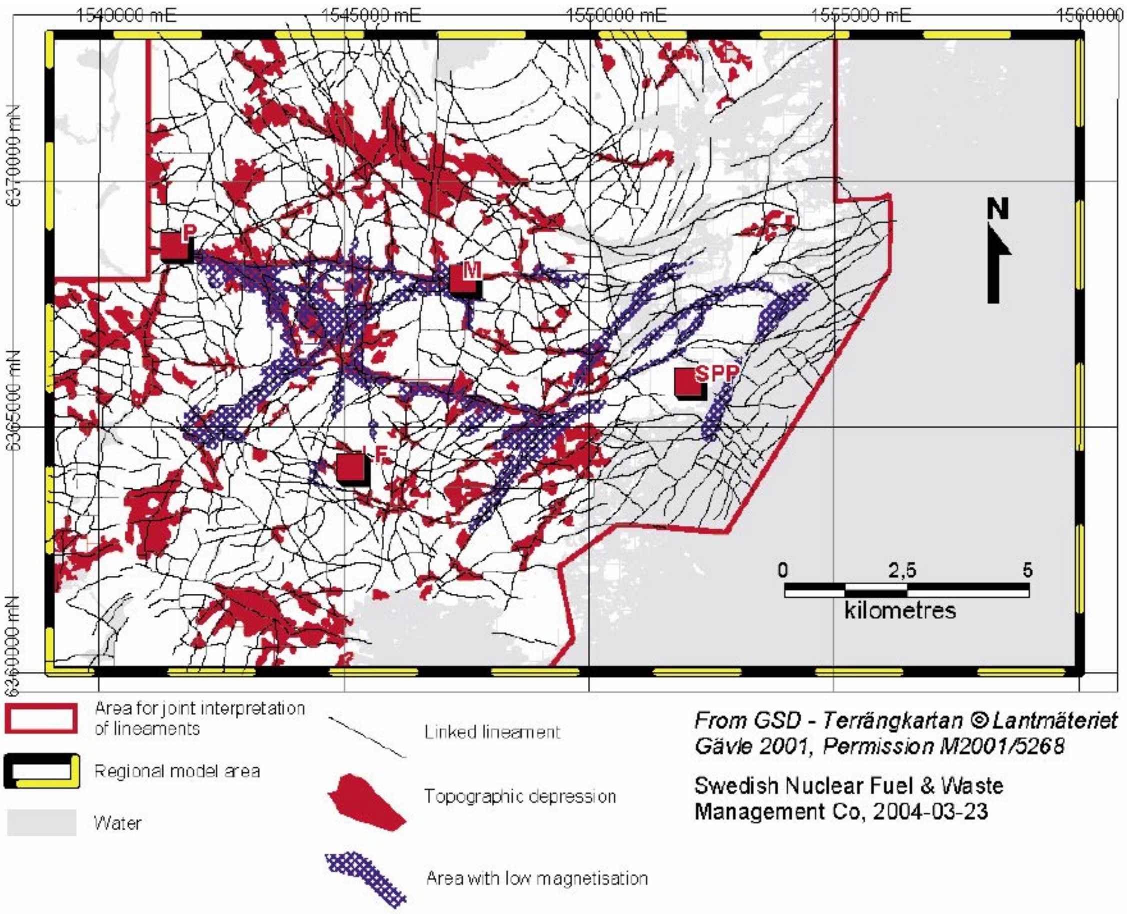

Figure 5-4. *Linked lineaments displayed on vast topographic depressions and areas with low magnetic susceptibility P = Plittorp, M = Mederhult, LF = Lilla Fjälltorpet, SPP = Simpevarp Power Plant.*

6 References

/1/ **Triumf C-A, 2003.** Identification of lineaments in the Simpevarp area by the interpretation of topographical data. Oskarshamn site investigation. SKB P-03-99. Svensk Kärnbränslehantering AB.

/2/ **Triumf C-A, Thunehed H, Kero L, Persson L, 2003.** Interpretation of airborne geophysical survey data. Helicopter borne survey data of gamma ray spectrometry, magnetics and EM from 2002 and fixed wing airborne survey data of the VLF-field from 1986. SKB P-03-100 /in press/. Svensk Kärnbränslehantering AB.

/3/ **Triumf C-A, 2004**. Joint interpretation of lineaments in the eastern part of the site descriptive model area. SKB P-04-37 /in press/. Svensk Kärnbränslehantering AB.

/4/ **Rönning H J S, Kihle O, Mogaard J O, 2003.** Helicopter borne geophysics at Simpevarp, Oskarshamn, Sweden. Simpevarp site investigation. SKB P-03-25. Svensk Kärnbränslehantering AB.

/5/ **Wiklund S, 2002.** Digitala ortofoton och höjdmodeller. Redovisning av metodik för platsundersökningsområdena Oskarshamn och Forsmark samt förstudieområdet Tierp Norra. SKB P-02-02. Svensk Kärnbränslehantering AB.

/6/ **Elhammer A, Sandkvist Å, 2004.** Detailed Marine Geological Survey of the sea bottom outside Simpevarp. SKB P-04-XX. In press. Svensk Kärnbränslehantering AB.

/7/ **Munier R, Stenberg L, Stanfors R, Milnes A G, Hermansson J, Triumf C-A, 2003.** Geological Site Descriptive Model. A strategy for the model development during site investigations. SKB R-03-07. Svensk Kärnbränslehantering AB.

/8/ **SKB, 2002.** Simpevarp – site descriptive model version 0. SKB R-02-35. Svensk Kärnbränslehantering AB.