P-05-261

Forsmark site investigation

Assessment of inferred lineaments in the north-western part of the Forsmark site investigation area

Present knowledge and recommendations for further investigations

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February 2006

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AP PF 400-05-036.

Abstract

SKB performs site investigations for localisation of a deep repository for high level radioactive waste at two sites, Forsmark and Oskarshamn. Lineament interpretation from topographic and airborne geophysical data, outlining possible deformation zones, is an essential part of the investigations at both sites.

The purpose of the present work was to carry out an assessment of the inferred lineaments at the Forsmark site and to provide recommendations for the investigations needed in order to define the origin of the lineaments. The work was focused on lineaments intersecting the north-western part of the Forsmark candidate area. It is based on information available in June 2005 and makes use of the version 1.2 site model.

Highest priority is given to lineaments exceeding 3,000 m in length. If these lineaments are verified to be deformation zones this will strongly influence the site evaluation. Lineaments 1,000–3,000 m are also important and those within the proposed depository area must be well investigated. Lineaments 500–1,000 m are generally less important at the present stage of the site investigation and the ones shorter than 500 m will have to be treated statistically when the site is described and evaluated. However, some short lineaments will be investigated in conjunction with investigation activities directed towards the major ones.

The recommended investigation programme is presented in the figure below. The programme will have to be continuously reconsidered and updated when new information is obtained.

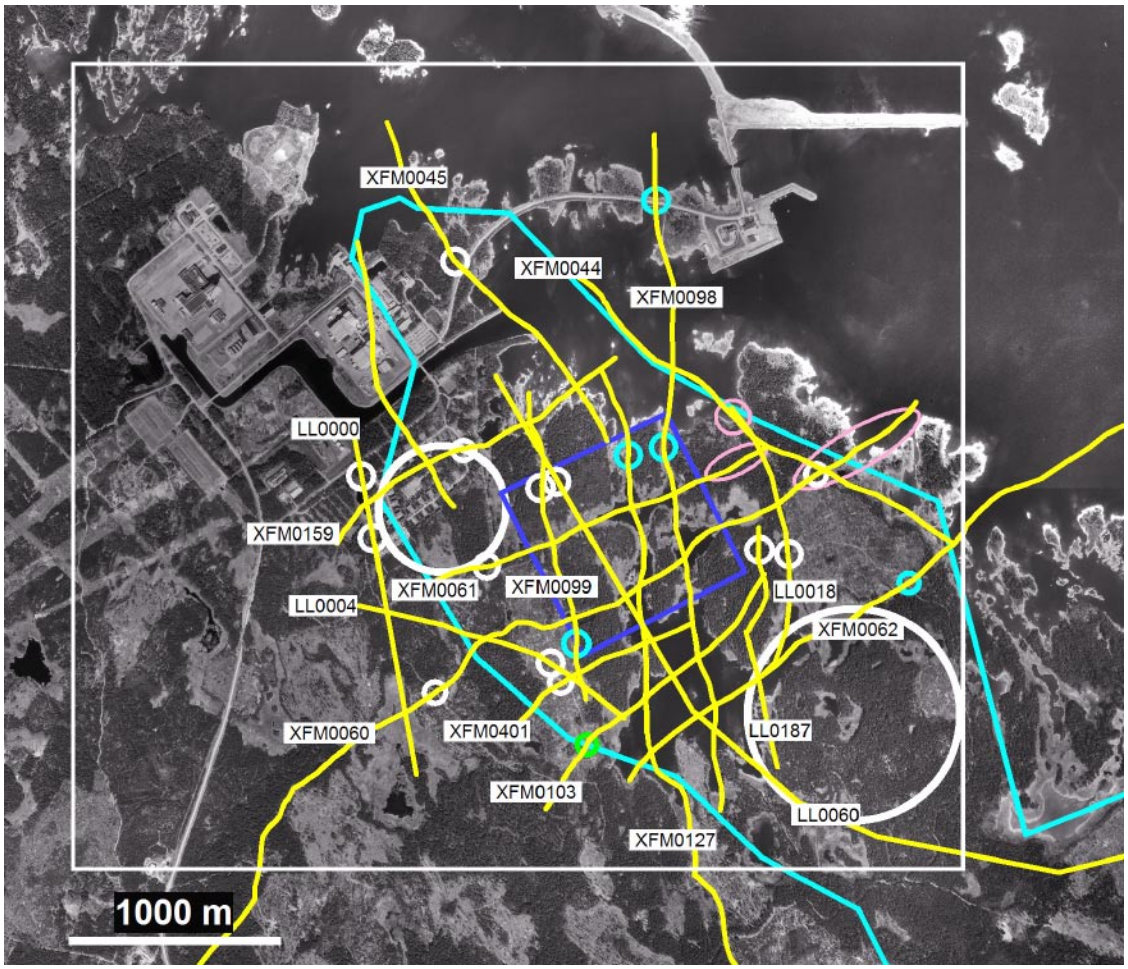
Sammanfattning

SKB bedriver platsunderökningar för att lokalisera ett djupförvar för högaktivt radioaktivt avfall på två platser, Forsmark och Oskarshamn. I bägge fallen är lineamentstolkning baserad på topografiska och flyggeofysiska data för att indikera möjliga deformationszoner en viktig del av undersökningarna.

Målet med föreliggande arbete var att utvärdera tolkade lineament i Forsmarks kandidatområde samt att rekommendera fortsatta undersökningar med syfte att klarlägga orsaken till lineamenten. Arbetet koncentrerades till den nordvästra delen av kandidatområdet och baseras på den information som var tillgänglig i juni 2005 samt version 1.2 av platsmodellen.

Högst prioritet ges till lineament som är längre än 3 000 m. Om dessa lineament visar sig vara deformationszoner har detta en betydande inverkan på utvärderingen av den aktuella platsen. Lineament som har längder i intervallet 1 000–3 000 m är också viktiga och de som övertvärar det tilltänkta deponeringsområdet måste noga undersökas. Lineament inom intervallet 500–1 000 m är generellt sett mindre viktiga i platsundersökningens nuvarande skede och de som är kortare än 500 m kommer att behöva behandlas med statistiska metoder när platsen skall beskrivas och utvärderas. Vissa korta lineament kommer dock att undersökas i samband med de undersökningar som inriktas på de längre lineamenten.

Det föreslagna undersökningsprogrammet presenteras i nedanstående figur. Programmet måste emellertid kontinuerligt omprövas och uppdateras allt eftersom ny information tillkommer.



Proposed investigation programme. Lineaments to be investigated in yellow. White circles indicate locations for trenching and blue circles for drilling. The violet ellipses indicate recommended field checks and the dark blue rectangle an area suggested for detailed ground geophysics. The two larger white circles show areas where also lineaments shorter than 1,000 m are suggested to be examined, to begin with by means of field checks. The Forsmark candidate area is outlined with a light blue line.

Föreslaget undersökningsprogram. De lineament som skall undersökas visas med gul färg. Vita cirklar visar föreslagen grävning, blå cirklar borrning. Violetta ellipser visar rekommenderade fältkontroller och den mörkblå rektangeln ett område som förslås bli undersökt med detaljerad markgeofysik. De två större vita cirklarna visar områden där även lineament kortare än 1,000 m föreslås bli undersökta, till att börja med genom fältkontroller. Forsmarks kandidatområde är markerad med en ljusblå linje.

Contents

1 Introduction

SKB performs site investigations for localisation of a deep repository for high level radioactive waste. The site investigations are performed at two sites, Forsmark and Oskarshamn. Lineament interpretation from topographic and airborne geophysical data, outlining e.g. possible deformation zones, is an essential part of the investigations at both sites.

At the Forsmark site, GeoVista AB has carried out extensive lineament interpretations. To begin with, an interpretation of topographic lineaments covering the mainland part of the site investigation area was carried out /Isaksson 2003/ and this interpretation was later integrated with an interpretation of lineaments from airborne geophysical data /Isaksson et al. 2004/. /Isaksson and Keisu 2004/ have presented an extended lineament interpretation, covering the complete Forsmark site investigation area.

Given the importance of the lineaments for the deformation zone modelling, it was decided to carry out an alternative lineament interpretation using another team and the Geological Survey of Finland (GTK) was asked to perform this alternative interpretation /Korhonen et al. 2004/. The area interpreted by GTK covers a limited, but central part of the site investigation area, including the Forsmark candidate area (Figure 1-1).

A comparison of two independent lineament interpretations /Johansson 2005/ has revealed that the results are, in principle, reproducible. Nevertheless, there are some significant discrepancies, which must be considered during the further assessment of the lineaments.

/Johansson 2005/ pointed out that further assessment of the inferred lineaments must mainly be based on data from outcrop observations, trenching, drilling, ground geophysics et cetera and he also presented a strategy for this assessment. The strategy involves, as a first step, the study of the inferred lineaments in order to assess their connection to verified, or from other data indicated deformation zones. Following this study, recommendations should be made concerning the further investigations needed to explain the origin of the lineaments.

The present document reports the results of the (first step) study and recommends further investigations. The work has been performed in accordance with AP PF 400-05-036 (SKB internal controlling document), see Table 1-1. The work is concentrated to the north-western part of the site investigation area (see Figure 1-1) to which the site investigations have now been focused /SKB 2005a/.

Table 1-1. Controlling document for the performance of the activity (SKB internal controlling document).

Activity plan	Number	Version
Fördjupad analys av tolkade lineament	AP PF 400-05-036	1.0

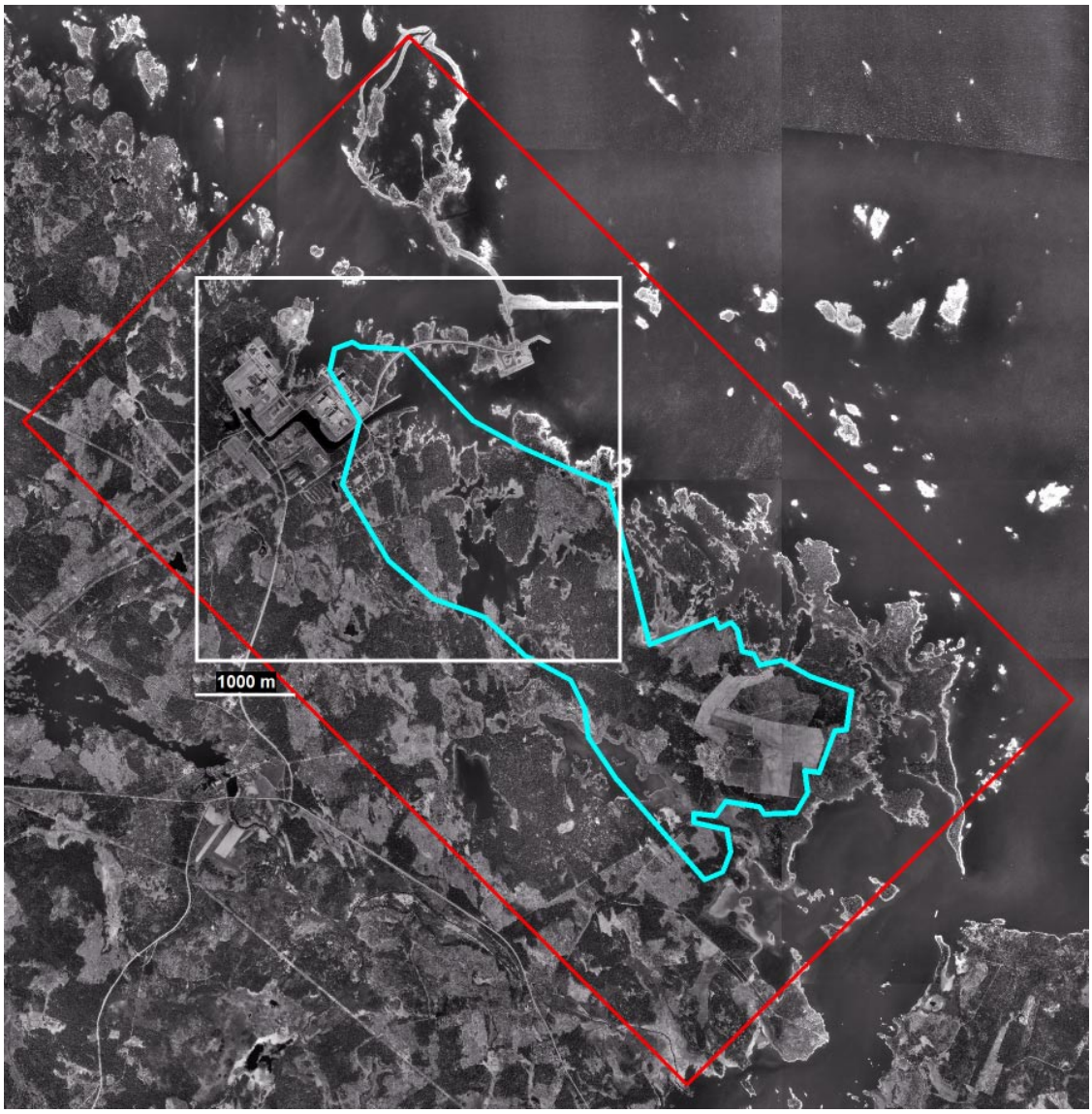


Figure 1-1. *The central part of the Forsmark site investigation area. The Forsmark candidate area is outlined in blue, the area for the alternative interpretation of lineaments in red and the study area in white.*

2 Objective and scope

The purpose of this work was to carry out an assessment of inferred lineaments at the Forsmark site and to provide recommendations for the investigations needed, in order to define the origin of the lineaments. The lineaments involved are the ones interpreted by GeoVista AB (primary interpretation) as well as the ones interpreted by GTK (alternative interpretation). The assessment is based on the primary interpretation and the alternative interpretation is considered when there are "alternative lineaments" that are not appearing in the primary interpretation or when the alternative lineament is more persistent. The study area is restricted to the north-western part of the Forsmark candidate area, see Figures 1-1 and 2-1.

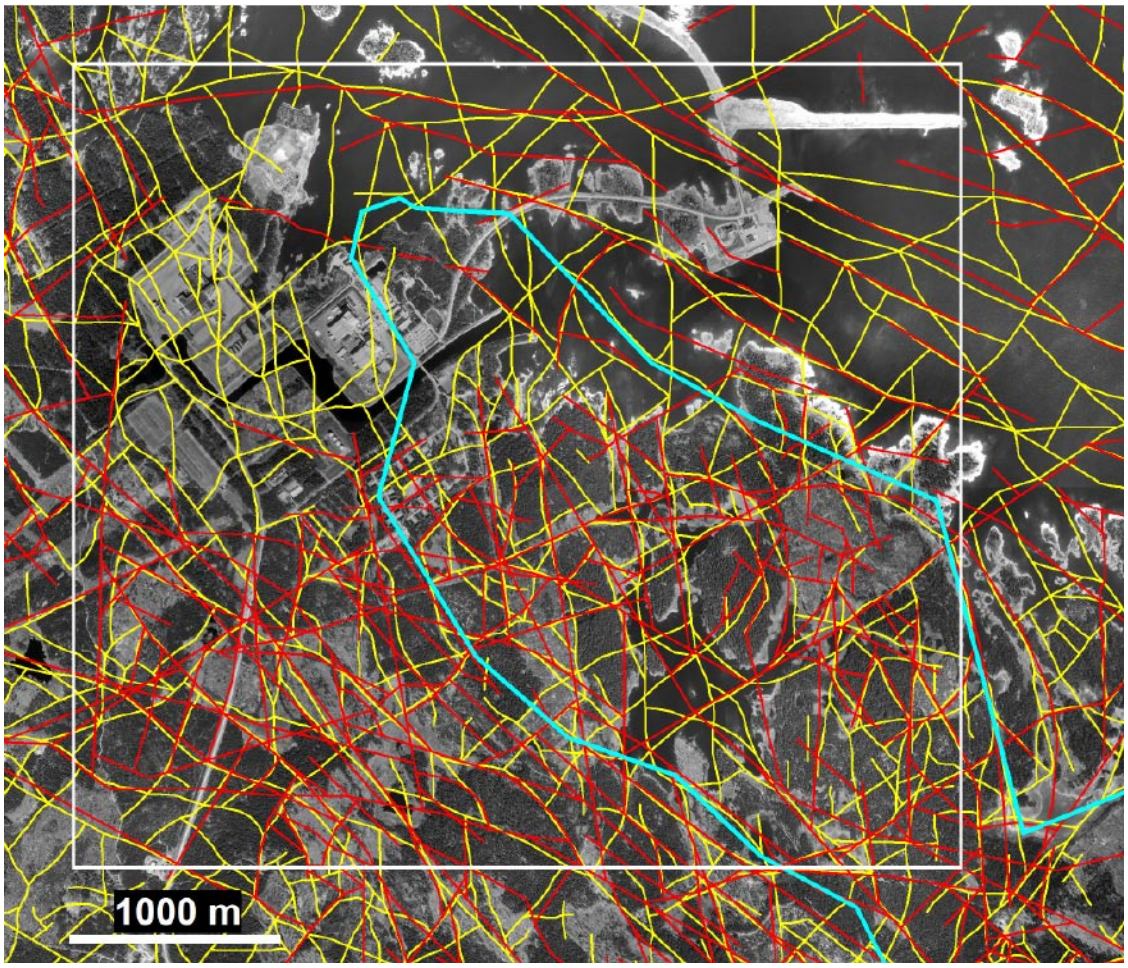


Figure 2-1. *Study area (white rectangle) and the Forsmark candidate area (blue line). Lineaments from the primary interpretation (covering the regional model area) in yellow and lineaments from the alternative interpretation in red.*

The work comprises the first step of the three-step-strategy presented by /Johansson 2005/. The three steps are the following:

As the first step, a careful assessment of the inferred lineaments is made according to the following principles:

Lineaments longer than (or equal to) 3,000 m are studied individually[1]. The complete lineament interpretation process (method specific interpretation, coordination and linking of lineaments) should be reviewed. All data relevant for a geological interpretation of the lineaments are compiled. Assessment of lineaments that are crossing or delimiting the repository area (volume) under investigation must be based on direct information (outcrop data, trenching, drilling). When needed, recommendations for complementary investigations are given.

Lineament 1,000–3,000 m are treated as above but assessment based on indirect information (mainly ground geophysics) can be accepted.

Lineaments 500–1,000 m are studied in a more generalised manner. The assessment is mainly based on indirect information.

Lineaments shorter than 500 m are generally not considered. In further modelling of the site, these lineaments will have to be treated statistically.

The second step includes the complementary investigations recommended during step 1.

The third step is the compilation of the results into a map of deformation zones of variable confidence. If applicable, other geological features such as dykes can also be included.

[1] The lineaments longer than (or equal to) 3,000 m are of special importance to the safety assessment of the site and are therefore treated separately.

3 Execution

The study of the inferred lineaments is, as recommended by /Johansson 2005/, based on the primary interpretation made by GeoVista AB /Isaksson et al. 2004/. The lineaments were classified according to their inferred length and studied accordingly.

At first, the correlation of the lineaments interpreted by GeoVista AB (hereafter referred to as GV lineaments) to the ones inferred by the Geological Survey of Finland (referred to as GTK lineaments) was studied. The lineaments studied are the linked lineaments which constitute the final product of the lineament interpretations /e.g. Isaksson et al. 2004/.

Secondly, the present knowledge of the cause of the various lineaments was documented. The so far available verifications, positive or negative, of the lineaments being caused by deformation zones were listed. Examples of verifications involved are outcrop observations, trenching, drilling and ground geophysics (mainly refraction seismics).

Finally, the lineaments considered most important for the assessment of the site are discussed and complementary investigations recommended. Recommendations for further investigations are presented in Chapter 5.

The work presented in this report is based on information available in June 2005, and makes use of the Forsmark version 1.2 site model /SKB 2005b/.

3.1 Work flow

The work flow comprised a number of sub-activities, namely to

- Search all GV and GTK linked lineament > 1 km in length within the selected area.
- Select from the linked lineament data base, an identity (e.g. ”XFM0835A0”, ”LL0003”).
- Copy the linked lineament to a separate file.
- Add new attributes to coordinated lineament files: X, Y, Investigation, Geological_Char, Verification_comment, GTK(or GV)_correlation.
- Select and copy all segments that form the selected linked lineament to a separate file.
- Sort the segments into S-N order and give them a new suffix (serial number) according to this order (XFM083503).
- Check and note correlations between GTK and GV segments.
- Open all method specific lineaments and copy those that form a basis for the selected linked lineament into a separate file. Add the lineament identity.
- Group the different lineaments according to origin and length and copy each group into a new file.
- Examine investigations carried out, that possibly can verify the existence (or non-existence) of a deformation zone: outcrop, trenches, drilling (KFM,HFM), refraction seismics, ground geophysics, modelling version 1.2.
- Document the investigations, geological character and possible verifications of the corresponding lineament segment.

This work flow produced a number of files, which have been delivered to SKB. These files are tools intended to be used for future up-dates of the present work. Especially the correlation and verification tables (see below) are "living documents" continuously calling for updates. The files are listed in Chapter 7.

3.2 Correlation

Linked lineaments longer than 1,000 m were reviewed and tabulated. Figure 3-1 shows the design of the resulting correlation table and the present update of the table is presented in Appendix 1. The lineaments 500–1,000 m were not studied individually and therefore not tabulated. The correlation of these lineaments is instead discussed in a more generalised manner (Section 4.3).

The correlation table contains the following main columns, which are designed to describe the procedure recommended for further follow up work:

Column I contains GV lineaments longer than 3,000 m and, when applicable, the corresponding GTK linements. These GV lineaments must be carefully evaluated, regardless of whether there are or are not corresponding GTK lineaments.

Column II contains GV lineaments 1,000–3,000 m, which also need to be carefully evaluated. However, the ones which are part of GTK lineaments longer than 3,000 m, should instead be involved in the evaluation of the corresponding GTK (> 3,000 m) lineament.

Column III contains GTK lineaments longer than 3,000 m. Some of these lineaments completely correspond to a GV lineament and have been involved in the evaluation of the GV lineaments found in Column I. The others also need to be evaluated as the lineaments in Column I.

Column IV contains GTK lineaments 1,000–3,000 m. Analogous to the Column III lineaments, these lineaments might have been involved in the evaluation of GV lineaments found in Columns I or II. If not, they should be added to the lineaments to be evaluated.

GV lineament > 3 km		**GV lineament 1–3 km**				**GTK lineament > 3 km**				**GTK lineament 1–3km**			
GV lineament > 3 km		GV lineament 1–3 km		GV lineament 1–3 km which constitutes part of a GTK lineament > 3 km		GTK lineament > 3 km, fully corresponding to GV lineament		GTK lineament > 3 km, only partly corrsponding to GV lineament		GTK 1–3 km, fully corresponding to GV lineament		GTK lineament 1–3 km, only partly corresponding to GV lineament	
File: Co_XFM_3km		File: Co_XFM_1-3km		File: Co_XFM_1-3km_LL_3km		File: LL_3km_fully_XFM		File: Co_LL_3km_not-fully_ XFM		File: LL_1-3km_fully_XFM		File: Co_LL_1-3km_not-fully_XFM	
GeoVista	corresponds	GeoVista	corresponds	GeoVista	corresponds	GTK	corresponds	GTK	corresponds	GTK	corresponds	GTK	corresponds
3,000 m	to GTK	1,000–3,000 m	to GTK	1,000–3,000 m	to GTK	3,000 m	to GeoVista	3,000 m	to GeoVista	1,000–3,000 m	to GeoVista	3,000 m	to GeoVista
ID_T	ID_T: LL	ID_T	ID_T: LL	ID_T	ID_T: LL	ID_T	ID_T: XFM	ID_T	ID_T: XFM	ID_T	ID_T: XFM	ID_T	ID_T: XFM
XFM0015A0	523			XFM0017A1	95, 122			LL0060	047, 099, 134, 163, 402, 408, 693 explains some parts + low magn area			LL0000	417, 100
XFM0017A0	part of 280, 12, 72, 8, 1, 430, 472	XFM0030A0	115					LL0095	17A1			LL0002	404, 719, 157
XFM0018A0	part of 523, 255, 88, no data	XFM0033A0	part of 470, part of 91					LL0122	17A1 , 037			LL0003	709, 99
XFM0035A0	part of 269, no data			XFM0037A0	122	LL0233	803					LL0004	734, 716, 133, 416
XFM0036A0	part of 522, 470, 89, no data?	XFM0042A0	102, no data			LL0237	803+1127+ 804			LL0005	127		
XFM0060A0	no data, part of 37, 120, 47, 46, 464	XFM0044A0	96, 118, no data			LL0364	1033+835+ (minor part of 805)			LL0006	98		

Figure 3-1. *Correlation table design.*

It should be noted that a typical correlation does not always involve one single GV lineament corresponding to one single GTK lineament, both of the same approximate length. Frequently, one GV lineament corresponds to two, or more, shorter GTK lineaments. The same comment applies to several longer GTK lineaments. Furthermore, a GV (or GTK) lineament sometimes corresponds to only a part of a GTK (or GV) lineament. This illustrates the uncertainty in linked lineament length, as pointed out by /Johansson 2005/.

3.3 Verification

The inferred lineaments are, in the site investigation context, considered to represent *possible deformation zones*. However, they must be verified if they are to be incorporated in the geological model of the site at a higher level of confidence. This verification should be based on direct information such as outcrop data or observations from trenching and/or drilling. Deformation zones verified by indirect information (for example ground geophysics) can only be incorporated in the model as zones of low confidence.

A linked lineament is made up of one or several co-ordinated lineaments, each one forming a segment of the linked lineament /e.g. Isaksson et al. 2004/. For practical reasons, such a segment is in this study defined as the smallest unit forming a linked lineament. Verification, by for instance a drill hole or an outcrop observation, is regarded to be valid only for the particular segment involved, not for the whole linked lineament.

Similar to the tabulation of the correlation, the presently available verifications of lineaments longer than 1,000 m (1,000–3,000 m and > 3,000 m respectively) were tabulated. Figure 3-2 shows the design of the verification tables and the present updates (as of June, 2005) of the tables are included in Appendix 1. Together with the other lineament attributes, this information is also present in the corresponding ESRI shape-files listed in the appendix and delivered to SKB.

Co_XFM_3km_ver							
ID	Method	Comment	Length	Investigation	Geological interpret	Verification	GTK_Correlation
XFM001501	magn	in the sea, partly EM indication	1,241				outside GTK area
XFM001502	topo, magn, VLF	partly in the sea	916				LL0404
XFM001503	magn, topo, EM	valley, wetland marker on IR	533	oc	BDZ	cataclastic rocks	LL0137, LL0034
XFM001504	magn, topo, EM	valley, wetland marker on IR	67				none
XFM001505	magn, topo		438	oc	DZ	mylonitic rocks	LL0139, LL0137
XFM001506	magn, topo		305				LL0139, LL0035
XFM001507	magn, topo	valley	915	oc	BDZ	cataclastic rocks, qz, ep	LL0159, LL0173, LL0016
XFM001508	magn, topo, EM		633				LL0523
XFM001509	magn, EM	lake	710				LL0523
XFM001510	magn,topo,EM		1,217	oc, HFM11, HFM12, gg	DZ, S>O, LR, MM	mylonitic and cataclastic rocks, ep, qz. modelled in ver 1.2	LL0523
XFM001511	magn, topo, EM	narrow wetland, narrow valley	265	oc	DZ	mylonitic and cataclastic rocks, qz, ep	LL0523, LL0123
XFM001512	magn, topo, EM	lake,bog	504	refrseis	LV	15 m 3,200 m/s, 130 m 4,800 m/s	LL0523

Figure 3-2. *Verification table design. The first lines of the verification table Co_XFM_3km_ver.xls for GV lineaments longer than (or equal to) 3,000 m. Linked lineament XFM0015, first 12 coordinated segments.*

4 Results

The results of the lineament study are presented in the form of maps that show both the correlation between the primary interpretation and the alternative interpretation and the presently available verifications. In the figures presented, the verifications override the correlation, i.e. if a segment of a lineament is verified as a deformation zone, it has been considered less important, in this context, to display the correlation.

The results are presented in Section 4.1 and 4.2 for lineaments longer than (or equal to) 3,000 m and 1,000–3,000 m, respectively.

Lineaments 500–1,000 m have not been scrutinised individually but are instead discussed in a more generalised manner in Section 4.3

4.1 Lineaments longer than 3,000 m

The Forsmark candidate area is delimited by a number of persistent lineaments related to the Eckarfjärden and Fiskarfjärden zones in the south-west and the Singö zone in the north-east, see Figure 4-1.

Within the study area, there are five inferred lineaments exceeding 3,000 m which intersect the Forsmark candidate area, see Figure 4-1. An additional lineament crossing the candidate area immediately to the south-east of the study area has also been included.

The three NE-SW trending lineaments (XFM0060, XFM0062 and XFM065) are well established and have all been included as deformation zones in the version 1.2 model of the site /SKB 2005b/.

The two NS trending lineaments (XFM0098, XFM0127) and the NW-SE trending LL0060 are not yet verified as deformation zones. They have all been subject to investigation by core drilling (KFM05A) in their central part but the results did not justify the lineaments to be modelled as deformation zones. The investigated segments are shown in white in Figure 4-1.

Further investigations: Given the importance of lineaments exceeding 3,000 m for the safety analyses of the site, these lineaments need to be further investigated in order to better define their existence and character. Of special importance is the extension of the lineament XFM0060. It is still unclear whether this lineament continues between the lineaments XFM0127 and XFM0098. Dividing XFM0060 into two shorter lineaments (zones) will have a strong influence on the evaluation of the site.

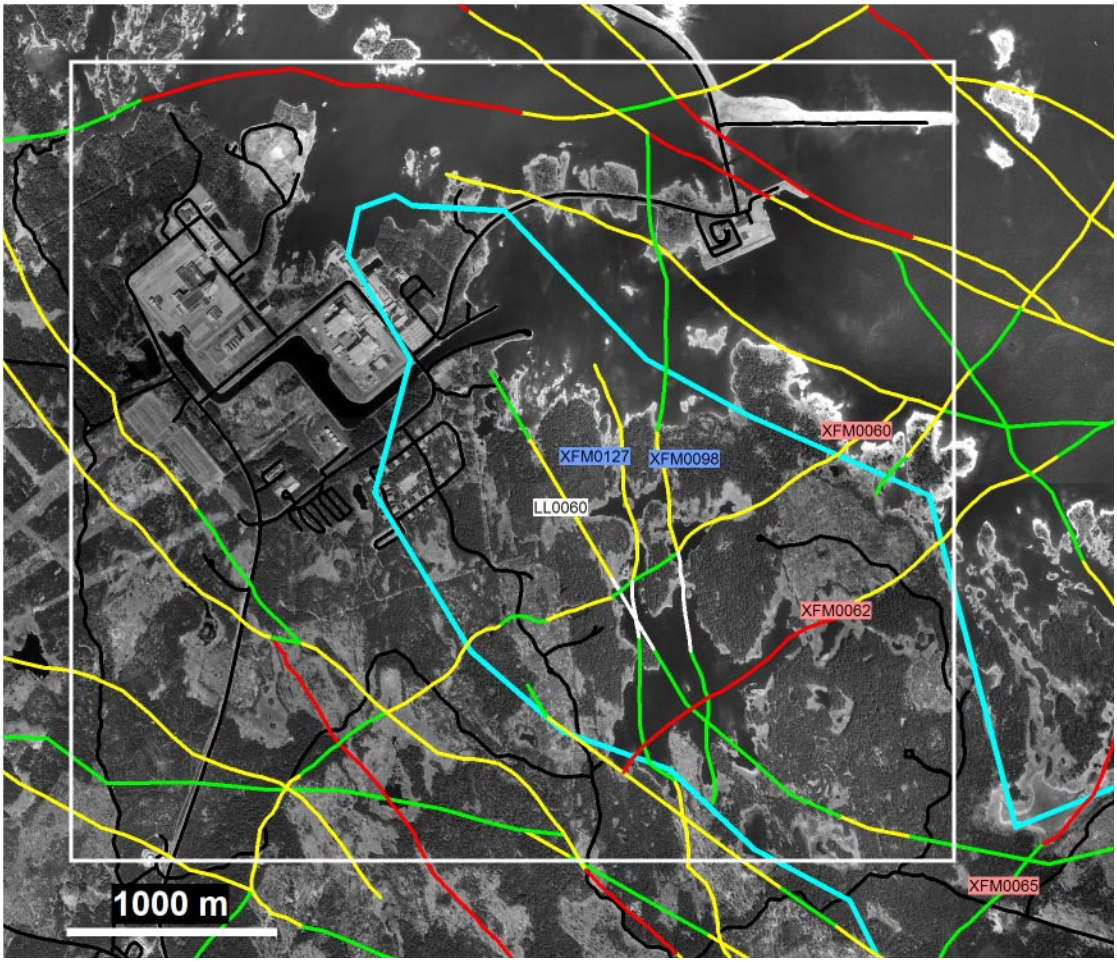


Figure 4-1. *Linked lineaments longer than, or equal to, 3,000 m. Lineament segments verified to be caused by deformation zones are shown as red lines and segments investigated but not verified as deformation zones are shown as white lines. Correlated GV and GTK segments are shown in yellow and uncorrelated (GV or GTK) segments in green. The identities of the NE-SW, NS and NW-SE trending lineaments are shown against reddish, blue and white backgrounds, respectively. The Forsmark candidate area is outlined with a light blue line.*

4.2 Lineaments, length 1,000–3,000 m

South-west of the candidate area, a very complex pattern of 1,000–3,000 m lineaments is found and forms part of the border zone, see Figure 4-2. The apparent complexity as compared to the north-eastern border zone is to a large extent explained by the absence of detailed topographic data in the north-eastern (coastal) sub area.

The lineaments intersecting the candidate area have again been grouped into NE-SW, NS and NW-SE trending ones (Figure 4-2).

Three of the six NE-SW trending lineaments are situated to the north-west (XFM0810) and to the south-east (XFM0063 and LL0253) of the potential depository area. The other three (XFM0159, XFM0061, XFM0103) are intersecting the central part of the area. Both the lineaments XFM0061 and XFM0103 have been incorporated in the version 1.2 site model.

Seven NS trending lineaments cut the candidate area and one (LL0000) that is found immediately to the west of the candidate area has been added. Most important are LL0002, XFM0099/LL0003 and possibly also LL0018 and LL0187. The others are, at this stage of the site investigation, more peripheral. The lineament LL0003 overlaps XFM0099 and should be seen as a possible extension of the latter.

Of the NW-SE trending lineaments, LL0490, LL0478, LL0476, XFM0045 and possibly XFM0427 are the ones cutting the central area of interest. Special attention must be paid to XFM0045, which could eventually be linked to XFM0127 (cp. Figure 4-1). The lineaments LL0476, LL0478 and LL0490, shown in white in Figure 4-2, have been subject to drilling but there is so far no support that they represent deformation zones.

Further investigations: Although not as critical as longer lineaments, the ones having an inferred length of 1,000–3,000 m are still important to the site description and such lineaments (possible deformation zones) cutting the central depository volume should not be left without further investigations.

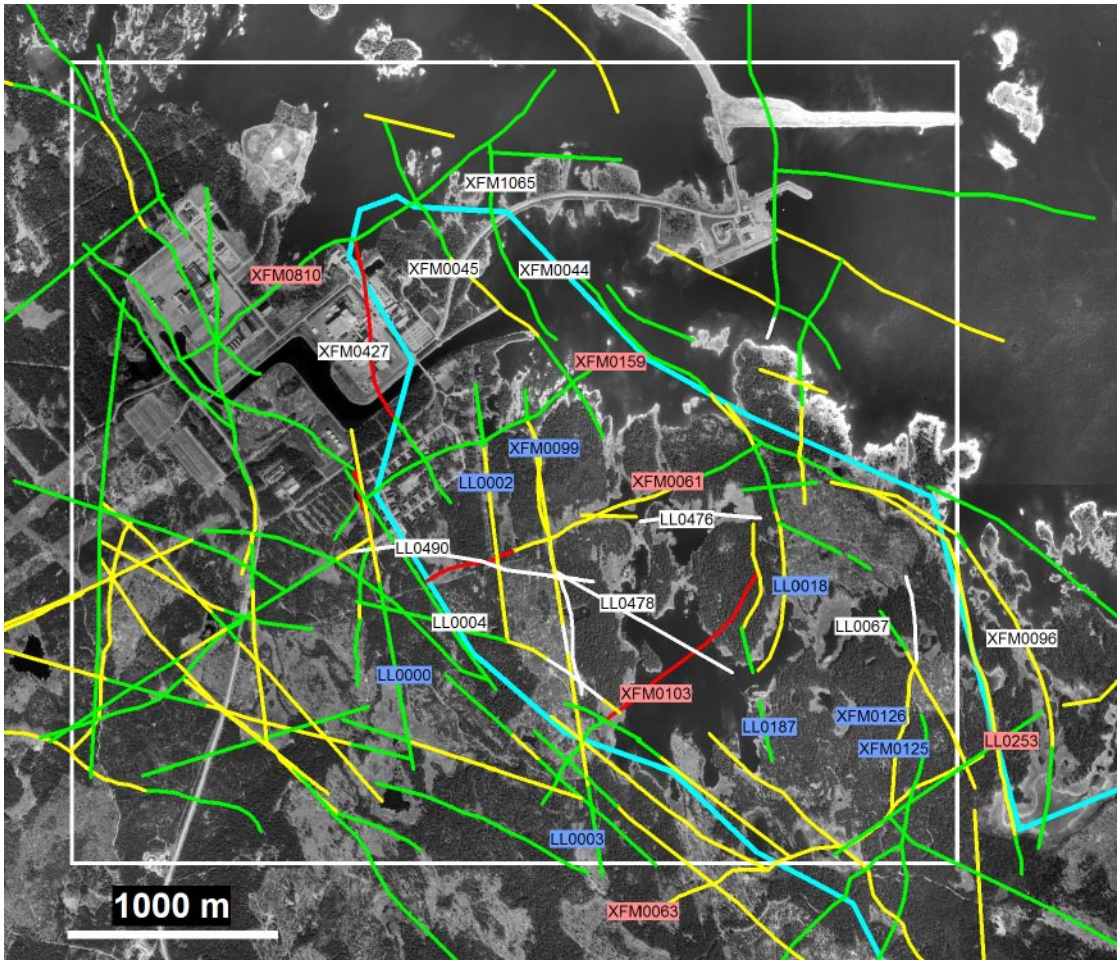


Figure 4-2. *Linked lineaments, 1,000–3,000 m long. Lineament segments verified to be caused by deformation zones are shown in red and segments investigated but not verified as deformation zones (negative verification) in white. Correlated GV and GTK segments are shown in yellow and uncorrelated (GV or GTK) segments in green. The identities of the NE-SW, NS and NW-SE trending lineaments are shown against reddish, blue and white backgrounds, respectively. The Forsmark candidate area is outlined with a light blue line.*

4.3 Lineaments, length 500–1,000 m

The 500–1,000 m long lineaments are displayed in Figure 4-3 together with the lineaments longer than 1,000 m. At the present stage of the site investigation, these shorter lineaments are generally not investigated by means of trenching or drilling and furthermore, the ground geophysical profiling is mainly focused on the major lineaments.

However, in connection with the investigations of the major lineaments, information is also obtained on the minor ones. Two lineaments shorter than 1,000 m have even been included in the present site model version 1.2 (see Figure 4-3). One of these lineaments, XFM0401, is almost 1,000 m (974 m) but the other one, XFM0404, is only 312 m. On the other hand, XFM0404 coincides with the southern part of a longer lineament, LL0002 (see also Figure 4-2), and the two lineaments should be further assessed together.

From Figure 4-3, it is obvious that most lineaments in the interval 500–1,000 m are in one way or another "related" to the longer lineaments. They appear as e.g. splines, extensions or as minor parallel lineaments. Investigations directed towards individual lineaments of this kind are hardly meaningful at this stage. However, some lineaments will be investigated and explained in conjunction with investigation efforts concerning the major lineaments.

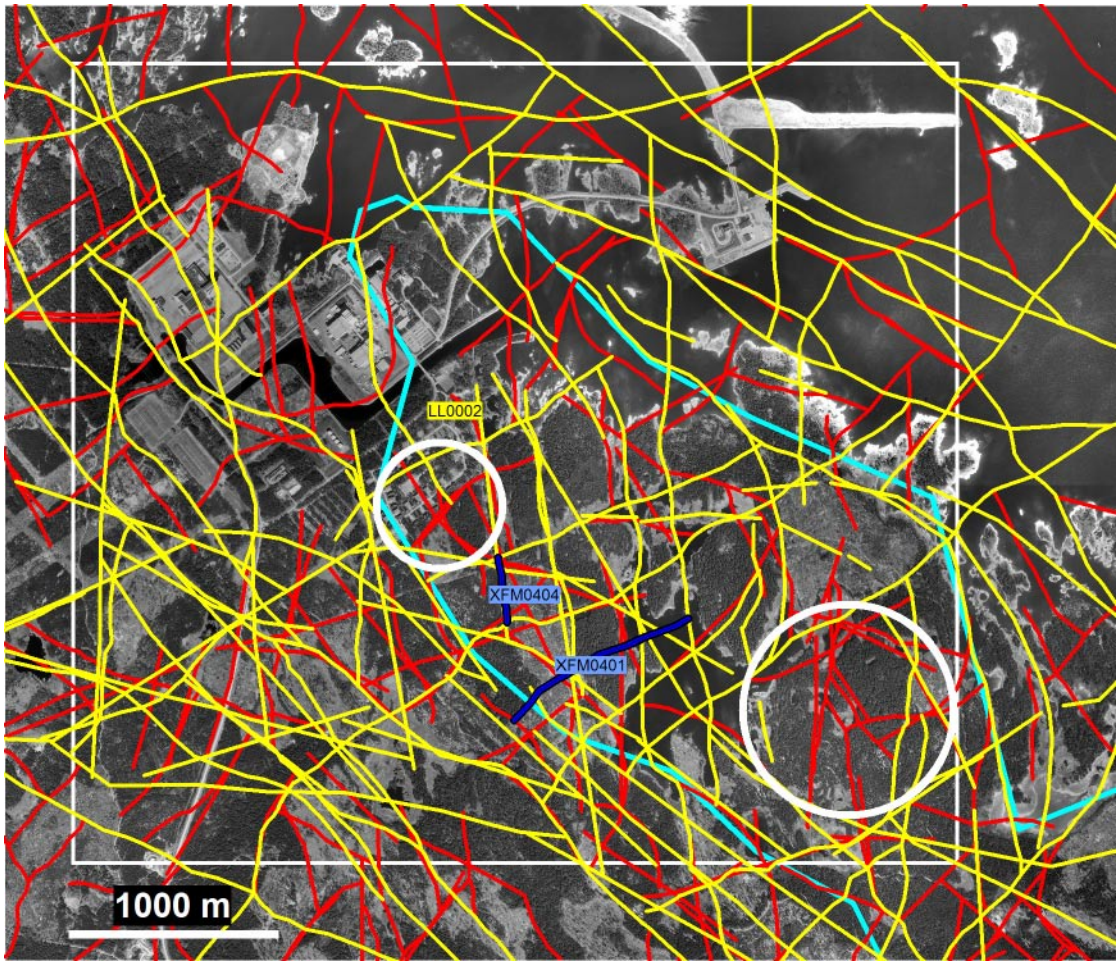


Figure 4-3. *Linked lineaments, length 500–1,000 m in red and lineaments longer than 1,000 m in yellow. Two lineaments, XFM0401 and XFM0404 (dark blue), have been included in the present site model (version 1.2). Lineament XFM0404 correlates with the much longer lineament LL0002. The two white circles mark areas where further control of lineaments shorter than 1,000 m is suggested. The Forsmark candidate area is outlined with a light blue line.*

Further investigations: As indicated above, there is no reason to focus on the investigation of lineaments shorter than 1,000 m at this stage of the site investigation. In principle, this should be left to the detailed site investigation. Nevertheless, there are two areas (white circles in Figure 4-3), within which a number of lineaments are suggested to be investigated. The investigations should aim at understanding the importance of these shorter lineaments (individual lineaments or clusters of lineaments) to the site description. In the first place, the investigations are suggested to be done in the form of field checks and thereafter, if deemed necessary, by e.g. ground geophysics and/or excavation.

5 Recommendations for further investigations

The recommended investigation programme has, on various occasions, been discussed with the Forsmark site investigation and modelling teams and these discussions have significantly influenced the programme presented.

The recommendations are focused on the north-western part of the site investigation area or, more precisely, lineaments intersecting the north-western part of the *Forsmark candidate area*. Lineaments delimiting the candidate area (border zones) are also highly important but not treated here. This is because the site investigation is now mainly concentrated on the potential repository volume. Investigation of the regional deformation zones to the north-east and to the south-west of the candidate area is planned at a late stage in the complete site investigation programme /SKB 2005a/.

When planning the investigation, it is important not only to study the linked lineament as such but also to study the method specific lineaments and the co-ordinating and linking processes which have formed the lineament under investigation. Figure 5-1 shows an example of a linked lineament, XFM0060A0, together with the corresponding method specific lineaments. It is obvious from Figure 5-1 that uncertainties sometimes may arise on when and how to coordinate and link the method specific lineaments. This must be considered when siting trenches, drill holes, ground geophysical profiles etc.

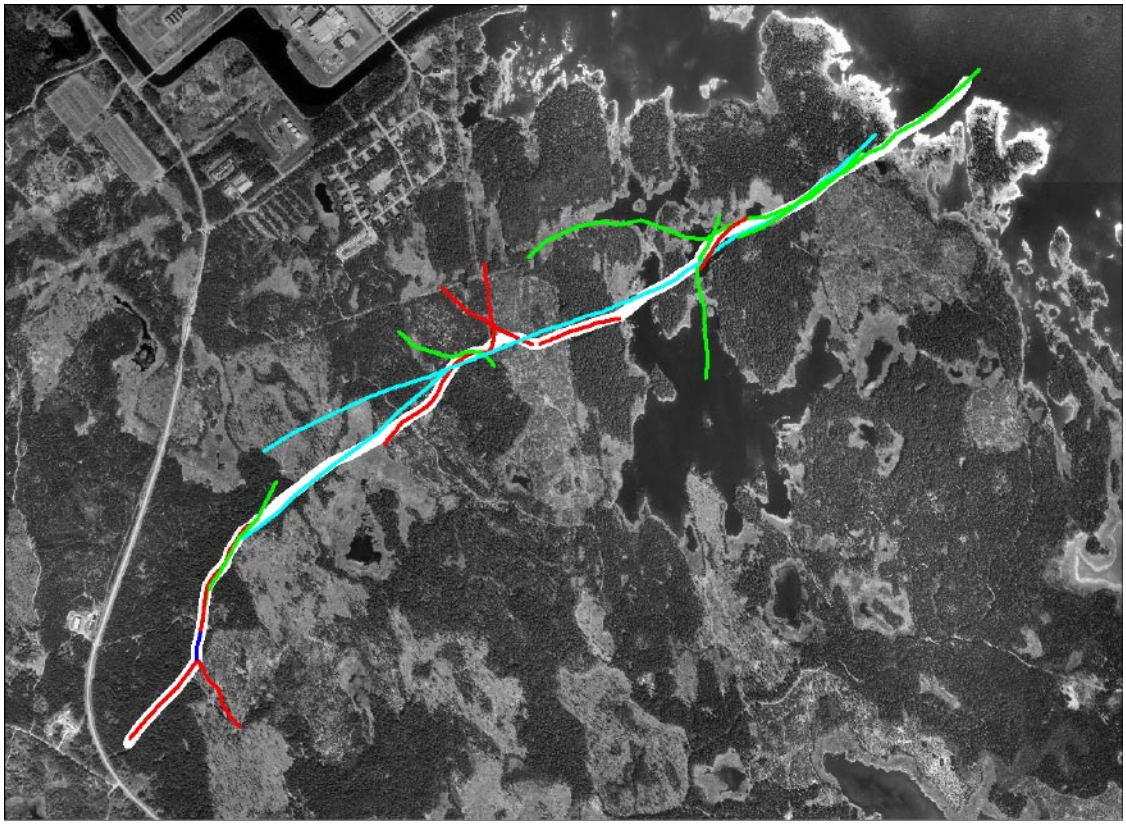


Figure 5-1. *Linked lineament XFM0060A0 and the corresponding method specific lineaments. Magnetic lineaments in blue, electromagnetic lineaments in green and topographic lineaments in red. The linked lineament is outlined in white.*

When the lineaments are investigated, it is important to take note of possible extensions based also on shorter lineaments. In many cases, the linking process suffers from uncertainties and alternative linking might for instance lead to the re-classification of a lineament from being shorter than 3,000 m to be longer than 3,000 m.

It is also important to bear in mind that a planning instrument like the one presented here must be continuously updated. New information will frequently give rise to new ideas calling for a modified investigation plan, both concerning which lineaments to examine and the order of priority.

The methodologies suggested are trenching, drilling, ground geophysics and field inspection. When drilling is proposed, this is thought to be the best method (sometimes meant to complement already performed trenching) but trenching could, for nature conservancy or technical considerations, be replaced by drilling.

The lineaments recommended to be further investigated have been grouped according to their approximate orientation. The groups are:

- Lineaments trending NE-SW (Figure 5-2).
- Lineaments trending N-S (Figure 5-3).
- Lineaments trending NW-SE (Figure 5-4).

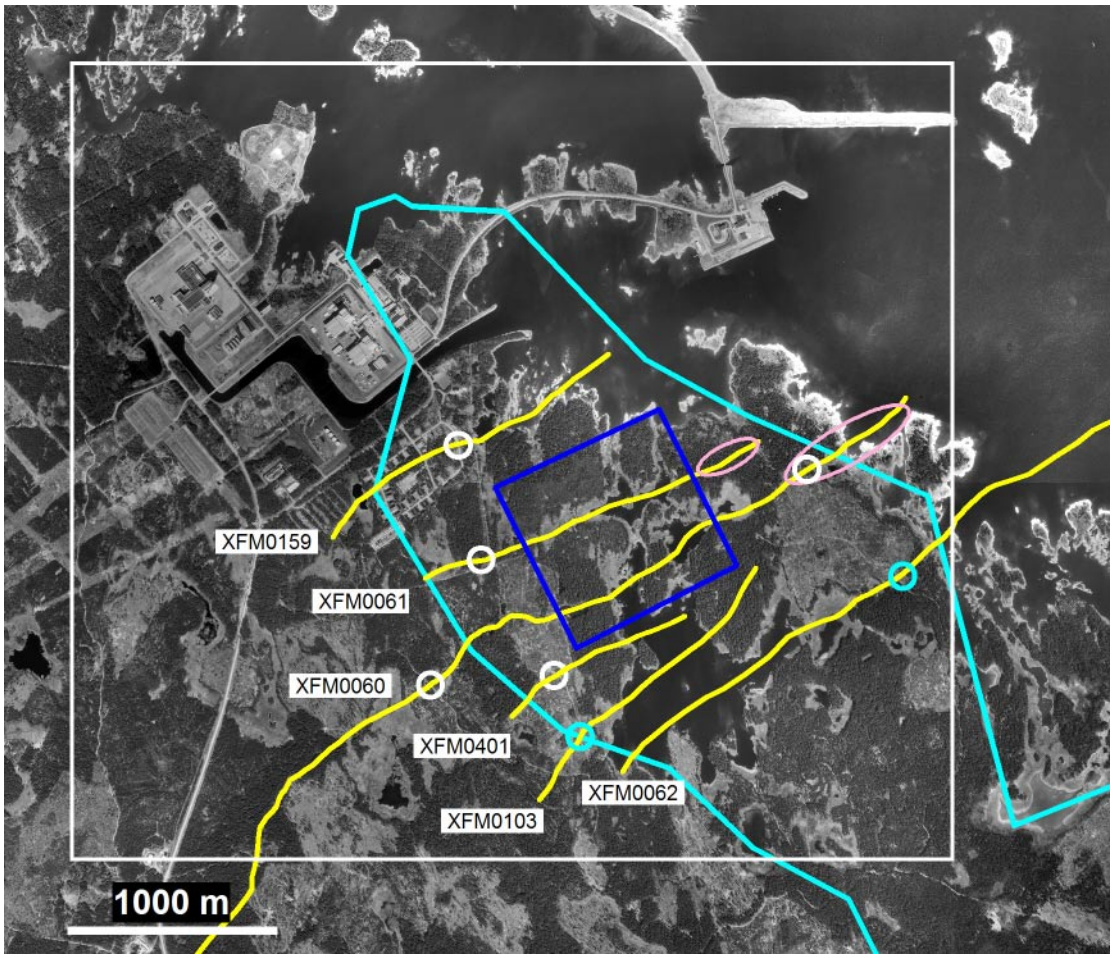


Figure 5-2. *Proposed investigation programme. Linked lineaments trending NE-SW. White circles indicate trenching and blue circles drilling. The violet ellipses indicate field checks and the dark blue rectangle the area suggested for detailed ground geophysics.*

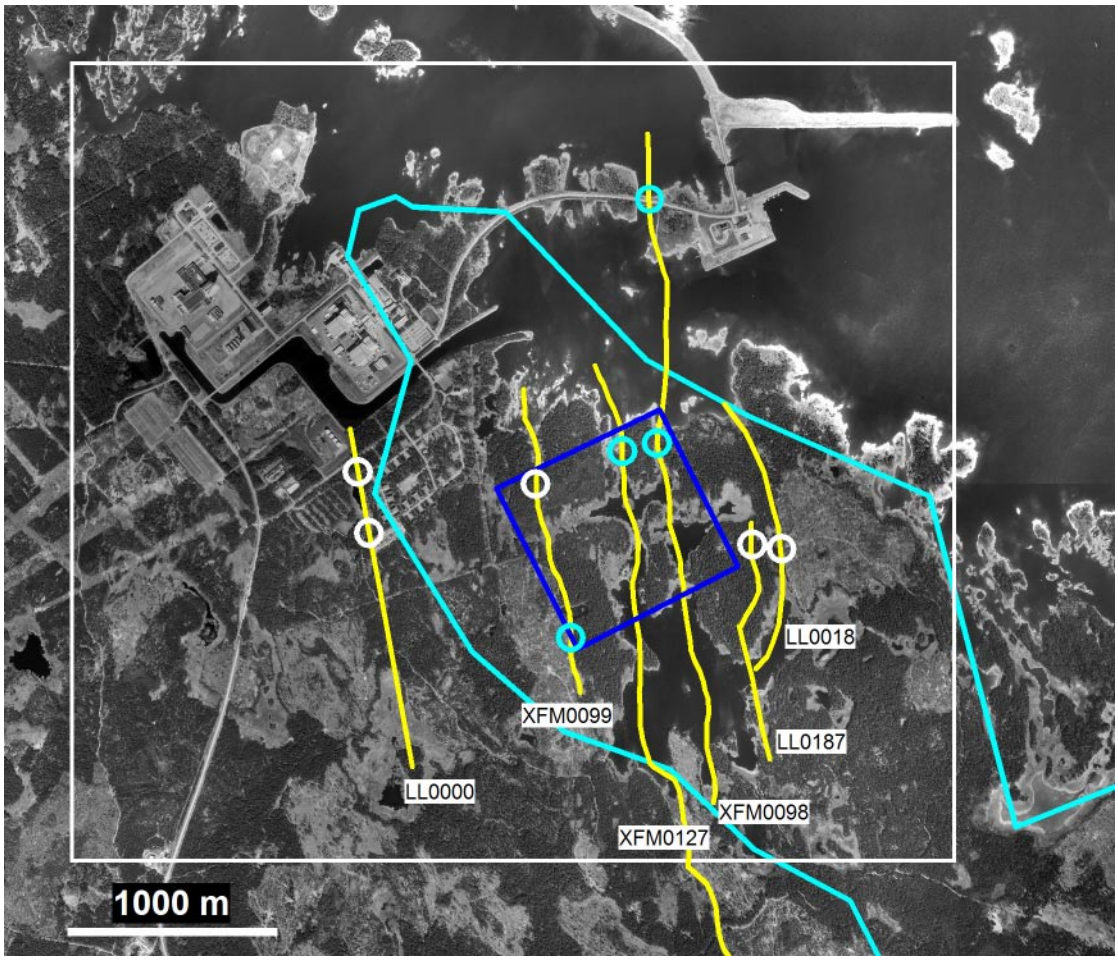


Figure 5-3. *Proposed investigation programme. Linked lineaments trending NS. White circles indicate trenching and blue circles drilling. The dark blue rectangle outlines the area suggested for detailed ground geophysics.*

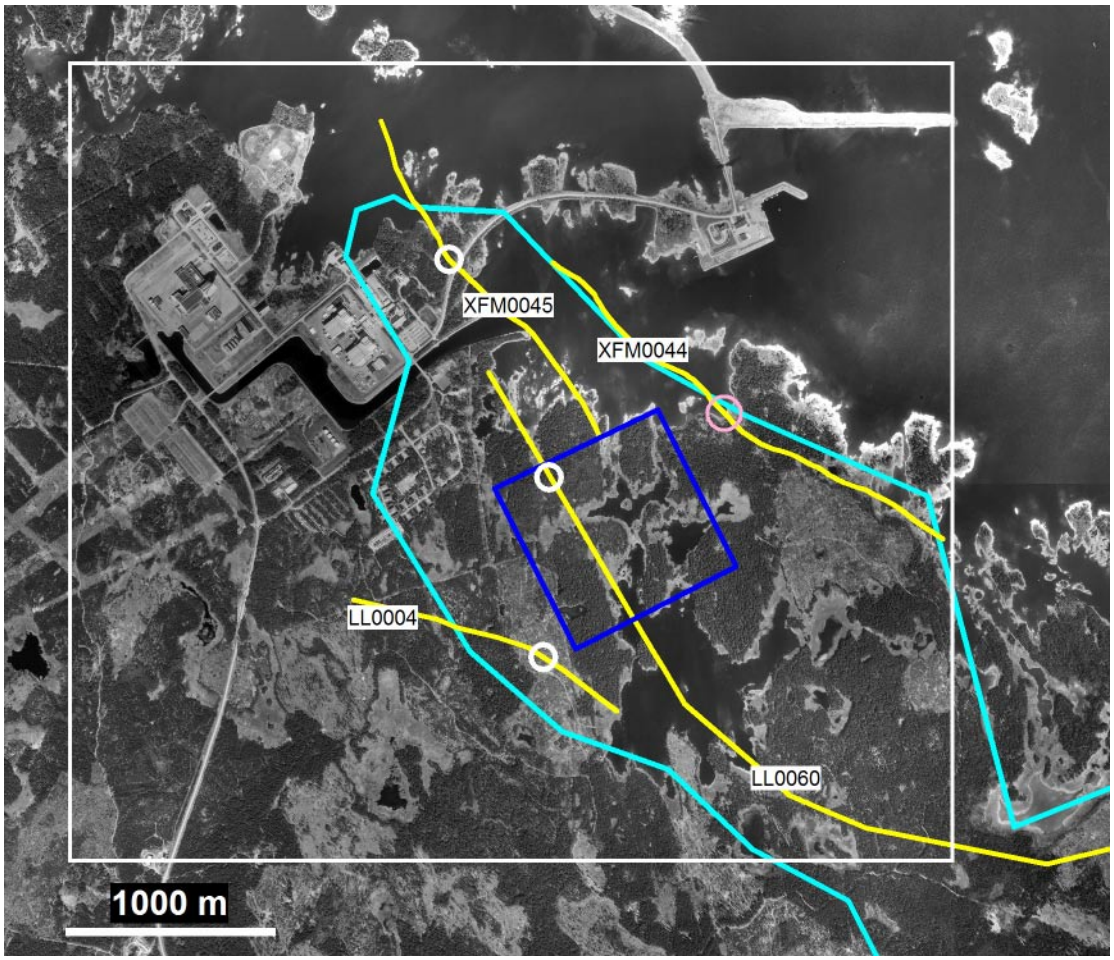


Figure 5-4. *Proposed investigation programme. Linked lineaments trending NW-SE. White circles indicate trenching, the violet circle indicates field check and the dark blue rectangle the area suggested for detailed ground geophysics.*

6 Data delivery

The following data files (cp. Figure 3-1) have been delivered to SKB in ESRI shape format:

File	Content of file	Comment
Co_XFM_3km	GV lineaments > 3,000 m	
Co_LL_3km_fully_XFM	GTK lineaments > 3,000 m fully correlated to GV lineaments	Documented in Co_XFM_
Co_LL_3km_not-fully_XFM	GTK lineaments > 3,000 m not correlated or weakly correlated to GV lineaments	
Co_XFM_1-3km	GV lineaments 1,000–3,000 m	
Co_XFM_1-3km_LL_3km	GV lineaments 1,000–3,000 m which are parts of GTK lineaments > 3,000 m	Provides higher accuracy
Co_LL_1-3km_fully_XFM	GTK lineaments 1,000–3,000 m fully correlated to GV lineaments	Documented in Co_XFM_
Co_LL_1-3km_not-fully_XFM	GTK lineaments 1,000–3,000 m not correlated or weakly correlated to GV lineaments	
Co_XFM_0-1km	GV lineaments < 1,000 m included in the version 1.2 site model	Contains XFM0401A0 and XFM0404A0

In Microsoft Excel format, the following files have been delivered:

Correlation of GeoVista and GTK lineaments (see Section 3.2)

GV_GTK_correlation.xls

Verification tables (see Section 3.3)

Co_XFM_3km_ver.xls

Co_LL_3km_fully_XFM_ver.xls

Co_LL_3km_not-fully_XFM_ver.xls

Co_XFM_1-3km_ver.xls

Co_XFM_1-3km_LL_3km_ver.xls

Co_LL_1-3km_fully_XFM_ver.xls

Co_LL_1-3km_not-fully_XFM_ver.xls

Co_XFM_0-1km_ver.xls

Abbreviations_ver.xls (abbreviations used in the verification tables)

7 References

Isaksson H, 2003. Interpretation of topographic lineaments 2002. SKB P-03-40. Svensk Kärnbränslehantering AB.

Isaksson H, Keisu M, 2004. Interpretation of airborne geophysics and integration with topography. Stage 2 (2002–2004). SKB P-04-282. Svensk Kärnbränslehantering AB.

Isaksson H, Thunehed H, Keisu M, 2004. Interpretation of airborne geophysics and integration with topography. Stage 1 (2002). An integration of bathymetry, topography, refraction seismics and airborne geophysics. SKB P-04-29. Svensk Kärnbränslehantering AB.

Johansson R, 2005. A comparison of two independent interpretations of lineaments from geophysical and topographic data at the Forsmark site. SKB R-05-23. Svensk Kärnbränslehantering AB.

Korhonen K, Paananen M, Paulamäki S, 2004. Interpretation of lineaments from airborne geophysical and topographic data. An alternative model within version 1.2 of the Forsmark modelling projekt. SKB P-04-241. Svensk Kärnbränslehantering AB.

SKB, 2005a. Forsmark site investigation. Programme for further investigations of geosphere and biosphere. SKB R-05-14. Svensk Kärnbränslehantering AB.

SKB, 2005b. Forsmark site investigation. Forsmark area – version 1.2. SKB R-05-18. Svensk Kärnbränslehantering AB

Appendix 1

GeoVista_GTK correlation file

GV_GTK_correlation.xls

Verification files

Co_XFM_3km_ver.xls

Co_LL_3km_fully_XFM_ver.xls

Co_LL_3km_not-fully_XFM_ver.xls

Co_XFM_1-3km_ver.xls

Co_XFM_1-3km_LL_3km_ver.xls

Co_LL_1-3km_fully_XFM_ver.xls

Co_LL_1-3km_not-fully_XFM_ver.xls

Co_XFM_0-1km_ver.xls

Abbreviations_ver.xls (abbreviations used in the verification tables)

GV_GTK_Correlation

GV lineament > 3 km		**GV lineament 1–3 km**				**GTK lineament > 3 km**				**GTK lineament 1–3km**			
GV lineament > 3 km		GV lineament 1–3 km		GV lineament 1–3 km which constitutes part of a GTK lineament > 3 km		GTK lineament > 3 km, fully corresponding to GV lineament		GTK lineament > 3 km, only partly corrsponding to GV lineament		GTK 1–3 km, fully corresponding to GV lineament		GTK lineament 1–3 km, only partly corresponding to GV lineament	
File: Co_XFM_3km		File: Co_XFM_1-3km		File: Co_XFM_1-3km_LL_3km		File: LL_3km_fully_XFM		File: Co_LL_3km_not-fully_ XFM		File: LL_1-3km_fully_XFM		File: Co_LL_1-3km_not-fully_XFM	
GeoVista	corresponds	GeoVista	corresponds	GeoVista	corresponds	GTK	corresponds	GTK	corresponds	GTK	corresponds	GTK	corresponds
3,000 m	to GTK	1,000–3,000 m	to GTK	1,000–3,000 m	to GTK	3,000 m	to GeoVista	3,000 m	to GeoVista	1,000–3,000 m	to GeoVista	3,000 m	to GeoVista
ID_T	ID_T: LL	ID_T	ID_T: LL	ID_T	ID_T: LL	ID_T	ID_T: XFM	ID_T	ID_T: XFM	ID_T	ID_T: XFM	ID_T	ID_T: XFM
XFM0015A0	523			XFM0017A1	95, 122			LL0060	047, 099, 134, 163, 402, 408, 693 explains some parts + low magn area			LL0000	417, 100
XFM0017A0	part of 280, 12, 72, 8, 1, 430, 472	XFM0030A0	115					LL0095	17A1			LL0002	404, 719, 157
XFM0018A0	part of 523, 255, 88, no data	XFM0033A0	part of 470, part of 91					LL0122	17A1 , 037			LL0003	709, 99
XFM0035A0	part of 269, no data			XFM0037A0	122	LL0233	803					LL0004	734, 716, 133, 416
XFM0036A0	part of 522, 470, 89, no data?	XFM0042A0	102, no data			LL0237	803+1127+ 804			LL0005	127		
XFM0060A0	no data, part of 37, 120, 47, 46, 464	XFM0044A0	96, 118, no data			LL0364	1033+835+ (minor part of 805)			LL0006	98		
XFM0062A0	no data?, part of 521, 357, 362	XFM0045A0	66, 394, no data			LL0523	15A0			LL0007	61		
XFM0098A0	part of 6, no data?	XFM0046A0	part of 268, part of 328					LL0524	805+part of 1021			LL0018	62, 160, 722, 44

XFM0127A0	part of 39, 5	XFM0047A0	part of 20, part of 60					LL0533	136 in SA +123 (outside)	LL0020	47		
XFM0137A0+B0	part of 100, 268, 236	XFM0061A0	part of 7							LL0039	127		
XFM0803A0	233 + 237	XFM0063A0	38, 253, 466							LL0046	60		
XFM0805A0	364	XFM0064A0	71, 398									LL0048	(421)
XFM0808A0	part of 384, 386, 258, no data	XFM0073A0	90									LL0049	711
XFM0809A0	part of 263	XFM0091A0	118							LL0056	125, 686, 126		
XFM0818A0	part of 65	XFM0099A0	3, 60, no data									LL0065	818, 678
XFM0836A0	part of 239	XFM0100A0	94									LL0067	102, 255, 685
XFM1127A0	237	XFM0101A0	525									LL0068	410, 100
		XFM0103A0	58									LL0072	17A0
XFM0065A0	part of 211, 19, 284	XFM0125A0	56									LL0076	703
		XFM0126A0	56									LL0089	452, 457, 36, 769
				XFM0136A0	533							LL0090	73, 420
		~~XFM0137B0~~	see XFM0137A0									LL0091	33, 462
		XFM0159A0	–									LL0092	451, 423
		XFM0423A0	part of 92									LL0093	15A0, 455
		XFM0427A0	no data									LL0096	672, 124, 44, (101)
		XFM0487A0	no data							LL0103	156 has a length of 880 m		
		XFM0726A0	181, 447, no data									LL0115	30, 783, 155
		XFM0789A0	no data									LL0118	91

				XFM0804A0	237							LL0141	141
		XFM0810A0	no data									LL0153	–
		XFM0813A0	371									LL0187	737, 162
		XFM1022A0	(232 ?)									LL0253	63, 670, 683
				XFM1033A0	364					LL0255	18		
		XFM1053A0	248							LL0263	809		
		XFM1065A0	no data							LL0268	137, part of 46		
		XFM1068A0	part of 479							LL0269	35		
												LL0341	167, 44
				XFM0835A0	364							LL0348	1094
				XFM1021A0	524							LL0399	–
												LL0435	642, 697
												LL0470	33, 446, 36
												LL0476	164
												LL0478	170, 733, 406
												LL0490	406
										LL0521	62		
										LL0522	36		
										LL0525	101, 648		
												LL0528	15A0, 459
												LL0534	48, 626, 707, 706

Co_XFM_3km_ver (each background section represents one linked lineament)

Co_XFM_3km_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GTK_Correlation**
XFM001501	magn	in the sea, partly EM indication	1,241				outside GTK area
XFM001502	topo, magn, VLF	partly in the sea	916				LL0404
XFM001503	magn, topo, EM	valley, wetland marker on IR	533	oc	BDZ	cataclastic rocks	LL0137, LL0034
XFM001504	magn, topo, EM	valley, wetland marker on IR	67				none
XFM001505	magn, topo		438	oc	DZ	mylonitic rocks	LL0139, LL0137
XFM001506	magn, topo		305				LL0139, LL0035
XFM001507	magn, topo	valley	915	oc	BDZ	cataclastic rocks, qz, ep	LL0159, LL0173, LL0016
XFM001508	magn, topo, EM		633				LL0523
XFM001509	magn, EM	lake	710				LL0523
XFM001510	magn,topo,EM		1,217	oc, HFM11, HFM12, gg	DZ, S>O, LR, MM	mylonitic and cataclastic rocks, ep, qz. modelled in ver 1.2	LL0523
XFM001511	magn, topo, EM	narrow wetland, narrow valley	265	oc	DZ	mylonitic and cataclastic rocks, qz, ep	LL0523, LL0123
XFM001512	magn, topo, EM	lake,bog	504	refrseis	LV	15 m 3,200 m/s, 130 m 4,800 m/s	LL0523
XFM001513	magn	magnetic minima connection on topo high	603	oc,gg	DZ, LR	mylonitic rocks, qz, ep; VLF: LFK000160, 165, 166	LL0523
XFM001514	magn, topo		516				LL0093, L0528
XFM001515	magn, topo	Disturbed area	635				LL0093
XFM001516	magn, topo	Disturbed area	434				LL0523
XFM001517	magn	Eckarfjärden zone?, Topographic high	452				LL0523
XFM001518	topo,magn	narrow valley	373	refrseis	LV	5 m 3,000 m/s	LL0523
XFM001519	magn	Eckarfjärden zone?, topo flatland	502	refrseis	LV	11 m 3,500 m/s, no LV on refrseis profile 150 m N	LL0523
XFM001520	magn, topo	Eckarfjärden zone?, No VLF	899				LL0523
XFM001701	bathy		1,319				LL0280 NW part
XFM001702	topo, VLF		630				LL0012
XFM001703	magn, topo	valley	510				LL0012
XFM001704	topo, EM	wetland	316				LL0012
XFM001705	EM, VLF, topo	In Fiskarfjärden, includes topo shorelines	336				LL0012
XFM001706	topo, EM, VLF	narrow marsh	115				LL0012
XFM001707	EM, VLF, topo, magn	In Fiskarfjärden, includes topo shorelines	225				LL0012
XFM001708	topo, magn		576				LL0012
XFM001709	magn, topo	aggregration of several parallell lineaments	305				LL0012

XFM001710	magn, topo	aggregration of several parallell lineaments	583	oc,gg	DZ, LR, MM	mylonitic rocks, qz, < 100 m to SW	LL0012
XFM001711	magn, topo, EM	aggregation of parallell lineaments	948				LL0072, LL0008
XFM001712	magn, topo, EM, VLF		840	gg	LR	slingram: LFM000560; VLF: LFK000160, 165, 166	LL0001, LL0430
XFM001713	topo,magn	disturbed area	133				LL0472 close
XFM001801	topo, magn	along bogs and wetland, valley	801				LL0523 partly close
XFM001802	magn	disturbed area	2,117				LL0255 NW of FMV, no data
XFM001803	topo		60				LL0088
XFM001804	topo, magn	topo edge	216				LL0088
XFM001805	topo, VLF, EM, magn	wetland, narrow valley, weak VLF, part EM	416				LL0088
XFM001806	EM, topo	wetland marker, edge	159				
XFM003501	magn	magnetic minima connection	475				just outside GTK area
XFM003502	magn, EM	magnetic minima connection	159				LL0269
XFM003503	topo, magn	narrow wetland, narrow valley, tele cabel?	147				LL0269
XFM003504	magn	magnetic minima connection	1,643				LL0269
XFM003505	magn	magnetic minima connection	1,069				just outside GTK area
XFM003601	magn	magnetic minima connection	992				LL0522 WNW part, LL0470 SE part 80 m apart
XFM003602	magn	magnetic minima connection	1,434				LL0522 ESE part, LL0089 WNW part
XFM003603	magn	magnetic minima connection	644	refrseis	LV	17 m 3,500 m/s	no data?
XFM006001	topo		441				outside GTK area?
XFM006002	topo, magn	narrow wetland, narrow valley, tele cabel?	109				LL0037
XFM006003	topo, VLF		193				LL0037
XFM006004	topo, VLF	narrow wetland, tele cabel?	316				LL0037
XFM006005	magn, topo, VLF		519				
XFM006006	magn, topo	valley	698	refrseis, gg	LV, LR	5–10 m 3,200 m/s, SR: LFM000561, VLF: LFK000164, check report	LL0120, LL0047
XFM006007	topo	narrow marsh, wetland	54				
XFM006008	magn, topo		205				LL0047 partly
XFM006009	magn, topo		324				LL0047
XFM006010	magn	in Bolundsfjärden	131				LL0047 and LL0046 overstep
XFM006011	magn	across island in Bolundsfjärden	250				LL0046
XFM006012	EM, topo, VLF, magn	in Bolundsfjärden	790	KFM06A, KFM06C		no data available in ver 1.2	LL0046

XFM006013	VLF		186				LL0046
XFM006014	VLF	Sea area	361				LL0464
XFM006201	magn	Bolundsfjärden	545	KFM05A	DZ	modelled in ver 1.2	LL0521
XFM006202	magn, VLF, topo	in Bolundsfjärden	800	KFM05A	DZ	modelled in ver 1.2	LL0521
XFM006203	topo, magn, VLF	wetland	569	refrseis, gg	LV, LR	10 m 4,000 m/s	LL0521
XFM006204	em-bathy, magn		676				LL0521
XFM006205	bathy, magn		516				LL0357 alternative route
XFM006206	rock, em-bathy	Along survey line	216				no data?
XFM006207	bathy, magn		422				LL0362 partly close
XFM006501	magn, topo, EM		824				LL0211 N-most part
XFM006502	magn, topo, EM, VLF		919				LL0019 NNE part, LL0211 S-most part
XFM006503	magn, topo, EM, VLF		945	HFM18	DZ	modelled in ver 1.2	LL0019
XFM006504	magn		856				LL0284
XFM006505	bathy, magn		434				LL0284
XFM009801	EM, topo	Bolundsfjärden inlet	257				
XFM009802	EM	in Bolundsfjärden	481				
XFM009803	EM, topo	in Bolundsfjärden	469	KFM05A		no NS zone has been detected in ver 1.2	LL0006
XFM009804	topo	IR, DEM 50 m grid	321				LL0006
XFM009805	topo, magn	narrow inlet and wetland	366				LL0006
XFM009806	em-bathy		453				no data?
XFM009807	em-bathy		441				no data?
XFM009808	em-bathy, rock	across roadbank	536				no data?
XFM012701	topo		168				LL0039
XFM012702	topo, VLF, magn		141				LL0039
XFM012703	topo	forest boundary, topo edge	245				LL0039
XFM012704	topo	parallell to weak magnetic minima connection	115				LL0039
XFM012705	topo		228				LL0039
XFM012706	EM, topo	narrow inlet	194				LL0039
XFM012707	topo, VLF	Bolundsfjärden	138				LL0039
XFM012708	EM	Bolundsfjärden	129				
XFM012709	EM	Bolundsfjärden	478				
XFM012710	EM	Bolundsfjärden	269	KFM05A		no NS zone has been detected in ver 1.2	LL0005
XFM012711	topo	narrow inlet, DEM 50 m grid	182				LL0005
XFM012712	topo	narrow marsh, inlet, IR	206				LL0005
XFM012713	topo	narrow inlet and marsh, IR	335				LL0005
XFM012714	bathy		342				LL0005
XFM013701	magn		215				LL0100
XFM013702	topo, magn	no VLF	334				LL0100
XFM013703	EM, magn		683				LL0100, W part

XFM013704	EM, VLF, topo		382				
XFM013705	EM, VLF, topo	located in the sea	325				LL0268
XFM013706	em-bathy, magn	wide valley	737	tunnel 1+2 mapping, refrseis	DZ, LV	Section C in tunnel mapping, 125 m; 15 m 3,700 m/s, 48 m 3,700 m/s, 35 m 3,800 m/s, 35 m 4,000 m/s in 4 of 7 profiles	LL0268
XFM013707	rock		242	refrseis	LV	30 m 3,900 m/s, 27 m 4,000 m/s	LL0268
XFM013708	magn		879	tunnel 3 mapping, refrseis	DZ, LV	section D (14 m, N80deg W) in tunnel mapping; 14 m 3,500 m/s, 15 m 3,500 m/s, 20 m 3,800 m/s, 10 m 4,000 m/s in 4 profiles	LL0268
XFM013709	em-bathy, magn	wide valley	455				LL0268
XFM013710	magn		292				
XFM013711	magn		365				LL0236
XFM013712	rock, magn		448				LL0236
XFM013713	bathy, rock, magn		200				LL0236
XFM080301	magn		252				outside GTK area
XFM080302	rock, bathy, magn		823				outside GTK area
XFM080303	rock, bathy, magn		664				outside GTK area
XFM080304	bathy, magn		305				outside GTK area
XFM080305	rock, bathy, magn	Singö line	2,574				LL0237
XFM080306	rock, bathy, magn	rock_surface edge, bathy minima	224				LL0237
XFM080307	rock, em-bathy, magn	Singö line; ca –14 m to background	812				LL0237
XFM080308	magn		829				LL0237
XFM080309	bathy, magn	poor data coverage	621				LL0237
XFM080310	rock, em-bathy, magn		625				LL0237
XFM080311	rock, magn	low velocity	668	SFR tunnel mapping, refrseis	DZ, LV	150 m from XFM1127, see tunnel mapping map-103; 80 m 2,000 m/s, 10 m 3,300 m/s, also profiles at 4,200 m/s	LL0233
XFM080312	rock, em-bathy, magn		430				LL0233
XFM080313	rock, em-bathy, magn		223				LL0233
XFM080314	em-bathy, magn		381				LL0233
XFM080315	rock, em-bathy, refrs, magn	also seismic refraction rock surface	687	tunnel 1+2 mapping	DZ	200 m wide, for more info, see tunnel mapping 1+2	LL0233
XFM080316	rock, em-bathy, magn	also seismic refraction rock surface, edge (bathy)	563	tunnel 1+2 mapping	DZ	Section H+G+H in tunnel mapping, 200 m wide, up to XFM1040A0, 50 m central section G: 10 fissures/m	LL0233

XFM080317	rock, em-bathy, magn	edge (bathy)	815				LL0233
XFM080501	rock, em-bathy, magn		820				LL0524, LL0364 NW part
XFM080502	rock, em-bathy, magn		362				LL0524
XFM080503	em-bathy, magn		766				LL0524
XFM080504	rock, topo, magn		192	modelling	DZ	modelled as NW805 in ver 1.2	LL0524
XFM080505	bathy, magn		553	borehole	DZ	modelled as NW805 in ver 1.2; zone 8 in SFR	LL0524, diverging to NW
XFM080506	bathy, magn		927				none
XFM080801	magn		238				
XFM080802	magn		498				LL0344
XFM080803	em-bathy, magn		388				no data?
XFM080804	em-bathy, magn		88				LL0386
XFM080805	magn		462				LL0386
XFM080806	rock, magn		375				LL0258
XFM080807	magn		442				LL0258
XFM080808	bathy, magn	edge	285				no data
XFM080809	magn		794				no data
XFM080810	magn		707				no data
XFM080811	magn		1,509				no data
XFM080901	magn		799				LL0263 only in W part
XFM080902	em-bathy, magn		315				LL0263
XFM080903	magn		235				LL0263
XFM080904	magn		453				LL0263
XFM080905	magn		1,648				LL0263
XFM081801	bathy, magn		605				LL0065
XFM081802	em-bathy, magn		863				LL0065
XFM081803	em-bathy, magn		497				
XFM081804	bathy		262				
XFM081805	em-bathy		1,016				
XFM083601	bathy, rock		366				
XFM083602	magn		442				
XFM083603	magn		867				LL0239
XFM083604	rock, em-bathy, magn		626				LL0239
XFM083605	bathy, magn		232				LL0239
XFM083606	magn		945				LL0239
XFM083607	magn, rock, em-bathy		397				LL0239
XFM083608	magn		590				LL0239
XFM112701	magn		201				LL0237
XFM112702	bathy, magn	Poor data coverage	636				LL0237 up to 80 m to the SSW
XFM112703	magn		1,317	SFR tunnel mapping	DZ	150 m from XFM0803, see tunnel mapping map-103	LL0237
XFM112704	magn		1,478				LL0237

Co_LL_3km_fully_XFM_ver

Co_LL_3km_fully_XFM_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GV_Correlation**
LL0233_01	magn						XFM0803
LL0233_02	magn						XFM0803
LL0237_01	magn						XFM0803, XFM1127
LL0237_02	magn						XFM1127
LL0237_03	magn						XFM1127
LL0364_01	magn						
LL0364_02	magn						XFM1033, XFM0835, XFM0805 (part of)
LL0523_01	magn						
LL0523_02	magn, vlf, topo						XFM0015
LL0523_03	magn, vlf						XFM0015
LL0523_04	magn, vlf, topo, em						XFM0015
LL0523_05	magn, vlf, topo						XFM0015
LL0523_06	magn, vlf						XFM0015
LL0523_07	magn						XFM0015
LL0523_08	magn, em						XFM0015
LL0523_09	magn, em, vlf						XFM0015
LL0523_10	magn, vlf						XFM0015
LL0523_11	magn						XFM0015
LL0523_12	topo						XFM0015
LL0523_13	magn						XFM0015
LL0523_14	topo, magn						XFM0015

Co_LL_3km_not-fully_XFM_ver

Co_LL_3km_not-fully_XFM_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GV_Correlation**
LL0060_01	magn						W-most part; XFM0693
LL0060_02	magn, em						Magnetic low area. E part; XFM0693
LL0060_03	magn						N part; XFM0047. Magnetic low area
LL0060_04	magn, em, vlf						S part; between XFM0047 and XFM0134. Magnetic low area
LL0060_05	magn, topo, em						
LL0060_06	magn, topo, em, vlf			KFM05A		no NW zone detected in ver 1.2	
LL0060_07	magn, topo, em			KFM05A		no NW zone detected in ver 1.2	

LL0060_08	magn, topo, em, vlf			central part; XFM0163 and XFM0402
LL0060_09	magn, topo, em			XFM0408 close
LL0060_10	magn, topo			XFM0408 close, N part; XFM0099
LL0060_11	magn	KFM08A	no data available in ver 1.2	S part; XFM0099
LL0095_01	em			XFM0022
LL0095_02	magn, em			XFM0022
LL0095_03	magn, em, vlf			XFM0022
LL0095_04	topo, vlf, em, magn			XFM0022
LL0095_05	topo, vlf, magn			XFM0620
LL0095_06	topo, magn			NW part; XFM0623. SE part; XFM0620
LL0095_07	topo			XFM0623
LL0095_08	topo, vlf			XFM0623
LL0095_09	topo, vlf, em			XFM0623 close
LL0095_10	topo, vlf, em, magn			NW part; XFM0017A1
LL0095_11	topo, vlf, em			XFM0017A1
LL0122_01	topo			W-most part XFM0037, E-most XFM0017A1, no joining link
LL0524_01	magn			XFM0805
LL0524_02	magn			SE part; XFM1021
LL0533_01	magn			XFM0123
LL0533_02	magn, topo			XFM0230, XFM0123 close
LL0533_03	magn, topo, em			XFM0230, XFM0123 close
LL0533_04	magn, topo, em, vlf			SE part; XFM0230. XFM0123 close
LL0533_05	magn, vlf			XFM0123 close
LL0533_06	magn			SE part; XFM0123 close
LL0533_07	magn, topo			NW part; XFM0136
LL0533_08	magn, vlf			XFM0136
LL0533_09	magn			XFM0136
LL0533_10	magn, em			XFM0136
LL0533_11	em			

Co_XFM_1-3km_ver

Co_XFM_1-3km_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GTK_Correlation**
XFM003001	topo	along road	535				LL0115
XFM003002	topo		228				LL0115
XFM003003	topo	disturbed area	590				Except N-most part; LL0115, parallell and close
XFM003301	topo,EM		229				
XFM003302	topo	wetland boundary	230				
XFM003303	topo,EM		437				LL0470, NW-most part; LL0091
XFM003304	magn,topo	wetland marker in IR, modified from IR	547				LL0091
XFM004201	topo	ground surface map 742499bl3	267				no data
XFM004202	topo	ground surface map 742499bl3	145				no data
XFM004203	rock, topo, EM	Old FMV ground geophysical survey, ground EM	334				no data
XFM004204	rock, topo		164				no data
XFM004205	rock, topo		560				LL0142
XFM004206	topo	narrow inlet on IR	277				S-most part; LL0142
XFM004207	topo,VLF	topographic markers on IR; edge, broad VLF	407				LL0102
XFM004208	topo,magn	partly wetland	427				LL0102
XFM004401	topo,magn	narrow inlet, magnetic minima connection	235				LL0096 parallell 50 m apart
XFM004402	topo,magn	DEM 50 m grid, magnetic minima connection	209				LL0096
XFM004403	topo,magn	marshes on a line, magnetic minima connection	402				Se-most part; LL0096
XFM004404	magn,topo		81				
XFM004405	topo		191				NW-most part; LL0018
XFM004406	topo,EM	Sea inlet	236				SE part; LL0018, NW part at sea
XFM004407	bathy		255				at sea
XFM004408	bathy		737	refrseis	LV	10 m 3,500 m/s	at sea
XFM004501	bathy, magn	Modified XFM0045A0	576				SE part; LL0066
XFM004502	magn		553	refrseis	possibly LV	possibly wrong direction compared to LV in 4 close profiles	LL0394
XFM004503	em-bathy		322				at sea
XFM004504	EM	inphase 880 Hz anomaly only, high uncertainty	412				at sea

XFM004601	magn		447				central part; LL0268 60% coverage
XFM004602	magn,topo	Partly topographic, no VLF	694				NW part; LL0328, 60% coverage
XFM004701	topo		122				
XFM004702	topo		162				
XFM004703	topo	NW part in narrow wetland, narrow valley	284				LL0020
XFM004704	topo,EM	NW part in narrow wetland, narrow valley	116				LL0020
XFM004705	topo,EM		214				LL0020
XFM004706	topo	wetland marker on IR	989				LL0020, NW-most part LL0060
XFM006101	magn,topo,EM,VLF		431	KFM01A	BDZ,s>o	modelled in ver 1.2	LL0007
XFM006102	magn,topo,VLF,EM	centre of lake, along marshes, valley	594				LL0007
XFM006103	topo,magn,EM	centre of lake	213				LL0007
XFM006104	topo,magn	centre of lake	177	KFM06A		no data available in ver 1.2	
XFM006105	magn	flat topo	308				
XFM006301	topo,magn,EM,VLF		161				LL0038
XFM006302	topo,VLF,EM		469				LL0038
XFM006303	VLF,magn	SE part EM	364				LL0038
XFM006304	VLF,magn		104				LL0253
XFM006305	topo,magn		350				LL0253
XFM006306	magn		362				LL0253
XFM006401	VLF		398				NW part; LL0071
XFM006402	topo,VLF,magn	bog, flat land	139				LL0071
XFM006403	magn,topo,VLF		937				SSW part; LL0398
XFM006404	magn		201				
XFM007301	topo		291				LL0090
XFM007302	topo		208				probably LL0090, straight line ca 100 m apart
XFM007303	topo,VLF	marsh and wetland	639				LL0090
XFM009101	topo	along powerline	1,002				LL0118 (continues to NE)
XFM009901	topo	along marshes, valley	902	HFM19, refrseis	LV	15 m 3,000 m/s, no NS zone detected in HFM19	LL0003
XFM009902	topo		324				LL0003
XFM009903	topo	narrow inlet and marsh, Sea	260				LL0060, S part; LL0003
XFM009904	topo	deeper water, IR lineament	183	HFM22		no data available in ver 1.2	at sea, no data
XFM010001	topo	S part in wetland, IR	317				N-most part; LL0094
XFM010002	topo		373				LL0094
XFM010003	topo	partly along road	270				LL0094

XFM010004	topo,magn	narrow marsh	381	refrseis, KFM07A	LV	3 profiles; 5 m 3,000 m/s, 18 m 3,600 m/s, 29 m 4,000 m/s. No data available from KFM07A in ver 1.2	LL0000
XFM010101	magn		209				LL0525
XFM010102	EM,magn		185				LL0525
XFM010103	topo,EM,magn	inlet and wetland marker on IR	644				LL0525
XFM010104	topo,magn,EM,VLF	narrow inlet, IR lineament	603				LL0525
XFM010301	topo		352				
XFM010302	topo,magn		160				
XFM010303	magn	in Bolundsfjärden	580	KFM05A	DZ	modelled in ver 1.2	NE part; LL0058
XFM010304	magn,topo	topo edge	439	KFM05A	DZ	modelled in ver 1.2	LL0058
XFM012501	magn		452				
XFM012502	magn	possible magnetic connection (= parallel banding)?	155				
XFM012503	magn	topo flat, possible magnetic connection (= parallel banding)?	629				S part; LL0056 (possibly also at N)
XFM012601	magn	on topo high flatland	345				LL0056, 50 m W
XFM012602	topo		155				LL0056
XFM012603	topo,magn	partly forest boundary but narrow valley	273			no DZ found in trench (but low magnetic dykes)	LL0056
XFM012604	magn		398				LL0056
XFM015901	topo	ground surface map 973531bl2	91				
XFM015902	rock, topo		126				
XFM015903	topo	ground surface map 973531bl2	195				
XFM015904	magn	urban area	443	KFM07A		no data available in ver 1.2	
XFM015905	VLF,topo,EM,magn	deeper water?, Sea inlet	446				SW part; possibly LL0484
XFM015906	bathy		270				
XFM042301	topo,EM	N part along road, S part along bog, S part EM	516				S part; LL0092, no data N part
XFM042302	rock, topo		873				no data
XFM042303	rock, topo, EM	Old FMV ground geophysical survey, ground EM	572				no data
XFM042701	topo	along road, urban area	198				Barackbyn, poor data
XFM042702	topo	along road, urban area	293	KFM07A		not yet evaluated	Barackbyn, poor data
XFM042703	topo		879	oc	DZ	Fracture zone in inlet, SE, shaft wall, uncertain location, within 100 m	no data

XFM048701	magn	Old FMV ground geophysical survey, ground magn	126				FMV area and coastline, poor or no data
XFM048702	rock, topo, EM, magn	30% ground EM minima, 50% ground magn	556				FMV area and coastline, poor or no data
XFM048703	topo	narrow inlet	288				FMV area and coastline, poor or no data
XFM072601	topo		219				S part; LL0447, N part; LL0181
XFM072602	topo		252				LL0181
XFM072603	bathy		397				coast area, poor data
XFM072604	EM	inphase 880 Hz anomaly	333				coast area, poor data
XFM078901	topo	ground surface map 742499bl3	538				FMV area, no data
XFM078902	rock		148				FMV area, no data
XFM078903	rock	ytberg	347				FMV area, no data
XFM081001	rock		870				no data
XFM081002	magn		164				no data
XFM081003	em-bathy, magn		1,002				no data
XFM081004	EM	inphase 880 Hz anomaly	251				no data
XFM081301	magn		1,211				LL0371
XFM102201	bathy	ground surface map 973531bl3	110				none magnetic = no data
XFM102202	rock, topo		561				none magnetic = no data
XFM102203	EM	inphase 880 Hz anomaly	613				none magnetic = no data
XFM102204	bathy		1,122				none magnetic = no data. LL0232, a 735 m possible extension to N
XFM105301	em-bathy, magn		429				NW-most part; LL0248
XFM105302	magn		639				LL0248
XFM106501	bathy	ground surface map 973531bl3	281				no data?
XFM106502	em-bathy	landfill in south part, across roadbank	749				no data?
XFM106801	rock		998	refrseis	LV	5–25, 3,800–4,000 m/s in 4 profiles. 8 other profiles show no LV.	LL0479, 75% towards SE
XFM106802	rock		739				FMV area, no data

Co_XFM_1-3km_LL_3km_ver

Co_XFM_1-3km_LL_3km_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GTK_Correlation**
XFM001714	topo, EM, magn		821				LL0095 ESE part
XFM001715	topo		268				LL0122 parallell 50–80 m SSW
XFM003701	topo		607				LL0122, W-most part
XFM003702	topo, EM, magn	valley, EM-anomaly coincide with mag high S of lineament	649				LL0122
XFM003703	EM, topo		377				LL0122
XFM013601	topo, magn		460				LL0533
XFM013602	magn	magnetic minima connection	805				LL0533
XFM080401	magn, em-bathy	edge, edge	1,089				LL0237
XFM080402	rock, magn		129				LL0237
XFM080403	bathy, magn		261	refrseis	LV	15 m 3,400 m/s, check tunnel 1+2	LL0237
XFM080404	rock, em-bathy, magn		323	tunnel 3 mapping, refrseis	DZ, LV	see section K (ca 25 m) in tunnel mapping; 6–13 m 3,600–4,000 m/s	LL0237
XFM080405	rock, em-bathy, magn	rock_surface also from refraction seism	378	refrseis	LV	22 m 3,600 m/s; 10 m 3,500 m/s	LL0237
XFM080406	rock, em-bathy, magn		702				LL0237
XFM083501	rock, em-bathy, magn		348				LL0289 close
XFM083502	em-bathy, magn		192				LL0289 close
XFM083503	magn		1,624				LL0364
XFM083504	rock, em-bathy, magn	irregular surveylines (SGU)	604				LL0364
XFM102101	rock, topo	topo (edge)	632				LL0524 poorly
XFM102102	bathy		501				LL0524 poorly
XFM103301	magn		1,534				LL0364 E part

Co_LL_1-3km_fully_XFM_ver

Co_LL_1-3km_fully_XFM_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GV_Correlation**
LL0005_01	topo						XFM0127
LL0005_02	topo, em						XFM0127
LL0005_03	topo						XFM0127
LL0006_01	topo, magn						XFM0098
LL0006_02	topo						XFM0098
LL0006_03	topo, em						XFM0098
LL0006_04	topo, magn, em						XFM0098
LL0006_05	topo, magn						XFM0098
LL0007_01	magn, vlf, em						
LL0007_02	magn, topo, vlf, em						XFM0061

LL0007_03	topo, vlf	XFM0061
LL0007_04	topo, vlf, magn, em	XFM0061
LL0007_05	em, magn, topo	XFM0061
LL0020_01	topo	XFM0047
LL0020_02	topo, em	XFM0047
LL0020_03	topo	S part; XFM0047
LL0020_04	topo, vlf, em	NW part; XFM0233
LL0020_05	topo, vlf, em, magn	XFM0233
LL0020_06	topo, vlf	XFM0047
LL0020_07	topo, em	XFM0047
LL0020_08	topo	XFM0047
LL0039_01	vlf	XFM0127
LL0039_02	topo	XFM0127
LL0046_01	vlf	XFM0060
LL0046_02	magn, vlf, em	XFM0060
LL0046_03	magn, vlf	XFM0060
LL0046_04	magn	XFM0060
LL0046_05	magn, em	XFM0060
LL0046_06	magn, vlf, em	XFM0060
LL0046_07	magn, vlf	XFM0060
LL0056_01	magn	S part; XFM0125
LL0056_02	magn, topo	S-most part; 686, XFM0126
LL0056_03	magn	XFM0126
LL0103_01	topo	XFM0156 (only 880 m long)
LL0255_01	magn	XFM0018
LL0263_01	magn	XFM0809
LL0263_02	magn	XFM0809
LL0268_01	magn	W-most part; XFM0046, E part XFM0137A0
LL0268_02	magn	XFM0137A0
LL0268_03	magn	XFM0137A0
LL0269_01	magn	XFM0035
LL0521_01	vlf	XFM0062
LL0521_02	vlf, magn	XFM0062
LL0521_03	vlf, magn, topo	XFM0062
LL0521_04	vlf, magn, em, topo	XFM0062
LL0521_05	magn, vlf	XFM0062
LL0521_06	vlf, topo, magn	XFM0062
LL0521_07	topo, vlf, magn	XFM0062
LL0521_08	topo, magn	XFM0062
LL0521_09	magn	XFM0062
LL0521_10	magn	XFM0062
LL0522_01	magn	XFM0036
LL0525_01	topo	XFM0648
LL0525_02	topo, em	XFM0101
LL0525_03	topo, em, magn	XFM0101
LL0525_04	topo, magn	XFM0101
LL0525_05	topo, em, magn	XFM0101
LL0525_06	topo, em	XFM0101

Co_LL_1-3km_not-fully_XFM_ver

Co_LL_1-3km_not-fully_XFM_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GV_Correlation**
LL0000_01	topo						N part; XFM0417 runs 40–60 m to the E
LL0000_02	topo, vlf						XFM0417
LL0000_03	topo			KFM07A		no data available in ver 1.2	75% with XFM0100 in S
LL0002_01	topo						XFM0404, XFM0719?
LL0002_02	topo, em						XFM0157
LL0002_03	topo, em, vlf			KFM07B		no data available in ver 1.2	XFM0157
LL0002_04	topo, vlf						
LL0002_05	topo			HFM21, KFM08A,B		no data available in ver 1.2	XFM1063 possible continuation to N
LL0003_01	topo						N part; XFM0709
LL0003_02	topo, em						XFM0709
LL0003_03	topo						S part; XFM0709, N part; XFM0099
LL0003_04	topo, em						XFM0099
LL0003_05	topo						XFM0099
LL0004_01	topo						XFM0734
LL0004_02	topo, magn			HFM13		no NW zone detected in ver 1.2	N part; XFM0716
LL0004_03	topo						XFM0716, XFM0133
LL0004_04	topo, vlf						W part; XFM0416
LL0004_05	vlf						
LL0018_01	topo, em						XFM0160 and XFM0062 forms bend
LL0018_02	topo						XFM0160
LL0018_03	topo, em						XFM0160 within 60 m
LL0018_04	topo						central part; XFM0722
LL0018_05	topo, em						XFM0044
LL0018_06	topo						XFM0044
LL0048_01	magn						
LL0048_02	magn, em						
LL0048_03	magn						
LL0048_04	vlf						E-most part; XFM0421
LL0049_01	magn						N part; XFM0711
LL0049_02	magn, em						XFM0711 40–70 m NE
LL0049_03	magn						SE part; XFM0711 40–70 m NE
LL0065_01	topo						XFM0808
LL0065_02	magn, topo						SE part; XFM0818
LL0065_03	magn						XFM0678

LL0065_04	magn	
LL0067_01	topo	XFM0102, part; XFM0255
LL0067_02	magn	XFM0685
LL0067_03	magn, em	S part; XFM0685
LL0067_04	magn	
LL0068_01	magn, em	
LL0068_02	magn, topo, em	XFM0410 50 m SW
LL0068_03	magn, topo	XFM0410 gently crossing
LL0068_04	magn	XFM0100
LL0072_01	vlf, topo	75% N part; XFM0017A0
LL0072_02	vlf	
LL0076_01	vlf	N part; XFM0703,
LL0076_02	vlf, em	XFM0703
LL0076_03	vlf	XFM0703 gently crossing
LL0076_04	vlf	
LL0089_01	topo	
LL0089_02	topo, vlf	XFM0452
LL0089_03	topo	XFM0452
LL0089_04	topo, em	
LL0089_05	topo, vlf, em	XFM0457
LL0089_06	topo, vlf	E part; XFM0036, W part; XFM0769
LL0089_07	topo	XFM0769
LL0090_01	topo, vlf	XFM0073 gentle crossing
LL0090_02	topo, em	
LL0090_03	topo, em	XFM0073
LL0090_04	topo, vlf	S-most part; XFM0073, N-most; XFM0420
LL0090_05	topo	XFM0420
LL0091_01	topo	XFM0033
LL0091_02	topo, em	XFM0033
LL0091_03	topo, em, vlf, magn	XFM0033
LL0091_04	topo	50% central part; XFM0462
LL0092_01	topo	S 70% part; XFM0451
LL0092_02	topo, em	N part; XFM0423
LL0092_03	topo	XFM0423
LL0093_01	topo, vlf	XFM0015A0
LL0093_02	topo	XFM0015A0, XFM0455
LL0093_03	topo, vlf	XFM0015A0 80–100 m NE
LL0093_04	topo, vlf	XFM0015A0 80 m NE
LL0093_05	topo	XFM0015A0
LL0096_01	topo	N-most part; XFM0672
LL0096_02	topo, em	XFM0124

LL0096_03	topo			XFM0124
LL0096_04	magn			in between XFM0124 and XFM0101, 120 m apart
LL0096_05	magn, topo			XFM0044
LL0096_06	vlf			
LL0115_01	topo			S part; XFM0030, XFM0783 short central section, N-most part; XFM0155
LL0118_01	topo			65% from SW; XFM0091 nicely
LL0141_01	topo			XFM0141 partly within 50–80 m
LL0153_01	topo			
LL0187_01	em			
LL0187_02	em			
LL0187_03	topo			XFM0737 - XFM0162 in a bend
LL0187_04	em	KFM06A	no data available in ver 1.2	possibly XFM0162
LL0253_01	magn			75% in SW part; XFM0063
LL0253_02	vlf			XFM0673
LL0253_03	topo			XFM0680
LL0341_01	magn			XFM0167 < 60 m SSW
LL0341_02	magn			
LL0341_03	magn			XFM0044 75 m SW
LL0348_01	magn			
LL0348_02	magn			W-part; XFM1094
LL0399_01	magn			
LL0435_01	em			SE-most part; XFM0642, XFM0697 small section
LL0435_02	vlf			
LL0470_01	vlf			Section in S; XFM0446, central section; XFM0036 80 m SW, N-most part; XFM0033
LL0476_01	vlf			
LL0476_02	vlf			
LL0476_03	vlf			XFM0164
LL0476_04	vlf	KFM06A	no data available in ver 1.2	
LL0478_01	vlf	KFM05A	no NW zone has been detected in ver 1.2	XFM0170, XFM0733, XFM0406
LL0490_01	vlf	KFM01A	no NW zone has been detected in ver 1.2	SE-most part; XFM0406

LL0528_01	topo	NW-most part; XFM0015A0
LL0528_02	topo, vlf	XFM0015A0
LL0528_03	topo	85% SE part; XFM0459
LL0534_01	topo	80% S part; XFM0048, N-most part; XFM0626
LL0534_02	topo, magn	XFM0626
LL0534_03	topo, magn, em	S-most part; XFM0626, at N; XFM0707 and XFM0706
LL0534_04	topo, magn	
LL0534_05	magn	

Co_XFM_0-1km_ver

Co_XFM_0-1km_ver							
ID	**Method**	**Comment**	**Length**	**Investigation**	**Geological interpret**	**Verification**	**GTK_Correlation**
XFM040101	topo, magn	along forest road and forest boundary	180				
XFM040102	magn		199	HFM13	DZ	modelled in ver 1.2	
XFM040103	magn		273				
XFM040104	magn	in Bolundsfjärden	314	KFM05A	DZ	modelled in ver 1.2	
XFM040401	topo	narrow marsh, wetland	350	KFM01B	DZ	modelled in ver 1.2	LL0002

Abbrevation used in the _ver files	
oc	outcrop
trench	investigation by trenching
KFM...	investigation by core drilling given by the drillhole identity
HFM...	investigation by percussion drilling given by the drillhole identity
refrseis	refraction seismics
gg	ground geophysics
DZ	deformation zone
BDZ	brittle deformation zone
S>O	sealed fractures more common than open fractures
O>S	open fractures more common than sealed fractures
LV	low velocity
LR	low resistivity
MM	magnetic minima