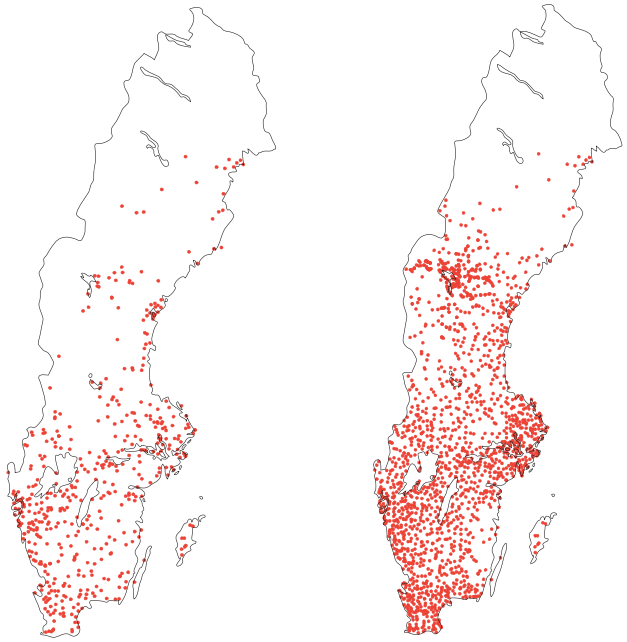
SSI report

SSI Rapport
2005:04

Rapport från Statens strålskyddsinstitut
tillgänglig i sin helhet via www.ssi.se

SKI Report 2005:10

Concentrations of Uranium, Thorium and Potassium in Sweden



SKi STATENS KÄRNKRAFTINSPEKTION
Swedish Nuclear Power Inspectorate

Statens strålskyddsinstitut
Swedish Radiation Protection Authority

SSI's Activity Symbols

Ultraviolet, solar and optical radiation
Ultraviolet radiation from the sun and solariums can result in both long-term and short-term effects. Other types of optical radiation, primarily from lasers, can also be hazardous. SSI provides guidance and information.

Solariums
The risk of tanning in a solarium are probably the same as tanning in natural sunlight. Therefore SSI's regulations also provide advice for people tanning in solariums.

Radon
The largest contribution to the total radiation dose to the Swedish population comes from indoor air. SSI works with risk assessments, measurement techniques and advises other authorities.

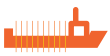
Health care
The second largest contribution to the total radiation dose to the Swedish population comes from health care. SSI is working to reduce the radiation dose to employees and patients through its regulations and its inspection activities.

Radiation in industry and research
According to the Radiation Protection Act, a licence is required to conduct activities involving ionising radiation. SSI promulgates regulations and checks compliance with these regulations, conducts inspections and investigations and can stop hazardous activities.

Nuclear power
SSI requires that nuclear power plants should have adequate radiation protection for the generalpublic, employees and the environment. SSI also checks compliance with these requirements on a continuous basis.

Waste
SSI works to ensure that all radioactive waste is managed in a manner that is safe from the standpoint of radiation protection.

Mobile telephony
Mobile telephones and base stations emit electromagnetic fields. SSI is monitoring developments and research in mobile telephony and associated health risks.



Transport
SSI is involved in work in Sweden and abroad to ensure the safe transportation of radioactive substances used in the health care sector, industrial radiation sources and spent nuclear fuel.

Environment
"A safe radiation environment" is one of the 15 environmental quality objectives that the Swedish parliament has decided must be met in order to achieve an ecologically sustainable development in society. SSI is responsible for ensuring that this objective is reached.

Biofuel
Biofuel from trees, which contains, for example from the Chernobyl accident, is an issue where SSI is currently conducting research and formulating regulations.

Cosmic radiation
Airline flight crews can be exposed to high levels of cosmic radiation. SSI participates in joint international projects to identify the occupational exposure within this job category.

Electromagnetic fields
SSI is working on the risks associated with electromagnetic fields and adopts countermeasures when risks are identified.

Emergency preparedness
SSI maintains a round-the-clock emergency response organisation to protect people and the environment from the consequences of nuclear accidents and other radiation-related accidents.

SSI Education
is charged with providing a wide range of education in the field of radiation protection. Its courses are financed by students' fees.

AUTHOR/ FÖRFATTARE: Bo Thunholm[1], Anders H. Lindén[1] och Bosse Gustafsson[1].
1. SGU

DEPARTMENT/ AVDELNING: Department of Waste Management and Environmental Protection/ Avdelning för Avfall och miljö.

TITLE/ TITEL: Concentrations of Uranium,Thorium and Potassium in Sweden/ Koncentrationer av uran, torium och kalium i Sverige.

SUMMARY: This report is largely a result of the Swed-ish contribution to an IAEA co-ordinated research programme (CRP) on the use of selected safety indicators in the assessment of radioactive waste disposal. The CRP was focusing on the assessment of the longterm safety of radioactive waste disposal by means of additional safety indicators based on data from natural systems with emphasis on description of existing data on radioactive elements and radionuclides. A major part of the work was focused on collecting data on geophysics as well as geochemistry and groundwater chemistry; mainly uranium (U), thorium (Th) and potassium (K). Data were interpreted resulting in maps and statistical description.

SAMMANFATTNING: Den här rapporten återger det svenska bidraget till IAEA:s koordinerade forskningsprogram om användningen av säkerhetsindikatorer vid utvärdering av förvar för radioaktivt avfall. Forskningsprogrammet fokuserade på utvärdering av långtidssäkerhet. Säkerhetsindikatorer baserade på data från naturliga system studerades. Tyngdpunkten låg på att beskriva existerande data för radioaktiva ämnen och radionuklider. Huvuddelen av arbetet fokuserade på att samla in geofysik, geokemi och grundvat-tenkemi data för U, Th och K. Data presenteras i rapporten i form av kartor och tabeller.

SSI rapport: 2005:04
april 2005
ISSN 0282-4434

Statens strålskyddsinstitut
Swedish Radiation Protection Authority

SKi STATENS KÄRNKRAFTINSPEKTION
Swedish Nuclear Power Inspectorate

Contents

Introduction

Safety indicators

A safety indicator has been defined as "a calculable, time-dependent quantity, integrated over all nuclides, which allows a statement on the safety of the total repository system by comparison with suitable, safety-related reference values" (Becker et al., 2002). The most commonly used safety indicators in this context are dose and risk. Within the IAEA a co-ordinated research programme (CRP on the use of selected safety indicators in the as-assessment of radioactive waste disposal) was started in the year 2000. The main idea was to test the use of concentrations and fluxes of radionuclides as safety indicators complementary to dose and risk. Such safety indicators can be used for qualitative evaluation of safety rather than for quantitative definition of safety limits.

What has been done

Estimates of natural concentrations of radioactive elements and radionuclides have been presented in various reports such as the UNSCEAR (2000). The possibility to use concentrations and fluxes as safety indicators complementary to dose and risk has been discussed in a number of papers over the last 10 years, e.g. Wingefors et al. (1999), "Nordic Flag Book" (2000) and Miller et al. (2002). In relation to these reports a Co-ordinated Research Programme (CRP) within IAEA started where different countries, including Sweden, presented data on natural concentrations on radioactive elements and radionuclides. This programme was finalised in the beginning of 2003 and the present report is largely based on the outcome of the CRP (IAEA, 2004). Within the EC SPIN project (Testing of Safety and Performance Indicators) various safety indicators have been evaluated (Becker et al., 2002).

Objective

The objective was to compile data of natural abundances of radioactive elements and radionuclides in Sweden, and to obtain ranges of concentrations and calculated radionuclide fluxes with emphasis on uranium, thorium and potassium in the overburden, bedrock and groundwater. In addition, data of Ra-226 and Rn-222 in groundwater are given. Most of the natural radioactivity is caused by radionucluides in the decay series starting with uranium-238, uranium-235, thorium-232 and potassium-40. Data of uranium, thorium and potassium are generally sufficiently abundant to be used for reference purposes. These data are supposed to contribute to the development of safety indicators by relating natural conditions to possible leakage from a radioactive waste repository. However, the approach for the development of such safety indicators is not included in this report.

Concentrations – Overview

Most of the data on concentration of elements are stored in databases at the Geological Survey of Sweden (SGU). All data are publicly available, although there is a policy to cover the cost for usage and distribution of data. Data from airborne measurements, petrophysical investigation and geochemical sampling are included in the regular map-

ping (e.g. Fredén, 1994), while most of the data on groundwater have been collected during certain investigations. If no reference is given the data source is the Geological Survey of Sweden.

Element concentrations are given in ppm or ppb for soil and bedrock and mg/L for groundwater whereas concentrations of radionuclides are given in Bq/kg or Bq/L.

Sources of data

When evaluating the presented data the difference in methods for sample preparation and analysis should be considered. A common method for geochemical analysis is Inductively-Coupled Plasma-Mass Spectroscopy (ICP-MS). X-Ray Fluorescence (XRF) has also been used but with a lower degree of accuracy. The quality of bulk analysis (made by XRF) is considered to be good for potassium while not quite satisfactory for uranium and thorium. For those elements, the analysis made by ICP-MS after acid extraction is far better but does not provide the total content.

For the airborne measurements gamma spectrometry has been used. This method has also been used for on-site measurements of outcrops and for petrochemical measurements on bedrock samples. When using gamma spectrometry the estimated content of uranium is based on measurements of Bi-214 that is assumed to be in a state of equilibrium with both Ra-226 and U-238. This assumption is somewhat uncertain, especially for the overburden due to the possible leakage of Rn-222. The estimated content of uranium when using this approach is denominated equivalent uranium (eU).

Airborne gamma-ray spectrometric measurements of equivalent uranium (eU), thorium and potassium have been made since the late 1940's. Digital data with spectral resolution are available from 1968. About 80 % of Sweden is covered with a spatial resolution of 200 x 40 m^2. However, the resolution has been improved and the present value is 200 x 16 m^2. Data from a total number of more than 40 million points are available in digital format.

Petrophysical data are based on in-situ gamma-ray spectrometric measurements from about 6000 outcrops with a total of about 20 000 observations. Measurements have been made for equivalent uranium (eU), thorium and potassium and other elements.

Petrochemical sampling and analyses have been made in connection with the regular mapping of the bedrock that is made by the Geological Survey of Sweden. A total amount of about 8000 observations is available, while the amount of data on equivalent uranium (eU) and thorium is limited to about 300 observations.

Geochemical analysis of uranium and other elements in glacial till has been made since 1982. Sampling is made with 1 sample per about 7 km^2. During the period 1987-1997 a low-density sampling of one sample per 40 km^2 was used. Sampling depth is about 1 m below the ground surface i.e. well below the zone which are influenced by anthropogenic activity and climatic conditions. Data before 1995 have a detection limit of 5 ppm, which should be taken into account. After 1995 the detection limit has been 0.1 ppm. A total amount of 26 000 observations are available. High-density data covers about 40 % of Sweden, whereas the low-density data covers about 50 %.

Groundwater data with emphasis on countrywide reference values can be divided into four groups:

1. One study was made in 1981 where 42 samples were collected in various types of groundwater bodies in different parts of Sweden (Aastrup, 1981). The objective was to find average values of uranium, radium and radon.

2. A second group of data is currently being processed within a research project at SGU. This study is focused on uranium, thorium and other elements in groundwater with emphasis on the crystalline bedrock (Ek, 2003).

3. Another group of data consists of about 2000 analyses of radon (Geological Survey of Sweden). The sampling process for this group of data is focused on a spatial distribution without any bias. Thus the data are fairly evenly distributed over Sweden and could be regarded as randomly chosen. This group of data has been collected within the countrywide mapping of groundwater with some additional data from various investigations.

4. A fourth group of data consists of analyses of radon and radium in groundwater, accounting for 499 samples (Kulich, 1988, Swedjemark, 1993). Within this group a total amount of 54 wells were selected for analyses of uranium (Östergren, et al., 2003).

Results

Airborne gamma-spectrometric measurements of equivalent uranium, thorium and potassium show variations in concentrations with fairly high values in some areas of Sweden (Table 1, Figure 1). The data represents mainly the upper part of the overburden with minor influence of outcrops. The overburden in Sweden, for the main part, consists of till made up of the local bedrock, and thus the concentrations of elements in the overburden are representative for the concentrations in the underlying bedrock.

The petrophysical measurement values should be fairly representative for the Swedish Precambrian bedrock (Table 2). The values are somewhat higher than the corresponding airborne data that represents mainly the upper part of the overburden. This is natural as the data from the airborne measurements represent average readings from measurements over till, clay, silt, sand, gravel, bare rocks, bogs, march and other wetlands (measurements over lakes and the sea are not included).

Another source of data, a database on petrochemistry (i.e. chemical analyses of the bedrock) gives similar results as the petrophysical database for the minimum, median and maximum values (Table 3). This database has about 300 observations for uranium and thorium whereas about 5000 observations are included for potassium. The mean value and standard deviation are fairly high owing to a few samples with extremely high values.

Table 1. *Statistical data for airborne gamma-ray spectrometric measurements of uranium (eU), thorium (Th) and potassium (K). Media: Overburden (mainly till), bedrock wetlands (data from Geological Survey of Sweden).*

	eU (ppm)	*Th (ppm)*	*K (ppm)*
Mean	1.79	6.40	15200
Std dev	1.48	4.96	9300
Min	0.00	0.00	0
Median	1.61	5.81	16200
Max	50.00	199.30	69500

Table 2. *Statistical data for gamma-ray spectrometric measurements on outcrops . Concentrations of uranium (eU), thorium (Th) and potassium (K). Media: Bedrock (data from Geological Survey of Sweden).*

	eU (ppm)	*Th (ppm)*	*K (ppm)*
Mean	5.06	16.10	32200
Std dev	9.03	21.43	13400
Min	0.00	0.00	0
Median	3.56	11.82	33000
Max	460.40	596.41	79000

Table 3. *Statistical data for petrochemical measurements on rock samples. Concentrations of uranium (eU), thorium (Th) and potassium (K). Media: Bedrock (data from Geological Survey of Sweden).*

	eU (ppm)	*Th (ppm)*	*K(ppm)*
Mean	129.6	24.1	27000
Std dev	1384.9	215.0	19000
Min	0.0	0.0	0
Median	2.0	6.7	27000
Max	18807.0	3603.1	120000

Geochemical characterisation of the overburden (Table 4-8, Figure 2) shows different results depending on methods used. The analysis made by ICP-MS after acid extraction is better but does not provide values on the total content. However, there is a strong correlation between the values after extraction and the total content, which means that the total content may be estimated from the values of the extracted samples.

The data in Table 6 – 7 could be compared with airborne data (Table 1), which largely have the same origin as the geochemical data (i.e. data from the upper part of the overburden).

The first group of data with a countrywide investigation of uranium and radium in groundwater shows that uranium ranges from 0.1 to 43.5 mg/L and that the radium-226 activity ranges from 0.5 to 1900 mBq/L with generally higher values in the Precambrian bedrock (Table 8). The second group of data showed very low values for thorium (Table 9). The third group of data including 499 randomly chosen drilled wells shows a median value of 12.0 mBq/L for radium-226 (Table 10, Figure 3). Radon in groundwater (based on about 2500 samples) shows median values for different media in the range 20 - 85 Bq/L (Table 11, Figure 3).

Table 4. *Comparison between methods for chemical analysis of uranium (U, ppm). Media: Overburden, mainly till (data from Geological Survey of Sweden).*

Percentile	*Total content (XRF)*	*Acid extraction (ICP-MS)*
0	<5	0.20
10	<5	0.89
20	<5	1.05
25	<5	1.11
30	<5	1.17
40	<5	1.30
50	<5	1.44
60	<5	1.62
70	<5	1.87
75	5	2.04
80	5	2.25
90	6	2.97
95	7	3.92
100	44	31.70

Table 5. *Comparison between methods for chemical analysis of thorium (Th, ppm). Media: Overburden, mainly till (data from Geological Survey of Sweden).*

Percentile	*Total content (XRF)*	*Acid extraction (ICP-MS)*
0	<10	1.1
10	<10	4.3
20	<10	5.0
25	<10	5.4
30	<10	5.7
40	<10	6.3
50	<10	7.0
60	<10	7.7
70	11	8.5
75	12	9.0
80	12	9.6
90	16	11.8
95	19	14.0
100	57	49.4

Table 6. *Bulk analysis on uranium (U), thorium (Th) and potassium (K)with XRF. Media: Overburden, mainly till. (data from Geological Survey of Sweden).*

	U (ppm)	Th (ppm)	K (ppm)
Min	<5	<10	3100
P10	<5	<10	19800
Q1	<5	<10	21800
Median	<5	<10	24100
Q3	5	12	27200
P90	6	16	29000
Max	44	57	56200

Table 7. *Concentrations after acid extraction for uranium (U) and thorium (Th) with ICP-MS. Media Overburden, mainly till (data from Geological Survey of Sweden*).

	U (ppm)	Th (ppm)
Min	0.20	1.1
P10	0.89	4.3
Q1	1.11	5.4
Median	1.44	7.0
Q3	2.04	9.0
P90	2.97	11.8
Max	31.70	49.4

Table 8. *Median values of uranium (U) and radium-226 (Ra-226) in different rock type aquifers. Based on 42 samples. Media: Groundwater (Aastrup 1981).*

Bedrock type	*Aquifer*	*U (µg/L)*	*Ra-226(mBq/L)*
Sedimentary bedrock	Quaternary deposits	1.0	6.0
	Bedrock	0.3	2.5
Precambrian bedrock	Quaternary deposits	0.6	3.5
	Bedrock	2.3	97.0

Table 9. *Concentrations of uranium (U) and thorium (Th) in groundwater. Drilled wells in crystalline bedrock Media: Groundwater in crystalline bedrock. (data from Ek, 2003.)*

	U (µg/L)	Th (µg/L)
Min	0.10	0.01
P10	0.48	0.01
Q1	1.72	0.02
Median	7.23	0.04
Q3	21.05	0.12
P90	40.50	0.28
Max	141.94	1.14

Table 10. *Statistical data for radium-226 (Ra-226, mBq/L) in randomly chosen drilled wells. Based on 492 samples. Media: Groundwater (data from Kulich, 1988, Swedjemark, 1993)*

	Drilled wells
Min	0.2
P10	2.0
Q1	5.0
Median	12.0
Q3	35.0
P90	117.0
Max	2455.0

Table 11. *Statistical data for radon-222 (Rn-222, Bq/L) in randomly chosen springs, dug wells and drilled wells. Based on 2500 samples. Media: Groundwater (Kulich, 1988, Swedjemark, 1993 and data from Geological Survey of Sweden*)

	Springs	*Dug wells*	*Drilled wells*
Min	1	1	0
p10	10	4	10
Q1	20	8	30
Median	39	20	85
Q3	85	49	220
P90	153	96	565
Max	845	947	9289

The group of 54 wells (group 4, selected from 499 wells) showed a median value of 2.6 mg/L for uranium (Östergren, et al., 2003). Another investigation of uranium in groundwater in 269 drilled wells in Uppsala municipality (Lewin and Simeonidis, 1998) showed a median of 12 µg/L with an approximate range between 0.2 and 246 µg/L. These values could be considered as fairly typical for uranium in groundwater in Swedish Precambrian bedrock. This could be compared with earlier estimations of uranium content of about 3 µg/L in springs, which should be similar to uranium content of the groundwater bodies in the overburden. Uranium content in surface waters has been estimated to be lower than 1µg/L.

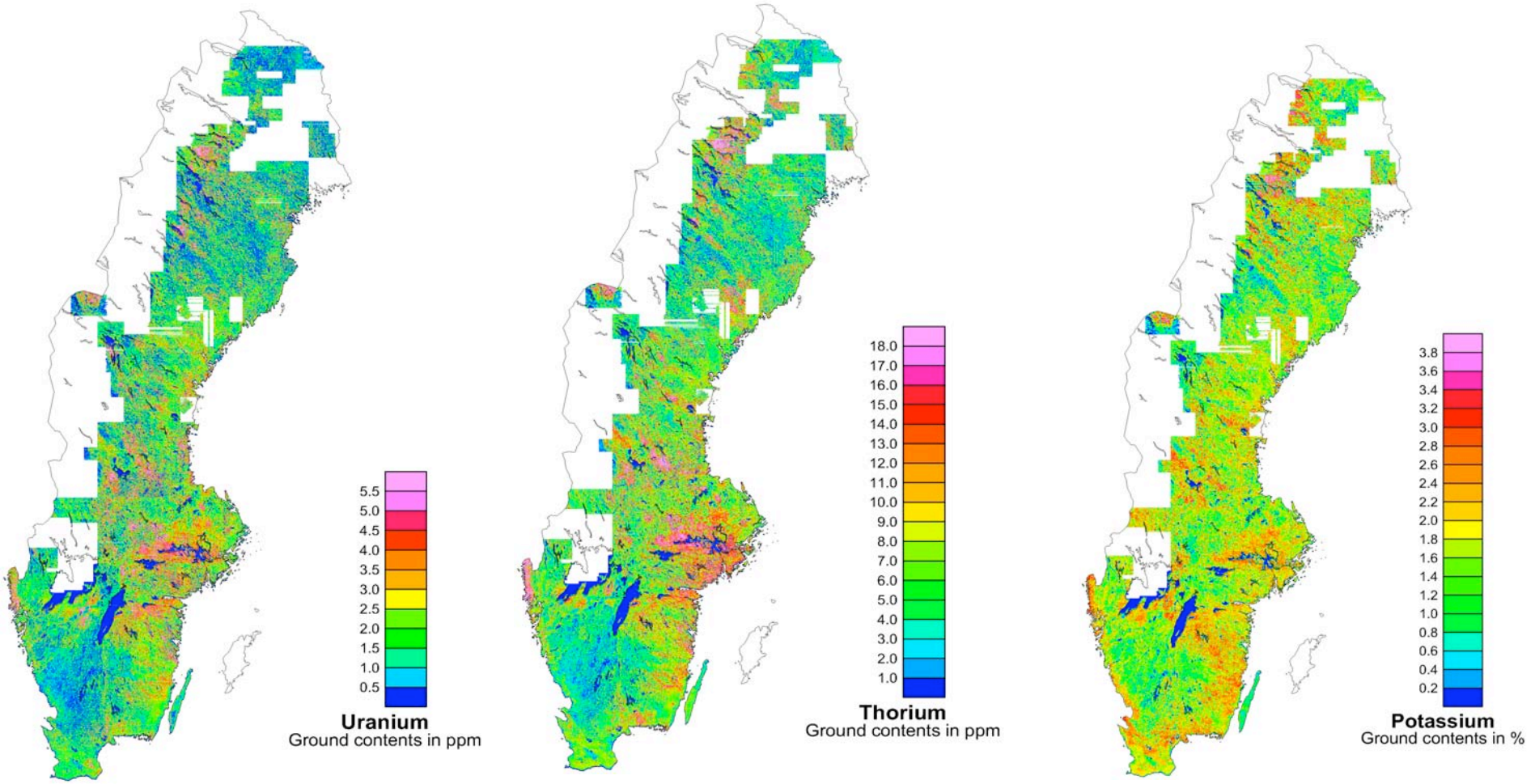


Figure 1 *Concentration of equivalent uranium (ppm), thorium(ppm) and potassium (%) in the upper 0.2 meters of the ground (soil, bedrock and peat). The data are based on airborne gamma-ray spectrometric measurements.*

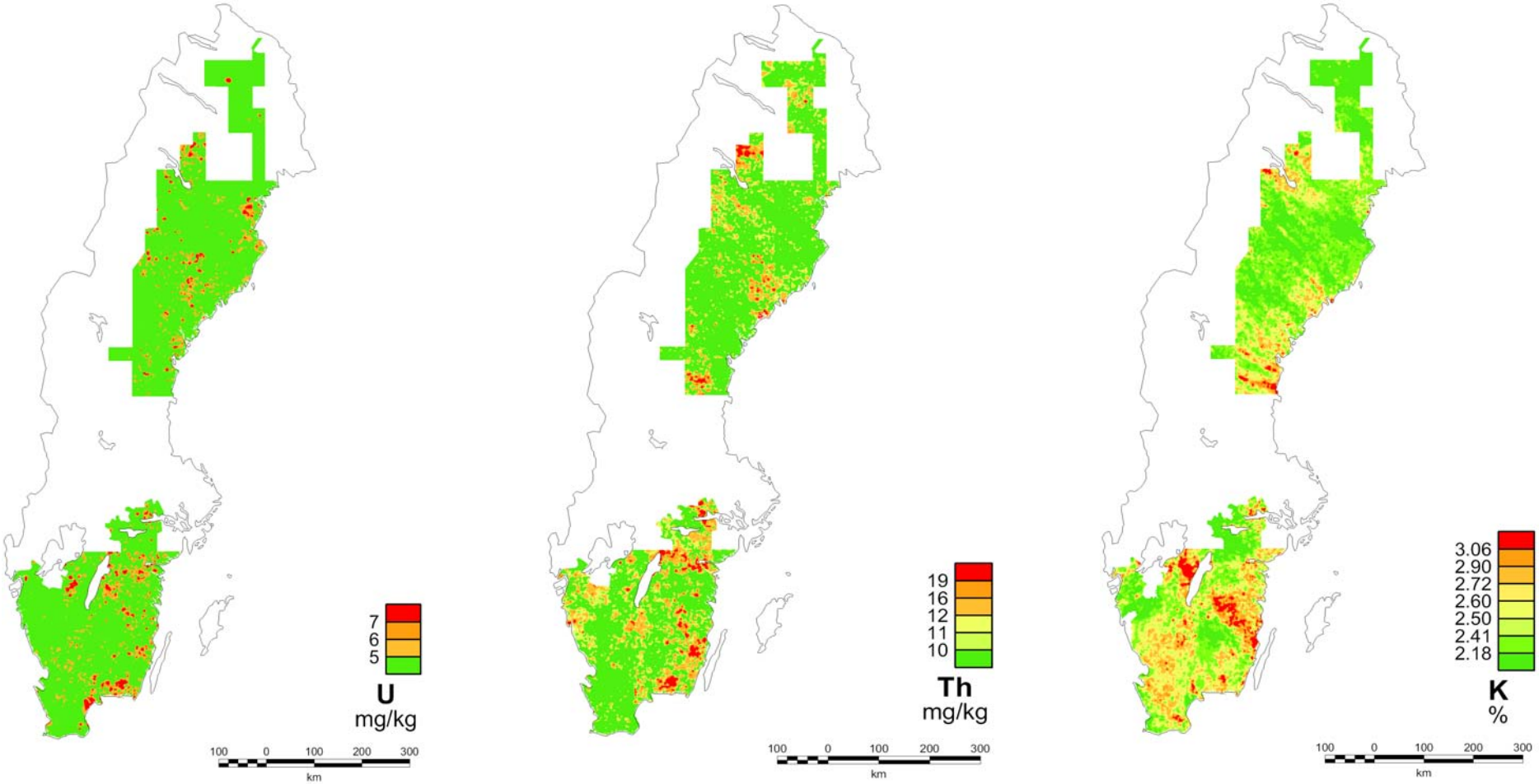


Figure 2 *Geochemical concentrations of uranium (ppm), thorium (ppm) and potassium (K, %).*

.

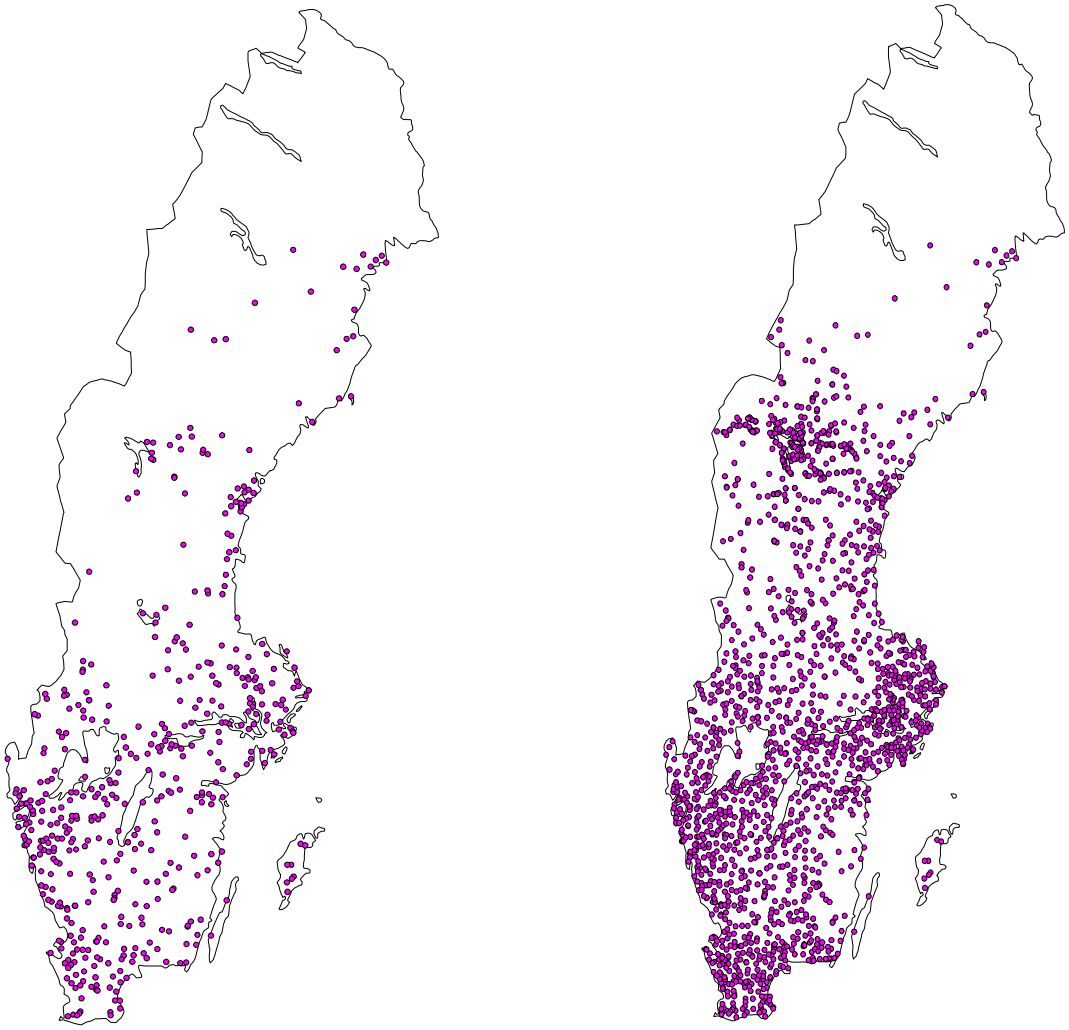


Figure 3 *Locations of wells with analysis of radium (left) and radon (right.)*

Study sites in the Uranium Archive

As a result of former uranium exploration in Sweden the Uranium Archive was established (Gustafsson, 2001). The Uranium Archive contains information from about 2000 sites with various amount and quality of data such as data from airborne gamma measurements, geochemistry and drillings. Data collection was focused on exploration thereby information about concentration in groundwater and fluxes is limited. Eight objects have been selected to show naturally extreme concentrations of uranium (Figure 4, Table 12). An extended list of uranium occurrences is given in the appendix.

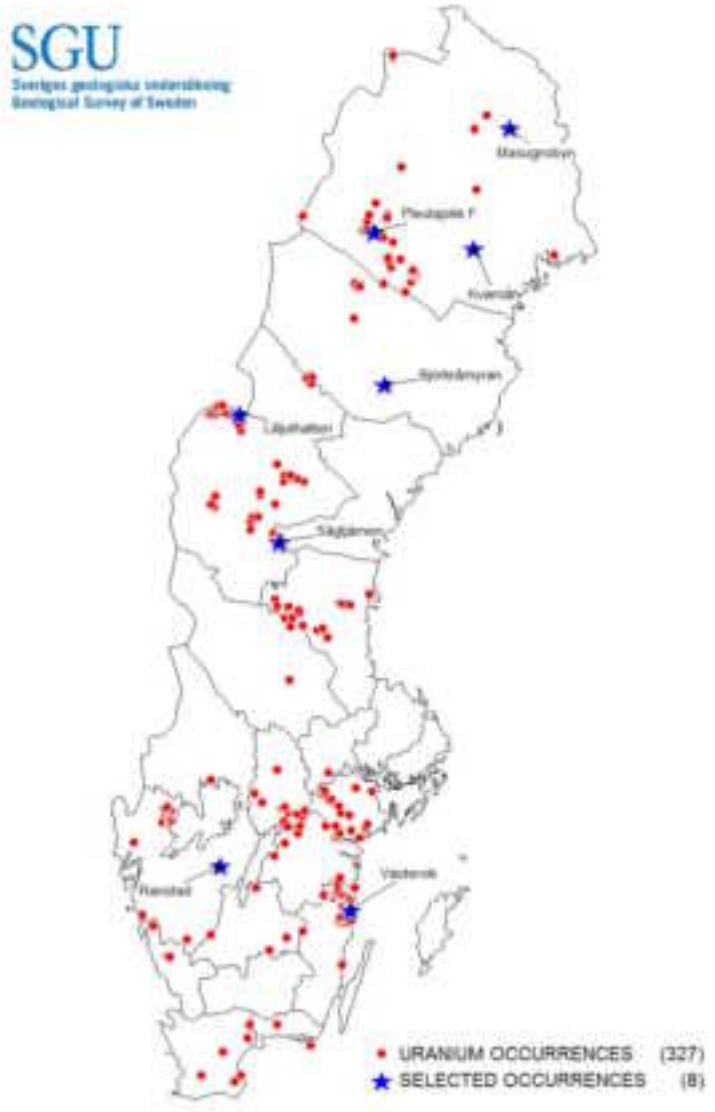


Figure 4 *Selected objects from the uranium archive*

Table 12. *Data from selected objects from the uranium archives*

Name	*Lat/Long WGS 84*	*Level(m)*	*Type*	*Mineral*	*Tonnage*	*Grade (%)*
Masugnsbyn	67°30'/21°59'	375	Secondary in peat	U	Unknown	0.06
Pleutajokk	66°16'/17°34'	550	Vein	Uraninite	5100	0.10
Kvarnån	66°1'/20°34'	250	Impregnation	Uraninite	1500	0.08
Björkråmyran	64°22'/17°48'	410	Cataclastic hydrothermal	U, Zr	>1500	0.10-0.50
Liljuthatten	64°0'/13°48'	700	Impregnation and veins	Pitchblende	2000	0.20
Sågtjärn	62°23'/14°56'	300	Pegmatoid	Pitchblende	600	0.06
Ranstad	58°18'/13°42'	120	Sediment	Uraninite	> 300 000	0.03
Västervik	57°45'/16°40'	50	Synsedimentary	Different	Unknown	0.05-1.00

Masugnsbyn

About 4.5 km NW of the village Masugnsbyn (67º27'N/22º2'E) the bog Laurivuoma is situated. In 1958 springwater and peat in the bog were found to contain spots strongly enriched in uranium. The bog consists mainly of sedge peat but changes gradually to the north to a mire type. It is 5 km long and 1 km wide but only small spots of it are enriched in uranium. Dwarf spruce and birch dominate the vegetation. It has been suggested that the uranium has been transported by intra-bedrock water as uranylcarbonate complexes and reduced by the anaerobic organic component when reaching the peat bog. The average uranium content of the organic component from the enriched parts is estimated at 900 ppm U. Up to 30,000 ppm U has been registered in air-dried peat. Radiometric maps from surface measurements show no spot bigger than 5 x 40 meters. No tonnage data is available.

During the late 50's AB Atomenergi carried out extensive geochemical research on uranium in the area by means of water, peat and plants. No bedrock uranium occurrence has been found in the near surroundings.

Pleutajokk

The Pleutajokk uranium deposits are located 30 km NW of Arjeplog at an altitude between 450 to 600 m above sea level. They occur in the valley of the Pleutajokk (Blåudajåkkå on modern maps) stream. The terrain is smoothly sloping towards the Lake Hornavan 1.5 km away. The whole uranium target area measures about 3 x 5 km but due to the glacial drift the radioactive and uranium anomaly area is of about the double size. The landscape is characterised by the transition between the alpine birch and pine forest with open bogs. There are a few outcrops in the area, some with uranium mineralization.

The mineralizations occur in strongly recrystallized acid volcanites and are all of vein type. The size of each vein seldom exceeds one centimetre and is mainly filled with quartz with a thin uraninite cover on the walls. Minor amounts of uranium titanate are present. The veins form fan shaped clusters. Wall rock alteration is characterised by albitization that extends several meters from the veins. The age of the mineralization is 1.74 Ga and of the surrounding barren granites 1.69 Ga.

Altogether eight localities of uranium mineralization have been identified. One has been found to be of economic interest and has been subject to exploration mining. It was covered with about 5 m of till and it is tied and oblique to a strike-slip fault. It is known down to -500 meter and seems to continue further down with consistent quality. Its lateral extension is about 400 meters. The amount of uranium is calculated at 2000 tonnes of 1,000 ppm.

Geochemical investigations have been performed by sampling of peat at the peat bog margins as well as sampling of the stream water. Gamma spectrometry measurements have been performed on surface near till in the distal parts of some of the boulder trains as well as radon surveys.

Other investigations in the area comprise boulder tracing, mineralogical studies, geological mapping, geophysical measurements (ground and airborne), trenching, diamond drilling including logging and test-mining with refinery tests.

Kvarnån

The Kvarnån uranium deposits are located 55 km WNW of Boden at an altitude of ca. 250 m above sea level. The landscape is forested spruce and pine on rather flat glacifluvial sediment with a narrow canyon along the Kvarnån River. The mineralization itself is partly naked in the bottom of this canyon where as well the exposed till contains several uranium bearing boulders.

The mineralization consists of rather patchy disseminations forming bands in the transition zone between metasediments and metavolcanites where the former dominates. The overall length is about 600 meters, the dip is around 35^0 and is known down to -200 meters but continues further down. The bands are orientated in the general structural trend of the supracrustals. The dominating uranium mineral is uraninite often enclosed by apatite. Small amounts of copper-sulphides have been observed. Some increase in potassium goes with the mineralization. The age is unknown but is probably Precambrian.

The uranium amount is 1400 tonnes at 700 ppm. One richer part has been calculated to 268 tonnes uranium at 3900 ppm uranium. The highest grade parts are associated with clorite-biotite bands which can be up to 20 meter wide with grades of 1,000 to 2,000 ppm U. Mineralization of 500 to 1,000 ppm U can reach 60 meter width.

Eight km SE of Kvarnån a minor uranium mineralization of the same type has been found. In addition two prospects with uranium bearing boulders in the glacial drift are known from the area but have been left in the exploration due to low uranium content.

Radon measurement is the only applied geochemical method.

Other investigations on the deposit are boulder tracing, mineralogical studies, geological mapping, geophysical measurements (ground and airborne), drilling (107 diamond drillholes - DDH) including logging, trenching and refinery tests.

Björkråmyran

The Björkråmyran uranium deposits are located 40 km NE of Åsele at an altitude of ca. 410 m above sea level. The terrain is flat with forests of spruce and pine and open bogs. There are no outcrops in the area. The mineralization is partly covered by till and partly by bogs.

The mineralization is situated in an area of Precambrian rocks of Svecokarelian age. The host rock is a course porphyric Revsund granite and metasupracrustals of mainly greywacke type. The mineralization occurs close to and partly in a fault zone. It is overlaid and partly transacted by an open fracture zone. The uranium is located in a metamict U-Zr-silica compound. The mineralization is characterized by strong sodium enrichment and is almost devoid of potassium. They are divided into at least three different bodies but have no known limitation horizontally or vertically.

Similar but less known uranium mineralization is found 3 km to the SE at Abborrviken.

Conducted geochemical investigations are sampling of peat at the peat bog margins and deep moraine/sub-outcrop radiometry.

Other investigations on the deposit are boulder tracing, mineralogical studies, geological mapping including tectonic, geophysical measurements (ground and airborne), drilling (87 DDH) including logging.

Lilljuthatten

The Lilljuthatten uranium deposit is located some 150 km NW of Östersund at an altitude of about 700 m above sea level and mainly above the tree line. The area is characterised by sparse vegetation and relatively well exposed bedrock.

The mineralization is situated in a pre-Cambrian "window" within the central Swedish Caledonides. Light grey, course grained and porphyric Olden granite dominates the bedrock. Dolerite dykes often intrude the granite. The uranium occurs in form of pitchblende and appears within the granite as impregnation and occasionally up to 5 mm joint filling along a mafic-rich crush zone. The textures within the granite are typical for a hydrothermal breccia with dark coloration. It is dated to an age of 420 ± 3 Ma (late Caledonian age). The ore estimations have proved at least 2,000 tonnes uranium with an average grade of 2,000 ppm U.

Within the Olden-Hotagen area there exists several other mineralizations, located on the western and eastern margin of the Olden window (Lilljuthatten is situated on the eastern margin).

Conducted investigations are geochemical sampling of peat from stream banks and peat bog margins as well as hydrogeological investigations including ground water level observations, water injection tests, test pumping in drill holes and water analysis.

Other investigations on the deposit is boulder tracing, detailed geological mapping, mineralogical studies, tectonic studies, geophysical measurements (ground and airborne), drilling (98 DDH) including logging and seismic tests.

Sågtjärn

The Sågtjärn uranium deposits are located 7 km W of Haverö at an altitude of ca. 270 m above sea level. The area is forested with a thick till cover and a few outcrops. Planted pines dominate the forest. The relief is moderate. The uranium occurrence, which covers about 700 x 400 meters, is situated in a broad valley bottom with numerous small lakes and marshes. A small part of it is exposed but most of it is covered with till.

The bedrock is a paragneiss of amphibolite facies. It has been derived from alternating argillitic and arenitic sediments. An arcose to subgreywacke environment has been suggested. The structure is a synformal open fold. Basic dykes, granitic dykes and pegmatites cut the gneiss. Uranium is found as impregnation in pegmatite neozomes, especially the biotite rich ones. There is a skarn horizon in the gneiss suggested the whole sequence to be a banded iron formation (BIF) affinity. The skarn contains minor amounts of scheelite, arsenopyrite, pyrrhotite and traces of chalcopyrite.

The uranium mineralization contains uraninite, monazite, molybdenite and chalcopyrite. Uranium is the only metal of economic interest. The uranium rich pegmatites occur as irregular sheetlike zones in the gneiss. The dip is around 50^0. An estimate of the resources gives 620 tonnes of uranium at 600 ppm U, or 400 tonnes at 1,000 ppm U.

Similar but smaller uranium mineralizations are found along a regional fault structure in NNW direction over a distance of 20 km.

Conducted geochemical investigation is sampling of peat at the peat bog.

Other investigations on the deposit are boulder tracing, mineralogical studies, geological mapping including tectonic, geophysical measurements (ground and airborne), drilling (43 DDH) including logging.

Ranstad

In the Billingen Mountain in the Västergötland county a huge but low grade uranium deposit is located in Upper Cambrium alum shales. The mountain consists of undisturbed and flat lying sediments with basalt on top. It is covered by forest and pasture and is widely seen surrounded by low flat farmland. The uranium-bearing layer is found in the lower part of the Peltura scarabæoides zone. The layer is exposed in the slope of the mountain. The main sub-outcrop area of this zone has been at Ranstad where 200 tonnes uranium was mined in an open pit during the period 1965 – 1969. A refinery test plant for uranium was constructed to treat the ore. The resource is calculated to 250 Mt containing 75,000 t uranium with an average uranium grade of 340 g/t. In a thin culm-bearing layer the grade can reach 5,000 ppm U. Thickness is reported to be 3.6 meter. Other trace elements are V (680 ppm), Mo (270 ppm), rare earth elements (REE) (410 ppm). The uranium phase is very fine grained and it has not been possible to identify any uranium bearing mineral but there is a positive correlation between uranium and the organic component and in some places also phosphorite.

The ore calculation is restricted to the vicinity of Ranstad covering about 28 km^2. The total alum shale area in Billingen is around 500 km^2 of which most of it is covered by younger phanerozoic rocks. The main composition of the alum shale is 68 % silicates, 12 % sulphides and 20 % kerogen. Biogen pyrite is the main sulphide. The oil content is about 1.8 %. Farmers have used the shale (especially the uranium rich culm layer) for burning limestone and heating up houses. Though Billingen was one of the first known uranium occurrences in Sweden still a lot of drilling remains to be done to get a reasonable good idea of the lateral uranium distribution.

Other alum shale hosted uranium occurrences in Sweden are found mainly in Östergötland, Närke, Kinnekulle and Halle-Hunneberg in Västergötland, northern Dalarna and Jämtland.

Västervik

In the Västervik-Gamleby area around 85 minor uranium occurrences have been identified. Many of them occur in meta-arenites and can be characterised as former heavy-sand type. Some still occur as distinct thin horizons other as impregnation or fissure fillings in the meta-arenite.

The most advanced investigated one is situated under the Old Water Tower in the town of Västervik. During the 50's the Johnson Company drilled about 15 DDH. The result from their exploration is still confidential and stored at their Engelsberg archive.

The well-exposed bedrock consists of quartzite. The uranium occurrence is stratigraphicly controlled partly in heavy-sand layers, partly in fissures and partly dispersed distributed. The anomaly radioactive area on surface is 100 x 80 meter big. The strongest radioactivity is found in the heavy sand layers. Those are a few mm wide, strongly deformed and winding. The minerals found here are hematite, ilmenite, zircon and rutile-anatas. Uranium occurs in uraninite, davidite and brannerite. Tucholite is found in fissures. Uranium

grade is around 100 – 600 ppm. In the heavy mineral bands it can be as much as 15,000 ppm U. The U:Th ratio exceeds 10:1.

Interpretation and application of data

The data presented are intended to be used for reference purposes and to support the development of safety indicators.

Concentration data for uranium, thorium and potassium are generally sufficiently abundant to be explored as references for safety indicators. However, it should be noted that the amount of data for Th in groundwater is somewhat limited. Sampling and analysis methods have to be considered when using the data. The total concentration is most relevant, but some methods can only measure a fraction of this.

Concentration data could be used for other applications than development of safety indicators. One possibility is to use data from mapping of radioactive elements to identify areas with possible risk for human health. Another possibility is the use of data from groundwater to develop criteria for drinking water quality.

The estimations of element fluxes for uranium, thorium and potassium were based on element concentration and data on runoff ranges (Raab and Vedin, 1995). The runoff was assumed largely to occur as groundwater runoff (i.e. precipitation – evapotranspiration). Thereby the element flux was estimated as element concentration x groundwater runoff. In addition, data on water fluxes and concentration data on potassium for a few river were used (Swedish Environmental Protection Agency).

The flux of potassium by groundwater is estimated to range between 100 and 400 kg/km^2/year. This estimate is based on median values of measured concentrations and possible ranges of groundwater runoff together with concentration data and studies on weathering rates (Olsson et al., 1993). Most of this flux is assumed to originate from weathering processes in the upper part of the soil. Values are generally higher in the south-western parts of Sweden mainly due to higher values on runoff. It should be noted that potassium is an important plant nutrient, which means that the flux is influenced by land use and vegetation. Data on total potassium concentration in some rivers indicate fluxes in the magnitude of 200 – 500 kg/km^2/year.

A rough estimate of uranium fluxes by using data on concentration together with data on groundwater runoff gives values of 0.2 – 2 kg/km^2/year. This is based on median values on concentration of uranium in groundwater (Table 9) and data on runoff ranges. Fluxes of thorium have not been estimated due to a very limited amount of data, which indicates very low values, below 0.1 mg/L. In general attempts to estimate fluxes proved to be difficult for various reasons. One difficulty is uncertainties owing to processes that are not in a steady state condition. This is largely due to the glaciation that ended about 10 000 years ago which means that the weathering processes are in an early stage compared with other parts of the world with no glaciation. Other difficulties are associated with the spatial scale. The fluxes of elements within the unsaturated zone could differ considerably from the corresponding catchment area. In addition, fluxes are supposed to vary between small catchments whereas a large river basin provides an average value for all catchments within the river basin as well as the contribution from deep flow paths within the basin.

The uranium archive can be used to get information about natural extreme values of uranium in the bedrock. This means that a possible leakage from a repository can be related

to natural anomalies. However any data on groundwater within the anomalies are not known.

Conclusions

Data on concentrations of uranium, thorium and potassium are extensive and may be used in the development of references for complementary safety indicators. However, useful data on fluxes are difficult to obtain, mainly due to problems in the treatment of spatial scales and non-steady state conditions of erosion processes. Additional difficulties could be found in the approach for comparing natural fluxes with possible fluxes from a leaching repository.

References

Aastrup, M. 1981. Naturligt förekommande uran-, radium-, och radonaktiviteter i grundvatten. SKBF/KBS TR 81-08, Stockholm.

Becker, D.-A., Buhmann, D., Storck, R, Alonso, J., Cormenzana, J.-L., Hugi, M., van Gemert, F., O'Sullivan, P., Laciok, A., Marivoet, J. , Sillen, X., Nordman, H., Vieno, T. and Niemeyer, M. 2002. Testing of Safety and Performance Indicators. Final Report of SPIN project. EUR report 19965 EN.

Ek, B.-M. 2003. FoU-seminarium vid SGU 11-12 mars 2003 – dokumentation. SGU – rapport 2003:4.

Fredén, C. (ed.). 1994. National Atlas of Sweden – Geology.

Geological Survey of Sweden. Information from databases. http://www.sgu.se.

Gustafsson, B. 2001. SGU Uranium Archive. Review, Present Status, Measures to be done. SGU report MINK 0026.

IAEA, 2004. Natural Safety Indicators for Use in relation to Radioactive Waste Disposal: Synthesis of CRP Results. IAEA-TECDOC (in press).

Kulich, J., Möre, H., and Swedjemark G.-A. 1988. Radon och radium i hushållsvatten. SSI-rapport 88-11.

Lewin, L. and Simoenidis, A. 1998. Mapping of Radon, Fluoride and Heavy Metals in Drilled Wells within Uppsala Municipality. Uppsala Kommun, Miljökontoret.

Miller, B., Lind, A., Savage, D., Maul, P. and Robinson, P. 2002. Natural elemental concentrations and fluxes: their use as indicators of repository safety. SKI report 02:3, SSI report 02:02.

Nordic Radiation Protection and Nuclear Safety Authorities. 1993. Disposal of High-Level Radioactive Waste. Consideration of Some Basic Criteria.

Nordic Radiation Protection and Nuclear Safety Authorities. 2000. Naturally Occurring Radioactivity in the Nordic Countries – Recommendations.

Olsson, M., Rosén, K and Melkerud, P.-A. 1993. Regional modelling of base cation losses from Swedish forest soils due to whole-tree harvesting. Applied Geochemistry, Suppl. Issue No 2. pp 189-194.

Raab, B. and Vedin, H. (eds.) 1995. National Atlas of Sweden – Climate, Lakes and Rivers

Swedish Environmental Protection Agency. Information on environmental monitoring. http://www.naturvardsverket.se/.

Swedjemark, G. A. Radon och radium i vatten. Underlag för bestämmelser. SSI-rapport 93-34.

Wingefors, S., Westerlind, M. and Gera, F. 1999. The use of safety indicators in the assessment of radioactive waste disposal, Proceedings of the International Symposium on Radioactive Waste Disposal: Health and Environmental Criteria and Standards, Stockholm, 1999. pp. 263-268.

UNSCEAR, 2000. Sources and Effects of Ionizing Radiation, United Nations Scientific Committee on the Effects of Atomic Radiation. UNSCEAR 2000 Report to the General Assembly, with Scientific Annexes, Volume I: Sources.

Östergren, I., Falk, R., Mjönes, L., and Ek, B.-M. 2003. Mätning av naturlig radioaktivitet i dricksvatten. Test av mätmetoder och resultat av en pilotundersökning. SSI-rapport 2003:07.

Appendix. Table with data from uranium occurrences in Sweden.

Uranium occurrences in Sweden. Coordinates are given in RT90 2.5 GON W

Municipality	**Name of object**	**Coordinate-North**	**Coordinate-East**	**County**	**Topographic map**	**Radia-tion (µR/h)**	**U (ppm)**	**Th (ppm)**
	Björkvattnet	7111200	1378400		Jävsöhatten SO: 21D SO			
Arjeplog	Arresåive	7281900	1594450	Norrbottens län	Sorsele NO: 24H NO			
Arjeplog	Måffe	7346900	1594600	Norrbottens län	Arjeplog NO: 25H NO			
Arjeplog	Virka	7305300	1605100	Norrbottens län	Stensund SV: 25I SV		600	
Arjeplog	Rebraur Västra	7340400	1607300	Norrbottens län	Stensund NV: 25I NV			
Arjeplog	Pleutajokk D	7353000	1580900	Norrbottens län	Jäkkvik SO: 26H SO			
Arjeplog	Pleutajokk B	7353200	1579150	Norrbottens län	Jäkkvik SO: 26H SO			
Arjeplog	Pleutajokk A	7353300	1579950	Norrbottens län	Jäkkvik SO: 26H SO			
Arjeplog	Pleutajokk C	7353850	1580450	Norrbottens län	Jäkkvik SO: 26H SO			
Arjeplog	Grutaure	7355400	1570350	Norrbottens län	Jäkkvik SV: 26H SV			
Arjeplog	Pleutajokk E	7355500	1580900	Norrbottens län	Jäkkvik SO: 26H SO			

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Arjeplog	Pleutajokk F	7356100	1582050	Norrbottens län	Jäkkvik SO: 26H SO			
Arjeplog	Autjak	7356800	1566500	Norrbottens län	Jäkkvik SV: 26H SV			
Arjeplog	Pleutajokk G	7357050	1581000	Norrbottens län	Jäkkvik SO: 26H SO			
Arjeplog	Harrejokk	7360000	1573900	Norrbottens län	Jäkkvik SV: 26H SV			
Arjeplog	Labbas 1	7370000	1573900	Norrbottens län	Jäkkvik SV: 26H SV			
Arjeplog	Sjiunjanjaure	7370500	1597300	Norrbottens län	Jäkkvik SO: 26H SO			
Arjeplog	Blocklund	7375800	1599900	Norrbottens län	Jäkkvik NO: 26H NO			
Arjeplog	Viepsajokk 1	7378400	1576200	Norrbottens län	Jäkkvik NO: 26H NO			
Arjeplog	Vuotsas	7378700	1599600	Norrbottens län	Jäkkvik NO: 26H NO			
Arjeplog	Akkapakte	7394700	1585100	Norrbottens län	Jäkkvik NO: 26H NO			
Arjeplog	Skuppesavon S S	7372600	1600000	Norrbottens län	Luvos SV: 26I SV			
Arjeplog	Skuppesavon S	7373500	1600200	Norrbottens län	Luvos SV: 26I SV			
Arjeplog	Skuppesavon N	7374400	1600200	Norrbottens län	Luvos SV: 26I SV			
Arjeplog	Gervåive 1	7318200	1600900	Norrbottens län	Stensund SV: 25I SV			
Arjeplog	Nasafjäll	7377100	1487000	Norrbottens län	Nasafjäll NO: 26F NO	1000	1000	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Arjeplog	Plättik2	7316700	1617500	Norrbottens län	Stensund SV: 25I SV			
Arjeplog	Gervåive	7312950	1602550	Norrbottens län	Stensund SV: 25I SV			
Arvidsjaur	Björklund östra	7269690	1624325	Norrbottens län	Storavan SV: 24I SV		1760	
Arvidsjaur	Björklund väst	7269790	1624175	Norrbottens län	Storavan SV: 24I SV		1970	
Arvidsjaur	Björklund centrala	7269790	1624225	Norrbottens län	Storavan SV: 24I SV		920	
Arvidsjaur	Rävaberget	7284600	1632400	Norrbottens län	Storavan NO: 24I NO		700	
Arvidsjaur	Långträsk	7293750	1633250	Norrbottens län	Storavan NO: 24I NO		490	
Arvidsjaur	JärntjärnbäckenÖst-ra	7294700	1637900	Norrbottens län	Storavan NO: 24I NO		1143	
Arvidsjaur	Sör Döttern 1	7296150	1633200	Norrbottens län	Storavan NO: 24I NO			
Arvidsjaur	Sör Döttern 2	7296500	1633800	Norrbottens län	Storavan NO: 24I NO			
Arvidsjaur	Liessetjåkke	7298000	1634550	Norrbottens län	Storavan NO: 24I NO			
Arvidsjaur	Norr Döttern 2	7298600	1634900	Norrbottens län	Storavan NO: 24I NO		30000	
Arvidsjaur	Kikkejaure Västra	7299655	1636655	Norrbottens län	Storavan NO: 24I NO			
Arvidsjaur	Norr Döttern 1	7300700	1634900	Norrbottens län	Stensund SO: 25I SO		1300	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Askersund	Kattegruvorna	6526520	1461770	Örebro län	Finspång NV: 9F NV			
Askersund	Vilhelmsgruvan	6526770	1461730	Örebro län	Finspång NV: 9F NV			
Askersund	Fräkengruvan	6526790	1461680	Örebro län	Finspång NV: 9F NV			
Askersund	Hästgruvan	6526800	1461640	Örebro län	Finspång NV: 9F NV			
Askersund	Västerby Fsp-brott	6523750	1458250	Örebro län	Finspång SV: 9F SV	1200		
Askersund	Wihelmsgruvan	6526760	1461700	Örebro län	Finspång NV: 9F NV			
Askersund	Stegehällsgruvor-na(Fe)	6523400	1461450	Örebro län	Finspång SV: 9F SV	250		
Bengtsfors	Långvattnet	6545160	1301500	Västra Götalands län	Mellerud NV: 9C NV			
Bengtsfors	Åsnebogruvan	6545300	1301000	Västra Götalands län	Mellerud NV: 9C NV			
Bengtsfors	Gruvan-1	6545160	1301500	Västra Götalands län	Mellerud NV: 9C NV	3000	3100	20
Bengtsfors	Gruvan-2	6545160	1301500	Västra Götalands län	Mellerud NV: 9C NV	3000		
Bengtsfors	Hällarna-1	6545480	1302640	Västra Götalands	Mellerud NV: 9C NV	3000	1400	150

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
				län				
Bengtsfors	Hällarna-2	6545480	1302640	Västra Götalands län	Mellerud NV: 9C NV	1300	950	100
Bengtsfors	Tjäderkullen	6545750	1301320	Västra Götalands län	Mellerud NV: 9C NV			
Bengtsfors	Härserud	6545480	1302640	Västra Götalands län	Mellerud NV: 9C NV			
Bengtsfors	Skolhusberget	6537000	1303900	Västra Götalands län	Mellerud NV: 9C NV	700		
Bengtsfors	Åsnebo	6545030	1301130	Västra Götalands län	Mellerud NV: 9C NV	800	40	70
Bengtsfors	Gruvan-3	6545300	1301450	Västra Götalands län	Mellerud NV: 9C NV	1300		
Bengtsfors	Dammeruddsbäcken	6545335	1302170	Västra Götalands län	Mellerud NV: 9C NV	400		
Bengtsfors	Predikstolen	6545515	1302980	Västra Götalands län	Mellerud NV: 9C NV	3000		
Bengtsfors	Hällarna-3	6545520	1302680	Västra Götalands	Mellerud NV: 9C NV	800		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
				län				
Bengtsfors	Stångmyrberget	6545600	1302850	Västra Götalands län	Mellerud NV: 9C NV	1500		
Bengtsfors	Tjäderkullen	6545750	1301320	Västra Götalands län	Mellerud NV: 9C NV	1200		
Bengtsfors	Hansebotjärnet-1	6546350	1301530	Västra Götalands län	Mellerud NV: 9C NV	400		
Berg	Klövsjö	6936650	1417120	Jämtlands län	Rätan NV: 17E NV			
Berg	Handsjö	6932000	1448000	Jämtlands län	Rätan NO: 17E NO			
Berg	Åviken	6972500	1363000	Jämtlands län	Storsjö SV: 18D SV			
Berg	Skålan	6948130	1417420	Jämtlands län	Rätan NV: 17E NV			
Berg	Storhallen	6954280	1419040	Jämtlands län	Hackås SV: 18E SV			
Berg	Tossåsen	6983600	1370250	Jämtlands län	Storsjö NV: 18D NV			
Berg	Sölvbacktjärn	6968600	1369100	Jämtlands län	Storsjö SV: 18D SV			
Berg	Tossåsberget	6954960	1427630	Jämtlands län	Hackås SO: 18E SO			
Berg	Myrviken	6985570	1429030	Jämtlands län	Hackås NO: 18E NO		200	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Berg	Oviken	6990000	1430000	Jämtlands län	Hackås NO: 18E NO			
Bjuv	Billesholm sten-kolsgruva	6217400	1323400	Skåne län	Helsingborg SV: 3C SV	250		
Boden	Brännspiken	7328000	1717000	Norrbottens län	Harads NV: 25K NV			
Boden	Kvarnån	7332600	1715900	Norrbottens län	Harads NV: 25K NV			
Bollnäs	Långmyrtjärnberg	6786000	1519400	Gävleborgs län	Ockelbo NV: 14G NV			
Bollnäs	Nissamyrbäcken	6833000	1540200	Gävleborgs län	Bollnäs NO: 15G NO			
Bollnäs	Nybodavallen	6834000	1537000	Gävleborgs län	Bollnäs NO: 15G NO			
Bräcke	Höksjön	6972050	1450200	Jämtlands län	Bräcke SV: 18F SV		2200	
Degerfors	No name	6566000	1421450	Örebro län	Karlskoga SV: 10E SV			
Degerfors	No name	6566225	1421480	Örebro län	Karlskoga SV: 10E SV			
Degerfors	Bergtjärn	6566225	1421475	Örebro län	Karlskoga SV: 10E SV	400		
Dorotea	Tåsjö	7150000	1492000	Västerbottens län	Risbäck SO: 22F SO			
Dorotea	Onbäcken	7151060	1500000	Västerbottens län	Vilhelmina SV: 22G SV			

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Enköping	Koholmen	6592300	1589800	Uppsala län	Strängnäs NO: 10H NO	400		
Enköping	Holstervik	6593450	1589800	Uppsala län	Strängnäs NO: 10H NO	350		
Enköping	Torsvi	6596450	1586600	Uppsala län	Strängnäs NO: 10H NO	400		
Eskilstuna	NE Tallholmen	6573250	1509800	Södermanlands län	Eskilstuna SV: 10G SV	1000		
Eskilstuna	Degersten	6574800	1558000	Södermanlands län	Strängnäs SV: 10H SV	800	130	40
Eskilstuna	SE Falla	6571050	1516400	Södermanlands län	Eskilstuna SV: 10G SV	1000	1080	20
Eskilstuna	Tandtorp-Ladubråten	6566500	1517600	Södermanlands län	Eskilstuna SV: 10G SV	2000	6840	270
Eskilstuna	NV Myrstugan	6572450	1514400	Södermanlands län	Eskilstuna SV: 10G SV	1000		
Eskilstuna	N Tallbacken	6573250	1512600	Södermanlands län	Eskilstuna SV: 10G SV	1500		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Falkenberg	V Korsbyn	6335550	1308645	Hallands län	Ullared NV: 5C NV	900	580	20
Falkenberg	Håkerud	6338000	1308915	Hallands län	Ullared NV: 5C NV	400		
Finspång	Fläskgruvan	6520900	1482400	Östergötlands län	Finspång SO: 9F SO			
Finspång	Klinta	6524200	1520950	Östergötlands län	Katrineholm SV: 9G SV	400	180	60
Flen	Gryt	6535650	1549550	Södermanlands län	Katrineholm NO: 9G NO	1200		
Gislaved	Ingelsbo	6367700	1363100	Jönköpings län	Gislaved SV: 6D SV	3000		
Gällivare	Meuresvare	7414200	1720000	Norrbottens län	Nattavaara SV: 27K SV			
Hallsberg	Römossen	6545350	1458250	Örebro län	Finspång NV: 9F NV	3000		
Hallsberg	Samsala järngruva	6547240	1462560	Örebro län	Finspång NV: 9F NV	1000	450	100
Hallsberg	Lundby	6557500	1477000	Örebro län	Örebro SO: 10F SO	200		
Hallsberg	S Karlsdal	6533480	1485200	Örebro län	Finspång NO: 9F NO	800		
Hallsberg	E Bjurhytta	6537720	1479600	Örebro län	Finspång NO: 9F NO	1000		
Hallsberg	V. Rävsjön	6539950	1466900	Örebro län	Finspång NV: 9F NV	650		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Hallsberg	Ormhult	6546340	1462050	Örebro län	Finspång NV: 9F NV	1000		
Hudiksvall	Lingarö	6846500	1576200	Gävleborgs län	Hudiksvall NO: 15H NO			
Hudiksvall	Majsaberget	6832000	1550000	Gävleborgs län	Bollnäs NO: 15G NO			
Härjedalen	Staverberget	6913500	1452500	Jämtlands län	Ånge SV: 17F SV		12500	
Jokkmokk	Manak S	7444800	1618750	Norrbottens län	Tjåmotis NV: 27I NV		800	
Jokkmokk	Manak M	7445500	1619350	Norrbottens län	Tjåmotis NV: 27I NV			
Jokkmokk	Manak N	7446000	1619300	Norrbottens län	Tjåmotis NV: 27I NV			
Jönköping	Björket	6434400	1424200	Jönköpings län	Jönköping NV: 7E NV	500		
Kalix	Pålänge	7322000	1824000	Norrbottens län	Kalix SV: 25M SV		300	
Karlskrona	Vingleskär	6213100	1497200	Blekinge län	Karlskrona SO: 3F SO			
Karlstad	Skutberget	6585850	1362800	Värmlands län	Karlstad NV: 10D NV		1600	1700
Katrineholm	Stentorpshagkärr	6521550	1531200	Södermanlands län	Katrineholm SO: 9G SO	3000	1150	150
Katrineholm	NE Bergnäs	6539050	1537500	Södermanlands län	Katrineholm NO: 9G NO	2800		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Katrineholm	SE Lillmyran1	6558350	1521400	Södermanlands län	Eskilstuna SV: 10G SV	1200	740	160
Katrineholm	Valfallagruvan	6555550	1523175	Södermanlands län	Eskilstuna SV: 10G SV	3000	5030	90
Katrineholm	NV Långtjärn	6558950	1525000	Södermanlands län	Eskilstuna SO: 10G SO	1000		
Katrineholm	Stavängsholmen	6549450	1535500	Södermanlands län	Katrineholm NO: 9G NO	600		
Katrineholm	N. Skyttorp	6549750	1534300	Södermanlands län	Katrineholm NO: 9G NO	600		
Katrineholm	SV Vädret	6565750	1512300	Södermanlands län	Eskilstuna SV: 10G SV	1000		
Kiruna	Kopparåsen W	7602250	1608250	Norrbottens län	Vadvetjåkka SV: 31I SV			
Kiruna	Kopparåsen S	7598200	1608650	Norrbottens län	Abisko NV: 30I NV			
Kiruna	Kopparåsen N	7601050	1608950	Norrbottens län	Vadvetjåkka SV: 31I SV			
Kiruna	Äijärova Mo	7519000	1733400	Norrbottens län	Vittangi SO: 29K SO		200	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Kiruna	Äijärova-N	7517800	1733700	Norrbottens län	Vittangi SO: 29K SO			
Kiruna	Masugnsbyn	7502000	1764000	Norrbottens län	Lainio SO: 29LSO		900	
Kristianstad	Ullarp	6204000	1380000	Skåne län	Kristianstad SO: 3D SO	1000		
Kristianstad	Ivö klack	6223200	1413300	Skåne län	Karlshamn SV: 3E SV	1000		
Krokom	Buretjakke	7094870	1399550	Jämtlands län	Kolåsen NO: 20D NO			
Krokom	Område 15	7095850	1392500	Jämtlands län	Kolåsen NO: 20D NO			
Krokom	Stensjöån	7099600	1399700	Jämtlands län	Kolåsen NO: 20D NO		5200	
Krokom	Område17	7099850	1398000	Jämtlands län	Kolåsen NO: 20D NO			
Krokom	Kläppibäcken	7095160	1404300	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Område 8 S	7095600	1401150	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Stensjödalen	7096150	1401050	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Tresjöarna	7096150	1402200	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Nöjdfjället SO	7096800	1405300	Jämtlands län	Hotagen NV: 20E NV		1000	
Krokom	Stensjöfjället	7097100	1401150	Jämtlands län	Hotagen NV: 20E NV			

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Krokom	Ravinen	7097300	1402200	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Område 6	7097450	1402100	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Nöjdfjället	7098000	1403450	Jämtlands län	Hotagen NV: 20E NV		700	
Krokom	Lilljuthatten	7099850	1401950	Jämtlands län	Hotagen NV: 20E NV		1900	
Krokom	Långtjärn	7099850	1406300	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Område18	7100000	1397250	Jämtlands län	Jävsöhatten SO: 21D SO			
Krokom	Spjutsjöarna	7100000	1400500	Jämtlands län	Håkafot SV: 21E SV			
Krokom	Område 5	7101250	1402960	Jämtlands län	Håkafot SV: 21E SV			
Krokom	Klockansexklumpen	7102000	1403050	Jämtlands län	Håkafot SV: 21E SV			
Krokom	Område 10	7102030	1400200	Jämtlands län	Håkafot SV: 21E SV			
Krokom	Prästrun	7075100	1404200	Jämtlands län	Hotagen NV: 20E NV			
Krokom	Mahkene	7100100	1385000	Jämtlands län	Jävsöhatten SO: 21D SO			
Krokom	Valle	7083650	1401950	Jämtlands län	Hotagen NV: 20E NV			

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Kungsbacka	Jöddesgård	6379400	1289520	Hallands län	Kungsbacka NO: 6B NO	3000		
Kungsbacka	1 km S. Karsjö	6381300	1285300	Hallands län	Kungsbacka NO: 6B NO	600		
Köping	Dåvö	6595500	1520850	Västmanlands län	Eskilstuna NV: 10G NV	600	160	90
Laxå	V Spännartorp	6554320	1432600	Örebro län	Karlskoga SO: 10E SO	1100		
Leksand	Digerbergsgruvan	6725460	1469230	Dalarnas län	Falun NV: 13F NV			
Leksand	Digerbergsgruvan	6725430	1469200	Dalarnas län	Falun NV: 13F NV			
Ljusdal	Riberget	6839200	1450300	Gävleborgs län	Voxna NV: 15F NV			
Ljusdal	Sandsjöån	6829400	1452850	Gävleborgs län	Voxna NV: 15F NV			
Ljusdal	Tjärdalsmyran	6828400	1466700	Gävleborgs län	Voxna NV: 15F NV			
Ljusdal	Hästtjärn	6828500	1467500	Gävleborgs län	Voxna NV: 15F NV			
Lund	Södra Sandby	6179000	1344000	Skåne län	Malmö NO: 2C NO	150		
Lund	Romelestugan	6169900	1350800	Skåne län	Tomelilla SV: 2D SV			
Lund	Krutladan	6171100	1351000	Skåne län	Tomelilla SV: 2D SV		1000	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Mellerud	Båsane	6522250	1297340	Västra Götalands län	Dals-Ed SO: 9B SO	190	140	30
Mellerud	Ljungbergen	6526075	1298550	Västra Götalands län	Dals-Ed NO: 9B NO		300	
Mellerud	Rönningen	6524650	1307450	Västra Götalands län	Mellerud SV: 9C SV			
Mellerud	V Berg-Snäcke-Ryr	6526940	1308860	Västra Götalands län	Mellerud NV: 9C NV	800	240	30
Mellerud	Ljungbergen	6526075	1298550	Västra Götalands län	Dals-Ed NO: 9B NO	2000	20	20
Mellerud	Rönningen	6524650	1307450	Västra Götalands län	Mellerud SV: 9C SV	1200		
Motala	Tybble 1	6519150	1469200	Östergötlands län	Finspång SV: 9F SV			
Motala	Baggetorp	6510900	1480200	Östergötlands län	Finspång SO: 9F SO			
Motala	Hållingtorp	6497400	1463040	Östergötlands län	Linköping NV: 8F NV	500		
Motala	Harhult - Daldiket	6519000	1466000	Östergötlands län	Finspång SV: 9F SV	800		
Motala	Tillefjärd	6520100	1466800	Östergötlands län	Finspång SV: 9F SV	2500		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Motala	Tybble järngruvor	6519150	1469700	Östergötlands län	Finspång SV: 9F SV	1000		
Munkedal	Barhult	6497500	1260200	Västra Götalands län	Vänersborg NV: 8B NV	500		
Mölndal	1,5 km NE Sisjön	6396200	1272200	Västra Götalands län	Kungsbacka NV: 6B NV	700		
Mönsterås	Mönsterås	6326000	1538650	Kalmar län	Oskarshamn NO: 5G NO			
Mörbylånga	NO. Kastlösa	6260800	1539300	Kalmar län	Kalmar SO: 4G SO	200	170	70
Nora	Gyttorp Ceritgruvan	6599650	1452000	Örebro län	Örebro NV: 10F NV	301	1700	20
Norrköping	Krokek	6505900	1532000	Östergötlands län	Katrineholm SO: 9G SO	1200	100	60
Norrköping	Raggansgruvan	6508250	1534800	Östergötlands län	Katrineholm SO: 9G SO	407	250	
Norrköping	Skrovsjögöl	6518950	1519050	Östergötlands län	Katrineholm SV: 9G SV	3000	130	80
Norrköping	Myckelmossasjön	6520650	1517400	Östergötlands län	Katrineholm SV: 9G SV	1000	900	140

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Norrköping	Björnkärret	6507600	1530950	Östergötlands län	Katrineholm SO: 9G SO	1600	870	110
Norrköping	E Svartgölen	6520250	1519400	Östergötlands län	Katrineholm SV: 9G SV	1500	780	200
Norrköping	NE Skrovsjögöl	6519300	1519250	Östergötlands län	Katrineholm SV: 9G SV	600		
Nyköping	Stavsjöbruk	6511000	1536000	Södermanlands län	Katrineholm SO: 9G SO		2500	
Nyköping	Kalkonberget	6513250	1550600	Södermanlands län	Nyköping SV: 9H SV	3000	1000	
Nyköping	NE Tidaberg	6513250	1551750	Södermanlands län	Nyköping SV: 9H SV	3000		
Nyköping	NV Sofilund	6514000	1551350	Södermanlands län	Nyköping SV: 9H SV	500		
Nyköping	Stenbro	6517800	1569850	Södermanlands län	Nyköping SV: 9H SV	500	160	50
Nyköping	Sätterstaberget	6518000	1569200	Södermanlands län	Nyköping SV: 9H SV	200	120	50

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Nyköping	SE Myra	6518600	1570550	Södermanlands län	Nyköping SV: 9H SV	800	300	70
Nyköping	Vreta	6522000	1573200	Södermanlands län	Nyköping SV: 9H SV	200		
Nyköping	Björkbacken	6523150	1572850	Södermanlands län	Nyköping SV: 9H SV	400	310	50
Nyköping	SE Moga	6504350	1563000	Södermanlands län	Nyköping SV: 9H SV	500	50	70
Nyköping	Björkholm	6512600	1549600	Södermanlands län	Katrineholm SO: 9G SO	3000	27000	2390
Nyköping	Björkholm	6512450	1551735	Södermanlands län	Nyköping SV: 9H SV	3000	1480	80
Nyköping	Stavsjö värdshus	6511200	1534350	Södermanlands län	Katrineholm SO: 9G SO	3000	1350	450
Olofström	Väst Stora Kroksjön	6244000	1414800	Blekinge län	Karlshamn NV: 3E NV	1000	430	540
Olofström	Sydost Stora Krok-sjön	6241850	1415300	Blekinge län	Karlshamn NV: 3E NV	1580	1610	280

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Oskarshamn	Lammholmen	6377200	1552000	Kalmar län	Kråkelund NV: 6H NV	400	590	120
Ovanåker	Stugberget	6795400	1505550	Gävleborgs län	Ockelbo NV: 14G NV			
Ovanåker	Losjön	6798000	1513200	Gävleborgs län	Ockelbo NV: 14G NV			
Ovanåker	Voxna station	6802300	1487100	Gävleborgs län	Voxna SO: 15F SO			
Ovanåker	Svensboberget	6820000	1483000	Gävleborgs län	Voxna SO: 15F SO			
Ovanåker	Stora Gillingen	6823400	1481100	Gävleborgs län	Voxna SO: 15F SO			
Ragunda	Näverån	7008150	1479000	Jämtlands län	Häggenås SO: 19F SO			
Ragunda	Dalbo	7005000	1487500	Jämtlands län	Häggenås SO: 19F SO			
Ronneby	Långasjön	6242200	1452180	Blekinge län	Karlskrona NV: 3F NV	700		
Rättvik	Lorttjärnarna	6800500	1470400	Dalarnas län	Voxna SV: 15F SV			
Rättvik	Älgtjärn	6812100	1462150	Dalarnas län	Voxna SV: 15F SV			
Rättvik	Kallbergssjön	6813700	1472200	Dalarnas län	Voxna SV: 15F SV			
Simrishamn	Stenshuvud	6171500	1403700	Skåne län	Simrishamn SV: 2E SV	1000	1000	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Skövde	Ranstad	6466500	1376200	Västra Götalands län	Skara SO: 8D SO		300	
Sorsele	Duobblon	7276650	1558800	Västerbottens län	Sorsele NV: 24H NV		450	
Sorsele	Gipperträsket	7280700	1564900	Västerbottens län	Sorsele NV: 24H NV			
Sorsele	Rabnaträsket	7282780	1556315	Västerbottens län	Sorsele NV: 24H NV			
Sorsele	Brånaberget	7277700	1563300	Västerbottens län	Sorsele NV: 24H NV			
Storuman	Laisbäcken	7234000	1556000	Västerbottens län	Stensele NV: 23H NV			
Strängnäs	Johannesdal	6569800	1579800	Södermanlands län	Strängnäs SO: 10H SO	1000		
Strömsund	Kvarnån	7142000	1498000	Jämtlands län	Alanäs NO: 21F NO			
Svalöv	Åkarp	6210000	1336000	Skåne län	Helsingborg SO: 3C SO	120	2500	
Svalöv	Bomagen	6217235	1333290	Skåne län	Helsingborg SO: 3C SO	300		
Svenljunga	Skillnabo	6361900	1331110	Västra Götalands län	Kinna SO: 6C SO			
Tomelilla	Andarum	6177600	1385400	Skåne län	Tomelilla NO: 2D NO	150		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Tomelilla	Listarum	6162630	1395640	Skåne län	Tomelilla SO: 2D SO			
Tranemo	Sävshult gård	6363100	1348300	Västra Götalands län	Kinna SO: 6C SO	300		
Vadstena	Fylla-Norrgård	6478930	1448580	Östergötlands län	Hjo NO: 8E NO		250	5
Valdemarsvik	Sondered	6434750	1556475	Östergötlands län	Loftahammar NV: 7H NV	2200	210	
Valdemarsvik	Skrikerums gruva	6447990	1536730	Östergötlands län	Västervik NO: 7G NO	3000		
Valdemarsvik	Skrikerums gruva	6448800	1536200	Östergötlands län	Västervik NO: 7G NO			
Varberg	Kantedalen	6337900	1304300	Hallands län	Ullared NV: 5C NV	500		
Vetlanda	Skärsjön	6346800	1442200	Jönköpings län	Växjö NO: 5E NO			
Vetlanda	Aplabäcken	6373480	1487200	Jönköpings län	Vetlanda SO: 6F SO	600	1730	1580
Vetlanda	Sunnerskogs S-Gr	6364700	1465150	Jönköpings län	Vetlanda SV: 6F SV	3000		
Värmdö	Uvö	6564200	1661850	Stockholms län	Värmdö SV: 10J SV	400		
Västervik	Öbälen	6386600	1535050	Kalmar län	Vimmerby NO: 6G NO		1000	
Västervik	Ljungskärr	6400150	1555900	Kalmar län	Loftahammar SV: 7H		>1000	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
					SV			
Västervik	Svenskgruvan	6399500	1536900	Kalmar län	Vimmerby NO: 6G NO	35	570	
Västervik	Trostad	6424600	1538050	Kalmar län	Västervik SO: 7G SO		1000	
Västervik	Källhagen gruvorna	6424900	1533700	Kalmar län	Västervik SO: 7G SO	300		
Västervik	Kroken	6403150	1554000	Kalmar län	Loftahammar SV: 7H SV		1000	
Västervik	Djupedals gruvor	6426830	1530800	Kalmar län	Västervik NO: 7G NO		5000	
Västervik	Kjällhagen	6424850	1533700	Kalmar län	Västervik SO: 7G SO		1700	
Västervik	Olserum V	6425450	1532550	Kalmar län	Västervik NO: 7G NO			
Västervik	Dunhällorna	6409800	1539900	Kalmar län	Västervik SO: 7G SO	2000		
Västervik	Syd Kyrksjön	6408325	1538250	Kalmar län	Västervik SO: 7G SO		4020	20
Västervik	V Klockartorpet	6408350	1540800	Kalmar län	Västervik SO: 7G SO	3000	5960	120
Västervik	V Ljungbo	6409300	1540375	Kalmar län	Västervik SO: 7G SO	1600		
Västervik	Torbogöl	6409875	1539150	Kalmar län	Västervik SO: 7G SO	1700	1830	790

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Västervik	Lofta kyrka	6423725	1539000	Kalmar län	Västervik SO: 7G SO	300		
Västervik	Henriksnäs	6386400	1546140	Kalmar län	Vimmerby NO: 6G NO	1200	520	30
Västervik	Häggebotorp	6392775	1538225	Kalmar län	Vimmerby NO: 6G NO			
Västervik	St.Flugen1	6393750	1533500	Kalmar län	Vimmerby NO: 6G NO	2000	6030	140
Västervik	Flugen stora	6393850	1533900	Kalmar län	Vimmerby NO: 6G NO			
Västervik	St Flugen2	6393850	1533900	Kalmar län	Vimmerby NO: 6G NO	2000	650	60
Västervik	Skjortö	6389200	1551800	Kalmar län	Kråkelund NV: 6H NV	2000	3840	90
Västervik	Tändsticksfabriken	6404850	1550000	Kalmar län	Västervik SO: 7G SO	3000		
Västervik	Båthuset	6405200	1549600	Kalmar län	Västervik SO: 7G SO	1000		
Västervik	N Lögarberget	6405350	1549575	Kalmar län	Västervik SO: 7G SO	2000	1090	10
Västervik	Lögarborget	6405350	1549650	Kalmar län	Västervik SO: 7G SO	1000		
Västervik	Rutsberg	6406450	1548950	Kalmar län	Västervik SO: 7G SO	1100	890	

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Västervik	Grantorpet	6407475	1542700	Kalmar län	Västervik SO: 7G SO	3000	8090	190
Västervik	Klockartorpet	6408000	1540835	Kalmar län	Västervik SO: 7G SO	1001	1970	
Västervik	Ödingen	6408775	1538250	Kalmar län	Västervik SO: 7G SO	1800		
Västervik	Röskär	6418000	1546700	Kalmar län	Västervik SO: 7G SO		500	
Västervik	SSV Älmkärr	6420250	1528100	Kalmar län	Västervik SO: 7G SO	3000	250	100
Västervik	Hersö	6420400	1546000	Kalmar län	Västervik SO: 7G SO		200	
Västervik	Djupedalsgruvor	6426625	1530810	Kalmar län	Västervik NO: 7G NO	1000	2330	180
Västervik	Djupedalsgruvor	6426630	1530370	Kalmar län	Västervik NO: 7G NO			
Västervik	Djupedalsgruvor	6426680	1530780	Kalmar län	Västervik NO: 7G NO			
Västervik	Gränsö	6401550	1553810	Kalmar län	Loftahammar SV: 7H SV	3000	3550	100
Västervik	N Malmö	6412600	1550925	Kalmar län	Loftahammar SV: 7H SV	1000		
Västervik	Äskedal - Livehamn	6422650	1558000	Kalmar län	Loftahammar SV: 7H SV	400		
Västervik	Vattentornet Väs-	6403495	1550160	Kalmar län	Loftahammar SV: 7H	1001		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
	tervik				SV			
Västervik	Lögareberget	6405350	1549650	Kalmar län	Västervik SO: 7G SO			
Västervik	Klockartorpet	6408900	1540200	Kalmar län	Västervik SO: 7G SO		200	
Västervik	Trostad	6424600	1538000	Kalmar län	Västervik SO: 7G SO		200	
Västervik	Bersummern	6425400	1531050	Kalmar län	Västervik NO: 7G NO	2500	500	200
Västervik	Vattentornet g:a	6403495	1550160	Kalmar län	Loftahammar SV: 7H SV			
Västervik	Långskären	6400150	1555600	Kalmar län	Loftahammar SV: 7H SV	1500	1060	
Västervik	Tvesäcken	6390100	1552900	Kalmar län	Kråkelund NV: 6H NV	100	750	60
Västervik	V. Olserum	6425190	1532540	Kalmar län	Västervik NO: 7G NO	1000		
Västervik	V. Olserum	6425390	1532430	Kalmar län	Västervik NO: 7G NO	300		
Västervik	V. Olserum	6425450	1532470	Kalmar län	Västervik NO: 7G NO	2000	350	350
Västervik	SV Olserum	6425050	1532400	Kalmar län	Västervik NO: 7G NO	3000	750	10
Västervik	Bersummen	6425400	1531050	Kalmar län	Västervik NO: 7G NO		560	200

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Västervik	Dalhem	6385200	1540800	Kalmar län	Vimmerby NO: 6G NO	500		
Västervik	Ljusgölen	6388360	1540200	Kalmar län	Vimmerby NO: 6G NO	1300		
Västervik	Östra Slingsö	6390600	1541400	Kalmar län	Vimmerby NO: 6G NO	1600		
Västervik	Stämbottensgölen	6391480	1537440	Kalmar län	Vimmerby NO: 6G NO	250		
Västervik	Stämgölen	6391480	1537800	Kalmar län	Vimmerby NO: 6G NO	1500		
Västervik	Smågrönsjöarna	6392240	1535400	Kalmar län	Vimmerby NO: 6G NO	600		
Västervik	V Mösjön	6409900	1538350	Kalmar län	Västervik SO: 7G SO	700	710	40
Västervik	Lilla Rätö	6413450	1546175	Kalmar län	Västervik SO: 7G SO	1000		
Västervik	Hultö U	6417900	1549100	Kalmar län	Västervik SO: 7G SO	1300		
Västervik	S Ören	6417925	1546525	Kalmar län	Västervik SO: 7G SO	700		
Västervik	Uknö	6421525	1544350	Kalmar län	Västervik SO: 7G SO	3000		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Västervik	Karlsberg	6423450	1538625	Kalmar län	Västervik SO: 7G SO	400		
Västervik	Hasselby	6423475	1542225	Kalmar län	Västervik SO: 7G SO	900		
Västervik	O Hasselby	6423550	1542850	Kalmar län	Västervik SO: 7G SO	700		
Västervik	NV Grånsten	6423740	1540800	Kalmar län	Västervik SO: 7G SO	600		
Västervik	Gustavberg	6424125	1538250	Kalmar län	Västervik SO: 7G SO	1500		
Västervik	O Ottinge	6424200	1514350	Kalmar län	Västervik SV: 7G SV	800		
Västervik	Norrsjö	6424250	1538950	Kalmar län	Västervik SO: 7G SO	500		
Västervik	S Björnsholm	6425050	1537875	Kalmar län	Västervik NO: 7G NO	800		
Västervik	Löckerum	6425800	1530200	Kalmar län	Västervik NO: 7G NO	1200		
Västervik	Anneberg	6427400	1527075	Kalmar län	Västervik NO: 7G NO	1500		
Västervik	Tindered varv	6429750	1540180	Kalmar län	Västervik NO: 7G NO	70		
Västervik	Skörserum	6431250	1532550	Kalmar län	Västervik NO: 7G NO	2000		
Västervik	Blidstena	6434500	1533490	Kalmar län	Västervik NO: 7G NO	700	10	40
Västervik	Nedre Kroktjärn	6434550	1521180	Kalmar län	Västervik NV: 7G NV	400		
Västervik	Korpklinten	6440560	1534200	Kalmar län	Västervik NO: 7G NO	800		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Västervik	Rorstad	6443100	1530450	Kalmar län	Västervik NO: 7G NO	450		
Västervik	Ryttartorpet	6402750	1553570	Kalmar län	Loftahammar SV: 7H SV	3000		
Västervik	Fiskartorpet	6404350	1553300	Kalmar län	Loftahammar SV: 7H SV	900		
Västervik	Vitudden	6404700	1550975	Kalmar län	Loftahammar SV: 7H SV	2000		
Västervik	N Vitudden	6405025	1550900	Kalmar län	Loftahammar SV: 7H SV	1000		
Västervik	Skogshyddan	6405100	1550375	Kalmar län	Loftahammar SV: 7H SV	1001		
Västervik	Torrön	6406000	1552600	Kalmar län	Loftahammar SV: 7H SV	1000		
Västervik	Lindholmen	6413350	1551500	Kalmar län	Loftahammar SV: 7H SV	900		
Västervik	S Björkö	6415325	1550350	Kalmar län	Loftahammar SV: 7H SV	500		
Västervik	N Vinö gård	6419975	1544775	Kalmar län	Västervik SO: 7G SO	1000		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Västervik	Björrisholm	6425700	1537650	Kalmar län	Västervik NO: 7G NO	500		
Västervik	Norra Björkö	6416600	1549950	Kalmar län	Västervik SO: 7G SO	700	340	3
Åmål	Lunden	6530260	1310985	Västra Götalands län	Mellerud NV: 9C NV	800	200	20
Åmål	Aten-2	6536610	1308535	Västra Götalands län	Mellerud NV: 9C NV	1000	1540	60
Åmål	Klockastrand	6540140	1309440	Västra Götalands län	Mellerud NV: 9C NV	500	460	20
Åmål	Bösterud	6541420	1308900	Västra Götalands län	Mellerud NV: 9C NV			
Åmål	Bösterud	6541420	1308900	Västra Götalands län	Mellerud NV: 9C NV	3000	1530	20
Åmål	Täppetjärnet	6548200	1305485	Västra Götalands län	Mellerud NV: 9C NV		29000	20
Åmål	Täppetjäret	6548200	1305485	Västra Götalands län	Mellerud NV: 9C NV	3000	29000	20
Åmål	Halvorskerud	6536750	1308710	Västra Götalands län	Mellerud NV: 9C NV	500		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Åmål	Stora Strand	6539880	1310290	Västra Götalands län	Mellerud NV: 9C NV	500	40	20
Åmål	Vallsjön	6543010	1310030	Västra Götalands län	Mellerud NV: 9C NV	400		
Ånge	Rönningsbäcken	6921650	1455100	Västernorrlands län	Ånge SV: 17F SV			
Ånge	Gillberget	6928000	1454700	Västernorrlands län	Ånge NV: 17F NV			
Ånge	Märrviken	6909250	1460900	Västernorrlands län	Ånge SV: 17F SV			
Ånge	Märrviken	6909400	1460900	Västernorrlands län	Ånge SV: 17F SV			
Ånge	Sågtjärnen	6920100	1455200	Västernorrlands län	Ånge SV: 17F SV			
Ånge	Sågtjärnen	6920050	1455200	Västernorrlands län	Ånge SV: 17F SV			
Ånge	Hammarmyren	6922800	1449500	Västernorrlands län	Rätan SO: 17E SO			

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
Åre	Rapmerejaureh	7098250	1370150	Jämtlands län	Kolåsen NV: 20D NV			
Åre	Björkvasselva	7109850	1371800	Jämtlands län	Jävsöhatten SV: 21D SV			
Åre	Sjaule	7108100	1371800	Jämtlands län	Jävsöhatten SV: 21D SV			
Åre	Flistjärn	7098450	1362000	Jämtlands län	Kolåsen NV: 20D NV		700	
Åre	Svenskån	7103500	1367100	Jämtlands län	Jävsöhatten SV: 21D SV			
Åre	Näipsulke	7101800	1376450	Jämtlands län	Jävsöhatten SO: 21D SO			
Åsele	Abborviken 2	7141140	1599040	Västerbottens län	Åsele NO: 21H NO			
Åsele	Björkråmyran	7142400	1596100	Västerbottens län	Åsele NO: 21H NO		1400	
Åstorp	Ormastorps sten-kolsgr	6226500	1319500	Skåne län	Helsingborg NV: 3C NV	250		
Örebro	Asker	6558500	1480500	Örebro län	Örebro SO: 10F SO	65		
Örebro	NE Skiratorp	6542000	1488800	Örebro län	Finspång NO: 9F NO	1100		
Örebro	SV Karl Abrahams-	6584400	1454200	Örebro län	Örebro NV: 10F NV	190		

Municipality	Name of object	Coordinate-North	Coordinate-East	County	Topographic map	Radia-tion (µR/h)	U (ppm)	Th (ppm)
	torp							
Östersund	Högremmen	7013500	1470300	Jämtlands län	Häggenås SV: 19F SV			
Östersund	Näverån	7009050	1474500	Jämtlands län	Häggenås SV: 19F SV			
Östersund	Lundkälen	7004700	1460810	Jämtlands län	Häggenås SV: 19F SV			
Östersund	Branamyren	7013470	1462690	Jämtlands län	Häggenås SV: 19F SV			
Östersund	Häggenås	7028120	1452230	Jämtlands län	Häggenås NV: 19F NV			

SSI-rapporter 2005

SSI reports 2005

2005:01 Reports from SSI:s International Independent Expert Group on Electromagnetic Fields 2003 and 2004.
SSI's Independent Expert Group on Electromagnetic Fields 190 SEK

2005:02 (SKI 2005:0) International Peer Review of Swedish Nuclear Fuel and Waste Management Company's SR-Can interim report
Budhi Sagar, Lucy Bailey, David G Bennett, Michael Egan, Klaus-Jürgen Röhlig

2005:03 (SKI 2005:06) Granskning av SKB:s SR-Can interimsrapport:SKI:s och SSI:s bedömning av SKB:s uppdaterade metoder för säkerhetsanalys
Benny Sundström och Björn Dverstorp et. al.

2005:04 (SKI 2005:10) Concentrations of Uranium, Thorium and Potassium in Sweden
Bo Thunholm, Anders H. Lindén och Bosse Gustafsson 130 SEK

SSI report

STATENS STRÅLSKYDDSINSTITUT, SSI, är central tillsynsmyndighet på strålskyddsområdet. Myndighetens verksamhetsidé är att verka för ett gott strålskydd för människor och miljö nu och i framtiden.

SSI är ansvarig myndighet för det av riksdagen beslutade miljömålet *Säker strålmiljö*.

SSI sätter gränser för stråldoser till allmänheten och för dem som arbetar med strålning, utfärdar föreskrifter och kontrollerar att de efterlevs. Myndigheten inspekterar, informerar, utbildar och ger råd för att öka kunskaperna om strålning. SSI bedriver också egen forskning och stöder forskning vid universitet och högskolor.

SSI håller beredskap dygnet runt mot olyckor med strålning. En tidig varning om olyckor fås genom svenska och utländska mätstationer och genom internationella varnings- och informationssystem.

SSI medverkar i det internationella strålskyddssamarbetet och bidrar därigenom till förbättringar av strålskyddet i främst Baltikum och Ryssland.

Myndigheten har idag ca 110 anställda och är belägen i Stockholm.

THE SWEDISH RADIATION PROTECTION AUTHORITY, SSI, is the government reguatory authority for radiation protection. Its task is to secure good radiation protection for people and the environment both today and in the future.

The Swedish parliament has appointed SSI to be in charge of the implementation of its environmental quality objective *Säker strålmiljö* ("A Safe Radiation Environment").

SSI sets radiation dose limits for the public and for workers exposed to radiation and regulates many other matters dealing with radiation. Compliance with regulations is ensured through inspections.

SSI also provides information, education, advice, carries out its own research and administers external research projects.

SSI maintains an around-the-clock preparedness for radiation accidents. Early warning is provided by Swedish and foreign monitoring stations and by international alarm and information systems.

The Authority collaborates with many national and international radiation protection endeavours. It actively supports the on-going improvements of radiation protection in Estonia, Latvia, Lithuania, and Russia.

SSI has about 110 employees and is located in Stockholm.

Statens strålskyddsinstitut
Swedish Radiation Protection Authority

Adress: Statens strålskyddsinstitut; S-171 16 Stockholm
Besöksadress: Solna strandväg 96
Telefon: 08-729 71 00, Fax: 08-729 71 08

Address: Swedish Radiation Protection Authority
SE-171 16 Stockholm; Sweden
Visiting address: Solna strandväg 96
Telephone: + 46 8-729 71 00, Fax: + 46 8-729 71 08

www.ssi.se