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Water compositions in the Lake Sibbofjärden – Lake Trobbofjärden area

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WATER COMPOSITIONS IN THE LAKE SIBBOFJÄRDEN/ TROBBOFJÄRDEN AREA

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ABSTRACT

The recipient evolution project aims at achieving an understanding of the processes occurring within a lake and its sediments during the life-time of the lake in order to permit predictions of long-term behaviour of radionuclides released into lake sediments.

An experimental program concerning field investigations in the drainage areas of Lake Sibbofjärden and Lake Trobbofjärden has been performed. This report covers the chemical analyses of surface and sediment pore waters as well as a study of trace radionuclide sorption in sediments.

Chemical data for surface water and sediments from several different types of lakes and streams have been collected.

The chemcial composition of the sediment pore water seems to be strongly related to the lake water composition in the upper layers, while changes, mainly in the ionic strength are occurring with increasing depth.

The next phase of this project will be focused on the development of a mathematical model, describing the time-dependent processes of importance to the turn-over of radionulclides during the various phases of the evolution of a lake.

Processes of chemical nature of large importance here are *eg* sorption of radionuclides on suspended material in the water, and migration and fixation in the sediment.

The chemical analyses described in this report give a data-base for use in connection with the modelling.

Data on average water composition at various stages of the lake evolution (pH, ionic strength, saturation state, contents of complex formers like phosfate, sulfate, fluoride, and organic compounds) give data for estimating the potential sorption on suspended matter

The migration and fixation in sediments is governed by pore water data like pH, Eh, ionic strength, content of complex formers, and physico-chemical properties like water content and organic content of the solid phase.

The study of sorption in sediment cores, coupled with an ongoing in-situ study of diffusion of radionuclides in sediments provide sorption and transport data for a validation of the model.

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1. INTRODUCTION

The recipient evolution project aims at achieving an understanding of the processes occurring within a lake and its sediments during the life-time of the lake in order to permit predictions of long-term behaviour of radionuclides released into lake sediments.

The first part of the project involved a literature survey (AGN 84), where an experimental program was outlined. This program concerns field investigations in the drainage areas of Lake Sibbofjärden and Lake Trobbofjärden. The field studies of the second part of the project are described in a series of reports of which this one covers the chemical analyses of surface waters and sediment pore waters as well as a study of trace radionuclide sorption in sediments.

The other reports are:

- "Recipient evolution - transport and distribution of elements in the Lake Sibbo- Trobbofjärden area" (SUN 86), with an overall material balance of the area and a description of trace element distributions in the sediments

- "Quantitative estimations of sedimentation rates and sediment growth in two Swedish lakes" (EVA 86), describing the sedimentation process in the lakes,

and

- "Description of vegetation in Lake Trobbo- and Sibbofjärden during summer 1985" (AGN 86).

The third phase of the project will be focused on the development of a mathematical model, describing the time-dependent processes of importance to the turn-over of radionulclides during the various phases of the evolution of a lake.

2. GEOLOGY OF THE AREA

A short description of the main geological features of the investigated area is given here. It is based on the description to the local geological map (PER 73), where further information can be found.

A map of the investigated area is given in Figure 1.

The bedrock of the area consists mainly of granite and gneiss. The degree of metamorphosis is great with a large mixing of different rocks and a large degree of migmatization. Several calcite bodies of varying size are found in the area. Also a large number of dolerite veins occurs.

Iron ores are found at various sites, *eg* at Hässle, where an abandoned iron mine is located.

Around Nynäs, bodies of quite pure calcite are encountered. In some cases these bodies are intruded by pegmatite.

Through Lake Trobbofjärden and towards Tegelkälla there is a pronounced crushed zone.

Glacial till is abundant in the area. In some locations, *eg* 250 m NW Strömstugan, a till depth of 5 - 6 m has been measured. The till has a low content of carbonate minerals, generally less than 0.1 %.

Postglacial clays are common in the valleys of the area. In the valley north of Lake Sibbofjärden, the clay depth varies from 1 m in the south to *ca* 5 m in the northern part. These clays are mainly free from calcium carbonate.

Clayish gyttja, covered by a thin layer of peat is found in some places, *eg* in some parts of the valley north of Lake Sibbofjärden. The organic content of this is usually 6.5 - 12 %.

Some bogs and fens are also found in the area. The bogs are characterized by a coherent cover of shpagnum species and a mainly ombrotrophic vegetation. Generally, the bogs are more or less overgrown by shrubs and pine. Many former bogs have been drained.

The fens are characterized by sedges, reed, horsetail, moisture-loving herbs, *etc.* Very often the fens are covered by birch and alder.

3. SAMPLING, ANALYSIS, AND LABORATORY MEASUREMENTS.

The complete sampling program is described by Sundblad (SUN 86). Here only sampling relevant to the chemical analyses is described.

3.1 Surface waters.

Sampling of lake water and surface water of the surrounding streams was performed at least 10 times per year, for the lakes also in connection with the collection of the contents of the sediment traps (*cf* EVA 86) and when taking sediment cores (*cf* 3.2 below). The following analyses were performed:

- pH, conductivity and temperture were measured in the field in connection with the sampling.
- suspended matter, pH, conductivity and chloride concentration were measured at the Studsvik laboratory on the sampling day.
- pH, conductivity, $KMnO_4$-demend, colour, turbidity, and inorganic species (Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe_{tot}, Fe(after aereation and filtration), Mn^{2+}, F^-, Cl^-, SO_4^{2-}, HCO_3^-, NH_4^+, NO_2^+, NO_3^-, and PO_4^{3-}) were determined at the SLL laboratory (Statens Lantbrukskemiska Laboratorium) at Ultuna on samples sent by mail on the sampling day.

The field and Studsvik laboratory analyses were performed for all water samples taken, while the analyses at SLL were performed for *ca* 10 samples per year from each sampling site. One set of samples were sent to the the SMHI laboratory in Norrköping as well as to SLL in order to compare the results.

3.2 Sediment pore waters.

Sediment cores from lakes Sibbofjärden, Trobbofjärden, Rundbosjön, Käxlan and Frillingen were taken. The core diametre was 60 mm and the length of the cores varied from 20 cm to 150 cm.

The Pt-electrode potetential ("Eh") vs depth was measured in some of the cores immediately after the core was taken into the laboratory.

Other cores were immediately cut into 2 cm thick slices that were carefully transferred into 100 ml centrifuge tubes with as little aeration as possible. The tubes were completely filled and tight lids were screwed on, before centrifuging at 17 000 rpm (42 000 g) at +4 °C for 100 min.

The free pore water was then gently removed from the tubes, using a hypodermic syringe, and immediately filtered through 0.4 μm Nuclepore filters.

pH and chloride concentration were then determined on a fraction of the sample, using a combination electrode and an ion-selective electrode respectively. The main part of the water was acidified to ph<2 and frozen to allow later trace element analysis (*cf* SUN 86).

The solid phase was frozen and freeze dried to allow determination of the total water content, organic content, and trace element content in the solid (*cf* SUN 86).

The method of extracting sediment pore water is discussed in further detail elsewhere (AND 86).

3.3 Sorption measurements

The sorption of trace radionuclides *vs* depth for the upper 20 cm of sediment cores from Lake Sibbofjärden was measured for the nuclides ^{85}Sr, ^{125}I, ^{134}Cs, ^{152}Eu, and ^{241}Am.

The sediment cores were cut into 2 cm thick slices and *ca* 10 ml of the sediment was diluted with 10 ml of pore water taken from a similar core, using the method described under 3.2 above. (The dilution was performed in order to allow an efficient mixing of radionuclide solution and sediment in a filled centrifuge tube). The sediment and water was mixed carefully in order to avoid unnecessary aeration in a 100 ml centrifuge tube and 0.1 ml of radionuclide stock solution added, giving total radionuclide concentrations of 10^{-7} M (Sr, Cs, I) and 10^{-9} M (Am, Eu). Radionuclide solution was also added to reference tubes, containing only 20 ml pore water. Pore waters from the top and bottom layers of the studied sediment were used for the reference tubes.

The tubes were vigourously shaken for some minutes and then stored at + 4 °C for 24 h. During this time they were shaken three of four times.

The tubes were then centrifuged at 17 000 rpm (42 000 g) at + 4 °C for 100 min and 1 ml samples of the water were withdrawn. The samples were counted for radioactivity, using a NaI(Tl) well-type detector.

The distribution coefficient, K_d, was calculated according to:

$K_d = q/c = (V/m)*(c_o-c)/c$

where q = activity of solid, Bq/kg
c = activity of liquid, Bq/m^3
c_o= activity of reference samples, Bq/m^3
V = volume of liquid, m^3
m = mass of solid, kg

pH and chloride concentration vs depth were also determined for the pore water.

4. RESULTS

4.1 Surface waters

4.1.1 Water composition.

A selection of results of the surface water analyses performed at the SLL laboratory is given in Table 1. Also data on ground water composition in a 100 m deep nearby borehole, drilled in igneous rock are included as a comparison (*cf* LAN 83).

- pH

The pH is varying over the year for the surface waters, *cf* Table 1. A maximum is observed in summer and a minimum in April when snow-melt provides large quantities of acid water. At 5 - 6 m depth in Lake Sibbofjärden, however, these variations are not as pronounced as in the surface waters. Generally pH at all sites was between 6.5 and 7.5 as an average over the year. Values up to 9.2 (Lake Sibbofjärden in summer) and down to 6.3 (Tegelkälla in April) have been measured, but these represent short episodes.

- Na, K, Cl, conductivity.

The ionic strength of the studied waters varies over a wide range, from the stream water at Hässle, representing a forest land catchment, having a very low ionic strength, to the inflowing water at Strömstugan, which is a brackish Baltic Sea water. (The variations with time in water composition at Strömstugan are due to changes between in- and outflow of water to Lake Sibbofjärden, *cf* SUN 86). The chloride concentrations of the studied waters vary from *ca* 3 ppm up to *ca* 3 800 ppm. In the saline waters Na, K and Cl are the dominating ions, while at low salinity other ions may have higher concentrations.

The correlation between Na- and Cl-concentration is quite strong, *cf* Figure 2. This is the case also for the K- and Cl-concentration at high ionic strength. The waters of low ionic strength, however, have a much higher K/Cl ratio than the saline water, *cf* Figure 3. The deep groundwater has concentrations close to those of the freshwaters in streams and lakes. The correlation of Na and K to Cl is however deviating a little from that of the surface waters.

- Ca

A high Ca-concentration is also found at high ionic strength. The correlation to Cl-concentration is also quite strong at high concentrations. As for K, this is not the case for low ionic strength, *cf* Figure 4.

There is hardly any correlation between the Ca and HCO_3^- concentrations. There are a number of waters with high carbonate concentration and low Ca-concentration, *cf* Figure 5, but also other combinations have been observed. The deep groundwater has a higher carbonate/Ca ratio than the other waters.

- Mn

The manganese concentration is mainly low and far below 1 ppm. This is normal for natural waters (STA 85).

- HCO_3^-

The carbonate concentration of aereated natural waters is determined by contact with the atmosphere. The correlation HCO_3^- - pH for the surface waters is however not always obvious, *cf* Figures 6 - 13, where this relation is given separately for the various sampling sites. The correlation to Ca-concentration is shown in Figure 5 and discussed above. The difficulty in obtaining reliable pH data, as discussed under 4.1.3 below, may be important here, although the correlation does not become more evident when using the pH values measured at the Studsvik laboratory instead of these from SLL.

- Fe

The total iron content of the waters is mainly below 1 ppm, although there are values up to 3.5 ppm. For aereated and filtered water the iron content is generally lower, in several cases below the detection limit. There are however several water samples where the concentration is above the calculated maximum solubility. This is further discussed under 4.1.2 below.

- SO_4^{-2}

The sulfate concentration is strongly correlated to the salinity.

- NH_4^+, NO_3^-, NO_2^+

The concentrations of these species vary between the sampling occations for the different sampling sites. Generally the concentrations may be expected to be strongly correlated to external factors like precipitation, sewage releases and fertilizing of soil. The largest variations are also observed in stream waters (Hässle, Brokulla, Tegelkälla), where transients may be expected to be of importance. For the lakes the variations are much smaller.

- PO_4^{-3}

The phosphate concentrations are generally low.

- F^-

There are dectectable concentrations fo fluoride in almost all samples. It is however usually below 0.5 mg/l.

- organic constituents

In the water analyses performed there is no direct measurement of concentration of organic matter neither in dissolved nor in particulate form. There are however some, indirect, methods that may give an indication on these.

The colour would be expected to be related to the concentration of organic complex formers (humic substances).

The $KMnO_4$-consumption is a measure of contents of oxidizable matter (mainly of organic origin in a surface water).

The suspended matter is partly organic (although not more than 10 - 20 % in lakes Sibbofjärden and Trobbofjärden, *cf* EVA 86). This material constitutes the particulates that could act as sorbents for cations, *eg* Fe (and trace radionuclides, if present).

4.1.2 Saturation state of the waters

The degree of saturation with respect to a number of minerals has been tested for some water analyses from each site, using the PHREEQE equilibrium computer code (PAR 80). The equilibrium constant data library used was NEALIB, supplied with the present version of PHREEQE (PAR 84). In this library only inorganic reactions that may occur in natural waters are included.

In all cases where there was a detectable concentration of Fe, the program also indicated a supersaturation with respect to Fe minerals (hematite, goethite, amorphous Fe-hydroxide).

No other minerals were over-saturated. The mineral apart from the iron minerals that was closest to saturation was in most cases calcite, although fluorite and gypsum sometimes have higher saturation indices.

(Saturation index, SI = log IAP/K_{sp}, where IAP = ion activity product = $\prod a_i^{n_i}$ in actual solution, a_i = activity of species i, n_i = stoichiometric coefficient of species i in precipitation reaction and K_{sp} = solubility product. For a saturated solution thus SI = 0.)

Closest to saturation with respect to calcite are the waters that are mixed with the Baltic water, *ie* at Strömstugan and in Lake Sibbofjärden (SI = -0.4 - - 0.6). Interactions with the calcite bodies that are encountered in several places in the area, *eg* at the shore of Lake Rundbosjön N of Nynäs, are obviously not of importance to the saturation state of the water. At Nynäs, the SI is -1.6 - -2.6, depending on the time of the year. Also the borehole water is undersaturated with respect to calcite (SI = -0.7).

Iron may be present in the water in other forms than as simple inorganic ions. This may explain the apparent supersaturation, since no organic complex formers are accounted for in the calculation.

Apart from ionic, iron may be present in the aqueous phase as organic complexes. This increases the possible iron concentration in the water, compared to the one predicted in inorganic speciation calculations. Iron may also be bound to suspended matter or to colloidal particles, formed *eg* by sorption on organic particles. Also these processes may explain an apparently high Fe-content.

The correlation of colour to any of the Fe concentrations that may be determined (total, dissolved, *ie* after aereating and filtration, and particulate, *ie* the difference between these two) is however very weak, *cf* Figures 14, 15 and 16.

The permanganate consumption is not strongly related to neither total nor particulate iron, *cf* Figures 17 and 19.

The best correlation for Fe seems to be between total Fe and suspended matter, *cf* Figure 18. For particulate Fe this correlation is not as obvious, *cf* Figure 20.

In order to illustrate the possible effect of organic complexation, new calculations, using the PHREEQE code with a fictitious organic complex former added to the data library have been performed. Various amounts of complex former, depending on the type of water, have been assumed to be present in the water. The complex former was assigned a molecular weigth of 1000, and a capability of forming 1:1-complexes with Fe with a complex formation constant, log K = 8. These data are based on typical data given by Thurman (THU 85), although the assumed molecular weigth may be somewhat high for soluble organics and the formation of 1:1-complexes may also be an underestimation.

The results of these calculations are shown in Table 2. The supersaturation is reduced by one to four orders of magnitude, although there still is a supersaturation for all cases. (The mineral that may be expected to be formed if iron is precipitated is however niether hematite nor goethite, as indicated by the equilibrium calculation, but an amorphous iron hydroxide that slowly recrystallizes to these minerals.)

This calculation, however shows that presence of 10 - 20 mg/l of organic complex formers may have a strong effect on the total solubility of iron.

4.1.3 Comparison of analysis data from different laboratories.

The data discussed above were only measured at the SLL laboratory. As mentioned under 3.1 above, pH and conductivity were also measured in the field in connection with the sampling and at the Studsvik laboratory. For one set of samples, total analyses were also performed at the SMHI laboratory. Comparisons of some of the pH and conductivity data from different sources are given in Tables 3 and 4.

As seen in Table 3, the differences in pH and conductivity may sometimes be quite large - up to one pH unit between field and SLL laboratory.

The differences may be attributed to factors like difficulties in calibrating electrodes and measuring pH under field conditions, especially in winter, but also to changes in the samples during the transport to the laboratories. In the discussion of the data the whole analysis performed at the SLL laboratory has been adopted in order to get an internally consistent set of data. This is not a judgement of the SLL pH value as the "correct", but a choice of one set of data.

The total chemical analysis comparison, Table 4, does not show any large differences between the laboratories, except for Ca, where SLL in all cases report higher values than SMHI.

4.2 Sediment pore waters

4.2.1 pH.

The pH gradients observed in the sediment pore waters were small, at most an increase of one pH unit in one metre was observed. The pH level in the upper layer pore water is close to that of the lake water, *cf* Tables 5 - 10.

4.2.2 Chloride concentration.

The chloride gradients may be very steep, *cf* Tables 5 - 10. Within one metre increases from tens of ppm to two or three thousand ppm have been observed. There seems to be an upper limit of *ca* 2500 - 3000 ppm Cl that is reached after 10 to 20 cm in the sligthly brackish Lake Sibbofjärden and after *ca* 1 m in the freshwaters.

In the low pH lakes Käxlan and Frillingen no large increase in chloride was observed in the range investigated (down to 16 or 20 cm, respectively). Practical problems in extracting long sediment cores from certain types of sediment with the equipment availible prevented investigation of deeper layers in these lakes.

The gradient in Lake Trobbofjärden may easily be explained by historical reasons, since the lake was a brackish Baltic bay until 1956 when it was cut off from the sea by a barrage in order to create a freshwater supply for the Studsvik laboratory (*cf* SUN 86).

The gradient observed in Lake Rundbosjön, which was cut off from the Baltic sea by land uplift *ca* 1000 years ago, however indicates that chloride may be transported from deeper sediment layers by diffusion (or be liberated in connection with the degradation of organic sediment material), since the gradient here is very similar to that in Lake Trobbofjärden.

Deeper sediment cores from the other old lakes in the area would give further information on the chloride gradients, but, as mentioned above, deep sediment cores from these lakes could not be sampled for practical reasons.

4.2.3 Redox conditions.

The platinum electrode potential ("Eh") was positive and *ca* 150 mV in the lake waters above the sediment surface, *cf* Tables 11 - 13. The potential decreases very rapidly from the sediment surface and down. For a core taken in Lake Sibbofjärden in summer the potential is below -200 mV at 6 cm depth, and in the cores taken in Lake Rundbosjön and Lake Trobbofjärden in winter the potential decreases even faster.

4.2.4 Water/solid ratio.

The water content of the sediment cores was in all cases high, *cf* Tables 5, 6, and 10. Few values were below 60 % water and close to the surface the water content was above 95 %.

In Lake Trobbofjärden there is a well-defined change in the properties of the sediment at *ca* 50 cm depth (*cf* SUN 86). In this layer there were threads of a low density material, making the phase separation difficult. This is also reflected in the concentration of organic material, which has a maximum value of 17 % in this layer, compared to *ca* 10 % in the rest of the core. This layer is encountered below the level that is thought to have been the surface at the time of cut off from the Baltic Sea. Also a slight increase in the water content is encountered at this level. Since only one sediment core of this length was taken from Lake Trobbofjärden, it is not possible to decide whether this is a local phenomenon or the effect is present over the whole lake.

4.3 Sorption of radionuclides in sediment cores.

The measured distribution coefficients for ^{85}Sr, ^{131}I, ^{134}Cs, ^{152}Eu, and ^{241}Am in sediment cores from Lake Sibbofjärden are given in Table 14. Generally the level of the distribution coefficients is of the order of magnitude that would be expected for a sorbent of high surface area in this pH range and ionic strength. (*cf* AND 83, AND 83:2, ALL 82). Some deviations may, however be noted:.

-Sr The slight increase in K_d with depth may probably be attributed to the increase in ionic strength of the pore water. The low sorption may be expected at the high ionic strength.

-Cs Cs is strongly sorbed by the sediment, especially in the layers close to the surface. The distribution coefficient is here much higher than encountered for most minerals in groundwater (*cf* AND 83). The decrease in K_d with about one order of magnitude in 20 cm cannot be attributed to the change in pH, which would give the opposite effect. The decrease is also too large to be explained by the increased ionic strength. The composition of the sediment however changes somewhat with depth due to degradation of organic material. Complex formation with solid organic material present in the surface layers but degraded further down may cause a high sorption in the surface layers.

-I The sorption of iodide in a lake sediment would be expected to be very low or none. There is however a significant sorption in the upper part of the sediment core. There are no inorganic interactions that may explain this behaviour. Formation of organic iodide compounds has been discussed in other contexts, *eg* when using iodide as a tracer for natural waters (BEH 81). Formation of such complexes with solid organic material in the upper parts of the sediment may occur and cause an apparent sorption.

-Eu *cf* Am.

-Am The sorption of Am and Eu would be expected to be quite similar since these elements are chemically quite similar. High K_d values are measured for both throughout the whole sediement core. These values are of the order of magnitude usually encountered for these nuclides on minerals, *ie* 1 - 10 m^3/kg (*cf* ALL 82). (The experimental method does not allow any accurate determination of K_d values above *ca* 1 m^3/kg, since the remaining radionuclide concentration in the water is very low at these values.)

5. CONCLUSIONS

Chemical data for surface water and sediments from several different types of lakes and streams have been collected and variations over the year studied. For the surface waters of lakes and the stream waters, variations in some parameters, mainly in pH are observed. The periods with large deviaitons from the average value are however short (*eg* snow-melt and warm summer periods). At larger depth in the lakes the water compositon is more constant over the year.

The chemcial composition of the sediment pore water seems to be strongly related to the lake water composition in the upper layers, while changes, mainly in the ionic strength are occurring with increasing depth.

The investigation of sediment pore water has to a large extent been focused on method development for extraction of long sediment cores from lakes of different types, and for laboratory separation of pore waters from the solid phase. The measured pore water parameters were pH, Cl^-, redox potential, water and organic content. More investigations on chemical conditions, *eg* carbonate concentration, and contents and properties of soluble organic complex formers would give a basis for a more porfound understanding of the possible behaviour of radionuclides released into lake sediments.

The sorption measurements in sediment cores have in all cases given distribution coefficients that are at least as high as would be expected for the type of material and the prevailing pH and ionic strength. In some cases, like for Cs and I in the surface layers, the sorption was higher or even very much higher than expected from earlier experience. This indicates that the sediment may act as a sink, or at least retard the release of these nuclides in a possible transport to sediments from the groundwater

The next phase of this project will be focused on the development of a mathematical model, describing the time-dependent processes of importance to the turn-over of radionulclides during the various phases of the evolution of a lake.

Processes of chemical nature of large importance here are *eg* sorption of radionuclides on suspended material in the water, and migration and fixation in the sediment.

The chemical analyses described in this report give a data-base for use in connection with a modelling of these processes.

Data on average water composition at various stages of the lake evolution (pH, ionic strength, saturation state, contents of complex formers like phosfate, sulfate, fluoride, and organic compounds) give data for estimating the potential sorption on suspended matter

The migration and fixation in sediments is governed by pore water data like pH, Eh, ionic strength, content of complex formers, and physico-chemical properties like water content and organic content of the solid phase.

The study of sorption in sediment cores, coupled with an ongoing in-situ study of diffusion of radionuclides in sediments provide sorption and transport data for a validation of the model.

Some important observations for the modeling phase are:

- reducing conditions in almost whole sediment
- Large Cl-gradients. In freshwater sediments down to *ca* 1 m , in brackish water to *ca* 20 cm. Maximum Cl-concentration in pore water *ca* 3000 ppm, minimum as overlying lake water.
- Moderate pH gradients in sediments. At most 1 pH unit in 1 m. May be positive as well as negative gradients.
- The sediment contains > 65% water down to at least 1 m depth.
- Sorption maxima have been observed in surface layer of sediment for I and Cs (probably also for Sr, Am and Eu).
- Unexpectedly high sorption of I in surface sediment.

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TABLE 1. Water analyses of surface waters

Site Date	Sibbo 2m 850131	Sibbo 2m 850510	Sibbo 2m 850704	Sibbo 2m 850912	Sibbo 2m 851107	Sibbo 2m 860114	Sibbo 2m 860319
Colour	50	70	40	70	10	45	40
Turbidity	3.8	18	1.9	3	2.8	4.7	4.5
Cond mS/m	555	290	405	472	500	480	490
pH	7.5	6.9	8.8	7.6	7.5	7.1	7.2
KMnO4mg/l	31	36	38	33	26	30	33
Ca mg/l	239	140	178	207	223	206	224
dH	33.5	19.6	24.9	29	31.2	28.8	31.4
Fe mg/l	.22	.8	.03	.07	.05	.21	.17
Fe EloF*	0	.66	0	0	0	0	0
Mn mg/l	.05	.13	.05	.21	.05	.06	.07
HCO3 mg/l	66	44	59	68	68	66	71
Cl mg/l	1700	850	1080	1420	1580	1395	1480
SO4 mg/l	280	150	190	225	200	220	225
NH4 mg/l	.07	.1	.12	.1	.05	.09	.13
NO3 mg/l	1.9	4.1	.62	.5	.5	2.44	2.05
NO2 mg/l	.05	.08	.1	.01	.01	.03	.03
PO4 ug/l	14	36	14	8	21	20	16
F mg/l	.4	.3	1	.4	nd	.5	.3
Na mg/l	945	455	610	805	920	780	760
K mg/l	32.5	20	26	30	34.4	23	31
susp mg/l	.83	1.04	1.5	5.6	6.5		

* mg/l Fe after aeration and filtration

TABLE 1. Water analyses of surface waters Page 2

Site Date	Sibbo 7m 850131	Sibbo 5 m 850510	Sibbo 7m 850704	Sibbo 7 m 850912	Sibbo 6 m 851104	Sibbo 6 m 860114	Sibbo 6 m 860319
Colour	45	70	15	50	15	35	20
Turbidity	4.1	5.4	1.4	2.5	3.3	3.5	2.2
Cond mS/m	570	465	620	639	540	520	570
pH	7.3	7.4	7	7.3	7.6	7.2	7.1
KMnO4mg/l	33	34	32	33	26	26	29
Ca mg/l	258	191	269	256	225	216	254
dH	36.1	26.7	37.7	35.8	31.5	30.2	35.6
Fe mg/l	.18	.38	.07	.11	.05	.09	.05
Fe EloF*	0	0	0	0	0	0	0
Mn mg/l	.07	.14	.72	1.22	.05	.05	.16
HCO3 mg/l	69	63	75	84	69	69	74
Cl mg/l	1700	1260	1800	2040	1575	1538	1750
SO4 mg/l	300	210	290	290	260	241	250
NH4 mg/l	.08	.1	.13	.16	.05	.06	.05
NO3 mg/l	1.9	2.38	1.38	.5	.5	1.2	1.49
NO2 mg/l	.06	.03	.05	.15	.01	.02	.03
PO4 ug/l	15	28	16	74	22	16	19
F mg/l	.4	.3	1.2	.5	nd	.5	.3
Na mg/l	940	735	1000	1050	920	850	900
K mg/l	35.2	29	40	40.8	34.8	32	38
susp mg/l	1.91	1.88	3.9	8.8	6.7		

* mg/l Fe after aeration and filtration

TABLE 1. Water analyses of surface waters Page 3

Site Date	Trobbo 850130	Trobbo 850204	Trobbo 850510	Trobbo 850704	Trobbo 850913	Trobbo 851104	Trobbo 860114
Colour	80	80	80	35	35	5	45
Turbidity	7.1	7.6	17	4.1	3.1	2.4	3
Cond mS/m	28	28.8	22.4	45	23	23.5	25
pH	7.1	6.9	6.9	7.2	7.4	7.2	6.9
KMnO4mg/l	37	38	39	36	35	30	32
Ca mg/l	30	31	23	24	23	25	25
dH	4.2	4.3	3.2	3.4	3.2	3.5	3.5
Fe mg/l	.43	.47	.79	.16	.37	.23	.16
Fe EloF*	0	0	.61	0	0	0	0
Mn mg/l	.05	.05	.09	.03	.05	.05	.05
HCO3 mg/l	31	33	22	29	30	30	30
Cl mg/l	33	35	26	24	28	28	28
SO4 mg/l	52	53	36	40	40	41	39
NH4 mg/l	.05	.05	.1	.09	.1	.1	.05
NO3 mg/l	2.61	2.3	3.16	.97	.5	.5	.93
NO2 mg/l	.04	.05	.03	.03	.02	.01	.02
PO4 ug/l	25	21	38	24	17	34	19
F mg/l	.2	.2	.2	.2	.3	.2	.2
Na mg/l	23	23	15.4	17	20	22	20
K mg/l	4.1	4.1	3.4	3.2	20	3.2	3.6
susp mg/l			15.5	5.5	3.5	5	

* mg/l Fe after aereation and filtration

TABLE 1. Water analyses of surface waters Page 4

Site Date	Trobbo 860319	Strömst. 841211	Strömst. 850313	Strömst. 850415	Strömst. 850912	Strömst. 851113	Strömst. 860114
Colour	40	10	45	45	40	25	30
Turbidity	3.1	.53	3.9	4.3	3.1	3.2	2.7
Cond mS/m	26	1200	560	423	490	555	1020
pH	6.9	7.8	7.3	7	7.6	7.6	7.3
KMnO4mg/l	32	27	41	44	33	26	21
Ca mg/l	26	492	271	192	225	381	429
dH	3.6	68.9	37.9	26.9	31.5	53.3	60.1
Fe mg/l	.19	.05	.28	.31	.09	.05	.14
Fe EloF*	0	0	0	0	0	0	0
Mn mg/l	.06	.05	.13	.21	.2	.05	.05
HCO3 mg/l	30	85	71	71	68	66	86
Cl mg/l	30	3840	1650	1200	1460	1660	3155
SO4 mg/l	43	580	267	210	225	260	445
NH4 mg/l	.05	.05	.05	.46	.1	.05	.12
NO3 mg/l	1.86	1.21	2.31	4.03	.5	.5	2.11
NO2 mg/l	.02	.01	.04	.06	.01	.01	.05
PO4 ug/l	28	24	79	25	7	14	29
F mg/l	.3	.4	.3	.3	.4	0	.7
Na mg/l	20	2140	840	680	810	850	1500
K mg/l	4	76	32.5	27	30.8	35.2	65
susp mg/l			6.8	11.3	4	4	8.5

* mg/l Fe after aereation and filtration

TABLE 1. Water analyses of surface waters Page 5

Site Date	Strömst. 860318	Strömst. 860411	Hässle 841211	Hässle 850313	Hässle 850415	Hässle 850704	Hässle 850726
Colour	75	125	160	150	165	30	190
Turbidity	22	27	5.8	8.6	7.3	10	20
Cond mS/m	410	135	9	15.1	9.1	9.8	7.8
pH	7	6.7	6.9	7	6.5	7.3	6.7
KMnO4 mg/l	20	46	92	72	113	69	105
Ca mg/l	190	76	14	28	16	15	11
dH	26.6	10.6	2	3.9	2.2	2.1	1.5
Fe mg/l	.48	.89	1.04	1.4	1.01	1.24	1.59
Fe EloF*	.38	.51	.76	1.06	.79	.72	1.16
Mn mg/l	.14	.09	.05	.06	.08	.07	.04
HCO3 mg/l	70	52	22	52	18	32	18
Cl mg/l	1200	366	7	5	3	3	6
SO4 mg/l	190	82	14	20	14	11	15
NH4 mg/l	.16	.31	.05	.09	.1	.05	.05
NO3 mg/l	4.28	7.5	6.86	3.44	1.51	.5	.5
NO2 mg/l	.05	.08	.02	.06	.03	.04	.03
PO4 ug/l	29	57	10	26	10	75	18
F mg/l	.4	.3	.2	.2	.2	.2	.2
Na mg/l	630	193	3.9	6.2	4	3.5	3.9
K mg/l	27	11.4	.8	1.8	1.4	1.8	1.8
susp mg/l				21	20	28	33.5

* mg/l Fe after aeration and filtration

TABLE 1. Water analyses of surface waters Page 6

Site Date	Hässle 850912	Hässle 851113	Hässle 860114	Hässle 860319	Hässle 860409	Brokulla 841211	Brokulla 850313
Colour	160	170	150	150	150	170	79
Turbidity	5.4	.61	5.2	7.3	22	58	22
Cond mS/m	8	9	9.4	10	8	36.5	29.5
pH	7.2	7.4	6.7	7.1	6.6	6.6	6.9
KMnO4 mg/l	86	119	76	78	74	78	24
Ca mg/l	12	13	14	16	13	53	44
dH	1.7	1.8	2	2.2	1.8	7.4	6.2
Fe mg/l	1.07	.97	.68	1.14	.75	3.54	1.34
Fe EloF*	.65	.83	.62	.96	.48	2.43	.6
Mn mg/l	.04	.05	.05	.08	.05	.42	.22
HCO3 mg/l	26	17	23	30	17	44	68
Cl mg/l	4	4	5	5	3	24	16
SO4 mg/l	9	13	14	13	14	24	57
NH4 mg/l	.1	.06	.11	.05	.07	.15	.61
NO3 mg/l	.5	1.41	1	1.44	2.08	6.32	5.74
NO2 mg/l	.01	.01	.04	.03	.04	.06	.19
PO4 ug/l	18	14	14	19	25	56	68
F mg/l	.2	.2	.2	.2	.1	.4	.4
Na mg/l	3.5	4.2	4.1	4.4	3.5	18	14
K mg/l	1.4	.9	1.4	1.4	1.4	4.4	5.8
susp mg/l	12.5	6	7.5				36

* mg/l Fe after aeration and filtration

TABLE 1. Water analyses of surface waters Page 7

Site	Brokulla	Brokulla	Brokulla	Brokulla	Brokulla	Brokulla	Tegelkäll
Date	850415	850702	850912	860114	860319	860409	841211
Colour	90	50	180	90	90	150	140
Turbidity	44	8.2	24	22	24	67	31
Cond mS/m	29	40	40	35	36	24	24.5
pH	6.7	7.6	7.8	6.7	7.2	6.7	6.2
KMnO4mg/l	48	29	38	37	28	43	66
Ca mg/l	39	56	52	47	49	37	31
dH	5.5	7.8	7.3	6.6	6.9	5.2	4.3
Fe mg/l	1.98	.47	1.07	.63	1.07	2.5	1.29
Fe EloF*	.69	0	.64	.49	.81	2	1.13
Mn mg/l	.25	.11	.18	.29	.22	.09	.25
HCO3 mg/l	40	78	70	54	84	43	31
Cl mg/l	17	30	31	23	23	15	17
SO4 mg/l	65	83	85	69	59	53	68
NH4 mg/l	.39	.05	.2	.67	.37	.24	.11
NO3 mg/l	9.67	1.58	1.3	8.17	5.63	15.2	.96
NO2 mg/l	.05	.04	.15	.13	.06	.11	.03
PO4 ug/l	71	35	75	35	85	81	10
F mg/l	.3	.7	.6	.4	.4	.3	.2
Na mg/l	15.2	22	23.4	19	16	12.9	13
K mg/l	4.7	6.2	6.6	5.8	6.6	5.3	2.4
susp mg/l	74.5	15.5	34	21			

* mg/l Fe after aeration and filtration

TABLE 1. Water analyses of surface waters Page 8

Site Date	Tegelkäll 850313	Tegelkäll 850415	Tegelkäll 850702	Tegelkäll 850726	Tegelkäll 850912	Tegelkäll 860121	Tegelkäll 860319
Colour	100	110	68	77	140	95	95
Turbidity	20	26	9.7	32	18	8.9	12
Cond mS/m	25	23.8	39	46.8	33	17	38
pH	6.5	6.2	7	6.1	6.4	6.4	6.8
KMnO4mg/l	51	58	45	51	80	51	54
Ca mg/l	32	30	49	56	38	22	30
dH	4.5	4.2	6.9	7.8	5.3	3.1	4.2
Fe mg/l	1.13	1.54	.71	1.32	.92	.48	.71
Fe EloF*	.75	1.26	.3	.97	.85	.4	.64
Mn mg/l	.2	.25	.18	.54	.27	.13	.12
HCO3 mg/l	35	16	49	18	23	20	37
Cl mg/l	21	15	32	36	27	10	32
SO4 mg/l	48	58	89	136	87	39	39
NH4 mg/l	.21	.16	.05	.05	.1	.08	.07
NO3 mg/l	4.51	7.74	.5	3.23	1.2	5.09	2.65
NO2 mg/l	.07	.04	.02	.03	.03	.03	.04
PO4 ug/l	36	10	29	18	17	12	17
F mg/l	.2	.2	.4	.5	.3	.2	.2
Na mg/l	17	13.2	26	28.5	22	8.5	17
K mg/l	2.9	2.9	4.1	4.9	4.1	1.8	2.7
susp mg/l	32	43	17.5	39.5	23.5	11.5	

* mg/l Fe after aeration and filtration

TABLE 1. Water analyses of surface waters Page 9

Site Date	Tegelkäll 860411	Nynäs 850702	Nynäs 850912	Nynäs 860114	Nynäs 860319	Nynäs 860409
Colour	150	47	50	40	35	50
Turbidity	7	4	1.99	2.2	2.2	6
Cond mS/m	16.7	13	13	14	15	13
pH	6.2	7.4	7.4	6.9	7	6.6
KMnO4mg/l	56	37	30	29	30	34
Ca mg/l	22	16	16	17	19	17
dH	3.1	2.2	2.2	2.4	2.7	2.4
Fe mg/l	1.66	.13	.12	.1	.15	.31
Fe EloF*	1.46	0	0	0	0	0
Mn mg/l	.08	.03	.06	.05	.05	.05
HCO3 mg/l	15	23	25	25	25	24
Cl mg/l	10	8	9	10	10	10
SO4 mg/l	38	26	24	27	26	24
NH4 mg/l	.13	.06	.1	.05	.05	.05
NO3 mg/l	10.6	.79	.5	.93	1.81	2.32
NO2 mg/l	.08	.03	.01	.02	.02	.02
PO4 ug/l	41	15	11	21	29	20
F mg/l	.2	.1	.2	.2	.2	.1
Na mg/l	8.8	6.2	7.7	7.9	8.1	7.6
K mg/l	3.6	2.3	1.8	2.3	2.2	2.3
susp mg/l		11.5	1	.5		

* mg/l Fe after aeration and filtration

TABLE 1. Water analyses of surface waters.
Data for 100 m deep borehole B6N.

Date	800616	800709	800917	801028	801210	801229	810224
Colour							
Turbidity							
Cond mS/m	3	3	3.3	3.5	2.45	3.6	3.8
pH	7.2	6.6	6.5	6.7	6.4	6.4	7
KMnO4mg/l	20	23	27	27	32	33	28
Ca mg/l	31	43	30	34	26	37	44
dH							
Fe mg/l	.07	.06	.07	.07	.18	.11	.15
Fe EloF*							
Mn mg/l	.28	.29	.3	.33	.1	.36	.41
HCO3 mg/l	195	200	218	230	133	227	256
Cl mg/l	12	11	12	12	10	12	12
SO4 mg/l	29	29	29	30	34	29	26
NH4 mg/l	.04	.04	.04	.05	.01	.01	.02
NO3 mg/l	.03	.04	.03	.03	.39	.01	<.01
NO2 mg/l	<.01	<.01	<.01	<.01	<.01	<.01	<.01
PO4 ug/l	20	10	10	10	10	10	10
F mg/l	.3	.26	.22	.23	.12	.24	.27
Na mg/l	39	40	43	43	26	45	39
K mg/l	2.8	2.9	2.9	3.7	2.4	2.8	2.9
susp mg/l							

* mg/l Fe after aeration and filtration

TABLE 2. Iron species and saturation state.
Influence of added organic complex former.

					log(IAP/K)		
	Fe+2	Fe+3	Fe(OH)2+	FeORGC	Fe(OH)3	Hematite	Goethite
Strömstugan							
0 mg/l*	1e-6	3.7e-13	7.6e-6	N/A	4e-7	17.20	6.20
10 mg/l*	1.1e-7	4.1e-14	8.3e-7	8.1e-6	4.4e-8	15.30	5.20
Hässle							
0 mg/l*	9.8e-7	2.9e-13	7.3e-6	N/A	3.3e-7	17.00	6.10
20 mg/l*	1e-8	3e-15	7.5e-8	8.5e-6	3.4e-9	13.10	4.10
Brokulla							
0 mg/l*	3.5e-6	9.6e-13	3e-5	N/A	1.7e-6	18.50	6.80
20 mg/l*	1.6e-6	4.3e-13	1.4e-5	2e-5	7.5e-7	17.80	6.40
Tegelkälla							
0 mg/l*	6.8e-6	5.3e-12	1.9e-5	N/A	3.3e-7	17.00	6.10
20 mg/l*	1.6e-6	1.3e-12	4.5e-6	1.2e-5	8e-8	15.80	5.50

* Amount of added organic complex former

TABLE 3. Comparison of field and laboratory measurements of pH and conductivity.

	pH			Conductivity, mS/m		
	Field	Studsvik	SLL	Field	Studsvik	SLL
850313						
Strömstugan	7.4	7.5	7.3	328	N/A	560
Hässle	6.8	7.1	7	11.9	N/A	15.1
Brokulla	7.4	7.1	6.9	38.3	N/A	29.5
Tegelkälla	7.5	6.8	6.5	22.2	N/A	25
Nynäs	7.7	7.1	6.8	11.6	N/A	16
851113						
Strömstugam	6.2	7.8	7.6	128	640	555
Hässle	7.3	6.9	7.4	20	9.6	9
Brokulla	7.4	7	6.7	94	44	35
Tegelkälla	6.7	6.3	6.4	69	35	17
Nynäs	6.8	7.3	6.9	31	14	14
860113						
Strömstugan	6.5	7.6	7.3	680	N/A	1020
Hässle	6.8	7.1	6.7	8	N/A	9.4
Brokulla	6.3	7.1	6.7	25.4	N/A	35
Tegelkälla	6.6	6.5	6.4	12.4	N/A	17
Nynäs	6.4	7.2	6.9	10.3	N/A	14

TABLE 4. Comparison of analyses performed at SLL and SMHI.

	Strömstugan		Hässle		Brokulla	
	SLL	SMHI	SLL	SMHI	SLL	SMHI
pH	7.6	7.5	7.4	6.5	6.7	6.6
Cond. mS/m	555	566	9	8.5	35	37.9
Colour	25	25	170	180	90	200
Turbidity	3.2	4.5	.61	7.4	22	56
HCO3- mg/l	66	63.9	17	16	54	50.9
SO4-2 mg/l	260	296	13	16	69	84
Cl- mg/l	1660	1580	4	4.1	23	25
NO3- mg/l	<.5	.008	1.41	1.6	8.17	12.3
NO2 mg/l	<.01	<.005	.01	<.005	.13	.011
PO4-2 mg/l	.014	.001	.014	.01	.035	.15
NH4 mg/l	<.05	.013	.06	.01	.67	.32
Ca mg/l	381	55.8	13	7.6	47	29.4
K mg/l	35.2	38	.9	1.11	5.8	6.1
Na mg/l	850	900	4.2	3.5	19	18.6
Fe mg/l	<.05	<.05	.97	1.07	.63	2.3
Mn mg/l	<.05	<.05	<.05	.05	.29	.33

TABLE 5. Porewater from sediment core from Lake Trobbofjärden.

Depth cm	pH	Cl- ppm	Water %	Organic %
lake water	7.1-7.4	27	100	
0 - 2	7.1	55	90	9.8
2 - 4	7.3	71	72	
4 - 6	7.4	81	69	7.5
6 - 8	7.3	81	73	
8 - 10	7.3	92	71	10
10 - 12	7.4	110	67	
12 - 14	7.4	130	66	9.4
14 - 16	7.9	140	64	
16 - 18	7.6	160	65	8.8
18 - 20	7.6	180	67	
28 - 30	7.7	360	65	13.1
38 - 40	7.8	650	66	
48 - 50	7.9	1000	73	17.3
58 - 60	8.2	1700	75	
68 - 70	8.3	2300	73	14.1
78 - 80	8.3	2300	70	
88 - 90	8.3	2800	56	8
98 - 100	8.2	2800	62	
108 - 110	8.3	2900	65	13.3

TABLE 6. Porewater from sediment core from Lake Sibbofjärden.

Depth cm	pH	Cl- ppm	Water %
lake water	7.3	*	100
0 - 2	7.4	2000	86
2 - 4	7.2	2000	82
4 - 6	7.2	2200	78
6 - 8	7.3	2300	74
8 - 10	7.5	2500	74
10 - 12	7.6	2600	75
12 - 14	7.6	2700	75
14 - 16	7.6	3200	74
16 - 18	7.6	3300	75
18 - 20	7.8	3300	74

* varies depending on depth and site. Usually 1000 - 2000.

TABLE 7. Porewater from sediment core from Lake Sibbofjärden.

Depth cm	pH	Cl- ppm
lake water	7.3	*
0 - 2	8	2250
2 - 4	8	2450
4 - 6	8.1	2450
6 - 8	8.1	2350
8 - 10	8.1	2450
19 - 21	8.1	2450
30 - 32	8.1	2550
41 - 43	8.1	2450
52 - 54	8.1	2350
63 - 65	8.1	2550
74 - 76	8.1	2660
85 - 87	8.1	2550
96 - 98	8.1	2450
107 - 109	8.2	2660
118 - 120	8.3	2660
129 - 131	8.3	2550

* varies depending on depth and site. Usually 1000 - 2000.

TABLE 8. Porewater from sediment core from Lake Käxlan.

Depth cm	pH	Cl- ppm
lake water	6.9	3
0 - 2	6.3	10
2 - 4	6.5	7
4 - 6	6.5	9
6 - 8	6.5	9
8 - 10	6.5	11
10 - 12	6.6	12
12 - 14	6.7	12
14 - 16	6.6	17
16 - 18	6.5	17
18 - 20	6.4	17

TABLE 9. Porewater from sediment core from Lake Frillingen.

Depth cm	pH	Cl- ppm
lake water	6.7	5
0 - 2	6.6	7
2 - 4	6.7	8
4 - 6	6.8	6
6 - 8	6.8	6
8 - 10	6.8	5
10 - 12	6.8	7
12 - 14	6.8	7
14 - 16	6.9	10

TABLE 10. Porewater from sediment core from Lake Rundbosjön.

Depth cm	pH	Cl- ppm	Water %
lake water	6.7	15	100
0 - 2	6.8	21	84
2 - 4	6.8	26	77
4 - 6	7.1	26	69
6 - 8	7	29	65
8 - 10	7.1	36	70
10 - 12	7.1	43	68
12 - 14	7	53	74
14 - 16	7	79	69
16 - 18	7	91	71
18 - 20	7.1	91	73
28 - 30	7.1	200	70
38 - 40	7.2	490	N/A
48 - 50	N/A	N/A	N/A
58 - 60	7.3	708	66
68 - 70	7.6	1150	67
78 - 80	7.6	1590	70
88 - 90	7.6	2040	65

TABLE 11. Platinum electrode potential in sediment core from Lake Sibbofjärden

Depth, cm	"Eh" mV
lake water	150
0	-33
2	9
4	27
6	-203
8	-367
10	-291
12	-324
14	-388
24	-412
38	-360
48	-370
58	-360

TABLE 12. Platinum electrode potential in sediment core from Lake Rundbosjön.

Depth, cm	"Eh" mV
lake water	140
1	-379
3	-374
5	-362
7	-358
9	-131
11	-323
21	-339
31	-329
41	-328

TABLE 13. Platinum electrode potential in sediment core from Lake Trobbofjärden.

Depth, cm	"Eh" mV
lake water	195
0	56
1	-285
2	-312
3	-325

TABLE 14. Sorption of radionuclides in sediment core from Lake Sibbofjärden.

Depth	pH	Cl	Kd, m3/kg				
cm		ppm	Sr-85	I-131	Cs-134	Eu-152	Am-241
lake water	*	*					
0 - 2	7.4	1980	.012	.023	5.86	13.1	12.5
2 - 4	7.2	1980	.011	.157	18.9	86	5.9
4 - 6	7.2	2150	.012	.16	2.8	4.4	2
6 - 8	7.3	2250	.01	.001	N/A	11.7	8.8
8 - 10	7.5	2450	.008	.0006	1.7	5.7	17.7
10 - 12	7.6	2550	.008	.0008	3.24	2	4.8
12 - 14	7.6	2660	.009	.0002	.28	3.7	4.8
14 - 16	7.6	3160	.009	.0003	.46	4.2	5.2
16 - 18	7.6	3290	.009	.0004	.44	4.2	1.9
18 - 20	7.8	3290	.007	.0008	.64	4.6	3.4

* pH and Cl varies depending on depth and site.
Typical ranges: pH 7.2 - 7.8, Cl 1000 - 2500 ppm.

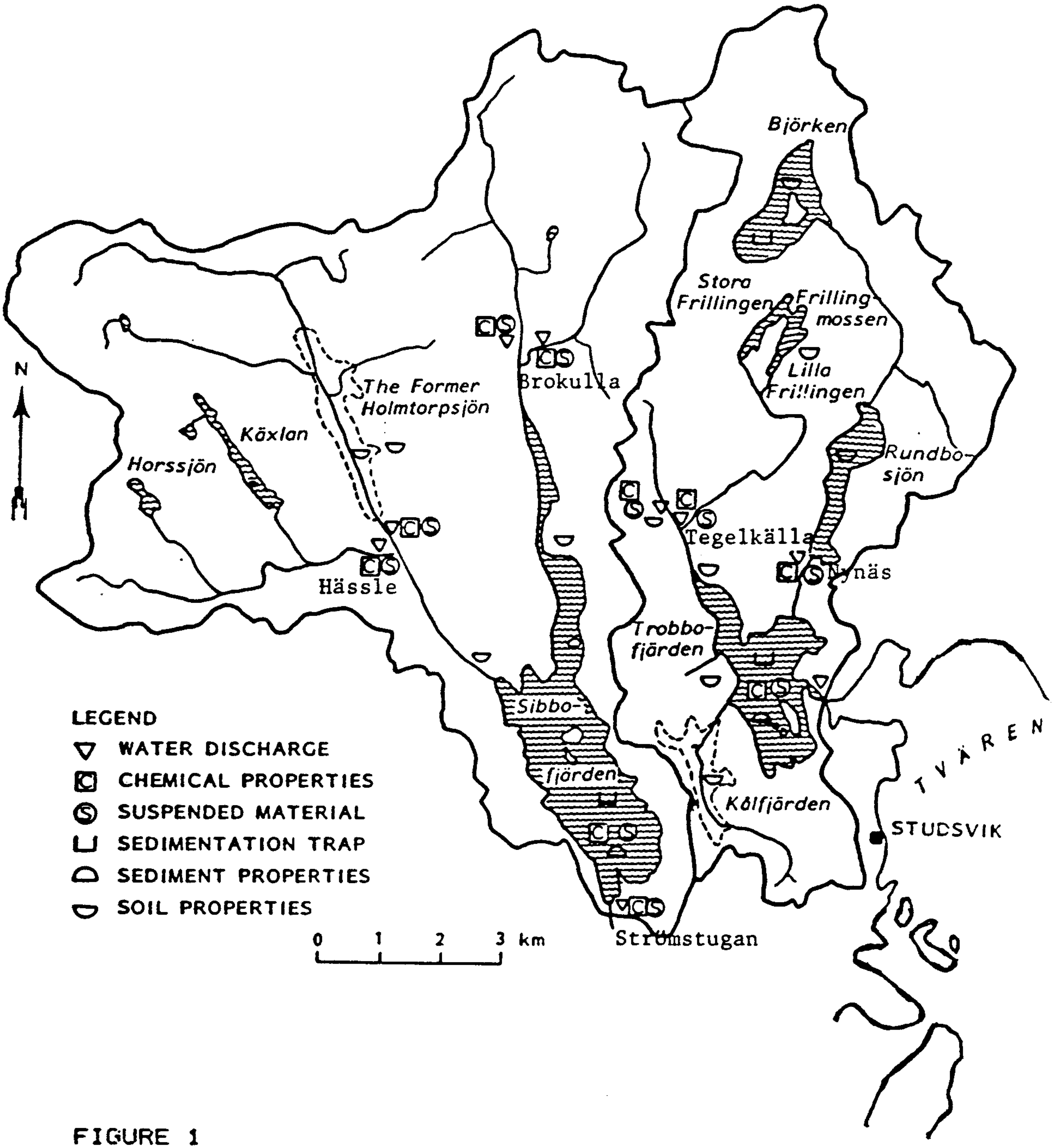


FIGURE 1
THE SIBBO- AND TROBBOFJÄRDEN AREA

Figure 2. Na vs Cl
All sites.

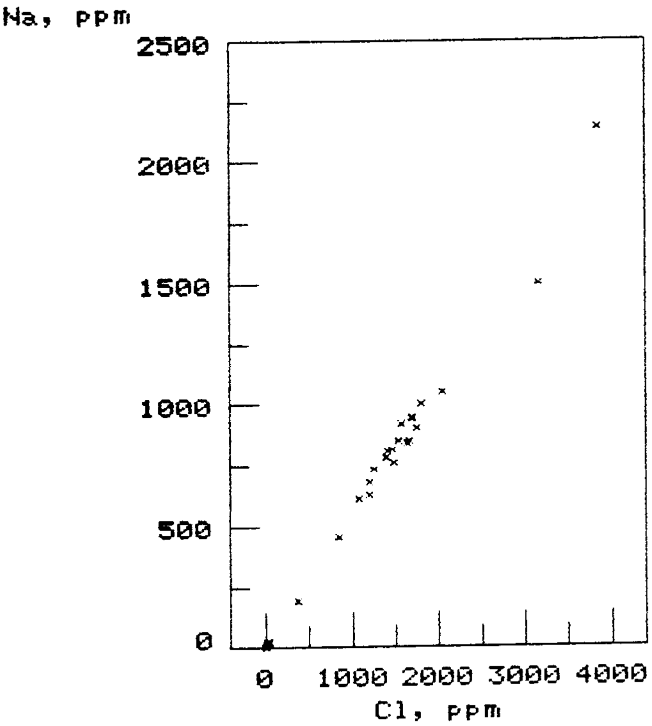


Figure 3. K vs Cl
All sites.

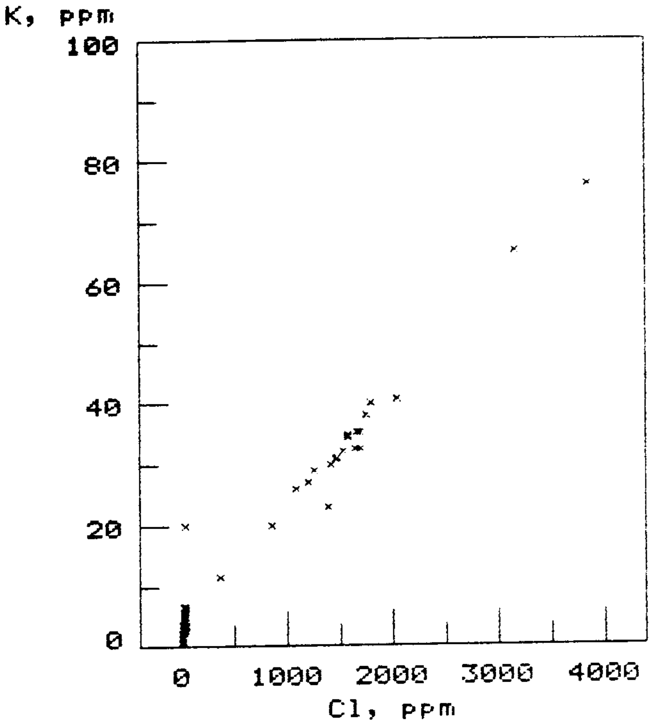


Figure 4. Ca vs Cl
All sites

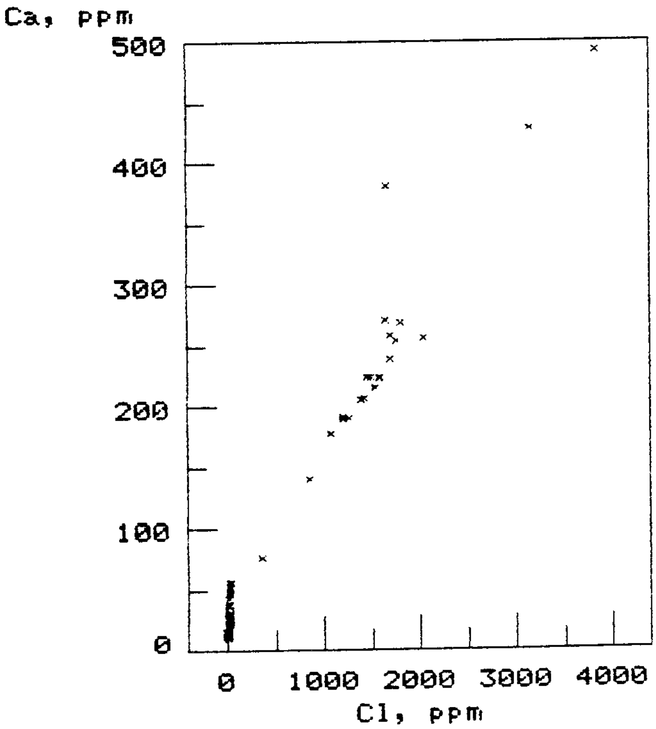


Figure 5. Ca vs HCO3-
All sites.

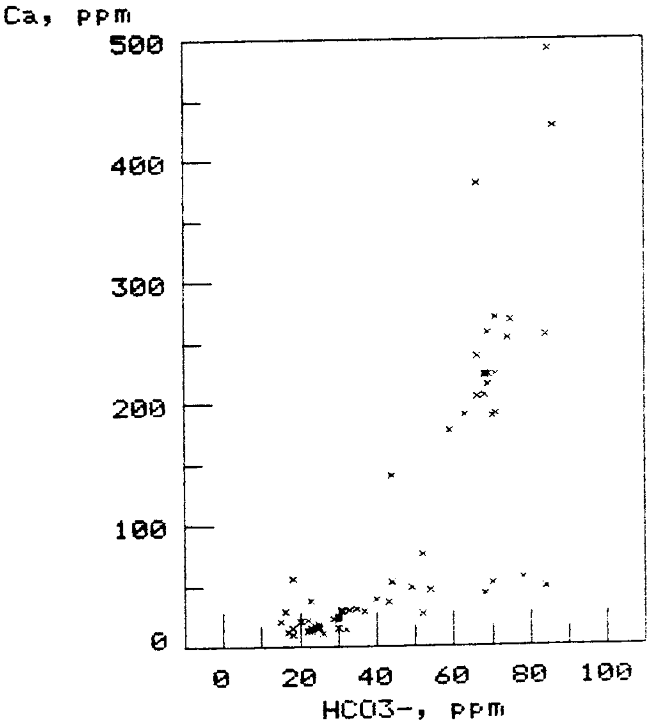


Figure 6. Lake Sibbofjärden, 2 m
HCO3- vs pH

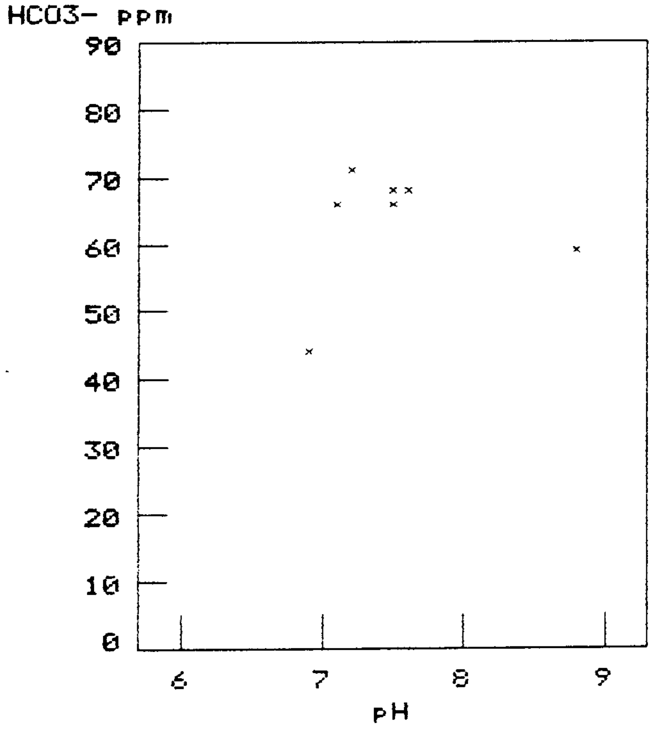


Figure 7. Lake Sibbofjärden, 6 m
HCO3- vs pH

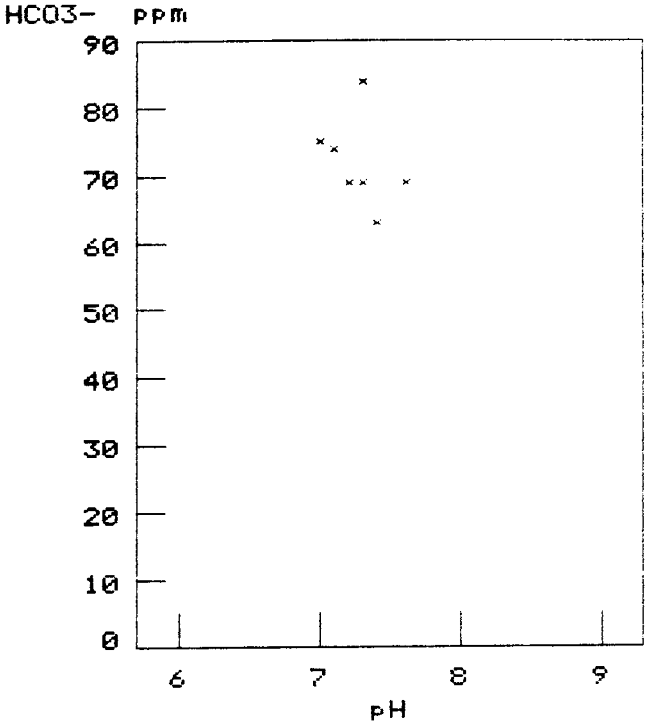


Figure 8. Lake Trobbofjärden
HCO3- vs pH

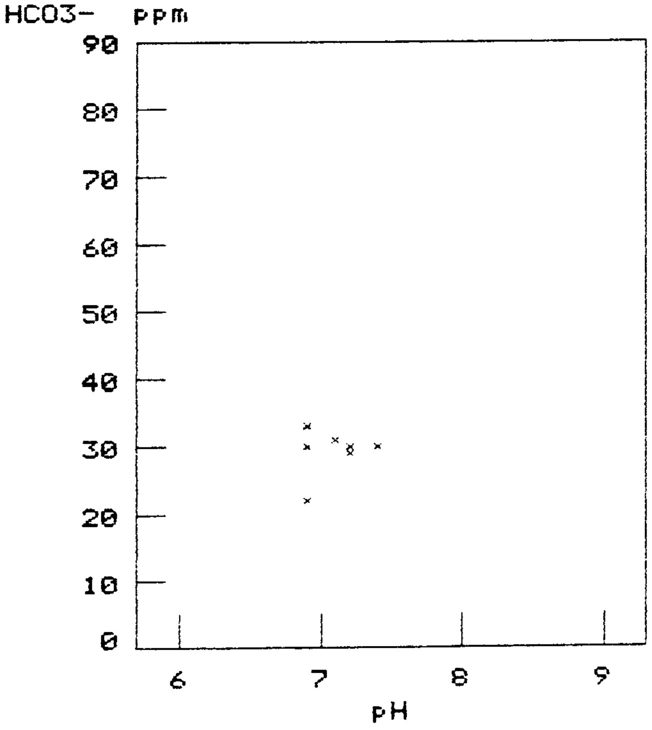


Figure 9. Strömstugan
HCO3- vs pH

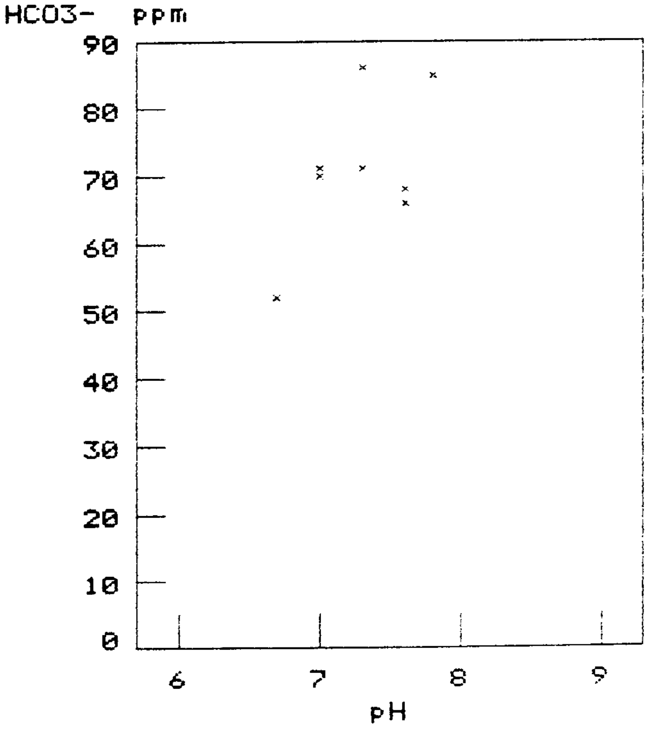


Figure 10. Hässle
HCO3- vs pH

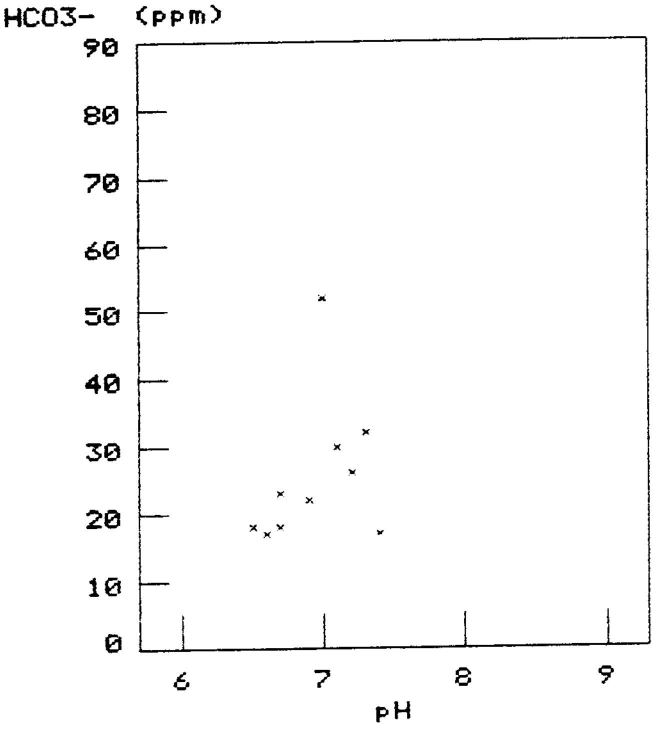


Figure 11. Brokulla
HCO3- vs pH

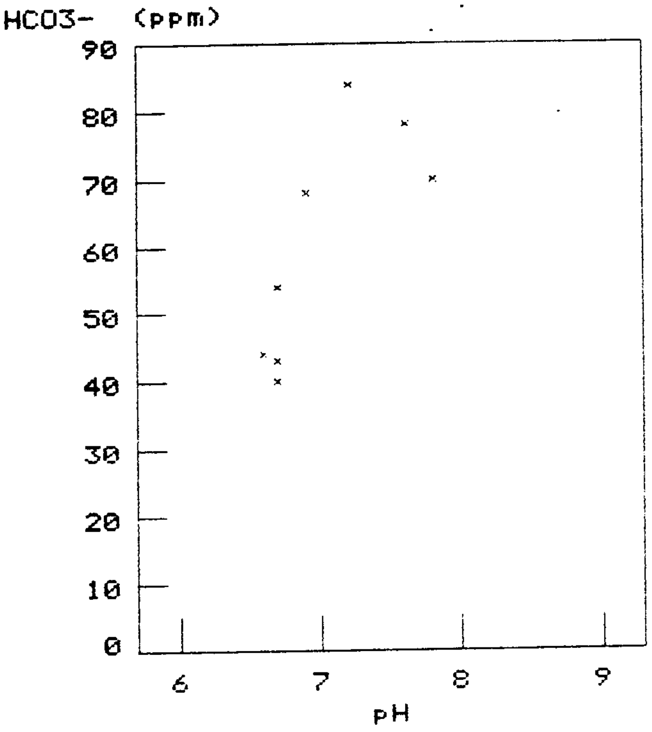


Figure 12. Tegelkälla.
HCO3- vs pH

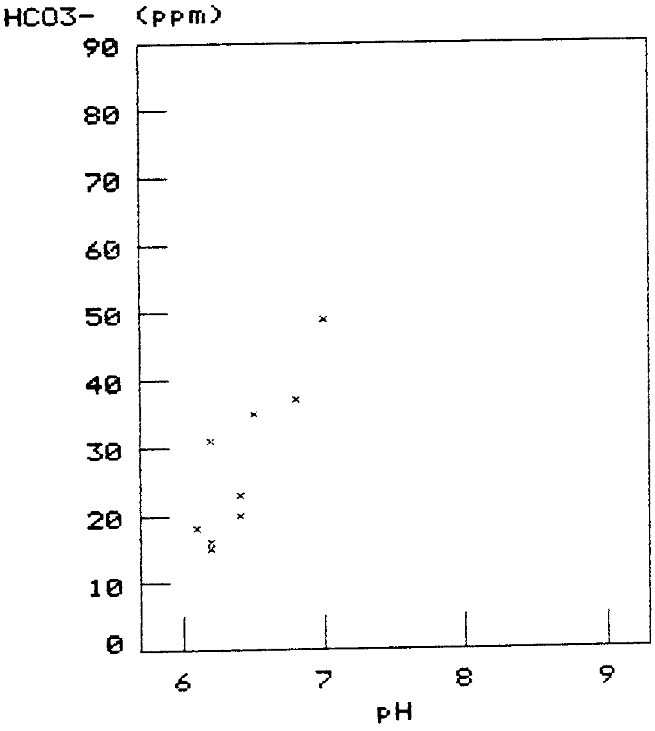


Figure 13. Nynäs.
HCO3- vs pH

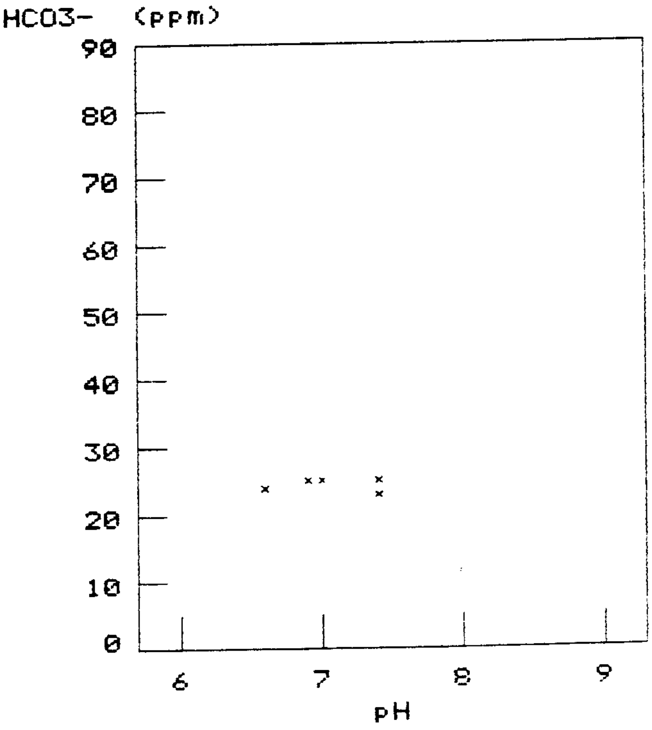


Figure 14. Total Fe vs colour.

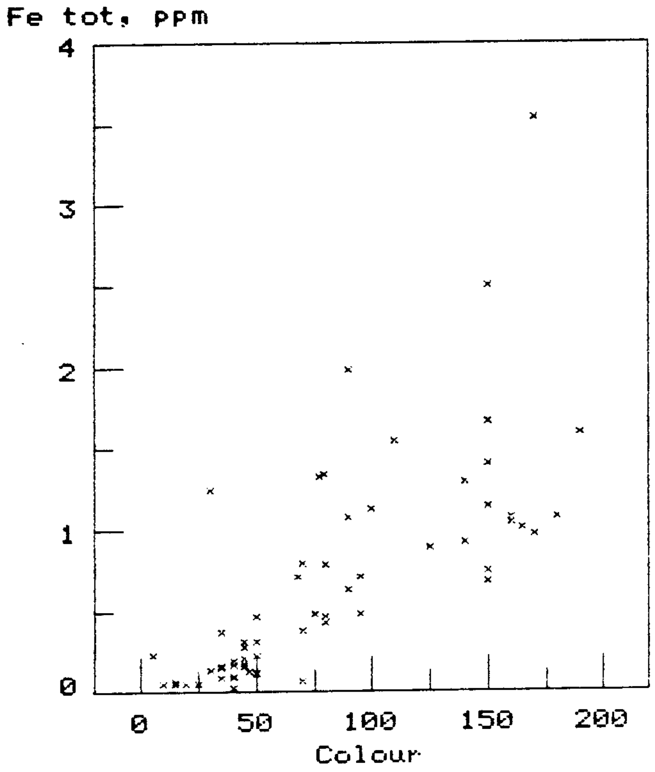


Figure 15. Dissolved Fe (ELoF) vs colour.

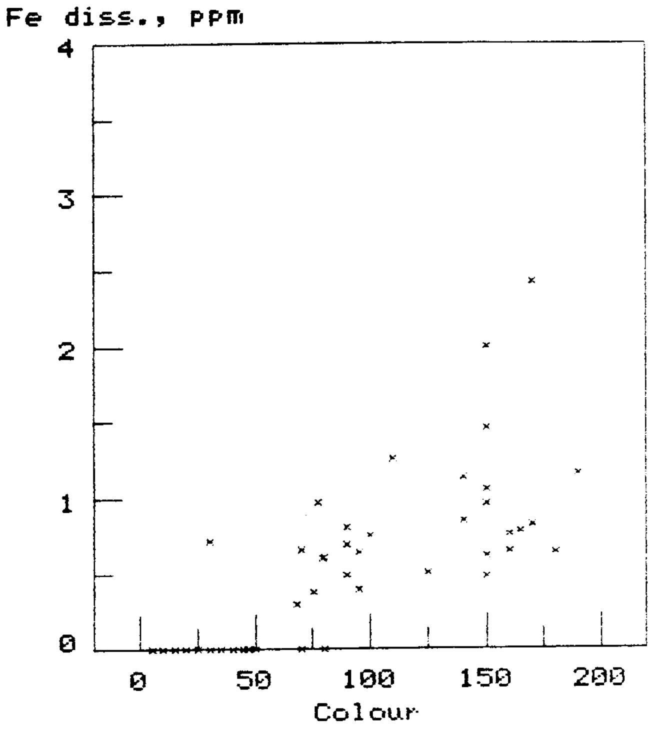


Figure 16. Particulate Fe vs colour.

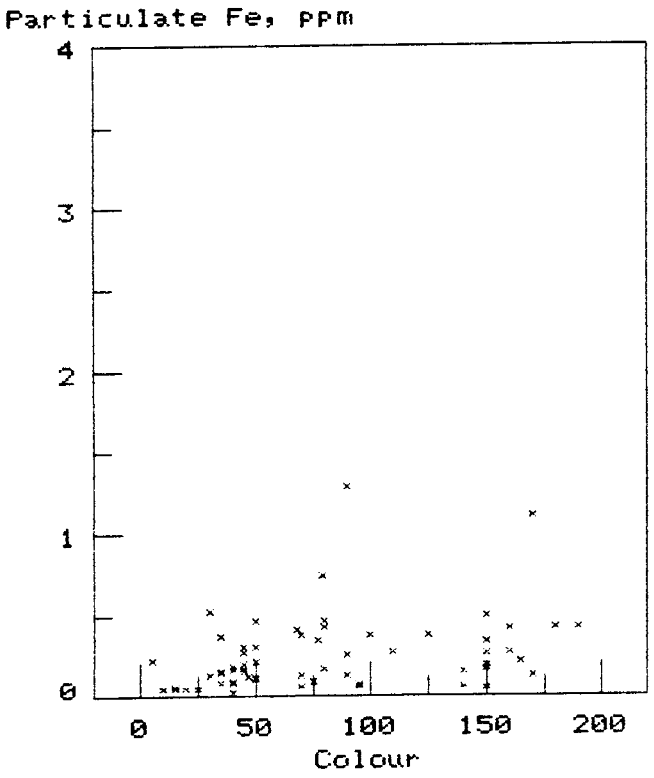


Figure 17. Total Fe vs KMnO4

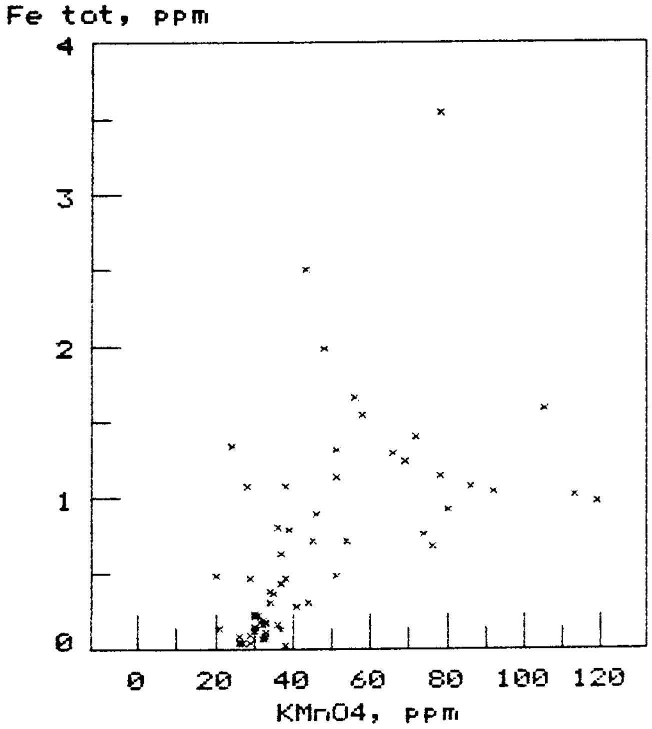


Figure 18. Total Fe vs suspended matter

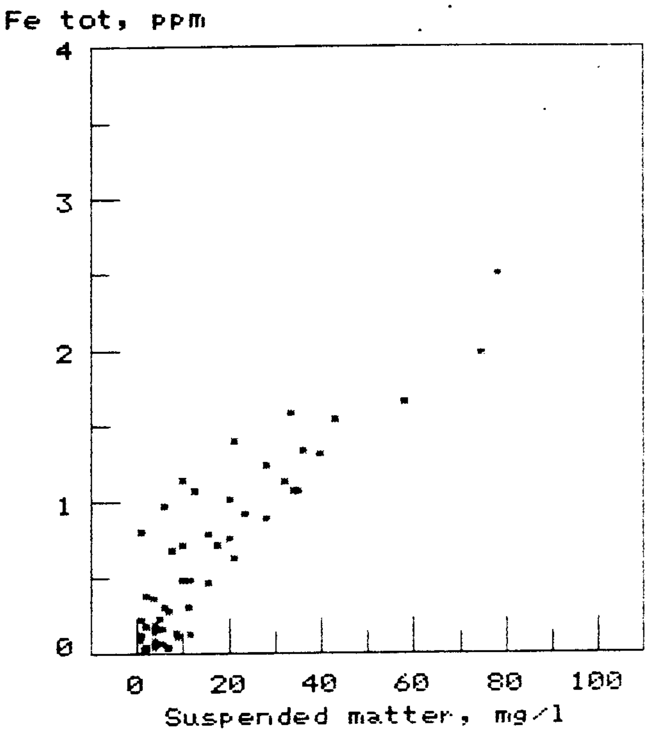


Figure 19. Particulate Fe vs KMnO4

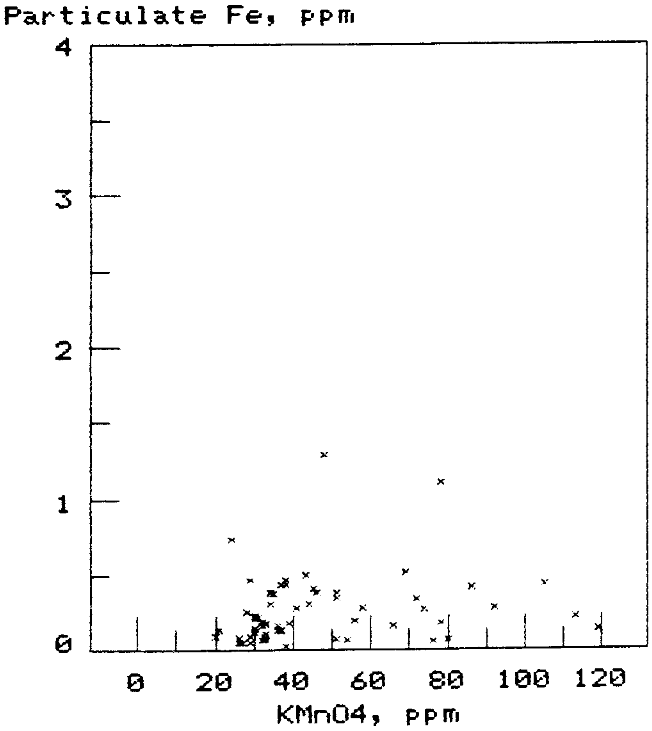
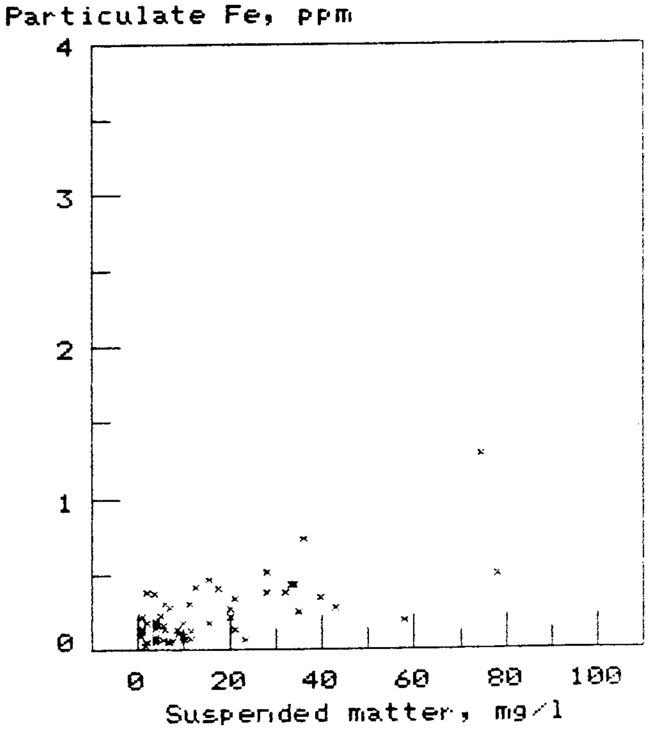


Figure 20. Particulate Fe vs suspended matter



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Roger Thunvik, Royal Institute of Technology, Stockholm
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Kirk Nordstrom[2]
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[2]U S Geological Survey, Menlo Park, California
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Eva-Lena Tullborg[2]
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[2]Swedisch Geological Company, Göteborg
[3]Royal Institute of Technology, Stockholm
[4]Studsvik Energiteknik AB, Nyköping
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Leif Nordgren
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[1]Swedish Geological Company, Uppsala
[2]Chalmers University of Technology, Göteborg
[3]Studsvik Energiteknik AB, Nyköping
[4]Swedish Geological Company, Göteborg
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