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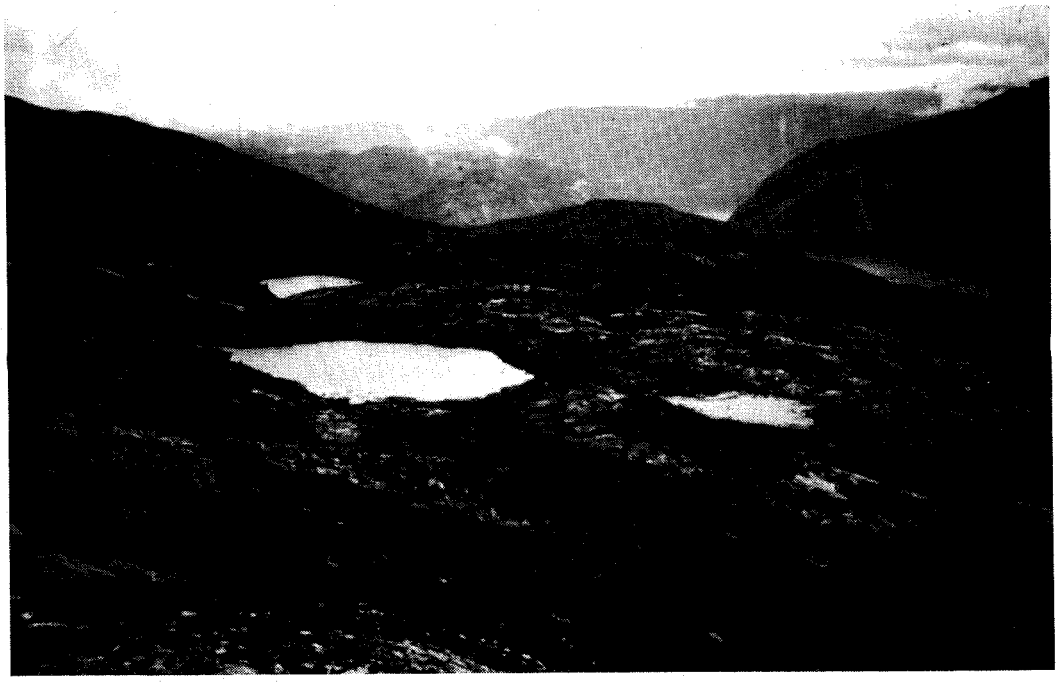
Acid Rain Research

REPORT 18/1989

Soil Chemistry 1983-86 at the RAIN Project Catchments



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Abstract: The aim of the RAIN project is to explain the effects of changed acid deposition on soils and waters. This report presents results from chemical and physical analyses of soil samples collected yearly 1984-86 at the RAIN project catchments at Sogndal and Risdalsheia. Estimates of historical weathering rates based on total elemental analysis of soil and bedrock are 295 and 12 meq/m^2/yr at Sogndal and Risdalsheia, respectively. Of the key chemical parameters measured only adsorbed sulfate shows statistically significant changes over the past 3 years that can be linked to the changed acid deposition. The pools of exchangeable base cations are too large to be significantly affected over only 3 years.

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Soil Chemistry 1983-86 at the RAIN Project Catchments

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November 1989

INTRODUCTION

The aim of the RAIN project (Reversing Acidification In Norway) is to explain the effects of changed acid deposition and to elucidate and quantify key processes in acidification and deacidification of soils and waters (Wright, Lotse & Semb 1988). These processes include:

- Sulfate adsorption by soils on addition of sulfuric acid
- Sulfate desorption as a result of decreased acid deposition
- Changes of the ion-exchange complex in connection with acidification and deacidification
- Release of aluminum
- Accumulation or release of nitrogen
- Production and dissociation of organic acids
- Historical and present-day weathering rates

Among the questions to be addressed are:

- How much will accumulated sulfur and sulfate desorption delay the recovery of runoff waters when acid deposition is decreased?
- How rapidly will soil and water recover after a major reduction in acid deposition?
- How much do weathering and ion exchange contribute to the recovery of soil and water?
- To what extent are soil changes reversible?

Answers to these questions are of paramount importance in developing mathematical models to describe and predict future consequences of changes in acid deposition. They are also central for decisions concerning policies and measures for environmental protection.

As an integral part of the RAIN project soil chemical and physical analyses are conducted yearly on representative soil samples collected at 3 of the 4 catchments at Sogndal and the 3 catchments at Risdalsheia. This report presents the results of

analyses for soil samples collected 1984, 1985, and 1986. Lotse and Otabbong (1985) give data for 1983, as well as sampling and analytical methods. In addition we summarize here calculations of historical weathering rates at Sogndal and Risdalsheia obtained from chemical analyses of soil and bedrock.

MATERIALS AND METHODS

Materials and methods have been described by Lotse and Otabbong (1985). We have made several modifications of methods, however, and these modifications are described below.

Soil pH

The pH of soil samples collected 1983 was measured in a 1:1 w/v soil/water or soil/1M KCl suspension. It was found, however, that for peaty samples the 1:1 w/v ratio was too narrow to be practicable. For samples collected 1984 and later the ratio was changed to 1:1 v/v. No significant difference in pH values was found using 1:1 w/v as compared to 1:1 v/v ratios.

Exchangeable (KCl) acidity, exchangeable aluminum and hydrogen

The exchangeable (KCl) acidity of soil samples collected 1983 was determined by titrating the KCl extract with 0.1M NaOH to a permanent pink endpoint using phenolphthalein as an indicator. Titration curves showed that some extracts had a buffer range between pH 7 and 8. This indicated that aluminum was titrated to form the aluminate ion, $Al(OH)_4^-$. Because the buffering of aluminum usually is described by the equations:

$$Al^{3+} + 3OH^- = Al(OH)_3$$
$$Al(OH)_3 + 3H^+ = Al^{3+} + 3H_2O$$

samples collected 1984 and later were titrated to pH 7.0 using an automatic titrator.

Exchangeable H^+ was originally obtained by subtracting exchangeable Al (assumed to have a 3^+ charge) from the exchangeable (KCl) acidity (Lotse & Otabbong 1985). However, titration of solutions containing HCl and $AlCl_3$ in various combinations showed that H^+ and Al species could be determined from the inflection point of the titration curve. Knowing the molar Al concentration as determined by atomic absorption spectrophotometry (AA), it was then possible to calculate the charge of Al species. The relationships between exchangeable acidity pH 7 and exchangeable acidity pH 8, exch. H^+ pH 7 and exch. H^+ pH 8, and exch. Al pH 7 and exch. Al pH 8 for samples collected 1983 are shown in Figures 1 to 6.

Cation exchange capacity at pH 7 (CEC pH 7)

CEC pH 7 was originally determined by Ca^{2+} saturation, removal of free salt, and replacement of adsorbed Ca^{2+} by NH_4^+ (Lotse & Otabbong 1985). The main problem with this method is connected with the removal of free salt, and the problem appears to be more serious for organic soils than for mineral soils. Soil samples tend to disperse after a few washings with water. Methanol or isopropyl alcohol is then used for further washings to avoid dispersion and loss of soil colloids. Three problems are inherent in this procedure: 1) the thickness of the electric double layer decreases when alcohol is added; 2) some exchangeable cations are removed by hydrolysis; and 3) some organic matter with adsorbed cations is dissolved and discarded with washings.

To minimize problems 2) and 3), the number of washings was originally limited to 5. However, there was some uncertainty whether free salt was effectively removed by 5 washings, especially from organic soils. A small modification of the procedure was therefore made in analyzing samples collected 1984-1986. After saturating the samples with Ca^{2+} using a 0.5M $Ca(OAc)_2$-pH 7 solution, one treatment with a 0.5M $CaCl_2$ solution was given. The samples were then leached with water and methanol until a test for chloride was negative.

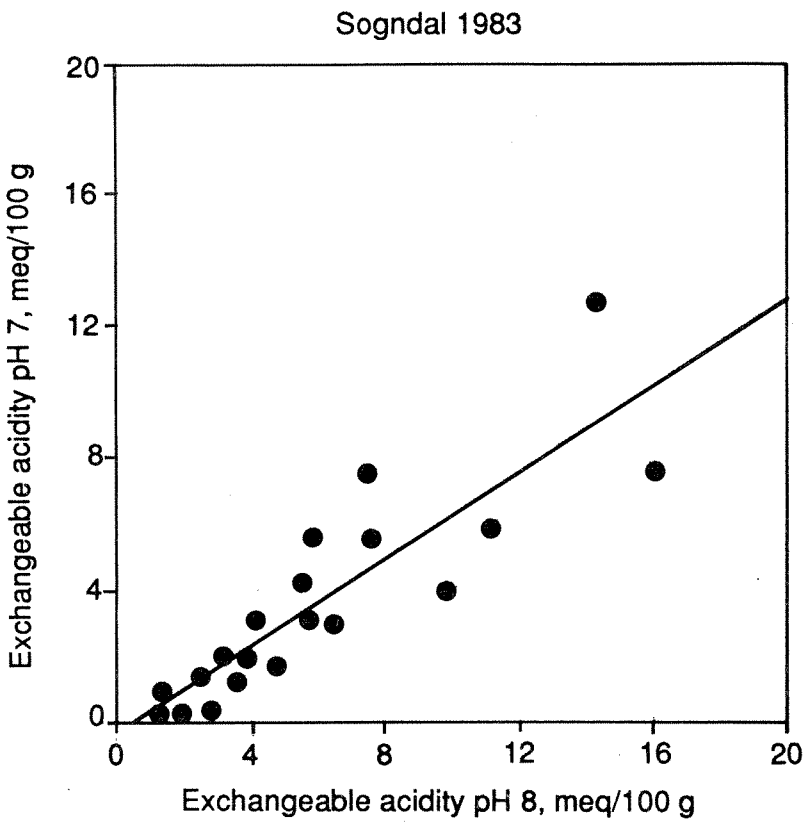

Fig. 1. Relationship between exchangeable acidity pH 7 and exchangeable acidity pH 8, Sogndal 1983. The least-squares regression is $y = -0.26 + 0.66\ x$, with $r^2 = 0.75$, and $n = 20$.

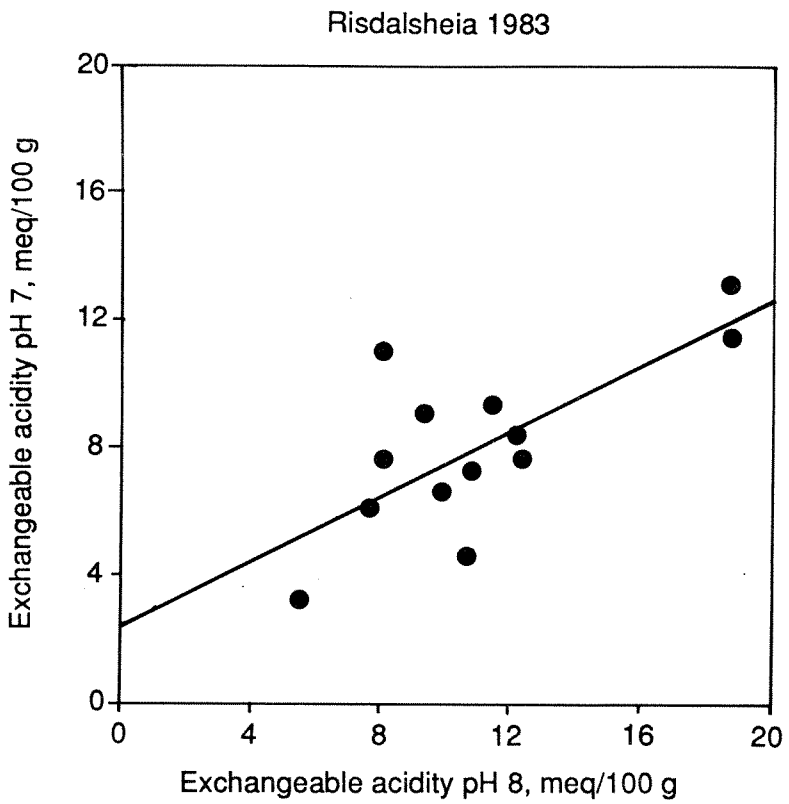

Fig. 2. Relationship between exchangeable acidity pH 7 and exchangeable acidity pH 8, Risdalsheia 1983. The least-squares regression is $y = 2.42 + 0.52\ x$, with $r^2 = 0.54$, and $n = 13$.

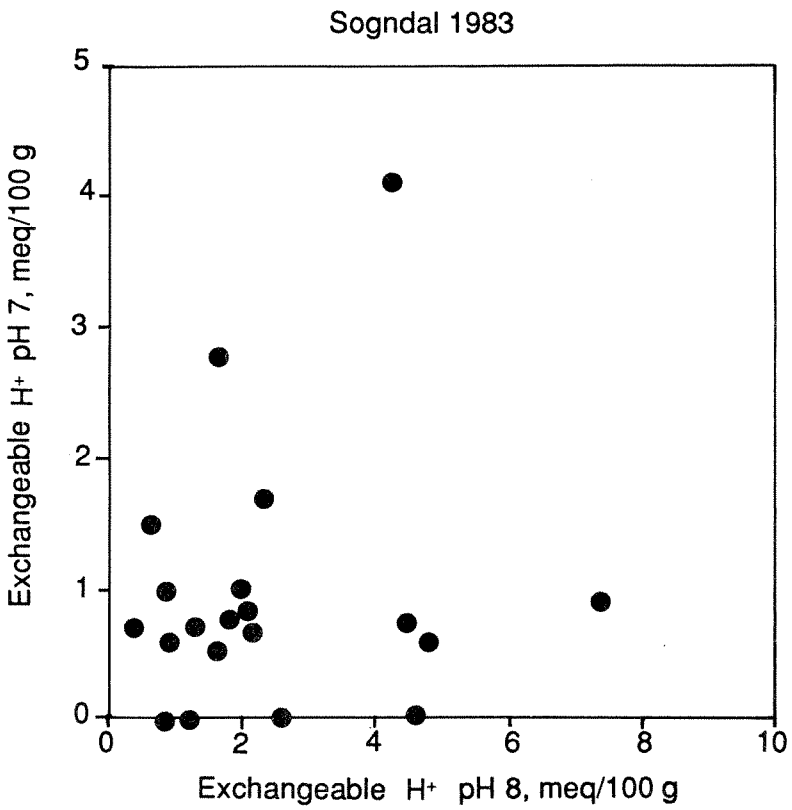

Fig. 3. Relationship between exchangeable H^+ pH 7 and exchangeable H^+ pH 8, Sogndal 1983. The least-squares regression is not significant.

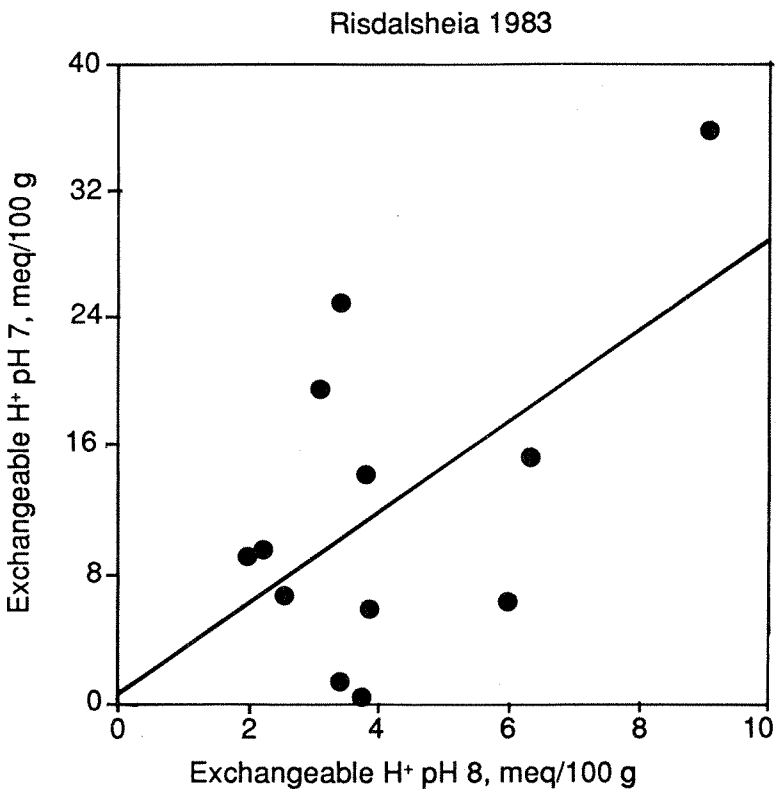

Fig. 4. Relationship between exchangeable H^+ pH 7 and exchangeable H^+ pH 8, Risdalsheia 1983. The least-squares regression is $y = 0.09 + 0.28\ x$, with $r^2 = 0.31$, and $n = 13$.

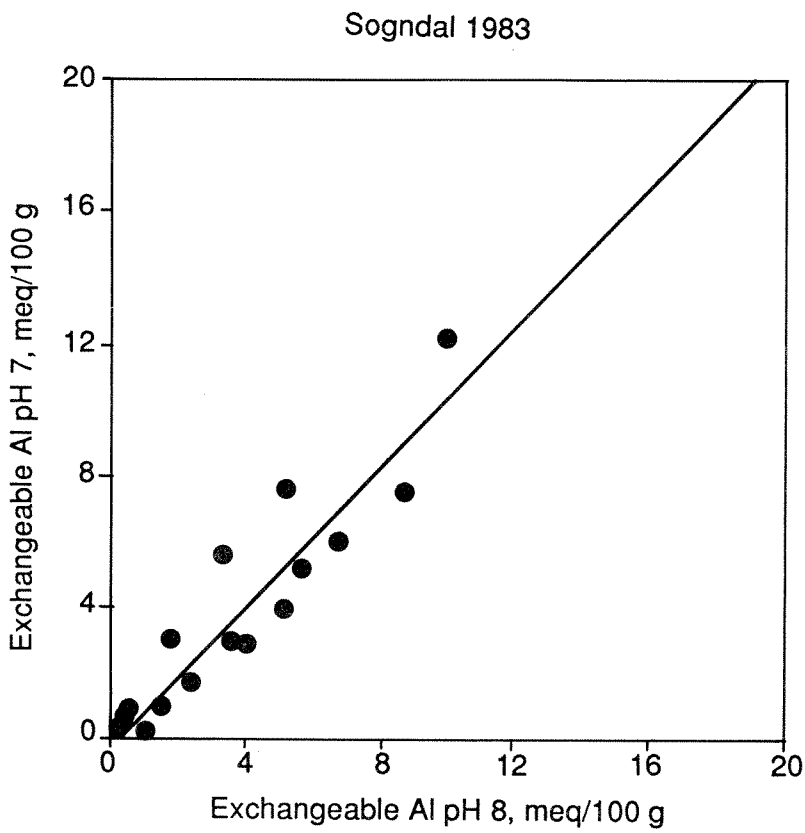

Fig. 5. Relationship between exchangeable Al pH 7 and exchangeable Al pH 8, Sogndal 1983. The least-squares regression is $y = -0.24 + 1.07\ x$, with $r^2 = 0.87$, and $n = 20$.

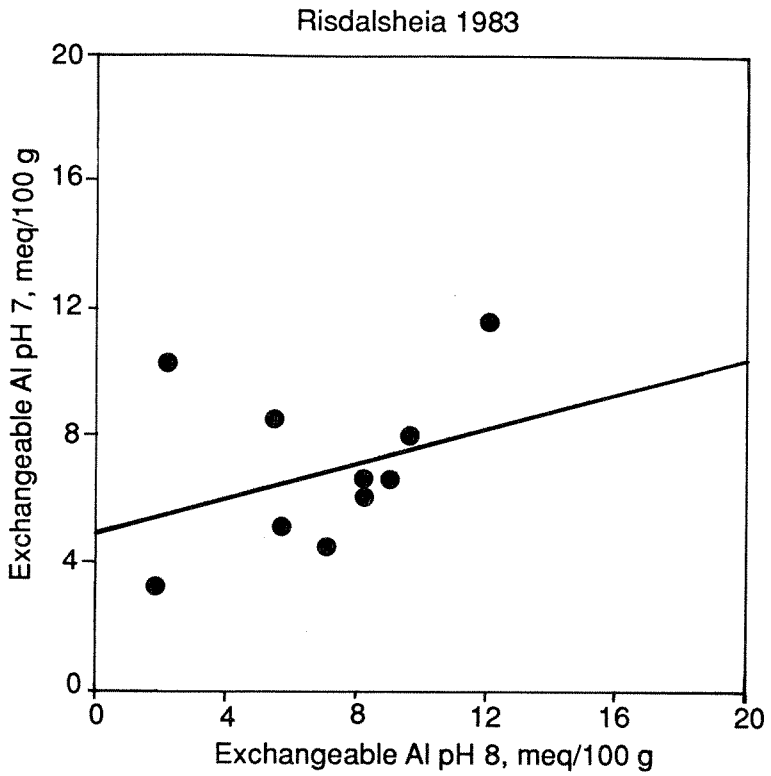

Fig. 6. Relationship between exchangeable Al pH 7 and exchangeable Al pH 8, Risdalsheia 1983. The least-squares regression is not significant.

The CEC values obtained by the modified method were lower than those obtained by the original method, as could be expected. The question was whether the results were a true measure of the CEC. Based on the above discussion, a reasonable assumption was that the values were too low. Because the CEC at the pH of the soil was determined as the sum of exchangeable cations, it was then decided that the CEC at pH 7 should also be determined as the sum of cations. Exchangeable H^+ was determined by titrating the 1M NH_4OAc (pH 7.0) solution with 1M HCl, measuring pH of the NH_4OAc extract, and reading exchangeable H^+ from the titration curve. Exchangeable H^+, sum of cations (CEC) and base saturation determined by this method for samples from Risdalsheia are given in Table 1. The CEC (pH 7.0) values calculated as the sum of cations are higher than those reported earlier (Lotse & Otabbong 1985) and higher than those given in the Appendix Tables 1, 3 and 5. It is believed that the sum of exchangeable cations is the best measure of the CEC of acid soils with high organic matter content, and this measure will be used in the future.

Exchangeable cations

Exchangeable cations in samples collected 1983 (Lotse & Otabbong 1985) were extracted by repeated shaking and centrifugation using 1M NH_4OAc adjusted to pH 7.0. Samples collected 1984 and later were leached on filter using the same extractant. The former method gave slightly higher values than the latter. The reason for the difference is believed to be abrasion of soil particles caused by repeated shaking and centrifugation of the soil suspension.

Sulfate adsorption isotherms

The procedure described by Lotse and Otabbong (1985) was modified slightly by making the ionic strength of the sulfate solutions approximately equal to that of the soil solution. Duplicate samples of undried < 4 mm soil equivalent to 2.5 g of oven-dried material were weighed into acid-washed centrifuge tubes. The soil

was shaken for 24 h at 20°C with 25 ml of a $2x10^{-4}$M NaCl solution containing 0, 1, 2, 4, 8, 16, and 32 mg SO_4^{2-}-S (K_2SO_4) per liter. The suspension was centrifuged at 4 000 rpm for 5 minutes at 20°C by a temperature-controlled centrifuge. The supernatant was filtered through a millipore filter (< 0.22 um) which had been washed three times with H_2O and checked for S adsorption. In calculating the amount of SO_4^{2-}-S adsorbed, allowance for NaCl-extractable SO_4^{2-}-S was made.

Chloride adsorption isotherms

Chloride adsorption was determined by a method similar to that used for SO_4^{2-}-S adsorption. The soil was shaken for 24 h at 20°C with 25 ml of a 10^{-4}M Na_2SO_4 solution containing 0, 8, 16, and 32 mg Cl^-/l (KCl). Allowance for Na_2SO_4-extractable Cl^- was made in calculating the amount of Cl^- adsorbed.

Average historical weathering rate

The average historical weathering rate is defined as the average decrease in total acid neutralizing capacity of mineral components (ANC(s)) per year during the last 10 000 years. The ANC(s) was measured as the equivalent sum of base cations minus the equivalent sum of acid anions as determined by total elemental analysis (Van Breemen et al. 1983; Van Breemen et al. 1984). The loss of some components of the original rock material has a concentrating effect on other components. In order to compare the ANC(s) of soil with that of parent rock, the ANC(s) of soil was adjusted to account for the loss of material by weathering and leaching, using TiO_2 as internal standard. A preliminary report is given by Lotse (1987).

Soil samples were extracted with 1M NH_4OAc to remove exchangeable cations, leached with 0.5M NH_4CO_3 to remove excess ammonium acetate, ignited at 600°C and weighed. The samples were then fused with lithium metaborate (Abbey 1970), and all elements except S and P were determined by atomic absorption spectrophotometry. Sulfur was determined with a Leco SC-32 sulfur analyzer,

and phosphorus was determined by the Murphy and Riley (1962) method.

Acidification of soils and runoff waters was defined as the decrease in ANC(s) and ANC(aq), respectively. The ANC(aq) was expressed as the equivalent sum of base cations minus the equivalent sum of strong-acid anions (Bolt and Bruggenwert, 1976).

RESULTS AND DISCUSSION

pH (H_2O), loss on ignition, %C, CEC (KCl), and BS

The results are presented in the Appendix Tables 1 to 7. The spatial variation within each catchment with respect to carbon content is very large. At Risdalsheia, field KIM, 0-15 cm, the C content varies between 8 and 36 percent. At Sogndal, field 2, 0-15 cm, % C varies between 1 and 26. Since the relationships between pH and % C, loss on ignition and % C, CEC and % C, and base saturation and % C are quite close (Reuss 1989), the spatial heterogenity in soils with respect to carbon content is the major source of variance in the data presented.

Changes in chemical properties of soils as a result of changes in acid deposition

The experimental treatments at Sogndal (acid addition) and Risdalsheia (acid exclusion) can be expected to cause long-term changes in soil chemistry. The experimental treatments are expected to affect primarily (1) the amounts of exchangeable base cations in the soil, and (2) the amount of adsorbed and water-soluble sulfate in the soil. The soil data now cover 3 years of treatment, and may already reflect changes due to treatment. We use the paired-sample t-test to evaluate the statistical significance of differences in soil chemistry between 1983-86. To account for possible year-to-year variations in bulk density and wetness we make our comparisons on the basis of

amount per volume soil (concentration multiplied by bulk density) rather than on the basis of amount per weight soil.

At both Sogndal and Risdalsheia only the amounts of water-soluble and adsorbed sulfate in the soil have changed significantly over the period 1983-86 (Tables 1 and 2). Changes in the amounts of base cations are not significant. The sizes of the pools of base cations are large relative to the expected yearly changes due to treatment, and thus 3 years is too short a period in which to reveal statisitically-significant changes.

Sulfate adsorption isotherms

Sulfate adsorption isotherms for soil samples collected 1983 at Risdalsheia and Sogndal were given by Lotse and Otabbong (1985). The determinations were repeated for samples collected 1987. The results are shown in Figures 7 to 10. The sulfate adsorption was of approximately the same magnitude 1983 and 1987.

Cloride adsorption isotherms

Chloride adsorption isotherms were determined for 8 samples from Risdalsheia and 8 samples from Sogndal. The results are shown in Figures 11 to 14. Chloride adsorption is almost as high as sulfate adsorption at Risdalsheia but only about half as high as sulfate adsorption at Sogndal.

Average historical weathering rate

Sogndal. The average $ANC_{(s)}$ is 19.5 eq kg^{-1} for soils and 20.7 eq kg^{-1} for rocks. In order to compare the $ANC_{(s)}$ of soil with that of parent rock, the $ANC_{(s)}$ of soil was adjusted to account for the loss of material by weathering and leaching, using TiO_2 as internal standard. The average adjusted $ANC_{(s)}$ of soils is 8.8 eq kg^{-1}, and the average $ANC_{(s)}$ is 11.9 eq kg^{-1}. The average historical weathering rate obtained by dividing $ANC_{(s)}$ with 10 000 years then becomes 1.2 meq kg^{-1} yr^{-1}. The total mass of ignited soil is 1809 x 10^3 kg and the catchment area 8388 m^2 for

Table 1. Results of paired-sample t-test for soils collected at Sogndal in 1983 and 1986. Catchments are SOG1 (no treatment), SOG2 (sulfuric acid addition) and SOG4 (sulfuric and nitric acid addition). n refers to numbers of pairs; p refers to level of significance (ns = not significant).

Parameter	Catchment	n	1983 x ± s.d.	1986 x ± s.d.	diff. 86-83	p
exch.Ca	SOG1	4	2.0±1.3	5.0±5.8	+3.0	ns
eq/m³	SOG2	14	3.5±3.5	3.4±2.3	-.1	ns
	SOG4	2	3.1±1.9	5.3±3.1	+2.2	ns
exch.Mg	SOG1	4	0.7±0.6	1.2±1.2	+0.5	ns
eq/m³	SOG2	14	0.8±0.9	0.6±0.6	-0.2	ns
	SOG4	2	0.8±0.6	0.9±0.3	+0.1	ns
exch.Na	SOG1	4	.28±.01	.21±.06	+.06	.07
eq/m³	SOG2	14	.33±.10	.29±.16	-.04	ns
	SOG4	2	.40±.20	.31±.03	-.09	ns
exch.K	SOG1	4	.63±.48	.58±.37	-.05	ns
eq/m³	SOG2	14	.49±.34	.54±.30	+.05	ns
	SOG4	2	.68±.34	.87±.32	+.19	ns
wat.-sol.	SOG1	4	.19±.05	.14±.02	-.05	.14
SO_4	SOG2	14	.21±.09	.26±.09	+.05	.17
eq/m³	SOG4	2	.19±.06	.19±.04	0	ns
ads.SO_4	SOG1	4	1.2±0.9	1.0±1.0	-0.2	ns
eq/m³	SOG2	14	1.6±1.6	3.0±3.4	+1.4	.17
	SOG4	2	1.2±1.4	0.6±0.3	-0.6	ns
total S	SOG1	4	.20±.05	.22±.07	+.02	ns
kg/m³	SOG2	14	.21±.09	.28±.14	+.07	.09
	SOG4	2	.27±.03	.23±.05	-.04	ns

Table 2. Results of paired-sample t-test for soils collected at Risdalsheia in 1983 and 1986. Catchments are KIM (roof, clean rain), EGIL (roof, acid rain) and ROLF (no roof, acid rain). n refers to numbers of pairs; p refers to level of significance (ns = not significant).

Parameter	Catchment	n	1983 x ± s.d.	1986 x ± s.d.	diff. 86-83	p
exch.Ca	KIM	15	2.4±2.6	3.1±3.2	+0.7	ns
eq/m³	EGIL	7	3.7±3.5	2.8±1.2	-.9	ns
	ROLF	3	5.1±3.5	2.5±2.2	-2.6	ns
exch.Mg	KIM	15	1.5±1.4	1.8±1.0	+0.3	ns
eq/m³	EGIL	7	1.9±1.8	1.7±0.8	-0.2	ns
	ROLF	3	3.0±2.4	1.3±1.0	-1.7	.14
exch.Na	KIM	15	.45±.15	.37±.18	-.08	ns
eq/m³	EGIL	7	.53±.43	.38±.14	-.15	ns
	ROLF	3	.52±.46	.29±.07	-.23	ns
exch.K	KIM	15	.70±.53	.66±.28	-.04	ns
eq/m³	EGIL	7	1.1±1.2	0.8±0.2	-0.3	ns
	ROLF	3	1.0±0.9	0.6±0.2	-0.4	ns
wat.-sol.	KIM	15	.50±.20	.33±.27	-.17	.11
SO_4	EGIL	7	.58±.50	.44±.10	-.14	ns
eq/m³	ROLF	3	.32±.32	.32±.05	0	ns
ads.SO_4	KIM	15	.42±.35	.14±.17	-.28	.03
eq/m³	EGIL	7	.27±.20	.13±.07	-.14	.15
	ROLF	3	.20±.21	.23±.14	+.03	ns
total S	KIM	15	.42±.28	.26±.38	-.16	ns
kg/m³	EGIL	7	.46±.40	.19±.02	-.31	.13
	ROLF	3	.26±.02	.76±.82	+.50	ns

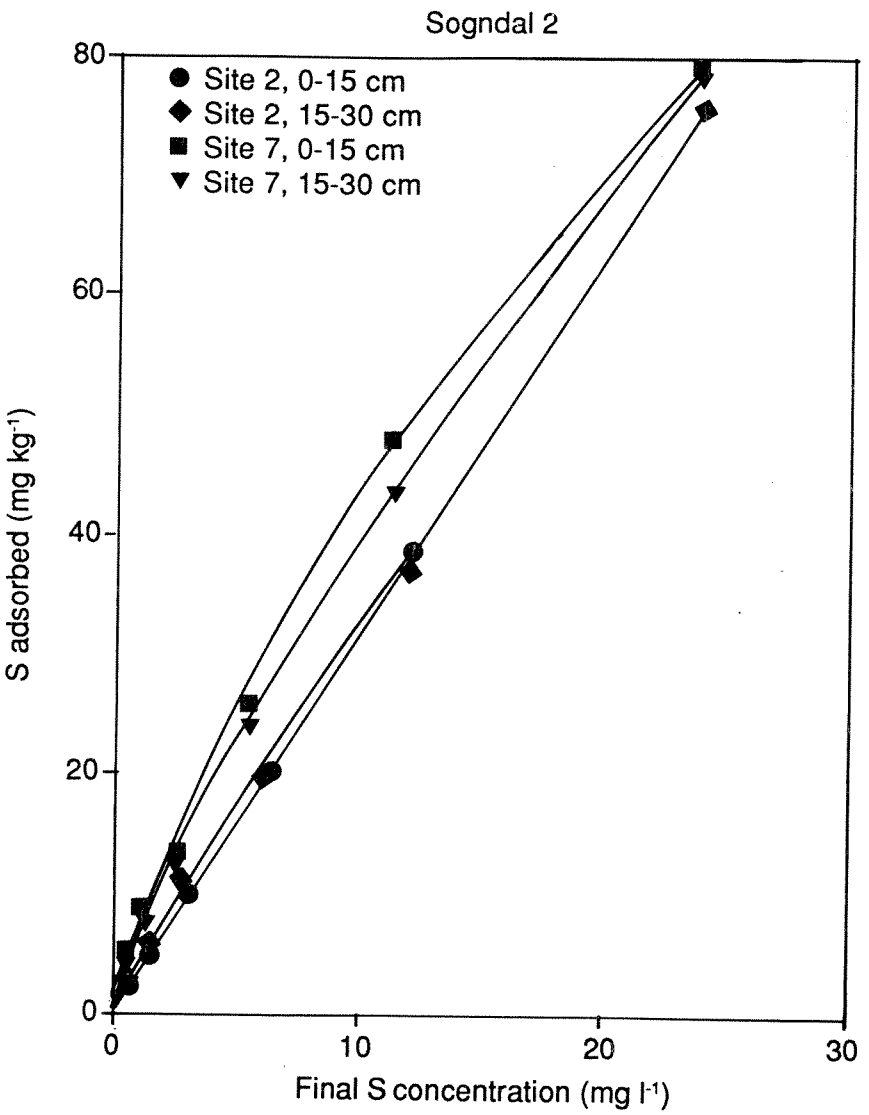

Fig. 7. Sulfate adsorption by soils from Sogndal 1987. Catchment SOG2 (sulfuric acid addition).

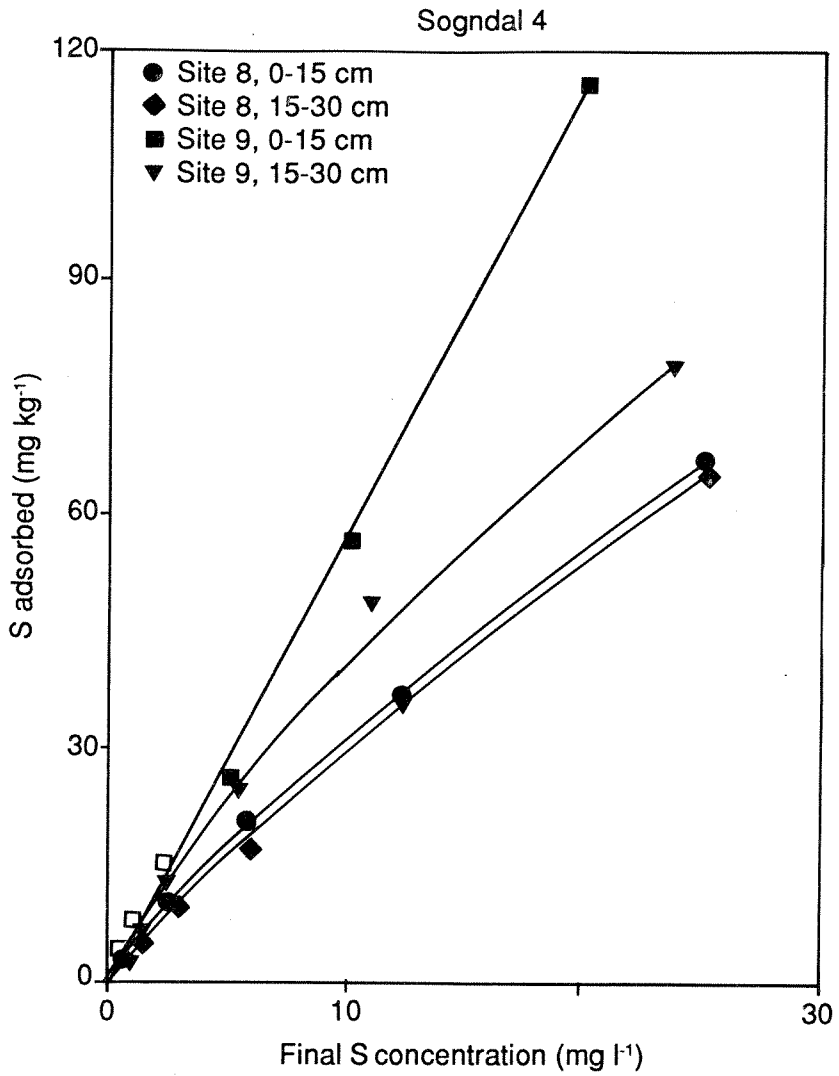

Fig. 8. Sulfate adsorption by soils from Sogndal 1987. Catchment SOG4 (sulfuric + nitric acid addition).

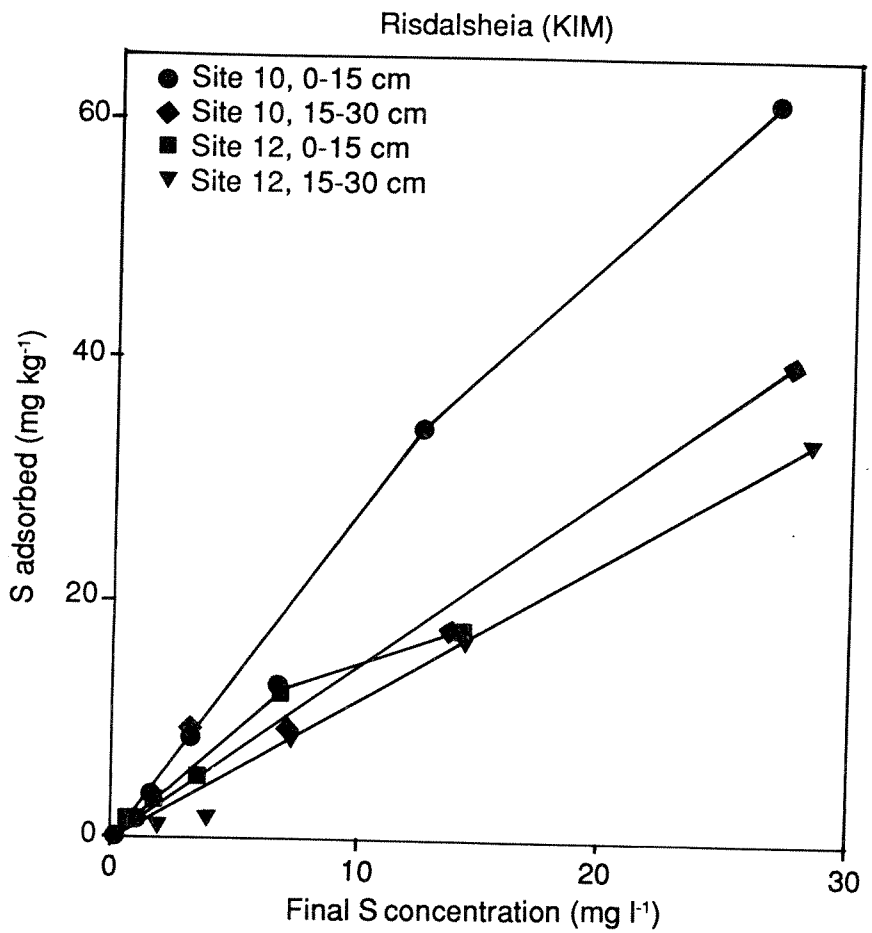

Fig. 9. Sulfate adsorption by soils from Risdalsheia 1987. Catchment KIM (roof, acid exclusion).

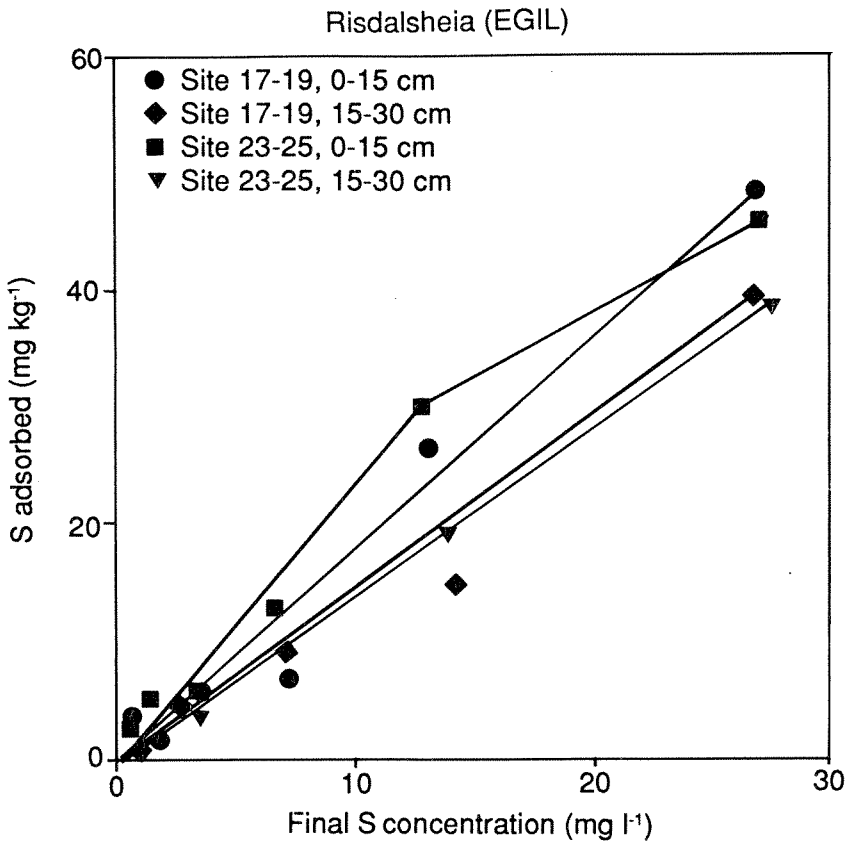

Fig. 10. Sulfate adsorption by soils from Risdalsheia 1987. Catchment EGIL (roof, acid rain).

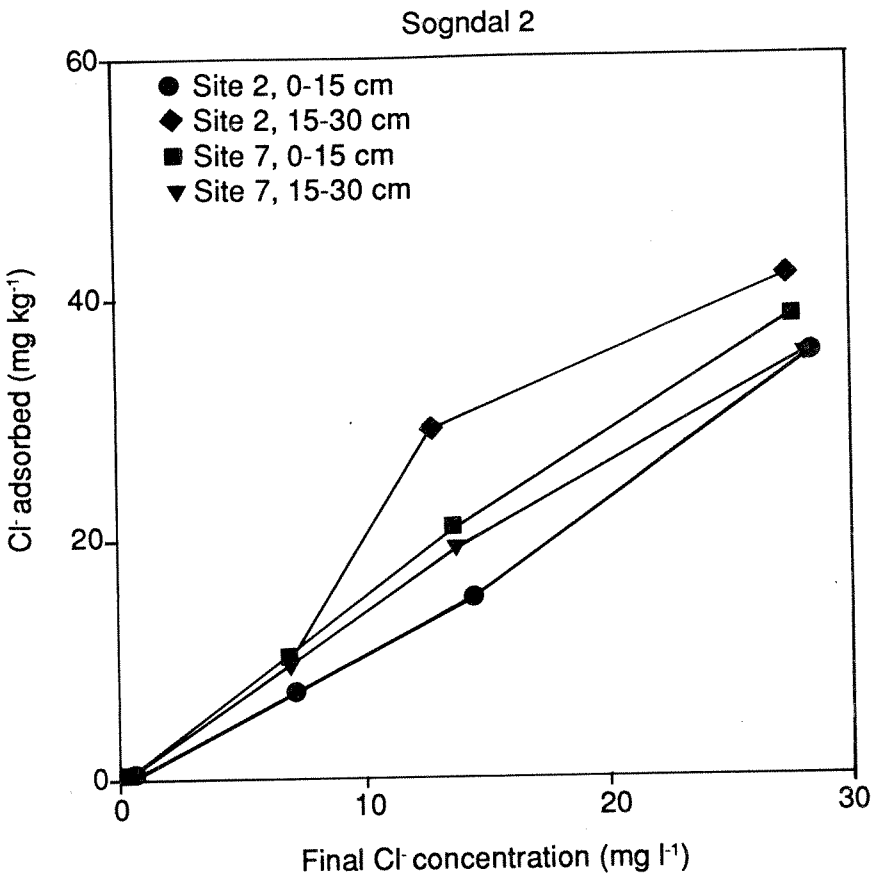

Fig. 11. Chloride adsorption by soils from Sogndal. Catchment SOG2 (sulfuric acid addition).

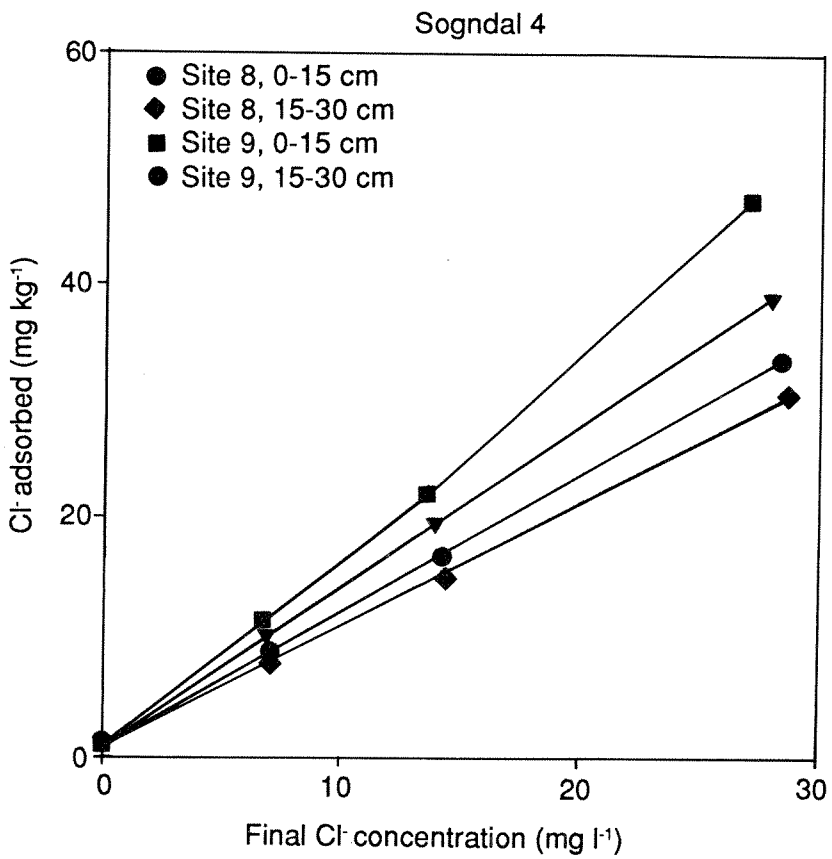

Fig. 12. Chloride adsorption by soils from Sogndal. Catchment SOG4 (sulfuric + nitric acid addition).

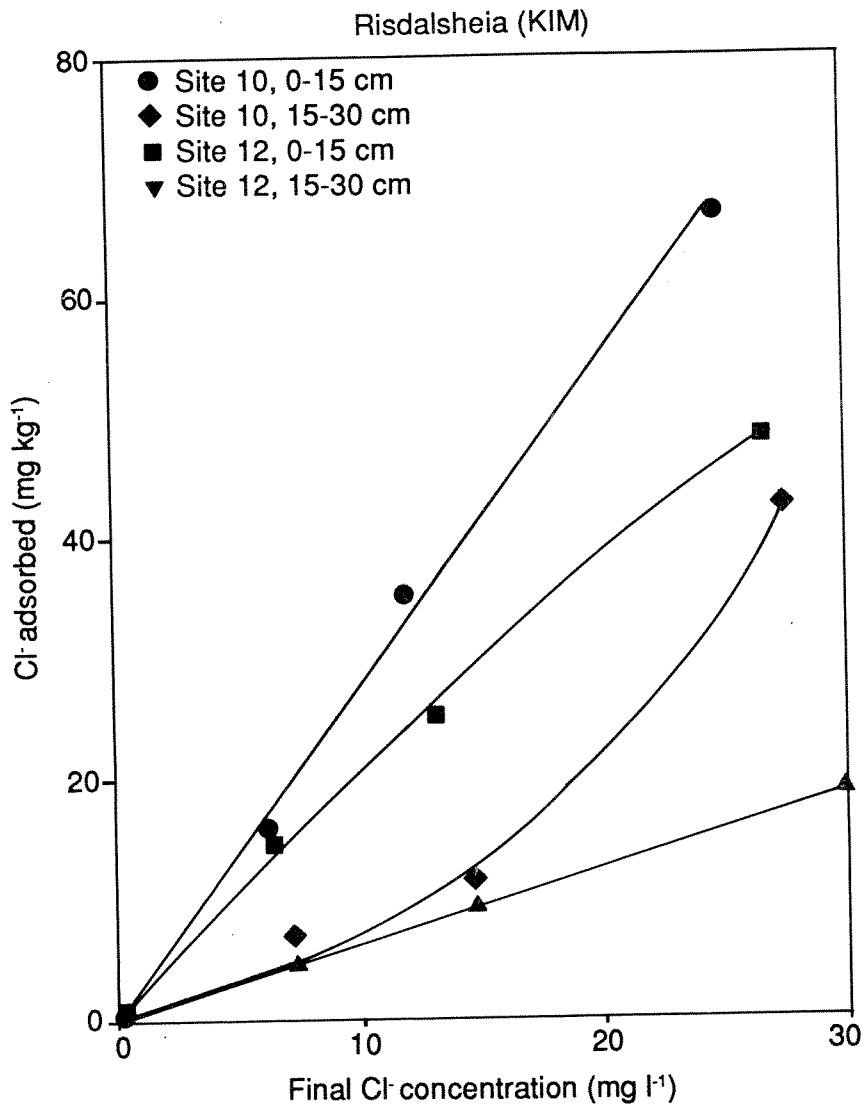

Fig. 13. Chloride adsorption by soils from Risdalsheia. Catchment KIM (roof, acid exclusion).

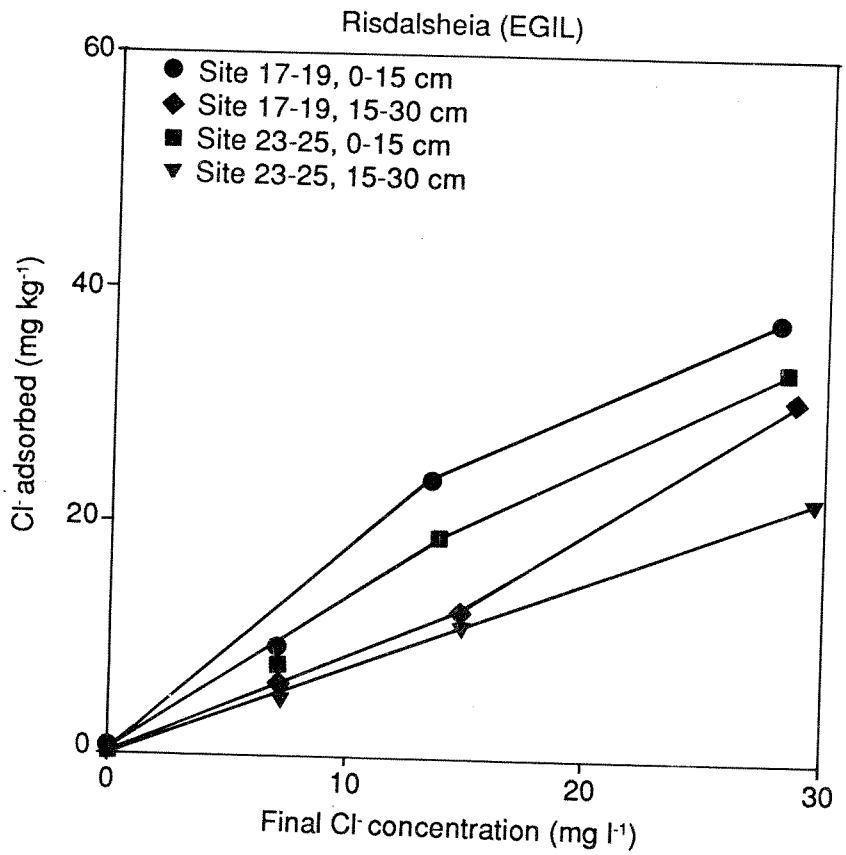

Fig. 14. Chloride adsorption by soils from Risdalsheia. Catchment EGIL (roof, acid rain).

SOG 2 + SOG 4. The average historical weathering rate at Sogndal is thus 259 meq m^{-2} yr^{-1}. A preliminary estimate of the average rate of historical weathering was given by Lotse (1987).

Risdalsheia. The TIO_2 content of the composite granitic rock samples taken at Risdalsheia is 0.61 %, and the average TiO_2 content of 15 soil samples is 0.76 %. The average $ANC_{(s)}$ is 12.6 eq kg^{-1} for bedrock and 11.0 eq kg^{-1} for soils. The average adjusted $ANC_{(s)}$ of soil is 9.9 eq kg^{-1}, and the average $ANC_{(s)}$ is 2.6 eq kg^{-1}. The average historical weathering rate then becomes 0.26 meq kg^{-1} yr^{-1}. Because the total mass of ignited soil is 49.2 x 10^3 kg and the catchment area 1076 m^2 for KIM + EGIL fields, the average historical weathering rate is 12 meq m^{-2} yr^{-1}. This value would be too low if the composite rock sample contained more dark minerals than the true parent material of the Risdalsheia soils.

CONCLUSIONS

Although acid addition at Sogndal has caused acidification of the soils by increased export of base cations, comparison of 1983 with 1986 soil samples indicates that this has not yet resulted in statistically significant change in the amounts of exchangeable bases on the soils. The pools of total sulfur and readily-available sulfate, however, have increased significantly at SOG2, presumeably due to acid addition.

Acid exclusion at the KIM catchment, Risdalsheia, has resulted in a small replenishment of base cations in the soils over the period 1983-86. The recovery of soils after a 50 % reduction in acid deposition may take several decades. The pools of total sulfur and readily-available sulfate decreased significantly at the KIM catchment over the period 1983-86, presumeably due to exclusion of acid precipitation.

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APPENDIX. Chemical data 1984-86. Risdalsheia and Sogndal.

Table 1. Chemical data for soil samples from Risdalsheia 1984.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign. (%)	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD KIM						
5	0 - 15	4.12	3.18	24.6	11.4	0.49	0.067	23	170	6.54	9.86	25.42
5	15 - 30	4.65	4.04	6.6	3.05	0.21	0.025	14	122	1.73	1.99	8.33
5	30+	4.63	4.29	n.d.	4.08	0.30	0.067	14	61	2.32	2.77	n.d.
8 + 9	0 - 15	4.38	3.43	18.5	9.07	0.43	0.051	21	178	5.74	7.45	20.51
9	15 - 30	4.73	4.08	5.5	2.83	0.18	0.027	15	104	1.62	1.85	8.42
10	0 - 15	4.29	3.33	47.3	24.2	0.97	0.14	25	173	12.96	19.98	37.18
10	15 - 30	4.75	4.04	17.1	8.70	0.48	0.079	18	110	1.90	2.52	16.68
10	30+	4.78	4.28	n.d.	20.6	0.72	0.17	29	121	4.23	4.78	21.70
11	0 - 15	4.02	3.06	43.7	20.5	0.80	0.10	26	205	8.90	14.11	33.03
11	15 - 30	4.52	3.74	30.9	17.0	0.82	0.16	21	106	8.20	9.28	28.65
12	0 - 15	4.05	3.07	30.3	14.6	0.56	0.065	26	225	7.79	11.69	27.52
12	15 - 30	4.40	3.98	10.6	5.05	0.34	0.039	15	129	3.55	3.79	16.09
12	30+	4.63	4.21	n.d.	3.69	0.23	0.044	16	84	2.02	2.22	12.12
14	0 - 15	4.08	3.26	42.1	23.1	1.21	0.17	19	136	12.95	17.70	34.07
14	15 - 30	4.25	3.75	24.8	12.0	0.82	0.11	15	109	9.79	10.67	25.57
14	30+	4.40	3.79	n.d.	14.1	0.73	0.11	19	128	8.84	10.73	25.06
Mean	0 - 15	4.16	3.22	34.4	17.15	0.74	0.073	26	220	9.15	13.47	
± SD		± 0.14		11.6	6.34	0.30	0.042				4.76	
	15 - 30	4.55	3.94	15.9	8.11	0.48	0.073	17	111	4.47	5.02	
		± 0.20		10.3	5.61	0.29	0.054				3.93	
	30+	4.61	4.14	n.d.	10.62	0.50	0.098	21	108	4.35	5.13	
		± 0.16			8.22	0.27	0.055				3.90	

n.d. = not determined

Table 1. Continued

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign. (%)	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD EGIL						
16 A	0 - 15	4.19	3.09	31.0	14.2	0.78	0.078	18	182	5.90	9.43	22.33
16 A	15 - 30	4.48	3.72	34.7	19.0	1.17	0.15	16	127	10.00	12.35	32.45
16 A	30+	4.63	3.85	34.7	15.8	1.08	0.13	15	122	7.92	9.71	29.13
17 - 19	0 - 15	4.02	3.16	29.2	16.6	0.73	0.095	23	175	7.33	9.78	23.60
17 - 19	15 - 30	4.09	3.19	14.0	7.31	0.33	0.039	22	187	4.64	5.82	14.79
17 - 19	30+	4.51	3.79	9.2	4.29	0.23	0.033	19	130	3.31	3.97	11.20
20 - 22	0 - 15	4.26	3.42	26.4	12.2	0.63	0.076	19	161	7.20	9.08	22.74
20 - 22	15 - 30	4.43	3.51	19.6	8.19	0.43	0.059	19	139	6.49	7.79	19.54
23 - 25	0 - 15	4.36	3.33	35.0	17.25	0.75	0.10	23	173	7.76	11.70	25.52
23 - 25	15 - 30	4.64	3.70	20.3	9.56	0.51	0.073	19	131	5.57	7.11	21.16
Mean	0 - 15	4.21	3.25	30.4	15.06	0.72	0.087	21	173	7.05	10.00	
± SD		± 0.14		3.6	2.32	0.07	0.012				1.17	
	15 - 30	4.41	3.53	22.2	11.02	0.61	0.080	18	138	6.68	8.27	
		± 0.23		8.8	5.40	0.38	0.049				2.84	
	30+	4.57	3.82	22.0	10.05	0.65	0.082	15	123	5.62	6.84	
		± 0.08		18.0	8.14	0.60	0.069				4.06	
						FIELD ROLF						
1 + 2	0 - 15	4.00	2.98	67.1	36.3	1.32	0.17	28	214	12.60	21.14	40.93
1 + 2	15 - 30	3.96	2.96	28.8	15.2	0.57	0.073	27	208	6.68	10.53	28.79
1 + 2	30+	4.38	3.61	13.2	6.73	0.31	0.066	22	102	4.74	5.93	15.80
3 - 5	0 - 15	4.05	2.99	52.8	26.6	1.01	0.14	26	190	5.31	10.14	31.90
3 - 5	15 - 30	4.36	3.49	19.2	9.38	0.43	0.055	22	171	5.59	7.20	19.22
3 - 5	30+	4.31	3.57	14.8	6.90	0.31	0.075	22	92	4.36	5.39	15.57
Mean	0 - 15	4.03	2.99	60.0	31.5	1.17	0.16	27	197	8.96	15.64	
± SD		± 0.04		10.1	6.9	0.22	0.02				7.78	
	15 - 30	4.16	3.23	24.0	12.29	0.50	0.064	25	192	6.14	8.87	
		± 0.28		6.8	4.11	0.10	0.013				2.35	
	30+	4.35	3.59	14.0	6.82	0.31	0.071	22	96	4.55	5.66	
		± 0.05		1.1	0.12	0	0.006				0.38	

Table 1. Continued

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σbase cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD KIM							
5	0 - 15	1.32	0.70	0.26	0.16	0.88	1.18	5.36	3.0	82	3.32	34	13
5	15 - 30	0.03	0.02	0.02	0.03	0.16	0.06	1.67	3.0	97	0.26	13	3
5	30+	0.03	0.02	0.27	0.04	0.09	0.03	2.29	2.9	99	0.45	16	n.d.
8 + 9	0 - 15	0.63	0.30	0.18	0.06	0.54	0.44	5.30	3.0	92	1.71	23	8
9	15 - 30	0.03	0.02	0.02	0.02	0.14	0.10	1.52	3.0	94	0.23	12	3
10	0 - 15	3.28	1.71	0.45	0.32	1.26	1.77	11.19	2.9	86	7.02	35	19
10	15 - 30	0.19	0.14	0.05	0.08	0.16	0.14	1.76	2.9	93	0.62	25	4
10	30+	0.14	0.07	0.03	0.10	0.21	0.25	3.98	3.0	94	0.55	12	3
11	0 - 15	2.18	1.24	0.44	0.19	1.16	2.43	6.47	2.8	73	5.21	37	16
11	15 - 30	0.19	0.31	0.07	0.08	0.43	0.50	7.70	2.8	94	1.08	12	4
12	0 - 15	1.76	0.82	0.30	0.12	0.90	2.09	5.70	2.9	73	3.90	33	14
12	15 - 30	0.05	0.03	0.03	0.04	0.17	0.14	3.41	2.9	96	0.24	6	1
12	30+	0.03	0.02	0.02	0.04	0.09	0.17	1.85	2.9	92	0.20	9	2
14	0 - 15	1.61	1.13	0.42	0.21	1.38	2.19	10.76	2.8	83	4.75	27	14
14	15 - 30	0.09	0.14	0.10	0.09	0.46	0.22	9.57	2.8	98	0.88	8	3
14	30+	0.74	0.50	0.20	0.12	0.33	0.41	8.43	2.8	95	1.89	18	8
Mean	0 - 15	1.80	0.98	0.34	0.18	1.02	1.68	7.46	2.9	82	4.32	32	
± SD		± 0.89	0.49	0.11	0.09	0.31	0.75	2.76					
	15 - 30	± 0.10	0.11	0.05	0.06	0.25	0.19	4.27	2.9	95	0.55	13	
		± 0.08	0.11	0.03	0.03	0.15	0.16	3.50					
	30+	± 0.24	0.15	0.13	0.08	0.18	0.22	4.14	2.9	95	0.77	14	
		± 0.34	0.23	0.12	0.04	0.11	0.16	3.00					

Table 1. Continued

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σbase cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD EGIL							
16 A	0 - 15	1.63	0.68	0.26	0.13	0.83	1.72	4.18	2.9	71	3.53	37	16
16 A	15 - 30	0.57	0.39	0.22	0.18	0.99	0.52	9.48	2.9	94	2.35	19	7
16 A	30+	0.44	0.30	0.15	0.12	0.78	0.23	7.69	2.9	97	1.79	23	6
17 - 19	0 - 15	0.92	0.47	0.29	0.10	0.67	1.39	5.94	2.9	81	2.45	25	10
17 - 19	15 - 30	0.34	0.19	0.10	0.06	0.49	0.95	3.69	2.8	80	1.18	20	8
17 - 19	30+	0.24	0.15	0.06	0.05	0.16	0.21	3.10	2.9	94	0.66	17	6
20 - 22	0 - 15	0.68	0.31	0.19	0.08	0.62	0.67	6.53	2.7	91	1.88	21	8
20 - 22	15 - 30	0.38	0.28	0.13	0.08	0.43	0.45	6.04	2.7	93	1.30	17	7
23 - 25	0 - 15	1.61	0.71	0.32	0.14	1.16	0.99	6.77	2.8	87	3.94	34	15
23 - 25	15 - 30	0.40	0.23	0.17	0.09	0.65	0.14	5.43	2.5	97	1.54	22	7
Mean	0 - 15	1.21	0.54	0.27	0.11	0.82	1.19	5.86	2.8	83	2.95	29	
± SD		± 0.48	0.19	0.06	0.03	0.24	0.46	1.17					
	15 - 30	± 0.42	0.27	0.16	0.10	0.64	0.52	6.16	2.7	91	1.59	20	
		± 0.10	0.09	0.05	0.05	0.25	0.33	2.43					
	30+	± 0.34	0.23	0.11	0.09	0.47	0.22	5.40	2.9	96	1.23	20	
		± 0.14	0.11	0.06	0.05	0.44	0.01	3.25					
						FIELD ROLF							
1 + 2	0 - 15	3.34	2.03	0.62	0.37	2.18	4.77	7.83	2.4	62	8.54	40	21
1 + 2	15 - 30	1.48	0.93	0.33	0.17	0.94	2.41	4.27	2.5	64	3.85	37	13
1 + 2	30+	0.44	0.26	0.12	0.08	0.29	0.29	4.45	2.5	94	1.19	20	8
3 - 5	0 - 15	2.33	1.11	0.39	0.15	0.85	2.20	3.11	2.4	59	4.83	48	15
3 - 5	15 - 30	0.70	0.32	0.14	0.07	0.38	0.80	4.79	2.5	86	1.61	22	8
3 - 5	30+	0.30	0.40	0.08	0.02	0.23	0.55	3.81	2.6	87	1.03	19	7
Mean	0 - 15	2.84	1.57	0.51	0.26	1.52	3.49	5.47	2.4	61	6.69	44	
± SD		± 0.71	0.65	0.16	0.16	00.94	1.82	3.34					
	15 - 30	± 1.09	0.63	0.24	0.12	0.66	1.61	4.53	2.5	75	2.73	30	
		± 0.55	0.43	0.13	0.07	0.40	1.14	0.37					
	30+	± 0.37	0.33	0.10	0.05	0.26	0.42	4.13	2.6	91	1.11	20	
		± 0.10	0.10	0.03	0.04	0.04	0.18	0.45					

Table 1. Continued

Site No.	Depth (cm)	Water-soluble SO_4-S (meq kg^{-1})	Adsorbed SO_4-S (meq kg^{-1})	Dry bulk density (g cm^{-1})
		FIELD KIM		
5	0 - 15	0.93	0.42	0.25
5	15 - 30	0.38	0.23	0.88
5	30+	n.d.	n.d.	0.74
8 + 9	0 - 15	0.78	0.87	0.48
9	15 - 30	0.47	0.67	1.14
10	0 - 15	1.72	1.10	0.24
10	15 - 30	0.88	1.71	0.80
10	30+	n.d.	n.d.	0.56
11	0 - 15	1.30	0.84	0.27
11	15 - 30	1.10	0.36	0.62
12	0 - 15	1.11	0.50	0.34
12	15 - 30	0.48	0.50	0.86
12	30+	n.d.	n.d.	1.01
14	0 - 15	2.31	1.15	0.29
14	15 - 30	1.62	1.02	0.56
14	30+	n.d.	n.d.	n.d.
Mean	0 - 15	1.36	0.81	0.31
± SD		± 0.57	0.30	0.09
	15 - 30	0.82	0.75	0.81
		± 0.48	0.55	0.21
	30+	n.d.	n.d.	0.77
		± n.d.	n.d.	0.23

n.d. = not determined

Table 1. Continued

Site No.	Depth (cm)	Water-soluble SO_4-S (meq kg^{-1})	Adsorbed SO_4-S (meq kg^{-1})	Dry bulk density (g cm^{-1})
		FIELD EGIL		
16 A	0 - 15	0.67	0.38	0.21
16 A	15 - 30	1.92	0.79	0.38
16 A	30+	1.78	1.08	n.d.
17 - 19	0 - 15	0.92	0.44	0.16
17 - 19	15 - 30	0.43	0.19	1.22
17 - 19	30+	0.51	0.45	n.d.
20 - 22	0 - 15	0.91	0.42	0.18
20 - 22	15 - 30	0.72	0.31	n.d.
23 - 25	0 - 15	1.26	0.83	0.19
23 - 25	15 - 30	1.27	0.50	1.08
Mean	0 - 15	0.94	0.52	0.45
$\pm$ SD		$\pm$ 0.24	0.21	0.51
	15 - 30	1.09	0.45	0.73
		$\pm$ 0.66	0.26	0.49
	30+	1.15	0.77	-
		$\pm$ 0.90	0.45	-
		FIELD ROLF		
1 + 2	0 - 15	2.36	1.16	0.08
1 + 2	15 - 30	1.11	0.72	0.62
1 + 2	30+	1.13	0.66	n.d.
3 - 5	0 - 15	0.61	0.39	0.15
3 - 5	15 - 30	0.85	0.53	n.d.
3 - 5	30+	1.24	1.03	n.d.
Mean	0 - 15	1.49	0.78	0.12
$\pm$ SD		$\pm$ 1.24	0.54	0.05
	15 - 30	0.98	0.63	0.62
		$\pm$ 0.18	0.13	0
	30+	1.19	0.85	n.d.
		$\pm$ 0.08	0.26	n.d.

n.d. = not determined

Table 2. Chemical data for soil samples from Sogndal 1984.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign. (%)	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
					FIELD 2							
1	0 - 15	5.10	4.24	27.0	11.6	0.50	0.062	23	187	3.43	4.60	19.18
1	15 - 30	5.21	4.55	13.4	5.39	0.21	0.023	26	234	0.47	0.80	12.65
2	0 - 15	5.04	4.19	26.3	11.0	0.43	0.049	26	224	3.77	5.68	20.14
2	15 - 30	5.24	4.60	10.2	3.29	0.17	0.016	19	206	0.82	1.10	8.50
3	0 - 15	5.41	4.91	5.9	2.03	0.13	0.019	16	107	0.21	0.59	4.76
3	15 - 30	5.90	5.20	2.5	0.86	0.06	0.006	14	143	0.12	0.44	2.52
4	0 - 15	5.31	4.95	7.4	2.86	0.13	0.023	22	124	0.22	0.50	5.07
4	15 - 30	5.46	4.90	7.6	2.66	0.10	0.013	27	205	0.25	0.53	5.69
5	0 - 15	4.91	4.10	50.0	21.9	1.07	0.13	20	168	6.10	8.70	22.05
5	15 - 30	4.76	4.22	45.8	22.1	1.08	0.12	20	184	6.71	8.26	31.23
6	0 - 15	5.05	4.15	27.1	12.6	0.46	0.051	27	247	3.86	7.86	23.18
6	15 - 30	5.29	4.38	13.1	4.87	0.17	0.021	29	232	0.90	2.57	12.81
7	0 - 15	5.35	4.72	15.9	6.08	0.25	0.044	24	138	0.71	1.46	10.09
7	15 - 30	5.34	4.73	12.6	5.10	0.20	0.023	26	222	0.91	1.27	9.97
7	30+	5.50	4.80	n.d.	1.41	0.07	0.005	20	282	0.26	0.50	4.73
Mean	0 - 15	5.17	4.47	22.8	9.72	0.42	0.054	23	180	2.61	4.20	
+ SD		± 0.19		15.05	6.85	0.32	0.037				3.42	
−	15 - 30	− 5.32	4.65	15.0	6.32	0.28	0.032	23	198	1.45	2.14	
		± 0.34		14.1	7.14	0.36	0.039				2.79	
	30+	− 5.50	4.80	n.d.	1.41	0.07	0.005	20	282	0.26	0.50	

n.d. = not determined

Table 2. Continued

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign. (%)	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD 4						
8	0 - 15	5.09	4.27	23.2	9.62	0.44	0.056	22	172	2.94	4.85	17.70
8	15 - 30	5.28	4.72	12.1	5.38	0.27	0.032	20	168	0.59	0.88	7.92
8	30+	5.37	4.81	12.0	5.06	0.24	0.028	21	181	0.47	0.69	7.63
9	0 - 15	4.64	3.87	54.1	26.9	1.08	0.12	25	224	11.38	13.94	32.99
9	15 - 30	5.04	4.22	21.1	8.45	0.36	0.048	23	176	2.30	3.18	18.26
Mean	0 - 15	4.87	4.07	38.7	18.3	0.76	0.088	24	208	7.16	9.40	
± SD		± 0.32		21.8	12.2	0.45	0.045				6.43	
	15 - 30	5.16	4.47	16.6	6.92	0.32	0.040	22	173	1.45	2.03	
		± 0.17		6.4	2.17	0.06	0.011				1.63	
	30+	5.37	4.81	12.0	5.06	0.24	0.028	21	181	0.47	0.69	
						FIELD 1						
10	0 - 15	5.14	4.29	25.7	11.32	0.50	0.055	23	206	3.01	4.59	17.95
10	15 - 30	5.56	4.90	7.9	2.44	0.12	0.014	20	174	0.31	0.46	5.76
10	30+	5.78	5.30	n.d.	0.42	0.03	0.004	14	105	0.09	0.34	1.17
11	0 - 15	5.20	4.35	21.6	9.08	0.41	0.048	22	189	2.54	3.70	15.51
11	15 - 30	5.10	4.58	10.1	3.53	0.20	0.025	18	141	0.73	1.01	8.98
Mean	0 - 15	5.17	4.32	23.7	10.2	0.46	0.052	22	196	2.78	4.15	
± SD		± 0.04		2.9	1.6	0.06	0.005				0.63	
	15 - 30	5.33	4.74	9.0	2.99	0.16	0.020	19	150	0.52	0.74	
		± 0.33		1.6	0.77	0.06	0.007				0.39	
	30+	5.78	5.30	n.d.	0.42	0.03	0.004	14	105	0.09	0.34	

Table 2. Continued

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD 2							
1	0 - 15	0.57	0.20	0.21	0.08	0.11	0.19	3.24	2.7	94	1.17	25	6
1	15 - 30	0.09	0.03	0.03	0.03	0.15	0.05	0.42	2.6	89	0.33	41	3
2	0 - 15	1.16	0.40	0.22	0.07	0.06	0.24	3.53	2.6	94	1.91	34	9
2	15 - 30	0.16	0.03	0.03	0.04	0.02	0.04	0.78	2.5	64	0.28	25	3
3	0 - 15	0.25	0.02	0.04	0.05	0.02	0.04	0.17	1.9	81	0.38	64	8
3	15 - 30	0.23	0.02	0.01	0.04	0.02	0	0.12	2.9	100	0.32	73	13
4	0 - 15	0.15	0.03	0.03	0.03	0.04	0.04	0.18	2.0	82	0.28	56	6
4	15 - 30	0.18	0.02	0.02	0.04	0.02	0.04	0.21	2.3	84	0.28	53	5
5	0 - 15	1.08	0.40	0.37	0.12	0.63	0.10	6.00	2.9	98	2.60	30	12
5	15 - 30	0.85	0.18	0.18	0.10	0.24	0.09	6.62	2.9	99	1.55	19	5
6	0 - 15	2.88	0.76	0.21	0.10	0.05	0.19	3.67	2.9	95	4.00	51	17
6	15 - 30	1.30	0.25	0.03	0.05	0.04	0.10	0.80	2.9	89	1.67	65	13
7	0 - 15	0.44	0.13	0.10	0.04	0.04	0.05	0.66	2.8	93	0.75	51	7
7	15 - 30	0.19	0.04	0.03	0.03	0.07	0.19	0.72	2.9	79	0.36	28	4
7	30+	0.13	0.02	0.02	0.03	0.04	0	0.26	2.3	100	0.24	48	5
Mean ± SD	0 - 15	0.93 ± 0.94	0.28	0.17	0.07	0.14	0.12	2.49	2.5	91	1.58	44	
	15 - 30	0.43 ± 0.46	0.08	0.05	0.05	0.08	0.07	1.38	2.7	89	0.68	43	
	30+	0.13	0.02	0.02	0.03	0.04	0	0.26	2.3	100	0.24	48	

Table 2. Continued

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD 4							
8	0 - 15	1.24	0.33	0.24	0.07	0.03	0.10	2.84	2.8	97	1.91	39	11
8	15 - 30	0.11	0.03	0.04	0.03	0.08	0.05	0.54	2.2	92	0.29	33	4
8	30+	0.10	0.02	0.03	0.03	0.04	0.05	0.42	2.0	89	0.22	32	3
9	0 - 15	1.23	0.48	0.36	0.16	0.33	0.37	11.01	2.9	97	2.56	18	8
9	15 - 30	0.52	0.09	0.08	0.11	0.08	0.11	2.19	2.8	95	0.88	28	5
Mean	0 - 15	1.24	0.41	0.30	0.12	0.18	0.24	6.93	2.9	97	2.24	19	
± SD		± 0.007	0.11	0.08	0.06	0.21	0.19	5.78					
	15 - 30	± 0.32	0.06	0.06	0.07	0.08	0.08	1.37	2.5	94	0.59	31	
		± 0.29	0.04	0.03	0.06	0	0.04	1.17					
	30+	± 0.10	0.02	0.03	0.03	0.04	0.05	0.42	2.0	89	0.22	32	
						FIELD 1							
10	0 - 15	0.83	0.33	0.29	0.07	0.06	0.18	2.83	2.7	94	1.58	34	9
10	15 - 30	0.07	0.02	0.02	0.03	0.03	0.04	0.27	2.2	87	0.15	33	3
10	30+	0.16	0.01	0.01	0.04	0.03	0	0.09	2.1	100	0.25	74	21
11	0 - 15	0.63	0.26	0.19	0.06	0.02	0.11	2.43	2.8	96	1.16	31	7
11	15 - 30	0.14	0.03	0.03	0.03	0.05	0.05	0.68	2.7	93	0.28	28	3
Mean	0 - 15	0.73	0.30	0.24	0.07	0.04	0.15	2.63	2.8	95	1.37	33	
± SD		± 0.14	0.05	0.07	0.007	0.03	0.05	0.28					
	15 - 30	± 0.11	0.03	0.03	0.03	0.04	0.05	0.48	2.5	90	0.22	30	
		± 0.05	0.007	0.007	0	0.01	0.007	0.29					
	30+	± 0.16	0.01	0.01	0.04	0.03	0.04	0.05	2.1	100	0.25	74	

Table 2. Continued

Site No.	Depth (cm)	Water-soluble SO_4-S (meq kg^{-1})	Adsorbed SO_4-S (meq kg^{-1})	Dry bulk density (g cm^{-1})
		FIELD 2		
1	0 - 15	0.50	1.09	0.43
1	15 - 30	0.24	1.34	0.53
2	0 - 15	0.71	1.99	0.43
2	15 - 30	0.25	1.61	0.78
3	0 - 15	0.19	2.13	1.14
3	15 - 30	0.20	0.92	1.16
4	0 - 15	0.09	6.50	0.92
4	15 - 30	0.13	1.39	0.77
5	0 - 15	0.88	0.81	0.28
5	15 - 30	0.42	0.62	0.31
6	0 - 15	0.76	2.32	0.43
6	15 - 30	0.55	2.88	0.77
7	0 - 15	0.39	5.74	0.62
7	15 - 30	0.22	1.96	0.74
7	30+	n.d.	n.d.	n.d.
Mean	0 - 15	0.50	2.94	0.61
$\pm$ SD		$\pm$ 0.30	2.25	0.31
	15 - 30	0.29	1.53	0.72
		$\pm$ 0.15	0.74	0.26

n.d. = not determined

Table 2. Continued

Site No.	Depth (cm)	Water-soluble SO_4-S (meq kg^{-1})	Adsorbed SO_4-S (meq kg^{-1})	Dry bulk density (g cm^{-1})
		FIELD 4		
8	0 - 15	0.63	3.20	0.44
8	15 - 30	0.20	4.00	0.77
8	30+	0.20	4.70	0.73
9	0 - 15	0.69	0.44	0.24
9	15 - 30	0.25	0.33	0.62
Mean	0 - 15	0.66	1.82	0.34
± SD		± 0.04	1.95	0.14
	15 - 30	0.23	2.17	0.70
		± 0.04	2.60	0.11
	30+	0.20	4.70	0.73
		FIELD 1		
10	0 - 15	0.54	1.35	0.40
10	15 - 30	0.13	2.83	0.90
10	30+	n.d.	n.d.	1.31
11	0 - 15	0.45	1.62	0.47
11	15 - 30	0.22	0.98	0.90
Mean	0 - 15	0.50	1.49	0.44
± SD		± 0.06	0.19	0.05
	15 - 30	0.18	1.91	0.90
		± 0.06	1.31	0
	30+	n.d.	n.d.	1.31

n.d. = not determined

Table 3. Chemical data for soil samples from Risdalsheia 1985.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD KIM						
5	0 - 15	4.30	3.13	24.1	10.30	0.41	0.048	25	215	5.49	9.81	25.74
5	15 - 30	4.59	4.04	7.1	2.21	0.15	0.026	15	85	2.92	3.19	12.13
8 + 9	0 - 15	4.42	3.54	20.7	7.81	0.37	0.048	21	163	4.63	8.05	23.56
9	15 - 30	4.22	3.94	7.0	3.00	0.18	0.020	16	150	3.66	3.82	12.00
10	0 - 15	4.09	3.21	69.0	34.55	1.29	0.17	27	203	16.86	29.69	26.70
10	15 - 30	4.32	3.89	26.8	13.15	0.62	0.090	21	146	9.33	10.75	n.d.
10	30+	4.74	4.29	11.9	5.24	0.21	0.043	24	122	2.14	2.29	9.81
11	0 - 15	4.26	3.16	44.1	22.55	0.91	0.11	25	205	8.42	16.43	n.d.
11	15 - 30	4.29	3.74	16.9	6.97	0.41	0.052	17	134	6.09	7.12	20.76
12	0 - 15	4.12	3.13	34.0	14.40	0.53	0.054	26	267	7.25	13.98	29.60
12	15 - 30	4.17	3.93	8.7	3.65	0.22	0.033	16	111	4.22	4.43	15.03
12	30+	4.44	4.22	10.3	4.62	0.27	0.045	17	103	2.94	3.06	14.00
14	0 - 15	4.53	3.58	37.8	22.55	1.27	0.17	18	133	10.89	17.08	38.66
14	15 - 30	3.94	3.88	23.0	11.95	0.87	0.10	14	120	7.49	7.86	24.19
Mean	0 - 15	4.29		38.3	18.69	0.80	0.10	23	198		15.84	
± SD		± 0.17		17.4	9.88	0.42	0.06				7.67	
	15 - 30	± 4.26		14.9	6.82	0.41	0.054	17	124		6.20	
		± 0.21		8.6	4.74	0.29	0.034				2.90	
	30+	± 4.59		11.1	4.93	0.24	0.044	21	113		2.68	
		± 0.21		1.1	0.44	0.04	0.001				0.54	

n.d. = not determined

Table 3. Continued.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD EGIL						
16 A	0 - 15	4.17	3.12	25.5	15.20	0.58	0.055	26	276	4.64	9.36	26.31
16 A	15 - 30	4.30	3.60	23.1	19.42	0.54	0.047	17	200	8.50	10.29	27.47
17 - 19	0 - 15	4.24	3.37	26.8	12.95	0.60	0.069	21	188	7.37	11.23	24.15
17 - 19	15 - 30	4.34	3.85	13.3	5.89	0.34	0.037	17	159	4.76	5.41	17.19
17 - 19	30+	4.61	4.15	2.3	0.57	0.04	0.014	14	41	1.50	1.59	4.37
20 - 22	0 - 15	4.50	3.47	24.8	11.70	0.53	0.069	22	170	6.15	9.74	n.d.
20 - 22	15 - 30	4.50	3.67	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	5.05	5.81	14.67
23 - 25	0 - 15	4.79	3.71	21.3	9.11	0.42	0.051	22	179	4.86	8.25	20.94
23 - 25	15 - 30	4.57	4.23	15.1	5.70	0.43	0.057	13	100	2.82	3.00	14.20
Mean	0 - 15	4.43		24.6	12.24	0.53	0.061	23	203		9.65	
± SD		± 0.28		2.4	2.54	0.08	0.009				1.23	
	15 - 30	4.43		17.2	10.34	0.44	0.047	16	153		6.13	
		± 0.13		5.2	7.87	0.10	0.010				3.04	
	30+	4.61		2.3	0.57	0.04	0.014	14	41		1.59	
						FIELD ROLF						
1 - 2	0 - 15	4.16	3.10	38.8	16.55	0.59	0.080	28	207	8.39	14.75	35.30
1 - 2	15 - 30	4.17	3.91	7.1	2.69	0.16	0.014	17	192	3.37	3.69	11.72
1 - 2	30+	4.59	4.27	5.4	1.49	0.11	0.051	14	29	1.93	2.02	6.38
3 - 5	0 - 15	4.44	3.39	25.8	12.75	0.51	0.056	25	228	5.89	10.13	28.57
3 - 5	15 - 30	4.11	3.89	9.7	4.34	0.27	0.037	16	117	3.85	4.07	13.36
3 - 5	30+	4.57	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	2.25	2.38	12.28
Mean	0 - 15	4.30		32.3	14.65	0.55	0.068	27	218		12.44	
± SD		± 0.20		9.2	2.69	0.06	0.017				3.27	
	15 - 30	4.14		8.4	3.52	0.22	0.026	16	155		3.88	
		± 0.04		1.8	1.17	0.08	0.016				0.27	
	30+	4.58		5.4	1.49	0.11	0.051	14	29		2.20	
		± 0.05		0	0	0	0				0.25	

n.d. = not determined

Table 3. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD KIM							
5	0 - 15	1.32	0.73	0.25	0.13	1.89	1.55	3.94	2.7	72	4.32	44	17
5	15 - 30	0.03	0.02	0.03	0.04	0.15	0.16	2.76	2.8	95	0.27	8	2
8 + 9	0 - 15	0.78	0.42	0.23	0.10	1.89	0.59	4.04	3.0	87	3.42	42	15
9	15 - 30	0.03	0.02	0.03	0.04	0.04	0.17	3.50	2.8	96	0.16	4	1
10	0 - 15	3.84	2.56	0.85	0.33	5.25	4.19	12.67	2.6	75	12.83	43	48
10	15 - 30	0.40	0.29	0.13	0.10	0.50	0.46	8.87	2.8	95	1.42	13	n.d.
10	30+	0.03	0.04	0.02	0.05	0.01	0	2.14	2.9	100	0.15	7	2
11	0 - 15	2.12	1.37	0.55	0.22	3.75	2.37	6.05	2.8	72	8.01	49	n.d.
11	15 - 30	0.28	0.02	0.07	0.07	0.66	0.41	5.68	2.8	93	1.03	14	5
12	0 - 15	2.14	1.13	0.40	0.19	2.87	2.21	5.03	2.8	69	6.73	48	23
12	15 - 30	0.04	0.03	0.05	0.06	0.03	0.20	4.02	2.8	95	0.21	5	1
12	30+	0.02	0.02	0.02	0.05	0.01	0.13	2.81	2.6	96	0.12	4	1
14	0 - 15	1.44	0.78	0.42	0.19	3.36	1.29	9.59	2.7	88	6.19	36	16
14	15 - 30	0.06	0.06	0.08	0.08	0.09	0.23	7.26	2.7	97	0.37	5	2
Mean	0 - 15	1.94	1.17	0.45	0.19	3.17	2.03	6.89					
± SD		± 1.06	0.76	0.23	0.08	1.27	1.24	3.51					
	15 - 30	± 0.14	0.07	0.07	0.07	0.25	0.27	5.35					
		± 0.16	0.11	0.04	0.02	0.27	0.13	2.37					
	30+	± 0.03	0.03	0.02	0.05	0.01	0.07	2.48					
		± 0.007	0.01	0	0	0	0.09	0.47					

n.d. = not determined

Table 3. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl Ca	Mg	K	Na	NH_4	H	Al	Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%) pH KCl	pH7
						FIELD EGIL							
16 A	0 - 15	1.32	1.26	0.23	0.15	1.76	1.56	3.08	2.6	66	4.72	50	18
16 A	15 - 30	0.29	0.55	0.12	0.12	0.71	0.33	8.18	2.8	96	1.79	17	7
17 - 19	0 - 15	0.77	0.51	0.26	0.11	2.21	1.01	6.37	2.8	86	3.86	34	16
17 - 19	15 - 30	0.07	0.09	0.05	0.05	0.39	0.17	4.59	3.0	96	0.65	12	4
17 - 19	30+	0.02	0.02	0.02	0.03	0	0.04	1.46	2.7	97	0.09	6	2
20 - 22	0 - 15	0.63	0.40	0.17	0.10	2.29	0.73	5.42	2.9	88	3.59	37	n.d.
20 - 22	15 - 30	0.06	0.06	0.07	0.05	0.52	0.38	4.67	2.7	92	0.76	13	5
23 - 25	0 - 15	0.63	0.35	0.24	0.11	2.06	0.31	4.56	2.9	94	3.39	41	16
23 - 25	15 - 30	0.02	0.03	0.06	0.06	0.01	0.13	2.69	2.8	95	0.18	6	1
Mean	0 - 15	0.84	0.63	0.23	0.12	2.08	0.90	4.86					
		± 0.33	0.43	0.04	0.02	0.23	0.52	1.40					
	15 - 30	0.11	0.18	0.08	0.07	0.41	0.25	5.03					
		± 0.12	0.25	0.03	0.03	0.30	0.12	2.29					
	30+	0.02	0.02	0.02	0.03	0	0.04	1.46					
						FIELD ROLF							
1 - 2	0 - 15	1.66	1.14	0.40	0.17	2.99	2.32	6.07	2.9	72	6.36	43	18
1 - 2	15 - 30	0.05	0.04	0.05	0.04	0.14	0.19	3.19	2.9	95	0.32	9	3
1 - 2	30+	0.02	0.01	0.03	0.03	0	0.11	1.82	2.3	94	0.09	4	1
3 - 5	0 - 15	1.00	0.55	0.21	0.10	2.38	0.99	4.90	2.8	83	4.24	42	15
3 - 5	15 - 30	0.06	0.05	0.05	0.04	0.02	0.14	3.71	2.9	96	0.22	5	2
3 - 5	30+	0.03	0.03	0.04	0.03	0	0	2.25	2.8	100	0.13	5	1
Mean	0 - 15	1.33	0.85	0.31	0.14	2.69	1.66	5.49					
± SD		± 0.47	0.42	0.13	0.05	0.43	0.94	0.83					
	15 - 30	0.06	0.05	0.45	0.04	0.08	0.17	3.45					
		± 0.007	0.007	0	0	0.08	0.04	0.37					
	30+	0.03	0.02	0.04	0.03	0	0.06	2.04					
		± 0.007	0.01	0.007	0	0	0.07	0.30					

n.d. = not determined

Table 3. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})	Dry bulk density (g cm^{-3})
		FIELD KIM		
5	0 - 15	0.98	0.36	0.45
5	15 - 30	0.27	0.22	1.38
8 + 9	0 - 15	0.91	0.70	0.61
9	15 - 30	0.14	0.44	1.14
10	0 - 15	2.36	0.74	-
10	15 - 30	0.76	1.02	0.75
10	30+	0.30	1.17	-
11	0 - 15	1.82	0.75	0.27
11	15 - 30	0.40	0.25	1.06
12	0 - 15	1.36	0.57	0.37
12	15 - 30	0.39	0.45	1.15
12	30+	0.27	0.90	1.05
14	0 - 15	2.18	0.55	0.38
14	15 - 30	0.70	1.29	0.67
Mean	0 - 15	1.61	0.61	0.42
$\pm$ SD		$\pm$ 0.61	0.15	0.15
	15 - 30	$\pm$ 0.44	0.61	1.03
		$\pm$ 0.24	0.44	0.27
	30+	$\pm$ 0.29	1.04	1.05
		$\pm$ -	0.19	0

Dash (-) indicates no data.

Table 3. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})	Dry bulk density (g cm^{-3})
		FIELD EGIL		
16 A	0 - 15	0.81	0.42	0.40
16 A	15 - 30	1.34	0.48	0.59
17 - 19	0 - 15	1.23	0.44	0.45
17 - 19	15 - 30	0.82	0.40	1.03
17 - 19	30+	0.29	0.60	n.d.
20 - 22	0 - 15	0.92	0.44	0.49
20 - 22	15 - 30	n.d.	n.d.	n.d.
23 - 25	0 - 15	0.96	0.62	0.55
23 - 25	15 - 30	0.62	2.80	0.93
Mean	0 - 15	0.98	0.48	0.47
$\pm$ SD		$\pm$ 0.18	0.09	0.06
	15 - 30	0.93	1.22	0.85
		$\pm$ 0.37	1.36	0.25
	30+	0.29	0.60	n.d.
		FIELD ROLF		
1 - 2	0 - 15	1.68	0.65	0.28
1 - 2	15 - 30	0.43	0.47	1.06
1 - 2	30+	0.42	2.98	1.25
3 - 5	0 - 15	0.62	0.42	0.43
3 - 5	15 - 30	0.28	0.47	1.01
3 - 5	30+	n.d.	n.d.	n.d.
Mean	0 - 15	1.15	0.54	0.36
$\pm$ SD		$\pm$ 0.75	0.16	0.11
	15 - 30	0.36	0.47	1.04
		$\pm$ 0.11	0	0.04
	30+	0.42	2.98	1.25

n.d. = not determined

Table 4. Chemical data for soil samples from Sogndal 1985.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD 2						
1	0 - 15	4.42	4.41	20.7	7.76	0.34	0.028	23	277	2.61	3.40	16.48
1	15+	4.70	4.69	9.4	3.13	0.14	0.007	23	447	0.75	1.0	8.07
2	0 - 15	4.40	4.38	24.3	9.75	0.38	0.053	26	184	3.65	5.11	19.98
2	15+	4.84	4.63	12.5	4.26	0.17	0.021	24	203	1.32	1.65	11.29
3	0 - 15	5.15	5.13	5.7	1.15	0.07	0.010	16	115	0.17	0.48	3.62
3	15+	5.40	5.27	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.13	0.41	2.76
4	0 - 15	4.77	5.06	7.7	2.47	0.12	0.015	21	165	0.25	0.45	5.42
4	15+	5.03	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.30	0.57	5.66
5	0 - 15	4.47	4.30	42.9	18.20	0.98	0.13	19	140	6.41	8.15	27.38
5	15+	4.20	4.36	46.7	19.25	1.25	0.19	15	101	6.16	7.21	28.44
6	0 - 15	4.72	4.56	15.1	5.84	0.24	0.027	24	216	1.59	2.32	13.44
6	15+	4.94	4.99	6.2	1.51	0.07	0.004	23	378	0.37	0.53	3.13
7	0 - 15	5.01	4.68	15.6	6.30	0.27	0.034	24	185	1.03	1.91	12.75
7	15+	5.01	4.92	8.3	2.58	0.12	0.014	22	184	0.44	0.65	7.02
Mean	0 - 15	4.71		18.9	7.35	0.34	0.042	22			3.12	
± SD		± 0.30		12.5	5.62	0.30	0.041				2.76	
	15+	± 4.87		16.6	6.15	0.35	0.047	18			1.72	
		± 0.37		17.0	7.39	0.50	0.080				2.46	

n.d. = not determined

Table 4. Continued.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD 4						
8	0 - 15	4.88	4.36	25.8	11.75	0.50	0.045	24	261	3.92	6.35	22.88
8	15+	4.80	4.60	19.1	7.54	0.35	0.040	21	189	1.81	2.22	15.62
9	0 - 15	4.93	4.13	45.8	22.50	0.95	0.085	24	265	9.61	11.42	34.39
9	15+	4.97	4.41	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	3.45	3.94	21.04
Mean	0 - 15	4.91		35.8	17.13	0.73	0.065	23			8.89	
± SD		± 0.04		14.1	7.60	0.32	0.028				3.59	
	15+	4.89		19.1	7.54	0.35	0.040	22			3.08	
		± 0.12		0	0	0	0				1.22	
						FIELD 1						
10	0 - 15	5.07	4.57	17.6	7.09	0.30	0.032	24	222	1.78	2.54	14.99
10	15+	5.33	4.95	n.d.	n.d.	n.d.	n.d.	n.d.	n.d	0.42	0.57	7.78
11	0 - 15	4.74	4.20	29.7	12.15	0.52	0.059	23	206	5.57	9.31	30.88
11	15+	4.80	4.26	18.9	8.63	0.34	0.034	25	254	4.10	5.44	20.42
Mean	0 - 15	4.91		23.7	9.62	0.41	0.046	23			5.93	
± SD		± 0.23		8.6	3.58	0.16	0.019				4.79	
	15+	5.07		18.9	8.63	0.34	0.034	25			3.01	
		± 0.37		0	0	0	0				3.44	

n.d. = not determined

Table 4. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl Ca	Mg	K	Na	NH_4	H	Al	Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%) pH KCl	pH7
						FIELD 2							
1	0 - 15	0.37	0.11	0.13	0.05	0.13	0.12	2.49	2.9	95	0.79	23	5
1	15+	0.12	0.03	0.03	0.03	0.03	0.09	0.66	2.5	88	0.25	25	3
2	0 - 15	0.97	0.24	0.16	0.05	0.03	0.29	3.36	2.8	92	1.46	29	7
2	15+	0.19	0.03	0.03	0.04	0.05	0.15	1.17	2.8	89	0.33	20	3
3	0 - 15	0.21	0.10	0.02	0.03	0.03	0.04	0.11	2.0	65	0.31	65	9
3	15+	0.20	0.01	0.01	0.03	0.03	0.02	0.05	2.9	38	0.28	68	10
4	0 - 15	0.11	0.01	0.02	0.03	0.03	0.04	0.21	2.3	84	0.20	44	4
4	15+	0.17	0.01	0.01	0.04	0.03	0.03	0.27	3.0	90	0.27	47	5
5	0 - 15	0.85	0.19	0.26	0.11	0.32	0.50	5.91	2.8	92	1.74	21	6
5	15+	0.58	0.10	0.10	0.09	0.18	0.50	5.66	2.8	92	1.05	15	4
6	0 - 15	0.38	0.10	0.10	0.04	0.11	0.15	1.44	2.7	91	0.73	31	5
6	15+	0.08	0.01	0.01	0.03	0.03	0.05	0.32	2.9	86	0.16	30	5
7	0 - 15	0.56	0.13	0.12	0.04	0.03	0.05	0.98	2.7	95	0.88	46	7
7	15+	0.12	0.02	0.01	0.03	0.03	0.05	0.39	2.4	89	0.21	32	3
Mean ± SD	0 - 15	0.49 ± 0.32	0.13 ± 0.07	0.10 ± 0.09	0.05 ± 0.03	0.10 ± 0.11	0.30 ± 0.34	2.07 ± 2.06					
	15+	0.21 ± 0.17	0.03 ± 0.03	0.04 ± 0.04	0.04 ± 0.02	0.05 ± 0.06	0.18 ± 0.19	1.22 ± 1.99					

Table 4. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD 4							
8	0 - 15	1.86	0.30	0.18	0.06	0.04	0.30	3.62	2.9	92	2.43	38	11
8	15+	0.25	0.05	0.05	0.04	0.03	0.17	1.64	2.9	91	0.41	18	3
9	0 - 15	0.79	0.34	0.31	0.09	0.28	0.44	9.17	3.0	95	1.81	16	5
9	15+	0.30	0.04	0.03	0.06	0.06	0.25	3.20	3.0		0.49	12	2
Mean	0 - 15	1.33	0.32	0.25	0.08	0.16	0.37	6.40					
± SD		± 0.76	0.03	0.09	0.02	0.17	0.10	3.92					
	15+	± 0.28	0.05	0.04	0.05	0.05	0.21	2.42					
		± 0.04	0.007	0.01	0.01	0.02	0.06	1.10					
						FIELD 1							
10	0 - 15	0.43	0.13	0.13	0.03	0.03	0.23	1.55	2.6	87	0.76	30	5
10	15+	0.06	0.01	0.02	0.02	0.03	0.05	0.37	2.5	88	0.15	26	2
11	0 - 15	2.87	0.40	0.16	0.07	0.24	0.31	5.26	3.0	94	3.74	40	12
11	15+	1.03	0.15	0.03	0.04	0.09	0.28	3.82	3.0	93	1.34	25	7
Mean	0 - 15	1.65	0.27	0.15	0.05	0.14	0.27	3.41					
± SD		± 1.73	0.19	0.02	0.03	0.15	0.06	2.62					
	15+	± 0.55	0.08	0.03	0.03	0.06	0.17	2.10					
		± 0.69	0.10	0.007	0.01	0.04	0.16	2.44					

Table 4. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})	Dry bulk density (g cm^{-3})
		FIELD 2		
1	0 - 15	0.67	2.01	0.57
1	15+	0.27	1.43	0.85
2	0 - 15	0.69	3.15	0.50
2	15+	0.23	1.78	0.72
3	0 - 15	0.20	2.03	1.37
3	15+	n.d.	n.d.	n.d.
4	0 - 15	0.11	8.88	0.93
4	15+	n.d.	n.d.	n.d.
5	0 - 15	0.80	1.57	0.31
5	15+	0.38	0.87	0.34
6	0 - 15	0.61	4.39	0.60
6	15+	0.22	5.90	0.89
7	0 - 15	0.56	4.87	0.59
7	15+	0.19	2.01	0.82
Mean	0 - 15	0.52	3.84	0.70
$\pm$ SD		$\pm$ 0.26	2.55	0.35
	15+	$\pm$ 0.26	2.40	0.72
		$\pm$	2.00	0.33

n.d. = not determined

Table 4. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})	Dry bulk density (g cm^{-3})
		FIELD 4		
8	0 - 15	0.55	0.65	0.50
8	15+	0.23	0.90	0.65
9	0 - 15	0.84	1.37	0.30
9	15+	n.d.	n.d.	n.d.
Mean	0 - 15	0.70	1.01	0.40
± SD		± 0.21	0.51	0.14
	15+	± 0.23	0.90	0.65
		FIELD 1		
10	0 - 15	0.38	1.91	0.61
10	15+	n.d.	n.d.	n.d.
11	0 - 15	0.32	1.04	0.46
11	15+	0.17	0.62	0.55
Mean	0 - 15	0.35	1.48	0.54
± SD		± 0.04	0.62	0.11
	15+	± 0.17	0.62	0.55

n.d. = not determined

Table 5. Chemical data for soil samples from Risdalsheia 1986.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD KIM						
5	0 - 15	3.90	n.d.	75.3	36.76	1.37	0.085	27	432	14.60	28.20	n.d.
5	15 - 30	3.90	2.98	8.93	4.26	0.16	0.005	27	852	3.28	4.40	13.17
8 + 9	0 - 15	4.14	3.19	37.9	18.83	0.82	0.080	23	235	7.67	13.51	32.71
9	15 - 30	4.29	3.44	13.0	6.12	0.31	0.023	20	266	4.74	5.87	16.16
10	0 - 15	4.44	3.65	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	15.28	26.81	n.d.
10	15 - 30	4.30	3.46	36.9	17.77	0.74	0.074	24	240	8.74	14.62	36.73
10	30+	4.75	4.01	19.9	10.90	0.47	0.071	23	154	5.56	6.32	21.73
11	0 - 15	3.97	3.05	73.0	35.71	1.39	0.16	26	223	13.00	25.63	n.d.
11	15 - 30	4.01	3.59	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	7.42	8.14	25.84
11	30+	3.93	3.10	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	7.88	12.59	31.87
12	0 - 15	4.01	2.99	53.7	27.81	1.07	0.11	26	253	8.20	19.29	n.d.
12	15 - 30	4.02	3.17	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	5.61	8.67	22.99
12	30+	4.16	3.34	12.8	6.93	0.31	0.026	22	267	5.72	7.12	18.97
14	0 - 15	4.19	3.24	44.6	20.25	0.96	0.11	21	184	10.99	16.81	n.d.
14	15 - 30	4.29	3.69	33.7	17.46	0.87	0.15	20	116	7.71	11.12	32.28
14	30+	4.36	3.74	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	6.61	8.71	26.33
Mean	0 - 15	4.11		56.9	27.88	1.12	0.109				21.71	
± SD		± 0.19		16.7	8.36	0.25	0.031				6.01	
	15 - 30	4.14		23.1	11.40	0.52	0.115				8.80	
		± 0.18		14.2	7.21	0.34	0.097				3.68	
	30+	4.30		16.4	8.92	0.39	0.049				8.69	
		± 0.35		5.0	2.81	0.11	0.032				2.79	

n.d. = not determined

Table 5. Continued.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD EGIL						
16 A	0 - 15	4.10	3.40	33.2	17.68	0.83	0.088	21	201	8.83	12.57	30.87
16 A	15 - 30	3.94	3.30	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	9.47	14.03	36.08
17 - 19	0 - 15	4.11	3.22	37.6	19.34	0.90	0.097	21	199	8.21	13.36	30.87
17 - 19	15 - 30	4.19	3.38	26.0	12.48	0.63	0.059	20	212	7.60	10.41	26.50
17 - 19	30+	4.20	3.50	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	7.94	9.81	26.71
20 - 22	0 - 15	4.03	3.26	28.9	14.93	0.66	0.070	23	213	7.26	10.62	n.d.
20 - 22	15 - 30	3.84	3.01	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	6.93	9.41	24.93
23 - 25	0 - 15	4.03	3.23	54.2	27.47	1.21	0.14	23	196	9.71	17.75	n.d.
23 - 25	15 - 30	4.47	3.71	14.3	7.25	0.38	0.034	19	213	5.20	6.26	18.03
Mean	0 - 15	4.07		38.5	19.86	0.90	0.099				13.58	
± SD		± 0.04		11.1	5.39	0.23	0.030				3.01	
	15 - 30	4.11		20.2	9.87	0.51	0.05				10.03	
		± 0.28		8.3	3.70	0.18	0.02				3.20	
	30+	4.20									9.81	
		± 0									0	
						FIELD ROLF						
1 - 2	0 - 15	3.82	2.80	51.7	27.29	1.02	0.13	27	210	11.19	18.72	n.d.
1 - 2	15 - 30	3.82	3.25	8.55	4.67	0.24	0.022	19	212	4.70	5.45	13.11
1 - 2	30+	4.12	3.83	6.63	2.77	0.16	0.019	17	146	2.84	2.99	10.07
3 - 5	0 - 15	3.98	2.97	57.6	26.95	1.06	0.12	25	225	9.54	17.30	n.d.
3 - 5	15 - 30	4.11	3.31	20.6	10.14	0.47	0.048	22	211	6.04	7.54	19.94
3 - 5	30+	5.02	4.23	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	1.45	1.60	5.35
Mean	0 - 15	3.90		54.65	27.13	1.04	0.125				18.01	
± SD		± 0.11		4.17	0.23	0.03	0.007				1.00	
	15 - 30	3.97		14.58	7.41	0.36	0.035				6.50	
		± 0.21		8.52	3.87	0.16					1.48	
	30+	4.57									2.30	
		± 0.64									0.98	

n.d. = not determined

Table 5. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl Ca	Mg	K	Na	NH_4	H	Al	Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%) pH KCl	pH7
						FIELD KIM							
5	0 - 15	5.72	2.80	0.86	0.44	3.78	6.95	7.65		52	13.60	48	n.d.
5	15 - 30	0.37	0.23	0.11	0.07	0.34	0.92	2.36	3.0	72	1.12	25	9
8 + 9	0 - 15	1.78	1.04	0.48	0.18	2.36	1.53	6.15	3.0	80	5.84	43	18
9	15 - 30	0.32	0.21	0.09	0.06	0.45	0.29	4.45	3.0	94	1.13	19	7
10	0 - 15	4.52	1.97	0.78	0.47	3.79	1.57	13.71	2.7	90	11.53	43	n.d.
10	15 - 30	2.54	1.22	0.36	0.18	1.58	1.15	7.59	2.7	87	5.88	40	16
10	30+	0.36	0.20	0.07	0.08	0.05	0.19	5.38	2.8	97	0.76	12	6
11	0 - 15	5.01	2.57	0.93	0.32	3.80	4.05	8.96		69	12.63	49	n.d.
11	15 - 30	0.24	0.14	0.07	0.10	0.17	0.30	7.12	2.9	96	0.72	9	3
11	30+	1.57	1.28	0.35	0.22	1.29	1.69	6.19	3.0	79	4.71	37	15
12	0 - 15	4.64	2.31	0.82	0.29	3.03	4.08	4.12	3.0	50	11.09	57	n.d.
12	15 - 30	1.30	0.57	0.27	0.12	0.80	1.42	4.19	2.7	75	3.06	35	13
12	30+	0.45	0.22	0.15	0.08	0.50	0.84	4.89	2.8	85	1.40	20	7
14	0 - 15	2.09	1.08	0.55	0.21	1.89	2.45	8.54	2.7	78	5.82	35	n.d.
14	15 - 30	1.24	0.87	0.31	0.19	0.80	0.36	7.35	2.8	95	3.41	31	11
14	30+	0.90	0.54	0.15	0.14	0.37	0.25	6.36	2.9	96	2.10	24	8
Mean	0 - 15	3.96	1.96	0.74	0.32	3.11	3.44	8.19					
± SD		± 1.63	0.75	0.18	0.12	0.83	2.06	3.23					
	15 - 30	± 1.00	0.54	0.20	0.12	0.69	0.74	4.51					
		± 0.89	0.43	0.13	0.05	0.50	0.49	2.37					
	30+	± 0.82	0.56	0.18	0.13	0.55	0.74	5.71					
		± 0.55	0.50	0.12	0.07	0.53	0.70	0.69					

n.d. = not determined

Table 5. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl Ca	Mg	K	Na	NH_4	H	Al	Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%) pH KCl	BS (%) pH7
						FIELD EGIL							
16 A	0 - 15	1.07	0.53	0.35	0.13	1.66	0.51	8.32		94	3.74	30	12
16 A	15 - 30	1.64	0.85	0.35	0.17	1.55	1.14	8.33		88	4.56	33	13
17 - 19	0 - 15	1.46	0.76	0.42	0.13	2.38	1.07	7.15		87	5.15	39	17
17 - 19	15 - 30	0.96	0.59	0.19	0.10	0.97	0.65	6.95		91	2.81	27	11
17 - 19	30+	0.40	0.32	0.14	0.11	0.90	0.40	7.53	2.9	95	1.87	19	7
20 - 22	0 - 15	0.92	0.49	0.33	0.12	1.50	0.91	6.34	3.0	87	3.36	32	n.d.
20 - 22	15 - 30	0.89	0.66	0.19	0.13	0.61	1.28	5.65	3.0	82	2.48	26	10
23 - 25	0 - 15	2.32	1.17	0.58	0.19	3.78	1.53	8.18	3.0	84	8.04	45	n.d.
23 - 25	15 - 30	0.17	0.14	0.15	0.07	0.53	0.17	5.03	3.0	97	1.06	17	6
Mean	0 - 15	1.44	0.74	0.42	0.14	2.33	1.01	7.50					
± SD		± 0.63	0.31	0.11	0.03	1.04	0.42	0.93					
	15 - 30	± 0.92	0.56	0.22	0.12	0.92	0.81	6.49					
		± 0.60	0.30	0.09	0.04	0.46	0.50	1.46					
	30+	± 0.40	0.32	0.14	0.11	0.90	0.40	7.53					
						FIELD ROLF							
1 - 2	0 - 15	3.24	1.70	0.63	0.21	1.75	2.65	8.54		76	7.53	40	n.d.
1 - 2	15 - 30	0.25	0.16	0.09	0.04	0.21	0.39	4.31		92	0.75	14	6
1 - 2	30+	0.04	0.03	0.03	0.02	0.03	0.15	2.69	3.0	95	0.15	5	1
3 - 5	0 - 15	3.28	1.45	0.53	0.20	2.30	2.37	7.17		75	7.76	45	n.d.
3 - 5	15 - 30	0.55	0.28	0.13	0.06	0.48	0.28	5.77		96	1.50	20	8
3 - 5	30+	0.02	0.02	0.04	0.03	0.04	0.03	1.42	2.6	98	0.15	9	3
Mean	0 - 15	3.26	1.58	0.58	0.21	2.03	2.51	7.86					
± SD		± 0.03	0.18	0.07	0.007	0.39	0.20	0.97					
	15 - 30	± 0.40	0.22	0.11	0.05	0.35	0.34	5.04					
		± 0.21	0.08	0.03	0.01	0.19	0.08	1.03					
	30+	± 0.03	0.03	0.04	0.03	0.04	0.09	2.06					
		± 0.01	0.007	0.007	0.007	0.007	0.08	0.90					

n.d. = not determined

Table 5. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})
		FIELD KIM	
5	0 - 15	1.62	0.75
5	15 - 30	0.28	0.14
8 + 9	0 - 15	1.97	0.53
9	15 - 30	0.41	0.25
10	0 - 15	n.d.	n.d.
10	15 - 30	1.92	0.47
10	30+	0.87	1.18
11	0 - 15	2.43	0.74
11	15 - 30	n.d.	n.d.
11	30+	n.d.	n.d.
12	0 - 15	1.99	0.59
12	15 - 30	n.d.	n.d.
12	30+	0.70	0.21
14	0 - 15	2.15	0.59
14	15 - 30	3.89	2.26
14	30+	n.d.	n.d.
Mean	0 - 15	2.03	0.64
$\pm$ SD		$\pm$ 0.29	0.10
	15 - 30	1.63	0.78
		$\pm$ 1.68	1.00
	30+	0.79	0.70

n.d. = not determined

Table 5. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})
		FIELD EGIL	
16 A	0 - 15	1.68	0.43
16 A	15 - 30	n.d.	n.d.
17 - 19	0 - 15	2.34	0.40
17 - 19	15 - 30	1.40	0.25
17 - 19	30+	n.d.	n.d.
29 - 22	0 - 15	1.25	0.57
20 - 22	15 - 30	n.d.	n.d.
23 - 25	0 - 15	3.11	1.07
23 - 25	15 - 30	1.00	0.41
Mean	0 - 15	2.10	0.62
± SD		± 0.81	0.31
	15 - 30	± 1.20	0.33
		± 0.28	0.11
		FIELD ROLF	
1 - 2	0 - 15	2.54	1.12
1 - 2	15 - 30	0.68	0.42
1 - 2	30+	0.30	0.42
3 - 5	0 - 15	1.36	0.56
3 - 5	15 - 30	0.67	0.45
3 - 5	30+	n.d.	n.d.
Mean	0 - 15	1.95	0.84
± SD		± 0.83	0.40
	15 - 30	± 0.68	0.44
		± 0.007	0.02
	30+	± 0.30	0.42

n.d. = not determined

Table 6. Chemical data for soil samples from Sogndal 1986.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD 2						
1	0 - 15	4.84	4.32	24.9	11.65	0.51	0.060	23	194	3.73	4.42	19.17
1	15+	5.03	4.77	9.9	3.56	0.17	0.025	21	142	0.81	0.99	8.93
2	0 - 15	4.72	4.22	26.8	11.10	0.41	0.054	27	206	4.83	6.45	23.19
2	15+	5.00	4.40	17.5	25.32	0.29	0.039	25	649	2.74	3.06	16.61
3	0 - 15	5.11	4.48	11.3	5.30	0.29	0.039	18	136	1.11	1.99	9.72
3	15+	5.71	5.03	5.0	1.48	0.09	0.013	16	114	0.09	0.55	4.31
4	0 - 15	5.14	5.07	6.3	2.17	0.11	0.013	19	167	0.14	0.31	4.14
4	15+	5.30	5.19	7.1	2.37	0.11	0.032	21	74	0.08	0.25	4.91
5	0 - 15	4.76	4.20	56.5	23.90	1.21	0.18	20	133	8.32	11.26	33.98
5	15+	4.62	4.28	57.1	26.70	1.64	0.22	16	121	7.51	8.92	33.21
6	0 - 15	5.08	4.34	42.4	11.95	0.43	0.054	28	221	5.00	8.82	23.51
6	15+	5.27	4.61	12.5	4.98	0.18	0.024	28	208	1.00	1.95	11.39
7	0 - 15	5.01	4.53	22.4	9.71	0.38	0.052	26	187	1.66	2.74	17.38
7	15+	5.16	4.73	13.9	5.64	0.23	0.013	24	434	0.76	1.03	11.89
Mean	0 - 15	4.95		27.2	10.83	0.48	0.065	23			5.14	
± SD		± 0.17		17.4	6.83	0.35	0.053				3.92	
	15+	5.16		17.6	10.01	0.39	0.052	22			2.39	
		± 0.33		17.9	11.03	0.56	0.075				3.03	

Table 6. Continued.

Site No.	Depth (cm)	pH (H_2O)	pH (KCl)	Loss on ign.	C (%)	N (%)	S (%)	C/N	C/S	Exch. (KCl) acidity (meq 100 g^{-1})	CEC (meq 100 g^{-1}) pH KCl	CEC (meq 100 g^{-1}) pH7
						FIELD 4						
8	0 - 15	4.94	4.38	23.6	10.05	0.43	0.039	23	258	2.08	4.36	20.84
8	15+	5.13	4.53	18.6	8.49	0.39	0.025	22	340	1.68	2.57	15.78
9	0 - 15	4.44	4.00	51.1	22.50	0.93	0.099	24	227	8.70	10.50	35.06
9	15+	4.81	4.32	31.7	13.55	0.55	0.043	25	315	4.18	5.58	26.06
Mean	0 - 15	4.69		37.4	16.28	0.68	0.069	24			7.43	
		± 0.35		19.4	8.80	0.35	0.042				4.34	
	15+	4.97		25.2	11.02	0.47	0.034	23			4.58	
		± 0.23		9.3	3.58	0.11	0.013				1.42	
						FIELD 1						
10	0 - 15	4.95	4.39	22.8	10.80	0.45	0.038	24	284	2.61	3.47	18.41
10	15+	5.24	4.84	13.9	6.02	0.24	0.028	25	215	0.50	0.69	10.68
11	0 - 15	4.89	4.09	34.5	15.45	0.61	0.071	25	218	6.04	10.01	30.93
11	15+	5.01	4.28	20.0	8.60	0.32	0.026	27	331	2.28	2.99	20.59
Mean	0 - 15	4.92		28.7	13.13	0.53	0.055	25			6.74	
± SD		± 0.04		8.3	3.29	0.11	0.023				4.62	
	15+	5.13		17.0	7.31	0.28	0.027	26			1.84	
		± 0.16		4.3	1.82	0.06	0.001				1.63	

Table 6. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD 2							
1	0 - 15	0.35	0.10	0.16	0.05	0.03	0.32	3.41	2.7	91	0.69	16	4
1	15+	0.10	0.01	0.02	0.02	0.03	0.15	0.66	2.8	81	0.18	18	2
2	0 - 15	1.09	0.27	0.19	0.04	0.03	0.17	4.66	3.0	96	1.62	25	7
2	15+	0.16	0.04	0.06	0.04	0.02	0.36	2.38	3.0	87	0.32	10	2
3	0 - 15	0.65	0.07	0.08	0.06	0.02	0.12	0.98	2.5	88	0.88	44	9
3	15+	0.36	0.01	0.03	0.05	0.01	0	0.09		100	0.46	84	11
4	0 - 15	0.12	0.01	0.02	0.02	0.004	0	0.14	2.0	100	0.17	55	4
4	15+	0.12	0.01	0.01	0.03	0.004	0	0.08	2.1	100	0.17	68	3
5	0 - 15	1.17	0.30	0.39	0.14	0.94	0.37	7.95	2.6	96	2.94	26	9
5	15+	0.54	0.13	0.21	0.08	0.45	0.34	7.17	2.6	95	1.41	16	4
6	0 - 15	2.77	0.72	0.24	0.07	0.02	0.30	4.70	2.7	94	3.82	43	16
6	15+	0.71	0.17	0.03	0.03	0.01	0.13	0.86	2.5	86	0.95	49	8
7	0 - 15	0.76	0.15	0.14	0.03	0.004	0.15	1.51	2.4	91	1.08	39	6
7	15+	0.17	0.04	0.04	0.02	0.004	0.09	0.67	2.6	88	0.27	26	2
Mean ± SD	0 - 15	0.99 ± 0.87	0.23	0.17	0.06	0.15	0.20	3.34					
	15+	0.31 ± 0.24	0.06	0.06	0.04	0.08	0.15	1.70					
			0.06	0.07	0.02	0.17	0.15	2.53					

Table 6. Continued.

Site No.	Depth (cm)	Exchangeable cations (meq 100 g^{-1}) pH KCl							Charge of Al spec.	Exch. Al (% of exch. acid.)	Σ base cations (meq 100 g^{-1})	BS (%)	
		Ca	Mg	K	Na	NH_4	H	Al				pH KCl	pH7
						FIELD 4							
8	0 - 15	1.75	0.22	0.18	0.06	0.07	0.16	1.92	2.6	92	2.28	52	11
8	15+	0.70	0.08	0.06	0.04	0.01	0.05	1.63	2.6	97	0.89	35	6
9	0 - 15	0.89	0.27	0.28	0.09	0.27	0.35	8.35	2.7	96	1.80	17	5
9	15+	0.75	0.24	0.25	0.07	0.09	0.25	3.93	2.7	94	1.40	25	5
Mean	0 - 15	1.32	0.25	0.23	0.08	0.17	0.26	5.14					
± SD		± 0.61	0.04	0.07	0.02	0.14	0.13	4.55					
	15+	0.73	0.16	0.16	0.06	0.05	0.15	2.78					
		± 0.04	0.11	0.13	0.02	0.06	0.14	1.63					
						FIELD 1							
10	0 - 15	0.50	0.16	0.16	0.03	0.01	0.19	2.42	2.6	93	0.86	25	5
10	15+	0.11	0.03	0.03	0.02	0.002	0.21	0.29		58	0.19	28	2
11	0 - 15	3.04	0.64	0.21	0.06	0.02	0.28	5.76	2.7	95	3.97	40	13
11	15+	0.48	0.12	0.05	0.04	0.02	0.18	2.10	2.6	92	0.71	24	3
Mean	0 - 15	1.77	0.40	0.19	0.05	0.02	0.24	4.09					
± SD		± 1.80	0.34	0.04	0.02	0.007	0.06	2.36					
	15+	0.30	0.08	0.04	0.03	0.01	0.20	1.20					
		± 0.26	0.06	0.01	0.01	0.01	0.02	1.28					

Table 6. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})	Dry bulk density (g cm^{-3})
		FIELD 2		
1	0 - 15	0.60	1.88	0.50
1	15+	0.22	2.39	0.91
2	0 - 15	0.64	3.02	0.46
2	15+	0.31	1.79	0.65
3	0 - 15	0.50	1.57	0.92
3	15+	0.22	0.63	1.46
4	0 - 15	0.15	10.0	1.25
4	15+	0.10	6.5	1.13
5	0 - 15	0.90	1.37	0.24
5	15+	0.63	0.75	0.29
6	0 - 15	1.22	5.96	0.29
6	15+	0.50	6.72	0.69
7	0 - 15	0.40	5.61	0.68
7	15+	0.25	3.20	0.96
Mean	0 - 15	0.63	4.19	0.62
$\pm$ SD		$\pm$ 0.35	3.18	0.36
	15+	0.32	3.14	0.87
		$\pm$ 0.18	2.53	0.37

Table 6. Continued.

Site No.	Depth (cm)	SO_4-S (H_2O) (meq kg^{-1})	SO_4-S (ads.) (meq kg^{-1})	Dry bulk density (g cm^{-3})
		FIELD 4		
8	0 - 15	0.41	0.84	0.55
8	15+	0.30	0.64	0.73
9	0 - 15	0.59	1.84	0.31
9	15+	0.30	2.21	0.48
Mean	0 - 15	0.50	1.34	0.43
± SD		± 0.13	0.71	0.17
	15+	0.30	1.43	0.61
		± 0	1.11	0.18
		FIELD 1		
10	0 - 15	0.31	2.08	0.53
10	15+	0.20	3.17	0.76
11	0 - 15	0.29	0.78	0.45
11	15+	0.21	0.53	0.62
Mean	0 - 15	0.30	1.43	0.49
± SD		± 0.01	0.92	0.06
	15+	0.21	1.85	0.69
		± 0.007	1.87	0.10

Table 7. Exchangeable H^+ (pH 7,0), sum of cations and base saturation (pH 7,0) of soil samples from Risdalsheia.

Site No.	Depth (cm)	Exchangeable H^+ (meq 100 g^{-1}) pH 7.0				cations (meq 100 g^{-1}) pH 7.0				BS ($\frac{\text{base cations}}{\text{cations}}$ x 100) pH 7.0			
		1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986
						FIELD KIM							
5	0 - 15	41.02	23.94	34.34	-	43.79	27.26	38.66	-	6.3	12.2	11.2	-
5	15 - 30	8.17	8.57	12.02	13.53	9.20	8.83	12.29	14.65	11.2	2.9	2.2	7.7
5	30+	-	-	-	-	-	-	-	-	-	-	-	-
8 + 9	0 - 15	26.67	17.69	26.40	42.46	28.53	19.40	29.82	48.30	6.5	8.8	11.5	12.1
9	15 - 30	-	7.99	12.39	16.73	-	8.22	12.55	17.86	-	2.8	1.3	6.3
10	0 - 15	63.80	49.24	94.15	-	72.69	56.26	106.98	-	12.2	12.5	12.0	-
10	15 - 30	37.67	15.51	49.29	50.83	39.63	16.13	50.71	56.71	5.0	3.8	2.8	10.4
10	30+	-	27.06	-	20.39	-	27.61	-	21.15	-	2.0	-	3.6
11	0 - 15	53.02	44.34	58.92	93.02	56.15	49.55	66.93	105.65	5.6	10.5	12.0	12.0
11	15 - 30	13.88	28.82	24.58	30.41	14.56	29.90	25.61	31.13	4.7	3.6	4.0	2.3
11	30+	-	-	-	42.64	-	-	-	47.35	-	-	-	10.0
12	0 - 15	-	34.44	45.36	71.60	-	38.34	52.09	82.69	-	10.2	12.9	13.4
12	15 - 30	-	16.76	16.79	27.97	-	17.00	17.00	31.03	-	1.4	1.2	9.9
12	30+	10.96	11.17	12.30	21.74	11.44	11.37	12.42	23.14	4.2	1.8	1.0	6.1
14	0 - 15	60.01	45.33	58.71	58.92	63.60	50.08	64.90	64.74	5.6	9.5	9.5	9.0
14	15 - 30	33.58	37.31	32.74	42.34	34.58	38.19	33.11	45.75	2.9	2.3	1.1	7.5
14	30+	-	29.16	-	29.30	-	31.05	-	31.40	-	6.1	-	6.7
Mean	0 - 15		35.83	52.99	66.50		40.15	59.90	75.35		10.6	11.5	11.6
± SD		±	12.77	23.97	21.33		14.47	27.23	24.61		1.5	1.1	1.9
	15-30	±	19.17	24.64	30.30		19.71	25.21	32.86		2.8	2.2	7.4
		±	11.65	14.45	14.40		11.97	14.88	16.11		0.9	1.2	2.9
	30+	±	22.46	12.30	28.52		23.34	12.42	30.76		3.3	1.0	6.6
		±	9.84	0	10.20		10.51	0	11.92		2.4	0	2.6

Dash (-) indicates no data.

Table 7. Continued.

Site No.	Depth (cm)	Exchangeable H^+ (meq 100 g^{-1}) pH 7.0				cations (meq 100 g^{-1}) pH 7.0				BS ($\frac{\text{base cations}}{\text{cations}}$ x 100) pH 7.0			
		1983	1984	1985	1986	1983	1984	1985	1986	1983	1984	1985	1986
							FIELD EGIL						
16 A	0 - 15	32.12	27.04	36.63	41.32	34.07	30.60	41.35	45.06	5.7	11.5	10.5	8.3
16 A	15 - 30	-	37.63	34.27	58.92	-	39.98	36.06	63.48	-	5.9	5.0	7.2
16 A	30+	-	40.22	-	-	-	42.01	-	-	-	4.3	-	-
17 - 19	0 - 15	33.89	28.37	31.09	41.97	36.00	30.82	34.95	47.12	5.9	8.0	11.0	10.9
17 - 19	15 - 30	-	14.98	19.09	35.32	-	16.16	19.74	38.13	-	7.3	3.3	7.4
17 - 19	30+	-	15.93	4.40	33.09	-	16.59	4.49	34.96	-	4.0	2.0	5.4
20 - 22	0 - 15	26.32	22.21	33.05	31.24	28.49	24.09	36.64	34.60	7.6	7.8	9.8	9.7
20 - 22	15 - 30	-	22.29	15.68	27.20	-	23.59	16.44	29.68	-	5.5	4.6	8.4
23 - 25	0 - 15	28.97	37.36	25.87	56.66	30.65	41.30	29.26	64.70	5.5	9.5	1.1	12.4
23 - 25	15 - 30	9.89	27.86	15.03	17.46	10.80	29.40	15.21	18.52	8.4	5.2	1.2	5.7
Mean	0 - 15		28.75	31.66	42.80		31.70	35.55	47.87		9.2	8.1	10.3
± SD		±	6.32	4.49	10.47		7.12	4.99	12.49		1.7	4.7	1.7
	15 - 30		25.69	21.02	34.73		27.26	21.86	37.45		6.0	3.5	7.2
		±	9.55	9.01	17.71		10.01	9.66	19.12		0.9	1.7	1.1
	30+		28.08		33.09		29.30		34.96		4.2		5.4
		±	17.18		0		17.97		0		0.2		0
							FIELD ROLF						
1 - 2	0 - 15	-	77.47	48.99	41.50	-	86.01	55.35	49.03	-	9.9	11.5	15.4
1 - 2	15 - 30	-	39.08	14.88	11.16	-	42.93	15.20	11.91	-	9.0	2.1	6.3
1 - 2	30+	-	16.33	7.19	8.78	-	17.52	7.28	8.93	-	6.8	1.2	1.7
3 - 5	0 - 15	-	48.89	37.91	55.16	-	53.72	42.15	62.92	-	9.0	10.1	12.3
3 - 5	15 - 30	-	21.89	19.03	23.59	-	20.64	19.25	25.09	-	7.8	1.1	6.0
3 - 5	30+	-	20.70	9.37	5.72	-	21.73	9.50	5.87	-	4.7	1.4	2.6
Mean	0 - 15		63.18	43.45	48.33		69.87	48.75	55.98		9.5	10.8	13.9
± SD		±	20.21	7.83	9.66		22.83	9.33	9.82		0.6	1.0	2.2
	15 - 30		30.49	16.96	17.38		31.79	17.23	18.50		8.4	1.6	6.2
		±	12.16	2.93	8.79		15.76	2.86	9.32		0.8	0.7	0.2
	30+		18.52	8.28	7.25		19.63	8.39	7.40		5.75	1.3	2.2
		±	3.09	1.54	2.16		2.98	1.57	2.16		1.48	0.1	0.6

Dash (-) indicates no data.