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SOIL PHOSPHATES AND THE GROWTH OF RADIATA PINE IN AUCKLAND AND NORTHLAND. A REPORT ON THE A734 SERIES OF TRIALS IN ESTABLISHED STANDS

by

M.F. Skinner and G. Nicholson

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FRI/INDUSTRY RESEARCH COOPERATIVES

EXECUTIVE SUMMARY

This report examines the form of phosphate (organic and inorganic) in a series of Auckland/Northland soils, and indicates that research effort should be directed towards elucidating the role of the organic phosphates in the nutrition of radiata pine.

Soil Phosphates and the Growth of radiata pine in Auckland Conservancy. A Report on the A734 Series of Trials in Established Stands

M.F.SKINNER
G.NICHOLSON

INTRODUCTION

At three sites in the Auckland Conservancy on soils of low, medium and high P retention, P was applied as either rockphosphate or superphosphate. Three years after treatment, there was little response to fertiliser at Waipoua (A734/1) and Tairua (A734/3) compared with Riverhead (A734/2) where at all 3 sites available P was shown to be deficient by the Bray extractant (Hunter and Graham, 1983).

STUDY AIM

The objective of this study was to characterise soil P at the 3 sites, and to determine the distribution of the applied P fertiliser.

METHODS

Soil Samples

Soil Samples were collected in 1985, 7 years after treatment.

(a). 150 cores/treatment from the controls, 150 kg P/ha as rock, and 150 kg P/ha as super, to a depth of 10 cm.

(b). 15 cores/treatment collected per plot for 10-30 cm and 30-50 cm.

Analyses

(a). 0-10 cm depth
Total P by carbonate fusion

Total inorganic P by acid extraction
Total organic P by ashing and acid extraction
Available P by Bray extractant

(b). 10-30 and 30-50 cm depths
Total and available P

RESULTS

TOTAL P in the surface 10 cm ranged from 60 ppm at Waipoua, 200 ppm at Riverhead, and 420 ppm at Tairua (Fig.1). Total P in the fertilised plots is at variance with that expected.

i. At Waipoua, P (from super) had penetrated to at least between 30 and 50 cm. P from rock was not detected.

ii. At Riverhead, super plots had accumulated P in the upper 10 cm (as expected), but there was no evidence of P from rock.

iii. At Tairua, P in both the super and rock plots was recovered within the top 10 cm.

ORGANIC P (0-10 cm) ranged from 8 ppm (17% of total) at Waipoua (Fig.2), 50 ppm (25% of total) at Riverhead, and 140 ppm (33% of total) at Tairua.

A Comment of P Recovery From Fertilised Plots

An application of 150 kg P/ha, taken to a depth of 10 cm equates to 150 kg P/1000 m3, or 150 kg P/1 million kg soil (i.e. 150 ppm). At Tairua, a high P-fixing soil, 200 ppm P was recovered from super plots, and 130 ppm from the rock plots. This agrees reasonably well with the amount added. The results from Riverhead and Waipoua are anomalous. About 150 ppm P from rock was recovered at Riverhead; there was no recovery of superphosphate. At Waipoua, some 40 ppm (equivalent to 80 ppm over the 30-50 cm depth) was recovered for superphosphate; no recovery for rockphosphate.

BRAY P results reflect the fertiliser additions at all three sites, and show elevated levels for both rock and super plots (Fig.3) Table 1 presents results for "available" P according to the Bray test.

Table 1. Distribution of Bray P according to site, treatment and soil depth.

Site	Depth(cm)	Control	Rock	Super
		.... Bray P (kg P/ha)		
Waipoua	0-10	5	12	12
	10-30	14	30	40
	30-50	8	16	50
		27	58	102
Riverhead	0-10	4	50	45
	10-30	4	10	8
	30-50	1	4	4
		9	64	57
Tairua	0-10	4	25	11
	10-30	4	8	4
	30-50	4	4	4
		12	37	19

Table 2 compares Bray P before treatment, and 6 years after fertiliser application.

Table 2. Comparison of Bray P from soil analyses (0-20 cm) at commencement to trial and 6 years later

Site	Before Super	FERTILISER TRT Control		Rock
		.....Bray	P (kg/ha).....	
Waipoua	2	12	27	32
Riverhead	3	6	55	49
Tairua	3	6	29	13

Comments

The control plots show significant increases in Bray P, the largest being at Waipoua, from 2 nto 12 kg P/ha. This increase suggests lateral movement of P from fertilised to control plots. The increases in Bray P at the other 2 sites (of medium to high P retention) may be a reflection of increased mineralisation of organic P via root processes (Skinner, 1978).

Supplementary data of relevance to the A734 Study

The ability of a soil to supply P depends on its buffer capacity to maintain P in solution. A single extract procedure will not provide this information. A sequential extraction procedure will yield information on buffer capacity. This approach was adopted for a series of soils which covered the range of soils used in the A734 series. The results for the sequential series of extractions is shown in Fig 4.

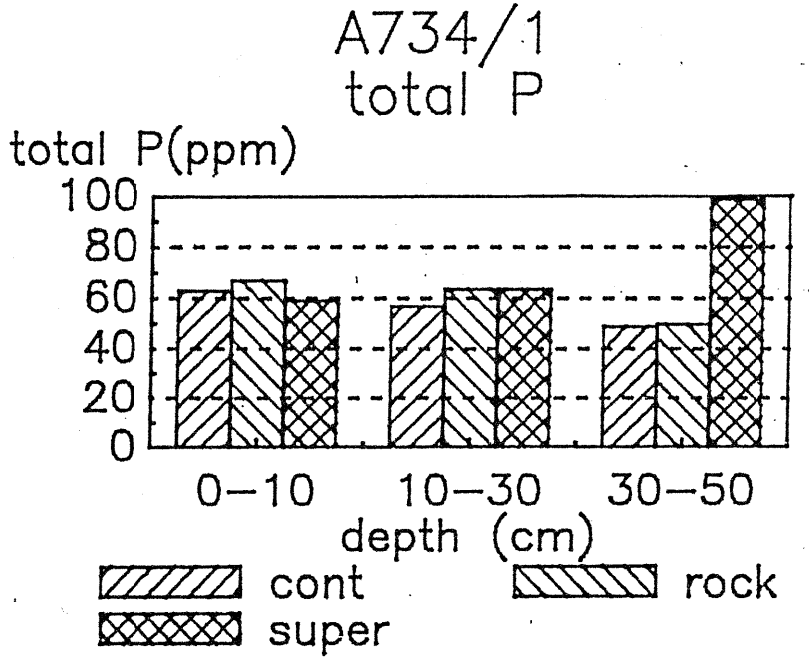
At WAIPOUA on a comparable soil to the A734 study, trial A522 (an establishment trial) showed high Bray P initially (extract 1), declining rapidly to about the levels recorded for the A734/1 STUDY. (The high initial level reflects burning prior to establishment). Control plots at less than 1 ppm P (1 kg P/ ha to a depth of 10 cm) indicates a completely inadequate supply of available P for radiata pine aged 7. Radiata aged between 4 and 6 requires about 25 kg P/ha (Madgwick,1977).

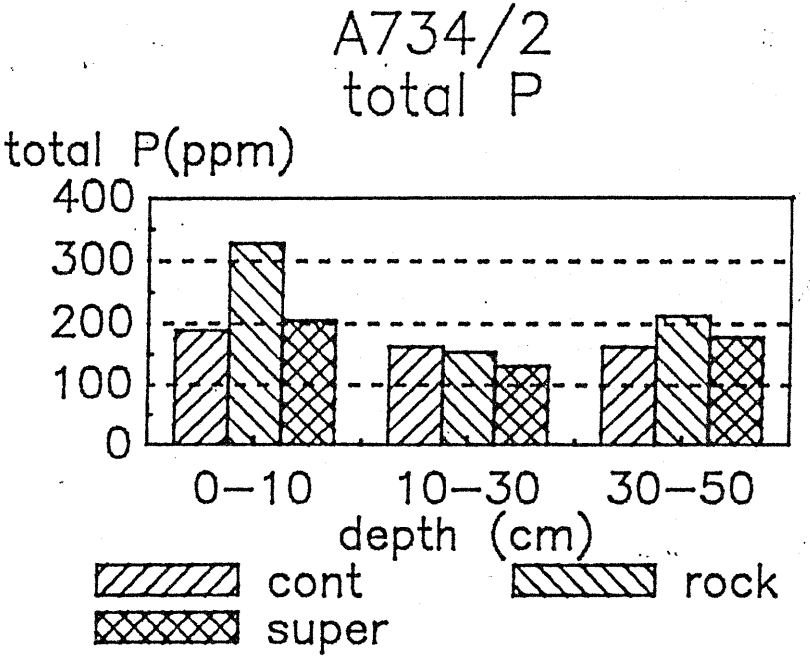
RIVERHEAD (A580) and TAIRUA (A581) Bray P levels were low (over several extractions). The Tairua site is not responsive; the Riverhead site is responsive. The differences between the sites are in total P (200 ppm at Riverhead, and 400 ppm at Tairua). The organic component is approximately doubled at Tairua. Since the Bray reagent extracts from the inorganic P fraction, and the levels are comparable between the 2 sites, the difference is P dynamics remains with the organic fraction.

REFERENCES

Madgwick H.A.I., Jackson D.S. and Knight P.J. Dry matter and nutrient data on Pinus radiata trees and stands. Branch Report 94, FRI, 1977.

Skinner M.F. Chemical and microbiological aspects of the growth of radiata pine in eastern Victoria. Ph.D Thesis. 1978.


A734/1
total P
total P(ppm)
100
80
60
40
20
0
0–10
10–30
30–50
depth (cm)
cont
rock
super


A734/2
total P
total P(ppm)
400
300
200
100
0
0–10
10–30
30–50
depth (cm)
cont
rock
super

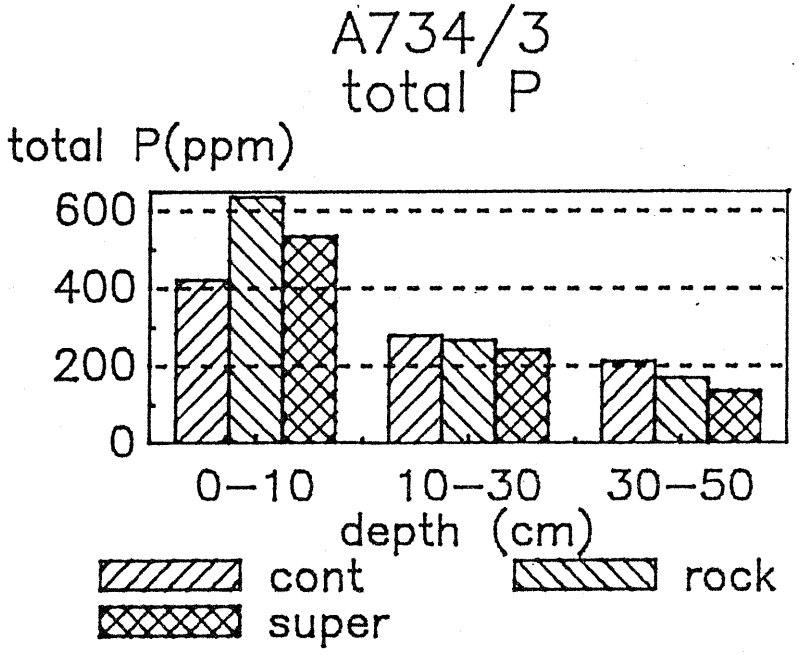
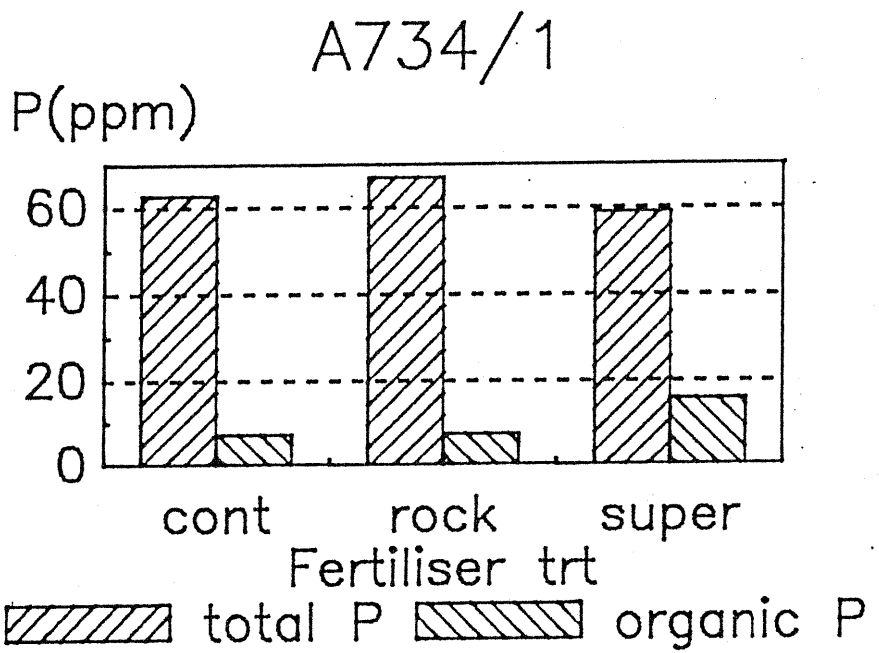
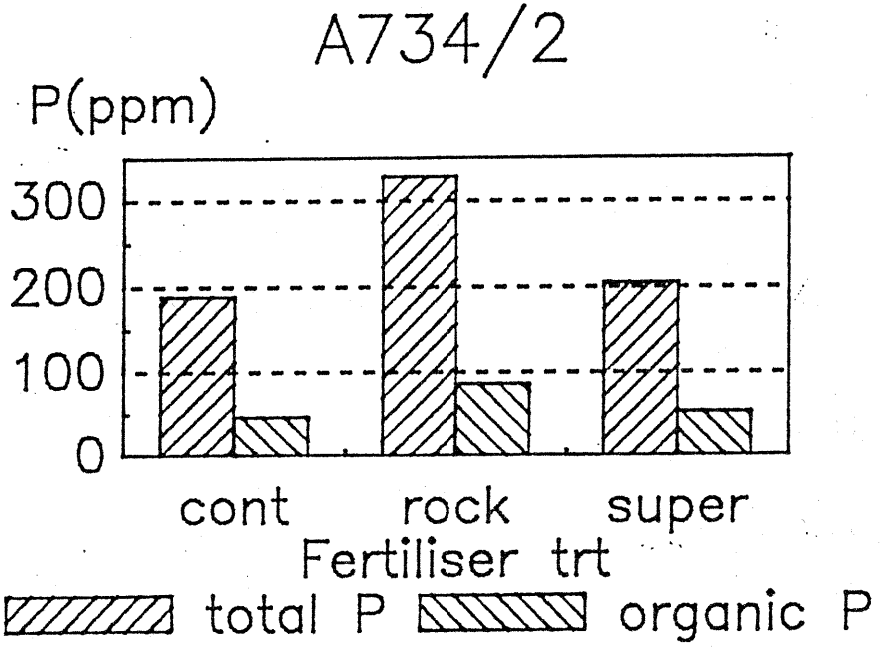

A734/3
total P
total P(ppm)
600
400
200
0
0–10
10–30
30–50
depth (cm)
cont
rock
super

Figure 1


A734/1
P(ppm)
60
40
20
0
cont
rock
super
Fertiliser trt
total P
organic P


A734/2
P(ppm)
300
200
100
0
cont
rock
super
Fertiliser trt
total P
organic P

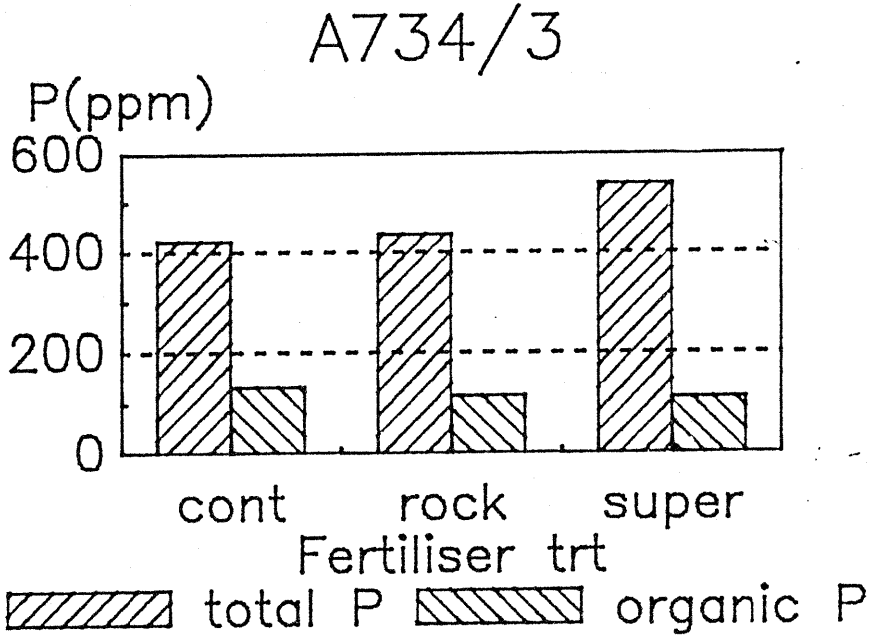
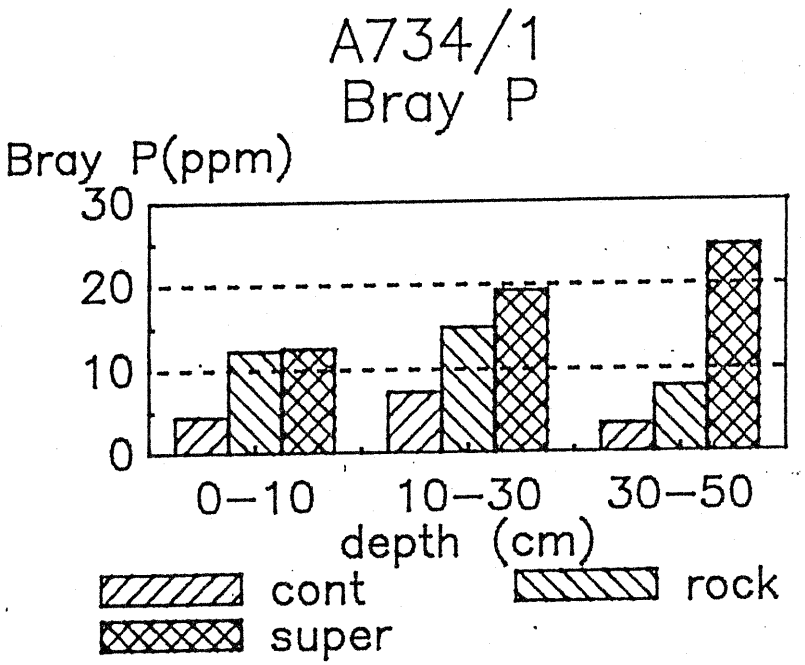
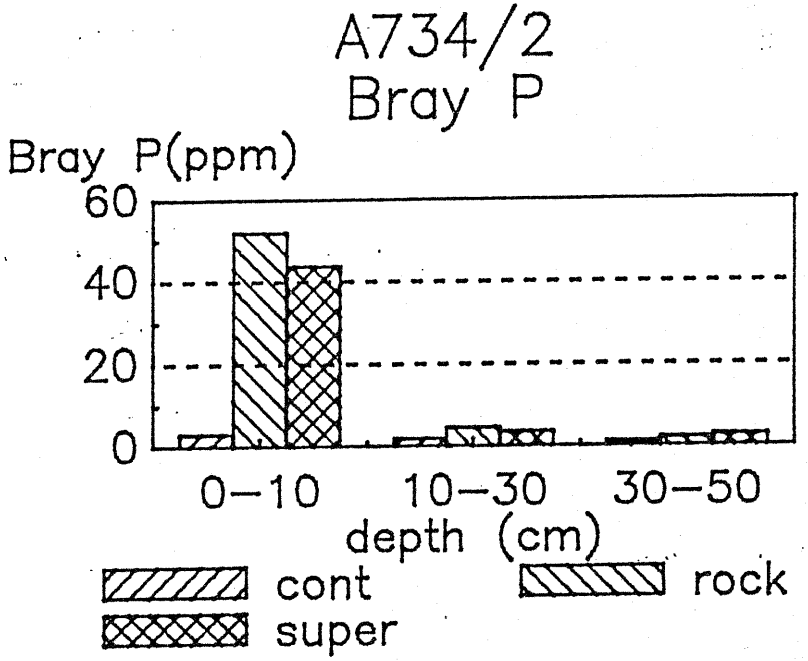

A734/3
P(ppm)
600
400
200
0
cont
rock
super
Fertiliser trt
total P
organic P

Figure 2


A734/1
Bray P
Bray P(ppm)
30
20
10
0
0–10
10–30
30–50
depth (cm)
cont
rock
super


A734/2
Bray P
Bray P(ppm)
60
40
20
0
0–10
10–30
30–50
depth (cm)
cont
rock
super

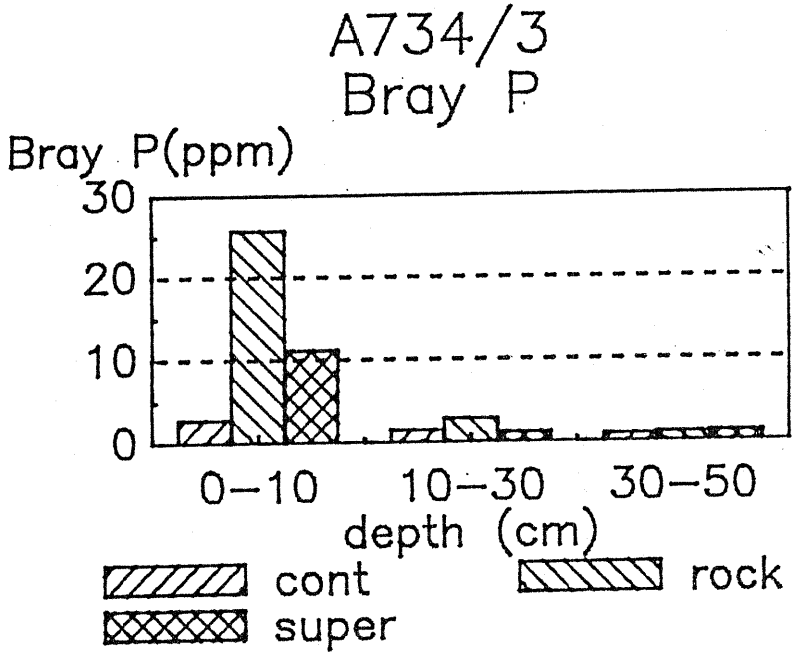
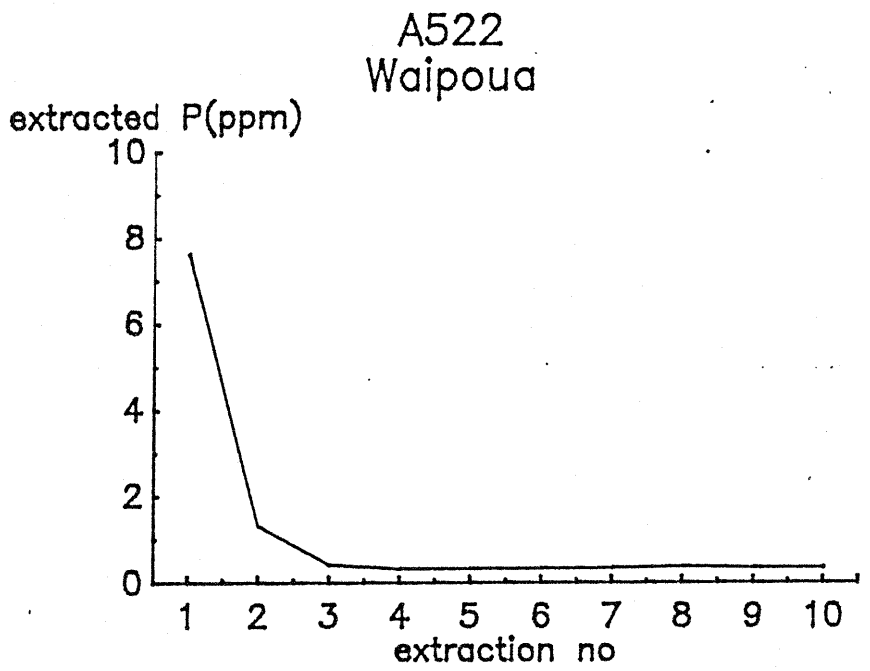
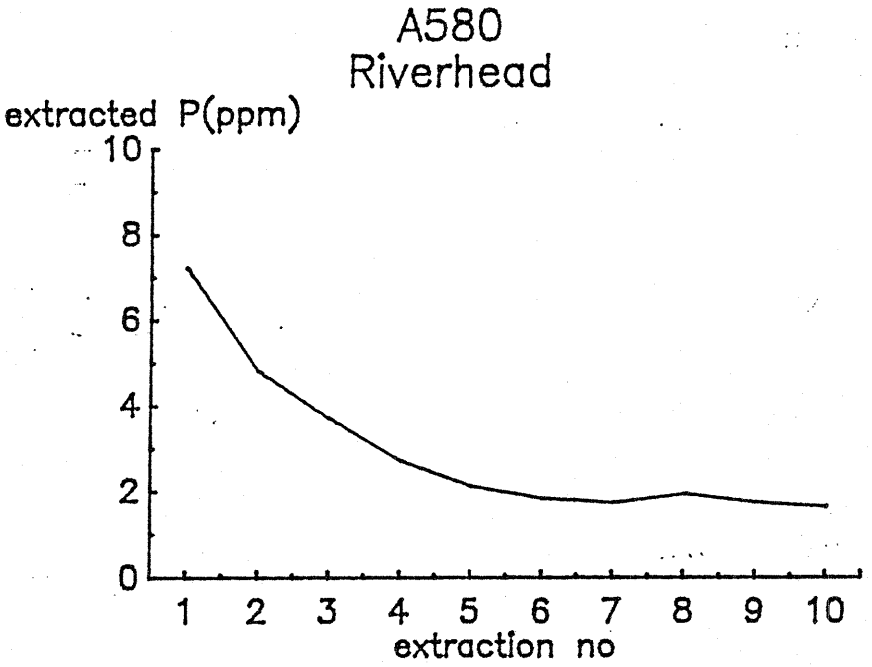

A734/3
Bray P
Bray P(ppm)
30
20
10
0
0–10
10–30
30–50
depth (cm)
cont
rock
super

Figure 3


A522
Waipoua
extracted P(ppm)
10
8
6
4
2
0
1 2 3 4 5 6 7 8 9 10
extraction no


A580
Riverhead
extracted P(ppm)
10
8
6
4
2
0
1 2 3 4 5 6 7 8 9 10
extraction no

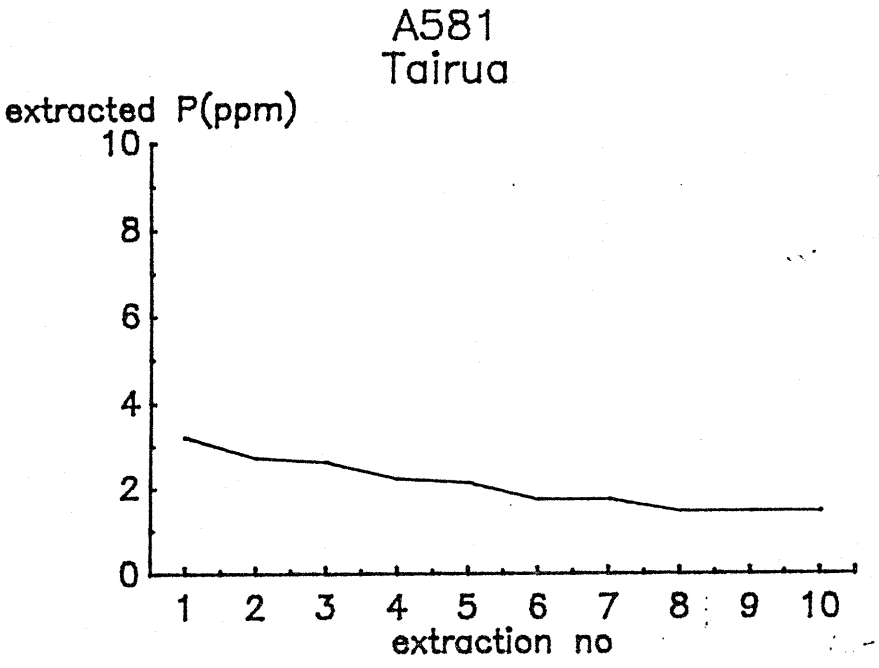

A581
Tairua
extracted P(ppm)
10
8
6
4
2
0
1 2 3 4 5 6 7 8 9 10
extraction no

Figure 4