



# **ENVIRONMENTAL RADIOACTIVITY ANNUAL REPORT**

**1989**

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## SUMMARY

*During 1989 artificial radioactivity in the environment in New Zealand and Rarotonga continued to be at a trace level only, typical of recent years. There has been no significant change in artificial radioactivity levels since 1988.*

*Average levels were: total beta activity in air, 0.09 mBq/m<sup>3</sup>; <sup>90</sup>Sr deposition, 0.1 MBq/km<sup>2</sup>; <sup>137</sup>Cs in milk, 0.19 Bq/gK; <sup>90</sup>Sr in milk, 0.041 Bq/gCa. Total beta activity depositions at Hokitika and Rarotonga were 264 MBq/km<sup>2</sup> and 88 MBq/km<sup>2</sup> respectively.*

*No artificial radionuclides were detected on high-volume air filters.*

*The report provides atmospheric monitoring data for natural <sup>7</sup>Be and <sup>210</sup>Pb, including plots of variations in concentration during the year. Average concentrations of <sup>7</sup>Be and <sup>210</sup>Pb were 2.6 mBq/m<sup>3</sup> and 0.06 mBq/m<sup>3</sup> respectively.*

*Cumulative <sup>137</sup>Cs deposition profiles are graphed for New Zealand monitoring sites, for the period 1955 - 1989.*

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## INTRODUCTION

The National Radiation Laboratory has been monitoring environmental radioactivity levels in the New Zealand and South Pacific regions since 1960, as described in earlier reports in this series<sup>1,2</sup>. Monitoring was initially conducted for radioactive fallout from nuclear weapons tests in the Northern Hemisphere, and then for fallout from the French testing programme in the Tuamotu Archipelago. When the French atmospheric testing programme was terminated in 1974 monitoring continued for residues from atmospheric tests and in order to detect any venting from the underground tests. The emphasis now is more on the need to provide warning of any influx of artificial radioactivity into the New Zealand and South Pacific regions, from any source. The National Radiation Laboratory is involved in international networks which have been set up by the International Atomic Energy Agency (IAEA) and the World Health Organisation (WHO) to improve cooperation and information dissemination, particularly during nuclear emergencies. It also takes part in quality assurance programmes run by the US Environmental Protection Agency (USEPA), WHO and IAEA.

The environmental monitoring programme now includes measurements of concentrations of naturally occurring radionuclides lead-210 ( $^{210}\text{Pb}$ ) and beryllium-7 ( $^7\text{Be}$ ) in the atmosphere. Beryllium-7 is produced mainly in the upper atmosphere through the interaction of cosmic radiation with oxygen and nitrogen atoms while  $^{210}\text{Pb}$ , being a decay product of gaseous radon-222 ( $^{222}\text{Rn}$ ) which diffuses out of soils, is of lower-atmospheric origin. These radionuclides are often used as tracers of air masses originating in the upper or lower atmosphere, and results of their measurements are included here for use in other environmental studies.

The environmental radioactivity monitoring programme comprises the following measurements:

**Atmospheric radioactivity** - total beta activity (TBA), fission product,  $^7\text{Be}$  and  $^{210}\text{Pb}$  levels are monitored with weekly sample collection at Kaitaia, Hokitika and Rarotonga;

**Radioactive deposition** - total beta activity deposition is monitored at Hokitika and Rarotonga, with weekly sample collection, while strontium-90 ( $^{90}\text{Sr}$ ) deposition is monitored with monthly collections at Kaitaia, Hokitika and Rarotonga;

**Radioactivity in milk** -  $^{90}\text{Sr}$  and caesium-137 ( $^{137}\text{Cs}$ ) concentrations are monitored in dairy milk powders with monthly sample collection from three New Zealand regions: Auckland, Taranaki and Westland.

Earlier reports in this series give information on terms of reference, reference levels and potential health hazard<sup>1,2</sup>, technical information<sup>3,4</sup>, the design of the programme<sup>3,5</sup>, and trends in levels<sup>4</sup>.

## 1989 MONITORING RESULTS

Monitoring results for 1989 are summarised in Tables 1 and 2, while fluctuations in atmospheric radioactivity during 1989 are illustrated in Figs 1 - 3, and variations in  $^7\text{Be}$  levels during the 3 year period 1987 - 1989 are depicted in Fig 4. Cumulative  $^{137}\text{Cs}$  deposition is illustrated in Fig 5. The precision of measurements is indicated by the 95% confidence limits tabulated with the results.

## Atmospheric radioactivity

Atmospheric radioactivity monitoring results are summarised in Table 1. The monitoring is conducted at Kaitaia, Hokitika and Rarotonga where centrifugal fan pumps draw air through filters (Microdon FA2311) at a flow rate of approximately  $2 \text{ m}^3/\text{min}$ . The filters are changed once per week, with a weekly volume sampled of approximately  $20\,000 \text{ m}^3$ , and analysed by high-resolution gamma spectroscopy for artificial gamma-emitting radionuclides and natural  $^7\text{Be}$ , by gas-flow proportional counting for total beta activity, and radiochemically for  $^{210}\text{Pb}$ .

No artificial radionuclides were detected on air filters from any monitoring site during 1989 (the limit of detection for individual radionuclides is of the order of 1 microbecquerel per  $\text{m}^3$ ).

The total beta activity, due mainly to the natural radionuclide  $^{210}\text{Pb}$  (and its decay product  $^{210}\text{Bi}$ ), ranged from  $< 0.04$  to  $0.25 \text{ mBq/m}^3$ , with means at the three sites of  $0.08 - 0.10 \text{ mBq/m}^3$  which were similar to those recorded in 1988<sup>6</sup>.

Beryllium-7 levels ranged from  $0.4$  to  $7.2 \text{ mBq/m}^3$ , with an overall mean of  $2.6 \text{ mBq/m}^3$ .

Lead-210 levels ranged from  $0.01$  to  $0.18 \text{ mBq/m}^3$ , with means at the three sites of  $0.06 \text{ mBq/m}^3$ , similar to the total beta activities recorded above.

The variation of total beta activity,  $^7\text{Be}$  and  $^{210}\text{Pb}$  levels with time is illustrated in Figures 1 - 3, which show 5-week moving average values for each site during 1989. Total beta activity and  $^7\text{Be}$  levels followed similar trends during the year at each site. As  $^7\text{Be}$  is mainly of upper-atmospheric origin, this suggests there was an upper-atmospheric influence on the beta activity levels also. At Rarotonga  $^{210}\text{Pb}$  levels also followed similar trends to the  $^7\text{Be}$ , suggesting  $^{210}\text{Pb}$  transported from the upper atmosphere predominated over surface sources there - this would perhaps be expected at this remote oceanic site. At Kaitaia and Hokitika there was a less obvious relationship between  $^{210}\text{Pb}$  and the other species, presumably because of the greater influence there of low-altitude transport from local, and perhaps Australian,  $^{222}\text{Rn}/^{210}\text{Pb}$  sources.

Filters from the periods when  $^{210}\text{Pb}$  levels were significantly lower than beta activity levels are being analysed radiochemically for other possible beta emitters and results will be reported later.

Trends in atmospheric  $^7\text{Be}$  levels during the period 1987 - 1989, since data became available during 1987, are illustrated in Fig 5. During 1989 similar trends were observed at Kaitaia and Hokitika, with winter minima, as also reported at Hokitika during 1986<sup>7</sup>. The winter minimum was less obvious at Hokitika in 1988. The Rarotonga data display pronounced peaks during the late-winter/spring period of each year, with minimum values occurring in autumn.

The above sets of results could be helpful in identifying any changes in atmospheric circulation patterns as data records are built up through future monitoring. Their reporting will be continued as long as possible.

## Radioactive deposition

The 1989 total beta activity deposition (Table 1) at Hokitika was  $264 \pm 12 \text{ MBq/km}^2$ , with 2880 mm of rainfall. At Rarotonga the deposition was  $88 \pm 17 \text{ MBq/km}^2$ , with 1815 mm of rain.

The increasing trend in beta activity deposition reported in 1989<sup>6</sup> for the Hokitika site, during the period 1985 - 1988, did not continue through 1989, with the above deposition being significantly lower than that recorded in 1988<sup>6</sup> - 336 MBq/km<sup>2</sup>. Deposited beta activity is now attributed mainly to natural <sup>210</sup>Pb<sup>5</sup> and so these variations are presumably due to some naturally variable phenomenon, rather than being part of a trend.

Strontium-90 deposition for the year (Table 1) continued to be at the limits of detection, typical of recent years: Kaitaia < 0.1 MBq/km<sup>2</sup>, Hokitika 0.2 MBq/km<sup>2</sup>, Rarotonga 0.1 MBq/km<sup>2</sup>. These <sup>90</sup>Sr depositions may be contrasted with the beta activity deposition (of mainly natural origin) recorded above.

Cumulative <sup>137</sup>Cs deposition levels at 6 New Zealand sites during the period 1955 - 1989, calculated<sup>8</sup> from <sup>90</sup>Sr deposition and annual rainfall data, are graphed in Fig 5 where it can be seen that by 1989 the cumulative deposition had dropped to 70% of the 1972 peak level.

This decrease was due to the radioactive decay and the lack of further significant fallout. Due to its shorter half-life and lower fission yield, <sup>90</sup>Sr cumulative deposition levels are about 60% of the <sup>137</sup>Cs levels. Normalised for rainfall, cumulative deposition of either of these radionuclides in New Zealand is about one quarter of that in the United Kingdom<sup>8</sup>, excluding any additional increment received in the UK from the Chernobyl reactor accident of 1986.

## Radioactivity in milk

Caesium-137 levels in cows' milk were assessed by gamma spectroscopic analysis of 3-month aggregates of monthly samples. Results are shown in Table 2, with units of Bq per gram potassium (Bq/gK) and Bq per kilogram of milk powder (Bq/kg).

The 1989 average <sup>137</sup>Cs levels were: Auckland 0.04 Bq/gK; Taranaki 0.46 Bq/gK; Westland 0.08 Bq/gK. The three-region mean was 0.19 Bq/gK or 2.6 Bq/kg powder, similar to the 1988 mean of 0.18 Bq/gK<sup>6</sup>.

Strontium-90 levels in cows' milk were measured by radiochemical analysis of 3-month aggregated samples. Results are shown in Table 2, with units of Bq per gram calcium (Bq/gCa) and Bq/kg powder.

The 1989 average <sup>90</sup>Sr levels were: Auckland 0.031 Bq/gCa; Taranaki 0.043 Bq/gCa; Westland 0.048 Bq/gCa. The three-region mean was 0.041 Bq/gCa or 0.5 Bq/kg powder, the same as in 1988<sup>6</sup>.

## CONCLUSION

Artificial radioactivity levels in the New Zealand and South Pacific environments, as indicated by measurements of atmospheric, deposited, and milk radioactivity, remained very low during 1989, consistent with an environment containing only traces of residual global weapons-test fallout.

The 1989 results were very similar to those reported for 1988<sup>6</sup> as indicated in the comparison of New Zealand site averages below:

	1989	1988	
TBA (air)	0.09	0.09	mBq/m <sup>3</sup>
TBA (rain)	264	336	MBq/km <sup>2</sup>
<sup>90</sup> Sr (rain)	0.1	0.1	MBq/km <sup>2</sup>
<sup>90</sup> Sr (milk)	0.5	0.5	Bq/kg powder
<sup>137</sup> Cs (milk)	2.6	2.4	Bq/kg powder

Atmospheric <sup>7</sup>Be concentrations showed winter minimum levels at Kaitaia and Hokitika, while levels peaked in the late-winter/spring period at Rarotonga. Lead-210 levels showed less obvious variations, although <sup>210</sup>Pb seems to be at least partly transported from the upper atmosphere, with this being particularly noticeable at Rarotonga.

There was no detectable influx of fresh fission products into the region during 1989.

## OTHER ENVIRONMENTAL WORK

A series of reports on the history of South Pacific fallout measurements was initiated during the year with the publication of Part 1<sup>8</sup>.

There was a continuing demand for export certificates and radioactivity tests during 1989, though there was less demand for tests on imported foodstuffs. During the year 427 export certificates were issued, 91 commercial tests performed, and 55 imports checked.

Radiochemical methods for analysing milk for <sup>90</sup>Sr were reviewed<sup>9</sup>. Reports have also been prepared for publication describing a device developed for monitoring radon levels in ground-water, and the use of radium-226 in calibrating high-resolution gamma spectroscopy systems. A method for demonstrating radioactive ingrowth in the <sup>226</sup>Ra decay series was also published<sup>10</sup>. Other reports were prepared for the Laboratory's publication *Radiation Protection News and Notes*<sup>11,12</sup>.

The Laboratory's involvement in international analytical intercomparisons continued, with the analysis of air filters for total beta activity, total alpha activity, <sup>137</sup>Cs and <sup>90</sup>Sr (USEPA); reactor effluent for gamma emitters (WHO); natural water for uranium isotopes (USEPA); milk for <sup>137</sup>Cs, <sup>131</sup>I, <sup>90</sup>Sr and K (USEPA); and vegetation for thorium isotopes (WHO).

In March 1989 the Laboratory's 10 year involvement in providing scientific services in the South Island in the areas of occupational hygiene, environmental chemistry, air pollution monitoring, and hazardous waste management, ceased as these functions were "devolved" to the Department of Scientific and Industrial Research as part of the current governmental restructuring programme.

Overseas visitors during 1989: Dr C Poletiko of the Environmental Monitoring Laboratory, Papeete, Tahiti; and Mr E Kuhles of Berthold Instruments, Germany.

## ACKNOWLEDGEMENT

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**TABLE 1: Summary of measured 1989 atmospheric and deposited radioactivity levels.**

Units: atmospheric levels :  $\text{mBq/m}^3$   
 deposition :  $\text{MBq/km}^2$   
 rainfall : mm

		Kaitaia	Hokitika	Rarotonga
<b>Atmospheric levels</b>				
TBA:	range	< 0.04-0.25	< 0.04-0.22	< 0.04-0.18
	mean	0.10	0.09	0.08
$^7\text{Be}$ :	range	1.0-7.2	0.5-4.5	0.4-6.0
	mean	3.0	2.4	2.3
$^{210}\text{Pb}$ :	range	0.02-0.15	0.02-0.18	0.01-0.12
	mean	0.06	0.06	0.06
Fission products		nil	nil	nil
<b>Deposition</b>				
TBA			$264 \pm 12$	$88 \pm 17$
$^{90}\text{Sr}$		< 0.1	$0.2 \pm 0.2$	$0.1 \pm 0.2$
Rain		1616	2880	1815

**TABLE 2: Caesium-137 and strontium-90 levels in dairy milk during 1989. Results are expressed as Bq <sup>137</sup>Cs per gram potassium, Bq <sup>90</sup>Sr per gram calcium, and as Bq per kilogram of milk powder, for each quarter year.**

**Caesium-137**

Qtr	Auckland		Taranaki		Westland	
	Bq/gK	Bq/kg	Bq/gK	Bq/kg	Bq/gK	Bq/kg
1	<0.04	<0.6	0.40 ± 0.02	5.6 ± 0.3	0.14 ± 0.01	2.1 ± 0.2
2	0.07 ± 0.01	0.9 ± 0.1	0.43 ± 0.03	5.2 ± 0.3	0.07 ± 0.01	0.9 ± 0.1
3	<0.04	<0.6	0.39 ± 0.02	5.2 ± 0.3	<0.04	<0.6
4	0.06 ± 0.01	1.0 ± 0.1	0.61 ± 0.04	9.2 ± 0.4	0.06 ± 0.01	1.0 ± 0.1
Mean	0.04	0.5	0.46	6.3	0.08	1.1

**Strontium-90**

Qtr	Auckland		Taranaki		Westland	
	Bq/gCa	Bq/kg	Bq/gCa	Bq/kg	Bq/gCa	Bq/kg
1	0.036 ± 0.006	0.45 ± 0.08	0.033 ± 0.006	0.40 ± 0.07	0.048 ± 0.006	0.64 ± 0.08
2	0.026 ± 0.004	0.36 ± 0.06	0.045 ± 0.006	0.54 ± 0.07	0.046 ± 0.006	0.63 ± 0.08
3	0.033 ± 0.005	0.44 ± 0.08	0.050 ± 0.006	0.65 ± 0.07	0.050 ± 0.006	0.59 ± 0.08
4	0.029 ± 0.005	0.37 ± 0.06	0.044 ± 0.006	0.57 ± 0.07	0.049 ± 0.007	0.63 ± 0.09
Mean	0.031	0.41	0.043	0.54	0.048	0.62

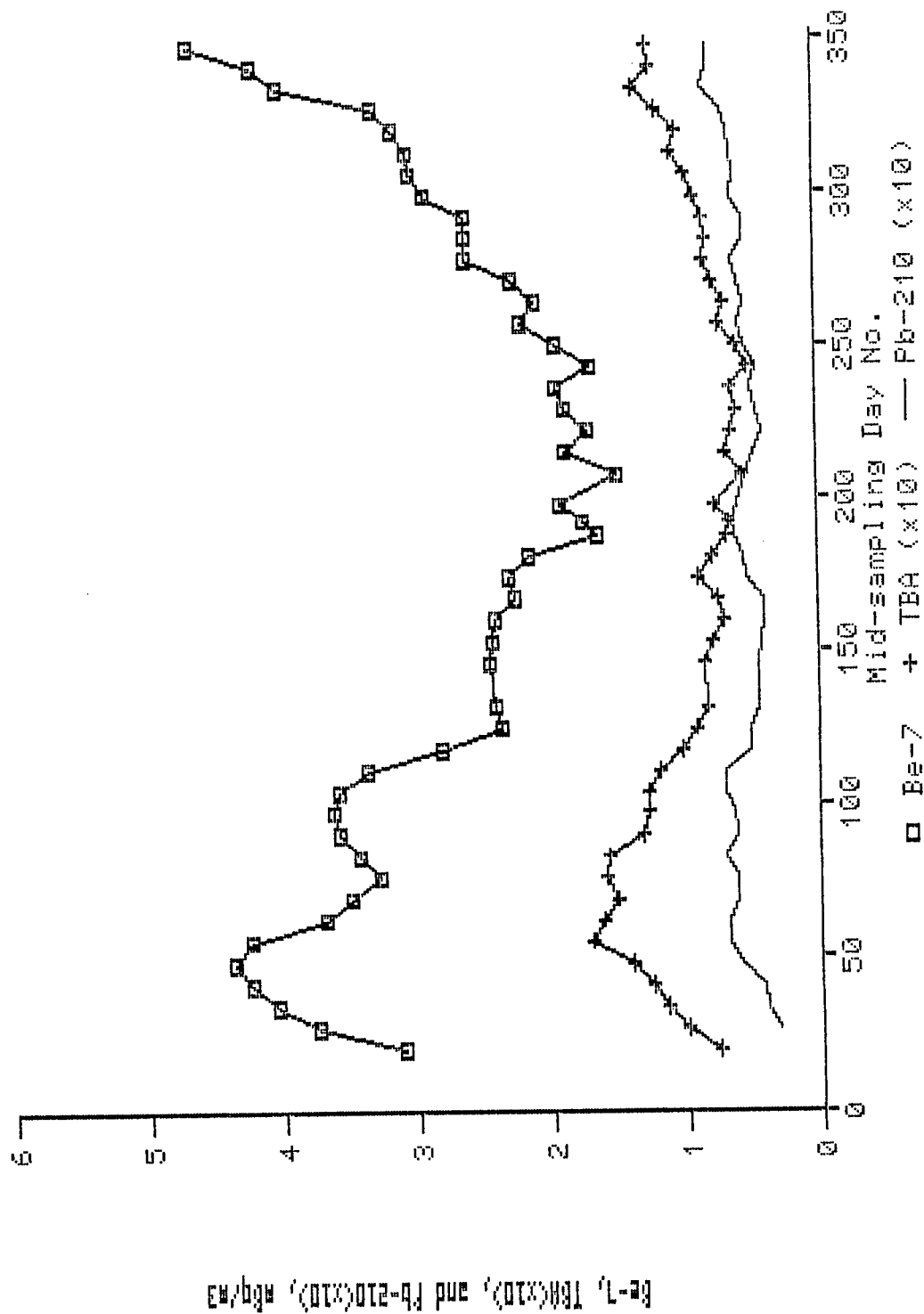


Fig 1. Five-week moving average atmospheric concentrations of total beta activity (TBA),  $^7\text{Be}$  and  $^{210}\text{Pb}$  at Kaitaia, plotted against time (day number at the middle of each 7-day sampling period). For scaling purposes TBA and  $^{210}\text{Pb}$  results were multiplied by 10.

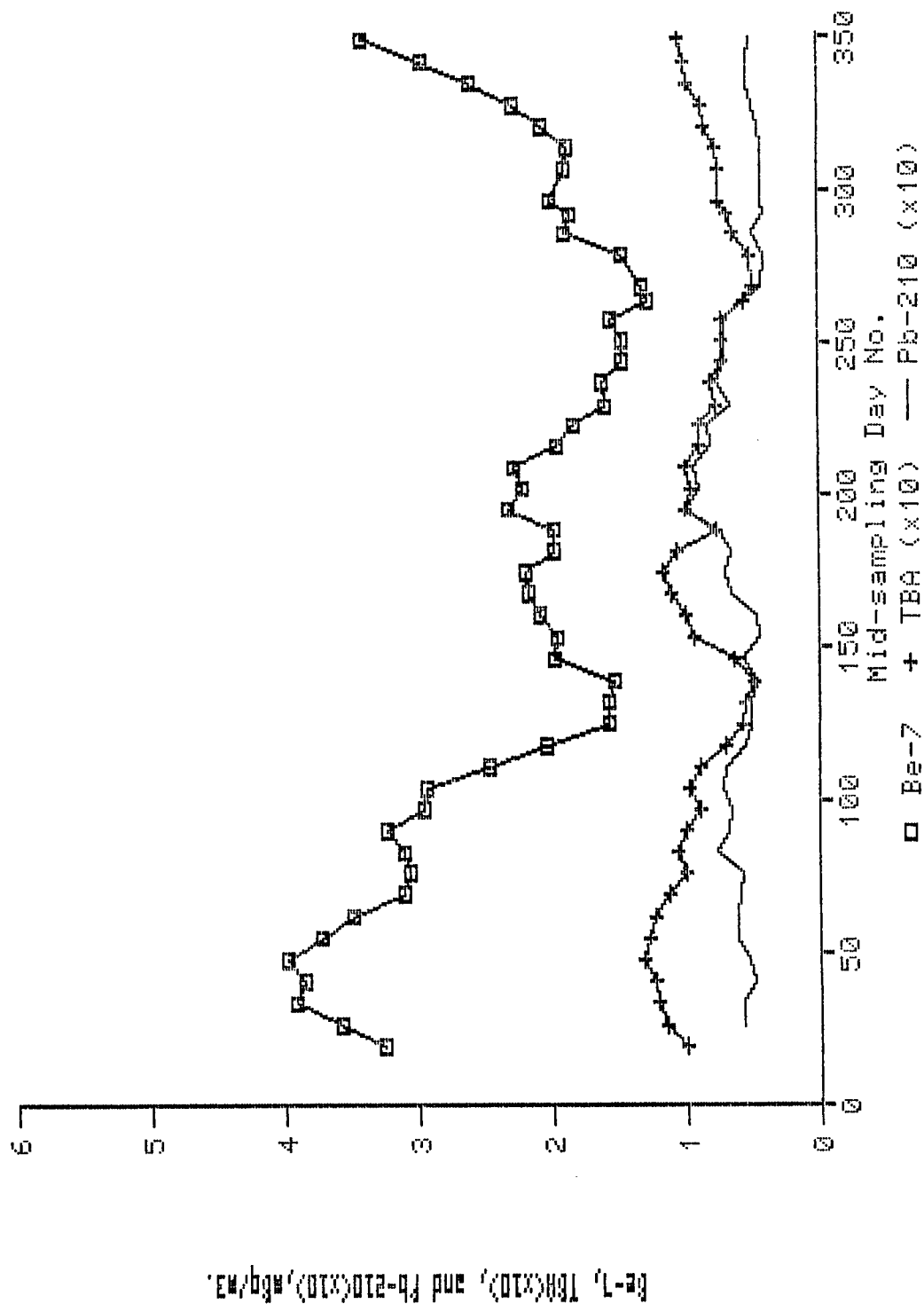


Fig 2. Five-week moving average atmospheric concentrations of total beta activity (TBA),  $^7\text{Be}$  and  $^{210}\text{Pb}$  at Hokitika, plotted against time (day number at the middle of each 7-day sampling period). For scaling purposes TBA and  $^{210}\text{Pb}$  results were multiplied by 10.

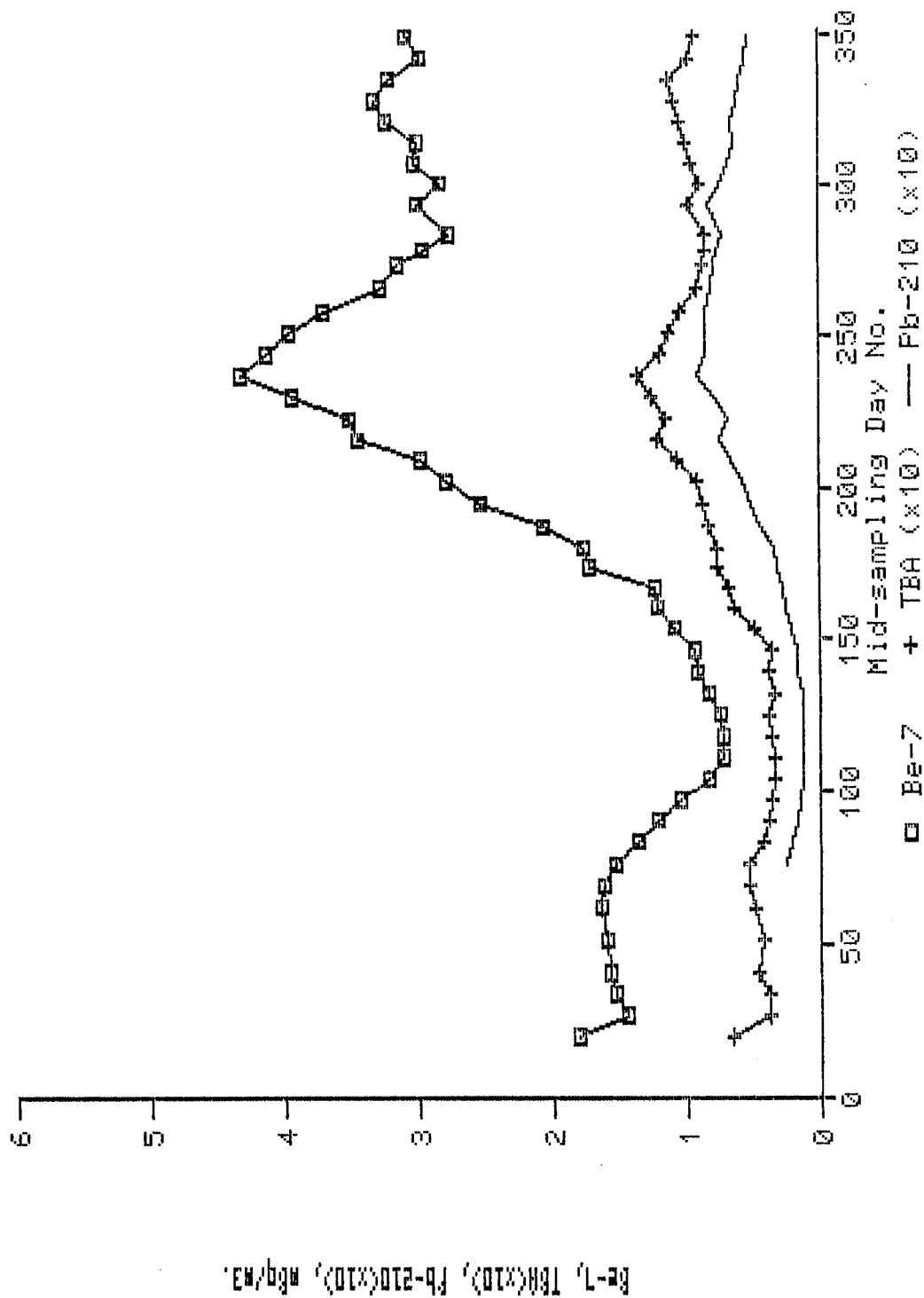


Fig 3. Five-week moving average atmospheric concentrations of total beta activity (TBA),  $^7\text{Be}$  and  $^{210}\text{Pb}$  at Rarotonga, plotted against time (day number at the middle of each 7-day sampling period). For scaling purposes TBA and  $^{210}\text{Pb}$  results were multiplied by 10.

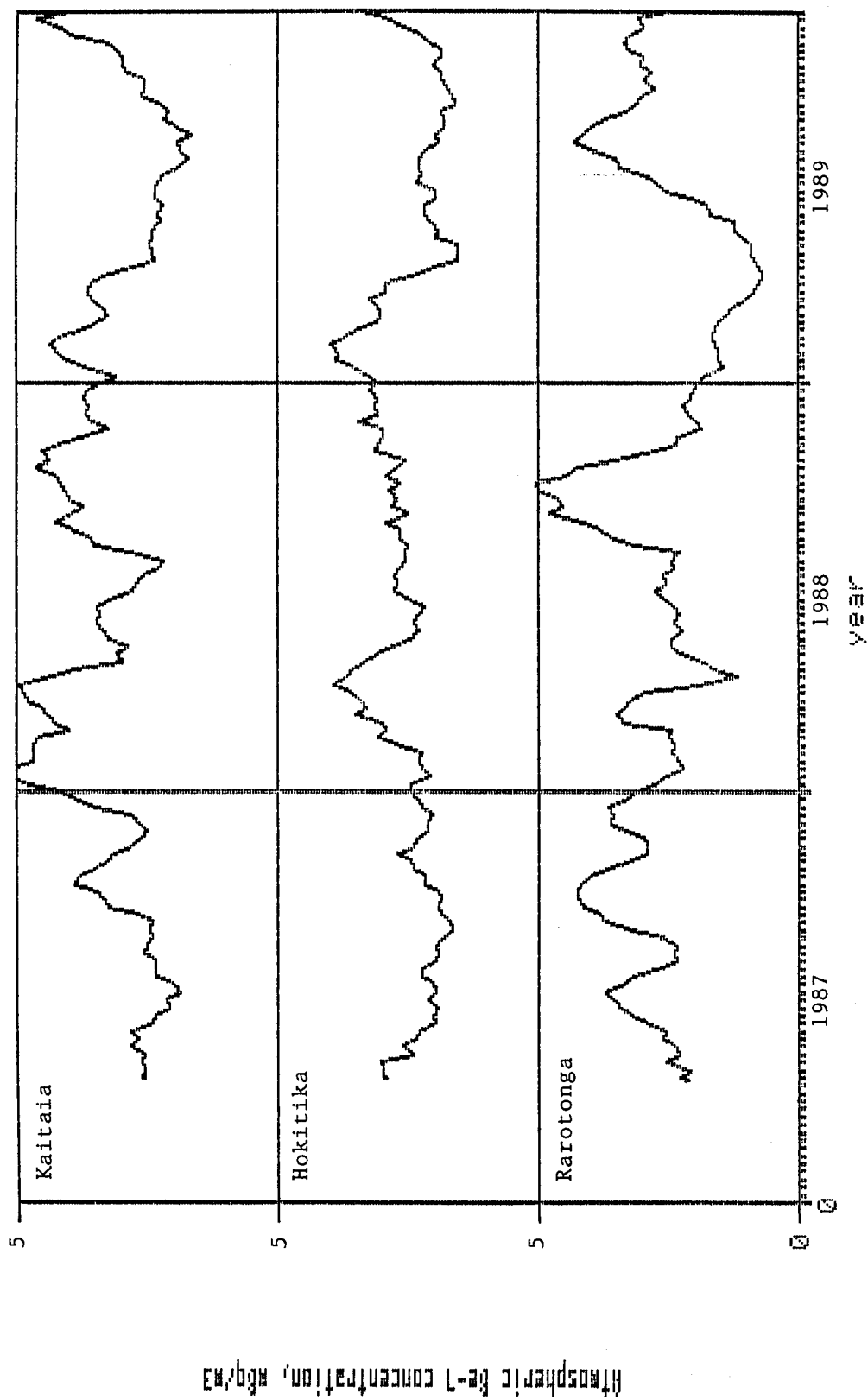


Fig 4. Variations in atmospheric <sup>7</sup>Be levels at Kaitaia, Hokitika and Rarotonga during the period 1987 - 1989.

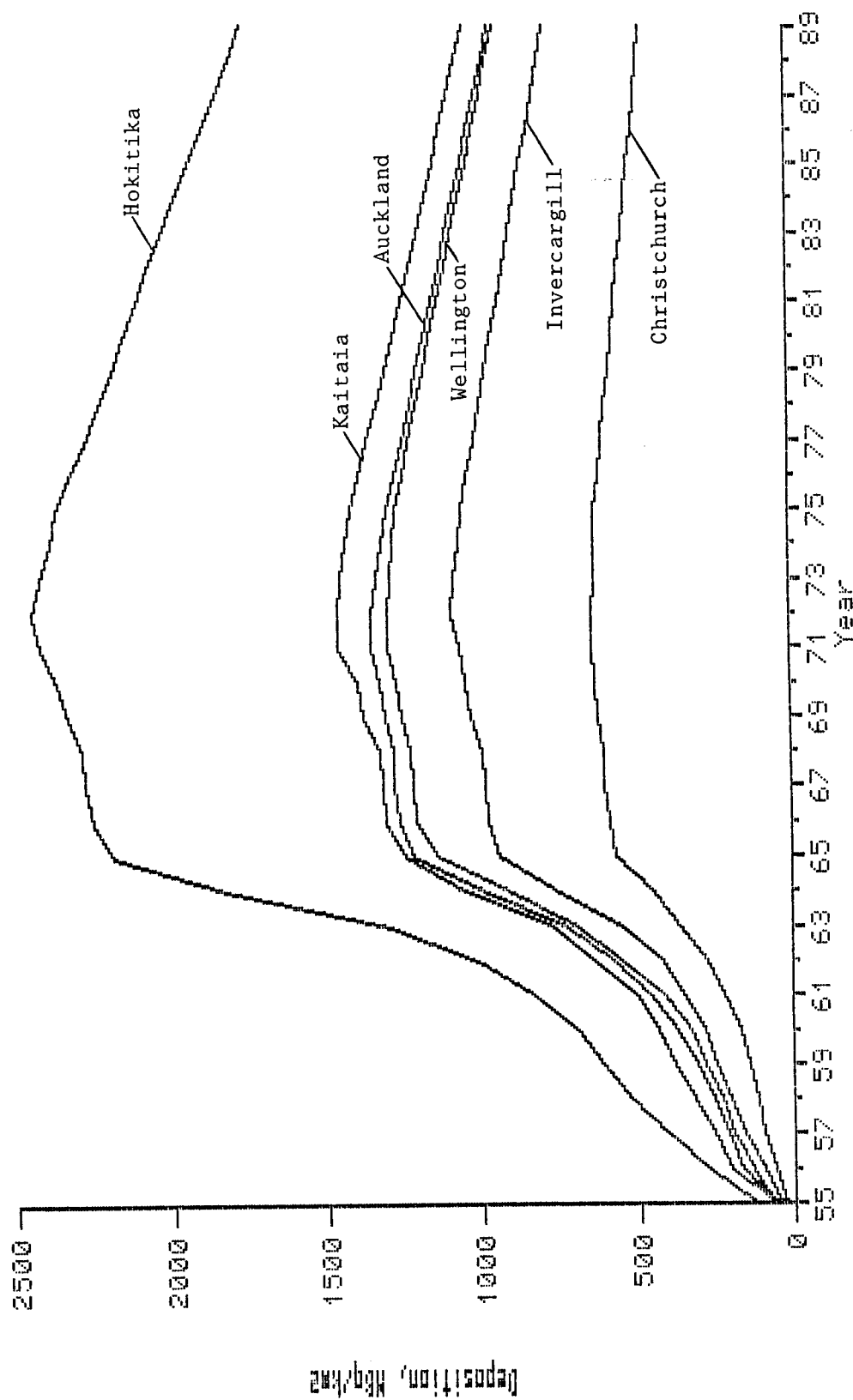


Fig 5. Cumulative  $^{137}\text{Cs}$  deposition at 6 New Zealand sites during the period 1955 - 1989<sup>8</sup>.