



Environmental radioactivity in the Faroes in 1974

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Publication date:
1975

Document Version
Publisher's PDF, also known as Version of record

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Citation (APA):
Aarkrog, A., & Lippert, J. E. (1975). *Environmental radioactivity in the Faroes in 1974*. Risø National Laboratory, Denmark. Forskningscenter Risøe. Risøe-R No. 324

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Danish Atomic Energy Commission
Research Establishment Risø

Environmental Radioactivity
in the Faroes in 1974

by A. Aarkrog and J. Lippert

July 1975

Sales distributors: Jul. Gjellerup, 87, Sølvgade, DK-1307 Copenhagen K, Denmark

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DK 7500167

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Research Establishment Risø

Health Physics Department

Abstract

Measurements of fall-out radioactivity in the Faroes in 1974 are presented. Strontium-90 (and ^{137}Cs in most cases) was determined in regularly collected samples of precipitation, grass, milk, fish, sea water, bread, and drinking water. In addition, analyses were made of spotsamples of lamb, potatoes, sea plants, vegetables, eggs, and human bone. Estimates are given of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faroes in 1974.

Whole body measurements were made on six individuals from the Faroes.

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Statens trykningskontor

F1 25

ISBN 87 550 0323 0

ABBREVIATIONS AND UNITS

FP	fission products
pCi	picocurie, 10^{-12} Ci, $\mu\mu\text{Ci}$
nCi	nanocurie, 10^{-9} Ci, $m\mu\text{Ci}$
mCi	millicurie, 10^{-3} Ci
MPC	maximum permissible concentration
S. U.	pCi $^{90}\text{Sr}/\text{g Ca}$
O. R.	observed ratio
M. U.	$\mu\text{Ci } ^{137}\text{Cs}/\text{g K}$
n Sr	natural (stable) Sr
S. D.	standard deviation, $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{(n-1)}}$
S. E.	standard error, $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{n(n-1)}}$
S. S. D.	sum of squares of deviations, $\Sigma(\bar{x}-x_i)^2$
f	degrees of freedom
s^2	variance
v^2	ratio between the variance in question and the residual variance
P	probability fractile of the distribution in question
\bar{x}	mean values
Σ	sum
η	coefficient of variation, relative standard deviation
A:	$\eta : 20-33\%$
B:	$\eta > 33\%$

1. INTRODUCTION

1.1.

The fall-out programme for the Faroes, which was initiated in 1962¹⁾ in close co-operation with the National Health Service and the chief physician of the Faroes, was continued in 1974. Samples of human bone were obtained in 1974 from Dronning Alexandrine's Hospital in Thorshavn.

1.2.

The present report will not repeat information concerning sample collection and analysis already given in Rissø Reports Nos. 64, 86, 108, 131, 155, 181, 202, 221, 246, 266, 292 and 306¹⁾.

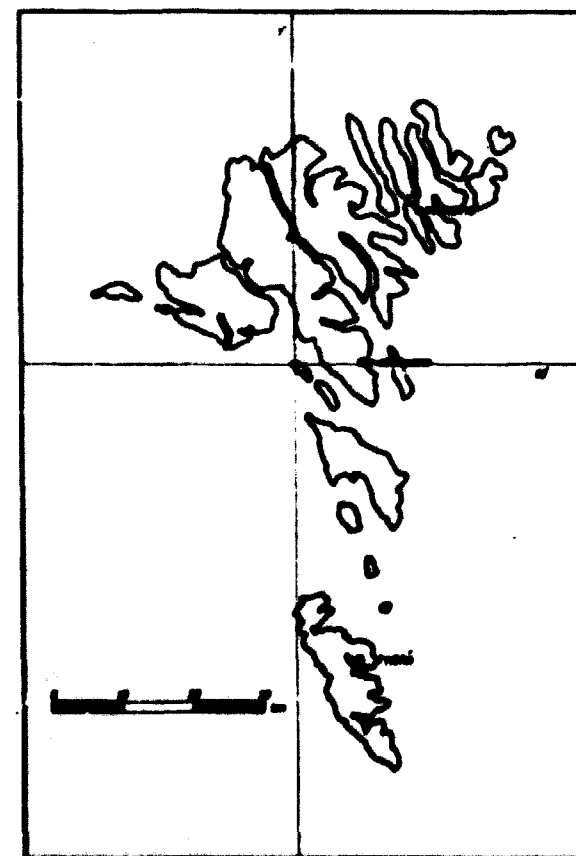


Fig. 2.1.1. The Faroes.

1.3.

The estimated mean diet of the Faroese as used in this report is still based on the estimate given by Professor E. Hoff-Jørgensen, Ph. D., in 1962.

1.4.

The present investigation was carried out together with corresponding examinations of fall-out levels in Denmark and Greenland, described in Risø Reports Nos. 323²⁾ and 325³⁾ respectively.

2. RESULTS AND DISCUSSION

2.1. Strontium-90 in Precipitation

Table 2.1 shows the ⁹⁰Sr content in precipitation collected at Høyvig (near Thorshavn) and Klaksvig in 1974. The amount of precipitation at Klaksvig was a factor of 1.9 greater than that found at Høyvig, and the amount of fall-out at Klaksvig was 1.7 times that measured at Høyvig.

The mean activity of ⁹⁰Sr in precipitation in 1974 was approx. 1.8 times higher than the 1973 levels in the Faroes. The amount of precipitation was somewhat lower in 1974 than in 1973 at Høyvig, but a little higher at Klaksvig.

Table 2.1

Strontium-90 in precipitation in the Faroes in 1974

Month	Høyvig		Klaksvig	
	pCi ⁹⁰ Sr/l	mCi ⁹⁰ Sr/km ²	pCi ⁹⁰ Sr/l	mCi ⁹⁰ Sr/km ²
Jan.	0.28	0.059	0.40	0.103
Feb.	1.06	0.146	0.34	0.088
Mar.	0.13 B	0.003 B	0.34 A	0.062 A
Apr.	2.82	0.034	-	-
May	2.53	0.081	3.61	0.180
June	1.68	0.131	2.00	0.324
July	1.33	0.110	1.76	0.105
Aug.	0.92	0.060	0.75	0.198
Sep.	0.64	0.072	0.57	0.145
Oct.	-	-	0.84	0.089
Nov.	0.50 A	0.059 A	0.49	0.113
Dec.	0.70	0.158	0.73	0.182
1974	\bar{x} 0.83	\bar{x} 0.913 Emm 1101	\bar{x} 0.76	Σ 1.589 Emm 2075

2.2. Strontium-90 and Caesium-137 in Grass

Grass samples were collected near Thorshavn in 1974. Table 2.2 shows the results. The mean S. U. content of the grass during the summer months was estimated at 264 S. U., and the mean S. U. in milk during June-September was 23.8 S. U. at Thorshavn (cf. 2.3), i. e., the observed ratio between the S. U. in milk and in grass was 0.09 (mean 1965-74 0.10 ± 0.01 (1 S. E.) fig. 2.2). The 1974 S. U. levels in grass were 1.1 times the 1973 levels. As compared with Danish grass in 1974²⁾, we found the S. U. levels in the Faroese grass to be higher by a factor of approx. 6 in the summer months.

The mean ratio between ¹³⁷Cs and ⁹⁰Sr in the grass (pCi/kg) was 2.7 in 1974. (Mean 1965-74: 2.2 ± 0.2).

Table 2.2

Strontium-90 and Caesium-137 in grass from Thorshavn 1974

Month	pCi ⁹⁰ Sr/g ash	pCi ⁹⁰ Sr/kg	pCi ⁹⁰ Sr/g Ca	pCi ¹³⁷ Cs/g ash	¹³⁷ Cs/ ⁹⁰ Sr
June	14.9	-	257	41.5	2.78
Aug.	21.9	-	271	55.5	2.54

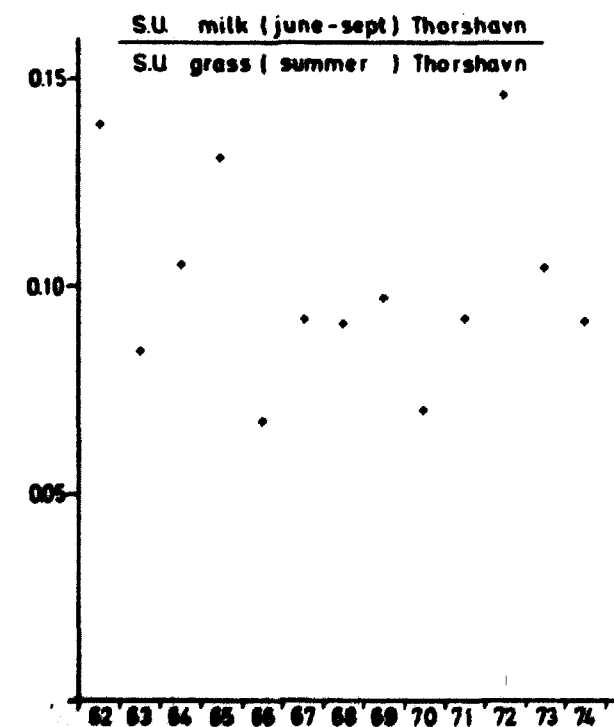


Fig. 2.2. The observed ratio between S. U. in milk and grass collected in the summer months at Thorshavn 1962-74.

2.3. Strontium-90 and Caesium-137 in Milk

As in previous years¹⁾, weekly samples of fresh milk were obtained from Thorshavn, Klaksvig, and Tvørá. Strontium-90 and ¹³⁷Cs were determined in bulked monthly samples.

Table 2.3.1 shows the results and tables 2.3.2, 2.3.3 and 2.3.4 the analysis of variance of the S. U., M. U., and pCi ¹³⁷Cs/l figures respectively. The variation between months was not significant. As also observed in previous years, the variation between locations was significant. The highest ¹³⁷Cs and ⁹⁰Sr levels were found in the milk from Tvørá and Klaksvig and the lowest in the Thorshavn milk.

Figure 2.3.1 shows the quarterly S. U. values and fig. 2.3.2 the quarterly pCi ¹³⁷Cs/l levels since 1962. The annual mean values for 1974 were 20 S. U. (~24 pCi ⁹⁰Sr/l) and 158 M. U., or 254 pCi ¹³⁷Cs/l, i.e. the 1974 levels were nearly equal to the 1973 mean levels.

The annual mean values of the M. U./S. U. ratio in Faroese milk are shown in fig. 2.3.3.

The mean M. U./S. U. ratio in 1974 was 7.7 ± 0.5 during the grazing period (May-October), and in the winter time it was 8.1 ± 0.4 , i.e. unchanged. This is in agreement with previous observations¹⁾.

Table 2.3.1

Strontium-90 and Caesium-137 in milk from the Faroes in 1974

Month	Thorshavn			Klaksvig			Tvørá			Mean		
	S.U.	pCi ¹³⁷ Cs/l	M.U.	S.U.	pCi ¹³⁷ Cs/l	M.U.	S.U.	pCi ¹³⁷ Cs/l	M.U.	S.U.	pCi ¹³⁷ Cs/l	M.U.
Jan.	14	101	56	23	318	219	22	303	178	20	241	151
Feb.	17	138	86	29	306	206	23	315	254	23	253	182
Mar.	16	107	67	18	260	141	18	375	238	17	247	149
Apr.	16	98	61	18	242	134	19	282	179	18	207	125
May	14	115	74	22	447	273	25	327	205	20	296	184
June	27	226	145	25	217	143	20	264	174	24	236	154
July	22	203	124	21	257	153	20	292	174	21	251	150
Aug.	26	143	92	22	221	126	26	471	274	25	278	184
Sep.	20	149	92	18	201	129	22	561	342	20	304	198
Oct.	19	124	74	(21)	(274)	(164)	22	400	244	21	266	161
Nov.	16	95	59	14	251	165	22	398	255	17	248	160
Dec.	13	96	57	14	204	124	21	358	203	16	219	128
Mean	18	133	82	21	267	165	22	362	227	20	254	158

Table 2.3.2

Analysis of variance of ln pCi ⁹⁰Sr/g Ca in Faroese milk in 1974 (from table 2.3.1)

Variation	SSD	f	s ²	v ²	P
Betw. months	0.688	11	0.063	1.886	-
Betw. locations	0.263	2	0.132	3.972	>95%
Remainder	0.696	21	0.033		

Table 2.3.3

Analysis of variance of ln pCi ¹³⁷Cs/g K in Faroese milk in 1974 (from table 2.3.1)

Variation	SSD	f	s ²	v ²	P
Betw. months	0.590	11	0.054	0.648	-
Betw. locations	7.224	2	3.612	43.686	>99.95%
Remainder	1.736	21	0.083	-	-

Table 2.3.4

Analysis of variance of ln pCi ¹³⁷Cs/l Faroese milk in 1974 (from table 2.3.1)

Variation	SSD	f	s ²	v ²	P
Betw. months	0.396	11	0.036	0.45	-
Betw. locations	6.920	2	3.460	43.66	>99.95%
Remainder	1.664	21	0.079		

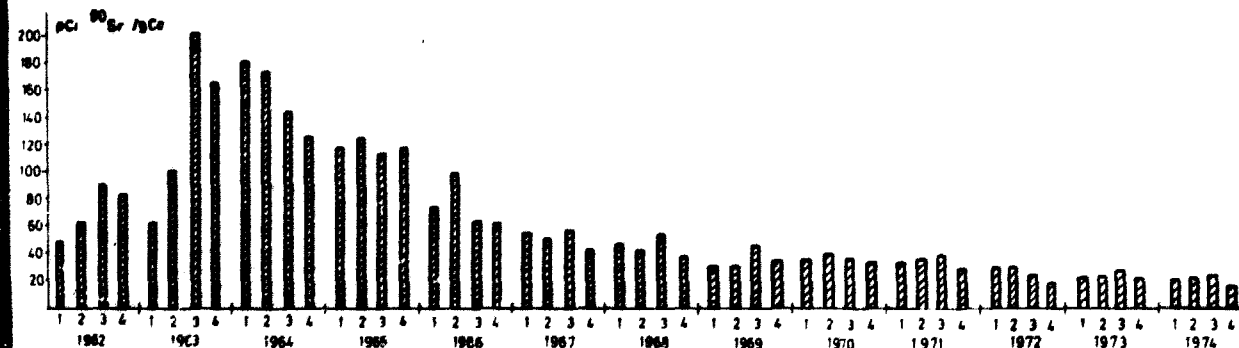


Fig. 2.3.1. Strontium-90 in Faroese milk 1962-74.

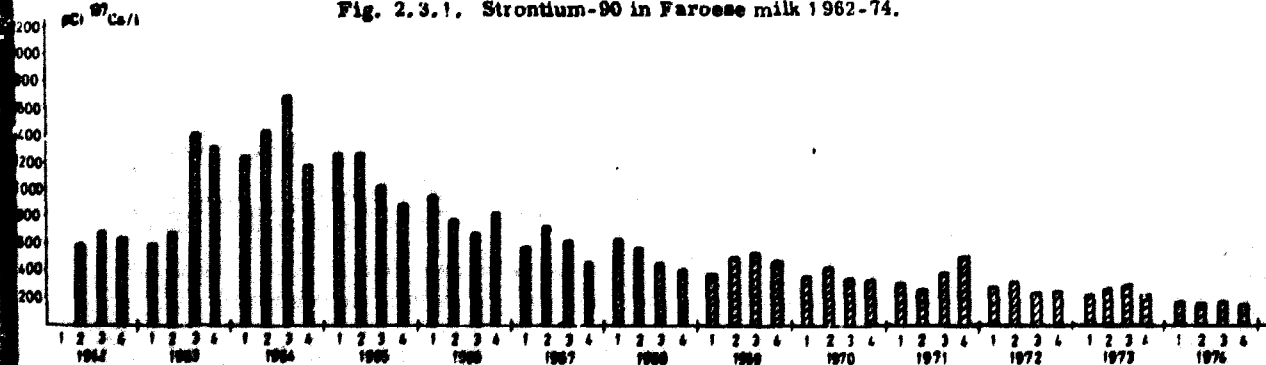


Fig. 2.3.2. Caesium-137 in Faroese milk 1962-74.

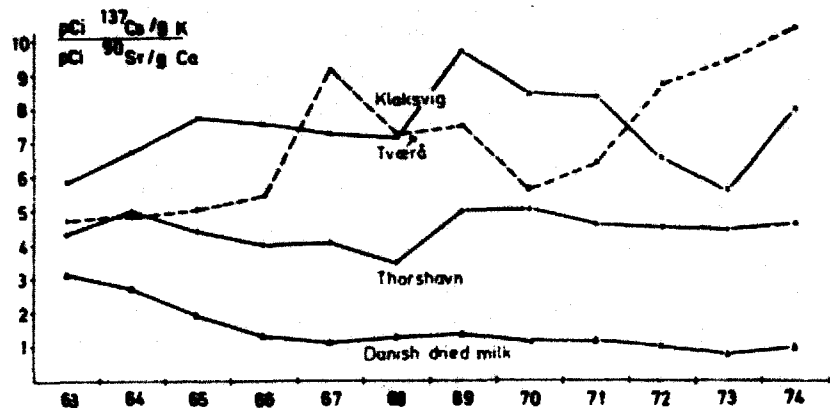


Fig. 2.3.3. M.U. S.U. ratios in Faroese and Danish milk 1963-74.

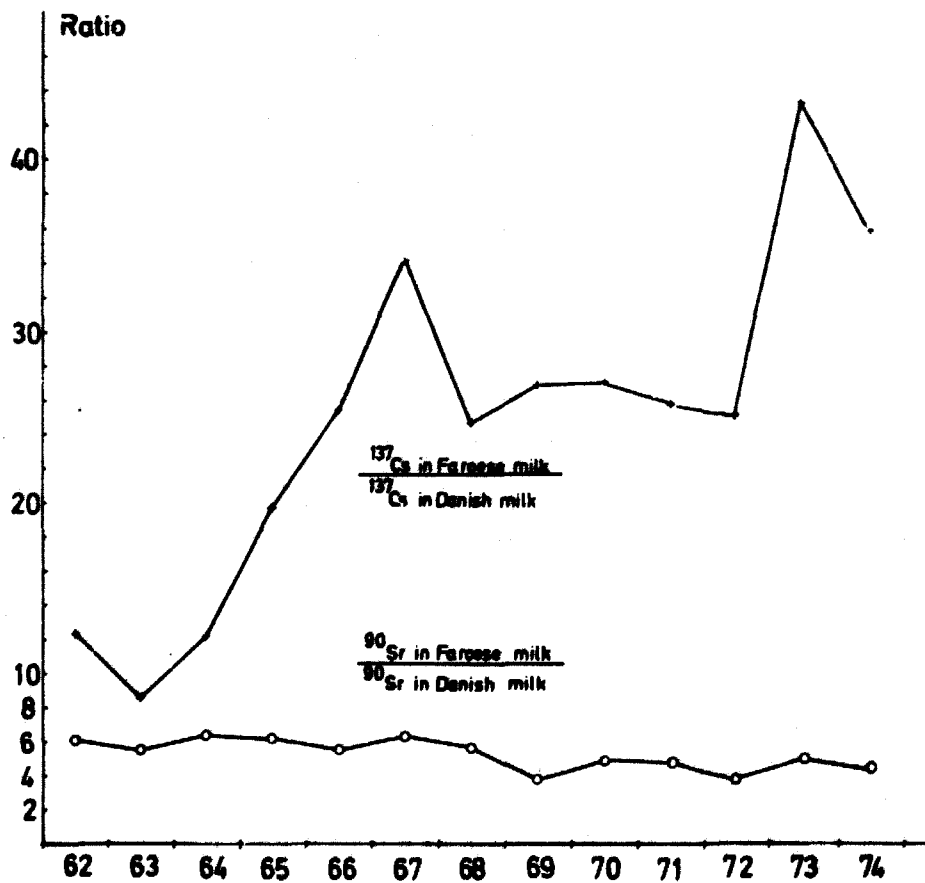


Fig. 2.3.4. A comparison between Faroese and Danish milk levels, 1962-74.

Figure 2.3.4 shows a comparison between the ^{90}Sr and ^{137}Cs levels in Faroese- and Danish-produced milk. It is evident that soil uptake plays an important role for the ^{137}Cs levels in the Faroes. The ratios between the ^{90}Sr levels in Faroese and Danish milk have shown a tendency to decrease through the years.

2.4. Strontium-90 and Caesium-137 in Terrestrial Animals

Lamb meat and bone were obtained from 3 locations in 1974.

The mean levels for meat were 14 pCi $^{90}\text{Sr}/\text{kg}$, or 156 S.U., and 1.44 nCi $^{137}\text{Cs}/\text{kg}$, or 390 M.U. The bone level was 126 pCi $^{90}\text{Sr}/\text{g Ca}$. As compared with 1973, the levels were somewhat lower in 1974.

Table 2.4

Strontium-90 and Caesium-137 in lamb from the Faroes in 1974

Location		pCi $^{90}\text{Sr}/\text{kg}$	pCi $^{90}\text{Sr}/\text{g Ca}$	pCi $^{137}\text{Cs}/\text{kg}$	pCi $^{137}\text{Cs}/\text{g Y}$
Høyvik	Meat	8.9	121	401	124
Høyvik	Bone	-	86	-	-
Tverð	Meat	19.1	166	2091	428
Tverð	Bone	-	162	-	-
Klarksvig	Meat	15.3	187	1841	619
Klarksvig	Bone	-	131	-	-

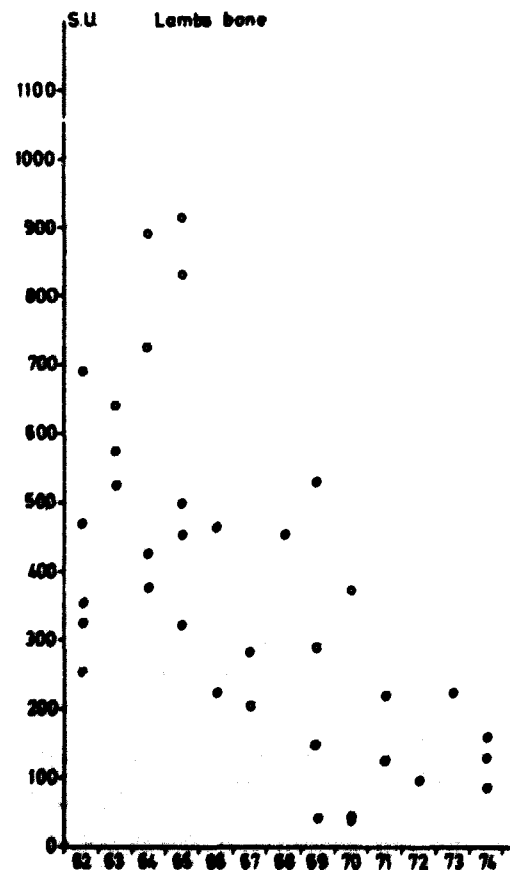


Fig. 2.4.1. S.U. in lamb bone collected in the Faroes 1962-74.

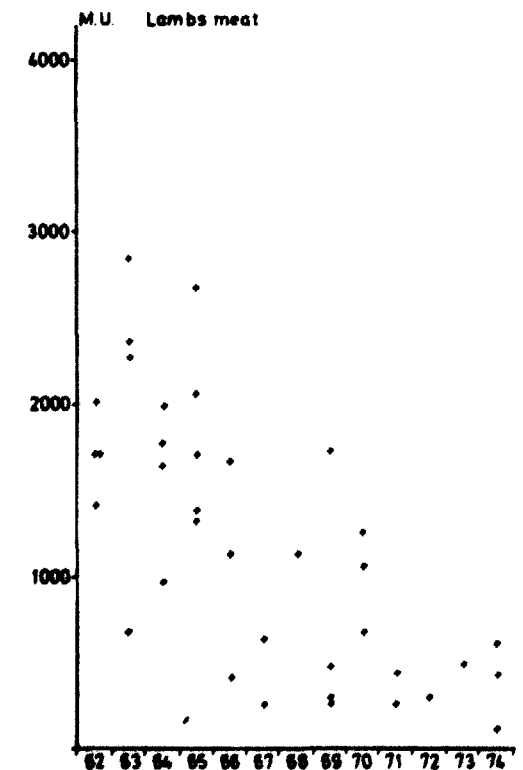


Fig. 2.4.2. M.U. in lamb meat collected in the Faroes 1962-74.

Table 2.5.1

Strontium-90 and Caesium-137 in sea animals from the Faroes in 1974

Sampling months		Species	Sample type	pCi ⁹⁰ Sr/kg	pCi ⁹⁰ Sr/g Ca	pCi ¹³⁷ Cs/kg	pCi ¹³⁷ Cs/g K
Apr.	Fish	Gadus aeglefinus	Meat	0.43 B	4.4 B	19	5.9
Apr.	"	Gadus callarias	Meat	0.61 B	4.3 B	14	3.5
June	Fish	Gadus aeglefinus	Meat	0.20 B	1.8 B	7.8	2.1
June	"	Gadus callarias	Meat	0.18 B	1.9 B	12	3.4
Oct.	Fish	Gadus aeglefinus	Meat	0.76	5.0	11	3.6
Oct.	"	Gadus callarias	Meat	0.81	7.3	9.6	2.9
Dec.	Fish	Gadus aeglefinus	Meat	1.04	8.7	6.0	1.6
Dec.	"	Gadus callarias	Meat	0.57	5.5	8.9	2.6
June	Whale	Globicephala melaeno I	Meat	0.42 B	1.8 B	7.6 A	3.5 A
June	"	Globicephala melaeno I	Bone	-	0.06 B	-	-
June	"	Globicephala melaeno II	Meat	0.28 B	1.2 B	16.1	8.0
June	"	Globicephala melaeno II	Bone	-	0.06 B	-	-

2.5. Strontium-90 and Caesium-137 in Sea Animals

Table 2.5.1 shows the ⁹⁰Sr and ¹³⁷Cs levels in fish and whale collected in 1974 in the Faroes. The mean levels in fish were 0.58 pCi ⁹⁰Sr/kg (S. E. : 0.11) and 11 pCi ¹³⁷Cs/kg (S. E. : 1.4). Whale contained 0.35 pCi ⁹⁰Sr/kg and 6 pCi ¹³⁷Cs/kg. Since 1967 the ¹³⁷Cs mean levels in fish from the Faroes have been nearly constant: 10-15 pCi ¹³⁷Cs/kg (cf. fig. 2.5.1).

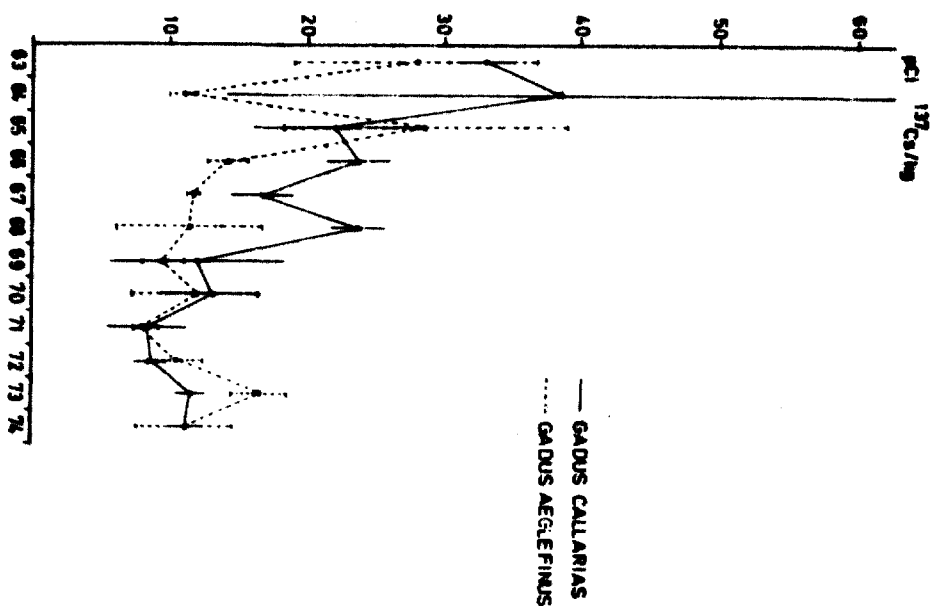


Fig. 2.5.1. Caesium-137 levels in meat of Cod and Haddock collected in the Faroes, 1963-74 (1 S. E. indicated).

2.6. Strontium-90 in Drinking Water

Drinking-water samples were collected as previously¹⁾. Table 2.6.1 shows the results and table 2.6.2 the analysis of variance. As in previous years, drinking water from Thorshavn contained more ⁹⁰Sr than that from Tward (cf. the explanation in Riser Report No. 181¹⁾).

Figure 2.6.1 shows the bimonthly mean levels of ⁹⁰Sr in drinking water from the three locations since 1962.

The mean level in 1974 was 0.31 pCi ⁹⁰Sr/l, i. e. nearly unchanged from the 1973 level.

Table 2.6.1

Strontium-90 in drinking water from the Faroes in 1974

pCi ⁹⁰Sr/l

Month	Thorshavn	Klaksvig	Tværå
Jan.	0.52	0.16	0.43
Mar.	0.41	0.12 A	0.30
May	0.50	0.28	0.31
July	0.56	0.26	0.31
Sep.	0.33	0.06 A	0.25
Nov.	0.44	0.07 B	0.20
1974	0.46	0.16	0.30

Table 2.6.2

Analysis of variance of ln pCi ⁹⁰Sr/l drinking water in 1974
(from table 2.6.1)

Variation	SSD	f	s ²	v ²	P
Betw. months	1.619	5	0.324	3.57	>95%
Betw. locations	4.563	2	2.282	25.18	>99.95%
Remainder	0.906	10	0.091		

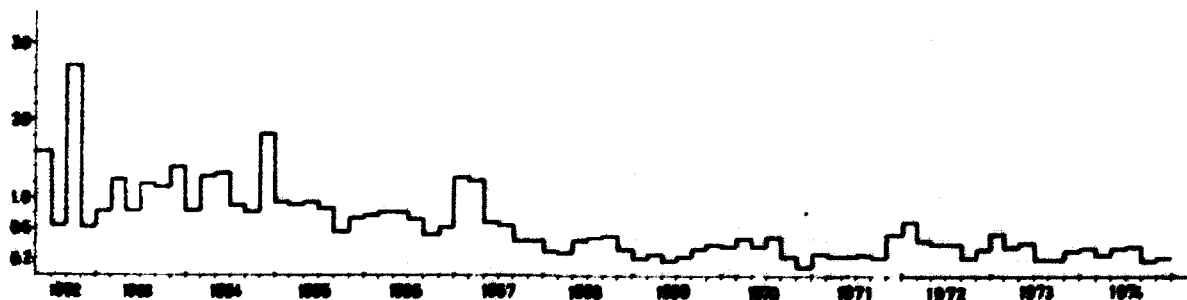


Fig. 2.6.1. Strontium-90 in drinking water, 1962-74 (mean of Thorshavn, Klaksvig and Tværå).

2.7. Strontium-90 and Caesium-137 in Miscellaneous Samples

2.7.1. Soil

No soil samples were collected in 1974 from the Faroes. From earlier years' observations we estimate the accumulated fall-out at Thorshavn to be 65 mCi ⁹⁰Sr/km² and that at Klaksvig to be 131 mCi ⁹⁰Sr/km².

2.7.2. Sea Water

Surface sea water was collected near Thorshavn on four occasions in 1974. The ⁹⁰Sr mean level was 0.105 pCi ⁹⁰Sr/l. (1 S. E.: 0.006).

Figure 2.7.2 shows the ⁹⁰Sr levels since 1962.

The samples were also analysed for ¹³⁷Cs. The mean was 0.23 ± 0.03 pCi ¹³⁷Cs/l. The ¹³⁷Cs/⁹⁰Sr ratio was: 2.3 ± 0.5.

North Sea water collected in 1974 showed a mean ratio of 2.0 (cf. Risø Report No. 323²), and also Risø Report No. 325³).

Table 2.7.2

Strontium-90 and Caesium-137 in sea water from the Faroes in 1974

Sampling month	⁹⁰ Sr pCi/l	¹³⁷ Cs pCi/l	Salinity o/oo
Mar.	0.09	0.32	35.2
June	0.10	0.19 A	35.2
Aug.	0.11	0.20 A	35.5
Dec.	0.12	0.20 A	35.5

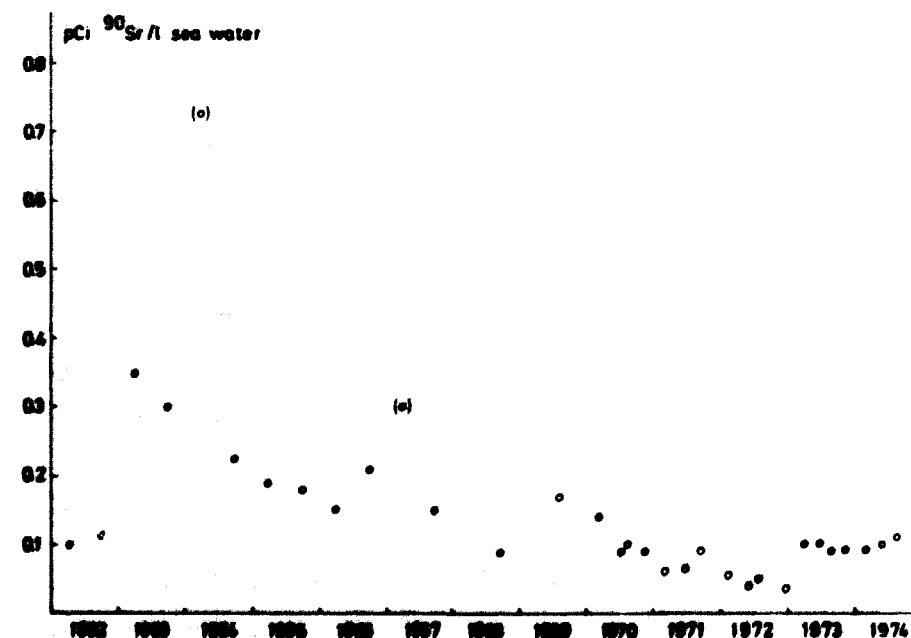


Fig. 2.7.2. Strontium-90 in Faroese sea water 1962-74.

2.7.3. Sea Plants

Two samples of laminaria were obtained in 1974. Table 2.7.3 shows the ^{90}Sr and the ^{137}Cs determinations.

Table 2.7.3

Strontium-90 and Caesium-137 in sea plants from the Faroes in 1974

Sampling month	Species	pCi ^{90}Sr /g ash	pCi ^{90}Sr /g Ca	pCi ^{137}Cs /g ash	pCi ^{137}Cs /g K
Apr.	Laminaria	0.39	6.1	0.250	1.3
Aug.	Laminaria	0.27	3.2	0.304 A	1.3 A

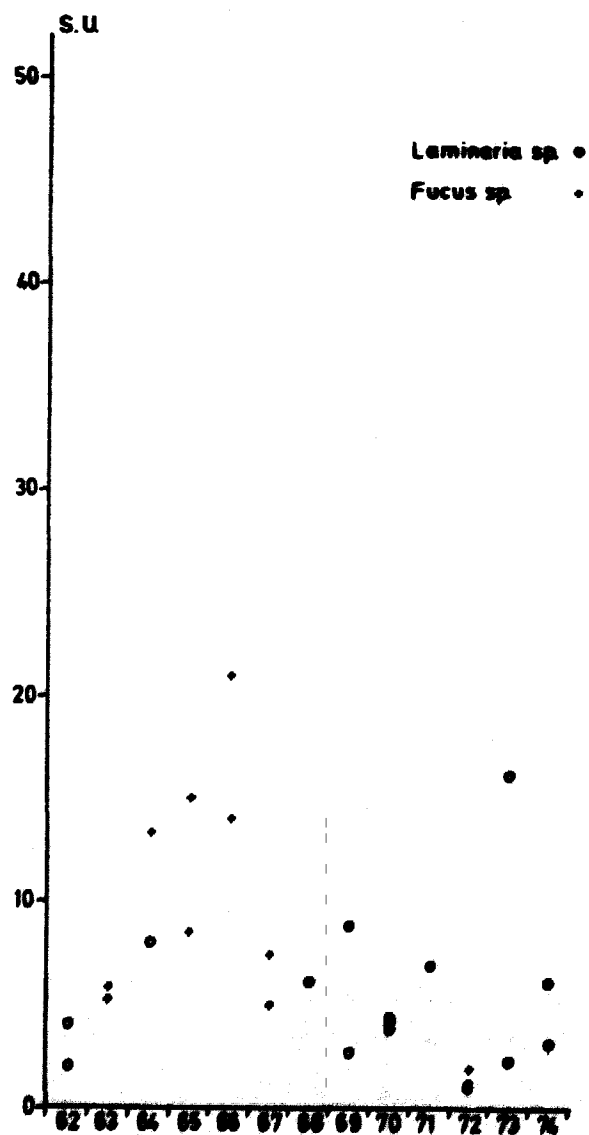


Fig. 2.7.3. S.U. in sea plants collected at Thorshavn 1962-74.

2.7.4. Vegetables

Tables 2.7.4.1 and 2.7.4.2 show the results of the ^{90}Sr and ^{137}Cs determinations.

This year potatoes were obtained from Thorshavn, Klaksvig and Tvørá. The ^{90}Sr and especially the ^{137}Cs levels were lower in the sample from Thorshavn than in the other samples. This may explain the considerable variation in the ^{137}Cs levels in particular which was observed in 1970, 1971 and 1973 (cf. fig. 2.7.4.1). For the period 1968-74 we use a constant level equal to the average for this period, i. e. 320 pCi ^{137}Cs /kg potatoes.

Table 2.7.4.1

Strontium-90 and Caesium-137 in vegetable and fruits from the Faroes in 1974

Sampling month	Species	pCi ^{90}Sr /kg	pCi ^{90}Sr /g Ca	pCi ^{137}Cs /kg	pCi ^{137}Cs /g K
Aug.	Carrots	5.3	23	5 B	1.8 B
Aug.	Spring cabbage	6.0	-		
Aug.	Cauliflower	7.8	14		

Table 2.7.4.2

Strontium-90 and Caesium-137 in potatoes from the Faroes in October 1974

Location	pCi ^{90}Sr /kg	pCi ^{90}Sr /g Ca	pCi ^{137}Cs /kg	pCi ^{137}Cs /g K
Høyvig	5.2	161	70	15
Klarksvig	15.7	579	452	112
Tvørá	8.5	260	463	96

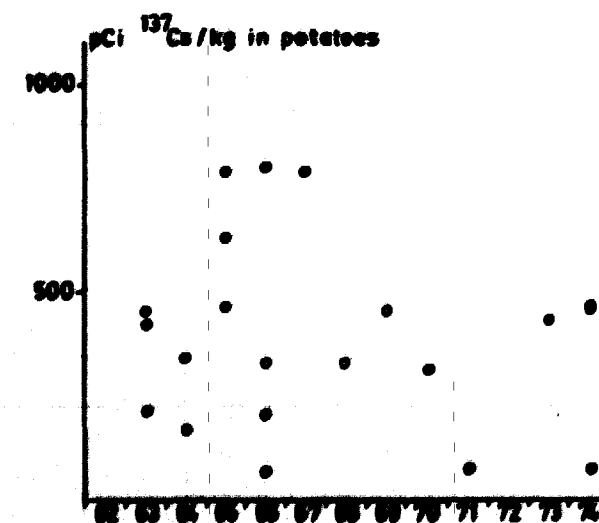


Fig. 2.7.4.1. Caesium-137 in Faroese potatoes collected 1962-74.

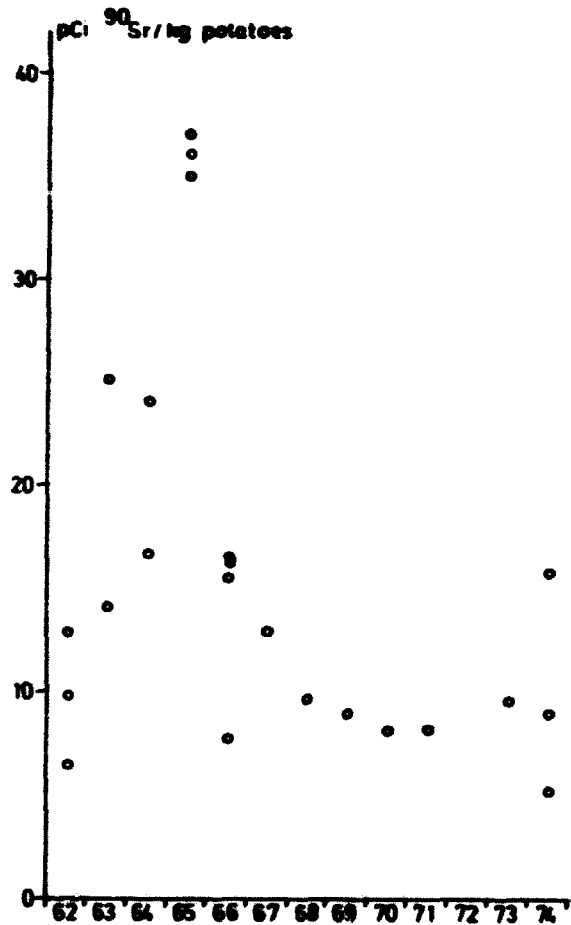


Fig. 2.7.4.2. Strontium-90 in Faroesse potatoes collected 1962-74.

2.7.5. Bread

As in previous years¹⁾, rye bread and white bread were collected at Thorshavn in June and December. The mean levels in white bread were 4.6 pCi ⁹⁰Sr/kg and 7.7 pCi ¹³⁷Cs/kg. The rye bread collected in 1974 contained on the average 13 pCi ⁹⁰Sr/kg and 17 pCi ¹³⁷Cs/kg, i. e. the bread levels were nearly equal to the 1973 levels. The ⁹⁰Sr levels in Faroesse bread were lower than the Danish²⁾, but the ¹³⁷Cs levels were perhaps a little higher.

Table 2.7.5

Strontium-90 and Caesium-137 in Faroesse bread in 1974

Month	Sort	pCi ⁹⁰ Sr/kg	pCi ⁹⁰ Sr/g Ca	pCi ¹³⁷ Cs/kg	pCi ¹³⁷ Cs/g K
June	White bread	4.5	2.1	10 A	6.2 A
June	Rye bread	15.1	6.5	12 A	5.8 A
Dec.	White bread	4.7	4.7	5.4	4.1
Dec.	Rye bread	11.5	7.4	22	8.5

2.7.6. Eggs

Eggs were collected from Thorshavn in June and December 1974. Table 2.7.6 shows the results. The mean levels were 1.5 pCi ⁹⁰Sr/kg (2.4 S. U.) and 8 pCi ¹³⁷Cs/kg.

Table 2.7.6

Strontium-90 and Caesium-137 in Faroesse eggs in 1974

Month	pCi ⁹⁰ Sr/kg	pCi ⁹⁰ Sr/g Ca	pCi ¹³⁷ Cs/kg	pCi ¹³⁷ Cs/g K
June	1.7 A	2.6 A	9.8 A	6.5 A
Dec.	1.2	2.2	6.1 B	4.4 B

2.7.7. Butter

The ⁹⁰Sr content was measured in a sample of butter collected in the Faroes in 1974. We found 3 pCi ⁹⁰Sr/kg butter (28 S. U.) and 17 pCi ¹³⁷Cs/kg (85 M. U.).

2.8. Humans

2.8.1. Strontium-90 in Human Bone

In 1974 a number of human bone samples were obtained from Dronning Alexandrine's Hospital in Thorshavn. Table 2.8.1 shows the results.

The mean level in bone of newborn infants was 1.9 pCi ⁹⁰Sr/g Ca, and from Danish measurements since 1963 we know that the observed ratio between the bone of newborn infants and the mothers' diet is 0.11. Hence,

Table 2.8.1

Strontium-90 in human vertebrae collected in the Faroes in 1974

Age	Month of death or sampling	Sex	pCi ⁹⁰ Sr/g Ca
~0	~10	F	1.93 ^{**}
~0	~5	M	1.94 ^{**}
69 years	9	F	1.29 ^Δ
75 "	-	F	2.69 ^Δ
80 "	12	M	3.07 ^Δ

^{**} Bulked sample from 3 individuals
^{**} Bulked sample from 4 individuals
^Δ Femur (from amputation)

the mothers' diet should have contained approx. 18 pCi $^{90}\text{Sr/g Ca}$. In 1973¹⁾ the ^{90}Sr level of the Faroese adult human diet was estimated at 12 pCi $^{90}\text{Sr/g Ca}$, and in 1974 we found (cf. 3) 10 pCi $^{90}\text{Sr/g Ca}$. As the bone samples were collected in May-October, it is reasonable to conclude that the estimated diet level is approx. 11. In contrast to last year¹⁾, it must be concluded that the levels in bone of newborn infants were higher than expected from the diet estimate. Similar observations have been made in Denmark²⁾. The higher levels in newborn infants bone may be due to a transfer of ^{90}Sr from the mother's bone. Here the S. U. -levels in recent years have been close to levels in the bone of newborn infants.

2.8.2. Wholebody measurements of ^{137}Cs

Four Faroese students from the University of Copenhagen and two Faroese patients from the eye clinic at the Rigshospital were measured in the Risø wholebody counter. The students had resided in Denmark for 1-2 months before the measurement, while the two patients had just arrived from the Faroes. We may thus expect the ^{137}Cs wholebody contents of the six persons to have been almost twice as high when they left the Faroes. (The biological half-life of ^{137}Cs being 2-3 months).

The mean level of the group was 36 ± 9 (1 SE) pCi $^{137}\text{Cs/g K}$, i. e. approx. 4 times higher than in a Danish control group²⁾. If we compare the estimated ^{137}Cs content of the Faroese diet to the Danish diet (cf. 3.11), we may conclude that the group has apparently consumed food in the Faroes with a lower ^{137}Cs content than our estimate for 1974 (cf. table 3.2).

Table 2.8.2

Wholebody measurements of Faroese in 1974

Measuring months	No.	Age	Weight	Sex	Height	^{137}Cs nCi/kg	M.U.	g K/kg
Oct. 74	84	20 y	65 kg	M	173 cm	139.5	76.9	1.8
	85	22 -	69 -	F	172 -	24.5	15.2	1.6
	86	20 -	55 -	F	159 -	44.7	30.0	1.5
	87	20 -	80 -	M	185 -	59.8	28.6	2.1
July 74	82	72 -	57 -	F	152 -	67.5	43.9	1.5
	83	22 -	65 -	M	174 -	46.3	24.3	1.9

3. ESTIMATE OF THE MEAN CONTENTS OF ^{90}Sr AND ^{137}Cs IN THE HUMAN DIET

3.1. Annual Quantities

The annual quantities are still based on the estimate made by Professor E. Hoff-Jørgensen, Ph. D., in 1962¹⁾ of a daily per capita intake of approx. 3000 calories.

3.2. Milk and Cream

75% of the milk consumed in the Faroes is assumed to be of local origin, and 25% comes from Denmark. Hence the ^{90}Sr content in milk consumed in the Faroes in 1974 was $1.2 \cdot (0.75 \cdot 20 + 0.25 \cdot 4.5) = 19.4$ pCi $^{90}\text{Sr/kg}$, and the ^{137}Cs content was $0.75 \cdot 254 + 0.25 \cdot 7.3 = 192$ pCi $^{137}\text{Cs/kg}$ (cf. 2.3 and ref. 2). 1 kg milk contains 1.2 g Ca.

3.3. Cheese

Nearly all cheese consumed in the Faroes is of Danish origin, and the Danish figures from ref. 2 were used: 38.3 pCi $^{90}\text{Sr/kg}$ and 5.3 pCi $^{137}\text{Cs/kg}$.

3.4. Grain Products

As most grain products are imported from Denmark, the Danish figures for 1974²⁾ were used in the calculation of the Faroese levels. The mean daily consumption of grain products in the Faroes is, as in Denmark, 80 g rye flour, 120 g wheat flour, and 20 g grits. Hence the mean concentration of ^{90}Sr in grain products consumed in the Faroes in 1974 is 14 pCi $^{90}\text{Sr/kg}$ and 13 pCi $^{137}\text{Cs/kg}$.

3.5. Potatoes

All potatoes consumed in the Faroes are assumed to be of local origin. The values from table 2.7.4.2 were used, i. e. 10 pCi $^{90}\text{Sr/kg}$ and 328 pCi $^{137}\text{Cs/kg}$.

3.6. Other Vegetables and Fruit

As the amount of vegetables and fruit grown in the Faroes is limited, the Danish figures from 1974²⁾ were used. Thus the mean contents in vegetables other than potatoes were 10 pCi $^{90}\text{Sr/kg}$ and 2 pCi $^{137}\text{Cs/kg}$, and the mean contents in fruit were 4 pCi $^{90}\text{Sr/kg}$ and 4 pCi $^{137}\text{Cs/kg}$.

3.7. Meat and Eggs

Meat and egg consumption in the Faroes is estimated to consist of 50% locally-produced mutton (or lamb), 25% local whale meat, and 25% sea birds and eggs.

The mutton contained 14 pCi ⁹⁰Sr/kg and 1.44 nCi ¹³⁷Cs/kg (cf. 2.4). Whale meat from 1974 contained 0.35 pCi ⁹⁰Sr/kg and 6 pCi ¹³⁷Cs/kg, sea birds from 1970¹⁾ and eggs (cf. 2.7.6): 1.5 pCi ⁹⁰Sr/kg and 1.5 pCi ⁹⁰Sr/kg, and 15 and 8 pCi ¹³⁷Cs/kg respectively.

Hence we estimate the mean content of ⁹⁰Sr in meat and eggs consumed in 1974 to be

$$0.50 \cdot 14 + 0.25 \cdot 0.35 + 0.25 \cdot \left(\frac{1.5 + 1.5}{2}\right) = 7.5 \text{ pCi } ^{90}\text{Sr/kg}$$

and the ¹³⁷Cs content to be

$$0.50 \cdot 1440 + 0.25 \cdot 6 + 0.25 \cdot 11.5 = 724 \text{ pCi } ^{137}\text{Cs/kg.}$$

3.8. Fish

All fish consumed in the Faroes is of local origin, and the mean contents in fish, obtained from subsection 2.5, were 0.6 pCi ⁹⁰Sr/kg and 11 pCi ¹³⁷Cs/kg.

3.9. Coffee and Tea

The Danish figures for 1974²⁾ were used, i. e. 25 pCi ⁹⁰Sr/kg and 37 pCi ¹³⁷Cs/kg.

3.10. Drinking Water

The mean value found in table 2.6.1 was used, i. e. 0.31 pCi ⁹⁰Sr/l. The ¹³⁷Cs content was estimated to be approx. one fourth (the ratio found in New York tap water in 1964⁴⁾) of the ⁹⁰Sr content, i. e. 0.1 pCi ¹³⁷Cs/l.

Tables 3.1 and 3.2 show the diet estimates of ⁹⁰Sr and ¹³⁷Cs respectively.

Table 3.1

Estimate of the mean content of ⁹⁰Sr in the human diet in the Faroes in 1974

Type of food	Annual quantity in kg	pCi ⁹⁰ Sr per kg	Total pCi ⁹⁰ Sr	Percentage of total ⁹⁰ Sr in food
Milk and cream	146	19.4	2832	46.4
Cheese	7.3	38.3	280	4.6
Grain products	80	14	1120	18.4
Potatoes	91	10	910	14.9
Vegetables	20	10	200	3.3
Fruit	18	4	72	1.2
Meat and eggs	37	7.5	278	4.5
Fish	91	0.6	55	0.9
Coffee and tea	7.3	25	182	3.0
Drinking water	548	0.31	170	2.8
Total			6099	

The mean annual calcium intake is estimated to be 600 g (approx. 200-250 g of creta praeparata). Hence the pCi ⁹⁰Sr/g Ca ratio in the total Faroese diet was 10 S.U., and the mean daily intake was 17 pCi ⁹⁰Sr.

Table 3.2

Estimate of the mean content of ¹³⁷Cs in the human diet in the Faroes in 1974

Type of food	Annual quantity in kg	pCi ¹³⁷ Cs per kg	Total pCi ¹³⁷ Cs	Percentage of total ¹³⁷ Cs in food
Milk and cream	146	192	28032	32.2
Cheese	7.3	5.3	39	0.0
Grain products	80	13	1040	1.2
Potatoes	91	328	29848	34.3
Vegetables	20	2	40	0.0
Fruit	18	4	72	0.1
Meat and eggs	37	724	26788	30.7
Fish	91	11	1001	1.2
Coffee and tea	7.3	37	270	0.3
Drinking water	548	0.1	55	0.0
Total			87130	

The mean annual intake of potassium is estimated to be approx. 1200 g. Hence the pCi ¹³⁷Cs/g K ratio becomes 73 and the daily intake of ¹³⁷Cs 230 pCi.

3.11. Discussion

Figure 3 shows the Faroese diet levels since 1962.

The 1974 ^{90}Sr levels in the total diet were a little lower than in 1973, and the ^{137}Cs levels were somewhat lower due to the lower levels in the samples of potatoes and lamb from this year. Nevertheless, as appears from fig. 3, the 1974 ^{137}Cs level fits the 1971 and 1972 levels and we may conclude that the 1973 level was overestimated.

The main contributors to the ^{90}Sr content in the Faroese diet were milk products and cereals, which together accounted for approx. 2/3 of the total ^{90}Sr content in the diet in 1974. As regards ^{137}Cs , milk products, meat (lamb), and potatoes were the most important contributors. In 1974, 97% of the total ^{137}Cs content in the diet originated from these products.

The Faroese mean diet contained 1.7 times as much ^{90}Sr and approx. 15 times as much ^{137}Cs as the Danish diet in 1974²⁾.

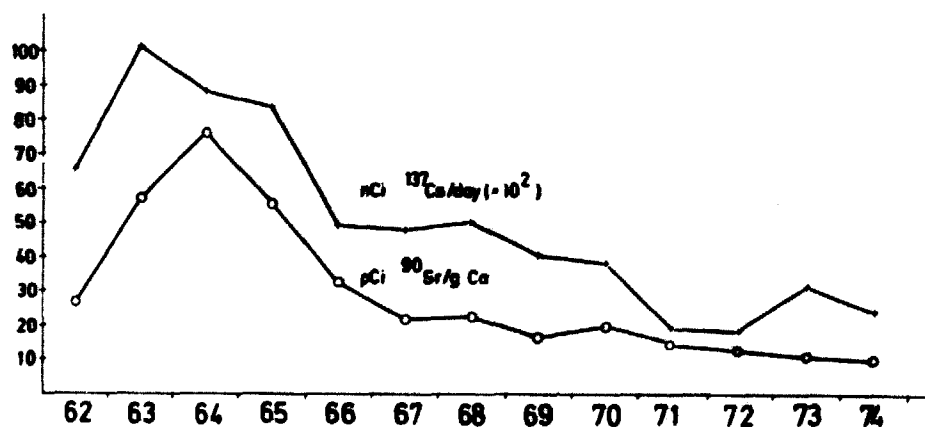


Fig. 3. Strontium-90 and Caesium-137 in Faroese diet, 1962-74.

4. CONCLUSION

4.1.

The ^{90}Sr fall-out rate in the Faroes in 1974 was approx. 1.3 mCi $^{90}\text{Sr}/\text{km}^2$. The accumulated fall-out by the end of 1974 was estimated at approx. 98 mCi $^{90}\text{Sr}/\text{km}^2$ (the mean at Thorshavn and Klaksvig).

4.2.

The mean level of ^{90}Sr in Faroese milk was 20 S.U. or 24 pCi $^{90}\text{Sr}/\text{l}$. The ^{137}Cs concentration was 158 pCi $^{137}\text{Cs}/\text{g K}$, or 254 pCi $^{137}\text{Cs}/\text{l}$.

Lamb contained 14 pCi $^{90}\text{Sr}/\text{kg}$ and 1.44 nCi $^{137}\text{Cs}/\text{kg}$. Fish showed mean levels of 0.6 pCi $^{90}\text{Sr}/\text{kg}$ and 11 pCi $^{137}\text{Cs}/\text{kg}$.

The mean content of ^{90}Sr in drinking water was 0.31 pCi/l.

The mean daily per capita intakes resulting from the Faroeses diet in 1974 were estimated at 17 pCi ^{90}Sr (10 S.U.) and 239 pCi ^{137}Cs (73 pCi $^{137}\text{Cs}/\text{g K}$).

4.3.

From the Faroese and Danish diet estimates and from measurements on Faroese and Danish bones, the Faroese bone levels in 1974 were estimated as follows: in newborn infants: approx. 1.9 S.U.; in small children (1 month - 4 years): approx. 3 S.U. (depending upon the amount of locally produced milk in the diet of the infants); in children and teenagers (5 - 19 years): approx. 3 S.U.; in adult vertebrae: approx. 3 S.U.

The mean content of ^{137}Cs in the Faroese adult was estimated at approx. 40 - 80 pCi $^{137}\text{Cs}/\text{g K}$. This estimate is based on whole-body measurements of six adults in 1974.

ACKNOWLEDGEMENTS

The authors wish to thank Mrs. Karen Mandrup, Mrs. Jytte Clausen, Mrs. Pearl Baade-Pedersen, Mrs. Ulla Wilhelmsen, Miss Lone Dyrgård Jensen, Mrs. Else Sørensen, and Mrs. Anna Madsen for their conscientious performance of the analyses.

Our special thanks are due to the staff of the pharmacy "Tjaldur" in Thorshavn and to all other persons in the Faroes who have contributed by collecting samples.

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