Table 1. CONCENTRATIONS OF CAESIUM-137 AND STRONTIUM-90 IN RIVER- AND RAIN-WATERS (FEBRUARY 1960-JULY 1962)

Time of collection	¹³⁷ Cs $\mu\text{mc./l.}$		⁹⁰ Sr $\mu\text{mc./l.}$	
	River*	Rain†	River*	Rain†
Feb. 1960	0.18	7.9	—	—
May 1960	0.070	2.8	—	—
Sept. 1960	0.063	1.2	0.10	0.41
July 1961	0.066	1.1	0.15	0.27
May 1962	0.24	11	0.51	4.8
July 1962	0.32	15	—	—

* At Kurihashi, River Tonegawa.

† At Kiriu City, Gunma Pref.

Regression analyses by use of the data shown in Table 1 showed the values of p_r for caesium-137 and strontium-90 as 0.013 and 0.072, respectively. This implies that 1.3 per cent of caesium-137 and 7.2 per cent of strontium-90 from the land surface which originated from fall-out would be carried by river to the sea. We have also obtained the values of 0.035 and 0.064 $\mu\text{mc./l.}$ for C_d respectively for caesium-137 and strontium-90; these concentrations indicate the run-off of the cumulative ground deposits as the result of weathering.

To check the geographical variation of these values, which may be recognized between different water sheds, measurements were made on the river waters collected from several localities in Japan during August 1962. The results shown in Table 2 indicate an approximate constancy between different rivers in the concentrations of both caesium-137 and strontium-90. This suggests the universal validity of the proportionality factors p_r for Japanese rivers.

Table 2. CONCENTRATIONS OF CAESIUM-137 AND STRONTIUM-90 IN RIVER WATERS IN JAPAN (AUGUST 1962)

River	Day of collection (August)	¹³⁷ Cs ($\mu\text{mc./l.}$)	⁹⁰ Sr ($\mu\text{mc./l.}$)
Öyodogawa	1	0.32	0.19
Shirakawa	3	0.32	0.39
Sendaigawa	8	0.37	0.37
Kuzuryūgawa	10	0.35	0.49
Aganogawa	19	0.21	—
Shinanogawa	19	0.45	0.46
Tonegawa	20	0.23	0.32
Av.		0.32 ± 0.08	0.37 ± 0.11

The validity of the values of C_d for different rivers is also supported by the work of Miyake and Tsubota¹, who reported a similar constancy for river waters collected in Japan during July–August 1961 when the deposition rate was the smallest and the contribution of the ground deposits through leaching was the largest.

The cumulative ground deposit (D) caused by the continuous and constant deposition rate (R) can be shown by the following equation:

$$D = \frac{(1 - p_r)R}{\lambda_e} (1 - e^{-\lambda_e t})$$

where p_r has been given earlier and λ_e is the effective decay constant on the ground, which can be expressed as $\lambda_p + \lambda_w$, where λ_p is the radioactive decay constant and λ_w is the weathering constant.

The run-off by river of the ground deposits of caesium-137 and strontium-90 can be estimated as 17.5 c. and 32 c. respectively per annum on the basis of the mean concentrations (C_d) as given earlier and the total discharge of 5×10^{14} l. of river water in Japan. By assuming the cumulative depositions of caesium-137 and strontium-90 as 80 and 28 mc./km² respectively in the spring of 1962 and the total land area as 3.65×10^5 km², the weathering constant λ_w would be calculated as 6.0×10^{-4} and 3.1×10^{-3} respectively for these radionuclides. These values are much lower than those of the radioactive decay constants by factors of 8 for strontium-90 and 40 for caesium-137. Half the ground deposits of caesium-137 and strontium-90 would only be leached out after 1,150 and 220 years, respectively. Hence, no weathering factors need to be considered, especially for caesium-137, in the future prediction of cumulative deposition. However, the slow penetration of the radionuclides into undisturbed soil and the mixing due to cultivation would result in

the attenuation of the external exposure and the extent to which the radionuclides may enter the food chain.

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METALLURGY

Grain Boundary Cavitation in Molybdenum

THE formation of cavities at grain boundaries under creep conditions had been observed in many metals and may lead to intercrystalline failure¹. We have observed such cavitation in molybdenum wires of 0.010 mm diam. heated by electron bombardment to temperatures between 1,500° and 2,500° C (that is, above 60 per cent of the absolute melting point) and strained a few per cent at rates of 1.5–2.5 per cent elongation per hour. These cavities are of the two types identified by McLean in Nimonic-type alloys², wedge-shaped and ellipsoidal. Zener³ suggested that wedge-shaped cavities are formed by the stress concentration at a grain boundary junction when sliding occurs on boundaries meeting there.

Table 1

	Stresses (lb./in. ²) on the molybdenum wire up to but not exceeding		
	1,000	2,000	3,000
No. of experiments	14	31	43
Percentage developing cavities	28	42	50
Percentage developing wedge cavities	7	26	36

Ellipsoidal cavities form at any point along a boundary which is roughly perpendicular to the strain axis. These cavities may link together, forming intercrystalline cracks. The proportion of experiments leading to the formation of cavities increases with the temperature of the molybdenum and with the total strain. The proportion of samples developing cavities, and the proportion of cavitated samples in which the cavities are of wedge type increase with the stress (Table 1). McLean reported the same relationship between cavity type and stress in alloys of Nimonic type².

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Enhanced Age-hardening in Aluminium–Magnesium Alloys

ALTHOUGH the solubility of magnesium in aluminium is as high as 16.8 per cent (alloy contents are expressed as atomic percentages) at 450° C (ref. 1), and decreases to an estimated value of 1 per cent at room temperature, the alloys show an abnormally small response to age-hardening. Furthermore, there is no evidence to indicate that the ageing characteristics of these alloys are changed by small additions of third elements, as happens in other binary alloys such as aluminium–copper² and aluminium–zinc³. For example, the addition of 0.45 per cent zinc to aluminium–8 per cent magnesium causes only a small increase in