

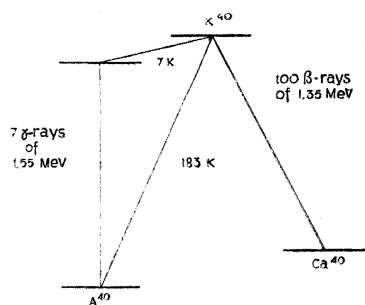


FIG. 1. Disintegration scheme for the decay of K^{40} with relative branching intensities.

the value of Běhounek. However, they cite this latter value erroneously as 1.3×10^{-11} . This fact renders it extremely likely that their own value also was taken too low by a factor ten.

- ¹ E. Gleditsch and T. Gráf, *Arch. f. Math. og Naturvid.* **44**, 63, 145 (1941).
- ² L. H. Gray and G. T. P. Tarrant, *Proc. Roy. Soc. A* **143**, 681 (1934).
- ³ E. Gleditsch and T. Gráf, *Phys. Rev.* **72**, 641 (1947).
- ⁴ A more detailed account will appear in *Ark. f. Mat. Astr. och Fysik.*
- ⁵ W. Mühlhoff, *Ann. d. Physik* **7**, 205 (1930).
- ⁶ F. Běhounek, *Zeits. f. Physik* **69**, 654 (1941).
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Significance of the Radioactivity of Potassium in Geophysics

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CONSIDERING recent data on the radioactivity of K^{40} , such as greater gamma-ray intensity,¹ higher beta-ray energy,² as well as a shorter half-value period³ than previously admitted, some interesting consequences in geophysics are apparent to us. We should like to point out two of these consequences, the first concerning the ionization balance of the atmosphere, the second the radioactive heat production of K^{40} in rocks and, more generally, in the earth's crust. Recent measurements by V. F. Hess⁴ with a thick-walled ionization chamber disclose a large discrepancy between the value of the ionization in air, produced by the gamma-rays of the different radioactive substances contained in Quincy granite, and that computed from the concentrations of these substances known by the measurements of Evans and Goodman.⁵ Assuming, according to Gray and Tarrant,⁶ that one gram of potassium is equivalent in its gamma-ray effect to 1.6×10^{-11} g of radium, Hess computes the value of 0.50 I (where I is a symbol for "ion pairs per cm^3 per sec.") for the ionization of the air due to the potassium contained in Quincy granite. Uranium and thorium will produce in the same case 0.64 I and 0.92 I , respectively. The total of 2.06 I , computed for a point above an infinite layer of rock, compares with the measured value of 5.18 I obtained on a ground of crushed granite.

With the use of our recent value¹ for the gamma-ray intensity of K^{40} , for potassium alone we obtain 2.6 I , which gives a total of $4.16 \pm 1.25 I$, in satisfactory agreement with the experimental result. Thus, in the case of granites, the gamma-rays of potassium play a more important part in the ionization of the air than those of the uranium and thorium families together.

For the radioactive-heat production of potassium, Evans and Goodman⁵ compute the value of $(5 \pm 2) \times 10^{-6}$ cal. per year per gram. If we admit $(7 \pm 1) \times 10^8$ years for the period of the beta-decay of K^{40} , we find 52.5 beta-rays per second for one gram of potassium. Their average energy² being 0.49 ± 0.06 Mev we compute for the beta-rays alone a heat production of $3.15 \times 10^7 \times 52.5 \times 0.49 \times 0.382 \times 10^{-13} = (31 \pm 6) \times 10^{-6}$ cal per year per gram of potassium (1 year $= 3.15 \times 10^7$ sec.). For 3.6 ± 0.8 gamma-quanta¹ of 1.55 ± 0.05 Mev, the heat production amounts to $3.15 \times 10^7 \times 3.6 \times 1.55 \times 0.382 \times 10^{-13} = (7 \pm 2) \times 10^{-6}$ cal. per year per gram of potassium. We thus arrive at a total heat output of $(38 \pm 7) \times 10^{-6}$ cal. per year per gram of potassium. In the case of acidic igneous rocks, Evans and Goodman⁵ compute, for average uranium, thorium, and potassium contents, the respective values of $(2.2 \pm 0.2) \times 10^{-6}$, $(2.6 \pm 0.4) \times 10^{-6}$, and $(0.14 \pm 0.06) \times 10^{-6}$ cal per year per gram of rock. We obtain in the same case for potassium alone $(1.1 \pm 0.2) \times 10^{-6}$ cal per year per gram of rock. This is about 20 percent of the total heat production in acidic igneous rocks. Much more important must have been the role played by potassium in the early history of the earth. Considering the total period of K^{40} , only $(2.4 \pm 0.5) \times 10^8$ years³ as a result of its dual decay, it is easy to see that 2.4×10^9 years ago, for example, a time which corresponds to 10 periods of K^{40} and leads us back to the beginning of the earth's history, $2^{10} = 1024$ times more K^{40} was present than today. The heat produced by K^{40} alone was about 200 times that generated at present by all the radioactive elements in the earth together. Of course, the heat output due to uranium and thorium then was also larger than now, but the difference did not exceed 50 percent of the present value. The tremendous source of energy, constituted by the active isotope of potassium, was diminishing continuously, but even 1.2×10^9 years ago was still about 6 times larger than the present disintegration energy of all radioactive elements in the earth's crust.

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³ E. Bleuler and M. Gabriel, *Helv. Phys. Acta* **20**, 67 (1947).

⁴ V. F. Hess, *Norsk Geologisk tidsskrift* **27**, 1 (1947).

⁵ R. D. Evans and C. Goodman, *Bull. Geol. Soc. Am.* **52**, 459 (1941).

⁶ L. H. Gray and G. T. P. Tarrant, *Proc. Roy. Soc. A* **143**, 681 (1934).

Excess-Defect Semiconductor Contacts

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TWO recent papers^{1,2} have dealt with the theoretical aspects of silicon-germanium rectifiers. Impurity centers giving rise to both excess and defect conductivity are shown to exist with corresponding energy levels only