Radioactivity Produced in Germanium*

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In continuing the study of the radioactivities produced in germanium,[1] we have checked most of the previous assignments of the isotopes after chemical separation. Four gallium and three arsenic isotopes were also produced from germanium. Seaborg and others[2] have reported recently on the same subject. They agree in general with our former assignments, but there remain some points which are not in accord with our present results. A further study is being carried out to make clear the discrepancy and some ambiguities.

Ge^{77} (8∼12 hr. e^-; 1.92 Mev). As has been suggested by one of the authors, this period was found in the germanium fraction of the Ge+SN sample and also in the Ge+D (3 Mev) sample. The results are in accord with Seaborg, although we are not quite certain whether the period should be 12 hours or shorter.

Ge^{75} (82±2 min. e^-; 1.10 Mev). In agreement with the former assignment done by one of us, the 82-min. period is produced by Ge (d, p), Ge (n, γ), Ge $(n, 2n)$, As (n, p) and Se (n, α). The results were checked by Seaborg and others.

Ge^{71} (30±4 hr. e^+; 1.15 Mev). In accord with the former results, a positron emitting period of about 30 hours was produced by Ge (n, γ), Ge $(n, 2n)$, Ge (d, p) and Se (n, α). Although the former value of 26 hours should be revised to be a little longer, yet the discrepancy between the result obtained by Seaborg (40 hours) is beyond the accuracy of the experiment. They also reported the 11-day period to be Ge^{71}, but we have not been able to find this period in the germanium fraction. Instead we found the 9-day period in the gallium fraction.

Ge^{69} 30-minute period reported by one of the authors has not been observed in Tokyo. We had accounted for the fact by the lack of energy in producing the $(n, 2n)$ reaction, but according to Seaborg and others they failed also. It might be an error due to the misinterpretation of the combined effect of gallium components (20 min. and 66 min.) produced in an appreciable amount.

Production of Ga^{68}, Ga^{70} and Ga^{72} in Ge+D and Ga^{70} and Ga^{72} in Ge+FN was chemically proved. One more long period of about 9 days (0.8 Mev) was found in the gallium fraction of the Ge+D sample, which is identical with the former suggestion. Probably this period is due to Ga^{74}.

We have reported[3] previously on the chemical identification of the 16-day and the 90-day periods as As^{74} and As^{77}, respectively. In addition to these a 50-hour period (e^+; 0.6 Mev) was also identified as an arsenic isotope. By making two successive chemical separations between germanium and arsenic fractions, it has been found that this isotope does not disintegrate successively. The fact shows that this period should be assigned to As^{73}. We failed to find the 88-minute (e^+) period in arsenic fraction. The former result[1] is probably due to the error of misinterpretation of the combined effect of the 66-min. and 30-hr. periods.

A more detailed report will be published shortly in the *Proceedings of the Physico-Mathematical Society of Japan.*

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[2] Seaborg, Livingood and Friedlander, Phys. Rev. **59**, 320 (1941).
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High Energy Gamma-Ray from Li+D

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A 440-KEV gamma-ray is the only one reported to have been observed when lithium is bombarded by deuterons.[1] We have observed gamma-rays from this reaction which are more energetic and more intense than the 440-kev gamma-rays. The latter have not been observed in our experiments.

An absorption curve in lead of the gamma-radiation showed that its energy was considerably greater than 440 kev. The energy was measured more accurately by using coincidence counters to find the maximum range of the Compton electrons in aluminum.[2] The maximum range was 8.7 mm corresponding to a gamma-ray energy of 4.9±0.3 Mev. Effects from the nuclear beta-rays from Li^8 were avoided by using 7.2 g/cm² of carbon as an absorber between the target and the Geiger counters.

To get the absolute yield of gamma-rays a thin target of LiOH (13.4 kev thick) was bombarded by 770-kev deuterons and the gamma-rays were counted by a single Geiger counter, assumed to be 2 percent efficient in counting gamma-rays of these energies. From the number of gamma-rays produced in this thin target, the number produced in a thick target of lithium was calculated for 770-kev deuterons from an excitation curve for the gamma-radiation which we had taken. The intensity of the gamma-radiation was found to be 3.0×10^6 quanta per microcoulomb. The yield of neutrons for this reaction is known,[3] and we find the ratio of gamma-rays to neutrons to be 3.3 percent.

The gamma-rays were observed from thick and thin targets of LiCl and thin targets of LiOH deposited on copper and on silver. This makes it fairly certain that the gamma-rays were not produced by bombardment of any other material. Furthermore the excitation curve for the gamma-rays was similar to that for the neutrons from Li^7 and for the beta-rays from Li^8 formed by the bombardment of lithium by deuterons. All three excitation curves showed resonances at about 700 and 1000 kev of deuteron energy.