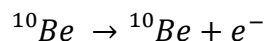# BERYLLIUM-10

The chemical element Beryllium (Be) has the atomic number 4, it can be found in the 2nd period of the periodic table and is an Alkaline earth metal. The only stable isotope of Beryllium is ^{9}Be and thus is considered one of the 22 mononuclidic elements. Eleven radioactive isotopes of Beryllium are known - – ^{5}Be to ^{8}Be and ^{10}Be to ^{16}Be.

At the end of the 18th century *LOIS-NICOLAS VAUQELIN*[1] isolated Beryllium as its oxide (BeO) from the minerals Beryl and Emerald. He named the new element G*lucine* for the sweet taste of some of its compounds. *MARTIN HEINRICH KLAPROTH*[2] made a similar discovery as his French colleague but preferred the name *Berryllina* because of its extraction from Beryl [1]. In the end the name Beryllium prevailed, although in France the element was still called *Glucinium* (with the symbol Gl) until 1957[3]. The isolation of the pure metal was achieved after three decades by *FRIEDRICH WÖHLER*[4] in 1827 with the so called *"Wöhler-Process"* [2]. This is a reduction method for the synthesis of pure aluminium which first worked in 1828. In the same year, *ANTOINE BUSSY*[5] managed to isolate Beryllium through the reduction of Beryllium chloride with potassium [3]

Beryllium-10 is, as already mentioned above, a radioactive isotope, which decays by beta decay (β-) with a half-life of 1.39×10^6 years [4] to the stable Boron-10 isotope (*Note: isotope of the month April 2019*).

The decay is described by the following chemical reaction:

$$^{10}Be \rightarrow {}^{10}Be + e^-$$

GL 1

Due to the relatively long half-life of Beryllium-10 (the other Be isotopes have a half-life of days or seconds) and the usage as an ubiquitary environmental tracer, as well as its application in geology, archaeology, glaciology and oceanography makes this isotope quite interesting.

In the earth's atmosphere ^{10}Be is mainly formed from nitrogen and oxygen by the separation process following cosmogenic radiation [6]. From there precipitation transports it to the earth's surface and into the water. The residence time of ^{10}Be in sea water is up to several 100 years [7] until it is adsorbed and built into organic and inorganic particles, which fall to the sea floor as sediment. There it decays to the stable ^{10}B isotope [8]. The occurrence in young marine

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[1] French pharmacist and chemist (1763-1829); discoverer of the element chromium
[2] German chemist (1743–1817)
[3] Besides Beryllium there are were several chemical elements discovered around the same time and independently of each other by German and French chemists, each wanting the rights of naming for themselves.
[4] German chemist (1800–1882)
[5] French pharmacist and chemist (1794–1882)

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sediments can be used to date them and determine variations in time and space of the production rate of ^{10}Be itself [8].

Theoretical approaches in the middle 1950s lead to the assumption that naturally occurring ^{10}Be can be used to date marine sediments [8] [9] [10]. Experiments followed in 1957 [11].

In general sedimentation rates can be determined with the ^{10}Be method analogue to the Ionium method:

$$\ln{}^{10}Be = \ln{}^{10}Be_0 - \frac{\lambda\, h}{a} \qquad\qquad \text{GL 2}$$

with: a = h/t = sedimentation rate
                 h = depth of the sediment below the sea floor

Low ^{10}Be concentrations lead to a restriction of this application to materials with high ^{10}Be concentrations [8] as it is the case with the mineral quartz.

In the late 1970s accelerator mass spectrometry (AMS) was developed [12]. With the AMS it was possible to measure 10^6 ^{10}Be-atoms at a concentration of ^{10}Be/^{9}Be $\approx 10^{-14}$.

Starting in the 1980s the AMS lead to an increase in the study of sediments and magmatic rocks. Deep sea sediments could be determined with a mean ^{10}Be concentration of $(5.7\pm3.2)\times10^9$ atoms per gram stone [13]. This is about one decimal power higher than can be found in fluviatile sediments and soils. This was explained by the slow sedimentation in the deep sea and therefore the possibility to extract ^{10}Be from the sea water.

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LITERATURE

[1] M. Hosenfeld u.a., 26. Gmelins Handbuch der anorganischen Chemie. Beryllium, Berlin: Verlag Chemie, 1930.

[2] M. J. Huber, *Struktur, Stabilität und Funktionalisierung metalloider Aluminiumcluster,* Cuvillier Verlag, 2008.

[3] F. W. Schweigger-Seidel, „Über Glycium (Beryllium) und Magnium," *Journal für Chemie und Physik (Jahrbuch Chemie und Physik),* Bd. 54, p. 241–243, 1828.

[4] J. Chmeleff, F. von Blanckenburg, K. Kossert und D. Jakob, „Determination of the 10Be half-life by multicollector ICP-MS and liquid scintillation counting," *Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms,* pp. 192-199, 2010.

[5] L. McHargue und P. Damon, „The global beryllium 10 cycle," *Reviews of Geophysics,* p. 141–158, 1991.

[6] G. Kovaltsov und I. Usoskin, „A new 3D numerical model of cosmogenic nuclide 10Be production in the atmosphere," *Earth and Planetary Science Letters,* pp. 182-199, 2010.

[7] G. M. Raisbeck et al., „10Be concentrations and residence time in the deep ocean," *Earth and Planetary Science Letters,* pp. 275-278, 1980.

[8] H. G. Stosch, „Einführung in die Isotopengeochemie," Institut für Mineralogie und Geochemie der Universität Karlsruhe, Karlsruhe, 2004.

[9] B. Peters, „Radioactive beryllium in the atmosphere and on the earth," *Proceedings of the Indian Academic of Sciences,* pp. 67 - 71, 1950.

[10] J. R. Arnold, „Beryllium-10 produced by cosmic rays," *Science, 124,* pp. 584-585, 1956.

[11] P. S. Goel, D. P. Kharkar, D. Lal, N. Narasappaya, B. Peters und V. Yatirajam, „Beryllium-10 concentrations in deep sea sediment," *Deep-Sea Research, 4,* pp. 202-210, 1957.

[12] A. E. Litherland, „Ultra-sensitive mass spectrometry with accelerators," *Annual Review of Nuclear and Particle Science, 30,* pp. 437-473, 1980.

[13] L. Brown, I. S. Sacks, F. Tera, J. Klein und R. Middleton, „Beryllium-10 in continental sediments," *Earth Planet Sciene Letters, 55,* pp. 370-376, 1981.

[14] B. Bourdon, S. J. Goldstein, D. Bourlès, M. T. Murrell und C. H. Langmuir, „Evidence from 10Be and U series disequilibria on the possible contamination of mid-ocean ridge basalt glasses by sedimentary material," *G3 Geochemistry Geophysics Geosystems,* p. Paper number 2000GC000047, 2000.

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