History and Philosophy of Science
История и философия на науката

NAMING OF CHEMICAL ELEMENTS

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Abstract. A summary review for the origin of the names and symbols of all chemical elements discovered up to now are presented along with the reasons for proposing these appellations.

Keywords: chemical elements, naming, discovery

In 1782 the French chemist Guyton de Morveau stated that, in the interest of science, it was necessary to have "a constant method of denomination, which helps the intelligence and relieves the memory". Ideally, an element or a compound should have a unique name because the proliferation of names for the same substance can lead to confusion. He developed the first system of chemical nomenclature. This system was refined in collaboration with Berthollet, de Fourcroy and Lavoisier and was submitted to the French Academy in 1787. In 1813 the great Swedish chemist Jöns Jakob Berzelius proposed chemical symbols using the initials of their Latin names that was slowly adopted and then was widely used. For use in chemical formulae, each atom is represented by a unique symbol in upright type. The atomic symbol consists of one or two letters used to represent the atom in chemical formulae. Berzelius supported Lavoisier's ideas and adapted the nomenclature to the German language, ameliorated the system and expanded it with many new terms. He determined the atomic weights of nearly all elements, and was the first to do so almost accurately. In September 1860, Dmitri Mendeleev (Fig. 1) attended the First International Chemical Congress in Karlsruhe (Germany) where 140 prominent chemists met to sort out contradictory lists of atomic and molecular weights. Mendeleev wrote Elements of Chemistry in 1868. He ranked the nearly 60 known chemical elements according to a periodic law, linking relative atomic weights of the elements to their properties. Mendeleev's Periodic Table rapidly became the basis for understanding elements and their compounds. Undoubtedly, every schoolchild was fascinated by its first acquaintance with the "Mendeleev's garden" and the periodicity of the properties of the elements: simplicity, coherence, rhythm, inevitability. Although the existence of a chemical industry as well as the expanding chemical knowledge and new theories at the time, the unifying and generally accepted concepts were missing.

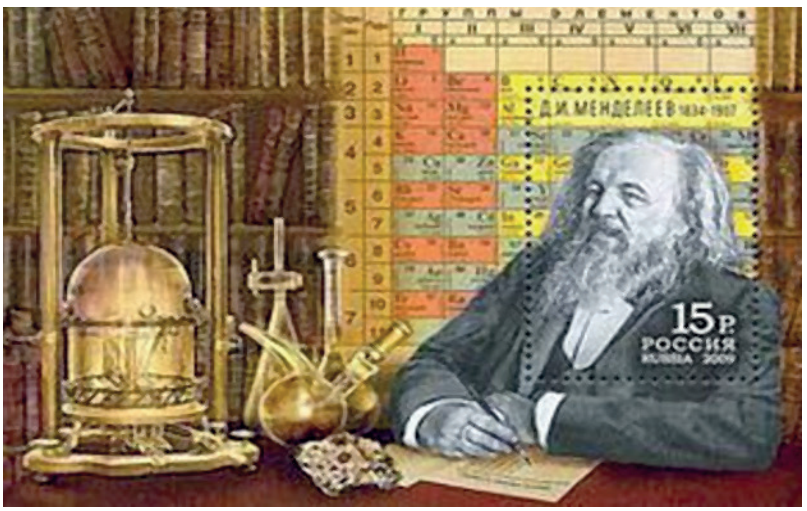


Figure 1. Dmitri Ivanovich Mendeleev

The International Union of Pure and Applied Chemistry (IUPAC) was formed in 1919 by chemists from industry and academia with aim to serves to advance the worldwide aspects of the chemical sciences and to contribute to the application of chemistry in the service of Mankind. The primary aim of chemical nomenclature is simply to provide methodology for assigning descriptors (names and formulae) to chemical substances so that they can be identified without ambiguity, and thereby to facilitate communication. It has been accepted in the past that the discoverers of a new element has the sole right to name it. When a new element is discovered, independently confirmed, and accepted by a joint IUPAC–IUPAP (International Union of Pure and Applied Physics) Working Group, the researchers are invited to propose a name and a symbol to the IUPAC Inorganic Chemistry Division (first issue was addressed in 1947). After careful examination of the suggestion and its suitability, the IUPAC Council usually approves the name and element symbol. The exact procedure for naming newly-synthesized elements is today apparent and internationally adopted.

"Discovery of a chemical element is the experimental demonstration, beyond reasonable doubt, of the existence of a nuclide. Conformation demands reproducibility…". Elements of atomic numbers greater than 103 are often referred to in the scientific literature but receive names only after they have been "discovered". Names are needed for these elements even before their existence has been established and approved by IUPAC. The name is derived directly from the atomic number of the element using the following numerical roots:

0 – nil	2 – bi	4 – quad	6 – hex	8 – oct
1 – un	3 – tri	5 – pent	7 – sept	9 – enn

The roots are put together in order of the digits which make up the atomic number and terminated by "-ium" to spell out the name, example:

104	Unq	Unnilquadium
106	Unh	Unnilhexium
118	Uuo	Ununoctium
170	Usn	Unseptnilium

For linguistic consistency, the names of all new elements should end in "-ium" according IUPAC's element naming rules from 1953. The suffix "-on" signifies that it is a noble gas. The suffix of every metal discovered in the past 220 years is either –um or –ium. Non-metal suffixes are longstanding traditions prior to 2002, every non-metal discovered in the past 225 years has either an –on or –in suffix. Helium was an exception because it was named before any chemical investigation, after it was detected in the solar spectrum and thought to be metallic. It is desirable that the names of elements in different languages differ as little as possible, examples Table 1. But the names of the seven metals, known as the metals of Antiquity, are different.

While the origin of the names of some elements is obscure (such as antimony) and is lost in antiquity, the names of others have been based on a property of the element, a mineral from which it was isolated, its place or area of discovery, a mythological character or concept, an astronomical object, or to honor an eminent scientist, Tables 2–7. In 1979 IUPAC approved a systematic nomenclature for elements with atomic numbers greater than one hundred.

Table 1. The names of some elements in six languages

Symbol	**Latin**	**English**	**Bulgarian**	**French**	**German**	**Russian**
C	Carbon	carbon	въглерод	carbone	Kohlenstoff	углерод
Sn	Stannum	tin	калай	étain	Zinn	олово
Sb	Stibium	antimony	антимон	antimoine	Antimon	сурьма
Au	Aurum	gold	злато	or	Gold	золото
Fe	Ferrum	iron	желязо	fer	Eisen	железо
Ag	Silver	silver	сребро	argent	Silber	серебро
N	Nitrogen	nitrogen	азот	azote	Stickstoff	азот

Cu	Copper	copper	мед	cuivre	Kupfer	медь
H	Hydrogenium	hydrogen	водород	hydrogène	Wasserstoff	водород
O	Oxygenium	oxygen	кислород	oxygène	Sauerstoff	кислород
Pb	Plumbum	lead	олово	plomb	Blei	свинец
Hg	Hydrargirium	mercury	живак	mercure	Quicksilber	ртуть

The elements named after "modern" celestial objects are presented in Table 2. As it is seen during 70 years (from 1968 till 1940), chemical element has not received name of such origin.

Table 2. Elements named after an astronomical object

Sym-bol	Year of discovery	Scientist	Origin of the name
Te	1782	Reichenstein	after the Latin name for "earth", tellus
U	1789	Klaproth	after planet Uranus, itself named after Greek god of the sky Uranus
Ce	1803	Berzelius/ Klaproth	after dwarf planet Ceres, itself named after Roman deity of agriculture Ceres
Se	1817	Berzelius	after Selene, Greek goddess of the moon
He	1868	Lokyer/ Janssen	after Helios, Greek god of the Sun
Np	1940	McMillan/ Abelson	after planet Neptune, itself named after Roman god of the sea
Pu	1940	Seaborg	after minor planet Pluto, itself a newly coined name, Pluto was the god of the underworld

As it is seen from Fig. 2 this group of elements named after an astronomical object compiles around 6% of the elements, followed by a group of nine names that were derived from mythology or superstition, Table 3.

Nearly 100 years (from 1844) no chemical element has received a name after a mythological character till 1945 when promethium, Pm was produced at Oak Ridge National Laboratory (USA). From 1827 (when aluminium was discovered) up to now no newly discovered/synthesized element is named after a mineral or similar substance, Table 4.

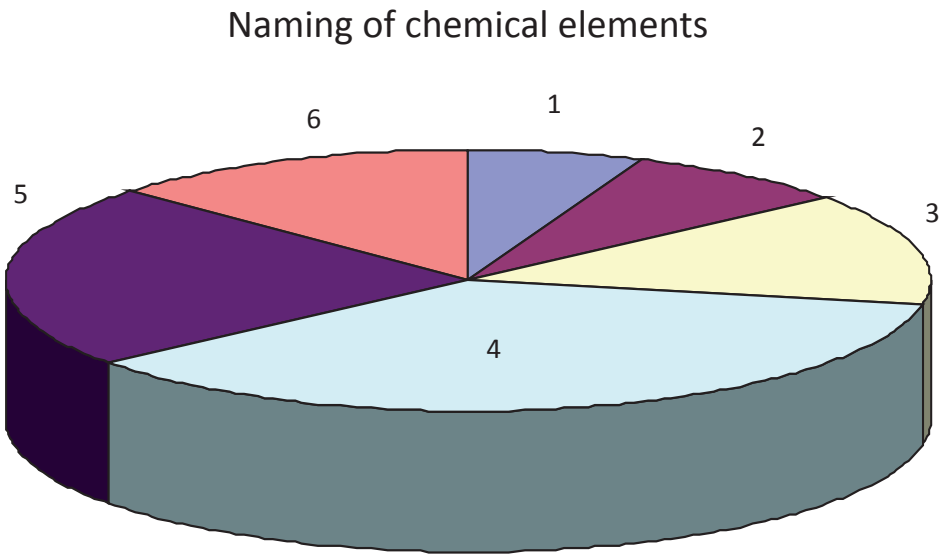


Figure 2. Elements named after: 1. an astronomical object 6%; 2. a mythological concept or character 8%; 3. a mineral or similar substance 14%; 4. a property of the element 36%; 5. a place or geographical region 23%; 6. a scientist 13 %.

Table 3. Elements named after a mythological concept or character

Sym-bol	Year of dis-covery	Scientist	Origin of the name
Hg	350 BC		known as quicksilver and was formerly named hydrargyrum (Greek „hydr- „ water and „argyros“ silver); the Roman god of messengers Mercury
Ti	1791	Gregor	named of the Titans of Greek mythology
Ta	1802	Ekaberg	its name comes from Tantalus, a character from Greek mythology
Ir	1803	Tennant	named for the Greek goddess Iris, personification of the rainbow, because of the striking and diverse colors of its salts
Pd	1803	Wollaston	named it after the asteroid Pallas, which was itself named after the epithet of the Greek goddess Athena, acquired by her when she slew Pallas
Th	1823	Berzelius	named after Thor, the Norse god of thunder
V	1830	Sefström	after the Germanic goddess of beauty and fertility, Vanadis

Nb	1844	Rose	The name comes from Greek mythology: Niobe, daughter of Tantalus
Pm	1945	Coryell, Glendenin, Richter	from Prometheus, the Titan in Greek mythology who stole fire from Mount Olympus and brought it down to humans, to symbolize „both the daring and the possible misuse of mankind‘s intellect“

Table 4. Elements named after a mineral or similar substance

Symbol	**Year of discovery**	**Scientist**	**Origin of the name**
Li	1817	Arfwedson	from Greek: lithos, „stone“
B	1808	Gay-Lussac, Thénard	the Arabic word buraq or the Persian word burah; names for the mineral borax
Ca	1808	Davy	from Latin calx, genitive calcis, meaning „lime“
C	1789	Lavoisier	from Latin: carb*o* „coal“
Si	1823	Berzelius	from Latin: silex, hard stone or flint
Na	1807	Davy	new Latin name natrium, which refers to the Egyptian *natron*, a natural mineral salt primarily made of hydrated sodium carbonate
K	1807	Davy	from the word „alkali“, which in turn came from Arabic*:* al-qalyah „plant ashes“; The English name for the element potassium comes from the word „potash“.
Al	1827	Wöhler	Ancient Greeks and Romans used aluminium salts as dyeing mordants and as astringents for dressing wounds; alum is still used as a styptic.
N	1772	D. Rutherford	The English word nitrogen entered the language from the French nitrogène, coined in 1790 by Chaptal, from the Greek „nitron“ (sodium carbonate) and the French gène (producing). The gas had been found in nitric acid.
Co	1732	Brandt	Kobald ore
Mo	1778	Scheele	Ancient Greek molybdos, meaning lead, its ores were confused with lead ores
W	1781	Bergman	The word tungsten comes from the Swedish language tung sten directly translatable to heavy stone, though the name is volfram in Swedish, which is alternatively named tungsten.
Zr	1789	Klaproth	zirconium is taken from the mineral zirkon, the most important source of zirconium; and from the Persian word „zargun“, meaning „gold colored“

Mn	1770	Bergman	named for various black minerals (such as pyrolusite) from the region of Magnesia in Greece which gave names to similar-sounding magnesium, Mg, and magnetite, an ore of the element iron, Fe. Figure 3.
Ni	1751	Cronstedt	The element‘s name comes from a mischievous sprite of German miner mythology, Nickel (similar to Old Nick), that personified the fact that copper-nickel ores resisted refinement into copper. This ore is now known to be nickeline or niccolite, a nickel arsenide.
Cd	1817	Hermann, Stromeyer	Latin cadmia, Greek meaning „calamine“, a cadmium-bearing mixture of minerals, which was named after the Greek mythological character (Cadmus, the founder of Thebes); zinc carbonate (calamine).

Figure 3. Pyrolusite, MnO_2 had been used for centuries to give a violet color to glass and pottery. Scheele reported three years of experiments on pyrolusite. Manganite, MnO(OH), the color is dark steel-grey to iron-black and the luster brilliant

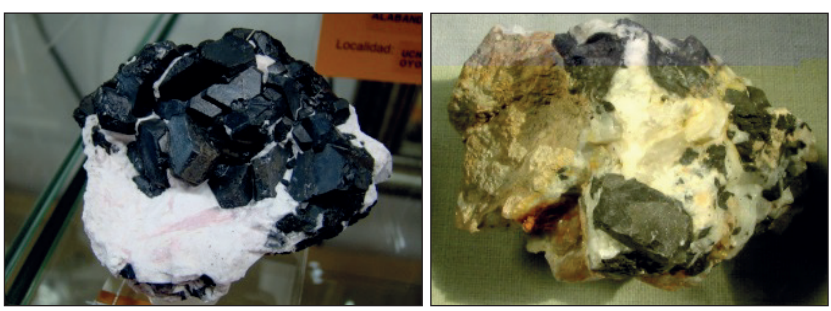


Figure 4. Alabandite or alabandine, (dMnS)

Figire 5. Purpurite is a mineral, basically manganese phosphate, ($Mn^{3+}PO_4$): 52.66% Mn_2O_3 and 47.34% P_2O_5

Figure 6. Rhodochrosite, $MnCO_3$

The rare earth elements (REs) exposed a weakness in Mendeleev's approach and posed a challenge: each element was individual and therefore could not occupy the same position in the Periodic Table as another element. In 1902, the Czech chemist Bohuslav Brauner addressed the lack of positions for REs on Mendeleev's period chart by extending the table downward after lanthanum, La. This odd name had a mythical sound and the REs are not only rare and precious but have special, unique qualities that no other elements have. Table 5 lists elements named after a property, as well as names constructed from other words. Carl Gustav Mosander, an assistant of Berzelius succeeded to separate a new rose-colored oxide from La_2O_3 in 1841. Lanthanum, La laid hidden in the mineral

cerite for 36 years, Table 5. Mosander named the oxide Didymium (Greek didymos, means "twin") because of the similarity with La. In 1843, he found that yttria (except Ce, La and didymia) contained three other oxides, a colorless (yttria), a yellow (erbia) and a rose-colored (terbia). A number of chemist did not succeed to separate Didymium until 1884, when at the age of 26 Carl Auer successfully separated the two earths and proposed the names of Pr (greenish salts) and Nd (new). Due to the exceedingly close chemical properties of lanthanoids, separating them from one another was an extremely difficult task for the chemists until now.

Figure 7. Manganocalcite, $(Ca,Mn)CO_3$ is a variety of calcite rich in manganese, which gives the mineral a pink color

Marie Curie is a legendary figure of science and one of the most important women in modern human history. She became interested in the source of radioactivity that Henri Becquerel discovered coming from pitchblende ore in 1897. She found that only two elements emitted appreciable ionizing radiation, U and Th. In 1898 Marie and Pierre Curie discovered Po and Ra. They noticed that the barium fraction containing Ra glowed in the dark. Later, Pierre and a student noticed that a speck of Ra emits heat: in one hour radium is able to melt more than its own weight of ice. This was the first hint of nuclear energy. M. Curie was the first women awarded a Nobel Prize (in Physics). In 1903, she, together with her husband and Henri Becquerel received this recognition for their investigations on the radiation phenomena. From her 1911 Nobel Lecture, it is evident that by mastering chemistry and radioactivity, she pioneered the concept of the "atom" and the state of the art of this "new science", today known as radiochemistry. In addition, Marie and Pierre Curie's daughter Irène and her husband, Frédéric Joliot, discovered artificial radioactivity and were awarded the Nobel Prize in 1935 in "recog-

nition of their synthesis of new radioactive elements". They irradiated light elements, such as aluminium, with alpha rays from a polonium source. Some times they obtained a proton and in others a neutron and (separately) a positron. The results for aluminium can be summarized by the equations: $^{27}Al_{13} + {}^{4}He_{2} \rightarrow {}^{30}P_{15} + {}^{1}n_{o}$,

$^{30}P_{15}$ is radioactive and decays emitting a positron $^{30}P_{15} \rightarrow {}^{30}Si_{14} + {}^{o}e_{+1}$.

Figure 8. Marie Curie

Elements named after color (Cr, Mn (Figures 4−7), Cl, I, Rh, Ir, Cs, Rb, Tl, In) are listed also in Table 5.

The suggested name by André Ampere in 1813 for an as-yet-unisolated element fluorine, F derived from the mineral fluorospar. Chlorine (Cl), bromine (Br) and io-

dine (I) were named from Greek adjectives describing a property but fluorospar was a source. After a century the tradition was remembered with the origin of the name of At, Table 5.

Table 5. Elements named after a property of the element

Sym-bol	Year of discovery	Scientist	Origin of the name
H	1766	Cavendish	from the Greek hydro meaning water and genes meaning creator, water was produced when hydrogen is burned
Rb	1861	Bunsen/ Kirchhoff	because of the bright red lines in its emission spectrum in the mineral lepidolite, from the Latin word rubidus, meaning „dark red“
Cs	1860	Bunsen/ Kirchhoff	the bright blue lines in its emission spectrum, a name derived from the Latin word caesius, meaning sky-blue
Ra	1898	M. and P. Curie	the French word radium, formed in Modern Latin radius (ray), called for its power of emitting energy in the form of rays
Ba	1772	Scheele	The most common naturally occurring minerals of barium are barite ($BaSO_4$) and witherite ($BaCO_3$), both being insoluble in water. Barium‘s name originates from the alchemical derivative „baryta“, which itself comes from Greek (barys), meaning „heavy.“
Be	1797	Vanquelin	For about 160 years, beryllium was also known as glucinum or glucinium (with the accompanying chemical symbol „Gl“, the name coming from the Greek word for sweet: γλυκυς, due to the sweet taste of beryllium salts
N	1772	D. Rutherford	Nitrogen gas was inert enough that Lavoisier referred to it as azote, from the Greek word (azotos) meaning „lifeless“.
P	1669	Brand	from Greek mythology, Φωσφόρος meaning „light-bearer“ (Latin Lucifer), referring to the „Morning Star“, the planet Venus.
As	2500BC		The word arsenic was borrowed from the Syriac word *(*al*)* zarniqa and the Persian word Zarnikh: „yellow orpiment“, into Greek as arsenikon. The similar Greek word arsenikos, „male“, „masculine“ or „potent“. The word was adopted in Latin arsenicum and Old French arsenic, from which the English word arsenic is derived.

Sn	3500BC		The English word ‚tin' is Germanic. The Latin stannum meant an alloy of silver and lead, mean ‚tin'; the earlier Latin word for it was plumbum candidum ‚white lead'. Stannum apparently came from an earlier stāgnum (meaning the same substance).
Cr	1797	Vanquelin	khroma (Greek) for color
Bi	1753	Geoffroy	from Arabic bi ismid, meaning having the properties of antimony or German words weisse masse or wismuth („white mass"), translated in the mid sixteenth century to New Latin bisemutum.
O	1772	Scheele	Greek (oxys) („acid", literally „sharp", referring to the sour taste of acids) and (-gonos) („producer"), because it was mistakenly thought that all acids required oxygen in their composition.
S	2000BC		from suelphlos Indo-European; swell meaning to burn slowly
F	1810	Ampère	after Latin fluo (to flow, in smelting), fluorite rocks were added to metal ores to lower their melting points during smelting.
Cl	1774	Scheele	from Ancient Greek: khlôros "pale green"
Br	1825	Belard/ Gmelin	from Greek: brómos, meaning „strong-smelling" or „stench")
I	1811	Courtois	from Greek meaning violet or purple, the color of iodine vapor
Ac	1899	Debierne	from the Ancient Greek aktis, aktinos, meaning beam or ray
Pa	1900	Crookes	The name meant „parent of actinium": Ac is a product of radioactive decay of Pa; from Greek: protos meaning first, before).
Ar	1894	Rayleigh/ Ramsay	Greek word αργον, meaning „lazy" or „inactive", as a reference that itundergoes almost no chemical reactions.
Rn	1900	E. Rutherford	Rutherford noticed that the compounds of thorium continuously emit a radioactive gas that retains the radioactive powers for several minutes; emanation (Latin „emanare" to elapse and „emanatio" expiration)
Tc	1937	E. Segrè	from the Greek *τεχνητός*, meaning „artificial"
Fe	5000BC		The English name Iron=Iren (Anglo-Saxon) is of uncertain origin.

Os	1803	Tennant	from Greek osme meaning „smell“ because of the ashen and smoky smell of the volatile OsO_4
Rh	1804	Wollaston	Greek rhodon meaning „rose“
Au	before 6000BC		The symbol Au is from the Latin: aurum, meaning „shining dawn“. Aurora was the goddess of dawn.
Ag	before 5000BC		Greek: árguros; Latin: argentum; both from the Indo-European root arg- for „grey“ or „shining“
Tl	1861	Crooks	from Greek, thallos, meaning „a green shoot or twig“
In	1863	Richter	named for the indigo blue line in its spectrum, the first indication of its existence in zinc ores, as a new and unknown element
Pt	1735	Ulloa	from the Spanish term platina: „little silver“
Ne	1897	Ramsay	the Greek word, νέον, neuter singular form of neos, meaning new
Kr	1898	Ramsay/Travers	from Greek: κρυπτός kryptos „the hidden one“
Xe	1898	Ramsay/Travers	the name xenon for this gas from the Greek word *ξένον* (xenon), meaning ‚foreign(er)‘, ‚strange(r)‘, or ‚guest‘
Zn	Before 1000BC		the German zinke, and supposedly meant „tooth-like, pointed or jagged“ (metallic zinc crystals have a needle-like appearance); Zink could also imply „tin-like“, relation to German zinn meaning tin.
La	1838	Mosander	from the Greek λανθανω meaning to lie hidden
Pr	1885	Welsbach	the Greek prasinos, meaning green, and didymos (δίδυμος), twin
Nd	1885	Welsbach	the Greek words neos (νέος), new, and didymos, twin
Pb	7000BC		plumbum nigrum (literally, „black lead“) by Romans to distinguish it from plumbum candidum (literally, „bright lead“) now tin
Sb	3000BC		The popular etymology, from anti-monachos or French antimoine, this would mean „monk-killer“, and is explained by many early alchemists being monks, and antimony being poisonous. Another etymology is the hypothetical Greek word antimonos, „against aloneness“, „not found as metal“, or „not found unalloyed“.
At	1940	Corson/Segre	the Greek word (astatos) means „unstable“

Within 15 years, three elements predicted by Mendeleev were discovered and named after the countries of discovery, and found to precisely match the predicted properties: 21 eka-Boron, Sc; 31 eka-Aluminium, Ga and 32 eka-Silicon, Ge, Table 6. The name polonium, proposed on 13 July 1898, has a provocative significance because Poland has disappeared as a state in 1795, being divided between Prussia, Russia and the Austrian Empire. Four countries situated in Europe have chemical elements named after their lands i.e. Fr, Ga, Ge, Po and Ru. So, France has not only two elements but its capital Paris (Lutetia) also give the name of element with number 71 in the Periodic Table. Another two elements (Ho and Hf) were named after European capitals of Sweden and Denmark respectively.

The three recognized laboratories (the Lawrence Berkeley Laboratory in California, the Joint Institute for Nuclear Research (JINR) in Dubna, Russia and Gesellschaft für Schwerionen Forschung in Darmstadt, Germany (Institute for Heavy Ion Research, IHIR)) have significant and indisputable contributions in synthesizing several transfermium elements and have the benefit to named chemical elements in its honor (Bk, Db and Ds), Table 6.

Table 6. Elements named after a place or geographical region

Symbol	Year of discovery	Scientist	Origin of the name
Fr	1939	M. Perey	France
Mg	1755	J. Black	a district in Thessaly called Magnesia, Greece
Sr	1787	Cruickshank	a village in Scotland Strontian
Ga	1875	Boisbaudran	from Latin Galia a meaning Gaul, France
Ge	1886	Winkler	Winkler named the element after his country, Germany.
Po	1898	M. and P. Curie	named after Marie Curie‘s native land of Poland (Latin: Polonia)
Sc	1879	Nilson	It was discovered by spectral analysis of the minerals euxenite and gadolinite from Scandinavia.
Y	1794	Gadolin	army lieutenant and part-time chemist Arrehenius found a heavy black rock near the Swedish village of Ytterby (now part of the Stockholm).
Hf	1922	Coster/Hevesy	Hafnia, the Latin name for Copenhagen, where it was discovered.
Db	1968	JINR	the town of Dubna in Russia, where it was first produced

Re	1922	Berg	It was named after the river Rhine in Europe.
Ru	1844	Claus	Ruthenia, a historical area: western Russia, Ukraine, Belarus
Hs	1984	IHIR	derived from the Latin name (Hassia) for the German state of Hesse where the institute is located
Ds	1994	IHIR	It was named after the city of Darmstadt, where it was discovered.
Cu	9000BC		In the Roman era, copper was principally mined on Cyprus, cyprium (metal of Cyprus), later shortened to cuprum.
Eu	1896	Demarçay	It is named after the continent Europe.
Ho	1878	Delafontaine	The element was named after the city of Stockholm.
Tb	1842	Mosander	named after the village Ytterby in Sweden
Cf	1950	Berkeley Lab	The element was named after California and the University of California.
Er	1842	Mosander	He named the new element after the village of Ytterby where large concentrations of yttria and erbium are located.
Yb	1878	Marignac	Examining samples of gadolinite, Marignac found a new component: erbia, and named it ytterbia, for Ytterby, the Swedish village where he found the new component of erbium. He suspected that ytterbia was a compound of a new element that he called „ytterbium“.
Tm	1879	Cleve	Cleve named the oxide thulia and its element thulium after Thule, Scandinavia.
Lu	1907	Urbain, Welsbach/James	Lutetium, derived from the Latin Lutetia (Paris)
Am	1944	Berkeley Lab	This transuranic element is located in the periodic table below europium, and thus by analogy was named after another continent, America.
Bk	1949	Berkeley Lab	It is named after the city of Berkeley, the location of the University of California Radiation Laboratory where it was discovered.
Lv	2000	Flerov/Lawrence Livermore Lab	Lawrence Livermore National Lab, itself named partly after the city of Livermore, California, USA. The city in turn is named after the American rancher Robert Livermore, a naturalized Mexican citizen of English birth.

The first two elements in Table 7, Sm and Gd were named for minerals, which had been named for Finnish chemist Johan Gadolin (yttria ore was renamed gadolinite in his honor) and the chief of staff of the Russian Corps of Mining Engineers, Vasilii von Samarski. The editor of Science stated that when Jean-Charles Galissard de Marignac chose the name gadolinium for the newly discovered element in 1886, he did not give any reason for the selection. The next element to be named after a human being directly or more correctly to say persons was curium, Cm. It was first produced and identified by the group of Seaborg at the University of California, Berkeley: $^{239}_{94}Pu + {}^{4}_{2}He \rightarrow {}^{242}_{96}Cm + {}^{1}_{0}n$. Thereafter (1944), naming an element after a famous scientist became an accepted and common option. Although, the first great debate without favourable decision was on the naming of the future element 43 at this time (after Henry Mosely): Ms, moseleyum.

Table 7. Elements named after a scientist

Symbol	Year of discovery	Scientist	Origin of the name
Gd	1880 1886	Marignac Boisbaudran	gadolinite, one of the minerals in which it was found, named for Johan Gadolin, who first analysized the mineral
Sm	1879	Boisbaudran	mineral samarskite from which it was isolated; The mineral was earlier named after a Russian mine official, Colonel Samarsky, who became the first person to have a chemical element named after him, albeit indirectly.
Cm	1944	Seaborg, James, Ghiorso	named after Marie and Pierre Curie – both were known for their research on radioactivity
Es	1952	Ghiorso	named after Albert Einstein
Fm	1952	Ghiorso and co-workers	named after Enrico Fermi, one of the pioneers of nuclear physics
Md	1955	Berkeley Lab	named after Dmitri Ivanovich Mendeleev
No	1966	Flerov Laboratory of Nuclear Reactions in Dubna, Soviet Union	In 1994, and subsequently in 1997, the IUPAC ratified the name nobelium (No) for the element on the basis that it had become entrenched in the literature over the course of 30 years and that Alfred Nobel should be commemorated in this fashion.

Lr	1961	Ghiorso	The team suggested the name lawrencium after Ernest Lawrence.
Rf	1969	labs in the Soviet Union / Berkeley	named in honor of physicist Ernest Rutherford
Sg	1974	Lawrence Berkeley National Laboratory	in the honor of the chemist Glenn Seaborg credited as a member of the group in recognition of his participation in the discovery of other actinides
Bh	1981	IHIR, Darmstadt	named in honor of Danish physicist Niels Bohr
Mt	1982	German research team in Darmstadt	Austrian physicist Lise Meitner, a co-discoverer of protactinium (with Otto Hahn) and one of the discoverers of nuclear fission.
Cn	1996	German research team in Darmstadt	after Nicolaus Copernicus to honor an outstanding scientist, who changed our view of the world
Rg	1994	IHIR, Darmstadt	the German physicist Whilhelm Röntgen, the discoverer of X-rays
Fl	1999	Flerov / Berkeley Labs	after Flerov Laboratory of Nuclear Reactions in Dubna, Soviet Union; to honor the Russian physicist Georgy Flyorov

Röntgen was awarded the first Nobel Prize in physics in 1901. He discovered almost all the properties of X-rays within the first few weeks of his investigation, and the temporary name he used for the sake of brevity remains still today.

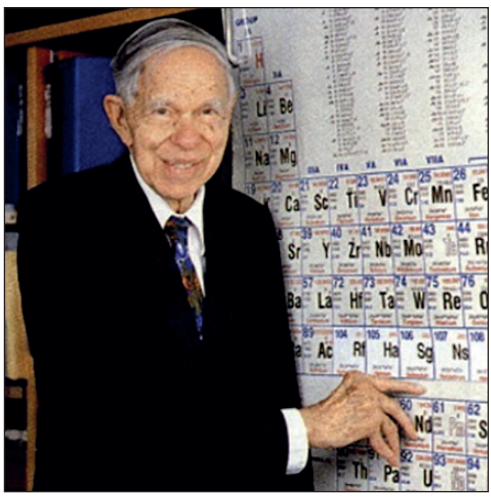
Ernest Rutherford was awarded the Nobel Prize in chemistry in 1908. In 1911, he concluded that the atom contains a very small "nucleus" where almost all its mass is concentrated; the nucleous should carry the positive charges, whereas it is surrounded by negatively charged electrons. Rutherford's comment on the gold foil experiment: "It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you." F. Soddy and E. Rutherford proposed a theory of radioactivity in 1902 and used the term transmutation to describe the spontaneous disintegration of radioactive elements into new elements at a rate characteristic for each element. The word "radioactivity" was first coined by Marie Curie. In 1913 Soddy proposed that an element emitting an alpha particle is transmuted into the element two spaces to left on the periodic table, whereas an element emitting a beta particle is transmuted into the element immediately to the right, as consequence this led to Soddy's proposal of isotopes. For his contributions

for understanding radioactive decay and proposing isotopes he was awarded the 1921 Nobel Prize for chemistry.

Niels Bohr also received the Nobel Prize in 1922 in physics for his contributions to atomic structure, nuclear theory and radiation. The discoverers of element 107 (Darmstadt Laboratory) had a wish to call it nielsbohrium (too long and includes the first and family name of the scientist) without precedent till then and the preposition of course was not accepted).

Earnest Lawrence and Stanly Livingston invented the cyclotron at the University of California, Berkeley in 1931. Later the laboratory was named Lawrence Berkeley and many artificial elements were produced there. It is noteworthy that six of the people (Lawrence, Fermi, Bohr, Einstein, Meitner, Seaborg) connected with or working on the top secret Manhattan project for USA to produce "a powerful bomb" now have elements named in their honor. The Austrian, later Swedish physicist, Lise Meitner, born in a Jewish family, worked on radioactivity. Radioactivity is a sensitive quantity and is detectable from very small amounts of material. Element 109, meitnerium, Mt is named in her honor, and, and together with Marie Curie, became the second female scientist who was recognized in the Periodic Table. In 1917, she and Otto Hahn discovered the first long-lived isotope of the element protactinium. On 15 November 1945, the Royal Swedish Academy of Sciences announced that Hahn had been awarded the 1944 Nobel Prize in chemistry "for his discovery of the fission of heavy atomic nuclei": the first bomb was dropped on 6 August 1945 (Hiroshima). McMillan and Seaborg shared the 1951 Nobel Chemistry Prize for discoveries in the chemistry of the transuranium elements. After World War II, under Seaborg's direction, teams in California, Berkely obtained Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No and Lr. In June 1974, a research team led by Ghiorso reported creating an isotope of element 106 with confirmed synthesis in 1994 by the team of D. C. Hoffman. Although three years continues the debate of priority for discovery of several elements including whether it is appropriate to name a chemical element for a living chemist (Sg), contending that a living person's accomplishments cannot be assessed from "the perspective of history". Seaborg and his colleagues argued that the precedent had been set by Es and Fm, but the both eminent scientist deceased before the official approving of the element names.

The Periodic Table now has 114 chemical elements (and the existence of 113 and 115 is already approved) and the search for new ones continues, certainly, in keeping with tradition, history and chemistry when choosing an appropriate name of the future new elements.



Figire 9. Glenn Seaborg shows seaborgium, Sg. He was the assistant of G. N. Lewis with whom he published a number of scientific papers. He was also an author of the actinide concept, analogous to the 4f-serie, and how this fit to the Periodic Table

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NOTES

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