

Paneth, IUPAC, and the Naming of Elements

by **Willem H. Koppenol**¹⁾

Laboratorium für anorganische Chemie, Departement Chemie und Angewandte Biowissenschaften,
Eidgenössische Technische Hochschule Hönggerberg, Wolfgang-Pauli-Strasse 10, CH-8093 Zürich
(e-mail: koppenol@inorg.chem.ethz.ch)

The procedure for assigning names to elements by the *International Union of Pure and Applied Chemistry* involves establishing priority of discovery, then inviting the discoverers to suggest a name. This protocol is in contrast with the suggestions of *Friedrich A. Paneth* from 1947, who believed that the discoverers of an element have the undisputed right to name it. This difference in philosophy came to light during a workshop convened 10 years ago for the purpose of naming elements 104–109, when the discoverers of these elements contended that they were solely entitled to name them. During the debate, and in support of the name seaborgium for element 106, it was argued that gadolinium, samarium, gallium, einsteinium and fermium had been named after living scientists. The history of the naming of these elements demonstrates that this is not the case; *Glenn T. Seaborg* is the first scientist for whom an element was named during his lifetime.

Introduction. – Generally, newly discovered plants and stars are named by their discoverers. This was – generally – the case for elements as well, until the late 1940s. The origin of older element names is obscure, and until 1949, elements were named after mythological characters or astronomical bodies (helium, plutonium), minerals (samarium, see below), places or areas (yttrium, germanium), or the elements' properties (technetium). In 1947, *Friedrich A. Paneth* [1] wrote that '(1) *The right to name an element should go to the first to give definitive proof of the existence of one of its isotopes.* (2) *In deciding the priority of discovery, there should be no discrimination between naturally occurring and artificially produced isotopes.* (3) *If a claim to such a discovery has been accepted in the past, but is refuted by later research, the name given should be deleted and replaced by one chosen by the real discoverer.*' While everybody would agree with the second suggestion, there are objections of a practical nature to the first and third suggestions. In the first case, where priority of discovery is disputed, the scientific community must contend with the concomitant use of two (or more) names for a single element. In the latter case, when it is later judged that priority of discovery must be reassigned, renaming the element after many years leads to confusion. In both cases, arbitration may be necessary, and the need for authoritative oversight in the naming process is clear. But to which organisation should this authority be given? Chemistry occupies a central place in science, and, since nearly all chemical societies are represented in the *International Union of Pure and Applied Chemistry (IUPAC)*, it is logical that this organization has been given the responsibility for naming new elements.

¹⁾ The author was Secretary of the *Commission on the Nomenclature of Inorganic Chemistry* of the *International Union of Pure and Applied Chemistry* from 1994–1997.

The Naming of Elements under IUPAC Auspices. – At the 15th IUPAC Conference, held in Amsterdam in 1949, the *IUPAC Commission on Nomenclature of Inorganic Chemistry (CNIC)* officially adopted names for elements that, because of language or conflicting views regarding discovery, had been known under two names: e.g., the name beryllium rather than glucinium, was officially adopted for element 4, niobium for element 41 rather than columbium (apparently still unrecognized by some metallurgists), and wolfram rather than tungsten for element 74 (but tungsten was later reinstated). Furthermore, *CNIC* decided on names for a number of transuranium elements (*Table 1*) [2]. An important milestone was the adoption of the name curium for element 96 as proposed by its discoverers, *Glenn T. Seaborg* and co-workers, because, for the first time, an element was named after scientists, namely *Pierre* and *Marie Curie*. Four more artificially synthesized elements were named in 1957 [3].

Table 1. *Element Names Adopted at the 15th IUPAC Conference, Amsterdam, 1949* [2]

Element	Name	Abandoned name
4	Beryllium	Glucinium
41	Niobium	Columbium
43	Technetium	Masurium
61	Promethium	Prometheum
71	Lutetium	Lutecium
72	Hafnium	
74	Wolfram	Tungsten ^{a)}
85	Astatine	
87	Francium	
91	Protactinium	Protoactinium
93	Neptunium	
94	Plutonium	
95	Americium	
96	Curium	

^{a)} Later, the name tungsten was reinstated.

In 1993, *CNIC* was charged with the duty to name elements 101 – 109. Although the undisputed discoverers of element 106 had proposed the name seaborgium after *Seaborg*, this name was not included in the list of proposed names, because tradition held that elements were not to be named after still-living scientists [4]. The recommendations by *CNIC* also resolved disputed names for elements that had had multiple names as a result of competing claims by the laboratories where these elements had been studied. When the recommendations were published, *CNIC* received a large number of letters, including one from *Seaborg* and *Albert Ghiorso* to the author, in which it was argued that the discoverers have the undisputed right to name the element they discovered, and that element 106 should be named seaborgium, and, further, that there was precedence for naming elements after living scientists. Some letter writers challenged the right of *CNIC* or *IUPAC* to make recommendations at all.

The last point, to challenge the authority of *IUPAC* to deal with element names, is a logical consequence of *Paneth's* first point, see above [1]. However, in 1949, *IUPAC* decided otherwise, as reviewed elsewhere [5]. Clearly, by 1994, this decision was being

ignored, and, instead, the suggestions of *Paneth*, though not identified explicitly, were followed.

Renaming Elements. – One might now ask what is *IUPAC*'s position on the renaming of elements, *Paneth*'s third point. Renaming of elements may lead to confusion and should therefore be avoided at all cost. When, in 1993, *CNIC* revisited the names of elements 101–103, they did not rename element 102, nobelium, although the joint *IUPAC–IUPAP Transfermium Working Group* [6] had assigned priority for the discovery of this element to the *Joint Institute of Nuclear Research* in Dubna, who had suggested to rename this element flerovium. Similarly, even if it were proven beyond a reasonable doubt that *Noddack*, *Tacke*, and *Berg* discovered element 43²⁾, the name technetium will not be changed back to masurium, confirming the dictate that ‘*Priority is only one factor to be considered in deciding which is the best name for general international adoption*’ [8].

Have Elements Previously Been Named after Living Scientists? – According to *Paneth*'s first point [1], the discoverers of a new element have the right to name it. He mentioned no limitations, thus, the name of a living scientist would be an option. The position of *CNIC* was that, according to tradition, no elements had ever been named after living scientists. However, it was argued by those who were in favor of giving element 106 the name seaborgium that there was precedence to do so in the five element names gadolinium, samarium, gallium, einsteinium, and fermium. However, closer examination of the history of these names demonstrates that, while they are named after scientists, those scientists were no longer alive at the time when the name was conferred.

Gadolinium after Gadolin. In 1787, *C. A. Arrhenius* discovered a new mineral that was later named gadolinite ($\text{Be}_2\text{FeLn}_2\text{Si}_2\text{O}_{10}$), in honor of *Johan Gadolin* (1760–1852), a well-known Finnish chemist [9]. Gadolinium oxide was isolated by *Jean-Charles Galissard de Marignac* in 1880 [10] and by *Paul-Émile Lecoq le Boisbaudran* in 1886. The element was named for the mineral by the latter in 1886, long after the death of *Gadolin* [9].

Samarium after Samarski-Bykhovets. The element name samarium is derived from samarskite, a mineral named by *H. Rose* [11] in 1847 after *V. E. Samarski-Bykhovets*, a Russian mining official who died in 1870. Samarium was named by its discoverer *Lecoq le Boisbaudran* 10 years later, in 1880 [10][12].

Gallium after Lecoq de Boisbaudran. This element was discovered by *Lecoq le Boisbaudran* in 1875: ‘*Les expériences que j’ai exécutées depuis le 29 août me confirment dans la pensée que le corps observée doit être considéré comme un nouvel élément, auquel je propose de donner le nom de Gallium.*’³⁾ [13]. Interestingly, a nomenclature concern was voiced in the same year: gallium might give rise to gallic acid, which would

²⁾ The discovery of masurium was rejected because this element would have decayed completely since the origin of the earth. However, the point has been made [7] that *Noddack*, *Tacke*, and *Berg* found masurium only in uranium containing ores.

³⁾ ‘*The experiments that I have carried out since the 29th of August confirm the idea that the material observed must be considered a new element, to which I propose to give the name Gallium.*’

lead to confusion, since a compound by that name, namely 3,4,5-trihydroxybenzoic acid, was already known [14]. Although *Lecoq de Boisbaudran* named gallium in honour of France: ‘*d’un nouvel élément, que j’ai nommé « Gallium » en l’honneur de la France.*’⁴⁾ [15][16], it has been asserted that *Lecoq de Boisbaudran* named Gallium after himself (coq = gallus in Latin). The only support for this notion is found in *Webster’s ‘Third New International Dictionary’* [17]. Other, more-pertinent sources do mention that *Lecoq de Boisbaudran* conferred the name gallium to honor France, known in Latin as Gallia, or, better, Gallia transalpina. For instance, in *Gmelins ‘Handbuch der Anorganischen Chemie’* [18] one finds the following statement: ‘*Zu Ehren seines Vaterlandes gab er ihm den von lateinischen “Gallia” abgeleiteten Namen Gallium.*’⁵⁾. This notion is supported by *Weeks and Leicester* in the book *Discovery of the Elements* [9]: ‘*Thus the three “nationalist” elements – gallium in France, scandium in Sweden, and germanium in Germany – were all discovered within fifteen years after their prediction by the great Russian chemist.*’ The great Russian chemist was, of course, *Mendeleeff*, who commented [19] favorably on *Lecoq de Boisbaudran’s* discovery. *Lecoq de Boisbaudran* was one of the great spectroscopists of his time, a true gentleman scholar. An obituary of *Lecoq de Boisbaudran* mentions that he was a modest man: ‘*His method was to work and publish almost simultaneously; so engrossed was he in his work that he cared little for public recognition*’ [20]. *Urbain* [21], who himself was credited with the co-discovery of lutetium and ytterbium, and who confirmed the occurrence of gallium in several ores [9], wrote: ‘*Als ich ihm eines Tag lebhaft vorstellte, wie wenig bekannt leider sein Werk sei, und ich ihm vorhielt, nicht genügend dafür gesorgt zu haben, dass es weiteren Kreisen bekannt würde, erwiderte er lächelnd, dass er sich darüber nicht beunruhigte, und dass der Wissenschaft sicher unparteiische Geschichtsschreiber erstehen werden. Ich hatte damals das Gefühl, nicht nur einem grossen Gelehrten, sondern einem wahrhaft grossen Menschen gegenüberzustehen.*’⁶⁾. Clearly, the claim of self-glorification is not supported by the literature and is inconsistent with first-hand reports of his character. Aside from the elements already mentioned, *Lecoq de Boisbaudran* also discovered holmium and dysprosium [9].

Fermium and Einsteinium after Fermi and Einstein. *Enrico Fermi* died on November 28, 1954, and *Albert Einstein* on April 18, 1955. The paper by *Ghiorso et al.* [22] on the discovery of elements 99 and 100, in which these names were proposed, was received June 20, 1955. Fermium and einsteinium were approved during the 19th IUPAC Conference, held in Paris in 1957 (See Table 2) [3].

Conclusions. – The authority assumed by IUPAC to decide the names of new elements has been challenged, as has the tradition that elements not be named for living scientists. The contention that earlier elements had been so named has been proven false *via* examination of history. Thus, *Glenn T. Seaborg* is not the sixth, but so far the only scientist for whom an element has been named during his lifetime.

⁴⁾ ‘*of a new element, that I have named « Gallium » in honor of France.*’

⁵⁾ ‘*In honor of his fatherland he gave it the name gallium derived from the Latin “Gallia”.*’

⁶⁾ ‘*When, one day, I put it to him how little known his work was, and brought to his attention that he had not taken care to have it known in broader circles, he responded with a smile that he did not worry about that, and that, for sure, independent historians of science would come forward. I had then the feeling that I stood before not just a great scientist, but also a truly great person.*’

Table 2. *Element Names Adopted at the 19th IUPAC Conference, Paris, 1957* [3]

Element	Name	Symbol
99	Einsteinium	Es
100	Fermium	Fm
101	Mendelevium	Md (replaces Mv)
102	Nobelium	No

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