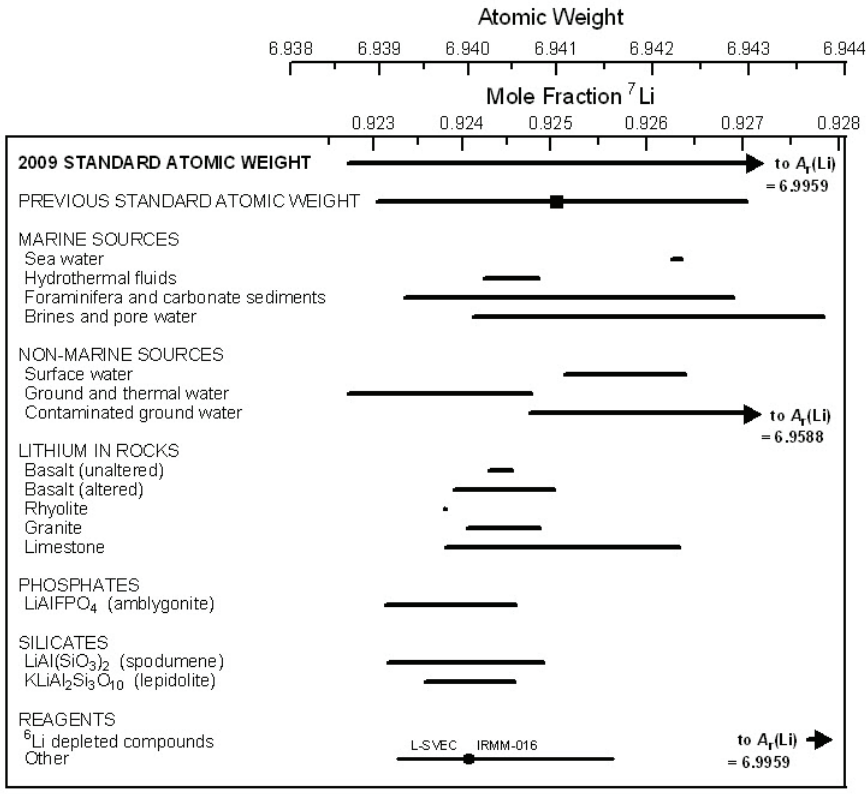

Figure 2. Variation in atomic weight with isotopic composition of selected lithium-bearing materials (modified from reference 2). Isotopic reference materials are designated by solid black circles. The previous (2007) standard atomic weight of lithium was 6.941 ± 0.002.

Rather than waste all of the left-over by-product of these isotopically fractionated lithium samples, this by-product, which would be enriched in ^{7}Li, was commercially distributed in laboratory reagents. Because of the fact that the enrichment of ^{6}Li was part of a classified military weapons program, the general scientific community and the public were never provided information that the lithium being distributed in the chemical reagents was depleted in ^{6}Li. This distribution resulted in labels on containers of reagents, which had incorrect atomic weight values listed on them.

The isotopic fractionation of lithium was first noted when measurements of the neutron cross section of various materials, that were normalized to the natural lithium standard cross-section value, provided results that were much lower than those same cross sections when measured against all other neutron cross-section standards.§

The large discrepancy in the isotopic abundance of ^{6}Li in reagents was later measured via neutron activation analysis and by mass spectrometric measurements. The detection of this problem was published in the open scientific literature at various times in 1958,[3] 1964,[4] 1966,[5] 1968,[6] 1973,[7] and 1997,[8] with ever increasing depletion of ^{6}Li in the commercial samples noted. Figure 2 shows the variation in isotopic composition and atomic weight of selected lithium-bearing materials. Note that lithium enriched in ^{7}Li has made its way into ground waters (see Figure 2), and the lithium isotopic composition has been used as an environmental tracer to identify lithium compounds in waste waters down gradient of a mental institution using pharmaceuticals containing lithium (T. Bullen, U.S. Geological Survey, written communication).

Although many of lithium's elemental properties would not affected by the use of depleted lithium, the incorrect atomic weight would lead to errors in the concentration of the lithium being used. It has a major effect when isotopically fractionated lithium is used as a reference in mass spectrometric measurements. In the neutron cross-section field, natural lithium was eliminated as a measurement standard more than half a century ago because of the problem of depleted ^{6}Li.

The atomic weight of terrestrial and commercial lithium sources varies between 6.9387 and 6.9959.[2] If the standard isotopic reference material's atomic weight is recommended, the value would be 6.94 (6), where the number in parentheses indicates the uncertainty needed to cover the isotopically fractionated lithium sources, which is an uncertainty of about 0.9% (see Figure 2). If a value were recommended that is accurate to one in the last quoted digit, the atomic weight becomes 6.9 (1), and an uncertainty of about 14%. In either case, lithium is the element with the least accurate atomic weight, and all because of the unacknowledged distribution of depleted ^{6}Li in chemical reagents in the distant past.

It has been noted on many occasions by the Commission on Isotopic Abundances and Atomic Weights that the published standard atomic weight is chosen to apply to samples for all potential users, no matter which terrestrial or commercial sample they

§ A similar (although a much less dramatic) result occurred from the use of natural boron as a neutron cross-section standard. This was due to the large value (about 3838 barns) of the cross section for the reaction ^{10}B (n, ^{4}He) ^{7}Li. There are two major boron sources in the world, which have different ratios of ^{10}B and ^{11}B in their samples. (However, that would also be a story for another day). The direct result of these problems with lithium and boron resulted in natural lithium and natural boron being eliminated as neutron cross-section standards by the late 1950s.