Lithium mining and processing

As with any mining operation, mining lithium has its impact on the environment. Mining companies today take sustainable development very seriously and responsibly and focus on environmental management more than ever. Every time we start talking about mining for resources, there are environmental concerns. While the United States and other developed countries are pursuing being free of fossil fuels in favor of alternative fuel and electral-powered cars, there is a bigger picture. When it comes to the mass production of hybrid and electric vehicles, the main problem has become a lack of batteries. And the main ingredient in growing demand is lithium. The elements are found in many in South America, where the cheapest extraction method by evasive salt brine in solar ponds uses the use of cheap and toxic PVCs; and in a lithium-rich area of Chile where extracting metals uses two-thirds of fresh drinking water in the area. Lithium is the 33rd most element, however, it does not naturally occur in pure form due to its high inactivity. Lithium metal, due to its alkali properties, erects and responds with water. Respiratory lithium dust or alkaline lithium compounds irritate the respiratory tract. Prolonged exposure to lithium can cause constructive fluid in the lungs, leading to pulmonary edema. The metal itself is a danger of handling because of the caustic hydroxide produced when in contact with the water caused the explosion. Lithium mining carries high environmental costs. Mining companies seeking lithium in northern Tibet, South American salt plains, and Chile as well as lithium in Bolivia's Salar De Uyuni require extensive extraction and water operations on dry land. But according to an article published by TIME, lithium mining, as observed in countries with deposits such as Chile, Argentina and China, seems less dangerous than other types of mineral extraction. Lithium can be one of the least tainted mining processes," said Marco Octavio Rivera of the Bolivian Environmental Defense League, although he noted that prolonged exposure to lithium can cause nervous system disorder. Everything comes at a cost, so although the environmental impact may not be worse than mountain mining, it will be important to pay attention to the environmental impact, because there will be one. Lithium is one of the most important metals of the 21st century. It makes it possible for rechargeable battery technology found in mobile phones, laptops, and vehicles But where does lithium actually come from and what goes into mining for lithium? There are two main sources of lithium: mining and brine water. Most of the world's lithium (87 percent) comes from the latter source. Between brine water sources, briny lake (known as salary) offers the highest density of lithium (1,000 to 3,000 parts per Salaries with the highest lithium density are located in Bolivia, Argentina, and Chile. Brine extracts lithium. Lithium earned from salaries is recovered in the form of lithium carbonate, a raw material used in lithium ion batteries. The production process is quite easy and requires only natural rationing, which leaves not only lithium, but also magnesium, calcium, sodium, and potassium. The lithium content of ocean water is much lower, melting by about 0.17 parts per million. However, about 20 percent of the lithium in seawater can be restored using a combination of membranes, filters, and ion exchange resins. Brine mining is usually a long process that takes from eight months to three years. But scientists are trying to develop technologies that can extract lithium and other valuable materials - including gold, zinc, copper, and slika - from brine water used by geothermal power plant. Collecting lithium from brine geoterma can make the entire lithium production process much faster and cheaper than the natural rationing process normally used. In 2010, for example, Symbol Materials received a $3 million raise from the U.S. Department of Energy to develop such technology. The symbol adapts the technology originally developed by Lawrence Livermore National Laboratory to create a series of filters and adsorption materials that can capture lithium and other materials in brine water that are pumped out of the ground by geothermal plants to generate energy. After removing lithium and other materials, water is sent back to the geothermal site for underground re-injection. New technology has also opened up the possibility of restoring brine oil fields, briny water that is bubbling when the oil well is being drilled. Last year, for example, MGX Minerals developed a method to extract over 83 percent of lithium in brine oil fields. But despite using traditional recovery methods, extracting lithium from brine is easier and cheaper than hard mining by about half. A balance of 13 percent of the world's lithium is found in more traditional mines. The density of lithium in rock (pegmatit) is higher than that found in brine, but the mining process has higher costs and a greater environmental footprint. However, hard lithium mining can be competitive, at least in existing mines. More than 145 minerals contain lithium, but only five (spodumene, lepidolite, petalite, amblygonite, and eucryptite) are used in lithium extraction. Of the five, spodumene provides the largest share of all lithium derived from minerals. In 2011, spodumene produced 12,500 while other sources only provide about 1,500 tonnes. After the spodumene is mined, it is heated to 1100°C, then cooled to 65°C and downwards, mixed, and grilled with concentrates Acid. Sulfuric acid starts from a reaction in which sulfate lithium replaces hydrogen. Slurry is then filtered and some additional compounds are added. After the pH level is adjusted, the mixture is concentrated through equencation. Finally, soda ash is added to create lithium carbonate. The smallest source of lithium is now available is the one contained in recycled electronics. Although lithium recycling is not yet capable of producing pure lithium enough for reuse in batteries, it can be used in glass and ceramics, the industry eats the second largest lithium after the lithium ion battery industry. But lithium recycling remains a niche market, and only one recycling facility for lithium ion batteries exists in the United States. In the future, hectorit clay deposits can provide significant sources of lithium. Getting clay itself will be easy, but it needs to be spread or roasted to extract lithium. Clay has not been exploited as a source of lithium, but analysts say that for American manufacturing purposes, land-rich lithium mining in Nevada could be almost as cost-effective as importing from Chile. Whether the lithium mining industry is shifting towards clay, oilfield brine, or some other rehabilitation method, it is clear that the rapid increase in lithium consumption over the past decade requires the expansion of lithium resources and similar production sites. In 2009, the lithium ion battery industry accounted for 21 percent of all annual lithium consumption. Today, that figure has nearly doubled, and battery production - particularly batteries for the manufacture of electric vehicles - will continue to combine larger share of lithium progressively. Single electric vehicles need a lithium of 10,000 mobile phones, and global electric vehicle sales will essentially double by 2021, then double again by 2025. In other words, expanding access to lithium must remain a priority for the EV and electronics industry. A more diverse supply of lithium can also help break the oligopoly that now controls trade. Today, only four companies (Chile's SQM, US-based FMC Corp and Albemarle Corp, and Talison Australia) produce 85 percent of all lithium. Finally, expanding lithium mining operations could protect lithium prices against potential surprises. For example, if Chile (which holds more than half of all known lithium reserves in the world) has been smashed, prices will rise dramatically, as they did in China a few years ago when Australia's spodumene shortage led to a 300 per cent price hike. Price increases such as can threaten the entire lithium ion battery industry - and a sustainable energy future along with it. Lithium is one of the main components of electric car batteries. See how the Detroit Auto Show Electric Car Rules. Chemical elements with atomic number 3 of this article chemical elements. For the use of lithium as a medicine, see Lithium (medicine). For other uses, see Lithium (blur). Chemical element with atomic number 3Lithium, 3LiLithium floating in oilLithiumPronunciation/ˈlɪθiəm/ (LITH-ee-əm)Appearancesilvery-whiteStandard atomic weight Ar, std(Li)[6.938, 6.997] conventional: 6.94Lithium in the periodic table Hydrogen Helium Lithium Beryllium Boron Carbon Nitrogen Oxygen Fluorine Neon Sodium Magnesium Aluminium Silicon Phosphorus Sulfur Chlorine Argon Potassium Calcium Scandium Titanium Vanadium Chromium Manganese Iron Cobalt Nickel Copper Zinc Gallium Germanium Arsenic Selenium Bromine Krypton Rubidium Strontium Yttrium Zirconium Niobium Molybdenum Technetium Ruthenium Rhodium Palladium Silver Cadmium Indium Tin Antimony Tellurium Iodine Xenon Caesium Barium Lanthanum Cerium Praseodymium Neodymium Promethium Samarium Europium Gadolinium Terbium Dysprosium Holmium Erbium Thulium Ytterbium Lutetium Hafnium Tantalum Tungsten Rhenium Osmium Iridium Platinum Gold Mercury (element) Thallium Lead Bismuth Polonium Astatine Radon Francium Radium Actinium Thorium Protactinium Uranium Neptunium Plutonium Americium Curium Berkelium Californium Einsteinium Fermium Mendelevium Nobelium Lawrencium Rutherfordium Dubnium Seaborgium Bohrium Hassium Meitnerium Darmstadtium Roentgenium Copernicium Nihonium Flerovium Moscovium Livermorium Tennessine Oganesson H↑Li↓Na helium ← lithium → beryllium Atomic number (Z)3Groupgroup 1 : H and alkali metalsPeriodperiod 2 Blocks Elements category Alkali metalElectron configuration[Dia] 2s1Electrons per shell2, 1Physical propertiesPhase in STPsolidMelting point453.65 K (180.50 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1603 K (1330 °C, 356.90 °F) Boiling point1 2426 °F) Coriander (near r.t.) 0.534 g/cm3when liquid (at m.p.) 0.512 g/cm3 Critical point 3220 K, 67 MPa (extrapolated)Haba fusion3.00 kJ/mol Heat vaporization136 kJ/molar mole heat capacity24.860 J /(mol· K) Pressure wap P (Pa) 1 10 100 1 k 10 k 100 k in T (K) 797 885 995 1144 1337 1337 1610 Properties of AtomOxi State+1 (Strong Base Oxide)Electronegativity ScalePauling: 0.98 Ionizing power1:520.2 kJ/mol 2:72 98.1 kJ/3rd mole: 11815.0 kJ/mol Radiusempirical Atom: 152 pm Covalent radius128±7 pm Van der Waals radius 182 pm Spectral line li Features whether Body-centered structure (bcc) Speed of sound is 6000 m/s (at 20 °C) Heat development46 µm/(m· K) (at 25 °C) Heatacy 84.8 W/(m· K) Electrical resistance92.8 nΩ·m (at 20 °C) Order magnet suspicion+14.2·10−6 cm3/mol (298 K)[1]Modulus young modulus4..9 GPa Shear modulus4.2 GPa Bulk modulus1 GPa Mohs hard0.6 Brinell hardness5 MPa CAS Number7439-93-2 HistoryDiscoveryOgos Arfwedson exileWilliam Thomas Brande (1821)Main isotopes of lithium Isotope Many Half Life (t1/2) Mod Damage Products 6Li 7.59% stable 7Li 92.41% stable category: Lithiumviewtalkedit | Lithium references (from Greek: λίθος, romantic: lithos, lit. 'stone') is a chemical element with the symbol Li and atomic number 3. It is a soft, white alkaline metal. Under standard circumstances, it is the lightest metal and the lightest solid element. Like all alkali metals, lithium is highly reactive and flammable, and should be stored in mineral oil. When cut, it showed off the metallic sparkle, but the damp air quickly swept it into dull silver grey, then black tarnish. It has never occurred freely in nature, but only in (usually ionic) compounds, such as pegmatitic minerals, which were once the main source of lithium. Due to its appropriateness as an ion, it is present in ocean water and is usually obtained from brines. Lithium metals are electrolytically sequestered from a mixture of lithium chloride and potassium chloride. The lithium nucleus of atoms verges upward stability, since both stable lithium isotopes found in nature have among the lowest binding power per nucleus of all stable nuclei. Due to relative nuclear stability, lithium is less common in solar systems than 25 of the first 32 chemical elements even though the nucleus is very light: it is an exception to the trend that heavier nuclei are less common. [2] For related reasons, lithium has important uses in nuclear physical. The transmutation of lithium atoms to helium in 1932 was the first fully man-made nuclear reaction, and lithium deuteride served as a combined firearm in ranked thermonuclear weapons. [3] Lithium and its compounds have several industrial applications, including heat-resistant and ceramic glass, lithium gris twisting, flux additions for iron, steel and aluminum production, lithium batteries, and lithium-ion batteries. This use uses more than three-quarters of lithium production. Lithium is present in biological systems in trace amounts; function is uncertain. Lithium salts have been shown to be useful as mood stabilization drugs in the treatment of bipolar disorder in humans. Atomic and physical properties of Lithium ingots with a layer of black nitride tarnish Like other alkaline metals, lithium has a single wire electron that is easy to administer to form a kasi. [4] Therefore, lithium is a good heat and electrical conductor as well as a highly reactive element, although it is the least reactive alkaline metal. Lithium's low reactivity is due to its proximity to its injap electrons to its nucleus (the balance of two electrons is in orbit 1s, much lower in energy, and take part in chemical bonds). [4] However, the lithium javelin is much more reactive than its solid form. [5] [6] Lithium metals are soft enough to with a knife. When cut, it has a silver white color that quickly changes to gray because it oxidizes lithium oxide. [4] Although it has one of the lowest melting points among all metals (180 °C, 453 K), it has the highest melting and boiling point of alkali metals. [7] Lithium has a very low concentration (0.534 g/cm3), matched with pain wood. [8] It is the most dense of all solid elements at room temperature; the next lightest solid element (potassium, at 0.862 g/cm3) is more than 60% solid. In addition, in addition to helium and hydrogen, as solid it is less dense than other elements as liquids, only two-thirds as solid as liquid nitrogen (0.808 g/cm3). [9] Lithium can float in the lightest hydrocarbon oils and is one of three metals that can float on water, the other two being sodium and potassium. Lithium floating in lithium oil multipliers heat development is twice as much as aluminum and nearly four times that of iron. [10] Lithium is superconductive below 400 µK at standard pressure[11] and at higher temperatures (more than 9 K) at very high pressures (>20 GPa). [12] At temperatures below 70 K, lithium, like sodium, undergoes a non-stop transformation of phase changes. At 4.2 K it has a rhombohedral crystal system (with a replay distance of nine layers); at higher temperatures it changes to a solid centered face and then centered a solid body. At liquid-helium temperature (4 K) the rhombohedral structure is encevalent. [13] Various forms of aotropic have been identified for lithium at high pressure. [14] Lithium has a special heat capacity of 3.58 kilojoules per kilogram-kelvin, the highest of all solids. [16] Therefore, lithium metal is often used in cooling for heat transfer applications. [15] Lithium chemistry and compounds respond with ease with water, but are significantly less serious than other alkaline metals. The response forms hydrogen gas and lithium hydroxide in an aqueous solution. [4] Due to its access to water, lithium is usually stored in hydrocarbons, usually petroleum jelly. Although heavier alkaline metals can be stored in solid materials such as mineral oils, lithium is not dense enough to sink completely into this liquid. [17] In the humid air, lithium quickly acted to form a black dye of lithium hydroxide (LiOH and LiOH· H2O), lithium nitride (Li3N) and lithium carbonate (Li2CO3, secondary reactions between LiOH and CO2). [18] The hexymeric structure of n-butyllithium debris in crystals When placed on a fire, a lithium compounds provide an interesting crimson color, but when the metal burns strongly, the fire becomes outstanding. Lithium will light and burn in oxygen when exposed to water or water vapor. [19] Lithium is flammable, and it is potentially an explosion when exposed to air and especially to water, although less than others Metal. Lithium-water reactions at normal temperatures are immediate but not malignant because the resulting hydrogen does not ignite by itself. Like all alkaline metals, lithium fires are difficult to destroy, requiring dry powder fire extinguishers (Class D type). Lithium is one of the few metals that responds with nitrogen under normal circumstances. [20] Lithium has a similar relationship with magnesium, atomic and ionic finger elements. Chemical similarities between the two metals include the formation of nitrics with reactions with N2, the formation of oxides (Li2O) and peroxides (Li2O2) when burned at O2, salts of the same ability, and the per stability of carbonate and nitrides heat. [18] The metal responds with hydrogen gas at high temperatures to produce lithium hydrants (LiH). [23] Other known binary compounds include halides (LiF, LiCl, LiBr, LiI), sulfide (Li2S), superoxide (LiO2), and carbide (Li2C2). Many other inorganic compounds are known where lithium combines with anions to form salts: borates, amides, carbonates, nitrates, or borohydride (LiBH4). Lithium aluminum hidride (LiAlH4) is commonly used as an agent reducing organic synthesis. LiHe, a very weak van der Waals, has been detected at very low temperatures. [24] Unlike other elements in group 1, lithium inorganic compounds follow duet rules instead of octet regulations. Organic chemistry Master plan: Organolithium realytic organolytic reagents are known where there is a direct bond between carbon atoms and lithium. These compounds have highly polarized metal-carbon bonds towards carbon, allowing them to effectively function as stable carbanions of metals, although their solution structure and solid state are more complex than this easy view suggests due to the formation of oligometric groups. [25] Therefore, these are very strong principles and nucleophiles. They have also been used in asymmetry synthesis in the pharmaceutical industry. For laboratory organic synthesis, many organolytic reagents are commercially available in the form of solutions. These reagents are highly reactive, and sometimes pyrophoric. Like its inorganic compounds, almost all lithium organic compounds officially follow duet rules (e.g., BuLi, MeLi). However, it is important to note that in the absence of aligning solvents or ligands, organolytic compounds form dimeric, tetrameric, and hexameric groups (for example, the actual BuLi [BuLi]6 and the actual MeLi [MeLi]4) that have various central bonds and increase the alignment number around lithium. These clusters are solved to smaller or monometric units with the presence of solvents such as dimethoxyethane (DME) or ligands such as tetramethylethylenediamine (TMEDA). [26] exception to duet rule, complex lithate two coordinates with four electron electrons lithium, [Li(thf)4]+[(Me3Si)3C)2Li]–, has been crystallinely characterized. [27] Isotopes Main plan: Lithium Naturally isotopes occur lithium consisting of two stable isotopes, 6Li and 7Li, the second being more numerous (92.5% natural involvement). [4] [17] Both natural isotopes have low nuclear binding energy for each nucleus (as opposed to the neighbouring elements on the table periodically, helium and beryllium); lithium is the only low-nombor element that can produce clean energy through nuclear fision. Both lithium nuclei have a lower power of each nucleus than any stable nucleides other than deuterium and helium-3. [29] As a result, although very light in atomic weight, lithium is less common in the Solar System than 25 of the first 32 chemical elements. [2] Seven radioisotopes have been characterized, the most stable are 8Li with half the life of 838 ms and 9Li with a half life of 178 ms. All radioactive isotopes that live have half a life shorter than 8.6 ms. The shortest isotope of lithium is 4Li, which regenerates through proton release and has a half-life of 7.6 × 10−23 s.[30] 7Li is one of the primordial elements (or , more correctly, primordial nuclides) produced in the Nucleosnsis Big Bang. A small number of both 6Li and 7Li are produced in stars, but are thought to be burned as fast as they are produced. [31] Additional lithium amounts of both 6Li and 7Li can be generated from solar wind, cosmic rays that hit heavier atoms, and from the early solar system 7Be and radioactive damage 10Be. [32] Although lithium was created in stars during brilliant nucleoynthesis, it was burned again. 7Li can also be generated in carbon stars. [33] Lithium isotopes rupture significantly during various natural processes,[34] including mineral formation (chemical deposition), metabolism, and ion exchange. Lithium ion substitutes magnesium and iron at octahedral sites in clay minerals, where 6Li takes precedence over 7Li, causing the enrichment of light isotopes in the process of hyperfiltration and stone changes. Exotic 11Li is known to show off the nucleus halo. A process known as laser isotope separation can be used to separate lithium isotopes, especially 7Li from 6Li. [35] The manufacture of nuclear weapons and other nuclear physical applications is the main source of artificial lithium fragments, with the 6Li light isotope maintained by industry and military stockins causing little change but can be measured in 6Li to 7Li ratios in natural sources, such as rivers. This has led to tremendous uncertainty in the weight of lithium standard atoms, as this quantity depends on the natural involvement ratio of these naturally occurred lithium isotopes, as they can be found in lithium mineral sources [36] Both stable isotopes are stable can be cooled laser and used to produce the first Bose-Fermi degenerate quantum mixture. [37] Lithium's occurrence is roughly as usual chlorine in the upper continental crust of The Earth, on a per-atomic basis. Master Plan of Astronomy: Nucleosynthesis, Stellar Nucleoynthesis, and Lithium Combustion Although it was synthesized in the Big Bang, lithium (together with beryllium and boron) is less numerous in the universe than other elements. This is the result of the rather low brilliant temperatures required to destroy lithium, together with the lack of the same process to produce it. [38] According to modern cosmology theory, lithium—in both stable isotopes (lithium-6 and lithium-7)—is one of three elements synthesized in the Big Bang. [39] Although the amount of lithium produced in the Big Bang nucleosynthesis depends on the number of photographs of each baryon, for the accepted values of much lithium can be calculated, and there is a cosmological lithium contention in the universe: older stars seem to have less lithium than they should, and some young stars have more. [40] Lithium deficiency in older stars appears to be due to the mixing of lithium into the star's interior, where it is destroyed,[41] while lithium is produced in younger stars. Although it translates to two helium atoms due to proton damage at temperatures exceeding 2.4 million degrees Celsius (most stars easily reach this temperature in their interior), lithium is more than current calculations would have predicted in later generations of stars. [17] Nova Centauri 2013 was the first in which lithium evidence was found. [42] Lithium is also found in brown dwarf substellar objects and certain anomalous oren stars. Because lithium is present in cooler brown dwarfs, less large, but destroyed in hotter red dwarf stars, its presence in star spectra can be used in lithium tests to distinguish both, as both are smaller than the Sun. [17] [43] [44] Certain oren stars can also contain high density of lithium. Oren stars were found to have higher-than-usual lithium density (such as Centaurus X-4) orbiting large neutron-star objects or black holes—whose graviti clearly draws heavier lithium to the surface of hydrogen helium stars, causing more lithium to be noticed. [17] On May 27, 2020, astronomers reported that the classic beginner explosion was a galactic lithium producer. [46] Terrestrial See also: Lithium minerals Although lithium is widely circulated on Earth, it does not occur naturally in the form of elements due to its high reactivity. [4] The amount of lithium content of seawater is very large and is estimated to be as large as billion tons, where the element exists at a relatively continuous concentration of 0.14 to 0.25 parts per million (ppm),[47][48] or 25 micromolars; [49] Higher concentrations 7 ppm was found near the hydrothermal ocque. [48] Estimated earth content between 20 to 70 ppm by weight. [18] Lithium is about 0.002 percent earth's crust. [50] In line with its name, lithium forms a fraction of the ignorant rocks, with the largest concentration in granite. Granite pegmatites also provide many lithium-containing minerals, with spodumene and petalite being the most commercially viable resource. [18] Another important mineral of lithium is lepidolite which is now an obsolete name for a series formed by polythionite and trilithionite. [52] Newer resources for lithium are hectorite clay, the only active development that passes through the West Lithium Corporation in the United States. [53] At 20 mg of lithium per kg of Earth's crust,[54] lithium is the 25th most important element. According to the Calcium and Natural Calcium Handbook, Lithium is a fairly rare element, although it is found in many miles and some brines, but always in very low concentrations. There are a large number of both lithium minerals and brine deposits but only a few of them are real or potentially commercial value. Many are very small, others are too low grade. [55] The U.S. Geological Survey estimates that in 2010, Chile has the largest reserve to date (7.5 million tonnes)[56] and the highest annual production (8,800 tonnes). One of the biggest reserve bases[note 1] lithium is in the Salar de Uyuni area of Bolivia, which has 5.4 million tonnes. Other major suppliers include Australia, Argentina and China. [57] As of 2015, the Czech Geological Survey regards the entire Ore Mountains in the Czech Republic as a lithium territory. Five deposits are registered, one near Cínovec [cs] is considered a potentially economical deposit, with 160 000 tons of lithium. [59] In December 2019, Finnish mining company Keliber Oy reported its Rapasaari lithium deposits had estimated proven ore reserves and were probable at 5.280 million tonnes. [60] In June 2010, The New York Times reported that American geologists conducted a ground survey on dry salt lakes in western Afghanistan believing that large deposits of lithium were located there. Pentagon officials say their initial analysis at one location in Ghazni Province shows the potential lithium deposits as large as Bolivia, which now has the largest lithium reserve in the world. [61] These estimates are based primarily on old data, collected primarily by the Soviets during their occation of Afghanistan from 1979-1989. Stephen Peters, head of the USGS Afghan Minerals Project, said that he was unaware of the USGS's involvement in any new survey for minerals in Afghanistan in the past two years. 'We don't any lithium discovery,'' he said. [62] Lithia (lithium brine) brine) with a tin ore mining area in Cornwall, England and an assessment project of test boreholes within 400 metres is being considered. If successful hot brines will also provide geothermal energy for lithium-ioning power and filtering processes. [63] Lithium biology is found in trace amounts in various plants, plankton, and invertebrates, at a density of 69 to 5,760 parts per billion (ppb). In vertebrates the density is slightly lower, and almost all vertebrate tissues and body fluids contain lithium between 21 to 763 ppb. [48] Marine organisms tend to take lithium bioaccumulate more than terrestrial organisms. [64] Whether lithium has a physiological role in any organism is unknown. [48] The history of Johan August Arfwedson is credited with the discovery of lithium in 1817 The Petalite (LiAlSi4O10) was discovered in 1800 by brazilian chemist and statesman José Bonifácio de Andrada e Silva in a mine on the Swedish island of Utö. [66] [67] However, it was not until 1817 that Johan August Arfwedson, then working in the laboratory of chemist Jöns Jakob Berzelius, tracking the presence of new elements while analyzing petalite ore. [69] [70] [71] [72] These elements form compounds similar to sodium and potassium, although their carbonates and hydroxide are less soluble in water and less alkaline. [73] Berzelius gave the alkaline ingredient the name lition/lithina, from the Greek word λιθoς (translated as litos, meaning stone), to reflect its discovery in solid minerals, as opposed to potassium, which has been found in plant ash, and sodium, which is known in part for its large amount in animal blood. He named the metal in the lithium material. [67] Arfwedson later pointed out that this same element is present in mineral spodumen and lepidolite. [74] In 1818, Christian Gmelin was the first to notice that lithium salts gave fire a bright red color. [67] However, both Arfwedson and Gmelin tried and failed to separate the pure element from the salt. [72] He was not exiled until 1821, when William Thomas Brande obtained it through lithium oxide electrolysis, a process that was originally used by chemist Sir Humphry Davy to isolate potassium alkali metal and sodium. [17] [76] [77] [78] Brande also describes some lithium pure salts, such as chloride, and, budgeting that lithia (lithium oxide) contains about 55% metal, estimated the weight of lithium atoms to be about 9.8 g/mol (modern value ~ 6.94 g /mol). [80] In 1855, greater lithium quantity was produced through lithium chloride electrolysis by Robert Bunsen and Augustus Matthiessen. [67] The discovery of this procedure led to commercial lithium in 1923 by the German company Metallgesellschaft AG, which electrolyzed lithium lithium liquid mixture potassium chloride. [82] Australian psychiatrist John Cade is credited with reintroducing and popularize the use of lithium to treat mania in 1949. [84] Not long after, throughout the mid-20th century, the lithium mood stabilized the usefulness of mania and depression in Europe and the United States. The expenditure and use of lithium underwent some drastic changes in history. The first major lithium application was in high temperature lithium gris for aircraft engines and similar applications in World War II and shortly the following. This use is supported by the fact that lithium-based soaps have a higher melting point than other alkaline soaps, and are less effective than calcium-based soaps. The small demand for lithium soap and twisted gris is supported by several small mining operations, mostly in the US. Demand for lithium increased abruptly during the Cold War with the earnings of nuclear combined weapons. Both lithium-6 and lithium-7 produce tritium when insinuated by neutrons, and are thus useful for the production of tritium by itself, as well as a form of solid combined fuel used in hydrogen bombs in the form of lithium deuterides. The US became a major producer of lithium between the late 1950s and mid-1980s. In the end, lithium stock is approximately 42,000 tan of lithium hydroxide. Lithium stock has been disposed of in lithium-6 by 75%, which is enough to affect the weight of lithium-measured atoms in many standard chemicals, as well as the weight of lithium atoms in some natural sources of lithium ions that have been contaminated by lithium salts released from isotope separation facilities, which have found their way into groundwater. [36] Lithium is used to reduce the melting temperature of glass and to improve the melting behavior of aluminum oxide when using the Hall-Héroult process. [86] Both uses dominated the market until the mid-1990s. After the end of the nuclear weapons race, demand for lithium declined and the sale of energy department stockists on the open market further reduced prices. [85] In the mid-1990s, several companies began extracting lithium from brine which proved to be a less expensive option than underground or open mining. Most mines are closed or shift their focus to other materials as only ore from pegmatit zones can be mined at competitive prices. For example, the U.S. mine near Kings Mountain, North Carolina was closed before the beginning of the 21st century. The construction of lithium ion batteries increased demand for lithium and became the dominant use in 2007. [88] With a surge in lithium demand in batteries in the 2000s, new companies have brine's efforts to meet growing demand. [89] It has been argued that lithium will be one of the main objects of geopolitical geopolitics. in a world that runs on renewable energy and relies on batteries, but this perspective has also been criticized for easily ramming the power of economic incentives for expanded production. [91] Production See also: List of countries by the lithium production of satellite images del Hombre Muerto, Argentina (left), and Uyuni, Bolivia (right), lithium-rich salt flats. Lithium-rich Brine is concentrated by pumping it into a solar epirating pool (visible in the left image). Lithium production has increased since the end of World War II. Metals are separated from other elements in ignorant minerals. The metal is produced through electrolysis from a mixture of 55% chloride lithium and 45% potassium chloride at about 450 °C.[92] In 2015, most of the world's lithium production is in South America, where brine containing lithium is extracted from the underground pond and concentrated by solar ponds The standard extraction technique is to ear water from the brine. Each group takes from 18 to 24 months. [93] Worldwide Reserves identified reserves in 2017, 2018, 2019 and 2020 estimated by the United States Geological Survey (USGS) of 14 million, 16 million, 14 million and 17 million tonnes respectively. [57] The estimated accurate world lithium reserves are difficult. [94] One of the reasons is that most lithium classification schemes are developed for solid ore deposits, while brine is a problematic liquid to treat with the same classification scheme as concentrations vary and pump effects. [96] Lithium resources around the world identified by the USGS began to increase in 2017 as the explorer continued. Resources identified in 2016, 2017, 2018, 2019 and 2020 were 41, 47, 54, 62 and 80 million tonnes respectively. [57] The world in 2013 is estimated to contain about 15 million tonnes of lithium reserves, while 65 million tonnes of known resources are reasonable. A total of 75% of everything is usually available in the world's ten largest deposits. [97] Another study stated that 83% of lithium geological sources were located in six brine, two pegmatites, and two sediment deposits. [98] The world's four best lithium manufacturer countries from 2019, as reported by the US Geological Survey are Australia, Chile, China and Argentina. [57] The intersections of Chile, Bolivia, and Argentina formed the region known as the Lithium Triangle. The Lithium triangle is famous for its high-quality salt-off homes including the Bolivian de Uyuni Salary, the Chilean Salary de Atacama, and the Argentine de Arizaro Salary. The Lithium triangle is believed to contain more than 75% of existing lithium reserves. [99] Deposits are available in South America throughout the Andes mountain chain. Chile is a major producer, followed by Argentina. Both recovered lithium from brine ponds. According to the USGS, Bolivian Bolivia The desert has 5.4 million tons of lithium. [100] [101] Half the world-renowned reserves are located in Bolivia along the Middle East slopes of the Andes. In 2009, Bolivia consulted Japanese, French, and Korean firms to begin extraction. [100] Production of lithium mines (2019), reserves and resources in tonnes according to the USGS[102] National Production Reserve[note 1] Argentine resources 6,400 1,700,000 17,000,000 Australians 42,000 2,800,000 6,300,000 Austrians - - 75,000 Bolivia - - 21,000,000 Brazilian 300 95,000 400,000 Canada 200 370,000 1,700,000 Chileans 18,000 8,600,000 8,600,000 Czech Republic - - 1,300,000 DR Congo - 3,000,00000 Finland - 40,000 Germany - - 2,500,000 Kazakhstan - - 40,000 Mali - - 1,000,000 Mexico - - 1,700,000 Namibia 500? 9,000 People of the Republic of China 7,500 1,000,000 4,500,000 Peru - - 130,000 Portugal 1,200 60,000 250,000 Russians - 1,000,000 Serbians - - 1,000,000 Spain - - 300,000 United States 870[note 2] 630,000 6,800,000 Zimbabwe 1,600 230,000 540,000 World totalling 77,000 17,000,000 80,000,000+ In the UNITED States, lithium is recovering from a brine pond in Nevada. [15] Deposits found in 2013 at Wyoming's Rock Springs Uplift are estimated to contain 228,000 tonnes. Additional deposits in the same formation are estimated at 18 million tonnes. [103] Over the years opinions have differed about growth potential. A 2008 study concluded that realistically achievable lithium carbonate production would be sufficient for only a fraction of the global market needs of PHEV and future EVs, that the demand from the mobile electronics sector will absorb much of the increased production planned over the next decade, and that the mass production of lithium carbonate is not environmentally sound, it will cause irrefutable ecological damage to the ecosystem that should be covered and liIon scheduling is not compatible with Cars'. [58] According to a later 2011 study by the Lawrence Berkeley National Laboratory and the University of California, Berkeley, the estimated lithium reserve base would then not be a factor in the large-scale battery production limit for electric vehicles as an estimated 1 billion batteries based on 40 kWh Li can be built with such reserves[104] - about 10 kg of lithium per car. [105] Another 2011 study at the University of Michigan and Ford Motor Company found sufficient resources to support global demand until 2100, including lithium needed for potentially widespread transport use. The study estimates global reserves at 39 million tonnes, and total lithium demand over a 90-year annual period at 12-20 million tonnes, depending on scenarios on economic growth and recycling rates. [106] In 2014, The Financialist stated that demand for lithium expanded in 2014 than 12% a year. According to Credit Suisse, this rate exceeds the availability of the drawn 25%. The publication compared the state of lithium 2014 with oil, where higher oil prices encouraged investment in expensive deep water and oil sands production techniques; that is, lithium prices will continue to increase until more expensive production methods that can increase the amount of output will get the attention of investors. [107] On 16 July 2018 2.5 million tonnes of high grade lithium sources and 124 million pounds of uranium sources were found in falchani hardstone deposits in the region of Puno, Peru. [108] There are budgeted 230 billion lithium tans in the ocean[109], but the density is 0.1-0.2ppm, making it more expensive to extract with 2020 technology than brine and stone-based soils. In 1998, the price of lithium metal was approximately 95 USD/kg (or US$43/lb). [110] After the 2007 financial crisis, major suppliers, such as Sociedad Química y Minera (SQM), fell the price of lithium carbonate by 20%. [111] Prices increased in 2012. Business Week 2012 article outlines oligopoly in lithium space: SQM, escorted by millionaire Julio Ponce, is the second largest, followed by Rockwood, which is supported by KKR & Co., and Philadelphia-based FMC, with Talison named as the largest producer [112] Global usage could jump to 300,000 metric tons a year by 2020 from about 150,000 tons in 2012, to match lithium battery demand that has grown by about 25% a year, coping with a 4% to 5% overall gain in lithium production. [112] Extracting Lithium extraction from seawater, published in 1975 Lithium and its compounds extracted from hard stones so that salt was extracted from water in mineral springs, brine ponds, and brine deposits became the dominant source in the 1990s. Lithium ore mining is more expensive and has beenpriced out of the market, but by 2018 hard rock is once again an important contributor. Low cobalt cathode for lithium batteries is expected to require lithium hydroxide instead of lithium carbonate as livestock, and this trend favors rock as a source. [113] [114] Electrodialysis has been reserved for extracting lithium from seawater, but it is not commercially advanced. [93] Another potential source of lithium is the leachates of geothermal well, which are brought to the surface. [116] Lithium restoration has been shown in the field; lithium is separated by easy filtering. [117] The processes and costs of the environment are mainly those that are already operating properly; the impression of clean environment may be positive. [118] Investment Main Article: Lithium as an investment At this time, there are several options available on the market to invest in metals. Although buying lithium physical shares is not possible, investors can buy shares of companies involved mining and producing lithium. [119] Also, too, can buy specialized lithium ETFs that offer exposure to a group of commodity manufacturers. Application of Estimated global lithium use in 2011 (pictured) and 2015 (number below)[120] Ceramics and glass (32%) Battery (35%) Lubricant grease (9%) Continuous casting (5%) Air treatment (5%) Polymer (4%) Main aluminum production (1%) Pharmaceuticals (<1%) Others (9%) Ceramic and glass Lithium oxide is widely used as a flux for processing sicaks, reducing melting points and viscosity of the material and leading to glazes with better physical properties including low cocale of thermal expansion. Worldwide, this is one of the biggest uses for lithium compounds. [120] Glazes containing oxide lithium are used for ovenware. Carbonate lithium (Li2CO3) is usually used in this application as it converts to oxide when heating. [122] Electrical and electronics In the late 20th century, lithium became an important component of electrolytes and battery electrodes, due to its high potential electrodes. Because of the low atomic mass, it has a high charge ratio and power to weight. Regular lithium-ion batteries can generate about 3 volts per cell, compared with 2.1 volts for lead acid and 1.5 volts for zinc-carbon. The lithium-ion battery, which can be recharged and has a high energy density, differs from lithium batteries, which are disposable (primer) batteries with lithium or its compounds as anods. [123] Other rechargeable batteries that use lithium include lithium-ion polymer batteries, lithium iron phosphate batteries, and nanowire batteries. Main grease lubricants: Lithium grease the third most common lithium consumption is in grease. Lithium hydroxide is a strong foundation and, when heated with fat, produces soap made of lithium stearate. Lithium soap has the ability to thicken the oil, and it is used to manufacture all purposes, high temperature lubricant grease. [125] [126] Metallurgy Lithium (e.g. as lithium carbonate) is used as a supplement to the continuous casting mold flux slab where it increases liquidity,[127][128] consumption that contributes 5% global lithium consumption (2011). [57] Lithium compounds are also used as additional substances (fluxes) to found sand for casting iron to reduce veins. [129] Lithium (as a fluoride lithium) is used as an additive to aluminium bliss (The Hall-Héroult process), reduces melting temperature and increases electrical resistance,[130] a consumption that includes 3% of production (2011). [57] When used as a flux for welding or marching, metal lithium promotes metal combinations during the process[131] and eliminates the formation of oxides by absorbing impurities. [132] Metal alloys with aluminium, cadmium, copper and manganag to make high twin aircraft parts (see also Lithium-aluminum alloy). [133] Silicone Silicone Lithium has been found to be effective in aiding the perfection of silicon nano-welding in electronic components for electrical batteries and other devices. [134] Other chemicals and industries use lithium in flames and pyrotechnics caused by ros red flames. [135] Lithium Pyrotechnics are used as pyrotechnic dyes and oxides in red sparks and flames. [15] The air purge of Lithium chloride and lithium bromide is hygroscopic and is used as a leaching for gas flow. [15] Lithium hydroxide and lithium peroxide are the most widely used salts in confined areas, such as spaceships and submarines, for carbon dioxide removal and air cleaning. Lithium hydroxide absorbs carbon dioxide from the air by forming lithium carbonate, and takes precedence over other alkaline hydroxide for its low body weight. Lithium peroxide (Li2O2) with the presence of moisture not only responds with carbon dioxide to form lithium carbonate, but also releases oxygen. [137] This reaction is as follows: 2 Li2O2 + 2 CO2 → 2 Li2CO3 + O2. Some of the compounds mentioned above, as well as lithium perchlorate, are used in oxygen candles that supply submarines with oxygen. It can also include small amounts of boron, magnesium, aluminum, silicon, titanium, manganese, and iron. [139] Lithium fluoride optics, artificially grown as crystals, are clear and transparent and are often used in expert optics for IR, UV and VUV (UV vacuum) applications. It has one of the lowest refractive indexes and the most distant delivery range in deep UV of the most common materials. [140] Fine lithium fluoride powder has been used for thermoopinescent ray dosimetry (TLD): when the sample is so exposed to radiation, it collects a crystal defect that, when heated, resolves through the release of blue light that is intensity-level with the absorbed dose, thus allowing this to be contained. [141] Lithium fluoride is sometimes used in canta focal telescopes. [15] High diss alignment of lithium niobate also makes it useful in non-linear optical applications. It is widely used in telecommunications products such as mobile phones and optical modulators, for components such as crystal resonant. Lithium applications are used in more than 60% of mobile phones. [143] Organic compounds and Organolithium polymers are widely used in the production of polymers and fine chemicals. In the polymer industry, which is the dominant user of this reagent, lithium alkyl compounds are pemangkin / beginner. [144] in the treatment of malfunctioning olefin anionic. [146] [147] For the production of fine chemicals, organolytic compounds serve as a solid and reagents for the formation of carbon-carbon bonds. Organolytic compounds are provided from lithium metal and alkyl halides. [148] Many other lithium compounds are used as reagents to provide organic organics Some popular compounds include lithium aluminum hydrants (LiAlH4), lithium triethylborohydride, n-butyllithium and tert-butyllithium usually used as a very strong base called superbases. Torpedo launches use lithium as a military application of Metallic lithium fuel and its complex hydrants, such as Li[AlH4], are used as high-power auxiliations for rocket propellants. [17] Lithium aluminum hydrants can also be used by themselves as solid fuels. [149] The Mark 50 torpedo stores a chemical power generation system (SCEPS) using a small tank of hexafluoride sulfur gas, which is scattered over solid lithium blocks. The reaction generates heat, creating a team to propel torpedoes in a closed Rankine cycle. [150] Lithium hydrants containing lithium-6 are used in thermonuclear weapons, where they serve as a firearm for the combined rating of bombs. [151] The Lithium-6 nucleus is considered a source material for tritium production and as a neutron absorber in the nucleus combined. Natural lithium contains approximately 7.5% lithium-6 from which a large amount of lithium-6 is produced by isotope separation for use in nuclear weapons. [152] Lithium-7 gained interest for use in nuclear reactor cooling. [153] Lithium deuteride is used as a fuel in Castle Bravo nuclear devices. Lithium deuteride is the combined fuel of choice in early versions of hydrogen bombs. When showered by neutrons, both 6Li and 7Li produce tritium - this reaction, which was not fully understood when the hydrogen bomb was first tested, is responsible for the results of the Castle Bravo nuclear test run. Tritium fius with deuterium in a combined reaction is rather easy to achieve. Although the granules remain secret, lithium-6 deuterides still appear to play a role in modern nuclear weapons as a combined material. [154] Lithium fluoride, when highly enriched in lithium-7 isotopes, forms the base of the LiF-BeF2 fluoride salt mixture used in liquid fluoride nucleus reactors. Lithium fluoride is chemically stable and the LiF-BeF2 mixture has a low melting point. In addition, 7Li, Be, and F are among several nucleides with heat neutron capture low enough not to poison fision reactions inside nuclear fision reactors. [note 3] [155] In the conceptal nucleus combined power plant (hypothesis), lithium will be used to produce tritium in caged magnetic reactors using deuterium and tritium as fuel. Naturally applicable tritium is extremely rare, and must be produced synthetically by circling the plasma in response to a lithium-containing 'blanket' in which neutrons from the deuterium-tritium reaction in plasma will fision lithium to produce more tritium: 6Li + n → + 3H. Lithium is also used as a source of alpha zarah, or helium nucleus. When 7Li is rained by accelerated Protons 8Be, which undergoes fision to form two two Particles. This feat, called breaking the atom at the time, was the first fully man-made nuclear reaction. It was produced by Cockroft and Walton in 1932. [156] In 2013, the US Government Accountability Office said the lack of lithium-7 was critical of the operation of 65 of the 100 American nuclear reactors placing their ability to continue providing electricity at some risk. Castle Bravo first used lithium-7, in Shrimp, its first device, which weighed just 10 tons, and generated massive nuclear atmospheric pollution of Bikini Atoll. This may include a decline in US nuclear infrastructure. [158] The equipment needed to separate lithium-6 from lithium-7 is mostly cold war waste. The US closed most of these machinery in 1963, when it had a large surprich of separate lithium, most of which were consumed in the twentyth century. The report said it would take five years and $10 million to $12 million to reestablish the ability to separate lithium-6 from lithium-7. [159] Reactors using lithium-7 heat water under high pressure and transfer heat through heat converters exposed to corrosion. The reactor uses lithium to overcome the corrosive effects of bored acid, which is added to the water to absorb excess neutrons. [159] Major medicinal articles: Lithium (medicine) Lithium is useful in the treatment of bipolar disorders. [160] Lithium Salt can also help for related diagnoses, such as calzoaffective disorders and major cycle depression. The active part of this salt is lithium ion Li+. [160] They can increase the risk of developing Ebstein's heart anomaly in babies born to women taking lithium during the first trimester of pregnancy. [161] Lithium has also been studied as a possible treatment for cluster headaches. [162] Biological roles See also: Lithium (medicine) The main food source of lithium is cereals and vegetables, and, in some areas, drinking water also contains large amounts. [163] Human intake varies depending on location and diet. Lithium was first detected in human organs and fetal tissue in the late 19th century. In humans there are no defined lithium deficiency diseases, but low lithium intake from water supply is associated with increased suicide rates, homicides and arrest rates for drug and other criminal use. The biochemical mechanisms of lithium action appear multifactorial and intertdeptional to the functioning of several enzymes, hormones and vitamins, as well as with growth and transformation factors. The precautionary Measures lithium Hazards GHS pictogram GHS Signals the word Danger GHS hazard statement H260, H314 GHS precautions P223, P231+232, P280, P305+351+338, P370+378, P422[164] NFPA 704 (diamond fire) [165] 2 3 2W Lithium is eroding and requires special handling to avoid skin contact. Respiratory lithium dust or lithium compounds (which (which alkaline) initially smooths the nose and throat, while higher exposure can lead to the formation of fluid in the lungs, leading to pulmonary edema. The metal itself is a control hazard because its relationship with moisture produces caustic lithium hydroxide. Lithium is safely stored in incomactive cases such as naphtha. [166] See also lithium dilithium halo nucleus isotopes from the list of national lithium by lithium-air production of Lithium batteries as an investment of Lithium Lithium Combustion Attachment (category) Lithium-ion battery Organolithium reagent Note ^b Appendix Archive November 6, 2011 in the Wayback Engine. By the USGS definition, the reserve base may include parts of the resource that have reasonable potential to be available in terms of economy in a period of planning beyond those who consider technology proven and current economics. Reserve principles include sources that are now economic (reserves), few economies (marginal reserves), and some that are now subeconomic (subeconomic sources). ^ In 2013 ^ Beryllium and fluorine apply as only one isotope, 9Be and 19F. Both, together with 7Li, as well as 2H, 11B, 15N, 209Bi, and stable isotopes C, and O, are the only nucleides with low enough heat neutron capture to be set off from actinides to serve as the main juzuk of melted salt peterak Reference ^ Weast, Robert (1984). CRC, Chemical and Physical Handbook. Boca Raton, Florida: Chemical Rubber Company Publishes. Pp. E110. ISBN 0-8493-0464-4. ↑ b Data set from: Lodders, Katharina (10 July 2003). Multiple Solar System and Continental Temperature Picker Elements (PDF). Astrophysical Journal. American Astronomical Union. 591 (2): 1220–1247. Bibcode:2003ApJ ... 591.1220L. doi:10.1086/375492. Archived from origin (PDF) on November 7, 2015. Retrieved 1 September 2015.CS1 main: ref=harv (link) Grafed in File:SolarSystemAbundances.jpg ^ Nuclear Weapon Design. American Scientific Alliance (October 21, 1998). fas.org ^ a b d e f g Krebs, Robert E. (2006). History and Use of Our Earth's Chemical Elements: Reference Guide. Westport, Conn.: Greenwood Press. ISBN 978-0-313-33438-2. ↑ Huang, Chuanfu; Kresin, Vitaly V. (Jun 2016). Note: Pollution is free to load lithium metal into the source of the muncung. Scientific Instrument Study. 87 (6): 066105. Bibcode:2016RScI ... 87f6105H. doi:10.1063/1.4953918. ISSN 0034-6748. PMID 27370506. ↑ Addison, C. C. (1984). Liquid alkali metal chemistry. Chichester [West Sussex]: Wiley. ISBN 978-0471905080. OCLC 10751785. ↑ Lide, D. R., ed. (2005). CRC Chemical and Physical Manual (86th ed.). Boca Raton (FL): CRC Press. ISBN 0-8493-0486-5. ↑ Ia Elemental - Lithium Element. education.jlab.org. ^ Nitrogen, N2, property, safety, MSDS, enthalpy, material harmony, gas liquid balance, density, fatigue, inflammation, transport properties. Encyclopedia.airliquide.com. Archived from the original on July 21, 2011. Retrieved 29 September 2010. ↑ Linear Development Multiplier. Engineering Tool Box. Archived from the original on November 30, 2012. Retrieved 2011-01-09. ↑ Tuoriniemi, Juha; Juntunen-Nurmilaukas, Kirsi; Uusvuori, Johanna; Pentti, Elias; Salmela, Anssi; Sebedash, Alexander (2007). Superconductivity in lithium is below 0.4 millikelvin at ambient pressure. Nature. 447 (7141): 187–9. Bibcode:2007Natur.447.. 187T. doi:10.1038/nature05820. PMID 17495921. Archived from the original on 25 June 2019. Retrieved 20 April 2018. ↑ Struzhkin, V. V.; Eremets, M. I.; Gan, W; Mao, H. K.; Hemley, R. J. (2002). Superconductivity in solid lithium. Science. 298 (5596): 1213–5. Bibcode:2002Sci ... 298.1213S. doi:10.1126/science.1078535. PMID 12386338. ↑ Overhauser, A. W. (1984). Lithium Crystal Structure at 4.2 K. Physical Review Letter. 53 (1): 64–65. Bibcode:1984PhRvL.. 53...64O. doi:10.1103/PhysRevLett.53.64. ↑ Schwarz, Ulrich (2004). High pressure modification of the metal elements of the main group. Zeitschrift für Kristallographie. 219 (6–2004): 376–390. Bibcode:2004ZK.... 219..376S. doi:10.1524/zkri.219.6.376.34637. ↑ a b e e g Hammond, C. R. (2000). Elements, in the Chemistry and Physical Handbook (81st ed). CRC press. ISBN 978-0-8493-0481-1. [page required] ^ SOLID SPECIAL HEAT. bradley.edu ^ a b d e g Emsley, John (2001). Natural Building Blocks. Oxford: Oxford University Press. ISBN 978-0-19-850341-5. ↑ a b d Kamienski, Conrad W.; McDonald, Daniel P.; Stark, Marshall W.; Papcun, John R. (2004). Lithium and lithium compounds. Kirk-Othmer Chemical Technology Encyclopedia. John Wiley & Sons, Inc. doi:10.1002/0471238961.1209200811011309.a01.pub2. ISBN 978-0471238966. ↑ XXIV.—On chemical analysis by spectrum observation. London Chemical Union Annual Tribal Journal. 13 (3): 270. 1861. doi:10.1039/QJ8611300270. ↑ Krebs, Robert E. (2006). History and use of the chemical elements of our earth: reference guide. Greenwood Publishing Group. p. 47. ISBN 978-0-313-33438-2. Archived from the original on 4 August 2016. ↑ Institute, American Geology; Unity, Geophysical America; Society, Geochemistry (January 1, 1994). International geochemistry. 31 (1–4): 115. Archived from the original on 4 June 2016. Cite Journal requires |journal= (help) ^ Greenwood, Norman N.; Earnshaw, Alan (1984). Chemical Elements. Oxford: Pergamon Press. Pp. 97–99. ISBN 978-0-08-022057-4. Cite has an unknown parameter blank: |1= (help) ^ Beckford, Floyd. University of Lyon online course (powerpoint) slideshow. Archived from the original on November 4, 2005. Retrieved 2008-07-27. definition:Slide 8-10 (Chapter ↑ Bretislav Friedrich (8 April 2013). APS physical. It's physical. 6: 42. Archived from the original on December 20, 2016. ↑ Sapse, Anne-Marie & von R. Schleyer, Paul (1995). Lithium chemistry: an overall overview of theory and experimentation. Wiley-IEEE. Pp. 3-40. ISBN 978-0-471-54930-7. Archived from the original on 31 July 2016. ↑ Nichols, Michael A.; Williard, Paul G. (February 1, 1993). Solid state structures n-butyllithium-TMEDA, -THF, and -DME complexes. Journal of the American Chemical Union. 115 (4): 1568–1572. doi:10.1021/ja00057a050. ISSN 0002-7863. ↑ C., Mehrotra, R. (2009). Organometallic chemistry : a unified approach. [Unknown place of publication]: New Age International Pvt. ISBN 978-8122412581. OCLC 946063142. ↑ Isotopes of Lithium. Berkeley National Laboratory, The Isotopes Project. Archived from the original on May 13, 2008. Retrieved 2008-04-21. ↑ Fail:Binding power curves - regular isotopes.svg show the binding power of the nuclides stable graphically; data set source is given in the background of the number. ↑ Sonzogni, Alejandro. Nuclides Interactive Chart. National Nuclear Data Center: Brookhaven National Laboratory. Archived from the original on 23 July 2007. Retrieved 2008-06-06. ↑ Asplund, M.; ET al. (2006). Lithium Isotopic Lot in Metal-poor Halo Stars. Astrophysical Journal. 644 (1): 229–259. arXiv:astro-ph/0510636. Bibcode:2006ApJ ... 644..229A. doi:10.1086/503538. ↑ Chaussidon, M.; Robert, F.; McKeegan, K. D. (2006). Isotopic variations of Li and B in Allende CAI: Evidence− for damage situ short 10Be and for the possible presence of short nuclide 7Be in the initial solar system (PDF). Geochimica et Cosmochimica Acta. 70 (1): 224–245. Bibcode:2006GeCoA.. 70..224C. doi:10.1016/j.gca.2005.08.016. Archived from the original (PDF) on 18 July 2010. ↑ Denissenkov, P. A.; Weiss, A. (2000). The production of lithium episodes with the addition of mixing red gergasi. Astronomy and Astrophysics. 358: L49–L52. arXiv:astro-ph/0005356. Bibcode:2000A& A... 358L.. 49D. ↑ Seitz, H. M.; Brey, G. P.; Lahaye, Y.; Durali, S.; Weyer, S. (2004). Isotopic signatures of lithium peridotite xenoliths and isotopic fractions at high temperatures between olivines and pyroxenes. Chemical Geology. 212 (1–2): 163–177. Bibcode:2004ChGeo.212.. 163S. doi:10.1016/j.chemgeo.2004.08.009. ↑ Duarte, F. J (2009). Tunnel Laser Application. CRC Press. p. 330. ISBN 978-1-4200-6009-6. ↑ a Coplen, T. B.; Bohlke, J. K.; De Bievre, P.; Ding, T.; Holden, N. E.; Hopple, J. A.; Krouse, H. R.; Lamberty, A.; Peiser, H. S.; ET al. (2002). Isotope variations–many selected elements (IUPAC Technical Report). Pure Chemistry and Use. 74 (10): 1987. doi:10.1351/pac200274101987. ↑ Truscott, Andrew G.; Strecker, Kevin E.; McAlexander, William I.; Partridge, Guthrie B.; Hulet, Randall G. (March 30, 2001). Fermi pressure in the Trapped Atomic Gas. Science. 291 (5513): 2570–2572. Bibcode:2001Sci ... 291.2570T. doi:10.1126/science.1059318. ISSN 0036-8075. PMID 11283362. ↑ Multiple Elements (PDF). Archived from the original (PDF) on September 1, 2006. Retrieved 2009-11-17. ↑ Boesgaard, A. M.; Steigman, G. (1985). Big bang nucleosynthesis - Theory and observation. Annual Study of Astronomy and Astrophysics. Palo Alto, CA. 23: 319-378. Bibcode:1985ARA&A.. 23..319B. doi:10.1146/annurev.aa.23.090185.001535. A86-14507 04-90. ↑ Woo, Marcus (February 21, 2017). The Cosmic Explosion the Universe Created. Earth. The BBC archived from the original on 21 February 2017. Retrieved 21 February 2017. A mystery cosmic refinery produces lithium. Scientists are now getting closer to knowing where it came from ^ Cain, Fraser (16 August 2006). Why The Old Star Seems To Lack Lithium. Archived from the original on 4 June 2016. ↑ First Lithium Testing of The Erupting Star. Archived from the original on August 1, 2015. Retrieved 29 July 2015. ↑ Fabric, Fraser. Brown Dwarf. The Universe Today. Archived from the original on February 25, 2011. Retrieved 2009-11-17. ↑ Reid, Neill (10 March 2002). The Classification of Dwarf L. Archived from the original on May 21, 2013. Retrieved 2013-03-06. ↑ Arizona State University (Jun 1, 2020). The brilliant blast class is found in lithium galaxy manufacturers. EurekAlert!. Retrieved 2 June 2020. ↑ Starrfield, Sumner; ET al. (May 27, 2020). Carbon-Oxygen Novae Classic Is a Galactic 7Li Manufacturer as well as the Potential of Supernova Ia Progenitors. Astrophysical Journal. 895 (1). arXiv:1910.00575. doi:10.3847/1538-4357/ab8d23. ↑ Lithium events. Institute of Ocean Energy, Saga University, Japan. Archived from the original on May 2, 2009. Retrieved 2009-03-13. ↑ b Some Facts about Lithium. ENC Laboratory. Archived from the original on 10 July 2011. Retrieved 2010-10-15. ↑ Schwochau, Klaus (1984). Metal welding from seawater. Inorganic chemistry. Topics in Current Chemistry. 124. Springer Berlin Heidelberg. Pp. 91–133. doi:10.1007/3-540-13534-0_3. ISBN 978-3-540-13534-0. ↑ lithium. Encyclopedia of Britannica. ↑ Atkins, Peter (2010). Shriver Inorganic Chemistry & Atkins (5th ed.). New York: W. H. Freeman and company. p. 296. ISBN 978-0199236176. ↑ Mindat.org - Mines, Minerals and More. www.mindat.org. Archived from the original on April 22, 2011. Retrieved 4 August 2019. ↑ Moores, S. (Jun 2007). Between the stone and the salt lake. Industrial Minerals. 477: 58. ↑ Taylor, S. R.; McLennan, S.M.; Continental crust: Composition and evolution, Blackwell Sci. Publ., Oxford, 330 pp. (1985). Quoted in Many elements (data pages) ^ Garrett, Donald (2004) Natural Lithium and Calcium Handbook, Academic Press, Quoted in Trouble with Lithium 2Rkibkan 14 2011 at the Wayback Machine, Meridian International Research (2008) ↑ Clarke, G.M. and Harben, P.W., Lithium Availability Wall Map. Published in June 2009. Referred to in the International Lithium Alliance Archived October 20, 2012 at Archive.today^a b e f Lithium Statistics and Information, the 2018 United States Geological Survey, archived from the original on March 3, 2016, was taken July 25, 2002^b Problems with Lithium 2 (PDF). Meridian International Research. 2008. Archived from the original (PDF) on July 14, 2011. Retrieved 29 September 2010. ↑ Czech Geological Survey (October 2015). Mineral Commodity Summary czech republic 2015 (PDF). Prague: Czech Geological Review. p. 373. ISBN 978-80-7075-904-2. Archived (PDF) from the original on January 6, 2017. ↑ Ore reserves grow Finland's lithium deposits by 50%. 2019. ↑ Rise, James (Jun 13, 2010). U.S. Recognizes Vast Mineral Wealth in Afghanistan. The New York Times. Archived from the original on 17 June 2010. Retrieved 2010-06-13. ↑ Page, Jeremy; Evans, Michael (June 15, 2010). The mineral wealth of the Taleban zone may rival Saudi Arabia's, the Pentagon said. Time. London. Archived from the original on May 14, 2011. ↑ Morris, Steven (January 20, 2017). The mining firm hopes to extract lithium from Cornwall's hot springs. Guard. p. 31. ↑ Chassard-Bouchaud, C.; Galle, P.; Escaig, F.; Miyawaki, M. (1984). Bioaccumulation of lithium by marine organisms in the coastal zones of Europe, the Americas, and Asia: microanalitic studies using secondary ion release. Comptes Rendus de l'Académie des Sciences, Série III. 299 (18): 719–24. PMID 6440674. ↑ D'Andraba (1800). Des caractères et des propriétés de plusieurs nouveaux minérauxde Suède et de Norwège, avec quelques. Journal de Physique, de Chimie, d'Histoire Naturelle, et des Arts. 51: 239. Archived from the original on 13 July 2015. ↑ Petalite Mineral Information. Mindat.org. Archived from the original on February 16, 2009. Retrieved 10 August 2009. ↑ a b c e f g Lithium:Historical information. Archived from the original on October 16, 2009. Retrieved 10 August 2009. ↑ Sunday, Mary (2003). Discovery of The Elements. Whitefish, Montana, United States: Kessinger Publishing. p. 124. ISBN 978-0-7661-3872-8. Retrieved 10 August 2009. ↑ Berzelius (1817). Ein neues mineralisches Alkali und ein neues Metall. Journal für Chemie und Physik. 21: 44–48. Archived from the original on December 3, 2016. From p. 45: Herr August Arfwedson, ein junger sehr verdienstvoller Chemiker, der seit einem Jahre in meinem Laboratorie arbeitet, fand bei einer Analyse des Petalits von Uto's Eisengrube, einen alkalischen Bestandtheil, ... Wir haben es Lithion genannt, um dadurch auf seine erste Entdeckung im Mineralreich anzuspielen, da die beiden anderen erst in der Natur entdeckt wurden. Sein Radical wird und Lithium genannt werden. (Mr. August Arfwedson, a young, highly skilled chemist, who had been working in my lab for a year, was discovered during petalite analysis of the Uto iron mines, an alkaline component ... We have named it lithion, to claim with it its first discovery in the realm of minerals, since both were first found in organic properties. His radicals would then be called lithium.) ↑ Johan August Arfwedson. Periodic schedule live!. Archived from the original on October 7, 2010. Retrieved 10 August 2009. ↑ Johan Arfwedson. Archived from the original on 5 June 2008. Retrieved 10 August 2009. ↑ a b van der Krogt, Peter. Lithium. Elementymology & Elements Multidict. Archived from the original on 16 June 2011. Retrieved 2010-10-05. ↑ Clark, Jim (2005). 1 Element Group. Archived from the original on 11 March 2009. Retrieved 10 August 2009. ↑ View: Arwedson, August (1818) Undersökning af några vid Utö Jernmalmsbrott förekommende Fossilier, och af ett deri funnet eget Eldfast AlkaliRkibkan 25 November 2017 at Wayback Machine, Afhandlingar i Fysik, Kemi och Mineralogy, 6 : 145-172. (in Swedish) Arwedson, Aug. (1818) Untersuchung einiger bei der Eisen-Grube von Utö vorkommenden Fossilien und von einem darin gefundenen neuen feuerfesten Alkali (Investigation of some minerals applicable in utö iron mines and refractory alkalis found in them), Journal für Chemie und Physik, 22 (1) : 93–117. (in German) ↑ Gmelin, C. G. (1818). Von dem Lithon [On lithium]. Annalen der Physik. 59 (7): 238–241. Bibcode:1818AnP.... 59..229G. doi:10.1002/andp.18180590702. Archived from the original on November 9, 2015. p. 238 Es löste sich in diesem ein Salz auf, das der Luft zerfloss, und nach Art der Strontiansalze den Arak mit einer purpurrothen Flamme brennen machte. (There is a dispersion in this [solvent; that is, absolute alcohol] salts that are aligned in the air, and by way of strontium salts, causing alcohol to burn with a red-purple flame.) ↑ b Enghag, Per (2004). Encyclopedia of Elements: Technical Data – History – Processing – Application. Wiley. Pp. 287–300. ISBN 978-3-527-30666-4. ↑ Brande, William Thomas (1821) Chemistry Manual, 2 ed. London, England: John Murray, vol. 2, pp. 57-58. Archived 22 November 2015 in The Wayback Machine ^ Various writers (1818). Annual tribal science and arts journal. Journal of Tribal Science and Royal British Institute of Art. 5: 338. Retrieved 2010-10-05. ↑ Timeline science and engineering. Encyclopedia of Science DiracDelta & Engineering. Archived from the original on December 5, 2008. Retrieved 2008-09-18. ↑ Brande, William Thomas; MacNeven, William James (1821). Chemical manual. Long. p. 191. Retrieved 2010-10-08. ^ R. (1855). Darstellung des Lithiums. Annalen der Chemie und Pharmacie. 94: 107–111. doi:10.1002/jlac.18550940112. Archived from the original on November 6, 2018. Retrieved 13 August 2015. ↑ Green, Thomas (June 11, 2006). Lithium Element Analysis. echeat. Archived from the original on April 21, 2012. ↑ Garrett, Donald E. (April 5, 2004). Lithium and Calcium Natural Chloride guidebook. p. 99. ISBN 9780080472904. Archived from the original on December 3, 2016. ↑ Shorter, Edward (Jun 2009). History of lithium therapy. Bipolar disorder. 11 (Suppl 2): 4–9. doi:10.1111/j.1399-5618.2009.00706.x. ISSN 1398-5647. PMC 3712976. PMID 19538681. ↑ b Ober, Joyce A. (1994). Commodity Report 1994: Lithium (PDF). U.S. Geological Survey. Archived (PDF) from the original on 9 June 2010. Retrieved 2010-11-03. ↑ Deberitz, Jürgen; Boche, Gernot (2003). Lithium und seine Verbindungen - Industrielle, medizinische und wissenschaftliche Bedeutung. Chemie in Unserer Zeit. 37 (4): 258–266. doi:10.1002/ciuz.200300264. ↑ Bauer, Richard (1985). Lithium - wie es nicht im Lehrbuch steht. Chemie in Unserer Zeit. 19 (5): 167–173. doi:10.1002/ciuz.19850190505. ↑ Ober, Joyce A. (1994). Minerals Yearbook 2007 : Lithium (PDF). U.S. Geological Survey. Archived (PDF) from the original on 17 July 2010. Retrieved 2010-11-03. ↑ Kogel, Jessica Elzea (2006). Lithium. Industrial minerals & commodities, markets, and usability. Littleton, Colo.: A Union for Mining, Metallurgy, and Exploring. p. 599. ISBN 978-0-87335-233-8. ↑ McKetta, John J. (July 18, 2007). Encyclopedia of Chemical Processing and Design: Volume 28 - Lactic Acid to Magnesium Supply-Demand Relationship. M. Dekker. ISBN 978-0-8247-2478-8. Archived from the original on May 28, 2013. ↑ Overland, Indra (1 March 2019). Renewable energy geopolitics: Dismantling four emerging myths (PDF). Energy & Research Social Science. 49: 36–40. doi:10.1016/j.erss.2018.10.018. ISSN 2214-6296. ↑ Greenwood, Norman N.; Earnshaw, Alan (1997). Chemical Elements (2nd ed.). Butterworth-Heinemann. p. 73. ISBN 978-0-08-037941-8. ↑ b Martin, Richard (8 Jun 2015). Quest to Mine Seawater for Lithium Advances. MIT Technology Study. Retrieved 10 February 2016. ↑ Tarascon, J. M. (2010). Is there a new gold lithium? Natural Chemistry. 2 (6): 510. Bibcode:2010NatCh ... 2..510T. doi:10.1038/nchem.680. PMID 20489722. ↑ Wood, Todd (October 19, 2011). Lithium: New California Gold Rush. Forbes. Archived from the original on December 19, 2014. ↑ Houston, J.; Butcher, A.; Ehren, P.; Evans, K.; Godfrey, L. (2011). Brine Prospect Assessment and Modification Requirements to Filing Standards (PDF). Economic Geology. 106 (7): 1225–1239. doi:10.2113/econgeo.106.7.1225. Archived (PDF) from the original on 20 July 2018. Achieved 28 2019. ↑ Vikström, H.; Davidsson, United States; Höök, M. (2013). Lithium availability and future spending prospects. Power. 110 (10): 252–266. doi:10.1016/j.apenergy.2013.04.005. Archived from the original on October 11, 2017. Retrieved 11 October 2017. ↑ Grosjean, P.W.; Medina, P.A.; Ole, G.A.; Kesler, S.E.; Everson, M.P; Wallington, T.J. (2011). Global Lithium Availability: Restraints for Electric Vehicles?. Journal of Industrial Ecology. 15 (5): 760–775. doi:10.1111/j.1530-9290.2011.00359.x. hdl:2027.42/87046. ↑ Halpern, Abel (January 30, 2014). Lithium Triangle. Latin trade. Archived from the original on 10 June 2018. ↑ b Romero, Simon (February 2, 2009). In Bolivia, Tight Grip on the Next Big Source. The New York Times. Archived from the original on July 1, 2017. ↑ USGS Mineral Commodity Summary 2009 (PDF). Usgs. Archived (PDF) from the original on 14 June 2010. ↑ Jaskula, Brian W. (January 2020). Mineral Commodity 2020 (PDF) Overview. The U.S. Geological Survey was reached on June 29, 2020. ↑ Wang Game Contributor (April 26, 2013). New Wyoming Lithium Deposit. Business People. Archived from the original on May 3, 2013. ↑ Wadia, Cyrus; Albertus, Paul; Srinivasan, Venkat (2011). Source restraints on potential battery power storage for grid and transport applications. Power Source Journal. 196 (3): 1593–8. Bibcode:2011JPS ... 196.1593W. doi:10.1016/j.jpowsour.2010.08.056. ↑ Profit, LL.; Nelson, P. (2010). Lithium-Ion Batteries: Checking Material Demand and Recycling Issues. Argonne National Laboratory. Archived from the original on 3 August 2016. Retrieved 11 June 2016. ↑ University of Michigan and Ford researchers looked at many lithium sources for electric vehicles. Green Train Congress. August 3rd, 2011. Archived from the original on September 16, 2011. ↑ Precious Mobile Metals. Financial experts. Credit Suisse. Jun 9, 2014. Archived from the original on February 23, 2016. Retrieved 19 June 2014. ↑ Plateau Energy Metals Peru unit finds a large source of lithium. Reuters. July 16, 2018. Archived from the original on 26 July 2018. ↑ Enamie Yang; Zhang's fans; Huaiping Ding; Ping Dia (September 19, 2018). Lithium Metal Welding from Seawater. Joule. Elsevier. 2 (9): 1648–1651. doi:10.1016/j.joule.2018.07.006. Retrieved 21 October 2020. ↑ Ober, Joyce A. Lithium (PDF). U.S. Geological Survey. Pp. 77–78. Archived (PDF) from the original on 11 July 2007. Retrieved 19 August 2007. ↑ SQM Announces New Lithium Price - SANTIAGO, Chile. PR Newswire. September 30th, 2009. Archived from the original on May 30, 2013. ↑ b Riseborough, Jesse. IPad Boom Strains Lithium Supplys After Prices Triple. Bloomberg BusinessWeek. Archived from the original on 22 June 2012. Retrieved 2013-05-01. ↑ Cafariello, Yusuf (10 March 2014). Lithium: Long-Term Investment Buys Lithium!. from the original on 12 June 2018. Receptioned 24 April 2015. ^ Kaskey, Jack (July 16, 2014). The Biggest Lithium Deal Triggered by SmartPhones and Teslas. bloomberg.com. Archived from the original on 12 June 2018. Receptioned 24 April 2015. ^ Marcelo Azevedo, Nicolò Campagnol, Toralf Hagenbruch, Ken Hoffman, Ajay Lala, Oliver Ramsbottom (June 2018). Lithium and cobalt – the story of two commodities. McKinsey. p. 9. Receded on January 29, 2020.CS1 main: various names: writer list (link) ^ Parker, Ann. Mining Geothermal Resources Archived September 17, 2012 on Wayback Machine. Lawrence Livermore National Laboratory ^ Patel, P. (16 November 2011) Startup for Catching Lithium from Geothermal Plants. technologyreview.com Od) Wald, M. (28 September 2011) Start-Up at the California Plans to Capture Lithium, and Market Share Archived April 8, 2017 at Wayback Machine. The New York Times ^ How To Invest in Lithium. commodityhq.com. Archived from the original on April 11, 2015. Receptioned 24 April 2015. ^ b Lithium (PDF). 2016. Archived (PDF) from the original on 30 November 2016. Receded on November 29, 2016 – through the United States Geological Survey (USGS). ^ Fmclithium.com (PDF). www.fmclithium.com. Archived from the original (PDF) on 7 September 2014. ^ Clark, Jim (2005). Several Group Compounds 1 Elements. chemguide.co.uk. Archived from the original on 27 June 2013. Reception on 8 August 2013. ^ Disposable Battery - Choosing between Alkali and Lithium Disposable Batteries. Batteryreview.org. Archived from the original on 6 January 2014. Receptioned October 10, 2013. ^ Battery Anodes > Batteries & Material Cells > Research > Energy Materials Centre in Cornell. Emc2.cornell.edu. Archived from the original on 22 December 2013. Receptioned October 10, 2013. ^ Totten, George E.; Westbrook, Steven R. & Shah, Rajesh J. (2003). Fuel and handbook lubricants: technology, real estate, performance, and testing. 1. International ASTM. p. 559. ISBN 978-0-8031-2096-9. Archived from the original on 23 July 2016. ^ Rand, Salvatore J. (2003). The importance of testing for petroleum products. INTERNATIONAL ASTM. pp. 150-152. ISBN 978-0-8031-2097-6. Archived from the original on 31 July 2016. ^ Mold Fluxes Theory and Practice Used in Continuous Casting: Compilation of Paperwork On Continuous Casting Fluxes Given at the 61st and 62nd Steel Conference, Iron and Community Steel ^ Lu, Y. Q.; Zhang, G. D.; Jiang, M. F.; Liu, H. X.; Li, T. (2011). Effects of Li2CO3 on Mold Flux Properties for High Speed Continuous Casting. Material Science Forum. 675–677: 877–880. doi:10.4028/www.scientific.net/MSF.675-677.877. ^ Test 1-2-3: Eliminating Vein Defects, Modern Casting, July 2014, archived from the original on April 2, 2015, taken March 15, 2015 ^ Haupin, W. (1987), Mamantov, Gleb; Marassi, Roberto (eds.), Chemical and physical properties Electrolyte, Molten Salt Chemistry: Introduction and Selected Applications, Springer, p. 449 ↑ Garrett, Donald E. (April 5, 2004). Lithium and Calcium Natural Chloride guidebook. Academic Newspapers. p. 200. ISBN 9780080472904. Archived from the original on December 3, 2016. ↑ Prasad, N. Eswara; Gokhale, Amol; Wanhill, R. J. H. (September 20, 2013). Aluminum-Lithium Alloy: Processing, Property and Application. Butterworth-Heinemann. ISBN 9780124016798. ↑ Davis, Yusuf R. ASM International. Handbook Committee (1993). Aluminum and aluminum alloys. ASM International. Pp. 121–. ISBN 978-0-87170-496-2. Archived from the original on May 28, 2013. Retrieved 2011-05-16. ↑ Karki, Khim; Epstein, Eric; Cho, Jeong-Hyun; Jia, Zheng; Li, Teng; Picraux, S. Tom; Wang, Chunsheng; Cumings, John (2012). Lithium-Assisted Electrochemical Welding in Silicon Nanowire Battery Electrodes (PDF). Nano's letter. 12 (3): 1392–7. Bibcode:2012NanoL.. 12.1392K. doi:10.1021/nl204063u. PMID 22339576. Archived (PDF) from the original on 10 August 2017. ↑ Koch, Ernst-Christian (2004). Typical Ingredients in Pyrotechnics: III. Use of Lithium and Its Compounds in Powered Systems. Propellants, Explosive Materials, Pyrotechnics. 29 (2): 67–80. doi:10.1002/prep.200400032. ↑ Wiberg, Egon; Wiberg, Nils and Holleman, Arnold Frederick (2001) Chemical Inorganic Archived 18 Jun 2016 at The Wayback Machine, Academic Newspaper. ISBN 0-12-352651-5, p. 1089 ↑ Mulloth, L.M. & Finn, J.E. (2005). Air Quality System for Space Symbolized Related: SpaceShip Air. Environment Chemistry Handbook. 4H. pp. 383–404. doi:10.1007/b107253. ISBN 978-3-540-25019-7. ↑ Use of lithium chemicals for manned spaceship air re-generation. Lithium Corporation of America & Aerospace Medical Research Laboratories. 1965. Archived from the original on October 7, 2012. ↑ Markowitz, M. M.; Boryta, D. A.; Stewart, Harvey (1964). Lithium Perchlorate Oxygen Candle. Pyrochemical Source of Pure Oxygen. Investigation and Development of Industrial Chemical Products & Engineering. 3 (4): 321–30. doi:10.1021/i360012a016. ↑ Hobby, Philip C. D. (2009). Building an Electro-Optical System: Making It All Work. John Wiley and the Kids. p. 149. ISBN 978-0-470-40229-0. Archived from the original on 23 June 2016. ↑ Eye Defects in Lithium Fluoride Films Driven by Gamma Irradiation. Proceedings of the 7th International Conference on Advanced Technology & Physical Zarah: (ICATPP-7): Villa Olmo, Como, Italy. 2001. World Scientists. 2002. p. 819. ISBN 978-981-238-180-4. Archived from the original on 6 June 2016. ↑ Sinton, William M. (1962). Influsered Spectroscopy of Planets and Stars. Optical Use. 1 (2): 105. Bibcode:1962ApOpt ... 1..105S. doi:10.1364/AO.1.000105. ↑ You have power: battery evolution and the future of fire cell (PDF). Toshiba. Archived (PDF) from the original on 17 July Retrieved 2009-05-17. ↑ Organometallics. IHS Chemicals. February 2012. Archived from the original on 7 July 2012. Retrieved 2 January 2012. ↑ Yurkovetskii, A. V.; Kofman, V. L.; Makovetskii, K. L. (2005). Polymerization of 1,2-dimethylenecyclobutane by organolithic beginners. Russian Chemistry Bulletin. 37 (9): 1782–1784. doi:10.1007/BF00962487. ↑ Quirk, Roderic P.; Cheng, Pao Luo (1986). Function of polymer organolithic compounds. Poly amination (styryl)lithium. Macromolecules. 19 (5): 1291–1294. Bibcode:1986MaMol.. 19.1291Q. doi:10.1021/ma00159a001. ↑ Stone, F. G. A.; West, Robert (1980). Advances in organometallic chemistry. Academic Newspapers. p. 55. ISBN 978-0-12-031118-7. ↑ Bansal, Raj K. (1996). Synthetic approach in organic chemistry. p. 192. ISBN 978-0-7637-0665-4. Archived from the original on 18 June 2016. ↑ Wayback Machine (PDF). Jun 28th, 2003. Archived from the original (PDF) on 28 June 2003. Cite uses generic headers (help) ^ Hughes, T.G.; Smith, R.B. & Kiely, D.H. (1983). Chemical Power Generation System Stored for Underwater Applications. Energy Journal. 7 (2): 128–133. Bibcode:1983JEner ... 7..128H. doi:10.2514/3.62644. ↑ Emsley, John (2011). Natural Building Blocks. ↑ Makhijani, Arjun & Yih, Katherine (2000). Nuclear Waste: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects. MIT Press. Pp. 59–60. ISBN 978-0-262-63204-1. Archived from the original on 13 June 2016. ↑ U.S. National Research Council. Sequestration and Transmutation Technology Systems Committee (1996). Remaining nucleus: technology for separation and transmutation. National Academy newspaper. p. 278. ISBN 978-0-309-05226-9. Archived from the original on 13 June 2016. ↑ Barnaby, Frank (1993). How nuclear weapons spread: the germination of nuclear weapons in the 1990s. Routledge. p. 39. ISBN 978-0-415-07674-6. Archived from the original on 9 June 2016. ↑ Baesjr, C. (1974). Chemical and thermodynamic fuels of moon salt reactors. Journal of Nuclear Materials. 51 (1): 149–162. Bibcode:1974JNuM ... 51..149B. doi:10.1016/0022-3115(74)90124-X. OSTI 4470742. ↑ Agarwal, Arun (2008). Nobel Prize winner in Physics. Issuance of APH. p. 139. ISBN 978-81-7648-743-6. Archived from the original on 29 June 2016. ↑ 'Separating Atoms': Cockcroft and Walton, 1932: 9. Light or Zarah? Archive 2 September 2012 at the Physical Department of the Wayback Machine, University of Cambridge ↑ Elements, America. Lithium-7 Metal Isotope. Elements of America. Archived from the original on 18 August 2019. ↑ b Wald, Matthew L. (October 8, 2013). Report Says Shortage of Nuclear Material Looms. The New York Times. Archived from the original on July 1, 2017. ↑ a b Kean, Sam (2011). Sudu's missing. ↑ Yacobi S; Ornoy A (2008). Is lithium teratogen real? What we can deduce from the Study? Reviews. Isr J Psychiatry Relat Sci. 45 (2): 95-106. PMID 18982835. ↑ Lieb, J.; Zeff (1978). Lithium treatment of chronic cluster headaches. British Journal of Psychiatry. 133 (6): 556–558. doi:10.1192/bjp.133.6.556. PMID 737393. ↑ Schrauzer, G. N (2002). Lithium: Genesis, nutrition taking, nutritional needs. Journal of the American College of Nutrition. 21 (1): 14–21. doi:10.1080/07315724.2002.10719188. PMID 11838882. ↑ Lithium 265969. Sigma-Aldrich. ↑ Technical data for Lithium Archived March 23, 2015 in Wayback Engine. periodictable.com ^ Furr, A. K. (2000). Laboratory safety CRC handbook. Boca Raton: CRC Press. Pp. 244–246. ISBN 978-0-8493-2523-6. Lithium exterior links in the Video Periodic Schedule (University of Nottingham) International Lithium Alliance USGS: Lithium Statistics and Information On Lithium Supply & Markets 2009 IM Conference 2009 Lithium Supply Mampan through 2020 in the face of the growing market of the University of Southampton, Mountbatten Centre for International Studies, Nuclear Lithium is maintained by the State in investingnews.com PortalsAccess related to the topic PortalChemistry PortalScienceKetd more about SSisterwikipedia ProjectsMediafrom CommonsDefinitionsfrom WiktionaryTextbooksfrom WikibooksLearning source from Wikiversity Found from