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**Magnesium**

From Wikipedia, the free encyclopedia

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Not to be confused with [manganese](https://en.wikipedia.org/wiki/Manganese) *(Mn)*.

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| --- | --- |
| Magnesium,  12Mg | |
| [CSIRO ScienceImage 2893 Crystalised magnesium.jpg](https://en.wikipedia.org/wiki/File:CSIRO_ScienceImage_2893_Crystalised_magnesium.jpg) | |
| **General properties** | |
| **Pronunciation** | [/mæɡˈniːziəm/](https://en.wikipedia.org/wiki/Help:IPA/English) ​([*mag-NEE-zee-əm*](https://en.wikipedia.org/wiki/Help:Pronunciation_respelling_key)) |
| **Appearance** | shiny grey solid |
| [**Standard atomic weight**](https://en.wikipedia.org/wiki/Standard_atomic_weight) **(*A*r, standard)** | [24.304, 24.307] conventional: 24.305 |
| **Magnesium in the** [**periodic table**](https://en.wikipedia.org/wiki/Periodic_table) | |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 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[Neon](https://en.wikipedia.org/wiki/Neon) | | [Sodium](https://en.wikipedia.org/wiki/Sodium) | Magnesium |  | | | | | | | | | | | | | | | | | | | | | | | | [Aluminium](https://en.wikipedia.org/wiki/Aluminium) | [Silicon](https://en.wikipedia.org/wiki/Silicon) | [Phosphorus](https://en.wikipedia.org/wiki/Phosphorus) | [Sulfur](https://en.wikipedia.org/wiki/Sulfur) | [Chlorine](https://en.wikipedia.org/wiki/Chlorine) | [Argon](https://en.wikipedia.org/wiki/Argon) | | [Potassium](https://en.wikipedia.org/wiki/Potassium) | [Calcium](https://en.wikipedia.org/wiki/Calcium) | [Scandium](https://en.wikipedia.org/wiki/Scandium) |  | | | | | | | | | | | | | | [Titanium](https://en.wikipedia.org/wiki/Titanium) | [Vanadium](https://en.wikipedia.org/wiki/Vanadium) | [Chromium](https://en.wikipedia.org/wiki/Chromium) | [Manganese](https://en.wikipedia.org/wiki/Manganese) | [Iron](https://en.wikipedia.org/wiki/Iron) | [Cobalt](https://en.wikipedia.org/wiki/Cobalt) | [Nickel](https://en.wikipedia.org/wiki/Nickel) | [Copper](https://en.wikipedia.org/wiki/Copper) | [Zinc](https://en.wikipedia.org/wiki/Zinc) | [Gallium](https://en.wikipedia.org/wiki/Gallium) | [Germanium](https://en.wikipedia.org/wiki/Germanium) | [Arsenic](https://en.wikipedia.org/wiki/Arsenic) | [Selenium](https://en.wikipedia.org/wiki/Selenium) | [Bromine](https://en.wikipedia.org/wiki/Bromine) | [Krypton](https://en.wikipedia.org/wiki/Krypton) | | [Rubidium](https://en.wikipedia.org/wiki/Rubidium) | [Strontium](https://en.wikipedia.org/wiki/Strontium) | [Yttrium](https://en.wikipedia.org/wiki/Yttrium) |  |  | | | | | | | | | | | | | [Zirconium](https://en.wikipedia.org/wiki/Zirconium) | [Niobium](https://en.wikipedia.org/wiki/Niobium) | [Molybdenum](https://en.wikipedia.org/wiki/Molybdenum) | [Technetium](https://en.wikipedia.org/wiki/Technetium) | [Ruthenium](https://en.wikipedia.org/wiki/Ruthenium) | [Rhodium](https://en.wikipedia.org/wiki/Rhodium) | [Palladium](https://en.wikipedia.org/wiki/Palladium) | [Silver](https://en.wikipedia.org/wiki/Silver) | [Cadmium](https://en.wikipedia.org/wiki/Cadmium) | [Indium](https://en.wikipedia.org/wiki/Indium) | [Tin](https://en.wikipedia.org/wiki/Tin) | [Antimony](https://en.wikipedia.org/wiki/Antimony) | [Tellurium](https://en.wikipedia.org/wiki/Tellurium) | [Iodine](https://en.wikipedia.org/wiki/Iodine) | [Xenon](https://en.wikipedia.org/wiki/Xenon) | | [Caesium](https://en.wikipedia.org/wiki/Caesium) | [Barium](https://en.wikipedia.org/wiki/Barium) | [Lanthanum](https://en.wikipedia.org/wiki/Lanthanum) | [Cerium](https://en.wikipedia.org/wiki/Cerium) | [Praseodymium](https://en.wikipedia.org/wiki/Praseodymium) | [Neodymium](https://en.wikipedia.org/wiki/Neodymium) | [Promethium](https://en.wikipedia.org/wiki/Promethium) | [Samarium](https://en.wikipedia.org/wiki/Samarium) | [Europium](https://en.wikipedia.org/wiki/Europium) | [Gadolinium](https://en.wikipedia.org/wiki/Gadolinium) | [Terbium](https://en.wikipedia.org/wiki/Terbium) | [Dysprosium](https://en.wikipedia.org/wiki/Dysprosium) | [Holmium](https://en.wikipedia.org/wiki/Holmium) | [Erbium](https://en.wikipedia.org/wiki/Erbium) | [Thulium](https://en.wikipedia.org/wiki/Thulium) | [Ytterbium](https://en.wikipedia.org/wiki/Ytterbium) | [Lutetium](https://en.wikipedia.org/wiki/Lutetium) | [Hafnium](https://en.wikipedia.org/wiki/Hafnium) | [Tantalum](https://en.wikipedia.org/wiki/Tantalum) | [Tungsten](https://en.wikipedia.org/wiki/Tungsten) | [Rhenium](https://en.wikipedia.org/wiki/Rhenium) | [Osmium](https://en.wikipedia.org/wiki/Osmium) | [Iridium](https://en.wikipedia.org/wiki/Iridium) | [Platinum](https://en.wikipedia.org/wiki/Platinum) | [Gold](https://en.wikipedia.org/wiki/Gold) | [Mercury (element)](https://en.wikipedia.org/wiki/Mercury_(element)) | [Thallium](https://en.wikipedia.org/wiki/Thallium) | [Lead](https://en.wikipedia.org/wiki/Lead) | [Bismuth](https://en.wikipedia.org/wiki/Bismuth) | [Polonium](https://en.wikipedia.org/wiki/Polonium) | [Astatine](https://en.wikipedia.org/wiki/Astatine) | [Radon](https://en.wikipedia.org/wiki/Radon) | | [Francium](https://en.wikipedia.org/wiki/Francium) | [Radium](https://en.wikipedia.org/wiki/Radium) | [Actinium](https://en.wikipedia.org/wiki/Actinium) | [Thorium](https://en.wikipedia.org/wiki/Thorium) | [Protactinium](https://en.wikipedia.org/wiki/Protactinium) | [Uranium](https://en.wikipedia.org/wiki/Uranium) | [Neptunium](https://en.wikipedia.org/wiki/Neptunium) | [Plutonium](https://en.wikipedia.org/wiki/Plutonium) | [Americium](https://en.wikipedia.org/wiki/Americium) | [Curium](https://en.wikipedia.org/wiki/Curium) | [Berkelium](https://en.wikipedia.org/wiki/Berkelium) | [Californium](https://en.wikipedia.org/wiki/Californium) | [Einsteinium](https://en.wikipedia.org/wiki/Einsteinium) | [Fermium](https://en.wikipedia.org/wiki/Fermium) | [Mendelevium](https://en.wikipedia.org/wiki/Mendelevium) | [Nobelium](https://en.wikipedia.org/wiki/Nobelium) | [Lawrencium](https://en.wikipedia.org/wiki/Lawrencium) | [Rutherfordium](https://en.wikipedia.org/wiki/Rutherfordium) | [Dubnium](https://en.wikipedia.org/wiki/Dubnium) | [Seaborgium](https://en.wikipedia.org/wiki/Seaborgium) | [Bohrium](https://en.wikipedia.org/wiki/Bohrium) | [Hassium](https://en.wikipedia.org/wiki/Hassium) | [Meitnerium](https://en.wikipedia.org/wiki/Meitnerium) | [Darmstadtium](https://en.wikipedia.org/wiki/Darmstadtium) | [Roentgenium](https://en.wikipedia.org/wiki/Roentgenium) | [Copernicium](https://en.wikipedia.org/wiki/Copernicium) | [Nihonium](https://en.wikipedia.org/wiki/Nihonium) | [Flerovium](https://en.wikipedia.org/wiki/Flerovium) | [Moscovium](https://en.wikipedia.org/wiki/Moscovium) | [Livermorium](https://en.wikipedia.org/wiki/Livermorium) | [Tennessine](https://en.wikipedia.org/wiki/Tennessine) | [Oganesson](https://en.wikipedia.org/wiki/Oganesson) | | [Be](https://en.wikipedia.org/wiki/Beryllium) ↑ **Mg** ↓ [Ca](https://en.wikipedia.org/wiki/Calcium) | | [sodium](https://en.wikipedia.org/wiki/Sodium) ← **magnesium** → [aluminium](https://en.wikipedia.org/wiki/Aluminium) | | | | |
| [**Atomic number**](https://en.wikipedia.org/wiki/Atomic_number)(*Z*) | 12 |
| [**Group**](https://en.wikipedia.org/wiki/Group_(periodic_table)) | [group 2 (alkaline earth metals)](https://en.wikipedia.org/wiki/Alkaline_earth_metal) |
| [**Period**](https://en.wikipedia.org/wiki/Period_(periodic_table)) | [period 3](https://en.wikipedia.org/wiki/Period_(periodic_table)#Period_3) |
| [**Block**](https://en.wikipedia.org/wiki/Block_(periodic_table)) | [s-block](https://en.wikipedia.org/wiki/S-block) |
| [**Element category**](https://en.wikipedia.org/wiki/Names_for_sets_of_chemical_elements#Category) | [alkaline earth metal](https://en.wikipedia.org/wiki/Alkaline_earth_metal) |
| [**Electron configuration**](https://en.wikipedia.org/wiki/Electron_configuration) | [[Ne](https://en.wikipedia.org/wiki/Neon)] 3s2 |
| Electrons per shell | 2, 8, 2 |
| **Physical properties** | |
| [**Phase**](https://en.wikipedia.org/wiki/Phase_(matter)) **at**[**STP**](https://en.wikipedia.org/wiki/Standard_conditions_for_temperature_and_pressure) | [solid](https://en.wikipedia.org/wiki/Solid) |
| [**Melting point**](https://en.wikipedia.org/wiki/Melting_point) | 923 [K](https://en.wikipedia.org/wiki/Kelvin) ​(650 °C, ​1202 °F) |
| [**Boiling point**](https://en.wikipedia.org/wiki/Boiling_point) | 1363 K ​(1091 °C, ​1994 °F) |
| [**Density**](https://en.wikipedia.org/wiki/Density)(near r.t.) | 1.738 g/cm3 |
| when liquid (at m.p.) | 1.584 g/cm3 |
| [**Heat of fusion**](https://en.wikipedia.org/wiki/Enthalpy_of_fusion) | 8.48 [kJ/mol](https://en.wikipedia.org/wiki/Kilojoule_per_mole) |
| [**Heat of vaporization**](https://en.wikipedia.org/wiki/Enthalpy_of_vaporization) | 128 kJ/mol |
| [**Molar heat capacity**](https://en.wikipedia.org/wiki/Molar_heat_capacity) | 24.869 J/(mol·K) |
| [**Vapor pressure**](https://en.wikipedia.org/wiki/Vapor_pressure)   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | ***P***(Pa) | **1** | **10** | **100** | **1 k** | **10 k** | **100 k** | | **at *T***(K) | 701 | 773 | 861 | 971 | 1132 | 1361 | | |
| **Atomic properties** | |
| [**Oxidation states**](https://en.wikipedia.org/wiki/Oxidation_state) | +1,[[1]](https://en.wikipedia.org/wiki/Magnesium#cite_note-1) **+2** (a strongly [basic](https://en.wikipedia.org/wiki/Base_(chemistry)) oxide) |
| [**Electronegativity**](https://en.wikipedia.org/wiki/Electronegativity) | Pauling scale: 1.31 |
| [**Ionization energies**](https://en.wikipedia.org/wiki/Ionization_energy) | * 1st: 737.7 kJ/mol * 2nd: 1450.7 kJ/mol * 3rd: 7732.7 kJ/mol * ([more](https://en.wikipedia.org/wiki/Molar_ionization_energies_of_the_elements#magnesium)) |
| [**Atomic radius**](https://en.wikipedia.org/wiki/Atomic_radius) | empirical: 160 [pm](https://en.wikipedia.org/wiki/Picometre) |
| [**Covalent radius**](https://en.wikipedia.org/wiki/Covalent_radius) | 141±7 pm |
| [**Van der Waals radius**](https://en.wikipedia.org/wiki/Van_der_Waals_radius) | 173 pm |
| [Color lines in a spectral range](https://en.wikipedia.org/wiki/File:Magnesium_spectrum_visible.png)  [**Spectral lines**](https://en.wikipedia.org/wiki/Spectral_line) **of magnesium** | |
| **Other properties** | |
| [**Crystal structure**](https://en.wikipedia.org/wiki/Crystal_structure) | ​[hexagonal close-packed](https://en.wikipedia.org/wiki/Close-packing_of_equal_spheres) (hcp)  [Hexagonal close packed crystal structure for magnesium](https://en.wikipedia.org/wiki/File:Hexagonal_close_packed.svg) |
| [**Speed of sound**](https://en.wikipedia.org/wiki/Speed_of_sound)thin rod | 4940 m/s (at r.t.) (annealed) |
| [**Thermal expansion**](https://en.wikipedia.org/wiki/Coefficient_of_thermal_expansion) | 24.8 µm/(m·K) (at 25 °C) |
| [**Thermal conductivity**](https://en.wikipedia.org/wiki/Thermal_conductivity) | 156 W/(m·K) |
| [**Electrical resistivity**](https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity) | 43.9 nΩ·m (at 20 °C) |
| [**Magnetic ordering**](https://en.wikipedia.org/wiki/Magnetism) | [paramagnetic](https://en.wikipedia.org/wiki/Paramagnetism) |
| [**Magnetic susceptibility**](https://en.wikipedia.org/wiki/Magnetic_susceptibility) | +13.1·10−6 cm3/mol (298 K)[[2]](https://en.wikipedia.org/wiki/Magnesium#cite_note-2) |
| [**Young's modulus**](https://en.wikipedia.org/wiki/Young%27s_modulus) | 45 GPa |
| [**Shear modulus**](https://en.wikipedia.org/wiki/Shear_modulus) | 17 GPa |
| [**Bulk modulus**](https://en.wikipedia.org/wiki/Bulk_modulus) | 35.4[[3]](https://en.wikipedia.org/wiki/Magnesium#cite_note-3) GPa |
| [**Poisson ratio**](https://en.wikipedia.org/wiki/Poisson%27s_ratio) | 0.290 |
| [**Mohs hardness**](https://en.wikipedia.org/wiki/Mohs_scale_of_mineral_hardness) | 1–2.5 |
| [**Brinell hardness**](https://en.wikipedia.org/wiki/Brinell_hardness_test) | 44–260 MPa |
| [**CAS Number**](https://en.wikipedia.org/wiki/CAS_Registry_Number) | 7439-95-4 |
| **History** | |
| **Naming** | after [Magnesia](https://en.wikipedia.org/wiki/Magnesia_(regional_unit)), Greece |
| [**Discovery**](https://en.wikipedia.org/wiki/Timeline_of_chemical_element_discoveries) | [Joseph Black](https://en.wikipedia.org/wiki/Joseph_Black) (1755) |
| **First isolation** | [Humphry Davy](https://en.wikipedia.org/wiki/Humphry_Davy) (1808) |
| **Main** [**isotopes of magnesium**](https://en.wikipedia.org/wiki/Isotopes_of_magnesium) | |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | [**Iso­tope**](https://en.wikipedia.org/wiki/Isotope) | [**Abun­dance**](https://en.wikipedia.org/wiki/Natural_abundance) | [**Half-life**](https://en.wikipedia.org/wiki/Half-life) **(*t*1/2)** | [**Decay mode**](https://en.wikipedia.org/wiki/Radioactive_decay) | [**Pro­duct**](https://en.wikipedia.org/wiki/Decay_product) | | **24Mg** | 79.0% | [stable](https://en.wikipedia.org/wiki/Stable_isotope) | | | | **25Mg** | 10.0% | stable | | | | **26Mg** | 11.0% | stable | | | | |
| * [view](https://en.wikipedia.org/wiki/Template:Infobox_magnesium) * [talk](https://en.wikipedia.org/wiki/Template_talk:Infobox_magnesium) * [edit](https://en.wikipedia.org/w/index.php?title=Template:Infobox_magnesium&action=edit)   | [references](https://en.wikipedia.org/wiki/List_of_data_references_for_chemical_elements) | |

**Magnesium** is a [chemical element](https://en.wikipedia.org/wiki/Chemical_element) with symbol **Mg** and [atomic number](https://en.wikipedia.org/wiki/Atomic_number) 12. It is a shiny gray solid which bears a close physical resemblance to the other five elements in the second column (group 2, or [alkaline earth metals](https://en.wikipedia.org/wiki/Alkaline_earth_metals)) of the [periodic table](https://en.wikipedia.org/wiki/Periodic_table): all group 2 elements have the same [electron](https://en.wikipedia.org/wiki/Electron) configuration in the outer electron shell and a similar crystal structure.

Magnesium is the ninth most abundant element in the universe.[[5]](https://en.wikipedia.org/wiki/Magnesium#cite_note-5)[[6]](https://en.wikipedia.org/wiki/Magnesium#cite_note-6) It is produced in large, aging [stars](https://en.wikipedia.org/wiki/Star) from the sequential addition of three [helium nuclei](https://en.wikipedia.org/wiki/Helium_nucleus) to a [carbon](https://en.wikipedia.org/wiki/Carbon) nucleus. When such stars explode as [supernovas](https://en.wikipedia.org/wiki/Supernova), much of the magnesium is expelled into the [interstellar medium](https://en.wikipedia.org/wiki/Interstellar_medium) where it may recycle into new star systems. Magnesium is the eighth most abundant element in the [Earth's crust](https://en.wikipedia.org/wiki/Earth%27s_crust)[[7]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Abundance-7) and the fourth most common element in the Earth (after [iron](https://en.wikipedia.org/wiki/Iron), [oxygen](https://en.wikipedia.org/wiki/Oxygen) and [silicon](https://en.wikipedia.org/wiki/Silicon)), making up 13% of the planet's mass and a large fraction of the planet's [mantle](https://en.wikipedia.org/wiki/Mantle_(geology)). It is the third most abundant element dissolved in seawater, after [sodium](https://en.wikipedia.org/wiki/Sodium) and [chlorine](https://en.wikipedia.org/wiki/Chlorine).[[8]](https://en.wikipedia.org/wiki/Magnesium#cite_note-8)

Magnesium occurs naturally only in combination with other elements, where it invariably has a +2 [oxidation state](https://en.wikipedia.org/wiki/Oxidation_state). The free element (metal) can be produced artificially, and is highly reactive (though in the atmosphere, it is soon coated in a thin layer of oxide that partly inhibits reactivity – see [passivation](https://en.wikipedia.org/wiki/Passivation_(chemistry))). The free metal burns with a characteristic brilliant-white light. The metal is now obtained mainly by [electrolysis](https://en.wikipedia.org/wiki/Electrolysis) of magnesium [salts](https://en.wikipedia.org/wiki/Salt_(chemistry)) obtained from [brine](https://en.wikipedia.org/wiki/Brine), and is used primarily as a component in [aluminium](https://en.wikipedia.org/wiki/Aluminium)-magnesium alloys, sometimes called [*magnalium*](https://en.wikipedia.org/wiki/Magnalium) or [*magnelium*](https://en.wikipedia.org/wiki/Magnalium). Magnesium is less dense than [aluminium](https://en.wikipedia.org/wiki/Aluminium), and the alloy is prized for its combination of lightness and strength.

Magnesium is the eleventh most abundant element by mass in the [human body](https://en.wikipedia.org/wiki/Human_body) and is essential to all cells and some 300 [enzymes](https://en.wikipedia.org/wiki/Enzymes).[[9]](https://en.wikipedia.org/wiki/Magnesium#cite_note-nih-9) Magnesium ions interact with [polyphosphate](https://en.wikipedia.org/wiki/Polyphosphate) compounds such as [ATP](https://en.wikipedia.org/wiki/Adenosine_triphosphate), [DNA](https://en.wikipedia.org/wiki/DNA), and [RNA](https://en.wikipedia.org/wiki/RNA). Hundreds of enzymes require magnesium ions to function. Magnesium compounds are used medicinally as common [laxatives](https://en.wikipedia.org/wiki/Laxatives), [antacids](https://en.wikipedia.org/wiki/Antacids) (e.g., [milk of magnesia](https://en.wikipedia.org/wiki/Milk_of_magnesia)), and to stabilize abnormal nerve excitation or blood vessel spasm in such conditions as [eclampsia](https://en.wikipedia.org/wiki/Eclampsia).[[9]](https://en.wikipedia.org/wiki/Magnesium#cite_note-nih-9)



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**Characteristics**

**Physical properties**

Elemental magnesium is a gray-white lightweight metal, two-thirds the density of aluminium. It [tarnishes](https://en.wikipedia.org/wiki/Tarnish) slightly when exposed to air, although, unlike the heavier [alkaline earth metals](https://en.wikipedia.org/wiki/Alkaline_earth_metals), an oxygen-free environment is unnecessary for storage because magnesium is protected by a thin layer of oxide that is fairly impermeable and difficult to remove. Magnesium has the lowest melting (923 K (1,202 °F)) and the lowest boiling point 1,363 K (1,994 °F) of all the alkaline earth metals.

Magnesium reacts with water at room temperature, though it reacts much more slowly than calcium, a similar group 2 metal. When submerged in water, [hydrogen](https://en.wikipedia.org/wiki/Hydrogen) bubbles form slowly on the surface of the metal – though, if powdered, it reacts much more rapidly. The reaction occurs faster with higher temperatures (see [safety precautions](https://en.wikipedia.org/wiki/Magnesium#Safety_precautions)). Magnesium's reversible reaction with water can be harnessed to store energy and run a [magnesium-based engine](https://en.wikipedia.org/wiki/Magnesium_injection_cycle).

Magnesium also reacts exothermically with most acids such as [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid) (HCl), producing the metal chloride and hydrogen gas, similar to the HCl reaction with aluminium, zinc, and many other metals.

**Chemical properties**

**Flammability**

Magnesium is highly [flammable](https://en.wikipedia.org/wiki/Flammability), especially when powdered or shaved into thin strips, though it is difficult to ignite in mass or bulk. Flame temperatures of magnesium and magnesium alloys can reach 3,100 °C (5,610 °F),[[10]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Dreizin,_Edward_L.;_Berman,_Charles_H._and_Vicenzi,_Edward_P._2000_30-10) although flame height above the burning metal is usually less than 300 mm (12 in).[[11]](https://en.wikipedia.org/wiki/Magnesium#cite_note-DOE-11) Once ignited, such fires are difficult to extinguish, because combustion continues in [nitrogen](https://en.wikipedia.org/wiki/Nitrogen) (forming [magnesium nitride](https://en.wikipedia.org/wiki/Magnesium_nitride)), [carbon dioxide](https://en.wikipedia.org/wiki/Carbon_dioxide) (forming [magnesium oxide](https://en.wikipedia.org/wiki/Magnesium_oxide) and [carbon](https://en.wikipedia.org/wiki/Carbon)), and water (forming magnesium oxide and hydrogen). This property was used in incendiary weapons during the [firebombing](https://en.wikipedia.org/wiki/Firebombing) of cities in [World War II](https://en.wikipedia.org/wiki/World_War_II), where the only practical [civil defense](https://en.wikipedia.org/wiki/Civil_defense) was to smother a burning flare under dry sand to exclude atmosphere from the combustion.

Magnesium may also be used as an igniter for [thermite](https://en.wikipedia.org/wiki/Thermite), a mixture of aluminium and iron oxide powder that ignites only at a very high temperature.

**Organic Chemistry**

Main article: [Grignard reagent](https://en.wikipedia.org/wiki/Grignard_reagent)

Organomagnesium compounds are widespread in [organic chemistry](https://en.wikipedia.org/wiki/Organic_chemistry). They are commonly found as [Grignard reagents](https://en.wikipedia.org/wiki/Grignard_reagents). Magnesium can react with [haloalkanes](https://en.wikipedia.org/wiki/Haloalkanes) to give [Grignard reagents](https://en.wikipedia.org/wiki/Grignard_reagents). Examples of [Grignard reagents](https://en.wikipedia.org/wiki/Grignard_reagents) are [phenylmagnesium bromide](https://en.wikipedia.org/wiki/Phenylmagnesium_bromide) and [ethylmagnesium bromide](https://en.wikipedia.org/wiki/Ethylmagnesium_bromide). The [Grignard reagents](https://en.wikipedia.org/wiki/Grignard_reagents) can function as a common [nucleophile](https://en.wikipedia.org/wiki/Nucleophile), attacking the [electrophilic](https://en.wikipedia.org/wiki/Electrophilic) group such as the carbon atom that is present within the polar bond of a [carbonyl](https://en.wikipedia.org/wiki/Carbonyl) group.

Relevant organic magnesium reagents outside the scope of Grignards are magnesium anthracene with magnesium forming a 1,4-bridge over the central hexagon used as a source of highly active magnesium and butadiene magnesium an adduct with [butadiene](https://en.wikipedia.org/wiki/Butadiene) and a source for the butadiene dianion.

**Source of light**

When burning in air, magnesium produces a brilliant-white light that includes strong ultraviolet wavelengths. Magnesium powder ([flash powder](https://en.wikipedia.org/wiki/Flash_powder)) was used for subject illumination in the early days of [photography](https://en.wikipedia.org/wiki/Photography).[[12]](https://en.wikipedia.org/wiki/Magnesium#cite_note-12)[[13]](https://en.wikipedia.org/wiki/Magnesium#cite_note-13) Later, magnesium filament was used in electrically ignited single-use photography [flashbulbs](https://en.wikipedia.org/wiki/Flash_(photography)#Flashbulbs). Magnesium powder is used in [fireworks](https://en.wikipedia.org/wiki/Fireworks) and marine [flares](https://en.wikipedia.org/wiki/Flare) where a brilliant white light is required. It was also used for various theatrical effects,[[14]](https://en.wikipedia.org/wiki/Magnesium#cite_note-14) such as lightning,[[15]](https://en.wikipedia.org/wiki/Magnesium#cite_note-15) pistol flashes,[[16]](https://en.wikipedia.org/wiki/Magnesium#cite_note-16) and supernatural appearances.[[17]](https://en.wikipedia.org/wiki/Magnesium#cite_note-17)

**Occurrence**

See also: [Category:Magnesium minerals](https://en.wikipedia.org/wiki/Category:Magnesium_minerals).

See also: [Boninite](https://en.wikipedia.org/wiki/Boninite)

Magnesium is the eighth-most-abundant element in the Earth's crust by mass and tied in seventh place with [iron](https://en.wikipedia.org/wiki/Iron) in [molarity](https://en.wikipedia.org/wiki/Molarity).[[7]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Abundance-7) It is found in large deposits of [magnesite](https://en.wikipedia.org/wiki/Magnesite), [dolomite](https://en.wikipedia.org/wiki/Dolomite), and other [minerals](https://en.wikipedia.org/wiki/Mineral), and in mineral waters, where magnesium ion is soluble.

Although magnesium is found in more than 60 [minerals](https://en.wikipedia.org/wiki/Mineral), only [dolomite](https://en.wikipedia.org/wiki/Dolomite), [magnesite](https://en.wikipedia.org/wiki/Magnesite), [brucite](https://en.wikipedia.org/wiki/Brucite), [carnallite](https://en.wikipedia.org/wiki/Carnallite), [talc](https://en.wikipedia.org/wiki/Talc), and [olivine](https://en.wikipedia.org/wiki/Olivine) are of commercial importance.

The Mg2+  
[cation](https://en.wikipedia.org/wiki/Cation) is the second-most-abundant cation in seawater (about ⅛ the mass of sodium ions in a given sample), which makes seawater and sea salt attractive commercial sources for Mg. To extract the magnesium, [calcium hydroxide](https://en.wikipedia.org/wiki/Calcium_hydroxide) is added to [seawater](https://en.wikipedia.org/wiki/Seawater) to form [magnesium hydroxide](https://en.wikipedia.org/wiki/Magnesium_hydroxide) [precipitate](https://en.wikipedia.org/wiki/Precipitate).

MgCl  
2 + Ca(OH)  
2 → Mg(OH)  
2 + CaCl  
2

Magnesium hydroxide ([brucite](https://en.wikipedia.org/wiki/Brucite)) is insoluble in water and can be filtered out and reacted with [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid) to produced concentrated [magnesium chloride](https://en.wikipedia.org/wiki/Magnesium_chloride).

Mg(OH)  
2 + 2 HCl → MgCl  
2 + 2 H  
2O

From magnesium chloride, [electrolysis](https://en.wikipedia.org/wiki/Electrolysis) produces magnesium.

**Forms**

**Alloy**

As of 2013, magnesium alloy consumption was less than one million tons per year, compared with 50 million tons of [aluminum alloys](https://en.wikipedia.org/wiki/Aluminum_alloy). Its use has been historically limited by its tendency to corrode, [creep](https://en.wikipedia.org/wiki/Creep_(deformation)) at high temperatures, and combust.[[18]](https://en.wikipedia.org/wiki/Magnesium#cite_note-giz-18)

**Corrosion**

The presence of [iron](https://en.wikipedia.org/wiki/Iron), [nickel](https://en.wikipedia.org/wiki/Nickel), [copper](https://en.wikipedia.org/wiki/Copper), and [cobalt](https://en.wikipedia.org/wiki/Cobalt) strongly activates [corrosion](https://en.wikipedia.org/wiki/Corrosion). Greater than a very small percentage, these metals precipitate as [intermetallic compounds](https://en.wikipedia.org/wiki/Intermetallic_compound), and the precipitate locales function as active [cathodic](https://en.wikipedia.org/wiki/Cathode) sites that reduce water, causing the loss of magnesium.[[18]](https://en.wikipedia.org/wiki/Magnesium#cite_note-giz-18) Controlling the quantity of these metals improves corrosion resistance. Sufficient [manganese](https://en.wikipedia.org/wiki/Manganese) overcomes the corrosive effects of iron. This requires precise control over composition, increasing costs.[[18]](https://en.wikipedia.org/wiki/Magnesium#cite_note-giz-18) Adding a cathodic poison captures atomic hydrogen within the structure of a metal. This prevents the formation of free hydrogen gas, an essential factor of corrosive chemical processes. The addition of about one in three hundred parts [arsenic](https://en.wikipedia.org/wiki/Arsenic) reduces its corrosion rate in a salt solution by a factor of nearly ten.[[18]](https://en.wikipedia.org/wiki/Magnesium#cite_note-giz-18)[[19]](https://en.wikipedia.org/wiki/Magnesium#cite_note-19)

**High-temperature creep and flammability**

Research showed that magnesium's tendency to creep at high-temperatures is eliminated by the addition of [scandium](https://en.wikipedia.org/wiki/Scandium) and [gadolinium](https://en.wikipedia.org/wiki/Gadolinium). Flammability is greatly reduced by a small amount of [calcium](https://en.wikipedia.org/wiki/Calcium) in the alloy.[[18]](https://en.wikipedia.org/wiki/Magnesium#cite_note-giz-18)

**Compounds**

Magnesium forms a variety of compounds important to industry and biology, including [magnesium carbonate](https://en.wikipedia.org/wiki/Magnesium_carbonate), [magnesium chloride](https://en.wikipedia.org/wiki/Magnesium_chloride), [magnesium citrate](https://en.wikipedia.org/wiki/Magnesium_citrate), [magnesium hydroxide](https://en.wikipedia.org/wiki/Magnesium_hydroxide) (milk of magnesia), [magnesium oxide](https://en.wikipedia.org/wiki/Magnesium_oxide), [magnesium sulfate](https://en.wikipedia.org/wiki/Magnesium_sulfate), and magnesium sulfate heptahydrate ([Epsom salts](https://en.wikipedia.org/wiki/Epsom_salts)).

**Isotopes**

Main article: [Isotopes of magnesium](https://en.wikipedia.org/wiki/Isotopes_of_magnesium)

Magnesium has three stable [isotopes](https://en.wikipedia.org/wiki/Isotope): 24  
Mg, 25  
Mg and 26  
Mg. All are present in significant amounts (see table of isotopes above). About 79% of Mg is 24  
Mg. The isotope 28  
Mg is radioactive and in the 1950s to 1970s was produced by several nuclear power plants for use in scientific experiments. This isotope has a relatively short half-life (21 hours) and its use was limited by shipping times.

The nuclide 26  
Mg has found application in [isotopic](https://en.wikipedia.org/wiki/Isotope) [geology](https://en.wikipedia.org/wiki/Geology), similar to that of aluminium. 26  
Mg is a [radiogenic](https://en.wikipedia.org/wiki/Radiogenic) daughter product of [26  
Al](https://en.wikipedia.org/wiki/Aluminium-26), which has a [half-life](https://en.wikipedia.org/wiki/Half-life) of 717,000 years. Excessive quantities of stable 26  
Mg have been observed in the [Ca-Al-rich inclusions](https://en.wikipedia.org/wiki/Ca-Al-rich_inclusions) of some [carbonaceous chondrite](https://en.wikipedia.org/wiki/Carbonaceous_chondrite) [meteorites](https://en.wikipedia.org/wiki/Meteorite). This anomalous abundance is attributed to the decay of its parent 26  
Al in the inclusions, and researchers conclude that such meteorites were formed in the [solar nebula](https://en.wikipedia.org/wiki/Solar_nebula) before the 26  
Al had decayed. These are among the oldest objects in the [solar system](https://en.wikipedia.org/wiki/Solar_system) and contain preserved information about its early history.

It is conventional to plot 26  
Mg/24  
Mg against an Al/Mg ratio. In an [isochron dating](https://en.wikipedia.org/wiki/Isochron_dating) plot, the Al/Mg ratio plotted is27  
Al/24  
Mg. The slope of the isochron has no age significance, but indicates the initial 26  
Al/27  
Al ratio in the sample at the time when the systems were separated from a common reservoir.

**Production**

See also: [List of countries by magnesium production](https://en.wikipedia.org/wiki/List_of_countries_by_magnesium_production)

| **Country** | **2011 production  (**[**tonnes**](https://en.wikipedia.org/wiki/Tonne)**)**[**[20]**](https://en.wikipedia.org/wiki/Magnesium#cite_note-20) |
| --- | --- |
| China | 661,000 |
| U.S.[[note 1]](https://en.wikipedia.org/wiki/Magnesium#cite_note-21) | 63,500 |
| Russia | 37,000 |
| Israel | 30,000 |
| Kazakhstan | 21,000 |
| Brazil | 16,000 |
| Ukraine | 2,000 |
| Serbia | 1,500 |
| Total | 832,000 |

[](https://en.wikipedia.org/wiki/File:Mg_sheets_and_ingots.jpg)

Magnesium sheets and ingots

[China](https://en.wikipedia.org/wiki/People%27s_Republic_of_China) is the dominant supplier of magnesium, with approximately 80% of the world market share. China is almost completely reliant on the [silicothermic](https://en.wikipedia.org/wiki/Silicothermic_reaction) [Pidgeon process](https://en.wikipedia.org/wiki/Pidgeon_process) (the reduction of the oxide at high temperatures with silicon, often provided by a ferrosilicon alloy in which the iron is but a spectator in the reactions) to obtain the metal.[[21]](https://en.wikipedia.org/wiki/Magnesium#cite_note-22) The process can also be carried out with [carbon](https://en.wikipedia.org/wiki/Carbon) at approx 2300 °C:

2MgO  
(s) + Si  
(s) + 2CaO  
(s) → 2Mg  
(g) + Ca  
2SiO  
4(s)

MgO  
(s) + C  
(s) → Mg  
(g) + CO  
(g)

In the United States, magnesium is obtained principally with the [Dow process](https://en.wikipedia.org/wiki/Dow_process), by [electrolysis](https://en.wikipedia.org/wiki/Electrolysis) of fused magnesium chloride from [brine](https://en.wikipedia.org/wiki/Brine) and [sea water](https://en.wikipedia.org/wiki/Sea_water). A saline solution containing Mg2+  
ions is first treated with [lime](https://en.wikipedia.org/wiki/Calcium_oxide) (calcium oxide) and the precipitated [magnesium hydroxide](https://en.wikipedia.org/wiki/Magnesium_hydroxide) is collected:

Mg2+  
(aq) + CaO  
(s) + H  
2O → Ca2+  
(aq) + Mg(OH)  
2(s)

The hydroxide is then converted to a partial [hydrate](https://en.wikipedia.org/wiki/Hydrate) of [magnesium chloride](https://en.wikipedia.org/wiki/Magnesium_chloride) by treating the hydroxide with [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid) and heating of the product:

Mg(OH)  
2(s) + 2 HCl → MgCl  
2(aq) + 2H  
2O  
(l)

The salt is then electrolyzed in the molten state. At the [cathode](https://en.wikipedia.org/wiki/Cathode), the Mg2+  
ion is reduced by two [electrons](https://en.wikipedia.org/wiki/Electron) to magnesium metal:

Mg2+  
+ 2   
e−  
→ Mg

At the [anode](https://en.wikipedia.org/wiki/Anode), each pair of Cl−  
ions is oxidized to [chlorine](https://en.wikipedia.org/wiki/Chlorine) gas, releasing two electrons to complete the circuit:

2 Cl−  
→ Cl  
2 (g) + 2   
e−

A new process, solid oxide membrane technology, involves the electrolytic reduction of MgO. At the cathode, Mg2+  
ion is reduced by two [electrons](https://en.wikipedia.org/wiki/Electron) to magnesium metal. The electrolyte is [yttria-stabilized zirconia](https://en.wikipedia.org/wiki/Yttria-stabilized_zirconia) (YSZ). The anode is a liquid metal. At the YSZ/liquid metal anode O2−  
is oxidized. A layer of graphite borders the liquid metal anode, and at this interface carbon and oxygen react to form carbon monoxide. When silver is used as the liquid metal anode, there is no reductant carbon or hydrogen needed, and only oxygen gas is evolved at the anode.[[22]](https://en.wikipedia.org/wiki/Magnesium#cite_note-The_Use_of_Solid-Oxide-Membrane_Technology_for_Electrometallurgy-23) It has been reported that this method provides a 40% reduction in cost per pound over the electrolytic reduction method.[[23]](https://en.wikipedia.org/wiki/Magnesium#cite_note-24) This method is more environmentally sound than others because there is much less carbon dioxide emitted.

The United States has traditionally been the major world supplier of this metal, supplying 45% of world production even as recently as 1995. Today, the US market share is at 7%, with a single domestic producer left, US Magnesium, a [Renco Group](https://en.wikipedia.org/wiki/Renco_Group) company in [Utah](https://en.wikipedia.org/wiki/Utah) born from now-defunct Magcorp.[[24]](https://en.wikipedia.org/wiki/Magnesium#cite_note-25)

**History**

[](https://en.wikipedia.org/wiki/File:Bolton-davy.jpg)

[Humphry Davy](https://en.wikipedia.org/wiki/Humphry_Davy)

The name magnesium originates from the [Greek](https://en.wikipedia.org/wiki/Ancient_Greek) word for a district in [Thessaly](https://en.wikipedia.org/wiki/Thessaly) called [Magnesia](https://en.wikipedia.org/wiki/Magnesia_(regional_unit)).[[25]](https://en.wikipedia.org/wiki/Magnesium#cite_note-26) It is related to [magnetite](https://en.wikipedia.org/wiki/Magnetite) and [manganese](https://en.wikipedia.org/wiki/Manganese), which also originated from this area, and required differentiation as separate substances. See [manganese](https://en.wikipedia.org/wiki/Manganese) for this history.

In 1618, a farmer at Epsom in England attempted to give his cows water from a well there. The cows refused to drink because of the water's bitter taste, but the farmer noticed that the water seemed to heal scratches and rashes. The substance became known as [Epsom salts](https://en.wikipedia.org/wiki/Magnesium_sulfate) and its fame spread.[[26]](https://en.wikipedia.org/wiki/Magnesium#cite_note-27) It was eventually recognized as hydrated magnesium sulfate, MgSO  
4·7 H  
2O.

The metal itself was first isolated by [Sir Humphry Davy](https://en.wikipedia.org/wiki/Humphry_Davy) in England in 1808. He used electrolysis on a mixture of magnesia and [mercuric oxide](https://en.wikipedia.org/wiki/Mercury(II)_oxide).[[27]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Davy1808-28) [Antoine Bussy](https://en.wikipedia.org/wiki/Antoine_Bussy) prepared it in coherent form in 1831. Davy's first suggestion for a name was magnium,[[27]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Davy1808-28) but the name magnesium is now used.

**Uses as a metal**

[](https://en.wikipedia.org/wiki/File:Bundesarchiv_Bild_102-12062,_Wasserreiter_mit_Magnesiumfackeln.jpg)

An unusual application of magnesium as an [illumination](https://en.wikipedia.org/wiki/Illumination_(lighting)) source while [wakeskating](https://en.wikipedia.org/wiki/Wakeskating) in 1931

Magnesium is the third-most-commonly-used structural metal, following [iron](https://en.wikipedia.org/wiki/Iron) and aluminium.[[28]](https://en.wikipedia.org/wiki/Magnesium#cite_note-29)

The main applications of magnesium are, in order: aluminium alloys, [die-casting](https://en.wikipedia.org/wiki/Die-casting) (alloyed with [zinc](https://en.wikipedia.org/wiki/Zinc)),[[29]](https://en.wikipedia.org/wiki/Magnesium#cite_note-BakerM._M._Avedesian1999-30) removing [sulfur](https://en.wikipedia.org/wiki/Sulfur) in the production of iron and steel, and the production of [titanium](https://en.wikipedia.org/wiki/Titanium) in the [Kroll process](https://en.wikipedia.org/wiki/Kroll_process).[[30]](https://en.wikipedia.org/wiki/Magnesium#cite_note-31)

Magnesium is used in super-strong, lightweight materials and alloys. For example, when infused with silicon carbide nanoparticles, it has extremely high specific strength.[[31]](https://en.wikipedia.org/wiki/Magnesium#cite_note-UCLA_Research-32)

Historically, magnesium was one of the main aerospace construction metals and was used for German military aircraft as early as World War I and extensively for German aircraft in World War II.

The Germans coined the name "[Elektron](https://en.wikipedia.org/wiki/Elektron_(alloy))" for magnesium alloy, a term which is still used today. In the commercial aerospace industry, magnesium was generally restricted to engine-related components, due to fire and corrosion hazards. Currently, magnesium alloy use in aerospace is increasing, driven by the importance of fuel economy.[[32]](https://en.wikipedia.org/wiki/Magnesium#cite_note-33) Development and testing of new magnesium alloys continues, notably Elektron 21, which (in test) has proved suitable for aerospace engine, internal, and airframe components.[[33]](https://en.wikipedia.org/wiki/Magnesium#cite_note-34) The European Community runs three R&D magnesium projects in the Aerospace priority of Six Framework Program.

In the form of thin ribbons, magnesium is used to [purify solvents](https://en.wikipedia.org/wiki/Solvent#Desiccant); for example, preparing super-dry ethanol.

**Aircraft**

* [Wright Aeronautical](https://en.wikipedia.org/wiki/Wright_Aeronautical) used a magnesium [crankcase](https://en.wikipedia.org/wiki/Crankcase) in the WWII-era [Wright Duplex Cyclone](https://en.wikipedia.org/wiki/Wright_R-3350) aviation engine. This presented a serious problem for the earliest models of the [Boeing B-29](https://en.wikipedia.org/wiki/Boeing_B-29) heavy bomber when an in-flight engine fire ignited the engine crankcase. The resulting combustion was as hot as 5,600 °F (3,100 °C) and could sever the wing spar from the [fuselage](https://en.wikipedia.org/wiki/Fuselage).[[34]](https://en.wikipedia.org/wiki/Magnesium#cite_note-35)[[35]](https://en.wikipedia.org/wiki/Magnesium#cite_note-36)[[36]](https://en.wikipedia.org/wiki/Magnesium#cite_note-37)

**Automotive**

[](https://en.wikipedia.org/wiki/File:Mg_alloy_car_engine_blocks.jpg)

Mg alloy motorcycle engine blocks

* [Mercedes-Benz](https://en.wikipedia.org/wiki/Mercedes-Benz) used the alloy [Elektron](https://en.wikipedia.org/wiki/Elektron_(alloy)) in the body of an early model [Mercedes-Benz 300 SLR](https://en.wikipedia.org/wiki/Mercedes-Benz_300_SLR); these cars ran (with successes) at [Le Mans](https://en.wikipedia.org/wiki/24_Hours_of_Le_Mans), the [Mille Miglia](https://en.wikipedia.org/wiki/Mille_Miglia), and other world-class race events in 1955.
* [Porsche](https://en.wikipedia.org/wiki/Porsche) used magnesium alloy frames in the [917/053](https://en.wikipedia.org/wiki/Porsche_917) that won Le Mans in 1971, and continues to use magnesium alloys for its engine blocks due to the weight advantage.
* [Volkswagen Group](https://en.wikipedia.org/wiki/Volkswagen_Group) has used magnesium in its engine components for many years.[[*citation needed*](https://en.wikipedia.org/wiki/Wikipedia:Citation_needed)]
* [Mitsubishi Motors](https://en.wikipedia.org/wiki/Mitsubishi_Motors) uses magnesium for its [paddle shifters](https://en.wikipedia.org/wiki/Paddle_shifters).
* [BMW](https://en.wikipedia.org/wiki/BMW) used magnesium alloy blocks in their [N52](https://en.wikipedia.org/wiki/BMW_N52) engine, including an aluminium alloy insert for the cylinder walls and cooling jackets surrounded by a high-temperature magnesium alloy AJ62A. The engine was used worldwide between 2005 and 2011 in various 1, 3, 5, 6, and 7 series models; as well as the Z4, X1, X3, and X5.
* [Chevrolet](https://en.wikipedia.org/wiki/Chevrolet) used the magnesium alloy AE44 in the 2006 Corvette [Z06](https://en.wikipedia.org/wiki/Corvette_C6).

Both AJ62A and AE44 are recent developments in high-temperature low-[creep](https://en.wikipedia.org/wiki/Creep_(deformation)) magnesium alloys. The general strategy for such alloys is to form [intermetallic](https://en.wikipedia.org/wiki/Intermetallic) precipitates at the [grain boundaries](https://en.wikipedia.org/wiki/Crystallite), for example by adding [mischmetal](https://en.wikipedia.org/wiki/Mischmetal) or [calcium](https://en.wikipedia.org/wiki/Calcium).[[37]](https://en.wikipedia.org/wiki/Magnesium#cite_note-38) New alloy development and lower costs that make magnesium competitive with aluminium will increase the number of automotive applications.

**Electronics**

Because of low weight and good mechanical and electrical properties, magnesium is widely used for manufacturing of mobile phones, laptop and [tablet computers](https://en.wikipedia.org/wiki/Tablet_computers), cameras, and other electronic components.

[](https://en.wikipedia.org/wiki/File:Magnesium-products.jpg)

Products made of magnesium: firestarter and shavings, sharpener, magnesium ribbon

**Other**

Magnesium, being readily available and relatively nontoxic, has a variety of uses:

* Magnesium is flammable, burning at a temperature of approximately 3,100 °C (3,370 K; 5,610 °F),[[10]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Dreizin,_Edward_L.;_Berman,_Charles_H._and_Vicenzi,_Edward_P._2000_30-10) and the [autoignition temperature](https://en.wikipedia.org/wiki/Autoignition_temperature) of magnesium ribbon is approximately 473 °C (746 K; 883 °F).[[38]](https://en.wikipedia.org/wiki/Magnesium#cite_note-39) It produces intense, bright, white light when it burns. Magnesium's high combustion temperature makes it a useful tool for starting emergency fires. Other uses include flash [photography](https://en.wikipedia.org/wiki/Photography), flares, [pyrotechnics](https://en.wikipedia.org/wiki/Pyrotechnics), and fireworks sparklers. Magnesium is also often used to ignite thermite or other materials that require a high ignition temperature.

[](https://en.wikipedia.org/wiki/File:Magnesium_Sparks.jpg)

* Magnesium firestarter (in left hand), used with a [pocket knife](https://en.wikipedia.org/wiki/Pocket_knife) and flint to create sparks that ignite the shavings
* In the form of turnings or ribbons, to prepare [Grignard reagents](https://en.wikipedia.org/wiki/Grignard_reagent), which are useful in [organic synthesis](https://en.wikipedia.org/wiki/Organic_synthesis).
* As an additive agent in conventional propellants and the production of [nodular graphite in cast iron](https://en.wikipedia.org/wiki/Ductile_iron).
* As a reducing agent to separate [uranium](https://en.wikipedia.org/wiki/Uranium) and other metals from their [salts](https://en.wikipedia.org/wiki/Salt_(chemistry)).
* As a [sacrificial (galvanic) anode](https://en.wikipedia.org/wiki/Sacrificial_anode) to protect boats, underground tanks, pipelines, buried structures, and water heaters.
* Alloyed with zinc to produce the zinc sheet used in [photoengraving](https://en.wikipedia.org/wiki/Photoengraving) plates in the printing industry, [dry-cell battery](https://en.wikipedia.org/wiki/Dry_cell) walls, and [roofing](https://en.wikipedia.org/wiki/Flashing_(weatherproofing)).[[29]](https://en.wikipedia.org/wiki/Magnesium#cite_note-BakerM._M._Avedesian1999-30)
* As a metal, this element's principal use is as an alloying additive to aluminium with these aluminium-magnesium alloys being used mainly for [beverage cans](https://en.wikipedia.org/wiki/Beverage_can), sports equipment such as golf clubs, fishing reels, and archery bows and arrows.
* Specialty, high-grade car wheels of magnesium alloy are called "[mag wheels](https://en.wikipedia.org/wiki/Magnesium_alloy_wheel)", although the term is often misapplied to aluminium wheels. Many car and aircraft manufacturers have made engine and body parts from magnesium.
* [Magnesium batteries](https://en.wikipedia.org/wiki/Magnesium_battery) have been commercialized as [primary batteries](https://en.wikipedia.org/wiki/Primary_battery), and are an active topic of research for rechargeable [secondary batteries](https://en.wikipedia.org/wiki/Secondary_battery).

**Safety precautions**

[播放媒体](https://upload.wikimedia.org/wikipedia/commons/d/db/Burning_Magnesium_Block%21.ogv)

Magnesium block heated with [blowtorch](https://en.wikipedia.org/wiki/Blow_torch) to self-combustion, emitting intense white light

|  |  |
| --- | --- |
| Magnesium | |
| **Hazards** | |
| [GHS pictograms](https://en.wikipedia.org/wiki/GHS_hazard_pictograms) | [The flame pictogram in the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)](https://en.wikipedia.org/wiki/File:GHS-pictogram-flamme.svg) |
| [GHS signal word](https://en.wikipedia.org/wiki/Globally_Harmonized_System_of_Classification_and_Labelling_of_Chemicals) | Danger |
| [GHS hazard statements](https://en.wikipedia.org/wiki/GHS_hazard_statement) | H228, H251, H261 |
| [GHS precautionary statements](https://en.wikipedia.org/wiki/GHS_precautionary_statements) | P210, P231, P235, P410, P422[[39]](https://en.wikipedia.org/wiki/Magnesium#cite_note-40) |
| [NFPA 704](https://en.wikipedia.org/wiki/NFPA_704) | NFPA 704 four-colored diamond  [0](https://en.wikipedia.org/wiki/NFPA_704#Red)  [0](https://en.wikipedia.org/wiki/NFPA_704#Blue)  [2](https://en.wikipedia.org/wiki/NFPA_704#Yellow) |

Magnesium metal and its alloys can be explosive hazards; they are highly flammable in their pure form when molten or in powder or ribbon form. Burning or molten magnesium reacts violently with water. When working with powdered magnesium, [safety glasses](https://en.wikipedia.org/wiki/Safety_glasses) with [eye protection](https://en.wikipedia.org/wiki/Eye_protection) and UV filters (such as welders use) are employed because burning magnesium produces [ultraviolet](https://en.wikipedia.org/wiki/Ultraviolet) light that can permanently damage the [retina](https://en.wikipedia.org/wiki/Retina) of a human eye.[[40]](https://en.wikipedia.org/wiki/Magnesium#cite_note-41)

Magnesium is capable of reducing [water](https://en.wikipedia.org/wiki/Water_(molecule)) and releasing highly flammable [hydrogen](https://en.wikipedia.org/wiki/Hydrogen) gas:[[41]](https://en.wikipedia.org/wiki/Magnesium#cite_note-42)

Mg (s) + 2 H  
2O (l) → [Mg(OH)  
2](https://en.wikipedia.org/wiki/Magnesium_hydroxide) (s) + H  
2 (g)

Therefore, water cannot extinguish magnesium fires. The hydrogen gas produced intensifies the fire. Dry sand is an effective smothering agent, but only on relatively level and flat surfaces.

Magnesium reacts with [carbon dioxide](https://en.wikipedia.org/wiki/Carbon_dioxide) exothermically to form [magnesium oxide](https://en.wikipedia.org/wiki/Magnesium_oxide) and [carbon](https://en.wikipedia.org/wiki/Carbon):[[42]](https://en.wikipedia.org/wiki/Magnesium#cite_note-43)

2 Mg + CO  
2 → 2 MgO + C (s)

Hence, carbon dioxide fuels rather than extinguishes magnesium fires.

Burning magnesium can be quenched by using a [Class D](https://en.wikipedia.org/wiki/Fire_extinguisher#Class_D) dry chemical fire extinguisher, or by covering the fire with [sand](https://en.wikipedia.org/wiki/Sand) or magnesium foundry flux to remove its air source.[[43]](https://en.wikipedia.org/wiki/Magnesium#cite_note-44)

**Useful compounds**

Magnesium compounds, primarily [magnesium oxide](https://en.wikipedia.org/wiki/Magnesium_oxide) (MgO), are used as a [refractory](https://en.wikipedia.org/wiki/Refractory) material in [furnace](https://en.wikipedia.org/wiki/Furnace) linings for producing [iron](https://en.wikipedia.org/wiki/Iron), [steel](https://en.wikipedia.org/wiki/Steel), [nonferrous metals](https://en.wikipedia.org/wiki/Nonferrous_metal), [glass](https://en.wikipedia.org/wiki/Glass), and [cement](https://en.wikipedia.org/wiki/Cement). Magnesium oxide and other magnesium compounds are also used in the agricultural, chemical, and construction industries. Magnesium oxide from [calcination](https://en.wikipedia.org/wiki/Calcination) is used as an electrical insulator in [fire-resistant cables](https://en.wikipedia.org/wiki/Mineral-insulated_copper-clad_cable).[[44]](https://en.wikipedia.org/wiki/Magnesium#cite_note-45)

Magnesium reacted with an [alkyl halide](https://en.wikipedia.org/wiki/Alkyl_halide) gives a [Grignard reagent](https://en.wikipedia.org/wiki/Grignard_reaction), which is a very useful tool for preparing [alcohols](https://en.wikipedia.org/wiki/Alcohols).

Magnesium salts are included in various [foods](https://en.wikipedia.org/wiki/Food), [fertilizers](https://en.wikipedia.org/wiki/Fertilizer) (magnesium is a component of [chlorophyll](https://en.wikipedia.org/wiki/Chlorophyll)), and [microbe culture media](https://en.wikipedia.org/wiki/Culture_medium).

[Magnesium sulfite](https://en.wikipedia.org/wiki/Magnesium_sulfite) is used in the manufacture of [paper](https://en.wikipedia.org/wiki/Paper) ([sulfite process](https://en.wikipedia.org/wiki/Sulfite_process)).

[Magnesium phosphate](https://en.wikipedia.org/wiki/Magnesium_phosphate) is used to fireproof wood used in construction.

Magnesium hexafluorosilicate is used for moth-proofing [textiles](https://en.wikipedia.org/wiki/Textile).

**Biological roles**

Main article: [Magnesium in biology](https://en.wikipedia.org/wiki/Magnesium_in_biology)

**Mechanism of action**

The important interaction between [phosphate](https://en.wikipedia.org/wiki/Phosphate) and magnesium ions makes magnesium essential to the basic [nucleic acid](https://en.wikipedia.org/wiki/Nucleic_acid) chemistry of all cells of all known living organisms. More than 300 [enzymes](https://en.wikipedia.org/wiki/Enzyme) require magnesium ions for their catalytic action, including all enzymes using or synthesizing [ATP](https://en.wikipedia.org/wiki/Adenosine_triphosphate) and those that use other [nucleotides](https://en.wikipedia.org/wiki/Nucleotides) to synthesize [DNA](https://en.wikipedia.org/wiki/DNA) and [RNA](https://en.wikipedia.org/wiki/RNA). The ATP molecule is normally found in a [chelate](https://en.wikipedia.org/wiki/Chelation) with a magnesium ion.[[45]](https://en.wikipedia.org/wiki/Magnesium#cite_note-46)

**Dietary sources, recommended intake, and supplementation**

[](https://en.wikipedia.org/wiki/File:FoodSourcesOfMagnesium.jpg)

Examples of food sources of magnesium (clockwise from top left): bran muffins, pumpkin seeds, barley, buckwheat flour, low-fat vanilla yogurt, trail mix, halibut steaks, garbanzo beans, lima beans, soybeans, and spinach

Spices, nuts, cereals, cocoa and vegetables are rich sources of magnesium.[[9]](https://en.wikipedia.org/wiki/Magnesium#cite_note-nih-9) Green leafy vegetables such as [spinach](https://en.wikipedia.org/wiki/Spinach) are also rich in magnesium.[[46]](https://en.wikipedia.org/wiki/Magnesium#cite_note-mlp-47)

In the [UK](https://en.wikipedia.org/wiki/United_Kingdom), the [recommended daily values](https://en.wikipedia.org/wiki/Dietary_Reference_Intake) for magnesium are 300 mg for men and 270 mg for women.[[47]](https://en.wikipedia.org/wiki/Magnesium#cite_note-48) In the U.S. the Recommended Dietary Allowances (RDAs) are 400 mg for men ages 19–30 and 420 mg for older; for women 310 mg for ages 19–30 and 320 mg for older.[[48]](https://en.wikipedia.org/wiki/Magnesium#cite_note-49)

Numerous [pharmaceutical preparations of magnesium](https://en.wikipedia.org/wiki/Magnesium_(pharmaceutical_preparation)) and [dietary supplements](https://en.wikipedia.org/wiki/Dietary_supplement) are available. In two human trials magnesium oxide, one of the most common forms in magnesium dietary supplements because of its high magnesium content per weight, was less bioavailable than [magnesium citrate](https://en.wikipedia.org/wiki/Magnesium_citrate), chloride, lactate or aspartate.[[49]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Firoz2001-50)[[50]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Lindberg1990-51)

**Metabolism**

An adult has 22–26 grams of magnesium,[[9]](https://en.wikipedia.org/wiki/Magnesium#cite_note-nih-9)[[51]](https://en.wikipedia.org/wiki/Magnesium#cite_note-52) with 60% in the [skeleton](https://en.wikipedia.org/wiki/Skeleton), 39% intracellular (20% in skeletal muscle), and 1% extracellular.[[9]](https://en.wikipedia.org/wiki/Magnesium#cite_note-nih-9) Serum levels are typically 0.7–1.0 mmol/L or 1.8–2.4 mEq/L. Serum magnesium levels may be normal even when intracellular magnesium is deficient. The mechanisms for maintaining the magnesium level in the serum are varying [gastrointestinal](https://en.wikipedia.org/wiki/Gastrointestinal_tract) absorption and [renal](https://en.wikipedia.org/wiki/Renal) excretion. Intracellular magnesium is correlated with intracellular [potassium](https://en.wikipedia.org/wiki/Potassium). Increased magnesium lowers [calcium](https://en.wikipedia.org/wiki/Calcium)[[52]](https://en.wikipedia.org/wiki/Magnesium#cite_note-ummedu-53) and can either prevent hypercalcemia or cause hypocalcemia depending on the initial level.[[52]](https://en.wikipedia.org/wiki/Magnesium#cite_note-ummedu-53) Both low and high protein intake conditions inhibit magnesium absorption, as does the amount of [phosphate](https://en.wikipedia.org/wiki/Phosphate), [phytate](https://en.wikipedia.org/wiki/Phytate), and [fat](https://en.wikipedia.org/wiki/Fat) in the gut. Unabsorbed dietary magnesium is excreted in feces; absorbed magnesium is excreted in urine and sweat.[[53]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Wester1987-54)

**Detection in serum and plasma**

Magnesium status may be assessed by measuring serum and erythrocyte magnesium concentrations coupled with [urinary](https://en.wikipedia.org/wiki/Urinary_system) and [fecal](https://en.wikipedia.org/wiki/Feces) magnesium content, but intravenous magnesium loading tests are more accurate and practical.[[54]](https://en.wikipedia.org/wiki/Magnesium#cite_note-55) A retention of 20% or more of the injected amount indicates deficiency.[[55]](https://en.wikipedia.org/wiki/Magnesium#cite_note-56) No [biomarker](https://en.wikipedia.org/wiki/Biomarker) has been established for magnesium.[[56]](https://en.wikipedia.org/wiki/Magnesium#cite_note-57)

Magnesium concentrations in plasma or serum may be monitored for efficacy and safety in those receiving the drug [therapeutically](https://en.wikipedia.org/wiki/Therapy), to confirm the diagnosis in potential [poisoning](https://en.wikipedia.org/wiki/Poison) victims, or to assist in the [forensic](https://en.wikipedia.org/wiki/Forensic_science) investigation in a case of fatal overdose. The newborn children of mothers who received [parenteral](https://en.wikipedia.org/wiki/Parenteral_nutrition) magnesium sulfate during labor may exhibit toxicity with normal serum magnesium levels.[[57]](https://en.wikipedia.org/wiki/Magnesium#cite_note-58)

**Deficiency**

Low plasma magnesium ([hypomagnesemia](https://en.wikipedia.org/wiki/Hypomagnesemia)) is common: it is found in 2.5–15% of the general population.[[58]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Ayuk-59) From 2005 to 2006, 48 percent of the [United States](https://en.wikipedia.org/wiki/United_States) population consumed less magnesium than recommended in the [Dietary Reference Intake](https://en.wikipedia.org/wiki/Dietary_Reference_Intake).[[59]](https://en.wikipedia.org/wiki/Magnesium#cite_note-60) Other causes are increased renal or gastrointestinal loss, an increased intracellular shift, and proton-pump inhibitor antacid therapy. Most are asymptomatic, but symptoms referable to [neuromuscular](https://en.wikipedia.org/wiki/Neuromuscular_medicine), [cardiovascular](https://en.wikipedia.org/wiki/Circulatory_system), and metabolic dysfunction may occur.[[58]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Ayuk-59) [Alcoholism](https://en.wikipedia.org/wiki/Alcoholism) is often associated with magnesium deficiency. Chronically low serum magnesium levels are associated with [metabolic syndrome](https://en.wikipedia.org/wiki/Metabolic_syndrome), [diabetes mellitus type 2](https://en.wikipedia.org/wiki/Diabetes_mellitus_type_2), [fasciculation](https://en.wikipedia.org/wiki/Fasciculation), and hypertension.[[60]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Geiger2012-61)

**Therapy**

* Intravenous magnesium is recommended by the ACC/AHA/ESC 2006 Guidelines for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death for patients with ventricular [arrhythmia](https://en.wikipedia.org/wiki/Heart_arrhythmia) associated with [torsades de pointes](https://en.wikipedia.org/wiki/Torsades_de_pointes) who present with [long QT syndrome](https://en.wikipedia.org/wiki/Long_QT_syndrome); and for the treatment of patients with digoxin induced arrhythmias.[[61]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Zipes2006-62)
* Magnesium sulfate – intravenous – is used for the management of [pre-eclampsia](https://en.wikipedia.org/wiki/Pre-eclampsia) and [eclampsia](https://en.wikipedia.org/wiki/Eclampsia).[[62]](https://en.wikipedia.org/wiki/Magnesium#cite_note-James2010-63)[[63]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Euser2009-64)
* Hypomagnesemia, including that caused by alcoholism, is reversible by oral or parenteral magnesium administration depending on the degree of deficiency.[[64]](https://en.wikipedia.org/wiki/Magnesium#cite_note-65)
* There is limited evidence that magnesium supplementation may play a role in the prevention and treatment of [migraine](https://en.wikipedia.org/wiki/Migraine).[[65]](https://en.wikipedia.org/wiki/Magnesium#cite_note-migraine-66)

Sorted by type of magnesium salt, other therapeutic applications include:

* [Magnesium sulfate](https://en.wikipedia.org/wiki/Magnesium_sulfate), as the [heptahydrate](https://en.wikipedia.org/wiki/Hydrate) called Epsom salts, is used as [bath salts](https://en.wikipedia.org/wiki/Bath_salts), a [laxative](https://en.wikipedia.org/wiki/Laxative), and a highly soluble [fertilizer](https://en.wikipedia.org/wiki/Fertilizer).[[66]](https://en.wikipedia.org/wiki/Magnesium#cite_note-67)
* [Magnesium hydroxide](https://en.wikipedia.org/wiki/Magnesium_hydroxide), suspended in water, is used in [milk of magnesia](https://en.wikipedia.org/wiki/Milk_of_magnesia) [antacids](https://en.wikipedia.org/wiki/Antacid) and [laxatives](https://en.wikipedia.org/wiki/Laxative).
* [Magnesium chloride](https://en.wikipedia.org/wiki/Magnesium_chloride), [oxide](https://en.wikipedia.org/wiki/Magnesium_oxide), [gluconate](https://en.wikipedia.org/wiki/Magnesium_gluconate), [malate](https://en.wikipedia.org/wiki/Magnesium_malate), [orotate](https://en.wikipedia.org/wiki/Magnesium_orotate), glycinate, [ascorbate](https://en.wikipedia.org/wiki/Ascorbate) and [citrate](https://en.wikipedia.org/wiki/Magnesium_citrate) are all used as oral magnesium supplements.
* [Magnesium borate](https://en.wikipedia.org/wiki/Borate), [magnesium salicylate](https://en.wikipedia.org/wiki/Magnesium_salicylate), and [magnesium sulfate](https://en.wikipedia.org/wiki/Magnesium_sulfate) are used as [antiseptics](https://en.wikipedia.org/wiki/Antiseptic).
* [Magnesium bromide](https://en.wikipedia.org/wiki/Magnesium_bromide) is used as a mild [sedative](https://en.wikipedia.org/wiki/Sedative) (this action is due to the [bromide](https://en.wikipedia.org/wiki/Bromide), not the magnesium).
* [Magnesium stearate](https://en.wikipedia.org/wiki/Magnesium_stearate) is a slightly [flammable](https://en.wikipedia.org/wiki/Fire) white [powder](https://en.wikipedia.org/wiki/Powder_(substance)) with [lubricating](https://en.wikipedia.org/wiki/Lubricant) properties. In [pharmaceutical](https://en.wikipedia.org/wiki/Pharmacology) technology, it is used in pharmacological manufacture to prevent [tablets](https://en.wikipedia.org/wiki/Tablet_(pharmacy)) from sticking to the equipment while compressing the ingredients into tablet form.
* Magnesium carbonate powder is used by athletes such as [gymnasts](https://en.wikipedia.org/wiki/Gymnastics), [weightlifters](https://en.wikipedia.org/wiki/Olympic_weightlifting), and [climbers](https://en.wikipedia.org/wiki/Climbing) to eliminate palm sweat, prevent sticking, and improve the grip on gymnastic apparatus, lifting bars, and climbing rocks.

**Overdose**

Overdose from dietary sources alone is unlikely because excess magnesium in the blood is promptly filtered by the [kidneys](https://en.wikipedia.org/wiki/Kidney),[[58]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Ayuk-59) and overdose is more likely in the presence of impaired renal function. In spite of this, [megadose therapy](https://en.wikipedia.org/wiki/Megavitamin_therapy) has caused death in a young child,[[67]](https://en.wikipedia.org/wiki/Magnesium#cite_note-68) and severe [hypermagnesemia](https://en.wikipedia.org/wiki/Hypermagnesemia) in a woman[[68]](https://en.wikipedia.org/wiki/Magnesium#cite_note-Kontani_M,_Hara_A,_Ohta_S,_Ikeda_T_2005_448–452-69) and a young girl[[69]](https://en.wikipedia.org/wiki/Magnesium#cite_note-70) who had healthy kidneys. The most common symptoms of overdose are [nausea](https://en.wikipedia.org/wiki/Nausea), [vomiting](https://en.wikipedia.org/wiki/Vomiting), and [diarrhea](https://en.wikipedia.org/wiki/Diarrhea); other symptoms include [hypotension](https://en.wikipedia.org/wiki/Hypotension), confusion, slowed heart and [respiratory](https://en.wikipedia.org/wiki/Respiratory_system) rate, deficiencies of other minerals, [coma](https://en.wikipedia.org/wiki/Coma), [cardiac arrhythmia](https://en.wikipedia.org/wiki/Cardiac_arrhythmia/bradycardia), and death from [cardiac arrest](https://en.wikipedia.org/wiki/Cardiac_arrest).[[52]](https://en.wikipedia.org/wiki/Magnesium#cite_note-ummedu-53)

**Function in plants**

[Plants](https://en.wikipedia.org/wiki/Plants) require magnesium to synthesize [chlorophyll](https://en.wikipedia.org/wiki/Chlorophyll), essential for [photosynthesis](https://en.wikipedia.org/wiki/Photosynthesis). Magnesium in the center of the [porphyrin ring](https://en.wikipedia.org/wiki/Porphyrin_ring) in chlorophyll functions in a manner similar to the iron in the center of the porphyrin ring in [heme](https://en.wikipedia.org/wiki/Heme). [Magnesium deficiency](https://en.wikipedia.org/wiki/Magnesium_deficiency_(plants)) in plants causes late-season yellowing between leaf veins, especially in older leaves, and can be corrected by either applying [epsom salts](https://en.wikipedia.org/wiki/Epsom_salts) (which is rapidly [leached](https://en.wikipedia.org/wiki/Leaching_(chemical_science))), or crushed [dolomitic](https://en.wikipedia.org/wiki/Dolomite) [limestone](https://en.wikipedia.org/wiki/Limestone), to the soil.

**See also**

* [List of countries by magnesium production](https://en.wikipedia.org/wiki/List_of_countries_by_magnesium_production)
* [Magnesium oil](https://en.wikipedia.org/wiki/Magnesium_oil)

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**Notes**

* 1. Capacity. Production figures withheld to avoid disclosing company proprietary data.

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