

Critical Mineral Resources of the United States— Economic and Environmental Geology and Prospects for Future Supply



Professional Paper 1802

**U.S. Department of the Interior
U.S. Geological Survey**

Periodic Table of Elements

1A																	8A				
1 H hydrogen 1.008																	2 He helium 4.003				
3 Li lithium 6.94	4 Be beryllium 9.012															5 B boron 10.81	6 C carbon 12.01	7 N nitrogen 14.01	8 O oxygen 16.00	9 F fluorine 19.00	10 Ne neon 20.18
11 Na sodium 22.99	12 Mg magnesium 24.31															13 Al aluminum 26.98	14 Si silicon 28.09	15 P phosphorus 30.97	16 S sulfur 32.06	17 Cl chlorine 35.45	18 Ar argon 39.95
19 K potassium 39.10	20 Ca calcium 40.08	21 Sc scandium 44.96	22 Ti titanium 47.88	23 V vanadium 50.94	24 Cr chromium 52.00	25 Mn manganese 54.94	26 Fe iron 55.85	27 Co cobalt 58.93	28 Ni nickel 58.69	29 Cu copper 63.55	30 Zn zinc 65.39	31 Ga gallium 69.72	32 Ge germanium 72.64	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.90	36 Kr krypton 83.79				
37 Rb rubidium 85.47	38 Sr strontium 87.62	39 Y yttrium 88.91	40 Zr zirconium 91.22	41 Nb niobium 92.91	42 Mo molybdenum 95.96	43 Tc technetium (98)	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3				
55 Cs cesium 132.9	56 Ba barium 137.3	*	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.9	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.5	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium (209)	85 At astatine (210)	86 Rn radon (222)				
87 Fr francium (223)	88 Ra radium (226)	**	104 Rf rutherfordium (261)	105 Db dubnium (268)	106 Sg seaborgium (271)	107 Bh bohrium (270)	108 Hs hassium (277)	109 Mt meitnerium (276)	110 Ds darmstadtium (281)	111 Rg roentgenium (280)	112 Cn copernicium (285)	113 Uut ununtrium (284)	114 Fl flerovium (289)	115 Uup ununpentium (288)	116 Lv livermorium (293)	117 Uus ununseptium (294)	118 Uuo ununoctium (294)				
Lanthanide Series*			57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium (145)	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.2	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.0	71 Lu lutetium 175.0				
Actinide Series**			89 Ac actinium (227)	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium (237)	94 Pu plutonium (244)	95 Am americium (243)	96 Cm curium (247)	97 Bk berkelium (247)	98 Cf californium (251)	99 Es einsteinium (252)	100 Fm fermium (257)	101 Md mendelevium (288)	102 No nobelium (259)	103 Lr lawrencium (262)				



Los Alamos

NATIONAL LABORATORY



element names in **blue** are liquids at room temperature

element names in **red** are gases at room temperature

element names in **black** are solids at room temperature

Modified from Los Alamos National Laboratory Chemistry Division; available at <http://periodic.lanl.gov/images/periodictable.pdf>.

Front cover (clockwise starting at top left).

Dry Lake Wind Power Project. This 63-megawatt-capacity facility in Arizona was the first utility-scale power project. The large wind turbines use generators that contain strong permanent magnets composed of neodymium-iron-boron. Photograph courtesy of Iberdrola Renewables, Inc., NREL 16701.

U.S. Air Force F-35 Lightning II Joint Strike Fighter. This and many other aerospace vehicles rely on electrical and mechanical components made of beryllium alloys. Photograph courtesy of the U.S. Air Force.

Flat-panel display and touchscreen devices. The screens are coated with indium-tin oxide, for which there are few chemical substitutes. Photograph by C.N. Mercer, U.S. Geological Survey.

Solar photovoltaic cells. This 2-megawatt ground-mounted array occupies the site of a former landfill at Fort Carson, Colorado. Tellurium is a critical component for the development of efficient thin-film photovoltaic cells that are needed for the production of electricity from sunlight. Photograph courtesy of the U.S. Department of Energy Western Area Power Administration.

Back cover. A handful of stibnite, which is the primary ore mineral for antimony. Antimony is widely used in plastics, rubbers, paints, and textiles, including industrial safety suits and some children's clothing, to make them resistant to the spread of flames. Photograph by Niki Wintzer, U.S. Geological Survey.

Front and back covers background image. Lithium-brine evaporating ponds at Clayton Valley, Nevada. Lithium has many uses, the most prominent being in batteries for cell phones, laptop computers, and electric and hybrid vehicles. Photograph by Doc Searls/CC-BY-2.0, http://commons.wikimedia.org/wiki/File:Chemetall_Foote_Lithium_Operation.jpg.

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