



BICYCLE MINERALS

Bicycles are used as a form of transportation, for fun and exercise, and even in professions like messenger delivery and sports. Bicycles are made with materials that come from mining.

Think About It: Have you ever wondered what materials are needed to make a bicycle and how we get these materials? Where are these materials found?

Minerals in Your Everyday Life



Directions for Activity:

The table on this page lists many of the mineral resources needed to make a bicycle, the percentage of the mineral resource imported by the United States and major sources. Add how each mineral resource is used in making a bicycle to this table. Then answer the questions on the back.

Mineral Resources Needed to Make a Bicycle

Mineral Resource	Net % Imported by U.S.	Major Sources	% U.S. Self-Sufficiency (Subtract % Imported from 100%)	Used In
BAUXITE AND ALUMINA	100	Australia, China, Brazil, Indonesia		
GRAPHITE (natural)	100	China, India, Brazil, North Korea		
IODINE	88	Chile, Japan, China, Azerbaijan, Russia		
IRON ORE	0	China, Australia, Brazil, India		
MAGNESIUM (metal)	31	China, Russia, Israel, United States	69	Example: Frame
MOLYBDENUM	0	China, United States, Chile, Peru		
QUARTZ (industrial sand)	0	United States, Italy, Germany, Australia		
SALT	19	China, United States, Germany, India		
SCANDIUM	100	China, Russia, Ukraine, Kazakhstan		
SULFUR	19	China, United States, Russia, Canada		
TITANIUM (sponge metal)	64	China, Japan, Russia, Kazakhstan		
ZINC	72	China, Australia, Peru, United States		

3 Li lithium 6.94	14 Si silicon 28.08	19 K potassium 39.09	20 C carbon 12.01	29 Cu copper 63.54	31 Ga gallium 69.72	32 Ge germanium 72.63	33 As arsenic 74.92	47 Ag silver 107.86	49 In indium 114.81	50 Sn tin 118.71	73 Ta tantalum 180.94	74 W tungsten 183.84	78 Pt platinum 195.08
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A World of Minerals in Your Mobile Device

Mobile phones and other high-technology communications devices could not exist without mineral commodities. More than one-half of all components in a mobile device—including its electronics, display, battery, speakers, and more—are made from mined and semi-processed materials (mineral commodities). Some mineral commodities can be recovered as byproducts during the production and processing of other commodities. As an example, bauxite is mined for its aluminum content, but gallium is recovered during the aluminum production process. The images below show the **ore minerals** (sources) of some mineral commodities that are used to make components of a mobile device. On the reverse side, the map and table depict the major source countries producing some of these mineral commodities along with how these commodities are used in mobile devices. For more information on minerals, visit <http://minerals.usgs.gov>.

Display

Silica (silicon dioxide or quartz) **sand**, with ceramic materials and then add potassium.

Layers of indium-tin-oxide are used to create transparent circuits in the display. Tin is also the ingredient in circuit board solder, and **cassiterite** is a primary source of tin.

Gallium provides light emitting diode (LED) backlighting. **Bauxite** is the primary source of this commodity.

Sphalerite is the source of indium (used in the screen's conductive coating) and germanium (used in displays and LEDs).

Electronics and Circuitry

The content of copper in a mobile device far exceeds the amount of any other metal. Copper conducts electricity and heat and comes from the source mineral **chalcopyrite**.

Tetrahedrite is a primary source of silver. Silver-based inks on composite boards create electrical pathways through a device.

Silicon, very abundant in the Earth's crust, is produced from the source mineral quartz and is the basis of integrated circuits.

Arsenopyrite is a source of arsenic, which is used in radio frequency and power amplifiers.

Tantalum, from the source mineral **tantalite**, is added to capacitors to regulate voltage and improve the audio quality of a device.

Wolframite is a source of tungsten, which acts as a heat sink and provides the mass for mobile phone vibration.

Battery

Spodumene and subsurface brines are the sources of lithium used in cathodes of lithium-ion batteries.

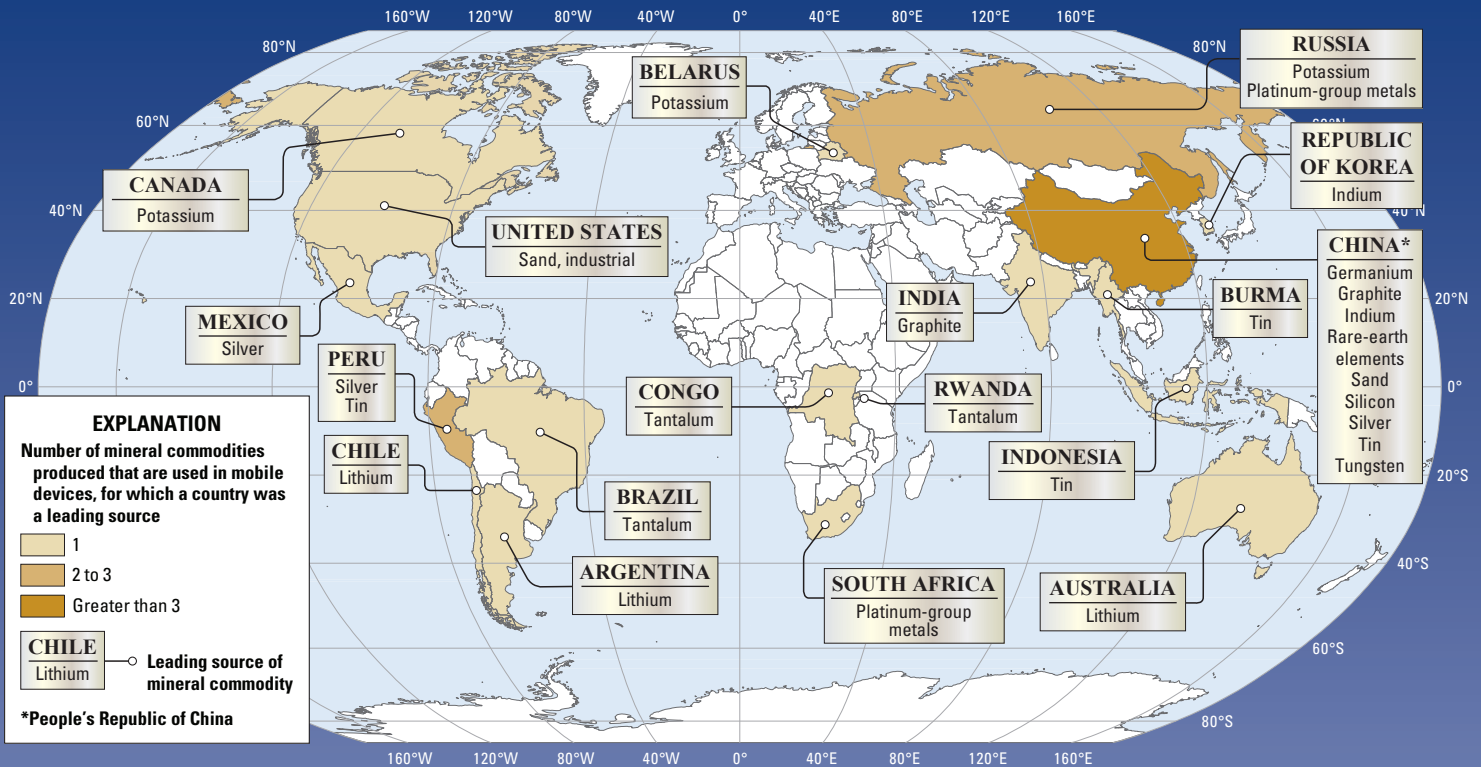
Graphite is used for the anodes of lithium-ion batteries because of its electrical and thermal conductivity.

Speakers and Vibration

Bastnaesite is a source of rare-earth elements used to produce magnets in speakers, microphones, and vibration motors.

Banner image courtesy of freevector-archive.com

Leading sources of mineral commodities used in mobile devices



Examples of mineral commodities used in mobile devices

Mineral commodity	Leading global sources by decreasing tonnage in 2014	Mineral source(s)	Applicable properties of the commodity	Where the commodities are used in a mobile device
Germanium	China ¹	Sphalerite	Conducts electricity	Battery, display, electronics and circuitry, and vibration components.
Graphite	China, India	Graphite	Resists heat, conducts electricity and heat, resists corrosion, and has a high performance-to-weight ratio	Battery anodes.
Indium	China, Republic of Korea	Sphalerite	Transparent and conducts electricity	Liquid crystal displays.
Lithium	Australia, Chile, Argentina, China	Amblygonite, petalite, lepidolite, and spodumene	Chemically reactive and has a high performance-to-weight ratio	Battery cathodes.
Platinum-group metals	South Africa, Russia, Canada	More than 100 different minerals	Conducts electricity	Circuitry, capacitors, and plating.
Potassium	Canada, Russia, Belarus	Langbeinite, sylvite, and sylvinitite	Strengthens glass	Screen glass.
Rare-earth elements	China	Bastnäsite, ion adsorption clays, loparite, monazite, and xenotime	Highly magnetic; blue, green, red, and yellow phosphors; and optical-quality glass	LED phosphors, screens, speakers, and vibration motors.
Sand, industrial	China, ² United States	Silica sand	Gives glass clarity	Screen glass and semiconductors.
Silicon	China	Quartz	Conducts electricity	Semiconductors.
Silver	Mexico, China, Peru	Argentite and tetrahedrite	Conducts electricity	Circuitry.
Tantalum	Rwanda, Brazil, Congo (Kinshasa)	Columbite and tantalite	Stores electrical charge well	Capacitors.
Tin	China, Indonesia, Burma, Peru	Cassiterite	Transparent and conducts electricity	Liquid crystal displays and circuit board solder.
Tungsten	China	Scheelite and wolframite	Highly dense and durable for vibrator's weight component	Vibrator.

¹People's Republic of China, hereinafter referred to as China.

²China is the world's largest producer of industrial sand; however, available information is inadequate to formulate a reliable estimate of output levels.

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ISSN 2332-3531 (print)
ISSN 2332-354X (online)
<http://dx.doi.org/10.3133/gjp167>

WHAT ARE YOU WEARING?!

Material	What is it?	Where does it come from?	Uses
Polyester	Manufactured, synthetic fiber; a type of plastic	Petroleum	Clothing
Nylon	Manufactured, synthetic polymer	Petroleum	Developed as a alternative to silk for parachutes in WWII; clothing, toothbrush bristles, umbrellas, kitchen utensils
Acrylic	Synthetic fiber made of compounds found in natural gas	Compounds extracted from natural gas	Clothing - substitute for wool; carpets, blankets
Spandex	Also called Lycra; type of plastic material made from polymers	Invented from a lab in 1959	Stretchy clothing
Neoprene	Synthetic waterproof rubber	Petroleum	Waterproof clothing; sportswear; wet suits
Polyester Fleece	Synthetic fiber; type of plastic	2 petroleum products – terephthalic & ethylene glycol	Warm clothing; Polartec, Polar Fleece; blankets; hats
Microfiber	Synthetic fiber; type of plastic made from polyester	Petroleum	Clothes; upholstery for furniture; blankets; cleaning cloths
Acetate	Soft and silky semi-synthetic fabric	Cellulose and acetic acid	Clothing – blouses, wedding and party attire, graduation gowns
Lycra	Brand name of Spandex; type of plastic material made from polymers	Invented from a lab in 1959	Stretchy clothing
Gor-Tex	Waterproof and windproof	Perfluorochemicals; “forever chemicals”	Water proof clothing and apparel (shoes, boots); also known as Teflon

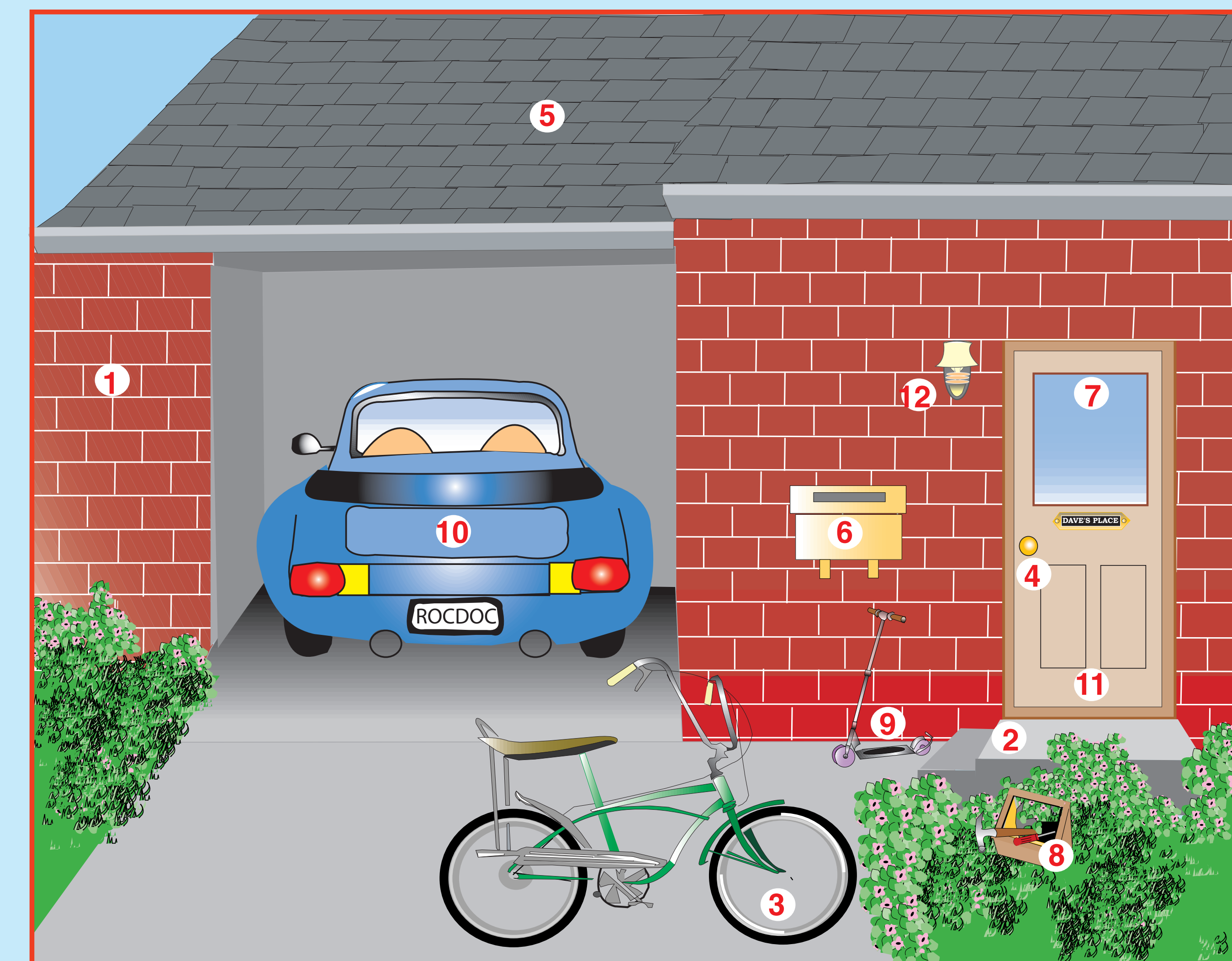
Minerals in Our Environment

- 1. DEODORANT:** Includes aluminum and the container is made of petroleum products.
- 2. TOOTH PASTE:** Includes fluorite, barite and calcite. The container is made of petroleum products or aluminum.
- 3. DRINKING GLASSES:** Includes feldspar, silica and soda ash.
- 4. ABRASIVE CLEANSER:** Includes silica or calcite.
- 5. LIPSTICK AND MAKEUP:** Includes clay, mica, talc, limestone and petroleum products.
- 6. PLUMBING:** Made of copper, clay and petroleum products.
- 7. RUGS:** Includes limestone, petroleum products and selenium.
- 8. PLASTIC SHOWER CURTAINS:** Contains petroleum products.
- 9. FLOWER POT:** Made of clays and metallic minerals for pigments in glaze.
- 10. TALCUM POWDER:** Contains talc and mica.
- 11. DANDRUFF SHAMPOO:** Includes coal tar, lithium clays and selenium. The container is made of petroleum products.
- 12. MIRROR:** Includes feldspar, silica and silver.
- 13. FAUCETS:** Includes iron, nickel and chromium.
- 14. TILES:** Made of clay, feldspar, wollastonite or talc, mineral pigments.
- 15. TOILET:** Includes clays, silica, copper, zinc, petroleum products and borates.



- 1. RADIO:** Includes aluminum, copper, gold, iron and petroleum products.
- 2. TOASTER:** Includes copper, iron, nickel, mica, chromium and petroleum products.
- 3. ELECTRICAL WIRING:** Includes copper, aluminum and petroleum products.
- 4. MICROWAVE:** Includes copper, gold, iron, nickel and silica.
- 5. STOVE:** Includes aluminum, copper, iron, nickel and silica.
- 6. REFRIGERATOR:** Includes aluminum, copper, iron, nickel, petroleum products and zinc.
- 7. TABLE SALT:** Includes halite; light salt can be made from sylvite. Most salt has added iodine.
- 8. PLATES:** Includes clays, silica and feldspar.
- 9. CUTLERY:** Includes iron, nickel, silver and chromium.
- 10. CLOCK:** Includes iron, nickel, petroleum products and silica.
- 11. STAINLESS STEEL SINK:** Includes iron and nickel.
- 12. BLACKBOARD:** Includes clays. Chalk includes limestone or petroleum products.
- 13. MAGNET:** Includes cobalt.
- 14. DISH RACK:** Made of petroleum products.

- 1. COMPUTER:** Includes gold, silica, nickel, aluminum, zinc, iron, petroleum products, and about thirty other minerals.
- 2. PENCIL:** Includes graphite and clays.
- 3. TELEPHONE:** Includes copper, gold and petroleum products.
- 4. BOOKS:** Includes limestone and clays.
- 5. PENS:** Includes limestone, mica, petroleum products, clays, silica and talc.
- 6. FILM:** Includes petroleum products and silver.
- 7. CAMERA:** Includes silica, zinc, copper, aluminum and petroleum products.
- 8. CHAIR:** Includes aluminum and petroleum products.
- 9. TELEVISION:** Includes aluminum, copper, iron, nickel, silica, rare earths, and strontium.
- 10. STEREO:** Includes gold, iron, nickel, beryllium and petroleum products.
- 11. COMPACT DISC:** Includes aluminum and petroleum products.
- 12. METAL CHEST:** Includes iron and nickel. The brass trim is made of copper and zinc.
- 13. CARPET:** Includes limestone, petroleum products and selenium.
- 14. DRYWALL:** Includes gypsum, clay, vermiculite, calcium carbonate and micas.



- 1. BRICKS:** Includes graphite, clays and silica.
- 2. CONCRETE STEP:** Includes gypsum, iron, limestone, clays and silica.
- 3. BIKE:** Includes barite, iron, nickel and petroleum products.
- 4. DOOR KNOB:** Includes copper and zinc, which make brass.
- 5. SHINGLES:** Includes petroleum products and clays.
- 6. MAIL BOX:** Includes copper and zinc, which make brass.
- 7. WINDOWS:** Includes silica, feldspar, soda ash, coal and salt.
- 8. TOOLS:** Includes iron and nickel.
- 9. SCOOTER:** Includes aluminum, calcite, mica, nickel, petroleum products, clays, silica and talc.
- 10. AUTOMOBILE:** Includes aluminum, barite, calcite, iron, lead, mica, nickel, petroleum products, clays, silica and zinc.
- 11. PAINT:** Includes titanium, gypsum, barite and sulfur.
- 12. LIGHT AND FIXTURE:** Includes tungsten, molybdenum, aluminum, silica, copper and zinc.

What's In A Hybrid Car?



- **Bauxite (aluminum).** Mined in Australia, China, Brazil, India, Guinea, Jamaica, Russia, Venezuela, Suriname, Kazakhstan, Guyana and Greece.
- **Cadmium (batteries).** Mined in China, Republic of Korea, Japan, Kazakhstan, Mexico, Canada, Russia, United States, India, Netherlands, Poland, Germany and Australia.
- **Chromite (chromium).** Mined in South Africa, India and Kazakhstan.
- **Coal (by-product coke is used to make steel).** Coal is mined world-wide, and constitutes 45% of the generation of U.S. electricity.
- **Cobalt (alloy; batteries).** Mined in Congo-Kinshasa, Canada, Zambia, Russia, Australia, China, Cuba, Morocco, New Caledonia and Brazil.
- **Copper (wiring).** Mined in Chile, United States, Peru, China, Australia, Russia, Indonesia, Canada, Zambia, Poland and Mexico.
- **Gold (circuitry).** Mined in China, United States, Australia, South Africa, Peru, Canada, Uzbekistan, Ghana, Papua New Guinea, Indonesia, Brazil, Mexico and Chile.
- **Iron ore (steel).** Mined in China, Brazil, Australia, India, Russia, Ukraine, United States, South Africa, Iran, Canada, Sweden, Kazakhstan, Venezuela and Mexico.
- **Lead (batteries).** Mined in China, Australia, United States, Peru, Mexico, Canada, India, Bolivia, Poland, Russia, Sweden, Ireland and South Africa.
- **Lithium (batteries).** Mined in Chile, Australia, China, Argentina, Portugal, Zimbabwe and Brazil.
- **Manganese (steel alloy).** Mined in South Africa, Australia, China, Gabon, Brazil, India, Ukraine and Mexico.
- **Molybdenum (steel alloy).** Mined in China, United States, Chile, Peru, Mexico, Canada, Armenia, Iran, Russia and Mongolia.
- **Nickel (batteries; alloy).** Mined in Russia, Canada, Australia, Indonesia, New Caledonia, Philippines, Columbia, China, Cuba, Brazil, Botswana, South Africa, Dominican Republic, Greece, Venezuela and Spain.
- **Platinum (circuitry).** Mined in South Africa, Russia, Canada, Zimbabwe, United States and Columbia.
- **Rare Earth Oxides - Lanthanum (batteries), Neodymium (electric motors).** Mined in China, India and Brazil.
- **Silica (silicon).** Mined in United States, Italy, Germany, United Kingdom, Australia, France, Spain, Japan, Poland, Hungary, South Africa, Mexico, Austria, Iran, Republic of Korea, Slovakia, Canada, Belgium, India, Bulgaria, Norway, Chile, Gambia, Turkey and Czech Republic.
- **Sulfur (chemical solutions).** Mined in United States, Canada, China, Russia, Japan, Saudi Arabia, Kazakhstan, Germany, United Arab Emirates, Republic of Korea, Mexico, Chile, Iran, France, Poland, India, Australia, Italy, Kuwait, Finland, Spain, South Africa, Netherlands and Uzbekistan.
- **Tungsten (wiring).** Mined in China, Russia, Canada, Austria, Bolivia and Portugal.
- **Vanadium (alloy).** Mined in China, South Africa and Russia.
- **Zinc (galvanizing).** Mined in China, Peru, Australia, United States, Canada, India, Kazakhstan, Ireland and Mexico.



To learn more about minerals and mining visit
www.MineralsEducationCoalition.org

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