Dedicated to the increase and diffusion of knowledge about how the nation's lands are apportioned, utilized, and perceived.

The Lay of the Land

The Center for Land Use Interpretation

SPRING 2026

As much as we attempt to wrestle matter into shapes and press it into utility, matter shapes us too; it pushes back, choreographing our movements by its resistances, affinities, transformations, temporalities, preferences. - A. Laurie Palmer

CLUI GETS CRITICAL

A MINERAL REFLECTION OF THE NATION

Rare Earth: Critical Minerals in the USA **was on view in the fall of 2025 at the Center's Los Angeles exhibit space. CLUI photo**

OVER THE PAST YEAR, THE CLUI has been looking at minerals a bit more closely than usual. Though minerals generally are found beneath the surface, they seem, at the moment, more topical then ever. Even critical.

The Department of the Interior, through the US Geological Survey, released its official federal list of critical minerals in 2022, naming 50 minerals of special importance to the nation's economy and security, where supply was considered vulnerable or at risk. In November 2025, ten more minerals were added, bringing the total to 60.

Looking at the domestic landscape of these critical minerals is a journey backwards, in a sense, to old mining districts where the US once produced many of these minerals. It is also a journey forwards, heading where technology and global geopolitics is leading us, into possible and nascent extracting and processing projects that are developing before our very eyes.

Other nations, agencies, and organizations have their own versions of such lists. The Department of Defense for example, has a Strategic and Critical Material Stockpile, managed by the Defense Logistics

continued on page 11

IN THIS ISSUE

CLUI SINKS INTO BORAX

GETTING TO THE BOTTOM OF THINGS

Pile of borax at Boron, California. The winter 2025/2026 CLUI exhibit *Boron Becomes Critical* examined one of the newest additions to the country's list of critical minerals. CLUI photo

BORAX SPANS THE OLD WEST, with its branded 20 mule teams heroically hauling ore across the barren desert—and the new west, a high-tech Mojave of wind and solar energy production and utility scale battery storage, overflown by hypersonic drones (all of which contain a bit of boron). The legend and legacy of borax continues, especially now that it has been declared a critical mineral by the US government.

Found on and around dry lake beds in the desert, borax has been used in ceramics for millennia. Today, borax and other borates containing boron are in bleaches, pesticides, fertilizers, wood preservatives, fire suppressants, glass, fiberglass insulation and composites. They are also in high-tech metals, rocket engines, nuclear reactor control rods, and cell phones, and are combined with rare earths like neodymium to make super-strong magnets for generators, actuators, and tiny motors, such as those in computer hard drives, car seats, and fighter jets. Borates are used as a dopant

continued on next page

Editor's Note

You've made it through the tangle of stuff and the fog of notions to this little roost in the infoscape, the Center's 49th newsletter. Welcome! In this issue we focus on critical minerals—further evidence that matter matters, maybe more than ever. We are materialists, before and after all, and clearly the mineral elements are the roots of everything on earth, even all the ones and zeroes. We are glad to have you aboard as we go to ground, one more time, looking for the right questions to ask amid the ocean of answers already out there.

in semiconductor production, for LCD screen manufacturing, and to improve the performance of batteries.

In the US, borax is best known as a laundry soap, thanks to the successful marketing of borax's principal miner and distributor, the U.S. Borax Company, and its 20 Mule Team brand, promoted in a popular radio and television program sponsored by the company, *Death Valley Days*, which ran from 1945 to 1970, and later in syndication.

Join us here on a journey across the desert, through a mixture of times and spaces, guided, but not drawn, by a team of 20 mules, and the curious connections that this mineral makes. We will begin at the current source of borax, in the Mojave Desert town of Boron, in a place once called Boron Valley.

Boron Valley: The Biggest Borate Pit

The outdoor overlook at the U.S. Borax pit. CLUI photo

The curtains part at the end of the introductory video presentation at the U.S. Borax Visitor Center, bringing in blinding light, and a view of the overexposed operation below that extends for six miles from left to right. The visitor center provides a good view, as it was built on top of a mountain of rock that that was removed to expose the orebody buried below. A classic overburden overlook.

The mine started as an underground operation in the 1920s by the Pacific Coast Borax Company, which had been mining borax on the edges of Death Valley at that time. In 1927, the company ceased operations there to focus on the Boron Valley's much richer deposit. By the time the mine became an open pit in the mid-1950s, the deposit was riddled with 200 miles of tunnels. Today the operation covers 20 square miles. Not long ago, this was the largest borate mine in the world. Now a few similarly sized pits in Turkey produce around 70% of the world's borates, while this mine supplies most of the rest. It is the largest open pit mine in California.

The U.S. Borax Visitor Center opened in 1997, and has not changed significantly since then, as the story has remained, mostly, the same. The pit just has gotten bigger and bigger, as the borax,

A 20 mule team display at the Borax mine. CLUI photo

processed in the industrial plant next to the pit, has flowed into the world at the rate of one million tons a year. Like industrial-scale ants, each of a dozen haul trucks move 200 tons of rock out of the pit at a time, dump it into crushers and conveyors that move it into the nearby plant, which makes it into a powdery form of boric acid and other bulk products. These are loaded directly into shipping containers or the company's fleet of rail cars that take it to their shipping terminal in the Port of Los Angeles. From there the company's ships take it to distribution and processing centers in Europe, Malaysia, and China, the largest importer of borates.

In November 2025, soon after boron was added to the nation's official list of 60 critical minerals, likely increasing the value of its assets, the company announced that its mine, and the rest of its supply and distribution network, was for sale for $2 billion. Interested parties reportedly include Elon Musk, BP, 3M, and BlackRock.

The 20 Mule Team Museum in the town of Boron tells the history of the mine and the community that grew up around it. Among the artifacts and hand-made displays in this independent local museum are numerous depictions of 20 mule teams, in paintings, photographs, and at least a dozen physical models of the team, at various scales, inside dioramas, and not, a testament to the power of the brand. CLUI photo

Death Valley: Built by the Borax Legend and Legacy

The overlook at Dante's View, in Death Valley, looks over the lowest point in the US, where borax was extracted and moved by 20 mule teams to the railway at the town of Mojave. CLUI photo

Borates were extracted from salt marshes and dry lakes in the Great Basin in the late 1800s, especially, and famously, from the bottom of Death Valley, the nation's lowest low point, the last in a chain of connected ice age lakes that once drained the eastern Sierra. The first major operation in the region was the Harmony Borax Works, which started in 1883. From here the romantic image of mule teams hauling large double wagons of ore across the desert to the nearest railhead, ten days and 165 miles away, was born.

Harmony Borax Works, in Death Valley, where the only remaining original 20 mule team wagons are on display. CLUI photo

Harmony Borax Works went out of business in 1888, after just five years, and never reopened. It was purchased in 1890 by Francis "Borax" Smith, whose Pacific Coast Borax Company grew to dominate the industry to this day. Rather than haul ore 165 miles across the desert in carts, Smith focused his borax extraction efforts closer to a railway, at Borate, a site near Calico, California. Smith acquired the underground mines there in 1890, and by linking them to the rails at Daggett, Borate became the primary source of borates in the USA for more than a decade.

By 1907 the mines at Borate were played out, and Smith switched mining back to Death Valley, this time at underground deposits in the Greenwater Range, on the east side of the valley, moving Borate's railway trestles, buildings and mining equipment to the Lila C Mine.

These new Death Valley mines became a larger operation than at Calico. Narrow-gauge railways snaked around the hills, connecting the mines, and hauling ore east, to the Tonopah and Tidewater railway, which Francis "Borax" Smith created to link mines to the national railroad lines to the south, at Ludlow. The company built a refinery and corporate town on the railway at Death Valley Junction, adding an elaborate U-shaped Spanish Revival-style corporate compound with a hotel, dormitories, dining hall, and a community meeting hall in 1925 (now the Amargosa Opera House).

Soon after, though, the large underground borate deposit at Boron was discovered, more than a hundred miles away, and all of the company's borax mining shifted there. In 1927, the company's Death Valley area mining operations ceased, and a new plan for Death Valley went into play.

Death Valley Becomes "Death Valley"

The elegant modernist National Park Service Visitor Center at Furnace Creek opened in 1960, as part of the NPS's Mission 66 initiative to improve its facilities across the country by the time of its 50th anniversary celebration in 1966. U.S. Borax donated the land for the visitor center as part of a deal in exchange for water rights controlled by the Park Service, which were needed to upgrade and expand the company's hotels and concessions. CLUI photo

The Pacific Coast Borax Company owned much of what there was to be owned in Death Valley, including the mining town next to its mines at Ryan; thousands of acres along roadways and in the hills; the ranch at Furnace Creek, a manufactured oasis and functioning agricultural operation at the heart of the valley; and it's corporate campus and refinery on the rail line at Death Valley Junction.

Faced with the end of borax mining in the valley, the company needed a way to enliven and sustain these assets. To do so, it would need to invert its economic model of extraction and removal, to attraction and visitation. To make it work, the company had to sell people on the idea of coming to what many considered the worst place for humans to be, where the official hottest temperature on earth was already on record in 1913 (134 degrees Fahrenheit). In some ways, though, Americans were already sold on hell on earth. It was baked into the Christian perspective, and playing with death from the relative safety of cars was a lot easier to enjoy.

Pacific Coast Borax was a capable marketer of the romantic West. The 20 Mule Team brand, which had been essential to the company's success, was conceived by its chief marketing director, Stephen T. Mather, who convinced his skeptical boss Francis "Borax" Smith to adopt it for their laundry products. After ten years with Smith, Mather left in 1904 to focus on his own borax company, which he and an associate had started some years before. It prospered, and was bought, begrudgingly, by Smith, a few years later, making Mather wealthier still.

Stephen Mather, who established the National Park Service, made his fortune in borax, principally at this mine, which he opened with his partner in 1908, and sold to Francis "Borax" Smith in 1911. Known as the Sterling Mine, it closed in 1921, and its equipment was shipped to the borax mines in Death Valley. It is located off the 14 freeway, in the hills near Agua Dulce, California, not far from Valencia, where U.S. Borax was headquartered in the 1990s. The mine site, with its rubble and ruins, remains fenced-off and posted by U.S. Borax. CLUI photo

Financially independent, and well connected in the mineral industry and political circles (including fellow members of the Sierra Club, the Boone and Crockett Club, and the National Geographic Society), Stephen Mather became an assistant to the Secretary of the Interior, working on subsidizing and promoting the nation's federal parks. He helped create the National Park Service and became its first director, in 1917. The basic principles and structures of the national parks were conceived and standardized under his tenure, which lasted until 1929, when he left because of illness. He died in 1930.

While serving in his official capacity, Mather was solicited by Pacific Coast Borax for assistance with promoting Death Valley as a national recreational resource, and as a National Park, to secure and sustain the company's assets in the region. He visited Death Valley as head of the NPS in 1927, along with his deputy, Horace Albright, and executives of Pacific Coast Borax. Among his recommendations was to have the management at the Old Faithful Lodge in Yellowstone National Park also manage the tourist resorts at Furnace Creek in the winter, when much of Yellowstone was closed, and Death Valley would be at its busiest.

As a former employee, and beneficiary of Pacific Coast Borax, Mather was aware of the conflict of interest that would be apparent if he were more involved, and officially excused himself from further engagement. However, his implicit support, effectuated by others, set the stage for Death Valley becoming Park Service property shortly after his death.

Pacific Coast Borax created a subsidiary called the Death Valley Hotel Company to develop tourist facilities, building the fancy Death Valley Inn near the ranch at Furnace Creek in 1927, and converting existing facilities into tourist hotels and attractions. Tourists rode a narrow gauge railway through the mines at Ryan, where a hotel was established at the former mining camp, and were brought to the valley by rails and carriages from the company's railway station and hotel at Death Valley Junction. Though progress slowed with the Depression, things picked up under the New Deal with lots of Civilian Conservation Corps activity, especially after Death Valley became a National Monument in 1933, under the tenure of the second director of the NPS, Horace Albright, Stephen Mather's trusted associate and assistant.

Having fulfilled Mather's wishes for Death Valley, Albright left his post later that year to run a new company, the United States Potash Corporation, a working partnership with Pacific Coast Borax, to open the first major potash mine in the western hemisphere, next to a dry lake bed in southeast New Mexico. Locomotives from the closed Death Valley mines were shipped to New Mexico, and put into service at the potash mine, which became the largest potash operation in the US. In 1956, United States Potash officially merged with with Pacific Coast Borax, which was then renamed the U.S. Borax and Chemical Company. U.S. Borax sold the potash mine in 1958, dropping the "and Chemical" part of its name, and has stayed focused on its borax production in Boron ever since. Albright remained an executive at U.S. Borax until he retired in 1962.

In the early 1950s, U.S. Borax opened the Borax Museum at the Furnace Creek Ranch in Death Valley, with wagons and other mining equipment on display outside. They also shored up the ruins of the Harmony Borax Works, a few miles north, where the only remaining original 20 mule team wagon set from its old days is still on display. In 1956, the company leased its three hotels to the Fred Harvey Company, which ran other tourist hotels and restaurants in western parks and railway towns. Since the late 1960s, the former U.S. Borax tourist services in Death Valley have been owned and operated by a series of corporate concession companies, including today's company, Xanterra.

The Death Valley Inn, owned and operated by Xanterra, which also operates the hotel concessions at other National Parks, including Yellowstone, Grand Canyon, and Glacier. Xanterra is owned by the privately held Anschutz Corporation, led by Fred Anschutz, who also owns sports teams, stadiums, and ticketing companies, such as AEG and LA's Crypto Arena. Marketed as a luxury brand of resorts, Xanterra recently spent $200 million upgrading its resorts at Death Valley to a point beyond the price range of most Americans. (Modest and locally owned accommodations are still available at Stovepipe Wells and Panamint Springs). CLUI photo

Before Death Valley became a national monument in 1933, Horace Albright promised that mining there would not be outlawed, an important point for the owners of mining claims in the region, including Pacific Coast Borax, which had by some counts more than 10,000 claims on federal and private land. After the monument was established, only relatively minor mining activity took place in the nascent park. That changed in 1971, when the Tenneco Corporation turned its Boraxo Mine, near Ryan, into an open pit, extracting a borate known as colemanite, which was not being mined at the big borax pit in Boron. By 1975 the company was producing 220,000 tons annually, from two adjacent open pits in Death Valley, 80% of the domestic supply of colemanite. In 1976, the Mining in Parks Act was passed, which increased the permitting and oversight of mines, and restricted large scale open pits in national parks. Mining in Death Valley was forced back underground.

Tenneco sold its claims to the American Borate Company, a partnership with Owens Corning, which uses borates in glass and fiberglass products. The company developed the Billie Mine, near U.S. Borax's Ryan mining camp. The mine, under construction for a few years, opened in 1982, accessing an ore body 1,200 feet underground. It operated until 2005, when it was the last commercial mine to operate in Death Valley (which by then was a full-fledged national park, and had been since 1994).

Though U.S. Borax stopped mining in Death Valley in 1927, it kept Ryan, its borax mining camp on the edge of Death Valley, initially as a hotel, then as a retreat, used occasionally by educational groups and field studies programs. In 2013, the company handed over the title and keys to the Death Valley Conservancy, a recently established non-profit which had been working with U.S. Borax to take over the site, and its many buildings, for years. Though it has not yet opened to the public as promised, the conservancy produced a new 20 mule team wagon train replica for U.S. Borax, which has appeared in parades like the Rose Bowl in Pasadena, promoting and celebrating borax and Death Valley heritage. When not out on parade, the $400,000 replica is on display in a new building at the Laws Railroad Museum & Historical Site in Bishop, California, the Owens Valley town where, incidentally or not, NPS director and U.S. Borax executive Horace Albright was born and raised.

The overlook at Zabriskie Point, in Death Valley (famous to some for its role in the 1970 Michelangelo Antonioni film, *Zabriskie Point*), was named after Chris Zabriskie, the manager of Pacific Coast Borax for 30 years, up to 1933, when Death Valley became a National Monument. The point overlooks 20 Mule Team Canyon, where some of the 3,000 acres inside the park that are still owned by U.S. Borax, and an estimated billion dollars of borax, remains. CLUI photo

Searles Valley: Powdered Borate Soup

Searles Valley, with Trona in the distance. CLUI photo

Searles Lake, the large dry lake in Searles Valley, forty miles southwest of Death Valley, used to be known as Borax Lake. It has been, and continues to be, a major source of borax for more than a century. The lake was first mined in a big way for borates by John Wemple Searles in 1873, using 20 mule teams to haul the ore long before Francis "Borax" Smith made such teams famous with his Death Valley borax branding decades later. Searles also hauled farther—all the way to the port at San Pedro, 179 miles (14 miles more than the Death Valley teams)—at least until the Southern Pacific Railway made it up to Mojave in 1876, 76 miles from Searles' Borax Lake plant.

These two borax companies, Searles' San Bernardino Borax Mining Company, and the Smith's larger Pacific Coast Borax Company, produced most of the borax mined in the US in the late 1800s, and they competed directly until 1897, when Smith bought out Searles' operations and shut it down. After Smith lost control of Pacific Coast Borax to his British partners in 1913, including its assets at Searles Lake, he focused on his many other businesses, mostly in the San Francisco Bay Area, while also trying to restore his prominence in the borax industry.

In 1920, Smith outbid Pacific Coast Borax to develop a borax mine near Las Vegas, and built the West End Chemical plant at Searles Lake to produce borax and soda ash from the lakebed. The West End plant was the first modern borax plant at Searles Lake, and substantially expanded, it continues to produce borax to this day.

The Trona Pinnacles, at the southern end of Searles Lake, are reminders of the connective mineral links extending through the chain of desert ice age lakes, all the way up to Mono Lake and its mostly submerged tufa towers. CLUI photo

Most of what is produced at the large industrial structures at the north end of the lake, around the town of Trona, are borate and soda ash products, including trona. Like borates, soda ash was used historically as a laundry and cleaning agent, and in glass production. Chiefly sodium carbonate, soda ash is a base chemical for a variety of industrial and commercial products, including water treatments, food additives, and fertilizers.

The modern buildup of industry in the Searles Valley started with a trona plant in 1908, which gave the town of Trona it's name. In 1914, the railway came to the valley, and operations ramped up, including one of the first mineral-based potash plants in the US. At that point, Germany controlled industrial potash production, and in the lead-up to World War I, other nations were scrambling to refine mineral potash for fertilizers and explosives. The potash plant opened in Trona in 1915, and a year later, in a partnership with Pacific Coast Borax, production was up to 36,000 tons.

By the end of the war, in late 1918, there were more than 100 potash plants in the US, most of which closed when cheap German potash came back on the market. The Trona plant, however, continued making potash, and was ready when the surge in domestic demand occurred again in the build-up to World War II.

Plants in Trona kept making potash until 1996, along with borax, boric acid, soda ash, and sodium sulfate. Most of the mineral extraction is done by solution mining: pumping water into layers of ore in the sediments under the surface of the lake, through drilled wells, and returning the water to the plants for processing, then back out again, through many miles of pipe criss-crossing the lake surface. Evaporation ponds on the lake surface also help to concentrate and isolate minerals, and dispose of unwanted salts.

The various plants in town and at Westend have been owned by a few different companies over the years: the American Trona Company became the American Potash and Chemical Corporation in 1926, which became the Kerr-McGee Chemical Corporation in 1969, then the North American Chemical Company in 1990, then the International Minerals and Chemical Corporation (IMC) in 1998. Then, finally, in 2004, with all the plants under the same ownership, the new company was called Searles Valley Minerals, and the name has stuck, so far.

The extensive industrial presence in the valley, with three processing plants making principally soda ash and borate products, are now consolidated under one company name, Searles Valley Minerals. CLUI photo

The history of the town of Trona and its extractive industry is preserved and presented at the Old Guest House Museum, operated by the Searles Valley Historical Society. CLUI photo

Since 2007, the company has been owned by the privately held Nirma Limited, based in Ahmedabad, India. It ships 1.75 million tons of product out of its US plants, by rail and truck, around a third of which are borates, making it the second largest producer of borates in the nation, behind the U.S. Borax mine in Boron, which ships around one million tons of borates annually.

One reason Searles Lake is so rich in minerals is that it received much of the ice age drainage from the Owens Valley, which drains the east side of the Sierra Nevada, as far north as Mono Lake, and has mineral-rich 14,000-foot mountain ranges on either side, 10,000 feet above the valley floor. During the ice age, glaciers scoured the the edges of the valley, grinding rocks into powder, which was carried downstream with the glacial melt. The valley's hot springs and vulcanism mixed other elements from hot fissures deep underground into a minerological soup that contains almost all of the naturally-occurring elements on the periodic table.

Owens Lake, at the top of the chain of lakes leading to Death Valley, was mined for soda ash in the late 19th century, long before the Los Angeles Department of Water and Power drained the lake, and exposed its bottom. The remains of these shoreline operations can still be seen at Cartago, Keeler, and Bartlett, where extraction and processing continued into the 1960s, and the ruins of the Pittsburgh Plate Glass plant remain. The exposed lake bed at Owens Lake continues to be mined today, by Rio Tinto, the owners of U.S. Borax, extracting trona that is shipped by truck to the processing plant next to their giant pit at Boron. CLUI photo

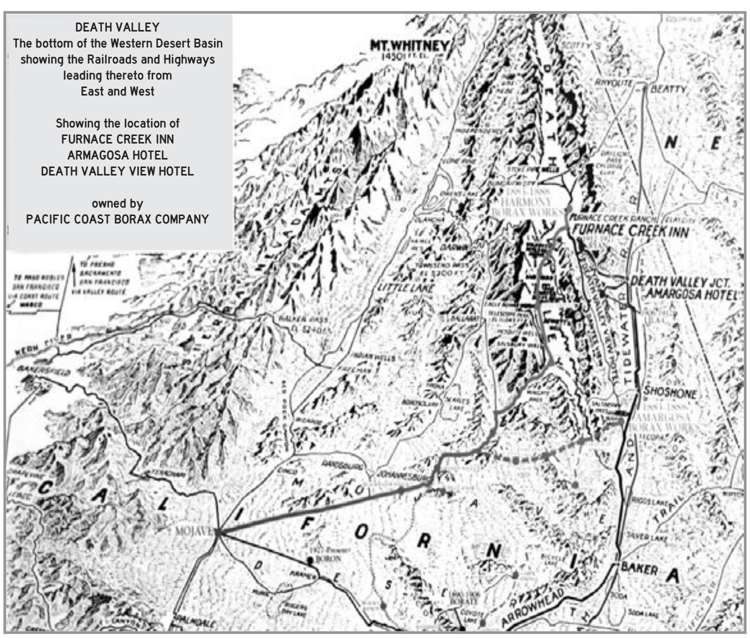
With time and movement, these minerals separated themselves to some degree by particle size and type. Some stayed in Owens Lake, at the bottom of the valley (where sediments extend another 10,000 feet below the surface), while others were washed onward, through today's Fossil Falls and Little Lake, into the Indian Wells Valley, and China Lake. With this low-walled basin filled up to its brim, drainage would flow through today's Poison Canyon into the Searles Valley.

Searles Valley, with its high walls, was often the end of the journey for the load of minerals from the Sierra Nevada and Inyo mountains, and was where the finest and lightest grains suspended in water would drop out, forming layered beds on the terminal lake's bottom over the course of a million years or more.

Sometimes even the Searles Valley would fill up beyond its brim too, and the waters would flow into the Panamint Valley, then through Wingate Pass, into Death Valley, and Badwater, the true pluvial end of the chain of pleistocene lakes. Nowhere else to go.

Trona's mule path today is a dedicated rail line from the plant. CLUI photo

Back on the Mule Path: The 20 Mule Team Rides Again



The 20 mule team route from Death Valley to Mojave is depicted on this map made by the Pacific Coast Borax Company.

The infamous 165-mile-long schleps of the 20 mule borax teams, from Death Valley to the railway at Mojave, started in the spring of 1884, and ended in the spring of 1888, when William Coleman's business empire, including the Harmony Borax Works, collapsed. The teams lasted much longer in legend than in fact.

During those four years, five separate 20 mule teams hauled around 22 tons of borax each, in two wagons, on every trip, taking ten days to get from the Death Valley borax works to Mojave, then ten days to get back with supplies, passing by one another every few days, going to and fro. Operating for nine months of the year, this equals around 275 trips, hauling around 6,000 tons of borax over the entire four years. (Today, the U.S. Borax mine and plant in Boron ships twice that amount every day.)

If a mule team were heading for Mojave with a load of borax today, they would find a very changed world, of course. Leaving from the reconstructed ruin of the borax works, the team would pass the modern amenities of the ranch at Furnace Creek, including campground, visitor center, airport, golf course, hotel, cabins, swimming pool, museum, stables, restaurants, solar plant, and a hundred trailers and buildings for worker housing (many of which came from the housing stock left from building the Boulder Dam).

The team would head south along the west side of Death Valley, past the base of Telescope Peak, then turn up the wide alluvial fan of Wingate Wash, leaving Death Valley over the southern end of the Panamint Mountains, through Wingate Pass. At this point, today, they would be inside the China Lake Naval Weapons Center, heading south into Pilot Knob Valley, where low-flying naval jets engage with land based electronic scoring systems, rocket batteries, mock convoys, and other test and training targets.

A few miles past Pilot Knob, a prominent landform used historically for navigation, the team would leave the naval station grounds, and after topping off the water tank at Blackwater Well, it is a nearly perfectly straight path for the last 50 miles, all the way to Mojave. Much of this stretch travels through what for a while was called Boron Valley, after Boron was discovered there. Though unknown to the borax haulers of yore, the mule team's trail comes within ten miles of the mine today.

The 20 Mule Team Parkway in California City's eastern proto-suburbs follows the original mule team route for more than 20 miles, and is partially paved. CLUI photo

Crossing Highway 395, this bee-line becomes a wide dirt road full of pits and mounds from off-highway vehicles. Officially named the 20 Mule Team Parkway, the road is the aspirational central artery for California City, a so-far unrealized desert development, started in the late 1950s, with room for as many as 400,000 residents. The city covers more than 200 square miles within its city limits, making it the third largest city in the state, in area, but with a population of just 15,000, most of whom live in a cluster in the center of town, still more than 20 miles away.

Out here on the fringes, grids and curving cul-de-sacs are etched into the ground across thousands of acres of open desert scrub, like suburban furrows, yet to sprout, and where ATVs buzz around like hopeful bees. The first buds of habitation along the Parkway are some of the most ephemeral, and perennial: a place called Seraphim Ranch, where the annual BEquinox festival is held most years, a desert party with artists in full flower, which some call LA's Burning Man. It's on a quarter-mile-square section of open desert that spans the parkway, owned by the Los Angeles League of Artists, with its own microgrid for encampments that sits empty most of the year.

The former overlook pavilion atop Galileo Hill. CLUI photo

A few miles further along the parkway is Galileo Hill, with a commanding view of the surrounds. This is where the visionary founder of California City, Nat K. Mendelsohn, would come to hone and share his vision for the future great city in the desert, starting in 1958, after he purchased the first 82,000 acres. Mendelsohn named the hill after his hero, Galileo Galilei, the Italian astronomer and polymath, and had a hexagonal look-out shelter built at the top of the hill. It still stands today, though it has been turned into a windowless and secure building, housing telecommunications equipment, and topped by radio antennas.

Galileo Park, at the northern base of the hill, was the designated anchor for the eastern part of California City, while Central Park anchored the downtown. Over the years, the "second city" around Galileo Park never filled out as hoped. A more Western-themed real estate entity, the Silver Saddle Ranch, took over in the 1980s, and stepped up marketing efforts, promising prosperity for those dreaming for the California Dream. The company would buy tax-delinquent empty lots at auction for as little as a few hundred dollars, and sell them to trusting buyers and investors, from as far away as Korea, for as much as $50,000, with hefty financing charges too. Many of the buyers were poor, and couldn't keep up the payments. And with most of the thousands of undeveloped lots appraised at around $2,000, there was nobody to sell the lots to. Little could be done but to default, and the cycle continued.

Silver Saddle land banking project, at Galileo Park. CLUI photo

In 2022, the state filed criminal charges against a number of people in connection with the project, and the showpiece of the development, the Silver Saddle Ranch at Galileo Park, has fallen into ruin. The landscaped ponds and trails are dried and cracked, and unwatered trees have collapsed on to buildings, now with broken windows and open doors. A modern Western ghost town. Having seen speculative mining booms and busts in the Death Valley Days, the 20 mule team passing by today might not be that surprised.

Borax Bill Park straddles 20 Mule Team Parkway five miles further down the road. This is a different kind of park, a kind of interstitial parking lot that serves as a threshold between the street-legal vehicle world, and the off-highway vehicle world. A place to get the toys off the trailer, read the posted rules of the non-road, head for the hills, and hose off in the public showers when you get back. It's also where first aid is available, and the Desert Incident Response Team has a forward base to help deal with inevitable mishaps. Services which would have been appreciated by the muleskinners in days of yore for sure.

California City Immigration Processing Center, along the 20 Mule Team Parkway. CLUI photo

Just another mile or two down the road is the densest settlement in the whole of California City: California City Correctional Facility, a looming concrete fortress, lit up at night and visible for miles around. The facility was built and operated by the Corrections Corporation of America, and opened in 1999. It has a capacity of more than 2,000 prisoners, and housed federal inmates until 2013, and state inmates after that until 2023, then closed in 2024. It opened again in 2025 as the California City Immigration Processing Center, one of a half dozen federal detention centers in Southern California, holding around 7,000 detainees, 1,300 of them here (as of February, 2026). The Corrections Corporation of America was renamed CoreCivic, in 2016, and is one of the largest private prison companies in the US, with dozens of facilities, in several states—many that are now housing immigrant detainees.

California City Central Park. CLUI photo

Four miles down the 20 Mule Team Parkway from CoreCivic is California City's civic core. The parkway's historic straight line is interrupted by the street grid at Central Park, the city's primary attraction. Built in the 1960s, the park had a 20-acre lake with a floating public pier, boats, and a contoured landscape with bridges and a scenic concrete waterfall. Though the waterfall no longer functions and portions of the park are closed, the site is still a welcome oasis in this otherwise arid place. All 20 of the mules would have loved it here.

More business opportunities in California City. CLUI photo

The diagonal path of the old mule team road re-emerges on the other side of the civic core, at Isabella Boulevard, where the grid of new roads peters out, and the old patterns of the desert return again, briefly. Now called Forest Boulevard, the seldom used dirt road runs for seven miles before hitting the fence line around a photovoltaic array next to Highway 58, where the highway makes its great arc around the town of Mojave.

After that the mule path hits the secure fence around Mojave Airport, and is no longer travelled, even by stray ATVs. As a faint vestige, barely visible on the ground, it passes a rocket engine test stand used to develop futuristic aircraft-launched spacecraft, then enters the airport's famous boneyard, where more than a hundred flightless airliners are being broken apart for parts and scrap.

Transplanted by the large paved diagonals of the airport's runways, the diagonal path of the 20 mule teams is untraceable now, and erased too as it leaves the airport and enters a few blocks of the town of Mojave. The team arriving at the railway would find the old depot, warehouse, and loading platforms long gone, given way to heavily used tracks of the Union Pacific, which thunderously lumbers through town today, hauling everything on earth, including borax.

There is a plaque, across from the tracks, commemorating the end of the mule team road. It's on the commercial strip of Highway 14, in front of a Wienerschnitzel, where the muleskinner there today might have opted for the drive-thru, before heading out on the long trip back to Death Valley. ♦

The California State Park Commission monument for the 20 Mule Team Borax Terminus in front of the Mojave Wienerschnitzel reads: "Just west of this point was the Southern Pacific Terminus for the twenty-mule-team Borax wagons that operated between Death Valley and Mojave from 1884 to 1889. The route ran from the Harmony Borax Mining Company works, later acquired by the Pacific Coast Borax Company, to the railroad loading dock in Mojave, over 165 miles of mountain and desert trail. A round trip required 20 days. The ore wagons hauled a payload of twenty-four tons. They were designed by J.W.S. Perry, Borax company superintendent in Death Valley, and were built in Mojave at a cost of $900 each. New borax discoveries near Barstow ended the Mojave shipments in 1889." CLUI photo

RARE EARTH INDEED
THE MOUNTAIN PASS MINE

Once the largest rare earth mine in the world, the Mountain Pass mine is still the only facility in the USA that mines and processes rare earths. CLUI photo

WITH ALL THE TALK ABOUT the geopolitics and hyper-criticality of rare earths, its important to remember that the pit that started it all has been there all along, riding the waves of the global marketplace, next to the interstate, for all to see coming and going between Las Vegas and Los Angeles.

The Mountain Pass Mine opened in the 1950s, and grew rapidly in the 1960s, when rare earths enriched the colors in cathode ray tubes, and the mine became known as the hole in the ground dug by color television. Through the 1970s and 1980s, Mountain Pass continued to be the nation's only rare earth mine, supplying most of the world's rare earths, still used in color TVs, but also in magnets enhanced by rare earth elements, used in products like speakers, microphones, guitar pickups, and model train motors. Rare earths were rapidly finding their way into all sorts of commercial, high-tech, and critical applications as well.

By the 1990s, China had scaled up production, especially at the Bayan Obo mine and processing complex in Mongolia, which became the largest single source of rare earths in the world. China also helped develop other sources, including mines in Myanmar. By the late 1990s, China's production had reduced prices enough that the Mountain Pass mine became too expensive to run. With mounting pressure from the state to address toxic waste problems too, most operations ceased in 1998.

The contamination problem was due to leaks and toxic accumulations along the liquid waste pipeline which ran from the mine, at the pass, to evaporation ponds in the middle of Ivanpah Dry Lake, 15 miles away in the valley below. Contamination included naturally-occurring radioactivity from minerals at the site becoming concentrated enough to pose a risk to the environment.

After paying fines and cleaning most of it up, the mine was allowed to start up again in 2004, though it did so in a limited way. In 2008, the Chevron oil company, its owner at the time, created an independent company, Molycorp, to modernize and upgrade the operation further, to make it competitive with the current global marketplace. With close to a billion dollars of support from the Department of Defense, to address contamination issues and expand processing capability, the mine opened again, in 2013. Despite the support, with China controlling close to 100% of global rare earth processing, it was unable to compete, and Molycorp filed for bankruptcy in 2015.

In 2017, while in "care and maintenance" status, with just eight employees, a new company, MP Materials, was formed to purchase and reboot the mine. MP Materials started limited production in 2018, focusing on neodymium and praseodymium, rare earth elements used to make high powered magnets used in electronics and motors.

In July, 2025, the Department of Defense bought $400 million worth of shares in MP Materials, as part of a new long-term multi-billion DoD commitment to the company, which includes building a $1.2 billion rare earth processing facility by 2028, north of Fort Worth, Texas.

Rare earth elements are found together in deposits all over the globe, but are only mined in a few places, as while most of them are not really "rare," they are expensive to process and separate from one another. There are 17 rare earths, 16 of which are on the critical minerals list.

Many of them are used to make powerful magnets for tiny motors, like those in adjustable car seats, computer memory storage drives, drones, and fighter jets. Rare earth magnets are also used in larger motors and generators, like those in electric cars and wind turbines. Some have luminescent properties that make them useful in lighting, electronic screens, lasers, and fiber optics. They are increasingly important in microelectronics of all kinds, including smartphones, and are used in defense systems that include exotic metal alloys, powerful camera lenses, nuclear reactors, and missile guidance systems.

Major mines in Mongolia, Myanmar, and South Africa are operational, and projects to create or enlarge existing operations are also underway in Australia, Vietnam, Tanzania, Canada, Greenland, and many other countries. Domestically, in addition to production being ramped up at Mountain Pass, other rare earth mines are in various stages of development, in southeast Nebraska, Wyoming, and West Texas—with more to come, no doubt. ♦

MP Materials, the new owners making a bet on the mine, is headquartered in Las Vegas. CLUI photo

The Periodic Table of the Elements, with Critical Minerals Highlighted

The minerals on the critical minerals list are specific elements, contained in mineral form. The critical mineral lithium, for example, is an element, number three on the periodic table, desirable because of its unique properties. Different minerals and ores that contain lithium, such as petalite, lepidolite, and spodumene, are mined and processed to extract the lithium and transform it into useful and marketable forms. Similarly the critical mineral beryllium, element number four on the periodic table, is processed and concentrated from bertrandite and beryl ores mined from the earth. And so it goes, across the periodic table, with just a few variations, such as graphite and metallurgical coal, two of the listed critical minerals, that are different mineral forms of the same element, carbon. The 60 official critical minerals are thus, in reality, mineral forms of 59 elements, exactly half of the 118 elements on the periodic table.

1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Cesium	56 Ba Barium	57-71	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89-103	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

CLUI GETS CRITICAL

continued from first page

Agency, where minerals are stored in caverns, warehouses, and piles outdoors, all over the land. However, the USGS list is considered the master list driving US policy, provided by the broadest cross section of stakeholders.

To make the list, the USGS consults with experts in academia, government, and industry, including with the Critical Minerals Subcommittee of the National Science and Technology Council, a cabinet-level committee with representatives of the federal departments of Commerce, Defense, Homeland Security, Interior, State, and Treasury, as well as the EPA, NSF, and NASA.

The process is led by the Department of Energy, along with the White House's Office of Science and Technology Policy, and the USGS. Laws governing the creation of the list (the Energy Act of 2020) call for periodic re-evaluation, and a new list, if necessary, every three years.

Many of the minerals on the list are used to make strong and lightweight metals, used in machinery, including aircraft engines, turbines, and weapons. Other minerals are used to make microelectronics that power devices of all kinds, from cell phones to radar. Some improve optics and imaging technologies for things like flat screens, satellites, and night vision devices. Also on the list are minerals used in the production of batteries, generators, actuators, and nuclear energy, though the list intentionally excludes most fuels. Recent additions include minerals used in fertilizers. Most of the named minerals are also elements on the periodic table.

Minerals are on the list because government agencies and industry experts consider them important, especially for security and defense technologies, but also because of the instability of their supply chain. Efforts to address the instability of global critical mineral resources (especially those controlled by China, as many of them are) have led to a speculative mining boom in the US.

The US Critical Mineral List

Aluminum, Antimony, Arsenic, Barite, Beryllium, Bismuth, Boron, Cerium*, Cesium, Chromium, Cobalt, Copper, Dysprosium*, Erbium*, Europium*, Fluorspar, Gadolinium*, Gallium, Germanium, Graphite, Hafnium, Holmium*, Indium, Iridium, Lanthanum*, Lead, Lithium, Lutetium*, Magnesium, Manganese, Metallurgical coal, Neodymium*, Nickel, Niobium, Palladium, Phosphate, Platinum, Potash, Praseodymium*, Rhenium, Rhodium, Rubidium, Ruthenium, Samarium*, Scandium*, Silicon, Silver, Tantalum, Tellurium, Terbium*, Thulium*, Tin, Titanium, Tungsten, Uranium, Vanadium, Ytterbium*, Yttrium*, Zinc, Zirconium

*16 of the 60 minerals on the list are rare earths, which are chemically related, and often mined together. They are primarily used in specialty metals, electronics, and magnetics.

Aluminum (atomic number 13)
Aluminum is one of the most familiar and widely used metals on the Critical Minerals list. It is most commonly alloyed with other minerals to become a lightweight durable metal used in familiar products, from jets to soda cans. The US consumes more than six million metric tons of aluminum metal annually (out of a global total exceeding 60 million metric tons). Aluminum is on the critical materials list because of its use in important defense products, such as aircraft, and because little of it is mined or smelted domestically.

New aluminum (also known as primary aluminum) is made from bauxite ore. During World War II and soon after, the US led the world in aluminum production, and a few dozen massive aluminum metal smelters and mills could be found along major rivers across the country. Today there are only four primary aluminum smelters still functioning in the US: Alcoa's smelters in Massena, New York, and Newburgh, Indiana, and Century Aluminum's smelters in Mount Holly, South Carolina, and Sebree, Kentucky. Primary aluminum is used for specialty aluminum products, like aircraft and aerospace, and defense products, and makes up less than 20% of the aluminum consumed in the US. Most of it is imported in metal form from smelters in Canada. The three largest producers of bauxite ore are Guinea, Australia, and China. A very small amount of bauxite is still mined in Arkansas, around the town of Bauxite, once an important domestic source of the material.

Aluminum is highly recyclable, and more than 80% of aluminum metal consumed in the US is from recycled material (known as secondary aluminum). This is the aluminum that is used in packaging, wiring, construction, and consumer products. Nearly half of the scrap produced in the US is exported, while most of the aluminum consumed in the US is imported, in the form of processed secondary scrap.

Antimony (51)
Antimony has widespread commercial uses, including ceramics, as a fire retardant in car seats and mattresses, and blended with lead to reduce corrosion in lead-acid batteries in vehicles. In a highly refined form antimony is used in semiconductor chips and infrared devices. Antimony is also paired with beryllium for use as a startup material in nuclear reactors. Antimony's military applications include its use as a combustion ingredient in detonators, smoke generators, and tracer bullets. It is also used to spark safety matches, and to provide glitter effects in fireworks.

China produces more than half of the world's antimony, followed by Russia and Tajikistan. The US stopped mining antimony in the 1980s. The nation's only antimony smelter, in Thompson Falls, Montana, processes imported material. A proposed mine is being developed in Idaho, located in a silver mining district where antimony was produced as byproduct. Approximately 15% of the 25,000 metric tons of antimony consumed in the US is recycled from, and then reused in, lead acid batteries.

Arsenic (33)
Arsenic is mostly used to preserve wooden railroad ties and light poles, and as an herbicide and insecticide. Arsenic also hardens lead in batteries and bullets. In a highly refined metallic form, arsenic is combined with other minerals, such as gallium, indium, and germanium in the production of semiconductors, solar cells, and infrared sensors in the fields of optics, telecommunications, and advanced electronics.

Arsenic is generally derived from gold, copper, and lead smelting, and domestic production officially stopped in 1985, when the ASARCO smelter in Tacoma, Washington, closed due to pollution problems. In recent years 95% of the arsenic metal used in the US has been imported from China. Arsenic also comes to the US from a hydro-metallurgical plant in Morocco. The US consumes around 8,000 metric tons annually.

Barite (56)
90% of barite's domestic use is by the oil and gas industry, as drilling mud, essential to lubricate and stabilize oil and gas wells. It is also used in brake pads and paint primer. Barite blocks X-rays and gamma rays, making it useful as a radiation shield in nuclear power plants. Its refined elemental form, barium, is used as an additive in high-tech ceramics and optics.

Northern Nevada continues to be the nation's largest domestic source of barite, where it is unearthed from open pits at four mines, each owned by one of the Houston-based global oil well services companies: Halliburton, Baker Hughes, Schlumberger, and NOV. Still, most of the barite used in the US comes from China and India.

Beryllium (4)
Beryllium is a commodity that can be refined into lightweight and strong metals that withstand heavy vibrations and high temperatures, properties that are highly prized in aerospace and defense applications. Beryllium is used in ceramics and electronics for missile guidance systems, radar, cell phone transmission, MRI machines, and nuclear weapons. Beryllium is also a critical component in nuclear reactor fuel and space-based mirrors and other optics.

One mine, in the Spor Mountains of western Utah, is the only domestic source of beryllium, and one of just a few sources of beryllium in the world. The company that extracts and processes the material, known for most of its existence as Brush Wellman, now called Materion, is still the only major US supplier of beryllium and its products, based out of a plant near the mine in Utah, and a larger engineering facility in Ohio. Around 200 metric tons are consumed in the US annually, though this amount fluctuates dramatically.

Bismuth (83)
Bismuth is a material and an element that is used in metallurgy, especially the manufacture of solder, bullets, and other items, as a less toxic form of lead (a similarly dense and heavy metal with a low melting temperature). Bismuth is used as the triggering material in fire sprinkler systems, in transistors and superconductors, and in pharmaceuticals (it is used to coat the stomach in products like Pepto-Bismol).

Bismuth is not directly mined. It is produced primarily from lead mining and refining, which once occurred all over the US, but which has decreased dramatically, starting in the 1980s, due to health and environmental legislation, and cheaper imported sources. Domestic production of bismuth finally stopped in 1997, with the closure of the ASARCO lead smelter in Omaha, Nebraska. The US recovers some bismuth from recycling, but imports most of its supply, around 2,500 metric tons annually, from China, Mexico, and other countries.

Boron (5)
Borax and other borates that contain boron have been used in ceramics and metallurgy for millennia. In modern times, borates have found their way into many commercial and industrial products, including bleaches, pesticides, fertilizers, wood preservatives, fire suppression, specialty glass (like Pyrex), rocket engines, and nuclear reactor control rods. Borates are a major component in fiberglass, including insulation and composites, and are combined with rare earths like neodymium to make super-strong magnets for generators, actuators, batteries, and tiny motors, such as those in computer hard drives. It is used as a dopant in semiconductor production, for LCD screen manufacturing, and for many components in cell phones.

As an element, boron is not generally found on its own, but rather in borate minerals and ores that accumulate in the beds of certain ancient pluvial lakes, including the bottom of Death Valley. More than half of the world's supply comes from open-pit mines in Turkey, operated by the Turkish government. Most of the rest comes from the US Borax mine located in the Mojave Desert town of Boron, California. Owned by the international mining company Rio Tinto, the Boron operation is California's largest open-pit mine, and ships around a million metric tons of product annually, including dried boric acid, all over the world.

Another major source of borates in the US is Searles Lake, 60 miles north of Boron, where a number of companies have been using a network of wells to extract and process potash and borates from a dry lakebed for more than a century. Also in the Mojave, near the town of Newberry Springs, a borate solution mine opened in 2024, operated by an Australian company called 5E Advanced Materials. In November 2025, the federal government added boron to its updated official list of 60 critical minerals.

Cerium (58)
Cerium is used in catalytic converters, ceramics, glass, metallurgy, and polishing compounds. It is used to control the colors in cathode ray TV tubes, LEDs, plasma screens, fiber optics, and lasers. Cerium is alloyed with aluminum to increase its temperature range in automotive parts, and alloyed with plutonium to make nuclear fuels.

Cerium is one of 16 rare earth elements that are on the critical minerals list, a group of minerals that are related to one another, and often extracted together, then processed separately. Rare earths are increasingly important to the production of batteries, and permanent magnets used in electrical generators, tiny electric motors, and actuators, as well as in other electronic devices and high-tech materials.

Cerium is among the rare earths that have been produced at the Mountain Pass mine in California, currently the only active rare earth mine in the US. The Mountain Pass mine opened in the 1950s, and quickly became the largest rare earth mine in the world. It was closed in 2002, due to environmental issues, and the fact that larger outputs from Chinese mines were making US production and processing too expensive to continue. The mine reopened in 2018, under new ownership (MP Materials Corporation), and with heavy support from the federal government. Efforts to open other domestic rare earth mines are also underway, in West Texas, Nebraska, Wyoming, Alaska, and a few other places.

Cesium (55)
Cesium metal is liquid at room temperature, and its uniquely high electropositivity and reactivity make it useful in research and development in chemistry and electronics. In various compounds, cesium is used in infrared detectors, optics, spectrophotometers, scintillators, and fluoroscopy. Isotopes of cesium are used for atomic clocks that control global time calibration and GPS satellites, and for food sterilization. Cesium formate is used in drilling fluids for oil and gas extraction.

Small amounts of cesium are involved in most of its applications. It is estimated that the US consumes around five metric tons of cesium annually, none of which is mined or processed domestically. Cesium is extracted primarily from pollucite ore, which for US consumption used to be sourced from the Bernic Lake Mine, in Manitoba, Canada, the world's largest producer of cesium, and one of only two cesium mines. Also known as the Tanco Mine, it was operated for years by the US-based Cabot Corporation, which shipped the cesium, tantalum, and rubidium produced there to its processing sites in the US and Japan. Since 2019, the Bernic Lake mine has been owned by Sinomine Resources, a Chinese company, which processes the cesium in China, and does not currently report how much cesium is shipped to the US.

Chromium (24)
More than 600,000 metric tons of chromium is consumed annually in the US, nearly all of it to make stainless steel. Chromium is produced from chromite ore, which is mixed with iron and processed into ferrochromium to make stainless steel. Chromium is used to make other important metal alloys too. Chromium is also used in nuclear, solar, geothermal, and wind energy production.

Though there has been some chromite ore extraction domestically, notably in the Stillwater Mountains of Montana, the US is dependent on foreign sources for nearly all of this material that it uses. The largest mine is in South Africa, though there are others in India, Zimbabwe, Turkey, Kazakhstan, and Finland. Recycled scrap stainless steel is also a source of chromium, providing around 15% of domestic demand.

Cobalt (27)
Cobalt is perhaps best known for its importance in the rechargeable lithium-ion batteries used in cars, computers, and electronics of all kinds. It is also important as a superalloy in jet engines, as well as for its uses in missile guidance systems, sensors, radar, and machine tools.

The US has produced small amounts of cobalt in the past, from mines where cobalt was extracted as a byproduct of other types of mining, including in the copper-nickel belt in northeastern Minnesota. Currently, the nation's only primary cobalt mine opened in 2022 in Idaho, but closed within months, due to plummeting prices from global suppliers. The mine is located next to a former cobalt mine that closed in the 1980s and became a Superfund site. Though around 70% of the world's supply of raw cobalt comes from mines in the Congo, most of the 8,000 or so metric tons used in the US comes in refined and metallic form from Norway, Canada, Japan, Madagascar, and other countries.

Copper (29)
Copper is a familiar metal used in electrical systems, including in wiring and electronic products. It is also used in pipes, metallurgy, roofing, and many other applications.

Approximately 1.1 million tons are produced annually in the USA, which accounts for most of the 1.6 million tons that are consumed domestically. 17 mines in the country account for 99% of this, with around 70% from mines in Arizona. Freeport-McMoRan is the largest US copper producer, with seven mines and one of the country's two active primary smelters, in Miami, Arizona. The other primary smelter is in Utah, connected to the Bingham Canyon Mine, owned by Rio Tinto, which is the largest man-made hole on earth, by some ways of measuring.

Recycling existing copper provides around 35% of domestic supply. There are a few large secondary copper smelters and refineries processing this material, located in Texas, Georgia, South Carolina, Kentucky, and other states. Copper was added to the critical minerals list in November 2025, despite the apparent abundance of it in the US.

Dysprosium (66)
Dysprosium is one of 16 rare earth elements that are on the critical minerals list. A quality shared by several elements in this group is tremendous magnetic strength, which makes them in high demand for motors, generators, speakers, microphones, and many other applications. Dysprosium is one of the most powerful of them all. It is used to enhance the efficacy of neodymium-iron-boron magnets, which are currently the most desired form of "permanent magnets," used in electric vehicle motors, wind turbines, micro-motors, and actuators. Dysprosium is also used in lasers, SONAR, metal-halide lamps, nuclear reactor control rods, and dosimeters.

China currently produces most of the world's rare earth elements. The only domestic source for them is the Mountain Pass mine in California. Mountain Pass is currently focusing primarily on a group of light rare earth elements (especially neodymium and samarium). Dysprosium is a heavy rare earth element, which are less prevalent, and harder to extract and refine. Efforts to open more domestic rare earth mines are underway, in West Texas, Nebraska, Wyoming, Alaska, and a few other places.

Erbium (68)
Erbium, like dysprosium, is one of 16 rare earth elements that are on the critical minerals list, which are in high demand especially for their use in permanent magnets used in motors, generators, actuators, batteries, EVs, and defense aviation and electronics. Like some other rare earths, erbium is also used in fiber optics, optical amplifiers, lasers, glass colorants, and as a neutron absorber in nuclear reactor control rods.

Erbium is one of the heavy rare earth elements, which means it is more expensive to extract and refine. Reserves exist at Mountain Pass, the only rare earth mine in the USA. Efforts to open more domestic rare earth mines are underway, but for the foreseeable future, China remains the main source of erbium.

Europium (63)
Europium is the softest, least dense, and most chemically reactive of the rare earth elements, and one of the rarest. In the 1960s europium provided the bright red phosphor that made color television's images colorful enough to become popular, which brought on a boom at the Mountain Pass mine, at the time the only viable source of europium. It's phosphorescent qualities are still used for color in CRTs, LEDs and other illuminated displays. Like other rare earth elements it is also used in a variety of high-tech, energy, and defense applications, including nuclear reactor control rods.

Europium is one of the medium and heavy rare earth elements on the critical minerals list (along with dysprosium, erbium, gadolinium, holmium, lutetium, terbium, thulium, ytterbium, and yttrium). Currently the Mountain Pass Mine, the only rare earth mine in the USA, is focusing on the extraction and processing of light rare earths (lanthanum, cerium, praseodymium, neodymium, promethium, and samarium), but heavy rare earth mining also occurs there. Primary sources are China, Australia, and Russia.

Fluorspar (9)
Fluorspar is a mineral containing the element fluorine. The US consumes around 500,000 metric tons of the material a year, much of it in the form of hydrofluoric acid, which is used to make a host of fluorine-related chemicals used in refrigerants, lithium-ion batteries, glass, welding products, castings for steel and iron, cement production, gasoline, and as a key ingredient in the processing of aluminum and uranium. Fluorine is important in some PTFE coatings, like Teflon, and in the fluoridation of public water supplies.

The US was the leading producer of fluorspar until the mid-1950s, mining from regions that included Illinois, Kentucky, and Utah. Foreign competition drove down prices, and by 1982, there was just one company in the US left, which closed its mine in 1996. Recent attempts to start domestic fluorspar mining include the Lost Sheep Mine, located in a former fluorspar district in the Spor Mountains of Utah (also the nation's primary source of beryllium). China is by far the largest producer, accounting for at least 70% of the world's production, followed by Mexico, and Mongolia.

Gadolinium (64)
Gadolinium is used in metallurgy to prohibit oxidation in steel. It's magnetism is used to make permanent magnets, and as a contrasting agent in magnetic resonance imaging (MRI). It's phosphorescent properties are used in TVs, LEDs, fiber optics, and lasers. Like some other rare earths, gadolinium is also a neutron absorber used in naval nuclear reactors.

Gadolinium is one of the heavy rare earth elements on the critical minerals list. Currently the Mountain Pass Mine, the only rare earth mine in the US, is focusing primarily on the extraction and processing of light rare earths, which are more abundant there, and easier to process. Sources for heavy rare earths like gadolinium are mostly in China, though rare earth mines also exist in Australia, India, and Brazil, and more are being explored.

Gallium (31)
US industry consumes only around 20 metric tons of gallium annually, but it is essential to many high-speed integrated circuits related to communications, including cell phones and high-voltage RF systems such as radar, and in optoelectronics. Gallium does not exist in mineable quantities by itself, and is usually extracted from bauxite and zinc ores.

Gallium has not been produced in the US since 1987, and now China accounts for most of its global production. A domestic mining operation focusing on gallium and rare earths has been proposed for a site in southwestern Montana.

Germanium (32)
Germanium is used in military optics, especially night vision and infrared applications, and in the production of solar cells.

A large zinc mine in Alaska ships ore to a processing facility in Canada that produces some germanium. Germanium and gallium are sometimes extracted at the same time from zinc processing, and the nation's only zinc smelter, located in Clarksville, Tennessee, may begin producing germanium soon. Germanium is also recovered from recycled military optics, including tank windows. China dominates global production of germanium.

Graphite (6)
Graphite is a crystalline form of carbon, used in brake linings, lubrication, steelmaking, fuel cells, and, increasingly, lithium-ion batteries.

No graphite is mined in the US, but the government has recently supported the development of a number of domestic graphite mining operations, and assessments are underway in Alabama, Alaska, Montana, and New York. A graphite processing facility for an Alaskan mine is planned for the former defense stockpile site in Warren, Ohio. China produces around 75% of the world's graphite.

Hafnium (72)
Hafnium is used in nuclear control rods, and hard metals alloys used in high-temperature applications like jet engines and gas turbines. Hafnium is closely aligned to zirconium, another critical mineral. Both are produced from heavy mineral sands.

A small amount of the hafnium used in the US is produced from surface mines in Florida and Georgia, but most of it comes from mines in Australia, South Africa, and other African nations. Processing is also performed in Russia, Germany and France.

Holmium (67)
Holmium, a rare earth, has the highest magnetic permeability and saturation of all the elements. This manifests in a strong magnetic field, and an ability to make metal magnets more powerful. Like other rare earths, holmium strongly absorbs neutrons, which make it useful in controlling nuclear reactors. Also, like other rare earths, holmium is used in lasers, fiber optics, permanent magnets, and glass coloring.

Holmium is one of the heavy rare earth elements on the critical minerals list. Currently the Mountain Pass Mine, the only rare earth mine in the US, is focusing primarily on the extraction and processing of light rare earths, which are more abundant there, and easier to process. Sources for heavy rare earths like holmium are mostly in China, though rare earth mines also exist in Australia, India, and Brazil, and more are being explored, including domestically in West Texas, Nebraska, Wyoming, and Alaska.

Indium (49)
Once used in aircraft engine bearings, indium has the effect of increasing the speed in some fiber optic telecommunication networks, where it is used in lasers and coatings. Indium is also used to increase speed in semiconductors, and in liquid crystal displays. Around 150 metric tons are consumed annually in the US.

Indium is extracted from zinc sulfide ores, and a zinc-copper-silver-indium mine in Utah's West Desert is under development. Otherwise, much of the domestic consumption of the material is recycled from scrapped LCD monitors, and imported from Korea and Japan. China is the largest global producer of the material.

Iridium (77)
Highly resistant to corrosion, iridium is used as a coating on anodes for electrochemical processes, as a metal in spark plug electrodes, in semiconductors, and in some types of flat-screen displays. It is also used in guided missile systems, aircraft engines, and radar screens. Less than three metric tons are consumed annually in the US.

Small amounts of iridium are extracted with other materials at a few mines in the US, including one in the Stillwater region in Montana, operated by a South African company. Iridium is one of the six closely aligned materials in the platinum metal group, which include the critical minerals palladium, platinum, rhodium, and ruthenium. Platinum group metals (PGMs) are generally mined together, then separated by processing the ore. The leading global producer is South Africa, followed by Canada and Russia.

Lanthanum (57)
Lanthanum is used to produce catalysts, ceramics, glass, polishing compounds, metallurgy, and batteries. Nickel-metal hydride batteries of the type used in some hybrid vehicles contain more than 30 pounds of lanthanum. It is also used in lighter flints, tungsten welding rods, phosphor and carbon lamps, and fiber optic cables.

Lanthanum is one of six light rare earth elements on the critical minerals list (along with cerium, praseodymium, neodymium, promethium, and samarium). Currently the Mountain Pass Mine, the only rare earth mine in the US, is focusing on the extraction and processing of neodymium and praseodymium for use in permanent magnets. China produces most of the world's lanthanum, though rare earth mines also exist in Australia, India, and Brazil, and more are being explored.

Lead (82)
Lead is a soft, dense, and heavy metal, used primarily in lead-acid batteries, which consume as much as 85% of the lead produced and imported in the US. The remaining 15% is used to make ammunition (3%), glass, ceramics, solder, and in many other things. The US was the largest producer of lead in the world until the 1980s, when environmental regulations began to have an effect on the industry. Today the US is ranked third, producing around 300,000 metric tons annually, behind Australia (430,000 metric tons) and China, which produces almost two million metric tons annually. All of the lead mined in the US has to be exported to be refined, as the last primary lead refinery in the nation was shut down in 2013. This is one of the reasons why lead was added to the critical minerals list in 2025.

Most of the lead mined in the US comes from five underground mines, located in the Viburnum Trend mining district in southeastern Missouri, operated by the Doe Run Company, which has dominated lead production in the US for more than 100 years. Doe Run is owned by the Renco Group, which also owns a large magnesium plant in Utah, which was originally a lead plant. Lead is also produced as a byproduct from four other domestic mines: two zinc mines in Alaska, and two silver mines in Idaho.

Lead is one of the most recyclable of metals, and more than 70% of the lead consumed in the US is from secondary, recycled sources, more than one million metric tons annually. Doe Run operates the largest lead recycling center in the country at one of its mine sites in Boss, Missouri, where more than eight million car batteries are reprocessed every year.

Lithium (3)
Lithium has uses in ceramics, medicine, and as an industrial lubricant, but close to 90% of it is used for lithium-ion batteries, which have rapidly emerged as the principal form of energy storage in industry, electronics, and electric vehicles.

Currently, the only source of lithium in the US is an evaporative surface mine in Silver Peak, Nevada. The mine has been producing lithium for decades, but only a very small fraction of the current national demand. The federal government recently supported more than 25 new lithium projects in the country, a few of which have broken ground. Australia currently mines the most lithium in the world, followed by Chile and China.

Lutetium (71)
Lutetium is used as a catalyst in petroleum cracking, in PET scanners and other medical imaging systems, and in scintillators that convert X-rays to visible light. It is also used to date meteorites.

Lutetium is one of the 16 rare earth elements that are on the critical minerals list, though it is especially difficult to isolate from the other rare earths, and global production is limited, usually less than 20 tons per year. China is the primary producer and processor of the material.

Magnesium (12)
Magnesium metal is principally alloyed with aluminum, creating a lightweight metal used in aviation, castings, and beverage containers. Magnesium is also used as an alloy to produce other hard lightweight metals of use in aerospace and defense applications.

For decades most primary magnesium production in the US was from a single mine and industrial plant in Utah, owned by US Magnesium. The mine extracted the material from Utah's Great Salt Lake, concentrating brine through 75,000 acres of evaporation ponds. Due to competition and advances in production and processing by Chinese suppliers, and increasing local environmental costs, the plant ceased production in 2022. The mine also extracted lithium from the brine, but stopped doing so in 2024. A related titanium plant at the site closed in 2016. Other magnesium sources in the US are being developed in Nevada and Wyoming. But currently no magnesium metal is being produced from scratch in the US.

Manganese (25)
Manganese is mostly consumed by the steel industry, as an important component in pig iron. In another form, manganese dioxide and sulphate is used in batteries, including the in-demand lithium-ion type. More than 700,000 metric tons of it is used annually in the US.

The US has not produced manganese since the 1970s, but due to its criticality, the US Defense and Energy departments have supported the accelerated opening of a mine and battery-grade production facility in Arizona, owned by an Australian company. South Africa produces most of the manganese ore consumed in the world, followed by Gabon and Australia. Processed manganese comes from Malaysia, Australia, and Norway.

Metallurgical Coal (6)
Metallurgical coal is used to make coke, a form of reactive carbon used in blast furnaces to make primary steel. It takes around three quarters of a ton of coal, turned into coke, to make a ton of steel, and the US steel industry uses more than 15,000,000 metric tons of this coal per year. Most of the major steel plants operate a nearby coke plant to feed into their furnaces. A third of the steel produced in the US is primary steel, requiring coke. The rest, two thirds, is made from recycled scrap steel.

The coal used for coke-making is different from most of the thermal coal used to boil water, to make steam, to make electricity in large power plants, which is what more than 90% of the coal consumed in the US is for. Metallurgical coal tends to come from eastern coal mines, not from the bigger western mines, which have higher ash and moisture content. West Virginia supplies as much as 40% of the metallurgical coal in the US. Metallurgical coal was added to the critical minerals list in November, 2025, despite the fact that around 75% of the metallurgical coal mined in the US is exported. The US is the second largest exporter of it in the world.

Neodymium (60)
Neodymium is one of the better-known rare earths, and is more abundant and commonly used than most. Neodymium is in lasers, glass, LCDs, and lighting, but its primary use is in magnets, found in microphones, speakers, headphones, small electric motors, like in hard drives, toys, and car seats, and in larger electric motors, used in electric cars, as well as in generators and wind turbines. Neodymium-iron-boron magnets are the strongest known magnets in the world, at ambient temperatures, and the most common form of permanent magnets. A wind turbine has a few tons of them.

Neodymium is one of the 16 rare earth elements that are on the critical minerals list, and is the primary mineral currently extracted at the Mountain Pass mine in California, the only major rare earth mine in the USA. Efforts to open other domestic rare earth mines are underway, in West Texas, Nebraska, Wyoming, Alaska, and a few other places. Globally, China currently controls at least 60% of rare earth mining, and 90% of rare earth processing.

Nickel (28)
Most nickel in the US is used to make stainless steel. Some is also used to make other corrosion-resistant superalloys. The aerospace industry is a major consumer of these nickel-based superalloys, used for things like jet engines. Nickel is also used in batteries. Around 200,000 metric tons is consumed in the US annually, around half of which is recycled from scrap.

The only domestic nickel mine, the Eagle Mine in Michigan, produces 17,000 metric tons a year, a fraction of what is consumed nationally, and its concentrated ore is shipped to Canada to be smelted. The Defense Department has recently supported a nascent nickel production project in Missouri. Indonesia dominates the global supply of mined nickel, though the US imports a considerable amount from Canada too.

Niobium (41)
Niobium is a hard metal, like titanium. Around 75% of niobium that is consumed in the US is used as an alloy in steel. 20% of it is used to make non-ferrous superalloys, favored by aerospace industries.

US mines stopped producing niobium in the 1950s. Today nearly all of it is mined in Brazil, although a company is in the early stages of developing the Elk Creek Project, a new niobium mine in southeast Nebraska, and the Department of Defense is helping to expand a plant in Boyertown, Pennsylvania, that produces tantalum (another critical mineral with similar properties) into one with niobium production capabilities as well.

Palladium (46)
Palladium is used in a variety of medical, metallurgical, and chemical applications, but most of it is consumed as a component in automotive catalytic converters, which remove pollutants coming out of the tailpipes of internal combustion engines.

Palladium is one of six closely aligned materials in the platinum metal group, which include the critical minerals platinum and rhodium. A South African company operates the only platinum group mines and processing facility in the US, located in the Stillwater region in Montana, which produces around eight metric tons annually. Around 70 metric tons are consumed annually in the US. Platinum group metals (PGMs) are generally mined together, then separated by processing the ore. The leading global producer is South Africa, followed by Russia and Canada.

Phosphate (15)
Phosphates are mineral compounds that contain phosphorous, an element that is essential to root growth and other plant functions. Phosphorous is one of the three primary nutrients used in agriculture (along with nitrogen and potassium), and is extracted from concentrated deposits of phosphate rock in large quantities, processed and distributed globally to supply industrial agriculture. The United States was the world's largest producer of phosphate rock from the end of the 19th century until 2006, when US production was exceeded by China. Today the US is the third largest global producer of phosphates. Most of it comes from a region east of Tampa, Florida called the Bone Valley, where all of the mines are now owned and operated by the Mosaic Company.

Mosaic was formed in 2004 by merging Cargill's crop nutrition division and IMC Global, and the merger instantly created the largest US-based producer of phosphate fertilizer, and potash. Mosaic is not the only company mining and processing phosphates in the US on a large scale. Nutrien operates the largest integrated phosphate mining and chemical plant in the nation, in Aurora, North Carolina. Idaho has major phosphate operations too, run by Itafos, Bayer/Monsanto, and Simplot, which also operates in Wyoming and Utah. Together, ten domestic phosphate operations generate more than 20 million metric tons of the product annually, slightly less than what the nation consumes. An additional three million metric tons or so is imported, usually from Peru or Morocco, the second largest global producer of phosphates, after China.

Phosphates have other uses, including in metallurgy, pharmaceuticals, lithium-iron-phosphate batteries, safety matches, and semiconductor manufacturing. It was added to the critical minerals list in November, 2025, along with potash, another material vital to industrial agriculture.

Platinum (78)
Platinum is a rare and precious metal of high value. It is the least reactive of all metals, meaning it does not easily corrode, even in extremely high temperatures. Platinum is used in a variety of medical, metallurgical, and chemical applications, including in aircraft turbines and LCD displays, but most of it is consumed as a component in automotive catalytic converters.

Platinum is one of six closely aligned materials in the platinum metal group, which include the critical minerals palladium, rhodium, iridium, and ruthenium. Platinum group metals (PGMs) are generally mined together, then separated by processing the ore. A South African company, Sibanye-Stillwater, operates the only US platinum group mines in the nation. The company's smelter and refinery, in Columbus, Montana, also recycles palladium and platinum from scrapped catalytic converters. Around 170 metric tons of platinum is produced annually, globally, not including secondary/recycled sources, and the US consumes around 70 metric tons. The Stillwater mine produces around two metric tons. The leading global producer of PGMs is South Africa, followed by Russia and Canada.

Potash (19)
Potash is a water-soluble mineral containing potassium. Potassium is vital to plant growth, and the mining and processing of potash is the primary source of potassium for large-scale industrial agriculture. Potassium is also used in chemicals, pharmaceuticals, soap, glass, batteries and other products, including, importantly, potassium nitrate, used to make gunpowder and explosives.

The potash industry expanded in the US in World War I, when prices and demand for it went up because Germany controlled much of the global supply at that time. Mineral rich dry lake beds in the southwest, like California's Searles Lake, ramped up production, starting in 1914. Industrial agriculture expanded after the war, with the integration of the Haber-Bosch process to use natural gas to create fixed nitrogen, further industrializing the supply of potash (and phosphates) for fertilizer.

Large amounts of potash were discovered in southeast New Mexico in the 1930s, and the area became the center of the potash industry in the US, producing more than three quarters of the potash mined in the US. Though reduced, more than half of domestic production still comes from here, from three mining operations, one owned by Mosaic, which is the nation's largest phosphate producer too, and the other two by Intrepid Potash, based in Denver. Intrepid also has two potash mines in Utah, and is the only US company dedicated solely to producing potash in the USA.

US companies operating in southeast New Mexico developed potash mines in Saskatchewan, Canada, which are now the largest producers in the world. More than 40 million metric tons of potash is mined globally, annually, and the Saskatchewan mines (the largest of which is owned by Mosaic), produce around a third of it. Other large producers are Belarus, Russia, and China. The US produces only half a million tons, and is dependent on imports, primarily from Canada, for more than 90% of its needs. Potash was added to the critical minerals list in November, 2025, along with phosphate.

Praseodymium (59)
Praseodymium is one of 16 rare earth elements that are on the critical minerals list. Unique industrial uses of it often relate to it's ability to filter yellow light. It is found in some types of goggles used in welding and glassblowing, and is alloyed with magnesium to make aircraft engine components. Otherwise it is used with other rare earths and minerals in magnets, batteries, ceramics, and colorants.

Praseodymium is one of six light rare earth elements (along with cerium, lanthanum, neodymium, promethium, and samarium). The Mountain Pass Mine, in California, the only major rare earth mine in the US, is focusing on the extraction and processing of light rare earths, primarily neodymium and praseodymium for use in permanent magnets. China produces and processes most of the world's praseodymium, though rare earth mines also exist in Australia, India, and Brazil.

Rhenium (75)
Rhenium is one of the rarest elements found on the earth. It has a very high melting point, and around 80% of it is combined with other metals, including nickel, to make superalloys for high-temperature applications, like jet engine turbines. General Electric, Rolls Royce, and Pratt & Whitney consume around two thirds of the world's rhenium. It is also used to make crucibles, electrical contacts, electromagnets, heating elements, mass spectrographs, thermocouplers, and as a catalyst to make high octane fuels.

Most rhenium is extracted from molybdenum processing, which occurs in some large-scale copper mines and refineries. The Continental Mine, in Butte, Montana, and Freeport-McMoRan's Sierrita mine in Arizona are a source. Rio Tinto's Bingham Canyon copper mine and refinery in Utah is also a source, though in recent years it has shipped its rhenium-containing molybdenite concentrates to Mexico to be processed, and from there to Chile for purification.

Rhenium was added to the critical minerals list in November, 2015. Though the US is one of the largest producers of rhenium, generating around 10 tons a year, this is less than half of what it consumes. Annual global production is around 60 tons, half of which comes from Chile, home of the largest copper mine in the world. Around 30% of rhenium is recovered from recycling.

Rhodium (45)
Rhodium is one of six platinum group metals. It is used mostly as an alloy with platinum and palladium, the more commonly found metals of the platinum group, in the fabrication of automotive catalytic converters. Small amounts are also used in neutron flux detectors in nuclear reactors.

Rhodium is considered very rare, and only around 30 metric tons of it are produced annually, globally. The only US platinum group mines and processing facilities in the nation are located in the Stillwater region of the Beartooth Mountains in Montana, which may produce a small amount of it. Some amount is recovered from scrap catalytic converters too. The leading global producer is South Africa, followed by Russia and Canada.

Rubidium (37)
Rubidium is a highly reactive alkali metal that reacts explosively with water. Rubidium is used in research test equipment, and in optoelectronics, night vision gear, and quantum computing. It is used as an oscillator for telecommunications synchronization, including cell networks and global positioning systems. Rubidium also provides the purple color in some fireworks. Rubidium is extracted mostly as a byproduct of cesium and lithium mining, and is consumed in very small quantities. As little as one or two metric tons are produced annually, globally.

Rubidium is not mined or processed domestically. In the past, the US-based Cabot Corporation produced it at its cesium mine in Bernic Lake, Manitoba, Canada, and processed it at its supermetals plant in Boyertown, Pennsylvania. However both facilities have been sold. Since 2019, the Bernic Lake mine has been owned by Sinomine Resources, a Chinese company which does not process rubidium in US. The Boyertown metals plant in Pennsylvania is now owned by Global Advance Metals, an Australian company that is focusing on tantalum and niobium processing at the site. China controls most of global rubidium production, though other sources are being considered, including on the remote Italian island of Elba.

Ruthenium (44)
Ruthenium is one of six platinum group metals (PGMs), and like the others is durable and non-reactive. Ruthenium is consumed in small amounts, primarily in electrical contacts and in thick film chip resistors, microcircuitry of the type used in electric vehicles.

A small amount of ruthenium is extracted from the Stillwater and East Boulder platinum group metal (PGM) mines in Montana. Some is also extracted from Stillwater's PGM recycling center in Columbus, Montana. Most of it comes from PGM mines in South Africa, and Russia's Ural Mountains. Only around 40 metric tons of ruthenium are produced annually, globally.

Samarium (62)
Samarium is one of 16 rare earth elements that are on the critical minerals list. It is mostly used in samarium-cobalt magnets, which are favored in high-temperature environments (above 150°C), as neodymium-iron-boron magnets lose effectiveness at these high temperatures. Samarium-cobalt magnets are used in things like military aircraft and missiles. An F-35 fighter jet contains around 50 pounds of samarium-cobalt magnets.

Samarium is one of six light rare earth elements (along with cerium, lanthanum, neodymium, promethium, and praseodymium). The Mountain Pass Mine, in California, the only major rare earth mine in the USA, is focusing on the extraction and processing of some light rare earths, but primarily neodymium and praseodymium for use in permanent magnets. China produces and processes most of the world's samarium.

Scandium (21)
Scandium is one of the lesser used rare earths, with fewer than 30 tons produced globally, annually (compared to more than 10,000 tons of neodymium, and 1,000 tons of samarium). Scandium's primary use is as an alloy with aluminum to make aerospace components and sporting equipment, such as baseball bats and lacrosse sticks. It is also used in some handguns. Scandium is used in metal-halide lamps as well.

Scandium is one of 16 rare earth elements that are on the critical minerals list, some of which are produced in small amounts at the Mountain Pass mine in California, the only major rare earth mine in the US. However scandium is not one of them. Most scandium is sourced and processed in China.

Silicon (14)
Silicon was added to the critical minerals list in November, 2025. While it is among the most prevalent elements on the planet (more than 90% of the earth's crust is made of silicates), and one of the most mined minerals (silica sand, from pits and dredging, is used to make concrete, ceramics and glass), sources of silica pure enough for making into feedstocks for electronics and metallurgy are less abundant. Primarily though, it is the relative lack of large-scale processing of highly refined silicon in the US, given the high demand for it, that makes it more of a critical material (semiconductors can require silicon that is refined to 99.9999999% pure elemental silicon). The supply of processed high-grade silicon for US computer and solar panel companies is mostly from Japan, Germany, South Korea, and China.

Around half of the silicon that is turned into metal is processed into ferrosilicon, which is used to make alloys of steel, and other iron-based metals. A more purified type of silicon is used to make other silicon metals, including monocrystalline silicon and polysilicon for semiconductors and solar panels, and as feedstock for chemical companies to make into all kinds of things. Companies that produce ferrosilicon and silicon metal in the US include Mississippi Silicon, which produces around 10% of the domestic supply at a new plant in Mississippi.

Only a few companies produce high purity silicon for semiconductors and solar panels in the US. Among them is Sibelco, a Belgian silica company with mines and plants in Spruce Pine, North Carolina; Hemlock Semiconductor, in Michigan; and Wacker Chemie, a German company with a plant in Tennessee. Another, the REC plant in Moses Lake, Washington, is attempting to restart production after shutting down in 2019. The US produces around 310,000 metric tons of ferrosilicon and silicon metal a year, and imports more from Canada, Brazil, Norway, and other countries. China produces 7,400,000 metric tons (about 80% of global production).

Silver (47)
Silver is a highly conductive metal used in semiconductors, photovoltaics, electric vehicles, communications equipment, missile guidance systems, satellites, and more. Half of the silver consumed in the US, though, is turned into investment bars, commemorative coins and medals, silverware, and jewelry. Still, it was added to the critical minerals list in November, 2025, to stimulate domestic production, as most of the silver consumed in the US is imported.

The US produces 1,100 metric tons of silver a year, around 17% of the silver it consumes. This comes from a few sources, including the largest silver mine in the country, the Greens Creek mine, located on an island off the coast of Juneau, Alaska. There are three other active silver mines in the US: the Rochester mine in Nevada (a state once known as the Silver State for its infamous Comstock Lode) and two in the Coeur d'Alene region of Idaho.

A major source of silver is as a byproduct or co-product at more than 30 base metal mines in the US. Additionally there are more than 20 refineries which produce silver from imported ore (1,200 metric tons/year), and scrap (also 1,200 metric tons). Around 4,200 metric tons of silver is imported annually, around two-thirds of US consumption, much of it from Mexico, which is the largest producer of silver in the world.

Tantalum (73)
Tantalum is a dense, hard, lightweight and ductile metal with a high melting point, used in making superalloys for jet engine components, nuclear reactors, missiles, and armor-piercing ammunition. Tantalum is also used in electronics, especially capacitors and resistors capable of withstanding high temperatures, making it useful in test equipment, data centers, GPS, and missile systems.

Little to no tantalum is mined in the US. The development of a domestic source has been subsidized by the US government, and Round Top Mountain, a proposed rare earth mine in western Texas, is expected to be a source for tantalum. Tantalum is processed in the former Cabot Supermetals plant in Boyertown, Pennsylvania, acquired by Global Advanced Metals, of Australia, which imports tantalum from its Australian mines. Tantalum is similar to the critical mineral niobium, with which it is often mined, though in smaller quantities. Australia was the primary source of the material for decades; however, recent developments in the Congo, Rwanda, and Burundi have made Africa the main source. Around a thousand metric tons is consumed in the US annually.

Tellurium (52)
Tellurium is a brittle metalloid that is used in metal alloys, and as a semiconductor. Tellurium has thermal and photoconductive properties which make it useful in certain electronic applications, and in thin-membrane, non-silica photovoltaic panels, which is its main commercial use. Tellurium is also used as a vulcanizing agent for rubber, in blasting caps, and in computer memory chips.

Tellurium is one the rarest solid elements, and is not generally found in mineable quantities. It is primarily extracted as a byproduct of large-scale electrolytic copper refining, where it is recovered from the sludge that collects on anodes. This occurs in two places in the US: at ASARCO's copper refinery in Amarillo, Texas, and at Rio Tinto/Kennecott's Bingham copper pit and refinery in Utah. China produces most of the world's tellurium.

Terbium (65)
Terbium is mostly used to create green phosphors in trichromatic (red/green/blue) lighting applications, in cathode ray tubes (TVs), LCD screens, and industrial and commercial lighting. Terbium is also used as a stabilizer in fuel cells, in magnetic actuators, fiber optics, and naval sonar systems.

Terbium is one of the 16 rare earth elements that are on the critical minerals list, most of which are produced in small amounts at the Mountain Pass mine in California, the only major rare earth mine in the US. Efforts to open other domestic rare earth mines are underway, in West Texas, Nebraska, Wyoming, Alaska, and a few other places. China currently produces around 95% of the world's rare earth elements.

Thulium (69)
Thulium is the second scarcest rare earth element, after promethium. Thulium is used in solid-state lasers and as a radiation source in X-ray devices. It is also used in high-temperature superconductors and dosimeters.

Thulium is one of 16 rare earth elements that are on the critical minerals list, some of which are produced in small amounts at the Mountain Pass mine in California, the only major rare earth mine in the USA. Thulium is not currently known to be extracted from there, nor is it mined or processed anywhere else in the US. Less than 50 metric tons are produced annually, globally, primarily in China.

Tin (50)
Tin is a ubiquitous metal, used in many essential things. Much of the tin consumed is for electronics, especially as solder. The rest is used in metal alloys, chemistry, the tinning of steel cans for food containers, and a myriad of other uses, including as a component in superconducting magnets, nuclear fuel rod cladding, lithium-ion battery anodes, and liquid crystal displays.

No tin is currently mined or smelted domestically. The last US tin mine closed in 1993, and though large placer deposits in Alaska remain from the early 1900s, including at Tin City, on the tip of the Seward Peninsula, these reserves pale in comparison to global sources that are currently supplying the world, such as those in Peru, Bolivia, Indonesia, Brazil, western Africa, and China. More than 350,000 metric tons of tin is produced annually, globally. The US consumes around 40,000 metric tons, annually, as much as 25% of which is recycled from industrial scrap.

Titanium (22)
More than 95% of the titanium concentrates extracted from the various and relatively abundant ores that contain it are consumed in the form of titanium dioxide, a white pigment used in paints, paper, plastics, and toothpaste. 3% or less is used to make titanium sponge, the feedstock for the durable lightweight metal alloys that make it a critical mineral. Titanium alloyed with aluminum is used in many commercial and military aircraft frames. Titanium alloyed with other metals are in jet engines, Apple computers, tennis rackets, eyewear, and many other products.

The US has been a major source of titanium in the past, including from a large mine in the middle of New York's Adirondack State Park, and from a magnesium extraction plant at Utah's Great Salt Lake. Production facilities included the massive TIMET plant in Las Vegas, and the ATI titanium sponge plant in Albany, Oregon. While these facilities have closed, some domestic titanium mining occurs in the Trail Ridge area of Georgia and Florida, but it doesn't supply the form of the mineral used in metallurgy. China dominates global titanium production, followed by Mozambique and South Africa.

Tungsten (74)
Tungsten is a hard metal principally coupled with carbide to make cutting tools for metalworking, construction, and mining. Tungsten wire is used in lighting filaments, X-ray tubes, electrodes, and welding. When alloyed with other heavy metals it is used in armaments, and penetrating projectiles, as well as in turbines and other machinery. Tungsten also is used in radiation screening, electron beams, and integrated circuits. Around 10,000 metric tons is consumed in the US annually, out of a global supply of around 80,000 metric tons.

The US has been a major producer of tungsten, historically, but it has not been mined domestically since 2015. Today its supply is dominated by China (more than 80% of global production), with some tungsten coming from Vietnam, Russia, Bolivia, Australia, and a few other countries. Some tungsten deposits in the US are in the early stages of being developed, and some mothballed mines may become active again.

Uranium (92)
Uranium was added to the critical minerals list in November 2025 (up to that point, fuels were outside the scope of the list). Its use is critical for powering nuclear reactors, those that power around 20% of the US electrical grid, but also for reactors that power all naval aircraft carriers and submarines. Uranium is also used in armor piercing bullets, and, of course, in nuclear weapons.

The US currently produces around 300 metric tons of uranium annually, around 1% of the uranium consumed in the nation's nuclear reactors. This came from a few intermittently active mines, mostly in Wyoming. Most of them are "in situ" mines, meaning they extract uranium by flushing water through underground ore bodies, like Wyoming's Lost Creek and Smith Ranch mines. The White Mesa Mill, in Utah, is the only remaining active conventional uranium mill in the nation. The US imports nearly all of the approximately 23,000 metric tons of uranium its commercial reactors consume, annually. Primary sources are Kazakhstan, Canada, Namibia, Australia, and Uzbekistan.

Vanadium (23)
Vanadium has been used to harden steel, since its first industrial use in the Model T. Vanadium is also used for alloys of aluminum and titanium, favored by defense industries for aircraft engines and structural components. Vanadium is used in utility-grade battery storage systems as well.

Mines in the southwest have produced small amounts of primary vanadium as a byproduct of uranium mining in recent years, and efforts are underway to produce more at projects proposed in Utah, Colorado, and Nevada. China is the largest global source of vanadium, producing around 70%, followed by South Africa and eastern Russia. Around 100,000 metric tons are produced annually, globally. The US consumes around 15,000 metric tons annually. Much of it is produced from secondary sources, extracted from steel smelter slag, ash, oil refining wastes, and other industrial processes, which generates as much as 8,000 tons a year in the US. A few hundred tons are produced from recycled metal sources in the US too. A few domestic companies specialize in processing it, such as U.S. Vanadium, in Arkansas.

Ytterbium (70)
Ytterbium is mainly used in stainless steel alloys, and in lasers. Ytterbium is also used as a gamma ray source. It is an unstable metal, which can spontaneously combust and explode at room temperatures, and is stored in sealed inert atmosphere containers. Its electrical resistance changes when subjected to high physical stress, which makes it useful in sensors that monitor ground deformations from earthquakes and explosions.

Ytterbium is one of 16 rare earth elements that are on the critical minerals list, some of which are produced in small amounts at the Mountain Pass mine in California, the only major rare earth mine in the USA. Ytterbium is not currently known to be extracted from there, nor is it mined or processed anywhere else in the US. Around 50 metric tons are produced annually, globally, primarily in China.

Yttrium (39)
Yttrium was originally highly prized for its contributions to the color red in the cathode ray tubes of early color televisions. Some of these properties are still of use in LED screens and lasers. Like some other rare earths, Yttrium is also used in aluminum and magnesium alloys, camera lens glass, superconductors, spark plug electrodes, and battery cathodes.

Yttrium is one of 16 rare earth elements that are on the critical minerals list, some of which are produced in small amounts at the Mountain Pass mine in California, the only rare earth mine in the USA. Though yttrium has been produced there historically, just about all of the 6,000 or so metric tons of yttrium produced annually is mined and processed in China.

Zinc (30)
Zinc is the fourth most consumed metal, measured by production tonnage, after iron, aluminum, and copper. Most of it is used to galvanize metal, limiting corrosion in iron and steel. Zinc is also used as an alloy to make bronze and brass, and is the primary metal in billions of US pennies. Zinc is used in smaller amounts in many industries and products, including rubber, agriculture, semiconductors, lasers, nuclear reactors, medicines, sunscreens, and dietary supplements.

Though the largest zinc mine in the world is in Alaska (the Red Dog Mine, which supplies around 10% of the world's zinc ore), the US imports just about all the zinc it consumes (mainly from Canada, where the ore from the Red Dog Mine is shipped and refined). There is only one primary zinc refinery currently operating domestically, in Clarksville, Tennessee, where a few mines also produce a limited amount of zinc. China produces (and consumes) much of the rest of the world's zinc ore, followed by Australia and Peru.

Zirconium (40)
Zirconium is used in high-temperature industrial applications, including ceramics, refractories, in foundry sands for metal castings, and in some critical hard metal alloys. It is used in cladding nuclear fuel, and is often sourced with a small amount of hafnium, another critical mineral to which it is closely aligned, which is also used in nuclear reactor control rods. Zirconium is used in flashbulbs, prosthetics, deodorants, space propulsion thrusters, and diamond-like cubic zirconia.

A small amount of Zirconium is produced from domestic surface mines in the heavy sands of the Trail Ridge district of northern Florida and southern Georgia, which also produce titanium. Most of the zirconium used in the US comes from zircon mines in Australia and South Africa.

UNCRITICAL MINERALS

THE OTHER HALF OF THE PERIODIC TABLE

Air Products helium gas plant in Liberal, Kansas. Several non-critical elements exist in gaseous form, and are harvested in air separation plants, or, more commonly, manufactured at petrochemical plants, which are abundant in the US. CLUI photo

THE CRITICAL MINERALS LIST COVERS half of the elements on the periodic table. This makes one wonder about the elements on the other half of the table. What's so *un*critical about them?

Several elements are gases, and are not on the list because they are captured or generated in abundance in the US through the nation's widespread network of gas production and petrochemical processing facilities. Located within most oil and gas refineries are gas production subsystems that capture or create various gases to be consumed by the facility or shipped off-site, as part of the elaborate and intermingled chemical production that goes on at these facilities. In some cases, especially for excess gases that are consumed off-site, the subsystem is operated independently, by one of the four big industrial gas companies—Linde, Air Liquide, Air Products, and Messer—that make and market bulk material that is consumed in a gaseous state (as opposed to a solid or liquid form). These industrial gas companies also operate stand-alone cryogenic air-separation facilities across the country, including at other types of gas-consuming industrial facilities, like steel mills.

Hydrogen (Atomic Number 1)

Among the industrially created and consumed gases is hydrogen, number one on the periodic table because it has one proton around its nucleus. It is the lightest and most abundant element in the universe, but despite its ubiquity, it requires quite a bit of technology and a lot of energy to isolate it for industrial use.

Nearly all of the hydrogen produced in the US is made at oil refineries and petrochemical plants, using the steam-methane reforming process, where high pressure and high temperature steam is forced into methane (aka natural gas) and a nickel catalyst, to make hydrogen. This process takes place inside a multi-tubular packed-bed reactor (a series of long narrow tubes that wind around inside the combustion chamber of an industrial furnace, heated to around 1,500 degrees Fahrenheit). Like a continuous contained and controlled explosion, this process produces 10 million metric tons of hydrogen in the US every year, around 15% of the global total.

Every ton of hydrogen produced this way consumes two tons of methane, five tons of water, and six megawatt hours of energy, equivalent to the energy consumption of 200 average American homes over the course of a full day. Six tons of carbon dioxide is produced as a byproduct, most of which is released into the atmosphere.

The majority (around 65%) of the hydrogen produced at these refineries is consumed by these refineries, mostly to make gasoline, but also many other petrochemicals, fuels, and chemical feedstocks. 25% or so is used just to make ammonia, the primary form of fixed nitrogen, which is used in agriculture to feed the world. That leaves around 10% for other uses, including being shipped off-site to other chemical plants and factories that use hydrogen for things like metallurgy, pharmaceuticals, food processing, fuel cells, and rocket propulsion.

Helium (2)

Element number 2 on the periodic table is another light gas, helium, one of the noble gases, meaning that it is stable and doesn't react much with other elements. Left alone in the atmosphere, helium rises into space and disappears from the planet. To capture it and make use of it, it has to be collected while trapped underground. This is done by extracting it from petrochemical gas wells, operating in deposits where helium exists in addition to the gas, in sufficient amounts to make it worth extracting. These wells are concentrated around southern Kansas and the panhandle of Texas and are connected by pipelines to the federal helium storage center near Amarillo.

The federal stockpile and its related processing infrastructure was established in the 1920s, when helium blimps were essential to naval defense. The stockpile is now run by industrial gas companies, which have since expanded the helium production network. In addition to it's use as a lifting gas in aerostats and balloons, helium is used in many high-tech applications, such as for cooling superconducting magnets, like those found in MRI machines; growing silicon wafers; and filling vacuums with inert gas. For much of the 20th century, the US controlled the global supply of helium. The US now produces around 68 million cubic meters, less than half the world's supply, largely because Qatar produces nearly as much as the US.

Other Noble Gases

Neon, argon, krypton, and xenon are other elements not considered critical, that are also inert noble gases, collected at petrochemical refineries, gas processing plants, cryogenic air-separation plants, and steelworks. Neon is still used in electric signage (though LEDs have replaced many neon signs) and is also used in semiconductor fabrication and lasers. Argon shares some of these uses, and is more commonly used for its stable, inert qualities to fill vacuums, as it is less prone to escape and cheaper to produce than other noble gases. Argon gas fills the cases containing the Declaration of Independence and US Constitution on display at the National Archives. Krypton is used in signage, lasers, semiconductors, medicine, and aerospace applications. Xenon is used in some of these ways, but has more uses in lighting, including flash and strobe photography, and is also used as a propellant in satellites and deep space probes.

Oxygen (8)

Oxygen is essential to organic life and, thankfully, still found in abundance in the atmosphere. It is generated for commercial consumption by industrial gas companies at more than 100 air separation plants across the country. It is used in blast furnaces, welding and cutting, rocket fuel, steelmaking, smelting, paper making, chemical production, water treatment, healthcare, and more. Like many other gases, it is transported and stored as a liquid in cryogenic compression tanks and pipelines, substantially reducing its volume. Around 5,000 tons of industrial oxygen is produced and consumed annually in the US.

CFIndustries nitrogen plant in Donaldsonville, Louisiana, is the largest single source of nitrogen in the US. CLUI photo

Nitrogen (7)

Nitrogen is the king of atmospheric gases, forming more than 80% of the earth's atmosphere, and making plant and animal life possible. Its industrialization changed the world for people, perhaps more than any other single element, and more of it is manufactured than any other elemental gas.

Though nitrogen is abundant in the air, and in rotting organic matter, capturing and controlling it in large quantities wasn't perfected until the Haber-Bosch process was invented in Germany, in the early 1900s. The process fixes nitrogen in the form of ammonia, produced using hydrogen, derived from natural gas, reacting with nitrogen from the air, in an energy-intensive industrial process which went into widespread use in the US during World War I, to produce explosives, and also set off a global revolution in industrial agriculture, enabling the population of the world to expand exponentially in modern times.

Around 14 million tons of fixed nitrogen in the form of ammonia is manufactured in the US annually. A significant amount of that comes from a single plant in Louisiana, operated by CF Industries, along the Mississippi River industrial corridor. There are around 35 more plants producing the material in the US, operated by CF, Nutrien, Koch, and others. Russia and India produce around the same amount as the US. Only China produces substantially more: 47 million metric tons.

Like nitrogen, ammonia is a gas, which is lighter than air. It is stored and transported in cryogenic pressure tanks, which turn it into liquid form, reducing its volume 850 times. It is transported in this way by refrigerated barges traveling on the nation's rivers, and by dedicated pressurized pipelines connecting Texas and Louisiana to the midwest. It is moved by rail cars and trucks as well, to distribution nodes all over the country, from where it is trucked to farms, and injected into the ground by machinery.

The US produces around 90% of the industrially fixed nitrogen that is consumed by agriculture and industry in the US, and has the capacity to produce more. Some of it is exported, and some is imported too. Clearly nitrogen is a critical mineral, but so long as the US can produce all it needs domestically, and doesn't run out of natural gas, it is unlikely to be found on the official critical minerals list.

Chlorine (17)

Chlorine is another mega-gas, with more than ten million metric tons produced in the US annually. 95% of chlorine is produced by the chlor-alkali process, where chlorine is the key element in a family of manufactured chemicals distinct from petrochemicals, as it uses salt (sodium chloride) and electricity for its production, and not hydrocarbons like methane (natural gas).

While chlorine by itself reacts violently with petroleum products, chlor-alkali chemicals are often combined with petrochemicals like ethylene to make plastics, notably PVC (polyvinyl chloride), a class of plastics used in pipes, packaging, bags, sheeting, building materials, cables, conduits, clothing, toys, and more. Chlorine is also combined with petrochemicals to make synthetic rubber, solvents, and pesticides. On its own chlorine is best known for its widespread use in water purification.

Because of its frequent mixing with petrochemicals, chlor-alkali plants are often co-located or adjacent to petrochemical plants, especially in Texas and Louisiana. They are often distinctly owned and operated, not an oil company subsidiary, and manufacture most of their products on site. There are 49 or so chlor-alkali production plants around the US, many of them owned by Olin, OxyChem, and Westlake.

When liquified chlorine gas is sold in bulk and shipped to other manufacturers and industrial customers, it is in specialized pressurized rail cars, as it is both volatile and toxic. Chlorine is remembered for its historic use as a chemical weapon, and for its connections to harmful chemical agents such as PCBs, DDT, Agent Orange, and other dioxins.

Uncritical Minerals From the Ground

The Minntac taconite mine in Minnesota is the largest source of iron for the US steel industry. CLUI photo

Critical or not, most elements on the periodic table are solids, not gases, and are collected from minerals found in the ground, including petrochemicals, rather then extracted from the air. Some of them can be found in abundance in the US, are easy enough to extract and ship, and are likely to stay off the critical minerals list for the foreseeable future.

Sulfur (16)
Once mined extensively in the US for use in chemicals and fertilizers, the last sulfur mine closed in 2000, as sulfur is produced in abundance by oil and gas refining and metals smelting. Every refinery processing crude oil and gas produces sulfur as a byproduct, and 150 or so facilities in the US collectively generate more than eight million metric tons of sulfur annually. The US is the second largest producer of sulfur in the world, following China, which makes more than twice as much. Russia and Saudi Arabia, with all of their refineries, are tied for third.

In the US, captured sulfur is usually shipped and consumed in the form of sulfuric acid, most of which (around two thirds) is used to manufacture phosphate fertilizers, generally in the form of phosphoric acid. In the US, most of that takes place in the phosphate mines and production plants east of Tampa, Florida. Sulfuric acid is used in the process, but much of it is not consumed into the final product, remaining instead in large and mildly radioactive phosphogypsum (calcium sulfate) waste stacks around the plants and mines.

The remaining third or so of sulfuric acid not destined for phosphate fertilizer is used in many industrial applications, including in batteries, metal refining and metal pickling, dyes, detergents, explosives, textile and paper making, and petroleum refining. Like nitrogen, the amount of sulfur produced in the US is limited only by the amount of petrochemicals that are produced domestically, especially gasoline, since that accounts for almost half of every barrel of oil consumed.

Sodium (11)
Sodium is plentiful, found in salt deposits of various types, and mined depending on the type of sodium compound that is being processed from the deposit. Sodium chloride for food and industrial use is made from solar evaporation ponds next to salt lakes and impounded bays in Utah, California, and Arizona, though more is mined from large underground deposits, found in several states, including Kansas, Louisiana, Michigan, Ohio, New York, and Texas. Top companies in this industry are Cargill and Morton.

The US produces around 40 million tons of salt a year. 40% of it is used as a de-icing agent on roads. Another 40% is used by chemical industries, where much of it is used to make chlorine and caustic soda, feedstocks for other chemicals. Food processing uses about 4%. Only China produces more salt than the US.

Sodium in the form of soda ash (sodium carbonate, also called trona) is used in glass, soap, metallurgy, and many chemical applications, such as adhesives, paper, and food processing. It is mined from dry lakes in California (Owens and Searles), but most of it comes from Green River, Wyoming, where since the 1950s, four large underground mines extract 90% of the soda that is produced in the US, around half of the world's supply.

Calcium (20)
Calcium is another plentiful element mined all over the US for different mineral compounds. Calcium oxide, extracted from pits, makes up the majority of the typical cement mixture used as a construction material. There are around 100 cement plants in the US, in 34 states, that produce around 85 million tons of cement every year. Plants in Texas, Missouri, California, and Florida account for nearly half of it. The US ranks fourth in cement production globally, with Vietnam producing 110 million tons, India 420 million tons, and China producing two billion tons, more than 20 times as much as the US.

Calcium oxide is also the prime ingredient in lime, which is classified as a separate commodity, primarily used in steelmaking, and in the manufacture of fertilizer, glass, paper, pulp, and sugar. 16 million tons of it is produced annually in the US, by more than 70 industrial plants in 28 states, with most production coming from Alabama, Missouri, Ohio, and Texas.

Calcium sulfate is gypsum, which is mined all over the US and used for drywall, fertilizer, cement, and other products. The US is the largest producer and consumer of gypsum, making 22 million tons of it annually, and consuming 44 million tons (the missing half comes mostly from Spain, Mexico, and Canada). There are around 45 gypsum mines in 15 states, principally California, Iowa, Kansas, Nevada, Oklahoma, and Texas.

Iron (26)
A number of elemental metals are mined in large enough quantities domestically that they are not on the critical minerals list (yet). These include iron, which is used primarily to make new steel, as opposed to steel that is made from scrap, which most of it is these days. 90% of the iron needed to meet domestic consumption comes from seven or so mines in Minnesota's Mesabi Range and Michigan's Marquette Range, and is shipped directly to the steel plants along along the shore of Lake Michigan, and to other inland plants. A few other smaller iron mines, including some in the southwest corner of Utah, provide most of the rest.

Total production of iron in the US is close to 50 million metric tons per year, which is primarily used to make the 80 million tons of raw steel produced annually, at the nation's dozen or so integrated steel mills, mostly owned by Cleveland-Cliffs or U.S. Steel, as well as from around 100 mini-mills that produce steel from scrap. The US is considered a major raw steel producer, currently ranked fourth in the world, behind Japan, India, and China, which produces more than ten times as much.

Gold (79)
The US is currently the fifth largest gold-producing nation, generating around 165 metric tons annually (behind Canada, Australia, Russia, and China, which alone produces more than twice as much). 70% of it comes from Nevada, mostly from three mines in the north central part of the state. Alaska, Colorado, Arizona, Idaho, South Dakota, and California are among the other states with active gold mines.

Half the gold consumed in the US is for jewelry and ornaments. However around 25% is used in industrial applications, such as electronics and coatings. Another major use, which varies according to gold's highly fluctuating value, is banked currency, stashed away in safes and vaults, public and private.

The US government holds what is considered to be the largest amount of "monetary" gold in the world, with more than 8,100 metric tons at five locations: Fort Knox, West Point, the Denver Mint, the Philadelphia Mint, and the Federal Reserve Bank of New York, which with more than 6,300 metric tons, is the largest known stockpile of gold in the world. The gold there, stored on bedrock, 80 feet underground at its offices in Manhattan, is owned by others, not the US government, and is held there for safekeeping. The current value is more than a trillion dollars.

Two Climax Molybdenum mines in Colorado produce most of the molybdenum consumed in the US. CLUI photo

Molybdenum (42)
The US is a major global producer of molybdenum, behind only Peru, Chile, and China. Most of it comes from two mines in Colorado, owned by Freeport-McMoRan. One, the Climax Mine, near Leadville, was the primary source of molybdenum in the world for many decades. In World War II, molybdenum was considered an important strategic resource, as it was used to make hardened steel for everything from aircraft engines to armor plating. Most of the nation's supply at that time came from this mine. By 1957, Climax claimed to be the largest underground mine in the world. It expanded as an open pit in the 1960s.

In 1976, the company opened a major underground operation at the Henderson Mine, 30 miles away, which is now the largest molybdenum mine in the nation, producing more than a billion pounds of molybdenum since opening. Molybdenum is also produced as a byproduct at copper mines in Arizona, Montana, Nevada, and at the Bingham Canyon Copper Mine in Utah, still called the biggest man-made hole on earth.

Around 33 thousand metric tons of molybdenum ore is produced annually in the US, around half of which is consumed domestically to produce hard metal alloys. Some is also used in chemical applications, including as catalysts, lubricants, and pigments.

Iodine (53)
The US is the third largest global producer of iodine, an element that, while not officially critical, has some critical functions. Two thirds of the world's iodine comes from desert nitrate mines in Chile, around 20,000 metric tons of it. Gas fields in Japan produce around half that amount. The US produces around 1,200 metric tons, from a subterranean brine pool in northwestern Oklahoma that has been the nation's only domestic source of raw iodine since the 1970s. The Iochem Corporation and Woodward Iodine Corporation operate iodine-rich brine extraction plants in the region.

Iodine is used in X-ray imaging, medicine, nutrition, LCD screens, and as a catalyst in various chemical processes. It also has some high-tech and military uses, such as laser weapons. Iodine is in potassium iodide pills, in some emergency kits, to be ingested to mitigate the effects of being exposed to high levels of radiation.

Bromine (35)
Like iodine, bromine is extracted from saline deposits. It can be extracted from sea water, but inland subterranean brine deposits can have higher concentrations of it, and be more cost effective. Israel's Dead Sea is the world's largest source, followed by brine wells in the US. Bromine is used as fire retardant in furniture, electronics and textiles, and as a disinfectant in water treatment, in place of chlorine. It is used in industrial chemical production, pharmaceuticals, drilling fluids, pesticides, plastics, and batteries.

Currently domestic bromine is produced exclusively from wells in the Smackover Formation, an old oil field in southern Arkansas. Two major companies operate there, producing around 225,000 metric tons of the material per year, which is around 30% of the global total. The Albemarle Corporation is centered around the town of Magnolia, where it operates brine extraction plants and a network of more than 230 miles of pipelines and 145,000 acres of leased land. LANXESS, a German chemical company, operates a network of wells and plants around the town of El Dorado. Both companies, and others, are also exploring the extraction of lithium from Smackover Formation brine.

Several critical and uncritical minerals are extracted as a by-product from mining processes for other minerals, at smelters and refineries, such as the refinery at the Bingham Copper mine, which produces gold, silver, molybdenum, tellurium, selenium, and more. CLUI photo

Selenium (32)
Selenium is one of several elemental minerals that are produced as a byproduct of processing other minerals. It is an element with a wide variety of uses, in metallurgy, glass manufacturing, agriculture, chemicals and pigments, electronics, batteries, and other applications, including dandruff shampoo. It is produced as a by-product of mineral processing, mostly electrolytic copper refining, where it is sourced from copper anode slimes.

Somewhere around 2,000-3,000 metric tons of selenium is produced globally annually, though a precise amount is hard to determine as China consumes most of what it produces, and US companies consider its production amounts proprietary information. But since the US is usually ranked as the fifth largest copper producer in the world, behind Chile, China, Peru, and the Democratic Republic of Congo, it is likely a significant producer of selenium. It would come principally out of the two electrolytic primary copper refineries in the US: one in Miami, Arizona, operated by Freeport-McMoRan, the largest US copper producer; and the other in Utah, connected to the Bingham Canyon Mine, owned by Rio Tinto.

Osmium (76)
Osmium is another element that is primarily produced as a metal-refining byproduct, in copper and nickel refining, and the processing of platinum-group metals (PGMs), which are domestically mined in the Stillwater Mountains in Montana, and a few other locations. Very small amounts of osmium are consumed domestically though, using domestically produced, or, more

likely, imported osmium from South Africa, Russia, or Canada. Less than a thousand pounds is produced globally annually, as it is rare and its qualities are shared by other metals. When osmium is consumed, it is as a hard metal alloy in high-wear applications.

Cadmium (48)
Cadmium is primarily sourced as a byproduct of zinc smelting, and the nation's only primary zinc smelter, located in Clarksville, Tennessee, generates around 300 metric tons a year. Though the US has a large zinc mine in Alaska, its ore is smelted in Canada. Secondary cadmium is sourced from scrap in the US, primarily from spent nickel-cadmium batteries. Cadmium is used mostly in nickel-cadmium (NiCd) batteries, but is also used in metal alloys, coatings, pigments, solar panels, and semiconductors, though not in a high quantity. The US is not a major producer of cadmium, so most cadmium consumed in the US is imported. Around 25,000 tons are produced annually globally, chiefly by China, Korea, Canada, and Japan.

Strontium (38)
Some once important elemental minerals are not being produced domestically at all anymore, yet remain off the critical list. Strontium has not been produced in the US since 1959. It is extracted from celestite ore, which the US imports from Mexico, in small quantities, around 1,000 tons a year. In the US, strontium is used primarily as an oil and gas well drilling fluid additive. Other nations use it to make powerful ceramic ferrite magnets. It also has uses in ceramics, glass, pyrotechnics, and medicine. As much as 500,000 tons is produced globally, mostly in Iran and Spain. Radioactive strontium-89 is produced at the Oak Ridge National Laboratory in Tennessee.

Mercury (80)
Mercury was heavily used in relays, paints, batteries, lighting, thermostats, and gold mining, but due to its toxicity to humans, it has not been mined as a commodity in the US since 1992, and its use is discouraged. Quicksilver mines in New Almaden and New Idria, California were major historic sources of mercury until the 1970s, when the use of mercury in gold mining was banned, and demand dropped considerably.

Since then, mercury has been recovered as a byproduct from processing gold and silver ore at some mines in Nevada, and more has been recovered from old batteries, fluorescent lamps, dental amalgam, medical devices, mercury switches, and contaminated soils. One of the largest sources of mercury is in the form of emissions from coal fired power plants, but most of that escapes into the atmosphere.

The Department of Energy has designated repositories for elemental mercury, including at the toxic waste site managed by Waste Control Specialists, near Andrews, Texas, which may hold up to 6,800 metric tons of mercury in a special storage building. More than 1,000 metric tons is held at the DOE site at Oak Ridge, Tennessee, for defense purposes (mercury is used in nuclear weapons). Though mercury exports from the US has been banned since 2013, some exceptions have been made, and specialized uses of the material continues using mercury imported into the US, primarily from Canada.

Thallium (81)
The element thallium is harvested as a byproduct in copper, lead, and zinc processing, and is highly toxic to humans. It has not been produced in the US since 1981, though other nations, primarily China, Kazakhstan, and Russia may produce as much as ten tons of it a year, collectively. It has uses in gamma radiation detection, high-temperature superconductors, infrared optical materials, photocells, and radioisotopes. With the atomic number of 81, thallium is on the upper end of the periodic table, where things begin to be more radioactive.

Radioactivity and the Decaying End of the Periodic Table

Many of the elements on the upper end of the periodic table are radioactive and exist only in experiments in physics labs, like the University of California's Berkeley National Lab, where 13 elements were discovered, between 1940 and 1974.
CLUI photo

Things begin to decay radioactively at the higher end of the periodic table. 36 of the 59 "uncritical" elements are radioactively unstable, and therefore a bit tricky to produce, process and consume. Naturally radioactive elements include polonium (atomic number 84), which, like many others, occurs in small amounts as a byproduct of the decay of uranium; astatine (85), which is uncommon outside of laboratories, and is used in medicine; radon (86), a common and sometimes dangerous naturally occurring radioactive gas that has limited industrial production or medical use anymore; francium (87), which has a 22-minute half-life and is only used in labs; radium (88), which was mined from the Colorado Plateau in the early 1900s, and processed by companies like the US Radium Corporation of New Jersey into products such as glowing paint for watch dials; actinium (89), a rarely occurring or used radioactive element; thorium (90), which has been used in the nuclear power industry, in glass production, and in consumer products, such as the mantles in gas camping lamps, mostly phased out in the 1990s; protactinium (91), occasionally used as a radioactive tracer in field science; and uranium (92), by far the most mined and processed radioactive element because of its usefulness in energy production and weapons, when enriched, and transformed into various isotopes. It was added to the critical minerals list in 2025.

There are also two radioactive element outliers with lower atomic numbers: technetium (43) which is a radioisotope made from molybdinum that is used in medicine; and promethium (61), which is the only one of the 17 rare earth elements that is not on the critical minerals list, and is chiefly made in very small amounts into isotopes in research reactors.

Radioactive elements with atomic numbers higher than uranium (92), referred to as transuranic, are mostly synthetic, generated in small quantities inside laboratories, particle accelerators, or highly specialized production facilities. These include plutonium, berkelium, californium, nobelium, lawrencium, and livermorium, names that reflect the importance of UC Berkeley's cyclotron in atomic science. The final element on the period table is oganesson, with atomic number 118. Fewer than ten atoms of which have ever been produced. It too is a gas. ♦

BOOKS OF INTEREST
ON THE SHELVES OF THE CLUI LIBRARY

Material World: The Six Raw Materials that Shape Modern Civilization, by Ed Conway, 2023
A globe-trotting journalist's materialist dig into the global industries of sand, salt, iron, copper, oil, and lithium. The sand chapters are especially compelling, describing how one of the most prevalent materials on earth can become so precious, when processed to the nth degree.

Chip War: The Fight for the World's Most Critical Technology, by Chris Miller, 2022
This book explains the essentials about the evolution of the silicon chip industry, whose remarkable, nearly ephemeral physical medium of microscopic integrated circuits/semiconductors/microprocessors is the infrastructure of the information age. In a lucid and global corporate way, this book almost does for the hardware of the digital age what Richard Rhodes did for the atomic bomb, or Daniel Yergen for the oil industry. With things changing so fast, propelled by the current craze for AI, a new afterward in the trade paperback edition released in September, 2025 gets us up to date, to that point at least. The book could be an important hard copy back-up for archeologists digging through the ruins after China and the US fight to the death over the TSMC plant in Taiwan.

Material Acts: Experimentation in Architecture and Design, by Kate Yeh Chiu and Jia Yi Gu, 2025
This catalog of an exhibition curated by the authors is a remarkable journey into a panoply of innovative materials. It presents the work of individuals, research groups, offices, and ateliers working with things like responsive bimetals, actuated elastomers, delaminated and non-dimensional lumber, jammed gravel, mycelium columns, bacterial cellulose sheeting, biocalcified paper foam, algae-laden hydrogels, printed adobe, fired-on-site masonry, waste plastic cladding, and more. It presents a formidable challenge to the dialectical industrial adage that "if it is not mined, it is grown." The exhibition was held in 2024 at Los Angeles' Craft Contemporary, a museum and exhibition space dedicated to craft-making.

Plywood: A Material History, by Christopher Wilk, 2017
Plywood is one of the most common, sustainable, and versatile building materials. Used to make floors, walls, roofs, shelving, cabinetry, and furniture, many of us are literally surrounded by it. And used as a form for concrete, it further shapes our built world. From its humble beginnings as 3-ply cross-grained veneers used in door panels, crates, and furniture, it was shaped into airplanes, cars, and boats through the 1940s, when it was deemed an "essential material" for World War II. After the war it found its way deeper into building construction, eventually competing with other emerging 4x8 foot sheet materials, like OSB (oriented strand board), MDF (medium density fiberboard), drywall, and other composite boards, in the 1970s. Among them all though, plywood endures, with integrity. This book tells the story of plywood in erudite words and images, including some of the American side of the story, but focused on design, since it was published in conjunction with an exhibit at the Victoria & Albert Museum in London.

The Apocalypse Factory: Plutonium and the Making of the Atomic Age, by Steve Olson, 2022
As a radioactive element, plutonium does not appear in nature. If any existed on the earth prior to humans, it would have decayed and disappeared long ago. It was "discovered" in the cyclotron at Berkeley in 1940, by Glenn Seaborg and others, as element 94, two steps away from its source, uranium (element 92). Its potential use as a fuel for nuclear bombs was clear enough, theoretically, to create the plutonium production plant at Hanford, Washington, as part of the Manhattan Project, which supplied the 13 pounds of plutonium239 used for the Trinity test, and more for the Fat Man bomb dropped on Nagasaki. Hanford went on to produce most of the plutonium in the US in its nine reactors until 1989, when the site became the most complex environmental clean-up project in the nation's history (total cost for clean-up estimated to be half a trillion dollars or more). This book is the latest to tell the tale of this end-of-the-world elemental metal made from scratch, as much as 1,000 metric tons of which exists on planet now (very carefully stored, one hopes).

Waste Wars: The Wild Afterlife of Your Trash, by Alexander Clapp, 2025
A impassioned and ground-truthed overview of the global trash industry confirms, once again and with vigor, yes, it's getting worse in unimaginable ways. Why do we make so much unnecessary stuff? Perhaps it's because while we may individually be rational and thoughtful people, we are collectively insane.

After Spaceship Earth: Art, Techno-Utopia, and Other Science Fictions, by Eva Diaz, 2025
A Lippardian art-historical curatorial romp/rodeo through post-Buckminster Fuller fallout, roping in contemporary artist projects by the likes of Mary Mattingly, Nils Norman, Oscar Tuazon, Connie Samaras, N55, Hito Steyerl, Trevor Paglen, Tom Sachs, Matthew Day Jackson, Jane and Louise Wilson, Tavares Strachan, Stewart Brand, Sun Ra, Octavia Butler, and many, many more. The best bits are about domes, as social space, projection space, expanded cinemaspace, moviedromes, geoscopes, network sensoriums, McLuhanesque teaching machines, global expo geodesics, and SAGE radometics. Despite remarkable depth and breadth, the author's Venn-diagramming leaves more out then in, of course, affirming the existence and importance of parallel universes.

Transformation of a Landscape, by Victoria Sambunaris, 2024
The latest tranche of big images from one of the great contemporary landscape photographers of the American West. Interesting thoughts and essays in additional sub-publications tucked into a pouch inside the hardcover binding.

Wild Visions: Wilderness as Image and Idea, by Ben A. Minteer, Mark Klett, and Stephen A. Pyne, 2022
Ah, wilderness, that "self-willed" wild place. This book gets at it from the POV of photography, and the format is neat: several chapter galleries, each with a text essay, some images picked by photographer Mark Klett, and a discussion. It narrows down towards the inevitable conclusion that wilderness might have dissolved into a notion, but then steps back. While it is perhaps debatable that wilderness is everywhere, or exists only in outer space, one area where wilderness is not likely to be found in abundance is in American wilderness areas.

Newsletter Editors: Matthew Coolidge, Sarah Simons, Jim Fox
CLUI Corps: Steve Badgett, Emma Barreto, Ann Basu, George Budd, Julia Christensen, Matthew Coolidge, Zoe Detweiler, Jim Fox, Oswaldo Gonzalez, Cynthia Hooper, Hilary Huckins-Weidner, Ben Loescher, Clay Mahn, Rob Ray, Prema Reyes, Sarah Simons, Deborah Stratman, Aurora Tang, Tellef Tellefson, Dan Torop, Igor Vamos, Sara Velas, Nico B. Young

THE CENTER FOR LAND USE INTERPRETATION
9331 Venice Blvd.
Culver City, CA 90232
www.clui.org clui@clui.org