The Geological Society of America

Visitor Guide

THE GEOLOGICAL SOCIETY OF AMERICA®

SCIENCE ▪ STEWARDSHIP ▪ SERVICE

THE GEOLOGICAL SOCIETY OF AMERICA®

Welcome to the Geological Society of America

The Geological Society of America is a nonprofit organization dedicated to the advancement of the geosciences. The Society was founded in New York in 1888. GSA is the first enduring society for the geosciences in the United States. In 1968, GSA headquarters offices moved from New York to Boulder, Colorado, and are now housed in a one-of-a-kind building at 3300 Penrose Place. The GSA headquarters building was constructed in 1972 to serve as a center for Society operations, programs, and activities. At that time, it was also determined that it should serve as a display gallery for the many rock and mineral specimens and other geologic works of art, natural and manufactured, that have been given to the Society since its founding.

GSA is an expanding global membership society with more than 25,000 members in 103 countries. Thirty percent of its members are students. The Society's primary activities are organizing scientific meetings and conferences and publishing scientific literature. Other activities include disbursing research grants, operating an employment matching and interview service, honoring outstanding scientific contributors with medals and awards, assisting teachers in geoscience education, and fostering public awareness of geoscience issues.

Visitors are always welcome at GSA, and we encourage you to tour the building and its grounds so that you, too, may appreciate the beauty of these objects and also catch a glimpse of the GSA headquarters staff at work.

This booklet has been prepared to lead you on a self-guided tour of the building. Specimens and other art objects are grouped by floor and a detailed description of each item is provided.

The Society is deeply indebted to all those friends at GSA who have donated objects for display. Their thoughtfulness and generosity make it possible for all who appreciate the beauty of nature to enjoy these treasures.

Again, welcome to GSA, and enjoy your tour.

John W. Hess, Ph.D.
Executive Director

Photo by Benjamin F. Smith Imaging.

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Published by the Geological Society of America, Inc.
3300 Penrose Place, P.O. Box 9140, Boulder, Colorado 80301-9140, USA

Printed in the USA.

Revised and updated in 2013 by the Geological Society of America.

Book design by Heather L. Sutphin.
Photography by Chris Brown, Eric Christensen, and Heather L. Sutphin unless otherwise stated.

GSA gratefully acknowledges the earlier work of Barb EchoHawk in the cataloging and written descriptions of GSA's specimen collection. The Society also acknowledges Prof. James S. Aber, of the Earth Science Department of Emporia State University, for information about Richard A.F. Penrose Jr. from Aber's website, http://academic.emporia.edu/aberjame/histgeol/penrose/penrose.htm.

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Preface

After many years of borrowing, owning, and renting offices in New York and then westward in Boulder, Colorado, the Geological Society of America finally moved into its own headquarters building in the autumn of 1972. Its street address, 3300 Penrose Place, was no accident; the staff arranged with the city to name the street in honor of the Society's benefactor, Richard A.F. Penrose, Jr.

Thanks to a generous endowment from Penrose, carefully tended by successive investment committees, to an able and cooperative architect and builder, and to the vision of many people on the GSA Council and staff, the headquarters building is not only functional but pleasing to the eye. Penrose's memory is kept alive, both through the building itself, and through the many pieces of his personal memorabilia—his rocking chair, his magnificent globe, and part of his outstanding library, which is rich in books on early explorations—housed in the building.

Though it was built more than forty years ago, the headquarters building bucks tradition with its unusual and spacious design and exhibits the grace and symmetry of Earth's materials. The many people associated with its planning were highly concerned with the view, the landscaping, and the ease and comfort of the staff. We hope the rocks, minerals, and colors that decorate our building will remind staff members and visitors how rich in color, form, and texture are the natural features of our Earth's crust.

Our Mission

To advance geoscience research and discovery, service to society, stewardship of Earth, and the geosciences profession.

Introduction to the Geological Society of America

In its 125th anniversary year, the Geological Society of America (GSA) has grown along with the times, while staying true to its mission as a steward of the geosciences. Founded in 1888 by some of the great geologists of the day, including James Hall, James Dwight Dana, and Alexander Winchell, the Society relocated from New York to Boulder, Colorado, in 1968, and in 1972, moved across town into what has become a one-of-a-kind, solar-paneled building.

In keeping with GSA's mission to be a leader in advancing the geosciences, the Society offers its 25,000 members a variety of publications, which include top-ranked journals *Geology*, *GSA Bulletin*, *Geosphere*, *Lithosphere*, *Environmental & Engineering Geoscience*, and the science and news publication *GSA Today*. It also publishes four well-respected books series: Field Guides, Special Papers, Memoirs, and Reviews in Engineering Geology.

Back in 1890, *GSA Bulletin* was the first GSA journal to make it into the hands of geologists. Now, readers access the latest developments in geology with online ahead-of-print articles and use their smartphones to view papers via mobile-optimized sites. Always progressive and forward-thinking, GSA continuously looks for ways to promote the geosciences and to provide services to its worldwide membership via social networks, including Twitter, Facebook, LinkedIn, and smartphone apps.

Investing in the future of the geosciences is a key component of GSA's mission as it celebrates its 125th year. Through its Education and Outreach and Employment Service programs, the Society offers numerous resources for diverse groups within the geosciences, including students, job seekers looking to advance in geoscience or geoscience-related career paths, geoscience educators, and members of the public. GSA members have access to employment assistance and mentor programs and are also encouraged to apply for field program awards and travel grants, and enroll in short courses. Through www.geosociety.org/educate, K–12 educators may download lesson plans and programming ideas. GSA, along with many partners and sponsors, fuels interest in geologic features with EarthCache™. This program allows anyone with a GPS unit to locate and study these features around the world.

As GSA celebrates 125 years of service to the worldwide community of geoscientists, whether in academia, industry, policy, or for students in preparation for one of these careers, its annual meeting remains a touchstone for the geoscience community at large. Seventeen specialty divisions,

Photo courtesy of Tim Ray, Vantage Point Imagery.

which any GSA member may join, convene at this meeting, where geologists from around the world present their latest research and discoveries in the field and in the lab. GSA also has seven regional sections, including the recently formed International Section plus six in North America: Cordilleran, Rocky Mountain, North-Central, South-Central, Northeastern, and Southeastern.

GSA is also dedicated to advancing the interests of the geosciences in public policy and maintains an office in Washington, D.C., where it monitors developments relating to the earth sciences and its funding on Capitol Hill.

Finally, in realizing the importance of continuing to fund promotion of and investment in the geosciences, the GSA Foundation, established in 1980, receives and administers contributions in support of GSA's mission. As an independent, tax-exempt organization, the Foundation accepts gifts by check or credit card, wire transfers, stock, and by bequests to the Society's programs. Recently completing a $10 million capital campaign, the Foundation also contributes to GSA's research grants program, and supplies matching student travel grants for each of GSA's Sections.

Over forty years since moving from New York to Boulder, the Society's employees are as dedicated as ever to working on behalf of the Society's mission to provide access to elements that are essential to the professional growth of earth scientists at all levels of expertise and from all sectors. Throughout 2013, we at GSA headquarters invite members and friends to celebrate 125 years of our science, stewardship of the Earth, and service to the earth sciences with us.

A Bit of Our 125-Year History

The Geological Society of America was founded in 1888 for the purpose of "the promotion of the science of geology by the issuance of scholarly publications, the holding of meetings, the provision of assistance to research, and other appropriate means."

Initially, 37 renowned geologists responded to an invitation to join the new Society, and by the end of the first year, membership had grown to 191. The question of beginning a Society-sponsored publication was tackled at the organizational meeting in December 1888, and a series to be known as the *Bulletin of the Geological Society of America* was proposed and adopted. The first volume of the *Bulletin* appeared in February 1890; the January/February 2013 volume is the 125th in a continuous series.

Annual meetings organized by the Society for the exchange of new knowledge were successful from the start. With the growth and specialization of the geologic profession, the formation of associated societies began in 1909 when the Paleontological Society was organized, followed by eight additional associations: Mineralogical Society of America, Society of Economic Geologists, Society of Vertebrate Paleontology, Geochemical Society, National Association of Geology Teachers, Geoscience Information Society, the Cushman Foundation, and Sigma Gamma Epsilon.

The Geological Society of America depended primarily on dues from its relatively few members until 1931, when the Society received a substantial bequest from Richard A.F. Penrose, Jr. As a result, it was able to expand its activities in many ways and to begin publication of its series of Memoirs and Special Papers and the annual *Bibliography and Index of Geology* (now published by the American Geological Institute). The Society also began issuing color wall maps and special publications in the field of engineering geology. The 24-part *Treatise on Invertebrate Paleontology*, a major reference work, was introduced in 1953. The series was copublished by GSA and the University of Kansas for a number of years. (In 2007, the University of Kansas Paleontological Institute became the sole publisher.)

The Geological Society of America today is proud to have been an integral part of that development as it continues to play an active role in the direction of the geologic sciences of the future.

A Note about Headquarters Architecture

The idea of geology as a natural, outdoor science is evident throughout the design of the Society's headquarters building. Three interior areas are arranged around skylighted atria featuring natural geologic sculptures and plants. The building brings the outdoors in and takes the indoors out by providing views of the trees and the Rocky Mountains through floor-to-ceiling glass walls.

Perhaps the most striking quality of the building is the absence of walls with holes for windows. Instead, a series of horizontal, broadly cantilevered concrete planes, each one larger than the one below, is supported by vertical arched slabs, which are visually connected only by mullions and glass. The strength and nature of concrete as the dominant material was emphasized by stripping away its cold gray sheath to reveal the warm brown aggregates underneath.

The shape of the building, even though somewhat symmetrical in structure, is nonetheless unique in design. Sections of internal space are related to the reception lobby in "pinwheel" fashion and are connected by half flights of stairs. To permit the variation of space requirements within each section, the arched walls project upward from the small base of the building to enclose additional areas at various locations on each floor and to provide support for the roof. Successive cantilevering to the top of the building not only provides protection from the bright Colorado sunshine, but also results in minimum coverage of the building base, freeing the site for natural growth.

Particular care was taken to emphasize the geometric forms of the building through the use of undulating earth shapes. Grass-covered berms provide visual and acoustic screening of the highway and define areas for plants that while indigenous to the general area, require encouragement to withstand the rigors of the climate along the Front Range of the Rockies. Included among the many species of plants selected are ponderosa and mugho pine, wild plum, red bud, and sumac; the shade provided by the latter is often used by deer as a resting place during the day. A feeding ground for robins, grackles, magpies, and other wild birds was provided along the walk to the front terrace where chokecherry bushes grow among groves of aspen, juniper, and sedum. Clusters of daffodils and tulips are a gift from Tjeerd H. van Andel, a former GSA Councilor.

Nature's Processes: A Brief Lesson in Geology

Minerals are naturally occurring chemical elements or compounds of several elements. Each mineral species has its own definite chemical composition and many other constant characteristics, such as color, hardness, luster, and specific gravity, which permit the mineralogist to identify it. Many minerals form crystals in geometric shapes that reflect their internal atomic arrangement, which, again, is particular to each species. Though many of our crystal specimens appear to be carved by hand, they are all naturally formed. No gem cutter could duplicate, time after time, the exact angles between crystal faces that characterize every crystal of quartz, for example, wherever in the world it may have been found.

Some minerals have crystallized from molten material or have formed in other ways, but most are formed by precipitation from solutions of various chemicals in water, hot or cold, much as crystals of sugar form in the bottom of a syrup pitcher.

Some rocks are masses of single minerals. Limestone, for example, is made up almost entirely of the mineral calcite. Most rocks, however, are aggregates of two or more minerals, such as granite, which is basically an intergrowth of the minerals quartz, mica, and feldspar. Rocks are not as constant in chemical composition as are minerals, and of course they possess no crystal forms.

Igneous rocks, such as granite, are formed by crystallization of minerals from molten material deep in the earth. For example, obsidian is really a natural volcanic glass, rather than an aggregate of minerals. It was formed from magma, or melt, similar to the kind that would have formed granite if it had cooled very slowly. Rapid cooling of the lava from a volcano, however, caused the melt to freeze as glass before it had time to form crystals.

Sedimentary rocks, such as sandstone and shale, are formed by accumulation of mud and sand grains, most commonly in bodies of water. As more sediments are piled above, the lower layers become consolidated and form rock. Other sedimentary deposits, such as limestone, are formed directly by precipitation of chemical compounds from ocean or lake water.

If preexisting rocks, sedimentary or igneous, are contorted, squeezed, or otherwise changed by mountain-building forces or chemical action, they are called metamorphic rocks. Gneiss, schist, and serpentine are examples.

With some exceptions, rocks are usually less beautiful and attractive to the layperson than are many mineral specimens. To geologists and petrologists, however, rocks are as fascinating and instructive as minerals are to mineralogists or as flowers are to botanists.

Rocks of the Rockies in the Walls

The GSA building itself is a display of specimens of most of the rocks that make up the Rocky Mountains—the range that sits just two miles west of the building. It is reinforced concrete, poured

in place, with all exposed surfaces sandblasted to etch away the Portland cement. This treatment left the aggregate pebbles in relief and brought out their individual tones and textures.

The gravel in the concrete came from the flood plain of Boulder Creek a short distance south of the building. It consists of rock fragments torn from the giant mountains by glaciers, frost, running water, and other mechanical weathering processes, then worn and rounded during their journey to the plains via Boulder Creek and its tributaries.

Virtually all the rock types that make up the Colorado Front Range can be found in the walls. Naturally, fragments of the harder and more durable rocks and minerals predominate—granite, gneiss, quartz, chert, and the like. But it only takes a little looking to find specimens of red-brown shales and sandstones of the Flatirons, of black obsidian glass from extinct volcanoes, and of ancient mica schists that were once sediments and were squeezed and contorted very early in geologic history. There are even a few minerals of copper and other ores to be seen in places, though we have yet to find a nugget of gold. As if to prove that geology is up to date, there is at least one fragment of man-made porcelain embedded in the lobby floor. Perhaps it was once a dish in some prospector's cabin in the early days of mining in Colorado.

Nature: The Original Artist

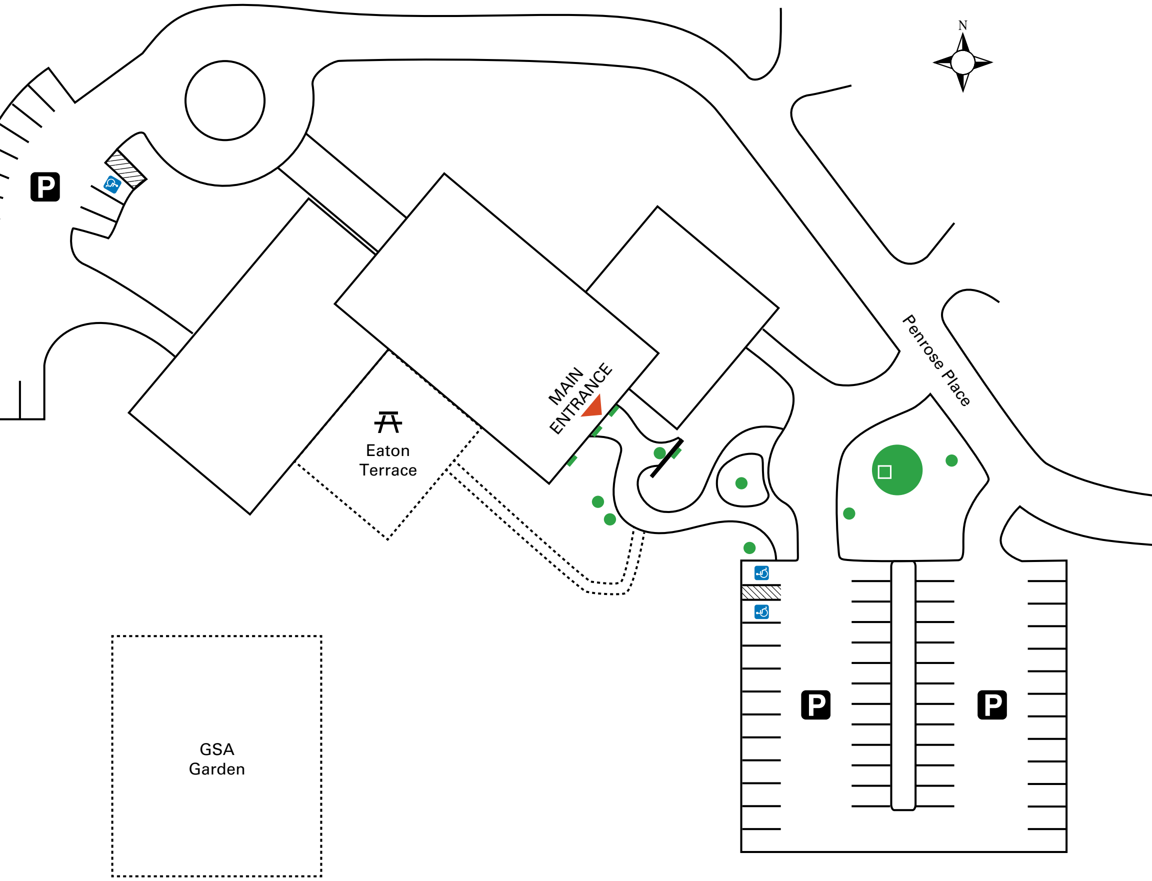
A few of our art objects—agate, petrified wood, and others—have been sawed and polished to spotlight their natural beauty. Or, they were prepared for special purposes, such as the sandblasted carving of the Society seal or the sundial. All of our natural sculptures, however, are truly formed by nature. You see them just as they came from the earth, with all of the shaping, carving, and polishing done by wind or running water, working with gravel, sand, or silt as natural tools.

Wall adornments throughout the building are not just decorative—they have stories to tell. For example, the rock slabs with dinosaur tracks tell of the time when these mighty creatures ruled the Earth, while the fossil fish from the Eocene Green River of Wyoming (outside the second floor Council Room) remind us of the importance of the sea and marine life throughout geologic time. The beautiful filigree of native copper on the Council Room wall affirms our appreciation of the mineral resources of our planet.

One thing is sure: nestled in the Front Range of the Rocky Mountains, our building and its many geological specimens and art objects tell a story of Earth in its ever-changing and awe-inspiring glory.

Outdoor Exhibits

Outdoor Map

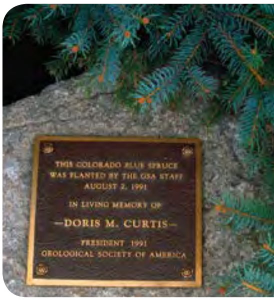


Outdoor Exhibits

■ Society Plaque

Arriving at GSA, you will notice that our building is situated on two scenic acres, with an additional two acres surrounding the building, populated by a variety of indigenous trees. Next to the sidewalk to the right of the front parking lot (facing west) is the original bronze plaque, now set in moss rock, that welcomed visitors to the Society's first headquarters building in New York more than a hundred years ago.

The stone and its emplacement are a gift from Luna B. Leopold, University of California at Berkeley, and a former president of the Society.



■ Doris Malkin Curtis Memorial Plaque and Colorado Blue Spruce

Doris Curtis (1914–1991), first woman president of the Geological Society of America, was widely admired for her spirit, her energy, and her contributions to science and to the geoscience community. During her career in the petroleum industry, academia, and consulting, she held leadership roles in a number of prominent geological and scientific organizations.

The plaque and the Colorado blue spruce were donated by GSA staff.

■ Stromatolite

Located in the rockbed to the right of the front parking lot, adjacent to the walkway, this two-ton specimen is from the 1.8-billion-year-old Kona Dolomite in the Chocolay Group of the Marquette Range Supergroup near Negaunee, Michigan.

The laminated domes in this ancient rock are stromatolites. They were built layer by layer almost 2 billion years ago by colonies of blue-green algae living at the bottom of a shallow sea. As part of their life processes, the algae secreted calcium carbonate, the same mineral that forms limestone. The calcium carbonate settled in thin layers that the algae grew over and through. Tiny grains of sediment were trapped in the layers, too. When the sediments were later converted to rock, they formed an impure limestone. Later still, they metamorphosed into dolomitic marble that still displays the stromatolites that the algae built.

Located by David K. Larue. Gift from A. Lindberg and Sons, Inc., of Ishpeming, Michigan, through L.L. Sloss.

■ Sundial

Carved in a polished slab of serpentine, the sundial to the left of the front walkway is a small but significant marker leading to the building. The sundial shows the exact time only four days each year: 15 April, 14 June, 1 September, and 25 December. During the summer, it is incorrect by as much as 6.5 minutes (on 26 July); in winter, it is off by as much as 16.4 minutes (on 3 November). In addition to these errors, which are related to Earth's orbit, the time shown is a full hour off during daylight-saving periods.

The origin of the stone is uncertain, but it was probably collected for the Smithsonian Institution by George Merrill. The stone itself was a gift from the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., through George Switzer and Harold H. Banks, Jr. Its transfiguration into a sundial is the gift of August Goldstein, Jr., Tulsa, Oklahoma, former treasurer of the Society. Calculations, design, and cutting were by Milton Erickson, Erickson Memorial Co., Denver, Colorado.

■ Serpentinite Boulder

The massive serpentine, in the small garden in the center of the front walkway, came from the Mother Lode area of the Sierra Nevada, California. It is from the same outcrop as the serpentine rock in the north atrium.

This large boulder is made up of metamorphic serpentine minerals that contain high concentrations of magnesium and iron. Serpentine soils and the runoff from serpentinite outcrops can be so acidic that many plant species cannot survive them without the addition of potassium and lime. Conversely, certain plant species grow only in serpentine soils.

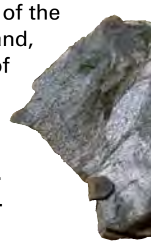
Gift from John A. Huberty, collected by Christopher W.H. Hulbe and students from Sacramento City College, California, through Bennie W. Troxel, former science editor for the Society.

■ Society Seal

The Society's seal, adopted in 1891, is reproduced on the wall in front of the building. It is a gift from Mrs. Barbara Campbell in memory of her husband, Arthur B. Campbell (1924–1971), a Fellow of the Society. At the time of his death, Campbell was chief of the branch of Rocky Mountain Environmental Geology, U.S. Geological Survey.

A commemorative plaque of the same stone, Spartan Pink granite from a stone quarry in Georgia, is set on top of the wall above the seal.

Cutting and emplacement of the seal and plaque were by Milton Erickson, Erickson Memorial Co., Denver, Colorado.



Before you reach the garnet specimen ahead, on your left you will see stairs and a pathway leading down to the Eaton Terrace, which is located near the southeast side of the building. The terrace was made possible through a contribution from Gordon P. and Virginia G. Eaton. From the terrace, you can view GSA's staff garden and the southern portion of the Society's land.

■ Garnet-Bearing Rock

Looking to the left of the serpentine garden, you will see a dark, spotted boulder. The red crystals embedded in the rock are garnet, a complex iron-magnesium-aluminum silicate mineral. Outlining the garnets are borders of black hornblende. Small, clear crystals of garnet are highly prized as gems, but these are not of gem quality; they are used for abrasives (garnet paper, for example, is a much better abrasive than sandpaper and is correspondingly more expensive).

This monolith is from the main ore zone of the garnet deposits at Gore Mountain in the southeastern part of the Adirondack Mountains of New York. The deposit has been mined continuously for more than 100 years and is the only commercial source of graded garnet abrasive powders obtained from a bedrock deposit. Gift from Barton Mines Corporation, North Creek, New York, through Charles B. Sclar, Lehigh University, Bethlehem, Pennsylvania.

■ Memorial Fountain

Next you will see giant clam shells fashioned into a fountain. The shells are from the largest living bivalve Mollusca family. They occur in the western and southern Pacific Ocean.

This display is in memory of Charles Lee McGuinness (1914–1971), who, at the time of his death, was chief of the ground water branch, U.S. Geological Survey, and chairman of the Hydrogeology Division of GSA.

Gift from the Hydrogeology Division of GSA.

■ Benchmark

Look carefully on the ground about 9 m (30 ft) to your right and you will see the small bronze benchmark, GSA-1 1973, which was established here by the U.S. Geological Survey (USGS). It is used by the Survey in its continuing program of providing horizontal and vertical controls for land surveyors and for preparation of topographic maps. Inside the front entrance of the building you can read the 1973 letter from the USGS certifying GSA headquarters as a permanent benchmark location. The precise location of the benchmark is 40°02′14.53″N, 105°14′58.67″W. Its elevation is 5312.874 ft above mean sea level.

The surveys were accomplished by Edwin Eckel, Douglas Hardwick, and Sim Farrow, U.S. Geological Survey, Denver, Colorado.

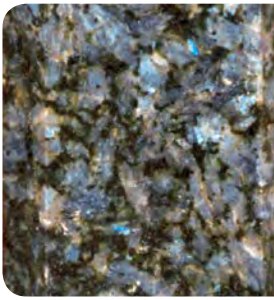
Granitized Hornfels

■ Granitic Specimens

The specimens on the walls next to the main entrance are two types of granitic rock. The specimen on the left wall, from the Fletcher-Mason quarry in Mason, New Hampshire, is gray and white granite cut by a pinkish band of pegmatite. The specimen on the right wall is a granitized hornfels from the Cornucopia gold mine in Oregon's Wallowa Mountains. The dark, dense fragments are hornfels, a metamorphic rock resulting from contact metamorphism, in this case when shales were "baked" by the intrusion of a magma body. At one time, this entire specimen may have been composed of fractured hornfels. The fractures likely allowed hot solutions to enter the rock, chemically altering some of it into granitic rock.

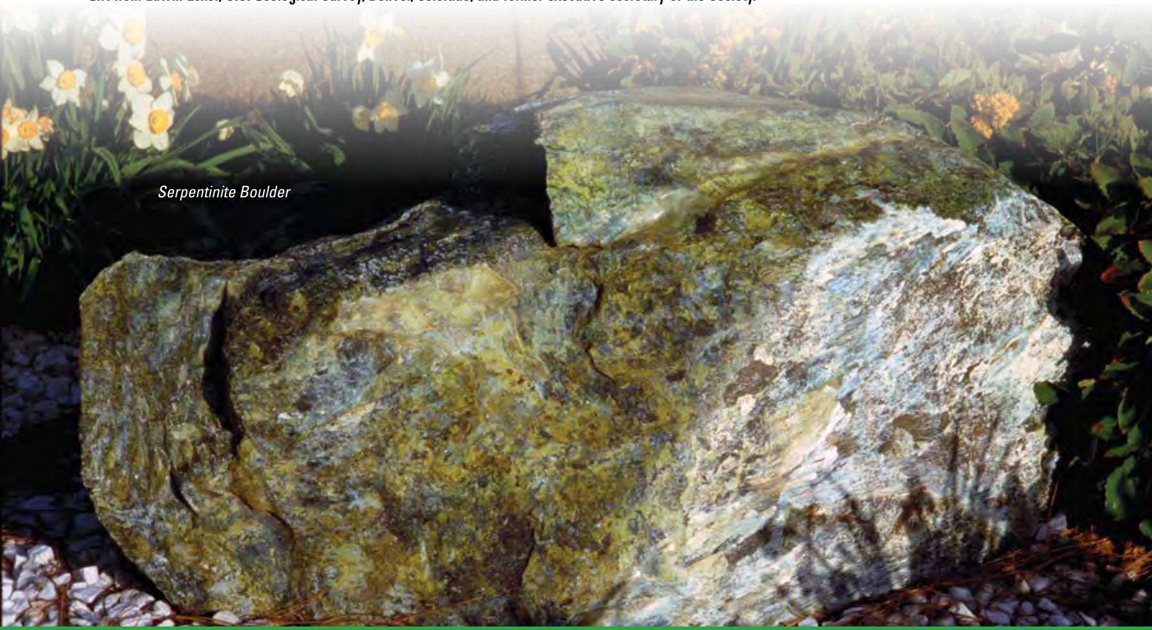
The Mason granite is a gift from Richard H. Jahns, Stanford University, Stanford, California, and a former president of the Society, and James W. Skehan, Boston College, Chestnut Hill, Massachusetts. The hornfels is a gift from G.E. Goodspeed, University of Washington.

■ Norwegian Blue Pearl Door Pulls



The stone handles on the front door are mostly orthoclase, with minor amounts of pyroxene, mica, and oxide. The feldspar is iridescent due to microscopic planes of albite which act as a refraction grating. The rock is Larvikite, an alkalic granitoid classified as either syenite or monzonite, quarried in the Oslo Graben and cut and polished in Italy.

Gift from Edwin Eckel, U.S. Geological Survey, Denver, Colorado, and former executive secretary of the Society.



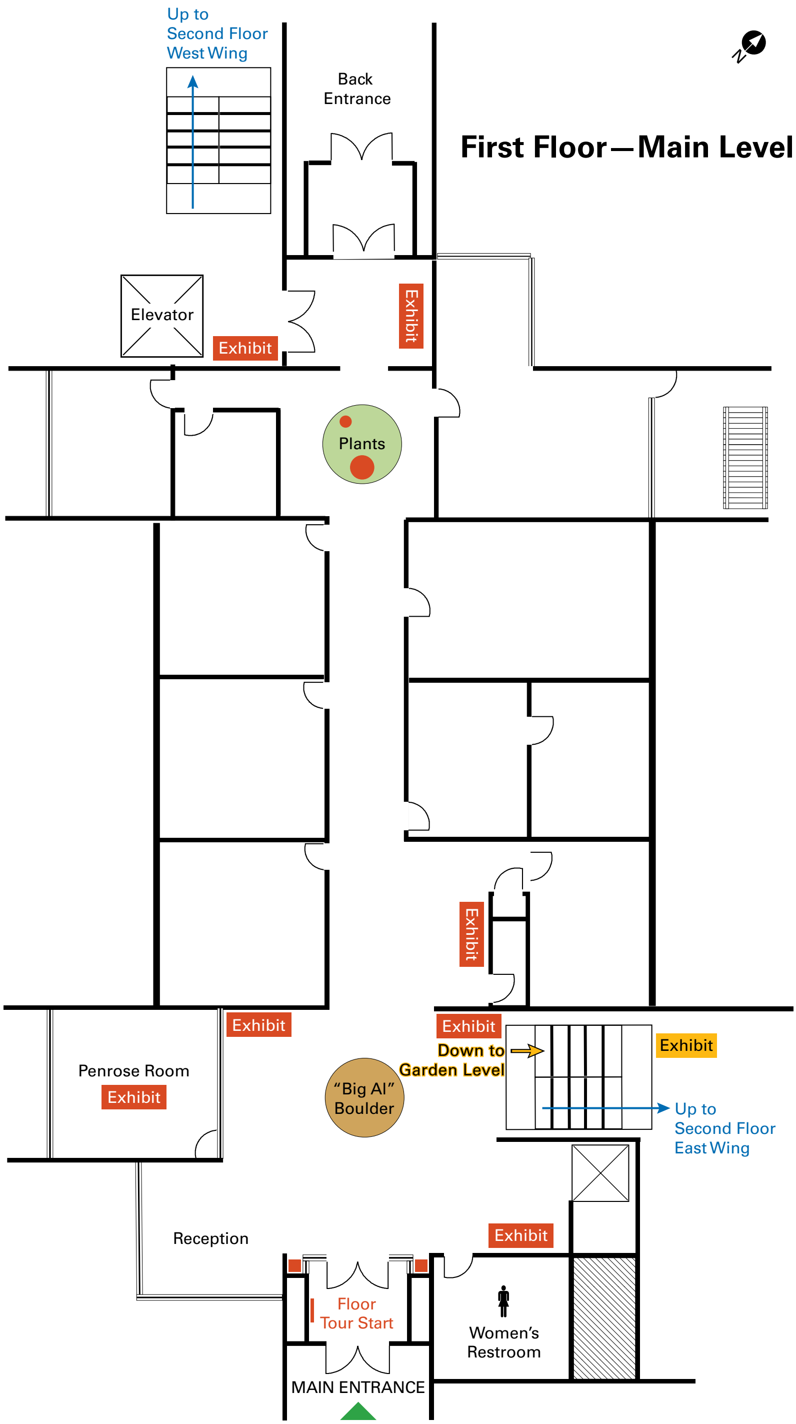
Serpentinite Boulder

First Floor

& Garden Level

Exhibits

First Floor—Main Level



First Floor Exhibits

■ Stone Tablet

As you enter the building, on your left you will see a tablet made of Spartan Pink granite from Georgia. This memorial, which carries the inscription "A generation comes, a generation goes, the Earth remains forever", Ecclesiastes (1:4), was a gift from Mrs. Barbara Campbell to her husband, Arthur B. Campbell, a GSA Fellow.

Stonework was crafted by Milton Erickson, Erickson Memorial Co., Denver, Colorado.

■ River-Sculptured Granite Boulder, aka "Big Al"

Walk inside and into the lobby atrium and you can't miss it—a 3 m (9 ft)-high, 8-ton boulder from the Big Thompson River, which flows out of the Rocky Mountains just west of Fort Collins, Colorado. Known affectionately by staff as "Big Al," this giant piece of Silver Plume granite, carved and polished by sand and gravel carried by the Big Thompson and its predecessors, epitomizes the enduring nature of our Society, our science, and our Earth through its massive appearance.

Found by Fred Handy. Donated by Mrs. Robert Danielson, on behalf of her father, Charles Webb.

■ Shaler and Penrose Busts

If you look behind you, on either side of the front door you will see busts of GSA's founding fathers, Nathaniel Southgate Shaler and Richard A.F. Penrose, Jr. Penrose's recreated office is to the left of the front atrium.

Bronze busts by sculptor Robert Aitken.

■ Orbicular Biotite Syenodiorite

On the walls adjacent to each bust are specimens of orbicular biotite syenodiorite. This type of rock typically forms deep in Earth's crust in quartz-poor zones near the edges of large granitic magma bodies.

The centers of the eye-like orbicules are pieces of rock that fell into the magma. The rings around them are minerals that precipitated one layer at a time as the magma slowly cooled and gradually changed in composition. The inner rings formed first and tend to be composed of darker, higher-temperature minerals than the outer rings, but certain conditions, such as partial melting of the trapped rock fragments, led to the precipitation of some light-colored inner rings.

Florence Koopman noticed this unusual rock in a 5-ft-wide dike that cuts through Precambrian granites and schists near Albuquerque, New Mexico. Her husband, geologist Francis G. Koopman, cut these slabs with a home-made wire saw.

Gift from Francis G. and Florence Koopman.

■ Miserite with Wollastonite

To the left of the Shaler bust and orbicular biotite specimen is a specimen of miserite with wollastonite. The pink mineral portion of this specimen is miserite, an uncommon silicate containing the rare earth element cesium. The grayish white mineral is wollastonite. It commonly forms fibrous masses of elongate brittle crystals that break with a splintery fracture. Wollastonite forms in metamorphosed impure limestones. It is used in ceramics and as a filler in paints, rubber, and plastics. Miserite was named in honor of longtime GSA Fellow Hugh D. Miser.

From the Union Carbide Vanadium Mine in Potash Springs, Arkansas. Gift from Charles Milton of George Washington University and the U.S. Geological Survey.

Penrose Room and Library

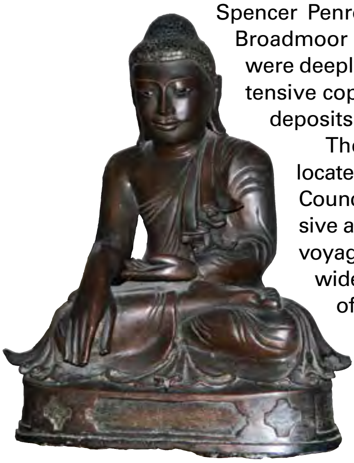
Richard A.F. Penrose, Jr., GSA's iconic benefactor who donated to the Society more than $4 million on his death in 1931, was a swashbuckling geologist and shrewd investor in mining stocks. He was born into a wealthy family and attended Harvard, graduating at age 23 with a Ph.D. He served on the faculty at the University of Chicago, where he gained much practical experience in field and mining geology. In 1903, he co-founded the Utah Copper Company (now part of Kennecott) to develop the rich Bingham Canyon copper deposits. This was the primary basis of his fortune. After his father's death in 1908, Penrose devoted himself almost entirely to investments and charities. He was well respected among geologists and was president of GSA in 1930.

Penrose joined the Society in 1889, less than a year after its founding, and served as its president in 1930, the year before his death.

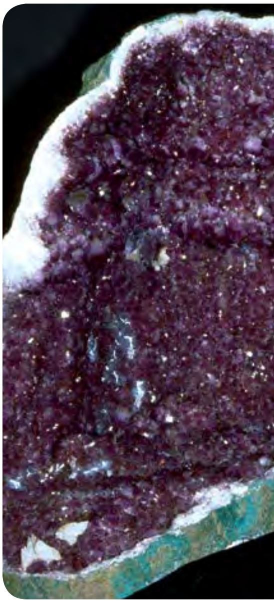
This room holds many pieces of furniture from Penrose's original office. The desk is made of Uruguayan mahogany. The bookcases and drawers for maps are also mahogany and built to Penrose's

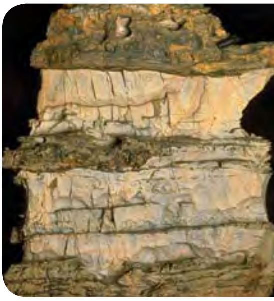
specifications. Among the books on the desk are *The Nature and Origin of Deposits of Phosphate of Lime*, Penrose's Ph.D. thesis at Harvard published as Bulletin 46 by the U.S. Geological Survey in 1888, and bound volumes of documents pertaining to the founding and rapid growth of GSA. The desk drawers contain some of his correspondence, his extensive field notes made during travels to mining locations around the world, and some of his lecture notes. In 12 years, he visited 60 countries.

The Persian rugs, carved wooden elephants, Buddha, and cast elephant on the desk were probably purchased by Penrose in Asia in 1901. The globe is one of a matched pair owned by Richard Penrose and his younger brother Spencer Penrose. Spencer's globe is in the lobby of the Broadmoor Hotel in Colorado Springs. The two brothers were deeply involved in the early development of the extensive copper deposits in Bingham, Utah, and the gold deposits at Cripple Creek, Colorado.



The Penrose Library, some books of which are located in the Penrose Room and the balance in the Council Room on the second floor, is a comprehensive and rare collection of books documenting early voyages and explorations. The collection reflects the wide-ranging interests of Penrose. Although some of the volumes have been restored, nearly all retain their original bindings, and many contain lovely lithographs and hand-colored illustrations.





Amethyst Geode

Immediately after the Penrose Room, you will see the truly eye-catching amethyst geode from Rio Grande do Sul, Brazil. Amethyst is a purple variety of quartz commonly found in fractures and cavities in basalt. Basalt forms from cooled lava and contains open cavities, where there were gas bubbles in the lava. Amethyst and other minerals crystallize from mineral-bearing fluids that enter the cavities. The crystals line or fill the cavities, forming geodes of various sizes. This unusual specimen is one of the largest of this quality ever found, weighing in at more than 300 kilograms (660 pounds). Approximately two months of careful hand labor was required to extract this specimen from the Miocene basalt that surrounded it.

Purchased by the Society.

Wind-Sculpted Stone of Chert and Dolomite

Directly across the atrium is a set of stairs leading down to two large specimen cases on the garden level. On your way down, you will notice a striped stone mounted on the wall. With alternating layers of blue-gray dolomite and dark gray chert, this sculpted stone is from the Johnnie Formation (southern Death Valley, California) of late Precambrian age and is estimated to be about 600 million years old.

The chert is resistant to wind erosion and thus stands out in sharp contrast to the softer dolomite, which is abraded more easily and rapidly. The chert, being very hard, is also more polished than the soft dolomite.

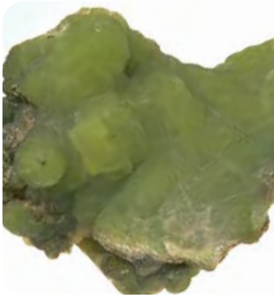
Gift from Bennie W. Troxel, former science editor of the Society.

If you take the stairs down, you will see two wooden specimen cases.

"Big Al" Boulder

Garden Level Exhibits

Starting with the first case, from left to right:



■ Green Stalactitic Calcite

This pale-green stalactitelike specimen of calcite probably grew in a cave and was found in Chihuahua, Mexico. Calcite is common in caves where long columns extend down from cave ceilings (stalactites) and up from cave floors (stalagmites). Calcite deposits develop when water carrying calcium bicarbonate in solution reaches a cavern. In the lower pressure of the cavern, carbon dioxide is released from the solution, and calcite (calcium carbonate) is slowly deposited on the roofs of caverns by dripping water and on the floors of caverns where the dripping water falls.

Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado.

■ Silicified Wood

The silica in petrified wood may come from volcanic ash interlayed with the sediments that buried the wood. Water moving through the layers dissolves silica from the volcanic ash and carries it through the sediments. Chalcedony and opal form from the silica-rich water when it moves into the wood. The silica can be deposited as a filling in the woody structure or as a replacement of the woody fibers themselves. When original wood fibers remain in petrified wood, the woody structure can still be seen, and soft woody tissue can be recovered by dissolving the silica in hydrofluoric acid.

Gift from the Department of Geology, Idaho State University, Pocatello, through H. Thomas Ore.

■ Muscovite

A mineral of the mica group, muscovite is colorless to pale brown. It is a common rock-forming mineral in igneous and metamorphic environments. Muscovite is useful in a broad range of applications because it is flexible; can be split into tough, thin sheets; is resistant to heat; and is a poor conductor. It is used in thermal and electrical insulators, in heat-resistant windows, as lustrous material in wallpaper, and as filler in rubber and plastics. Colorless, flawless plates of mica are used as wedges in polarizing microscopes. Muscovite's name comes from Russia, where thin sheets of the mica were used as stove windows.

Gift from William J. LeVeque, Claremont, California.

■ Negative Pseudomorphs of Quartz after Barite

This specimen is composed of quartz that grew over older crystals of barite. After the quartz formed, the barite crystals dissolved, leaving long tabular holes in the quartz where the barite used to be.

Gift from the Geology Museum, Colorado School of Mines.

■ Prehnite

Prehnite, valued as a gemstone, typically forms sea-green botryoidal crusts with radiating ridges formed by the edges of its curved crystals. It is most frequently found lining cavities in basalts, often with zeolite minerals and calcite. Prehnite is also found in gray, white, and colorless forms. Green specimens like this one can fade when exposed to air and light. It is named for Colonel van Prehn of the Netherlands, who brought specimens home from South Africa in 1774.

Quartz Crystal Aggregate

Quartz is a common mineral found in many kinds of igneous, sedimentary, and metamorphic rocks. Quartz varieties share the same chemical composition but differ widely in color, pattern, and form. Some quartz is transparent and colorless, but it also occurs in a wide range of colors produced by impurities or defects in atomic structure. Amethyst, citrine, milky quartz (this specimen), rose quartz, and smoky quartz are among the familiar varieties. Other varieties include aventurine, a colored quartz with tiny glistening flakes of mica, iron oxide, or clay, and tiger's-eye, a quartz variety with chatoyant bands of yellow and brown.

Quartz is used to make glass and in optical and electronic instruments. Some varieties, such as amethyst, citrine, and tiger's-eye, are valued as gemstones. Others are used in sandpaper and abrasives because of their resistant, sharp-edged grains.

Analcime Crystals

The mineral analcime forms shiny, glass-clear crystals. They are usually white, colorless, or gray, and may be tinted with green, yellow, or red. Small but brilliant analcime crystals occur in the basalt that caps Table Mountain in Golden, Colorado. It takes its name from the Greek *an* ("not") and *alkimos* ("strong") in reference to its weak pyroelectric properties. When heated, analcime's surfaces develop weak electrical charges.

Gift from Bethlehem Steel Corporation, through Gilbert L. Hole.

Polished Dolomite Marble Spheres

The reddish-pink dolomitic marble in these spheres was originally dolomitic limestone. It has been metamorphosed to marble and is intermixed with other metamorphic minerals, including calcite, phlogopite mica, and serpentine. Dolomite is usually slightly harder than limestone and slightly more resistant to weathering because it is less reactive to acid and has lower solubility. Dolomite is named for Déodat de Dolomieu (1750–1801), a French mineralogist.

Gifts from Lafayette College, Easton, Pennsylvania, through Arthur Montgomery and Paul J. Roper, in recognition of Lafayette alumnus Edwin B. Eckel's contributions to the Society and to geology.

Beryl Crystal

White crystals like this specimen are relatively uncommon. Beryl crystals in igneous pegmatites are often a meter or more (several feet) in length. A crystal 8.5 m (27 ft) long and 2 m (6 ft) wide was quarried in Maine, and a 180 metric ton (200 ton) crystal was found in Brazil.

From the Bob Ingersol mine, Black Hills, Keystone, South Dakota. Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado.

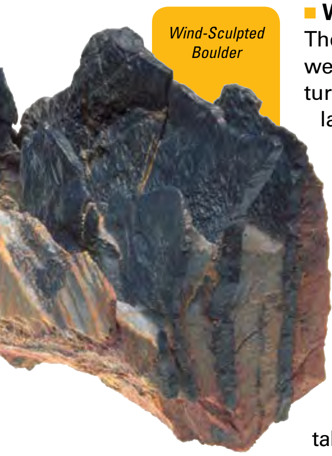
Polished Variscite Spheres

Most variscite is pale green to bright emerald green. Intense blue colors are fairly unusual. Variscite rarely forms distinct crystals; instead, it typically fills small veinlets or forms nodules, crusts, or fine-grained masses. In these spheres, the variscite is cut by veins of other minerals—crandallite (yellow, tan, and white), wardite (blue-gray), and millisite (white). In North America, variscite has been found only in the western United States. It is sometimes used as a gemstone. The name variscite comes from Variscia, the region in Germany where it was first identified.

Mined from Clay Canyon, Fairfield, Utah, by Edwin Over and Arthur Montgomery; shaped by B.F. Shepherd, Ingersoll-Rand Co. The spheres are gifts from Lafayette College, Easton, Pennsylvania, through Arthur Montgomery and Paul J. Roper, in honor of Lafayette alumnus Edwin B. Eckel.

■ **Native Sulfur with Celestite**
This specimen comes from Sicily, where fine crystals of native sulfur (yellow) occur in association with celestite and other minerals. Native sulfur is a minor ore of sulfur, and celestite is the principal ore of strontium. Strontium is used to make specialty glass, glaze, enamel, caustic soda, and in the processing of sugar beets. It is also used in strontium nitrate, which produces the bright crimson flame in fireworks and signal flares. Strontium is also used in batteries, paints, rubber, waxes, refrigerant solutions, and pharmaceuticals.
Gift from the Department of Geology, University of Tennessee, Knoxville, through Otto C. Kopp.

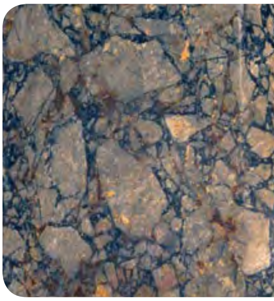
■ **Agate Slab**
This slab of agate, polished on both sides, is from Brazil. Fluids rich in dissolved silica filled a cavity in basalt rocks and left behind this agate. The horizontally layered, fine-grained silica was deposited layer-by-layer from solution. The crystalline quartz filled the remainder of the cavity later.
Purchased by the Society.



■ **Wind-Sculpted Boulder of Chert and Dolomite**
The alternating layers of darker chert and light dolomite were worn down by wind-blown sand, silt, and moisture. Chert is more resistant to weathering, so the chert layers stand out as polished ridges. Dolomite is more soluble and less resistant to weathering; it forms the indented layers.

■ **Spodumene Crystal**
This crystal, from Minas Gerais, Brazil, is of gem-quality spodumene. Spodumene is characterized by long, flat crystals with deep, lengthwise grooves and an uneven, splintery surface. The sharply defined change in color near the center of the crystal is especially rare. Spodumene occurs in white to green prismatic crystals, often of great size. It takes its name from the Greek *spodumenos* ("burned to ash") in reference to the ashy-colored, woodlike appearance of its weathered surfaces. The pink gem variety is known as kunzite, after G.F. Kunz, a noted American gemologist.
Gift from Raymond M. Thompson, Englewood, Colorado.

■ **Fossil Brachiopod**
Brachiopods have lived since the early Paleozoic. Although most forms are extinct, one branch has survived to modern times. Brachiopods were at their peak during the middle and late Paleozoic, about the time this brachiopod was alive. They lived attached to rocks, shells, or other hard surfaces at the bottom of the sea.
Gift from Xu Zheng-Liang, East China Geological Institute.



■ **Tourmaline-Cemented Breccia**
This unusual breccia, from the Cananea mining district in Sonora, Mexico, forms a ring around a copper and silver ore body. It contains fragments of volcanic rhyolite and igneous quartz monzonite porphyry, all cemented by black tourmaline. The feldspar-bearing rock fragments are veined by quartz.
Gift from Compañía Minera de Cananea, S.A. de C.V., courtesy of Guillermo A. Salas, Cananea, Mexico.

■ **Stibnite**

Stibnite is the most common of the antimony minerals. It is often found in groups of long-bladed crystals with lengthwise striations. The crystals are slightly flexible and sometimes have angular bends in them or may be twisted along their lengths. Stibnite is a low-temperature mineral found in veins mineralized by hydrothermal solutions, in hot spring deposits, in pegmatites, and in deposits where the original minerals have been replaced by others. China is home to large antimony deposits.
Gift from Xu Zheng-Liang, East China Geological Institute.

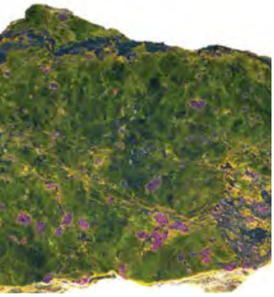
■ **Quartz Crystal with Tourmaline**

Several dark green tourmaline crystals grew near the base of this large quartz crystal from Minas Gerais, Brazil. Tourmaline crystals vary in color, with either horizontal bands like these or with concentric rings radiating from the center of the crystal outward.
Purchased by the Society.

Copper Dragon

■ **Obsidian**

Obsidian is volcanic glass. It forms when lava solidifies very rapidly, usually when hot lava flows into a cool body of water like a lake or a sea. The lava solidifies too quickly for minerals to form crystal structures, so an amorphous glass is formed instead. The mottled patterns of black and brown in this specimen from Ixtepeque Volcano, Guatemala, are the result of flowing lava layers that left bands and streaks of color. The small gray spheres are feldspar fibers cemented by silica; they barely had time to form before the lava solidified. Some obsidian also contains "stone bubbles" with crystals arranged in concentric shells inside large cavities. These are left behind by gases escaping from the lava. Obsidian fractures in the same way as glass, along nested sets of arcs. Razor-sharp edges result where the fractures intersect. These sharp edges have made obsidian a desirable material for tool-making. It is also used in jewelry and art objects.
Gift from Gabriel Dengo, Guatemala City, Guatemala.



■ **Stichtite in Serpentine**

The lilac stichtite is a rare alteration product of the green serpentine minerals that form most of this specimen. Stichtite was first described in 1910 from the site in Dundas, Tasmania where this specimen was collected. It is named for Robert Sticht, an Australian metallurgist born in the United States.
Gift from the Department of Geology, University of Tennessee, Knoxville.

■ **Lyons Sandstone**

The sand grains in this sandstone were deposited by wind in sand dunes 250 million years ago. The Permian Lyons Sandstone is resistant to weathering because it is composed mostly of quartz grains cemented by silica. Most of the sandstone splits evenly along its flat bedding planes and has been widely used as a building stone in Boulder and on the University of Colorado, Boulder, campus.

Galena Crystals

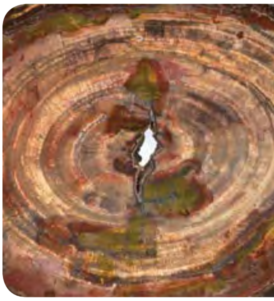
Galena is the most common of the lead minerals. It frequently contains enough silver to be mined as a silver ore, too. Soft and heavy, it is dark lead-gray with a metallic luster. It typically takes the form of cube-shaped crystals.

These large cubic galena crystals, from the Royal Flush mine, Socorro County, New Mexico, were deposited from mineralizing fluids that moved into limestone layers through fractures and fault zones. The limestone has been partially altered to clay minerals. The clear stubby crystals are smoky quartz.

In addition to being a source of lead, galena has been used as the radio crystal in crystal-detector radio receivers.

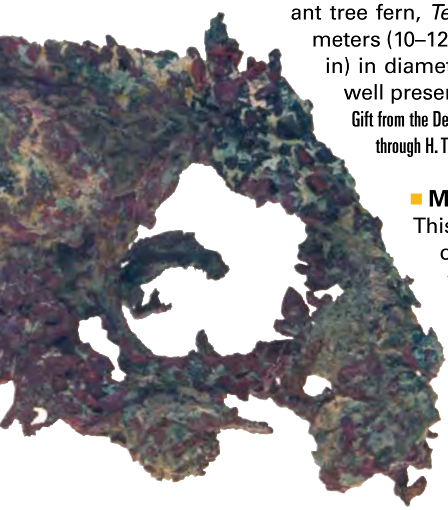
Gift from James McGlasson, Colorado School of Mines, Golden, Colorado.

Silicified Wood



This specimen, from the Upper Cretaceous Wayan Formation in Wayan, Idaho, is a cross section through the trunk of a giant tree fern, *Tempskya*. The tree ferns grew to several meters (10–12 ft) in height, with trunks up to 40 cm (16 in) in diameter. The internal structure of the plant is well preserved.

Gift from the Department of Geology, Idaho State University, Pocatello, through H. Thomas Ore.



Malachite on Native Copper

This specimen is made up almost entirely of native copper, but was covered with a thin coating of green malachite and other minerals when the copper oxidized.

Gift from William J. LeVeque, Claremont, California.

Copper Dragon

This fine cluster of native crystalline copper is thinly coated with the red-brown dust of cuprite (copper oxide). The blue-green color is a mixture of other copper minerals. To some, the specimen appears to resemble a dragon. The specimen is from the South Pit, Chino mine, Santa Rita, New Mexico, known for ruby red cuprite crystals scattered across native copper.

Gift from Gregory E. McKelvey, Bear Creek Mining Company, Tucson, Arizona.

Linarite on Fluorite

Deep blue linarite crystals and gray fluorite crystals form this rock from Blanchard mine in Socorro County, New Mexico. Some samples of linarite fluoresce. The word “fluorescence” is derived from fluorite’s characteristic violet-blue luminescence under ultraviolet light. Fluorescent minerals emit light when exposed to ultraviolet light of certain wavelengths. These minerals glow in the dark under black light. Their luminescence is caused by the motion of electrons in their atomic structures—the minerals absorb energy from light. The absorbed energy temporarily boosts electrons in the minerals to higher energy levels. As the electrons return to their normal energy levels, the extra energy is released in the form of light. Linarite is named for its discovery site near Linares, Spain.

Quartz Crystal with Ghost
The black area in this colorless quartz crystal shows the "ghost" or shape of the crystal at earlier stages of growth. The dark material was mixed into the crystal as it grew. Tiny bits of carbon, sulfide minerals, or tiny dark tourmaline crystals can color all or part of a quartz crystal dark gray or black. This is not the same as smoky quartz in which dark colors are produced by crystal defects activated by radiation.

Amethyst


Amethyst

Amethyst quartz, such as this specimen from Guanajuato, Mexico, is colored purple or violet by iron impurities in its crystal structure. The purple turns darker when amethyst is exposed to radiation. Heating can cause amethyst to become colorless or yellow-brown.
Gift from the Geology Museum, Colorado School of Mines

Colemanite
Colemanite was first identified as a distinct mineral in 1882 in the Death Valley borate deposits. Furnace Creek and the Death Valley flats have been mined for colemanite and borax for more than a hundred years. Colemanite is used to make glass and is a source of boron, whose compounds are used in atomic energy. Colemanite is named for William T. Coleman, a San Francisco merchant and mine owner.
Large specimen collected by Modesto Leonardi and donated by the Department of Geology, California Academy of Sciences, San Francisco, courtesy of Charles W. Chesterman. Smaller specimens are gifts from Robert Countryman, Tenneco Oil Co., Lathrop Wells, Nevada.

Pyrite Crystals
Pyrite often crystallizes in cubes, octahedrons, and pyritohedrons with striated crystal faces. Pyrite cubes up to 15 cm (6 in) across have been found in mines near Leadville, Colorado. This specimen is from Bingham, Utah. Pyrite also forms nodules and masses.

Pyrite is burned to produced sulfur dioxide and sulfuric acid. Pyrite struck with steel will produce sparks, and large masses of pyrite have spontaneously combusted in mines. Its name comes from the Greek *pyr* ("fire").
Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado.

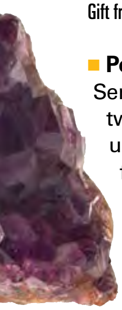
Scalenohedral Calcite Crystals
Calcite forms crystals with hexagonal symmetry, but also forms in tabular crystals, needlelike crystals, and in masses or grains that do not exhibit crystalline shapes. Some calcite crystals are very large; crystals weighing 450 kg (1000 lbs) have been found in a limestone cave in New York. This specimen is from Terlingua, Texas.
Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado. Collected by J. Harlan Johnson.

Fossil Ammonite Impression
The patterned form pressed into this sandstone was made by the shell of an ammonite. Ammonites are a group of extinct marine animals that lived from the Paleozoic more than 400 million years ago until the close of the Cretaceous Period about 65 million years ago. Their soft, tentacled bodies were enclosed in a shell. The shell was divided into chambers that made intricate curved patterns on the shell.
Gift from Harrison Cobb, Boulder, Colorado.

Chrysotile Asbestos

Asbestos is not the name of a specific mineral—it is a commercial term for a group of silicate minerals that readily separate into thin, strong fibers that are flexible, heat resistant, and chemically inert. Chrysotile and tremolite are two minerals that were commonly used in asbestos. Asbestos was widely used in a variety of industrial products, though rarely now because asbestos has been found to be carcinogenic. This specimen is from Salt River Canyon, Arizona.

Gift from Harrison Cobb, Boulder, Colorado.



Polished Serpentinite Spheres

Serpentine is a soft, massive metamorphic rock. It is composed mainly of two serpentine minerals, antigorite and chrysotile. Serpentine, frequently used as a decorative rock, has slick, smooth surfaces. Seams and veins of fibrous chrysotile are mined for use in fireproof materials. Serpentine gets its name from the "snakeskin" appearance of sleek, greasy, multicolored serpentinite rock surfaces.

From Williams Quarry, Easton, Pennsylvania; shaped by B.F. Shepherd, Ingersoll-Rand Co. Gifts from Lafayette College, Easton, Pennsylvania, through Arthur Montgomery and Paul J. Roper, in honor of Lafayette alumnus Edwin B. Eckel.

Siderite with Goethite

Siderite is a minor ore of iron. Its shiny brown, reddish brown, gray, or white crystals often are curved. Siderite becomes black and magnetic when it is heated. In this specimen, goethite has formed as an alternation product on the bladed siderite crystals. It may be from the Gilman mining district in Eagle County, Colorado, where siderite is common in masses and as a lining in cavities in the rocks.

Siderite forms in a variety of environments. It forms masses or concretions in clay, coal seams, and shale. It occurs with sulfide minerals in hydrothermal veins with silver, lead, and copper ores. It is found as a replacement deposit in limestones that have been altered by iron-bearing solutions. It is also found in a few igneous rock types including pegmatite. Siderite gets its name from the Greek *sideros* ("iron").

Deep Sea Drill Core

Deep Sea Drill Core

This section of drill core was collected during the Deep Sea Drilling Project at Site 169 southwest of Hawaii at latitude 10°40.2′N, longitude 173°33.0′E. It was recovered in 5407 m (17,740 ft) of water at a depth of 187 m (614 ft) below the sea floor. The dark igenous rock solidified from magma with high iron and manganese content. This rock intruded into Cretaceous sedimentary layers that were deposited at the bottom of the ocean.

Permanent loan from the National Science Foundation, through W.R. Riedel, curator, Deep Sea Drilling Project.

Fulgurite

This rock was formed when a 50,000-volt power line fell apart during a storm near Gold Hill, west of Boulder, Colorado. The electricity flowed through the wet grus (crumbly decomposed granite) and fused it. The white chunks are pieces of feldspar, one of the main minerals of granite. Fulgurites are usually formed by lightning.

Gift from Mary C. Eberle.

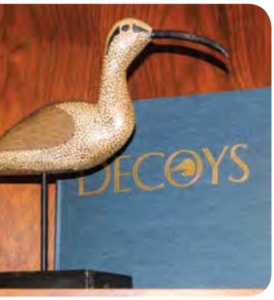
Carved Elephant

■ **Jasper**

Jasper is a hard, dense form of chalcedony (a variety of quartz). Usually mottled in shades of red, yellow, and brown, its colors come from finely divided iron oxide minerals (hematite and goethite) mixed into its tiny interlocking quartz crystals. Jasper is often associated with deposits of iron ore. It is valued as a gemstone and for its ornamental qualities.
Gift from Lee Gladish, GSA staff member.

■ **Carved Elephant**

This carved elephant is one of four such sculptures probably purchased by R.A.F. Penrose, Jr., during his travels in Burma in 1901. The other three are located in the Penrose Room on the first floor.



■ **Curlew Decoy and Book**

Hand-carved curlew decoy and copy 68 of 550 of *American Decoys*, published 25 December 1972.
Gift from Volker Kerchoften.

■ **Weathered Sandstone**

This Cretaceous Dakota Sandstone from Grand County, Colorado, has been weathered and shaped by wind-blown sand, by rain and moisture, and by temperature extremes. The sandstone itself is light in color, but a black coating developed while the boulder sat exposed to the weather due to the oxidation of manganese and iron deposited at its surface.

Ceremonial Gavel

■ **Ceremonial Gavel**

The head of this ceremonial gavel is cut from jasper conglomerate of Precambrian age from Bruce Mines, Ontario. The handle is of wood that is about 60,000 years old. The wood was uncovered in an interglacial peat bed at Les Vieilles Forges, near Three Rivers, Quebec. Because the original handle was broken when the Council was first called to order with it, the gavel is no longer used.
Gift from the Geological Survey of Canada, 1961.

■ **Calcite "Angel Wings"**

These pure white tabular crystals of calcite seem to form angel wings. They possibly formed in a cavern, where the delicate "wings" had room to grow.
Gift from Rose Ann Nyari.

Wooden Cask

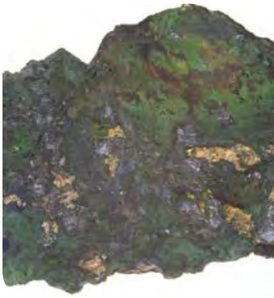
■ **Wooden Cask**

This cask, from the Waikato Valley of New Zealand, was fashioned from wood that is at least 10,000 years old. The wood is from the fire-ravaged remains of an ancient forest that was covered by molten lava during a volcanic eruption.
Gift from Robert F. Legget, Ottawa, Ontario, Canada, a former president of the Society.

■ **Fossil Plants**

The fossil plants preserved in this specimen grew in a swampy area 300 million years ago. They were buried by dark muds that were eventually compressed and cemented to form the black shale that now holds the thin carbon traces of those ancient plants. This specimen was found above a coal layer in an abandoned strip mine in Pennsylvania. It contains the remains of seed ferns *Neuropteris ovata* and *Alethopteris serlii.*

Sphalerite
This slab, from the Commodore No. 5 mine in Creede, Colorado, shows hundreds of near-perfect sphalerite crystals. Sphalerite is a heavy mineral that often forms brilliantly shiny crystals but also occurs as dull, fine-grained masses. This crystal slab formed one wall of a vein where ore minerals were deposited from hot waters containing dissolved zinc, lead, and copper. This specimen also contains small amounts of dark gray galena and brassy chalcopyrite. Sphalerite gets its name from Greek *sphaleros* (“treacherous”) because its many colors and growth habits make it difficult to recognize and because it is easily confused with other minerals such as galena and siderite.
Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado.



Chalcocite, Azurite, and Malachite
This specimen (two pieces) is from the Kennecott Company’s Jumbo mine, one of the largest chalcocite-rich ore bodies on record, near McCarthy, Alaska. Chalcocite is the black mineral, azurite is the deep blue or deep violet mineral, and malachite is the bright green one; all are important ores of copper. Chalcocite is named from the Greek *chalkos* (“copper”).
Gift from Edward M. MacKevett, Jr., U.S. Geological Survey, Menlo Park, California.

Sand Calcite Crystals
Sand calcite crystals like these occur in enormous quantities in a single bed of sand near Badlands National Park. This specimen is from Rattlesnake Butte, south of Interior, Washabaugh County, South Dakota.
Gift from the Department of Earth Sciences, University of South Dakota, Vermillion, through Valentine J. Ansfield.

Jadeite
Jadeite boulders of this size and character were common on the banks and in the stream bed of Clear Creek, San Benito County, California, prior to the mid-1950s. Because of the tremendous interest shown by amateur mineralogists and rockhounds for jadeite and other lapidary materials, the course of Clear Creek for several miles downstream and upstream from the Clear Creek mercury mine was, within a few years following the discovery of jadeite, stripped bare of all jadeite boulders.

Jadeite is one of two minerals that constitute jade, the gem material. Although tons of jadeite have been picked up along the course of Clear Creek in San Benito County, very little if any of it can be considered true gem-quality jade. Jade is valued most highly when it is translucent or semi-transparent, intensely and evenly colored, and without flaws. It gets its name from the Spanish *piedra de ijada* (“stone of the side”) because it was applied to the side of the body to treat kidney disorders.
Collected by Charles W. Chesterman and donated by him on behalf of the Department of Geology, California Academy of Sciences, San Francisco.

Leaf Impression
When this finely laminated rock split, it revealed the dual impression of a carbonized leaf. The leaf fell into shallow lake water where it was gradually covered by layers of limy mud and silt that were later compressed and cemented to form rock.
Purchased by the Society.

After you’ve finished viewing the specimens in these cases, you can take the stairs back up to the first floor.

As you make a right down the first floor hallway, you'll notice something on the ground foreign to your usual office building. This dinosaur bone has had a few different homes since its excavation, with its final display location still to be decided.

■ Cast of Dinosaur Footprint

This cast was made in a latex mold taken from the only known fossilized track of *Tyrannosaurus rex.* The hallux, or fourth digit on the hind food, is characteristic of *T. Rex.* The track's northeastern New Mexico location showed that *T. Rex* ranged about 250 miles farther south than previously known. The rocks that surround the track indicate that *T. Rex* roamed across a broad river floodplain in sub-tropical wetlands dominated by palm trees and ferns, in what is now the northern part of the state.

Located and donated by Charles Pillmore.

To the left of the dinosaur footprint cast is a case that contains several specimens. From the top, left-hand corner:

■ Zebra Rock

Zebra rock is named for the distinctive "zebra stripes" that run across it. It has been found only in the extreme northeast of Western Australia. This area is now covered by the waters of the Ord River Reservoir, but a few additional localities were recorded after 1945. Various explanations for these distinctive stripes have been proposed, including leaching of iron from the lighter bands, periodic deposition of iron-rich layers, gravitational separation in ripple marks, and precipitation of iron oxide.

Collected and donated by Curt Teichert, University of Kansas, Lawrence.

■ Cinnabar

Cinnabar is a low-temperature mineral found near recent volcanic activity, around hot springs, or in veins or rocks mineralized by hydrothermal solutions. Red, earthy cinnabar like this specimen is found near Terlingua, Texas, along faults and fractured folds in deformed Cretaceous limestones. Clay layers above the limestones helped seal in the mineral-bearing solutions that deposited the ores.

Gift from William J. LeVeque, Claremont, California.

■ Pyrite Cubes

Pyrite is often known as "fool's gold" because its shiny metallic crystals can be mistaken for real gold. However, pyrite is often found in close association with gold and other metals and may be mined for the gold or copper associated with it. Unlike gold, which is soft, malleable, and golden yellow, pyrite is hard, brittle, and brassy yellow. It is sometimes tarnished with a brown or iridescent film of iron oxide.

■ Chalcopyrite and Galena on Dolomite

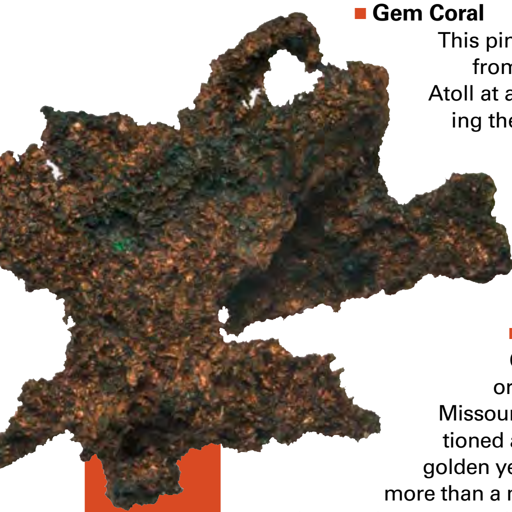
This specimen is characterized by brassy metallic chalcopyrite crystals and dark gray metallic galena crystals scattered across a base of pink dolomite crystals. Chalcopyrite, which often has a tarnish of deep blue, purple, and black, appears in masses more frequently than in distinct crystals. It is an important copper ore named from the Greek *chalkos* ("copper") and *pyrites* ("fiery").

Galena, which often appears as cubic crystals, is an important ore of zinc. Zinc has been mined commercially in Missouri, where this specimen was collected. This state is part of a large tri-state mining district stretching

into Oklahoma and Kansas. This area is famous for pink dolomite crystals like these.
Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado.

■ Goethite

Goethite is a natural rust that commonly forms when iron-bearing rocks and minerals are exposed to water and oxygen. It is named for Johann Wolfgang von Goethe (1749–1832), a German philosopher and poet who was also an amateur mineralogist.



Native Copper

■ Gem Coral

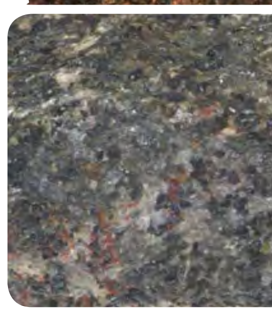
This pink, gem-quality coral was dredged from the western outer slope of Bikini Atoll at a depth of about 46 m (150 ft), during the Bikini Scientific Re-Survey in the summer of 1947.
Collected and donated by R. Dana Russell, Estes Park, Colorado.

■ Scalenohedral Calcite Twin

Calcite is a common mineral in the ores of the tri-state mining district of Missouri, Oklahoma, and Kansas, as mentioned above. The district is known for the golden yellow scalenohedral crystals, some more than a meter (3 ft) long.
Collected by Charles J. Adami in 1899. Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado.

■ Native Copper

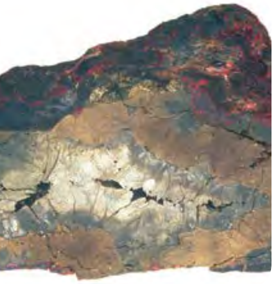
These jagged masses of native copper probably formed in highly fractured rock where copper-bearing fluids could spread in many directions. This sample has been cleaned with acid to remove rock fragments that once surrounded it. This copper probably came from ore deposits of Bisbee, Arizona, that formed about 170 million years ago.
Gift from William J. LeVeque, Department of Mathematics, Claremont Graduate School, Claremont, California.



■ Willemite, Zincite, and Franklinite

Zinc has been mined commercially in Franklin, New Jersey, since 1840. Franklinite, so named for the town, is an important ore of zinc and a minor iron-manganese ore. The ores contain green willemite, deep red zincite, and black franklinite, often with white or pink calcite. The ore also contains many unusual high-temperature minerals.

Ores from Franklin are highly fluorescent. The fluorescence occurs where manganese ions have replaced other metallic ions in the minerals' atomic structures. Willemite, often used as a gemstone, fluoresces bright green or bright yellowish-green in ultraviolet light when manganese has replaced some of its zinc ions. It is named for King Willem I of the Netherlands (1772–1843). Calcite fluoresces bright red when it contains ions of manganese, while zincite takes on a red tint in ordinary light when it contains manganese.



■ Vanadinite

This specimen of tabular hexagonal crystals of vanadinite comes from Morocco. The luster of these crystals is typical of vanadinite, which can be bright red, orange-red, yellow, and brown, with multiple colors showing up in a single specimen.

In North America, vanadinite is found almost exclusively in the southwestern United States and Mexico. Unusually large crystals, up to 1.5 cm, have been mined near Villa Ahumada, Chihuahua, Mexico.

Vanadinite is used for toughening steel for use in mechanical parts. It is also used in the electrical and chemical industries, in printing, and in the manufacture of ceramics, paints, and dyes.

Gift from Harold Krueger, Krueger Enterprises, Inc., Cambridge, Massachusetts.

Rhodochrosite

■ Rhodochrosite

Rhodochrosite is a carbonate mineral that is mined for manganese. When exposed to air, rhodochrosite's typical rose-red color can quickly be covered by a crust of black manganese oxide. It is Colorado's state mineral.

■ Mercury Ore

The polished surface of this specimen, from San Luis Obispo, California, gives an inner view of a mercury ore composed of red cinnabar, reddish-black metacinnabar, brassy metallic pyrite, and lighter colored marcasite. Cinnabar and metacinnabar are the primary ores of mercury.

Collected and loaned by Edwin B. Eckel, U.S. Geological Survey, Denver, Colorado, and former executive secretary of the Society.

■ Rock Crystal Quartz

This gem-quality crystal, discovered near Hot Springs, Arkansas, is nearly flawless. Note the wispy ghosts, or faint parallel growth lines, that run across the crystal. Crystals like these grow during the cooling of hot, hydrothermal solutions that have invaded rock fractures and cavities.

Purchased by the Society.

■ Amazonite with Albite, Smoky Quartz, and Goethite

These minerals, from Crystal Park, Colorado (near Pikes Peak), formed millions of years ago from igneous fluids that solidified into granitic pegmatite (coarse-grained igneous rock). The blue-green crystals are amazonite. The thin, white crystals are cleavelandite, a variety of albite often found in pegmatites. The elongated, nearly black crystals are smoky quartz. Their dark color results from exposure to natural radiation. Smoky quartz is frequently found in pegmatites. The black lumpy masses are goethite, a common iron oxide mineral.

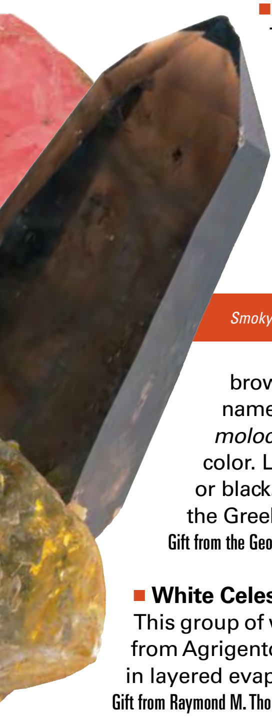
Gift from Raymond M. Thompson, Englewood, Colorado.

Amazonite

■ Tennanite Crystals on White Drusy Quartz

This specimen, from Chihuahua, Mexico, features dark tennanite crystals scattered across a white quartz slab. Tennanite is an important copper ore mineral and is named for English chemist Smithson Tennant (1761–1815).

Gift from Raymond M. Thompson, Englewood, Colorado.

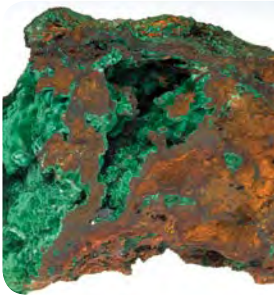


Smoky Quartz with Topaz

■ Smoky Quartz with Topaz

This specimen is made up of smoky quartz and yellow topaz. Smoky quartz, or cairngorm, ranges from pale smoky brown to almost black. The topaz from Teofilio, Brazil, is a hard mineral that forms in certain igneous and metamorphic environments. In addition to yellow, topaz can be colorless or shades of white, blue, green, brown, violet, pink, and red. Gem-quality topaz is found in the Pikes Peak region.

Gift from Raymond M. Thompson, Englewood, Colorado.



■ Malachite and Limonite

In this specimen from Bisbee, Arizona, bright green malachite encrusts massive brown limonite. Malachite is copper ore and is valued as an ornamental stone and gemstone. It takes its name from the Greek *moloche* ("mallow") for its typical grass-green to emerald-green color. Limonite is an ore of iron found in shades of yellow, brown, or black. It is used in paints and pigments. Limonite is named from the Greek *leimons* ("meadow").

Gift from the Geology Museum, Colorado School of Mines, Golden, Colorado.

■ White Celestite Crystals with Native Sulfur

This group of white celestite crystals and yellow native sulfur crystals are from Agrigento, Sicily. Celestite, sulfur, and salts are often found together in layered evaporite deposits.

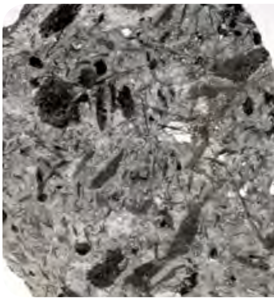
Gift from Raymond M. Thompson, Englewood, Colorado.

■ Sand-Barite Roses

Sand-barite roses, or "desert roses," are Oklahoma's official state rock. Their roselike appearance is due to naturally grown clusters of sandy barite crystals that develop when barium-rich groundwater moves through sand-rich rocks or layers. The rosettes, from central Oklahoma, inherited their red color from the ancient red sandstones in which they grew. The sand-barite roses are harder than the rock they formed in, so they are left behind when the rock around them is exposed at Earth's surface and weathers away.

The sand-barite rosettes of Oklahoma occur mostly in Garber Sandstone, which was deposited during the Permian Period, about 250 million years ago. The area just east of Norman is particularly renowned for its abundant and well-formed specimens.

Gift from the Oklahoma Geological Survey, courtesy of Kenneth S. Johnson.



■ Magnetite in Metamorphosed Limestone

This specimen is from the Cornwall iron mine once in central Pennsylvania. This mine was closed at the end of 1972 after 230 years of continuous operation. The specimen is an aggregate of magnetite crystals (iron oxide) and a group of crystals of analcite.

Gift from Bethlehem Steel Corporation, through Gilbert L. Hole.

■ Blue Celestite Crystals

These clear blue, gem-quality crystals of celestite are from Katsepe-Majunga, Madagascar. Celestite is named from the Latin *caelestis* ("of the sky") and was recognized in 1820 when it was found during excavation of the Erie Canal in Niagara County, New York. Crystals up to 45 cm (1.5 ft) long have been found in dolomite caves along Put-in-Bay on South Bass Island near the southern shore of Lake Erie in Ohio.

Gift from Raymond M. Thompson, Englewood, Colorado.

■ Rhombohedron Calcite

This large honey-colored specimen, from near Big Bend National Park, Texas, illustrates how calcite forms rhombohedrons. Calcite is doubly refractive, bending light rays along double paths. Looking at print through a clear calcite rhombohedron produces a double image.

Gift from Harrison Cobb, Boulder, Colorado.

■ Indicolite Tourmaline

This is a single crystal of indicolite, the dark blue variety of tourmaline. This crystal's flat base is unusually large and defined. The lengthwise striations and the crystal's convex, rounded triangular cross section are typical of tourmaline.

Gift from Raymond M. Thompson, Englewood, Colorado.

Indicolite Tourmaline

■ Fluorite and Calcite

Underneath the "fuzzy" surface of this specimen are large, box-shaped transparent crystals of yellow and purplish fluorite. The "fuzz" is actually a thin layer of tiny, sharp calcite crystals that grew over the larger fluorite crystals. This specimen is from Cave-in-Rock, Hardin County, Illinois. Fluorite is commonly blue or purple, but occurs in many other colors. It is the ore of fluorine, and is used in glass and enamel and in the manufacture of hydrofluoric acid.

Gift from John W. Palmer, Cave-in-Rock, Illinois.

As you make your way down the first-floor hallway, you will come to a rock sculpture in the west atrium. At 1.7 billion years old, this migmatite specimen is even older than the Silver Plume granite ("Big Al") in the main lobby. (See framed poem mounted on wall southeast of rock.)

■ Migmatite

Found in Rocky Mountain National Park on the west side of the Bierstadt moraine, along the road to Bear Lake, is part of the Precambrian Idaho Springs Formation, a thick sequence of sedimentary and igneous rocks that were formed 1.7 billion years ago. In the last portion of its history, this piece of rock was broken away from the layers of Idaho Springs Formation and deposited in the flank of a glacial moraine. Its surface has been smothered by gravel, sand, and silt carried by streams, glaciers, and wind. This ancient rock is displayed at GSA headquarters through a special agreement with the National Park Service.

Indefinite loan, courtesy of J.L. Dunning, Superintendent, Rocky Mountain National Park; National Park Service Association No. 662, Catalog No. 6201. Selected by R. Dana Russell of Estes Park, Colorado, author of the accompanying poem-history.

■ **Natural Cast of Dinosaur Track**

Behind the migmatite is the natural cast of a dinosaur's hind footprint that filled with sand. The sand-filled track and the layers below and above it were buried, compressed, and cemented to form rock. Later, they were uplifted and eroded enough to be exposed at the surface. The sand-filled track has been preserved, but the softer underlying layers that originally held the footprint have been worn away. The sandstone cast now provides an upside-down look at the ancient footprint.

Donated by H. Richard Blank, Jr., and Nancy A Blank Kaesler in memory of their father, Horace R. Blank, Sr., who collected the fossil in the late 1930s.

■ **Cast of Dinosaur Skull**

While the origins of this skull cast are unknown, it is nonetheless a perfectly fitting unofficial doorman that greets GSA employees as they arrive in the morning and then bids them farewell as they leave each evening.

■ **Giant Selenite Crystal**

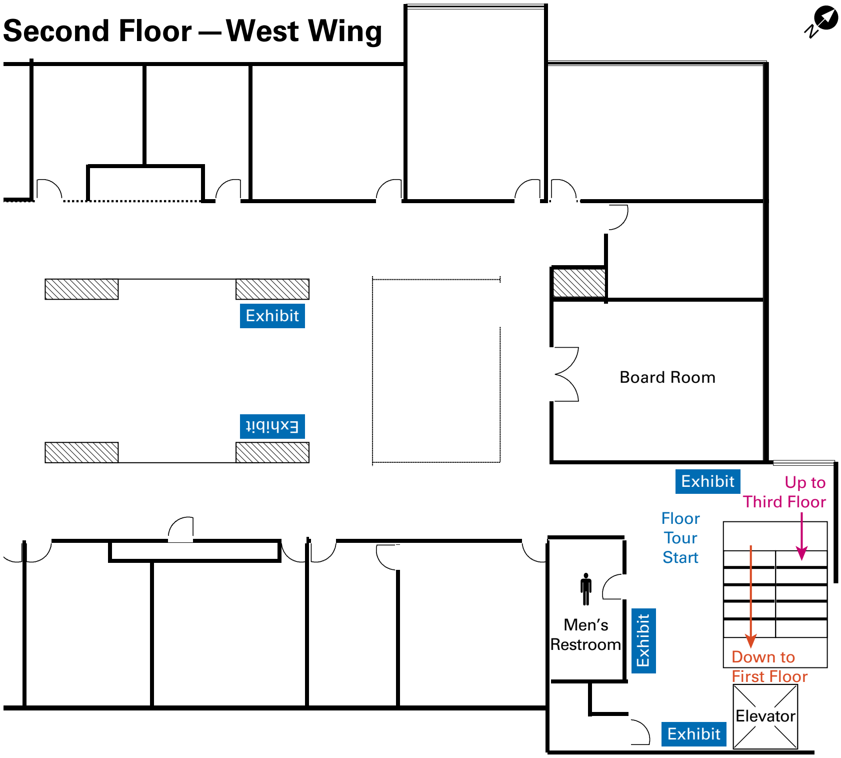
Enormous, nearly flawless selenite crystals like this one are rare. Taking its name from the Greek *selenites* ("moonstone"), this crystal was found in 1892 at the basal Entrada Formation at Caineville, Utah. Selenite is a transparent variety of gypsum and is usually found with salts deposited along the edges of hypersaline shallow seas in arid climates. It is especially common in rock of Permian, Triassic, and early Jurassic ages across the Colorado Plateau. The snow-white dunes at White Sands National Monument in New Mexico are made of white gypsum sand.

Gift from the Department of Geology, Brigham Young University, Provo, Utah, through Morris S. Peterson.

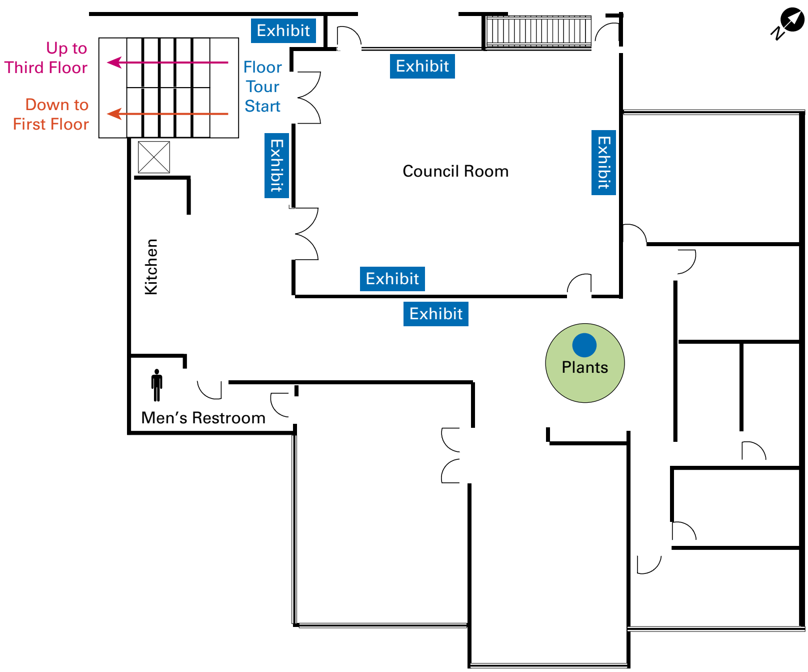
Taking the stairs up to the right will lead you to the second floor (exhibits listed on p. 37–42). The stairs going down lead to headquarters offices.

Second Floor Exhibits

Second Floor — West Wing



Second Floor — East Wing



Second Floor Exhibits—West Wing

Passing the elevator on your left and heading up the staircase, you will come to a striking photo of Mount Everest.

Mount Everest Aerial Photo

This vertical photo of Mount Everest (8848 m [29,028 ft]) was taken on 22 December 1984 from an altitude of 11,700 m (39,000 ft), or 3000 m (10,000 ft) above Mount Everest. A specially equipped Learjet 35 with a Wild RC-10 camera and Aerocolor 2554 film was used to capture the image. This is one of 360 photos taken by Swissair Photo Surveys to create a map of Mount Everest for Boston's Museum of Science and the National Geographic Society.
Gift from Swissair Photo Surveys, Ltd.

The Valley of Mexico

Around the corner and to your left, you will see an oil painting, *The Valley of Mexico.* Painted by Raul del Corral, the painting depicts the Valley of Mexico in Velasco style. Two famous volcanoes, Popocatepetl and Iztaccihuatl, form the background.
Gift from Zoltan de Cserna, Universidad National Autónoma de México.

Fossil Fish

On the adjacent wall is a specimen of an ancient fossil fish from the Green River Formation, similar to the ones displayed near the Society's Council Room. This fossil fish is *Notogenus osculus* Cope, a member of the family Gonorhynchidae. It lived in an ancient lake that stretched across southwestern Wyoming and northern Utah, 53 to 37 million years ago.
Gift from Edwin C. Buffington, Marine Geology Branch, Naval Undersea Center, San Diego, California.

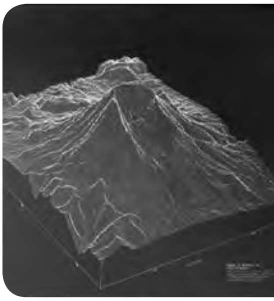
Continue down the short hallway, turn left, and then follow the hallway until you reach a pillar on the right. Turn right and proceed to the display case. Here you will find a memorial to volcanologist David A. Johnston.

At 8:32 a.m. on 18 May 1980, the day that Mount St. Helens erupted, Johnston radioed the famous "Vancouver, Vancouver, this is it" transmission to the U.S. Geological Survey office where he was on staff. He was among 57 people who died in the massive eruption that followed.

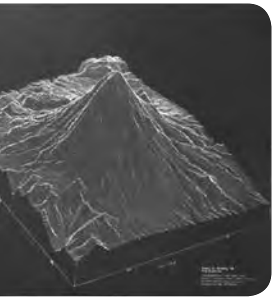
Mount St. Helens Volcanic Bomb

A volcanic bomb is a sticky chunk of magma ejected from a volcano that then cools and becomes rounded in flight. This specimen was thrown about 1.6 km (1 mile) by an eruption on 22 July 1980. It was collected by helicopter by Richard P. Hoblitt and Michael Montgomery from high on the northwest side of Mount St. Helens.

The rock is composed of dacite; it probably came from a small, steep-sided circular volcanic dome that formed at a vent inside the crater of the larger volcano. The "bread crust" on the bomb formed while it flew through the air. The cracks formed because the outer surface cooled into a crust while gases were still being released from the hotter center.
Donated in memory of David A. Johnston by his friends and colleagues of the U.S. Geological Survey.



Also notice the framed views of Mount St. Helens to the left of the memorial.



■ **Views of Mount St. Helens**

These three-dimensional views were made from a digital elevation model produced at the U.S. Geological Survey Western Mapping Center. Before (left) and after (right) the eruption of 18 May 1980.

Gift from U.S. Geological Survey Western Mapping Center, through Nicolas R. Serbu.

On the wall opposite the memorial are three specimens. From the top:

■ **Acasta Gneiss**

The Acasta Gneiss, from Northwest Territories, Canada, is an assemblage of 4-billion-year-old metamorphic rocks. Individual mineral grains more than 4 billion years old have been found in younger rocks in western Australia, but the Acasta Gneiss is currently the oldest known whole rock in the world. This specimen was collected from an island in an unnamed lake drained by the Acasta River. The Acasta Gneiss was dated by uranium-lead radiometric analysis using naturally radioactive zircon grains in the rocks. This dating method indicates when the rocks were formed, so the rocks from which they were formed are older than the date indicated by the ion microprobe analyses.

Collected and donated by Donald G. Hadley.

■ **Fossilized Whale Vertebra**

The group of huge marine animals we call whales may be up to 75 million years old, but this fossilized vertebra is probably just a few million years old. The size of this specimen illustrates just how large whales are and that they are supported by the buoyancy of the sea.

Gift from Richard P. Snyder, U.S. Geological Survey, Denver, Colorado.

■ **Volcanic Bomb**

A twist of molten lava was thrown into the air from the throat of a volcano. The lava cooled and solidified in flight before dropping back down to the ground as this volcanic bomb. It was found on the eastern border of the Lunar Crater Quadrangle, central Nevada (38°22′N, 116°W).

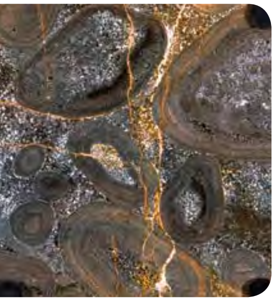
Gift from Richard P. Snyder, U.S. Geological Survey, Denver, Colorado.

Volcanic Bomb

Proceed forward and turn left, returning to the spot where you began this floor's tour. To begin touring the third floor, proceed up the stairs and turn to p. 43.

Once you have completed the third floor tour, proceed down the stairs to the second floor–east wing where you will see the Orbicular Gabbro specimen on your left. A floor plan is provided on p. 36.

Second Floor Exhibits—East Wing



■ **Orbicular Gabbro**

This specimen of orbicular gabbro was found near El Cajon, in southern California. Gabbro, a term describing any dark, coarse-grained igneous rock, forms deep in Earth's crust from the slow cooling and crystallization of iron- and manganese-rich fluid magmas. The minerals in the rings you see formed in

several ways: by gradual cooling of the magma itself, by chemical reactions between the magma and pieces of fallen rock, and by crystallization of material that melted when it fell into the magma.
Gift from the Department of Geology, California State University, San Diego, through Richard L. Threet.

Rock Crystal Quartz

Rock crystal is transparent, colorless quartz. This rock crystal specimen weighs 86.6 kg (191 lbs). Rock crystal boulders ten times larger have been found in Calaveras County, California, and crystals weighing 4 metric tons (almost 9000 lbs) have been found in Brazil. Rock crystal is used for lenses, wedges, and prisms in optical instruments and for frequency control in electronics. It can be grown synthetically in laboratories to ensure that it has the exact electrical and optical properties needed for industrial use. As a gemstone, it is fashioned into beads or other ornamental objects.
Courtesy of the National Institute of Standards and Technology, Time and Frequency Division, through Ralph F. Desch.

Fossil Fish

Before stepping in to view the Council Room specimens, notice the Fossil Fish between the two sets of double doors. These fossilized armored herring are *Diploymystus dentatus*, members of a marine species that adapted to living in freshwater. They have living relatives in the coastal waters off Peru and eastern Australia. This specimen is from the Green River Formation of the Fossil Syncline Basin some 19 km (12 miles) west of Kemmerer, Wyoming.

When these two fish died, they sank to the bottom of an ancient lake. Gradually, they were covered by a thick sequence of thin-layered sediments and organic material. The fleshy parts of the fish probably were destroyed shortly after they died, but their fins, scales, and bones were preserved as the sediments compacted and cemented to form rock. Millions of years later, these rock layers were exposed at Earth's surface. Museum workers carefully removed the rock outer layer, leaving the bones in relief. Although the precise age of the fish deposit is not known, it is probably late early Eocene, possibly 55 million years old.
Gift from the Department of Geology, University of Wyoming, Laramie, through Paul O. McGrew.

The Council Room was constructed to accommodate the Society's Council, which meets at least twice a year to discuss management of GSA's affairs. In addition to the geological specimens listed, the room also houses books from the collection of Richard A.F. Penrose, Jr. On display are gifts from geological organizations all over the world, including Iran and China.

Photo of Richard A.F. Penrose, Jr.

As you enter the Council Room through the right-hand set of double doors, you will first see a photo of the Society's benefactor, Richard A.F. Penrose, Jr., displayed in the bookcase on your right. If you haven't already visited the Penrose Room and Library on the first floor and would like to learn more about him, turn to p. 16.

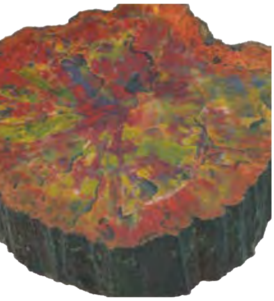
Quartz Crystals

Small quartz crystals formed along two crystal faces of the larger quartz crystal. Crystal size is affected by the temperature, pressure, and chemistry of the fluids from which the crystals grow.

■ Oil-Bearing Algal Structures

Algae have lived on Earth for billions of years. They range in size from simple, unicellular forms to giant seaweeds several meters long. Different algae have different life cycles and physiological processes. This specimen was cut through the center of limestone deposits produced by a colony of blue-green algae. The algae lived along the shores of an ancient lake where sediments were deposited. These would later become the oil shales of western Colorado and eastern Utah. The dark stain is caused by oil trapped in openings in the limestone. This specimen, part of the Douglas Creek Member of the Green River Formation, is from algae beds near P.R. Springs, Utah, 110 km (70 miles) south of Vernal near the Utah-Colorado state line.

Collected and donated by Michael Evetts and John Chronic.



■ Chalcedony in Petrified Wood

More than 40 species of fossil plants, as well as fossil fish, clams, amphibians, and dinosaurs have been found in the Triassic Chinle Formation in and around Petrified Forest National Park, Arizona. Most of the petrified wood is from conifer trees that were distant relatives of today's South Pacific Norfolk pine. The conifers grew on nearby highlands, but they were carried by floodwaters to the swampy lowlands and buried by silt, sand, and mud. Volcanic ash that fell on the area provided silica to the groundwater that moved through the sediments. Chemical reactions between the organic material in the wood and the silica-rich groundwater resulted in the precipitation of chalcedony within open wood cells and as a replacement of wood fibers. In some petrified wood, the wood structure still remains, with original wood fibers locked into the chalcedony that fills the cells.

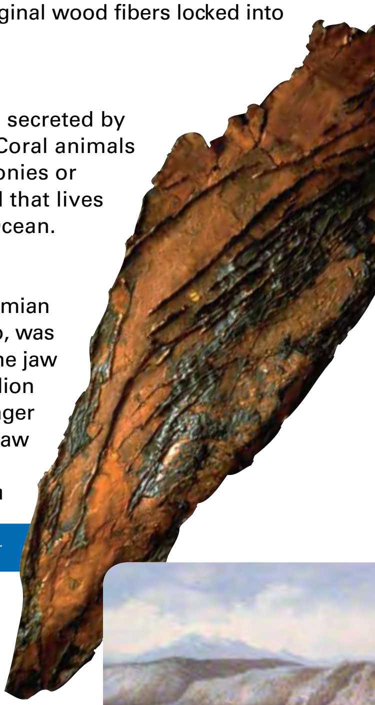
■ Modern Solitary Coral

Coral is the hard, calcareous external skeleton secreted by coral polyps for their support and habitation. Coral animals live as individuals or as members of coral colonies or reefs. This specimen, *Fungia*, is a solitary coral that lives on or near reefs in many areas of the Pacific Ocean.

■ Fossilized Shark (*Helicoprion*) Teeth

This fossilized spiral of shark teeth, from the Permian Phosphoria Formation near Soda Springs, Idaho, was discovered in a phosphate mine. It came from the jaw of an ancient shark that lived more than 280 million years ago. The shark may have retained its younger teeth, coiling them backward into and along its jaw as newer teeth developed.

Gift from the Department of Geology, Idaho State University, Pocatello, through H. Thomas Ore.

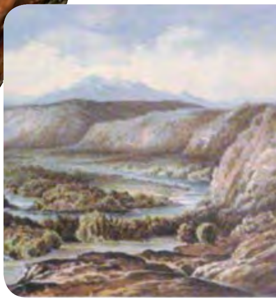


Native Copper

■ Native Copper

The shape of this slab of Precambrian native copper, from the White Pine district in Michigan, reflects the shape of the spaces that were invaded by copper-bearing solutions about 1 billion years ago. Northern Michigan's Keweenaw Peninsula has yielded huge masses of native copper weighing more than 450 metric tons (roughly 1 million lbs).

Gift from the Copper Range Company, through Wayne S. Cavender.



■ Sand-Selenite Bladed Crystals

These crystals, from Naica, Chihuahua, Mexico, formed in an arid, evaporitic environment in sand-rich layers not far below Earth's surface. Their bladed shape is a typical crystal form of selenite, the colorless gypsum that cements the sand grains together.
Purchased by the Society.

By exiting the Council Room from the single, southeast door, you will come upon an atrium with a rock garden that features a serpentine boulder as described below.

■ Serpentine Boulder

This boulder is made up of metamorphic serpentine minerals that contain high concentrations of magnesium and iron. This boulder, and another large one in the flower garden near the front of the building, are from the Mother Lode area on the western slope of the Sierra Nevada, California.
Collected by Christoph W.H. Hulbe and students from Sacramento City College. Ecologic concept from Helen L. Cannon, U.S. Geological Survey, Denver, Colorado. Gifts from John A. Huberty, through Bennie W. Troxel, former science editor of the Society.

As you make your way back down the hall, on the right you will see five framed drawings.

■ J.J. Young Drawings

These are from the *Report of Exploring Expedition from Santa Fe, New Mexico, to the Junction of the Grand and Green Rivers, in 1859*, by Captain J.N. Macomb, which was published in 1876 by the U.S. Department of Engineering. The drawings, by J.J. Young, are adapted from sketches by J.S. Newberry.
Gift from Edwin B. Eckel, U.S. Geological Survey, Denver, Colorado, and former executive secretary of the Society.

■ Stick Chart

One of the earliest forms of maps, this navigational chart was designed and used for centuries by inhabitants of the Marshall Islands, Micronesia, and other islands scattered over thousands of square miles of the western and southern Pacific Ocean. The sticks represent currents, wave patterns, and prevailing winds. Shells represent islands, though they are not necessarily in their correct geographic locations. If a navigator became lost on a voyage, the original chart was burned and a new one constructed.

Gift from Edwin B. Eckel, U.S. Geological Survey, Denver, Colorado, and former executive secretary of the Society.

As you round the corner past the Council Room, you will see the next specimen mounted above the stairway leading to the first floor.

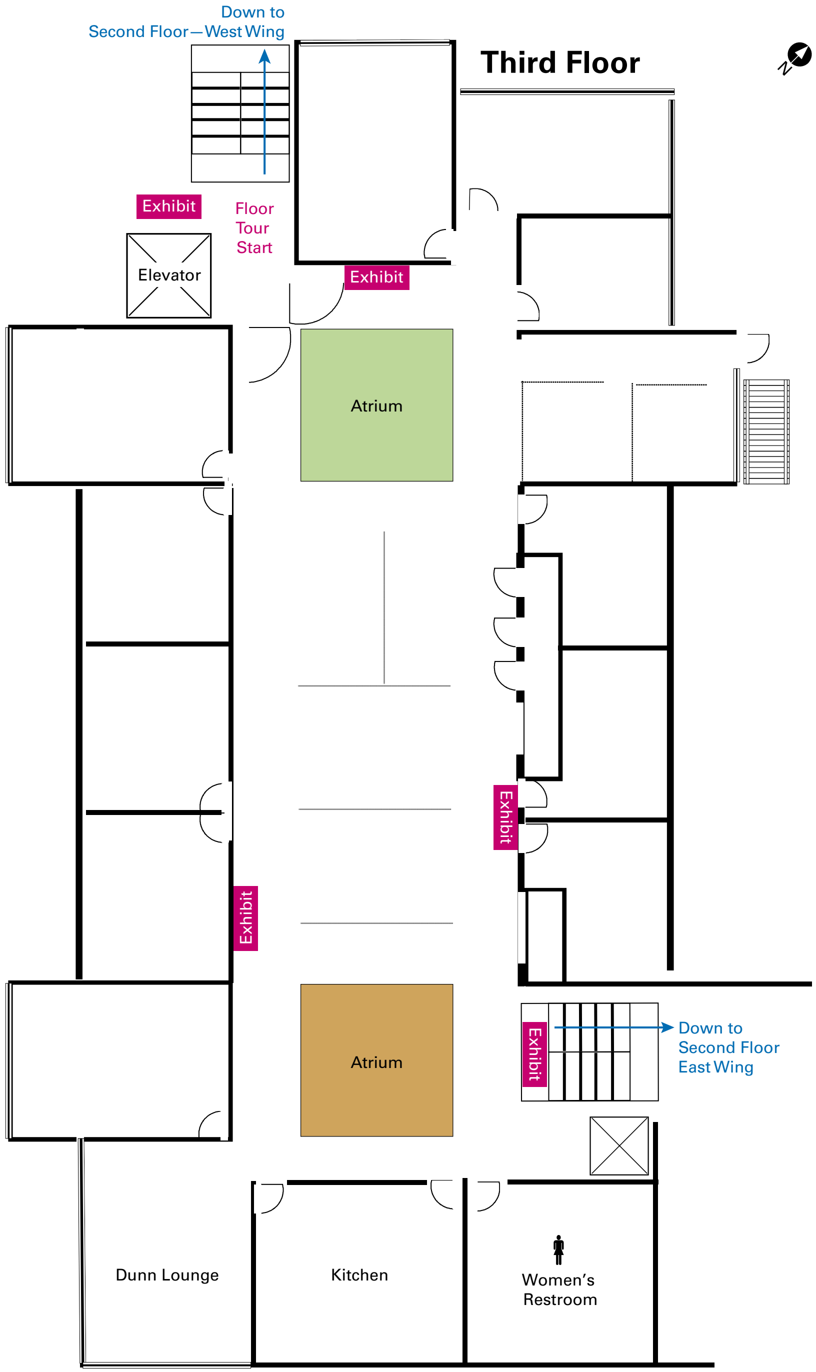
■ Fluorite

This specimen, from the lead-zinc mines near Joplin, Missouri, consists of large, near-perfect cubic crystals of fluorite. Fluorite is a common mineral that takes its name from the Latin *fluere* ("to flow") because it is easily melted. Fluorite spans the spectrum, from colorless to shades of purple, blue, green, yellow, brown, pink, or white. The colors are produced by impurities and defects in the internal crystal structure. Exposure to radiation can turn fluorite very dark, from purple to black. The fluorite crystals in this specimen are encrusted with small, doubly terminated crystals of white calcite.

Gift from Robert F. Herron, Santa Monica, California.

If you have not already toured the third floor, take the stairs up and walk past both atria to view the first specimen. *Turn to p. 45 to read about the 3-D model of Mount Everest.*

Third Floor Exhibits


Down to
Second Floor—West Wing
Third Floor
N
Exhibit
Floor
Tour
Start
Elevator
Exhibit
Atrium
Exhibit
Exhibit
Atrium
Exhibit
Down to
Second Floor
East Wing
Dunn Lounge
Kitchen
Women's
Restroom

Third Floor Exhibits

■ **Orthophoto Map of Mount Everest**
Opposite the 3-D model is an orthophoto map of Mount Everest's northwest face. This map is based on a photo taken at 13,500 m (44,300 ft) on 22 December 1984 from a Learjet photo-mapping flight sponsored by Boston's Museum of Science and the National Geographic Society. The process of orthophotography corrects the normal distortion found in vertical images of rough, mountainous country so that the photo can be precisely fitted to an accurate map. This permits accurate plotting of both geologic details and climbing routes.

■ **3-D Model of Mount Everest**
This model of Mount Everest, shown above 7900 m (26,000 ft), is a project of the National Geographic Society and Boston's Museum of Science.
Prepared by Sigurds Rauda from contouring by Swissair Photo Surveys of Zurich. Gift from Bradford and Barbara Washburn.

Taking an immediate left at the top of the stairs will lead you to shelves lined with specimens. From left to right:

■ **Baltimore Gneiss**
Gneiss is a foliated rock in which thicker bands of light- and darker-colored minerals alternate. Varieties are distinguished by texture (e.g., augen gneiss), characteristic minerals (e.g., hornblende gneiss), or general composition and/or origin, such as this specimen. The Baltimore Gneiss is a Precambrian formation of banded biotite mica gneiss and hornblende gneiss. It was formed by the metamorphosis of sedimentary and igneous rocks and was named for outcrops near Baltimore, Maryland.

■ **Gneiss Cobble**
This specimen is from the Idaho Springs Formation in Boulder County, Colorado. This formation is made up of the oldest exposed rock in the Colorado Rockies. It originally contained interbedded igneous and sedimentary rocks. They were metamorphosed by intense regional deformation about 1.7 billion years ago.

3-D Model of Mount Everest

Pyrite with Quartz

Tiny quartz crystals, scattered pyrite crystals, and a few larger quartz crystals encrust this specimen. Pyrite is a minor ore of iron and is the most widespread and abundant of the sulfide minerals. It occurs in many kinds of igneous, metamorphic, and sedimentary rocks.

Calcite Cavern Crystals

Calcite Cavern Crystals

The yellowish exterior surface of this specimen is typical of calcite that forms from slowly dripping solutions in limestone caves. Its interior shows coarse white crystals of calcite growing outward from a central core. This specimen is from Crystal Cave, Pennington County, South Dakota.

Gift from the Geology Museum, Colorado School of Mines.

Septarian Concretion

Many concretions, or mineral masses, form around a piece of shell, bone, wood, or other organic material. The organic matter causes chemical reactions that help concentrate and precipitate certain minerals from the water contained in the pore spaces between sediment grains. Septarian concretions are common in fine-grained sediments deposited in marine settings. The concretions are cut by intersecting cracks filled by calcite, siderite, or other minerals. The concretions may begin as a gelatinous mass that hardens first on the outside, then cracks as the core of the mass loses water.

Chrysotile Asbestos

Asbestos is a commercial term for a group of silicate minerals that readily separate into thin, strong fibers that are flexible, heat resistant, and chemically inert. Once widely used in a variety of industrial products, it is now rarely used commercially because asbestos has been found to be carcinogenic.

Barite-Crested Blades

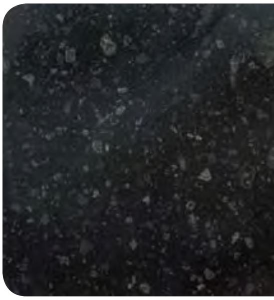
Barite, the mineral that cements "desert roses," is the principal ore of barium. It is a soft, heavy nonmetallic mineral that gets its name from the Greek *barys* ("heavy"). It is used in drilling muds where its weight helps prevent blowouts from high pressure in drillholes. It is also used to make glass and paint, as a filler for paper and textiles, in cosmetics, and in medicine.

Oncolite

Oncolites are rounded structures with concentric internal bands formed by the addition of organic or mineral material around a core. This specimen, collected in Sevier County, Utah, from the Paleocene lower Flagstaff Formation, formed from the gradual buildup of layers of algae around a snail shell that is now fossilized at the oncolite's center. The algae lived in an ancient lake, but the snail itself was a land snail that apparently washed into the lake from a stream or a flood. Today, this type of snail is found only in warmer tropical climates. The bands in the oncolite are formed from calcium carbonate produced by the life processes of the algae. They also contain silt that was

trapped by the algae and a few open pore spaces. The snail shell is filled with limy mudstone, calcite, and the fossilized shell of a smaller snail.

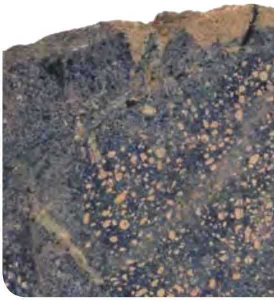
Gift from Malcolm P. Weiss, Northern Illinois University, DeKalb.



■ **Impact Breccia**

Breccias, like this one from the Onaping Formation, overlie the rich ore bodies of the Sudbury mining district in Levack, Ontario, Canada. They were once thought to be volcanic breccias, but they are now recognized as deposits formed by the catastrophic impact of an asteroid-sized body almost 2 billion years ago. Fragments of rocks blasted out by the impact fell back into the crater and were altered and cemented by upwelling magma.

Gift from Bevan M. French, Goddard Space Flight Center, Greenbelt, Maryland.



■ **Volcanic Breccia**

The rock fragments—or clasts—within this specimen are volcanic in origin. Their angular edges indicate that they were transported a limited distance after they were ejected by the volcano. This slab, from the San Juan region of southwestern Colorado, has been polished to highlight the fragments.

Gift from Edwin Eckel, U.S. Geological Survey, Denver, Colorado, and former executive secretary of the Society.

■ **Fossil Nautiloid**

These extinct creatures are of Devonian age and lived in a shallow sea (about 350 million years old) where the Atlas Mountains of Morocco are now. They are distinguished by a straight, rather than curved shell, with a central siphuncle and septa curved concave toward the living chamber. This polished fossil is a relative of today's chambered nautilus.

Presented to GSA as a centennial birthday gift by the American Association of Petroleum Geologists, through Fred A. Dix.

Fossil Nautiloid

■ **Dinosaur Footprint**

This is one of three dinosaur track specimens at GSA from the Connecticut River Valley in Massachusetts; the other two specimens appear on the wall above the stairwell on the other side of the third floor. For more information, see p. 53.

Permanent loan from the Pratt Museum, Amherst College, Amherst, Massachusetts, through Gerald P. Brophy.

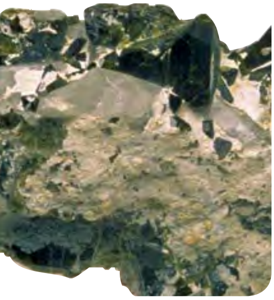
■ **Silicified Wood with Quartz Crystal**

Like most petrified wood, this specimen is preserved primarily by chalcedony, a form of quartz with crystals too small to see. However, individual quartz crystals are visible on some of the petrified wood's surfaces. Visible crystals like these usually form in open spaces or hollows that existed in the wood when it was buried by sediment.

■ **Pyrrhotite Crystal with Sphalerite and Galena**

This large, single golden-bronze crystal contains smaller crystals of dark gray sphalerite and lead-gray galena. Pyrrhotite rarely forms large crystals like this one. It is more often found in massive form, often associated with nickel and copper minerals. Pyrrhotite's metallic red-brown to golden-bronze surfaces are often tarnished dark brown. Specimens, including this one, collected in Santa Eulalia, Chihuahua, Mexico, are highly iridescent. Most pyrrhotite is moderately magnetic. The strength of magnetism in pyrrhotite is affected by how much iron is "missing" from its atomic structure. Pyrrhotite is named from the Greek *pyrrhotes* ("redness").

Gift from Raymond M. Thompson, Englewood, Colorado.



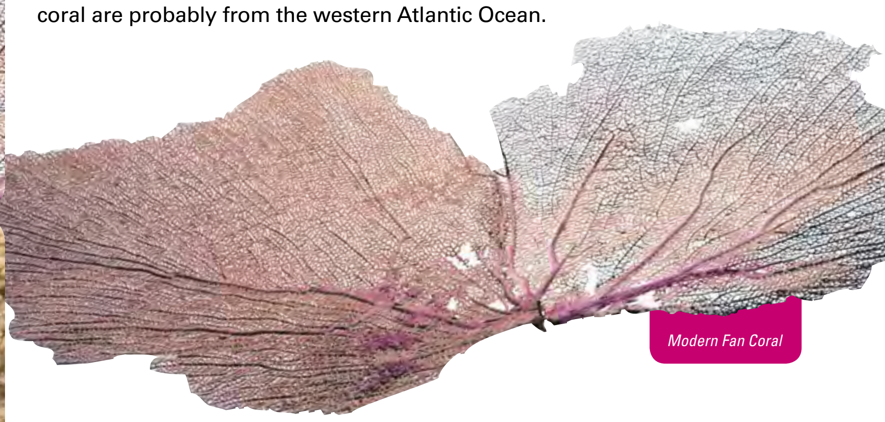
■ **Epidote**

Epidote is a minor gemstone found in shades of green, tinted with yellow, brown, or black. These two specimens represent two different kinds of epidote. The specimen with pistachio green granular masses of epidote also contains black tourmaline and white quartz. The specimen with dark green epidote crystals contains white calcite; it may come from the Calumet iron mine in Chaffee County, Colorado, a location known for short, well-formed epidote crystals like this one. Many epidote crystals have lengthwise striations, or grooves. Transparent crystals are strongly pleochroic, changing color from green to brown when the crystal is viewed from different directions.

Epidote is formed in some igneous environments and is found in a variety of metamorphic rocks. Its name is from the Greek *epi* ("over") and *didonai* ("to give") because its crystals frequently grow larger on one side than the other.

■ **Modern Fan Coral**

Coral is a general name for any of a large group of bottom-dwelling, attached, marine coelenterates of the class Anthozoa. These two specimens of modern coral are probably from the western Atlantic Ocean.



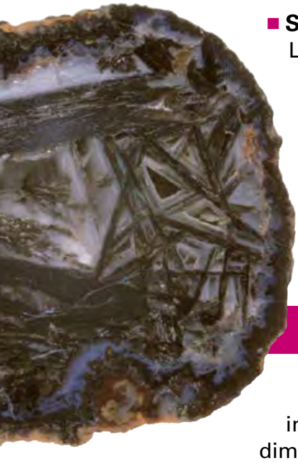
Modern Fan Coral

■ **Quartz**

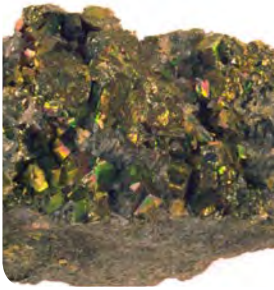
This large quartz specimen represents one of many varieties of the rock housed at GSA headquarters.

■ **Bladed Sand Selenite Crystals**
Selenite is the clear, colorless variety of gypsum, occurring in distinct, transparent monoclinic crystals or in large crystalline masses.

■ **Stibnite- and Calcite-Filled Geode**
Long, dark crystals of stibnite and compact white calcite fill this geode, which formed in a layer of limestone. Limestone can dissolve into a solution as waters move through it, so cavities and openings develop fairly easily in limestone. These open areas make it easier for mineral-bearing fluids to pass through the rock. The thin, irregular blue-gray band near the outer edge of the geode is chalcedony, frequently one of the first minerals to line the wall of a cavity.



Stibnite- and Calcite-Filled Geode



■ **Mercury Ore**
This specimen from California contains two sets of dimorphs, minerals that can crystallize in two different internal arrangements. Cinnabar and metacinnabar are dimorphs of mercury sulfide, and pyrite and marcasite are dimorphs of iron sulfide. Cinnabar is bright red, though impurities can color it brown. Marcasite is pale brass-yellow to almost white, but when tarnished it becomes a deeper yellow to brown. Marcasite forms from low-temperature acidic solutions in metamorphic and igneous settings. When exposed to air, it disintegrates easily into a white powder.
Gift from Edwin Eckel, U.S. Geological Survey, Denver, Colorado, and former executive secretary of the Society.

■ **Stibnite and Cinnabar**
Stibnite is a lead-gray mineral with a brilliant metallic luster. It often has a black or iridescent tarnish. Its name is from *stibi*, the Greek word for antimony. Stibnite is often found with cinnabar in hot spring deposits or in veins that were mineralized by hydrothermal fluids. The lead-gray stibnite and red cinnabar in this specimen may also contain gold and silver. This specimen was probably collected in Shoshone County, Idaho.
Gift from William J. LeVeque.

■ **Fossil Graptolites**
Graptolites are colonial animals whose carbonized remains are found in Paleozoic rocks. Although they are thought to have been extinct for more than 400 million years, recent discoveries in both the Pacific and Atlantic oceans have raised the possibility that relatives of the graptolites are alive today. Graptolites' name is derived from the Greek *graptos* ("painted" or "written") and *lithos* ("stone").
Gift from Xu Zheng-Liang, East China Geological Institute.

■ **Fossil Belemnites**
These cigar-shaped fossils are the remains of belemnites, extinct marine cephalopods that were the ancestors of the modern cuttlefish, squid, and octopus. The thick shell of the belemnite protected its soft body parts, and its head and tentacles extended from the open, broader end of the shell.

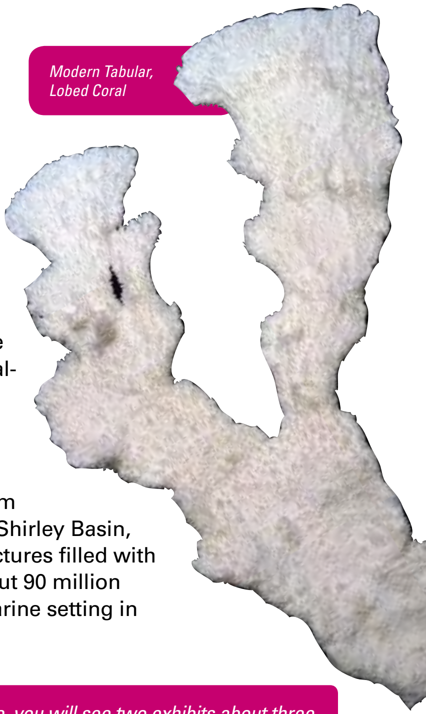
Fossil Belemnites

■ **Oil Shale**

The fine laminations in this oil shale, from the Eocene Green River Formation, probably represent annual sets of seasonal layering of fine- and finer-grained sediment deposited at the bottom of a large inland lake. Oil shales do not produce oil directly. Instead, they contain kerogen, a solid material that produces oil when the shales are distilled under extreme heat.

■ **Modern Branched Coral and Modern Tabular, Lobed Coral**

Coral is commonly found in warm seas and has been abundant in the fossil record since the Ordovician Period about 500 million years ago. Corals produce external skeletons of calcium carbonate. They grow as solitary individuals or in colonies.



Modern Tabular, Lobed Coral

■ **Calcite-Cemented Sand Crystals**

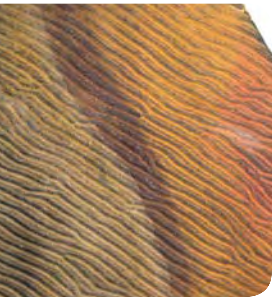
This group of crystals, from South Dakota, contains more sand grains than calcite. The crystals take their shape from crystalline calcite that cements the sand grains together.

Gift from the Geology Museum, Colorado School of Mines.

■ **Sandstone**

The shape of this sandstone specimen, from the Upper Cretaceous Frontier Formation, Shirley Basin, Wyoming, formed when it broke along fractures filled with white calcite cement. The sandstone is about 90 million years old. It was deposited in a shallow marine setting in south-central Wyoming.

After you have viewed the specimens in the case, you will see two exhibits about three quarters of the way down the hallway in front of you, on the right- and left-hand walls. The first, on your right, Ripple Marks, was formed in Late Cambrian Potsdam Sandstone found in Keeseville, New York.



■ **Ripple Marks**

Ripples form in sand that is moved by wind, waves, or water currents. Ripples that are steeper on one side than the other are typically formed by directional currents like those found in streams. Ripples that slope evenly from each side of their crests are usually formed by wave action where water moves back and forth across the sand. The broad rusty bands that cross these ripples are iron oxide stains that precipitated from moisture between the layers of Late Cambrian Potsdam Sandstone. The rock layer with the mirror image of these ripples is on display at the National Museum of Natural History in Washington, D.C.

Collected 4 December 1886 by Charles Doolittle Walcott. Gift from the National Museum of Natural History, Smithsonian Institution, through George Switzer and Harold H. Banks, Jr.

The exhibit on the left-hand wall, Intertidal Sand Bodies, is directly opposite.





■ Intertidal Sand Bodies

These epoxy relief peels from the Minas Basin, Bay of Fundy, Nova Scotia, preserve sedimentary structures from a modern-day intertidal zone. The Bay of Fundy records the highest tidal ranges in the world. Trenches were dug across a tidal bar in several places so that the patterns within the bar could be seen in cross section. While each of these specimens tells its own story to a sedimentologist, they are exhibited here primarily for their interesting textures.

Gifts from George deVries Klein, University of Illinois, Urbana-Champaign.

As you round the corner, you will see these specimens displayed on the walls above the stairs.



■ Dinosaur Footprints

These specimens contain tracks made by dinosaurs walking in mud and sand near ancient shores. Over time, the tracks were covered by more layers of mud and sand and were buried deeply enough to be compressed and cemented into rock before being uplifted and eroded to the surface again. The larger slab contains tracks of several individuals.

The black numbers on the specimens were painted by Charles H. Hitchcock, who collected these tracks in the Connecticut River Valley, Massachusetts, before 1840. Dinosaurs had not yet been identified, and Hitchcock believed that these were the tracks of giant birds.

Permanent loan from the Pratt Museum, Amherst College, Amherst, Massachusetts, through Gerald P. Brophy.

■ Lichen-Covered Branches

Lichens are any of numerous plants consisting of a fungus, usually of the class Ascomycetes, living in symbiotic relationship with certain green or blue-green algae, characteristically forming with a crustlike, scaly, branching growth on rocks or tree trunks. Another specimen is on the outside wall south of the front door. The lime-green lichen is alive and requires occasional watering to maintain its extremely slow growth.

Gift from S. Warren Hobbs, U.S. Geological Survey, Denver, Colorado.


Lichen-Covered Branch

As you descend to the second floor–east wing, you will see the GSA Council Room (p. 39) and additional specimens. Continuing downstairs to the first floor will return you to the beginning of the tour.

We hope you enjoyed your visit
and the many natural wonders you have seen.

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