

November 2007 Mineral of the Month: Thomsonite-Ca

Rare in a nation abundant with fellow zeolite group minerals, this month's mineral is a natural filter that some scientists believe was formed in connection with the event in India that killed off the dinosaurs!
We invite you to learn all about this mineral, known since 2000 as thomsonite-Ca.

PHYSICAL PROPERTIES

Chemistry: $\text{Ca}_2\text{Na}(\text{Al}_5\text{Si}_5\text{O}_{20})\cdot 6\text{H}_2\text{O}$ Hydrus Calcium Sodium Aluminosilicate (Hydrus Calcium Sodium Aluminum Silicate)

Class: Silicates Subclass: Tectosilicates

Group: Zeolite Subgroup: Natrolite

Crystal System: Orthorhombic

Crystal Habits: Commonly prismatic, bladed, and acicular; also massive; often fibrous, radial, and as spherical, rounded aggregates.

Color: Usually colorless or white; also, pale shades of green, yellow, pink, brown, and red.

Luster: Vitreous; pearly on cleavage surfaces.

Transparency: Transparent to translucent

Streak: White

Refractive Index: 1.511-1.530

Cleavage: Perfect in one direction, good in another

Fracture: Uneven, subconchoidal; brittle.

Hardness: 5.0-5.5

Specific Gravity: 2.3-2.4

Luminescence: None

Distinctive Features and Tests: Best field marks are long, thin, bladed crystals; often radial or spherical habit; and occurrence with other zeolite minerals in amygdaloidal cavities in basaltic volcanic rock. Thomsonite-Ca is difficult to identify and is often confused with other zeolite minerals, notably thomsonite-Sr [hydrus strontium calcium sodium aluminum silicate, $(\text{Sr},\text{Ca})_2\text{Na}(\text{Al}_5\text{Si}_5\text{O}_{20})\cdot 6-7\text{H}_2\text{O}$] and mesolite [hydrus sodium calcium aluminosilicate, $\text{Na}_2\text{Ca}_2(\text{Al}_6\text{Si}_9\text{O}_{30})\cdot 8\text{H}_2\text{O}$]. Positive species differentiation can require laboratory analysis.

Dana Classification Number: 77.1.5.9

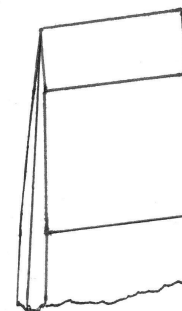


Figure 1.
Thomsonite-Ca crystal

NAME

Thomsonite, the original mineral from which thomsonite-Ca has been identified, is named in honor of Scottish chemist Thomas Thomson (1773-1852) and is correctly pronounced TOM-sen-ite. The "Ca" suffix in the name indicates that the mineral is the calcium-rich end-member of a solid solution series. The suffix is expressed verbally either as "thomsonite-calcium" or phonetically as "thomsonite-see-ay." In nontechnical literature, thomsonite-Ca is usually referred to simply as "thomsonite." If you are like us, it may be difficult to get used to writing the name "thomsonite" without a "p" in it, as "Thompson" is a more common name, at least in this country, than "Thomson."

Because of confusion with other zeolite minerals, thomsonite-Ca has numerous alternative names, some deriving from theories of chemical composition or the names of localities and researchers. Among these are "bagotite," "charphostilbite," "comptonite," "echellite," "faeroelite," "koodilite," "lintonite," "mesolitine," "ozarkite," "picrothomsonite," "thomsonite," "thompsonite," "tonsolite," "tonsonite," and "tripoclase." In European mineralogical literature, thomsonite-Ca is referred to as "thomsonit-Ca" and "thomsonita-Ca." Thomsonite-Ca is also known as "calcium thomsonite."

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COMPOSITION

Thomsonite-Ca is the fourth zeolite mineral that we have featured as our Mineral of the Month, and by far the rarest. Our other zeolite minerals include scolecite $[\text{Ca}(\text{Al}_2\text{Si}_3\text{O}_{10})\cdot 3\text{H}_2\text{O}]$ in May 1997, stilbite-Ca, $[(\text{Ca}_{0.5}\text{K},\text{Na})_9(\text{Al}_9\text{Si}_{27}\text{O}_{72})\cdot 28\text{H}_2\text{O}]$ in May 1999, and heulandite-Ca $[(\text{Ca}_{0.5}\text{NaK})_9(\text{Al}_9\text{Si}_{27}\text{O}_{72})\cdot 24\text{H}_2\text{O}]$ in November 2002.

The chemical formula of thomsonite-Ca, $\text{Ca}_2\text{Na}(\text{Al}_5\text{Si}_5\text{O}_{20})\cdot 6\text{H}_2\text{O}$, identifies its elemental components as calcium (Ca), sodium (Na), aluminum (Al), silicon (Si), oxygen (O), and hydrogen (H). Its molecular weight is made up of 9.94 percent calcium, 2.85 percent sodium, 16.73 percent aluminum, 17.41 percent silicon, 51.57 percent oxygen, and 1.50 percent hydrogen. The cations (positively charged ions) in the thomsonite-Ca molecule include two calcium ions, each with a +2 charge, a sodium ion with a +1 charge, and five aluminum ions, each with a +3 charge. These provide a cumulative cationic charge of +20. The anion (negatively charged ion) in the thomsonite-Ca molecule is the silicate radical $(\text{Si}_5\text{O}_{20})^{20-}$. Because the silicon ions each have a +4 charge and the oxygen ions a -2 charge, the cumulative anionic charge is -20, which balances the cationic +20 charge to provide the thomsonite-Ca molecule with electrical stability.

The “6H₂O” in its chemical formula means that thomsonite-Ca is a hydrous (or hydrated) mineral with six attached water molecules (H₂O). These water molecules are collectively known as “water of hydration.” Consisting of complete, electrically neutral water molecules, water of hydration does not affect the electrical balance of the parent molecule. Water molecules can attach themselves to other molecules because of their unusual atomic configuration, in which two hydrogen ions are grouped together on one side of a large oxygen ion. These grouped hydrogen ions retain a small positive charge, while the opposite side of the water molecule, dominated by the large oxygen ion, retains a small negative charge. This resulting polarity enables water molecules to act as tiny dipole magnets that attach themselves to certain other molecules in a weak attraction called “hydrogen bonding.”

Thomsonite-Ca is a member of the silicates, the largest and most abundant mineral class. Silicates are combinations of silicon and oxygen with one or more metals. The basic silicate structural unit is the silica tetrahedron $(\text{SiO}_4)^{4-}$, which consists of a silicon ion surrounded by four equally spaced oxygen ions positioned at the four corners of a tetrahedron (a four-faced polyhedron). In silicate minerals, silica anions and metal cations join together like polymers (repeating chains) to form seven types of structures: independent tetrahedral silicates (nesosilicates); double tetrahedral silicates (sorosilicates); single- and double-chain silicates (inosilicates); ring silicates (cyclosilicates); sheet silicates (phyllosilicates); and framework silicates (tectosilicates).

Thomsonite-Ca is a framework silicate or tectosilicate (actually a modified tectosilicate). Other important members of the tectosilicates include quartz [silicon dioxide, SiO_2] and several feldspar minerals (aluminum silicates containing potassium, calcium, and/or sodium). As in all silicates, the fundamental structural unit is the silica tetrahedron $(\text{SiO}_4)^{4-}$. But as a member of the zeolite group (see “The World of Zeolites”), the thomsonite-Ca crystal lattice is based on a modified silicate structure in which silica tetrahedra $[(\text{SiO}_4)^{4-}]$ and alumina tetrahedra $[(\text{AlO}_4)^{5-}]$ alternate. This arrangement is reflected in thomsonite-Ca’s chemical formula $\text{Ca}_2\text{Na}(\text{Al}_5\text{Si}_5\text{O}_{20})\cdot 6\text{H}_2\text{O}$, which shows the aluminum ions $[\text{Al}^{3+}]$ as a structural part of the aluminosilicate radical $(\text{Al}_5\text{Si}_5\text{O}_{20})^{5-}$. A single molecular unit of thomsonite-Ca consists of five silica tetrahedra and five alumina tetrahedra. Because of this unusual arrangement, thomsonite-Ca, although structurally categorized as a tectosilicate, is best described as an aluminosilicate.

In the repetitive, three-dimensional lattice of thomsonite-Ca, the silica and alumina tetrahedra covalently share all four of their oxygen ions. This creates a network of hollow, cell-like structures separated by

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channels and containing large volumes of empty space. Because the charge of the aluminosilicate tetrahedron is -5, additional cations are necessary to provide electrical balance. To achieve balance, each thomsonite-Ca molecular group binds ionically to two calcium ions [2Ca^{2+}] and one sodium ion [Na^{1+}]. The channels and hollow structures within and between the molecular units provide space for the attachment of six water molecules by hydrogen bonding.

This unusual structure explains the physical properties of thomsonite-Ca. Its hollow, molecular cells and intermolecular channels, typical of all zeolite minerals, account for thomsonite-Ca's very low specific gravity (density) of only 2.3-2.4. The alternate layering of silica and alumina tetrahedra in a sheet-like arrangement is reflected in one-directional perfect cleavage. Thomsonite-Ca (Mohs 5.0-5.5) and other zeolite minerals are among the softest of all silicates for two reasons: The considerable distances between ions within the molecules weaken the bonding strength, and the ionic bonding of the calcium and sodium cations is inherently weak.

Unlike all other hydrous minerals, zeolites can lose and regain water of hydration without altering their crystal structures. Also, because their network of hollow spaces and channels allows certain ions, atoms, and molecules to pass through while blocking others, zeolites act as natural molecular filters. Finally, the weak ionic bonding within zeolite molecules is easily broken, enabling certain cations (calcium and sodium in the case of thomsonite-Ca) to be replaced by other metal cations in a phenomenon called "ion exchange." All these zeolitic properties have many industrial applications, as we will discuss.

Metal-cation substitution also enables thomsonite-Ca to form the "thomsonite series," a graded, solid-solution series with thomsonite-Sr [hydrous strontium calcium sodium aluminum silicate, $(\text{Sr},\text{Ca})_2\text{Na}(\text{Al}_5\text{Si}_5\text{O}_{20})\cdot 6-7\text{H}_2\text{O}$]. Within this series, strontium replaces calcium in thomsonite-Ca. Cationic substitution between metal cations of similar size and charge occurs in many minerals. Because calcium and strontium ions have nearly identical ionic radii and a +2 charge, they substitute readily for each other without disrupting the crystal lattice. Thomsonite-Ca technically becomes thomsonite-Sr when the weight of the replacing strontium exceeds that of the calcium. These two minerals are visually indistinguishable, but thomsonite-Ca is slightly harder and less dense than thomsonite-Sr. Although rare itself, thomsonite-Ca is much more abundant than thomsonite-Sr. The group name "thomsonite" is used when the species have not been distinguished.

Thomsonite-Ca occurs almost exclusively in amygdaloidal cavities in basaltic volcanic rocks. These cavities form from gas bubbles during the solidification of silica-deficient magma. Later, percolating alkaline groundwater deposits zeolite minerals, often in well-developed, radiating crystal forms. Thomsonite-Ca also occasionally occurs as a cementing material in sandstones and rarely as a minor component of granitic pegmatites.

As an allochromatic ("other-colored") mineral, the colors of thomsonite-Ca are created not by essential chemical components, but by the presence of color-causing impurities called chromophores. Pure thomsonite-Ca is colorless or white, but trace amounts of nonessential elements create a wide range of pale colors.

Its Dana mineral-classification number 77.1.5.9 first identifies thomsonite-Ca as a tectosilicate and a member of the general zeolite group. The subclassification (1) next defines it as one of the true zeolites, a group of hydrous aluminosilicates that can lose and regain water of hydration without altering their crystal structures. Finally, thomsonite is a member of the natrolite group (5) as the ninth (9) of eleven members. Other group members include thomsonite-Sr, natrolite [hydrous sodium aluminosilicate, $\text{Na}_2(\text{Al}_2\text{Si}_3\text{O}_{10})\cdot 2\text{H}_2\text{O}$], mesolite [hydrous sodium calcium aluminosilicate, $\text{Na}_2\text{Ca}_2(\text{Al}_6\text{Si}_9\text{O}_{30})\cdot 8\text{H}_2\text{O}$], and scolecite [hydrous calcium aluminosilicate, $\text{Ca}(\text{Al}_2\text{Si}_3\text{O}_{10})\cdot 3\text{H}_2\text{O}$].

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COLLECTING LOCALITIES

Although relatively rare, thomsonite-Ca is widely distributed. It has only a few notable sources of quality specimens, most of which provide only micromount material. Our specimens were collected at Shendurni in the Jalgaon district in the Maharashtra state of the Republic of India.

Russia's thomsonite-Ca sources include the Pouyva Mine at Saranpaul in Tyumenskaya Oblast', Western-Siberian Region; the Lovozero, Kovdor, and Khibiny massifs on the Kola Peninsula in Murmansk Oblast', Northern Region; and the Tunguska and Nizhnyaya rivers at Evankia in Krasnoyarsk Territory, Eastern-Siberian Region. In Europe, specimens are found on Streymoy, Nolsoy, and Eysturoy islands in Denmark's Faeroe Islands. The type locality at Old Kilpatrick in Dumbartonshire, Scotland, also continues to yield specimens. Other European sources include the Höwenegg Quarry at Immendingen, Hegau, Baden-Württemberg, Germany; the Pentuma and Niu Corbu quarries near Noragugume, Nuoro Province, Sardinia, Italy; and the Heia Quarry at Tvedalen, Larvik, Vestfold, Norway.

Australian specimens are found in the basalt quarries at Jindivick, Victoria; Japanese specimens at Hayata in Saga Prefecture on Kyushu Island and at Mt. Ohsa in Okayama Prefecture on Honshu Island; and South African specimens in the Wessells basalt quarry at Hotazel in the Northern Cape Province's Kalahari manganese fields.

In North America, Canadian specimens are collected at the Poudrette, Uni-Mix, and Desourdy quarries at Mont Saint-Hilaire, Rouville County, Quebec; and at Cape d'Or on the Bay of Fundy in Cumberland County, Nova Scotia. Mexican sources include Sierra de Perote at Santa Maria in Jalisco, and the San Antonio Mine near Aquiles Serdán in Chihuahua. In the United States, thomsonite-Ca specimens are found at North and South Table Mountain at Golden, Jefferson County, Colorado; the Kimzey magnetite mine at Magnet Cove, Hot Spring County, Arkansas; the Glens Ferry area of Elmore County, Idaho; Thomsonite Beach on the north shore of Lake Superior at Grand Marais, Lake County, Minnesota; the basalt quarries at Paterson in Passaic County, New Jersey; and the Chapman Quarry at Clatskanie in Columbia County, Oregon.

JEWELRY & DECORATIVE USES

Because of its very small crystal size, thomsonite-Ca has no conventional use in jewelry—with one notable exception. At Grand Marais on the shore of Lake Superior in northeastern Minnesota, pink and green varieties of thomsonite-Ca occur in both massive and crystalline forms in amygdules in the Terrace Point basalt flow. After the basalt weathers into shoreline sediments, lake waves tumble the thomsonite-Ca, destroying all delicate crystals, but rounding the massive material into polished pebbles. Rarely larger than a golf ball and typically showing bands of pink and green amid the dark basalt host rock, these pebbles are collected, worked, and sold as semiprecious gemstones. Mineral collectors and jewelry makers scour the local beaches, while scuba divers gather specimens from the offshore lake bottom. In the most valued pieces, bright thomsonite-Ca forms circular “eyes” in the dark basalt. Just south of Grand Marais is Thomsonite Beach and the Thomsonite Beach Inn, which maintains a small but impressive exhibit of local thomsonite-Ca beach specimens. These specimens are artificially polished and mounted into such jewelry items as earrings, necklaces, and pendants, or fashioned into decorative objects such as paperweights and belt buckles.

Mineral collectors value thomsonite-Ca specimens for their rarity and crystalline forms for both study and display purposes. Because this is a new find of exceptional quality, and quite rare among the many zeolite minerals found in India in abundance, our specimens this month are especially valuable.

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HISTORY & LORE

In 1820, Thomas Thomson (1773-1852), a Scottish chemist, mineralogist, and regius professor of chemistry at the University of Glasgow, studied zeolite-mineral specimens collected from a canal cut at Old Kilpatrick in Dumbartonshire, Scotland. He identified a new zeolite mineral that university colleagues named in his honor. In the 1920s, researchers used X-ray-diffraction to determine the basic atomic structure of thomsonite and other zeolites, a major step forward in the ability to differentiate species.

In the late 1950s, when the International Mineralogical Association first began formally listing and approving mineral names, thomsonite was “grandfathered” as a previously confirmed mineral species. Thomsonite remained an accepted mineral species until the late 1990s, when mineralogists began studying strontium-rich thomsonite specimens obtained from the Rasvumchorr and Yuksporr mountains in the Khibiny Massif of Russia’s Kola Peninsula. They learned that thomsonite actually existed in a graded, calcium-strontium solid-solution series and that the calcium-rich and strontium-rich end-members qualified as separate species. In 2000, the IMA approved the renaming of thomsonite. The calcium-rich end-member of the solid-solution series became “thomsonite-Ca,” while the newly discovered and much rarer strontium-rich end-member became “thomsonite-Sr.”

In metaphysical lore, zeolites replace negative energy with happiness, facilitate a stable relationship between one’s emotions and intellect, decrease brashness and laziness, and enhance mental clarity.

TECHNOLOGICAL USES

Although natural thomsonite-Ca, because of both rarity and recovery difficulties, has no commercial value, it has served as the model for its own synthesis. Synthetic thomsonite-Ca has several specialized zeolitic applications in science and industry, as explained below.

THE WORLD OF ZEOLITES

The Romans were the first to discover and document the practical application of zeolite minerals, using them as early as 100 B.C. to purify water in their aqueduct systems. Swedish mineralogist Axel Fredrick Cronstedt (1722-1765) discovered the first zeolite mineral, stilbite, in 1756, and was the first to study zeolite minerals in a scientific context. Cronstedt’s stilbite has now been redefined as stilbite-Ca $[(Ca_{0.5}K,Na)_9(Al_9Si_{27}O_{72}) \cdot 28H_2O]$, and stilbite-Na $[(K,Na,Ca_{0.5})_9(Al_9Si_{27}O_{72}) \cdot 28H_2O]$. Observing how heated stilbite specimens vibrated as their water of hydration separated and evaporated, Cronstedt coined the word “zeolite,” literally “stone that boils,” from the Greek zein, “to boil,” and lithos, or “stone.”

By 1900, researchers had identified eight zeolite minerals and learned of their ability to absorb and filter particulate matter from aqueous solutions and to exchange metal cations. Although the industrial potential of zeolites was obvious, the minerals were then thought to exist in small quantities only within amygdaloidal cavities in basaltic rocks. By the 1920s, X-ray diffraction had defined the basic zeolite crystal structure, while revealing that the channel size within the honeycomb-like lattices was specific to each zeolite species, and that fluids could move freely through these channels without affecting the shape or rigidity of the lattice. In 1926, researchers coined the term “molecular sieving” to describe zeolitic filtering.

Following World War II, researchers began addressing the need for zeolite-like materials in industry. Since zeolites were still thought to occur only in small quantities in basalt, mining remained impractical and

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researchers turned to synthesizing zeolites, closely studying the dozen known zeolite minerals as synthesis models. Laboratories created the first synthetic zeolite—synthetic stilbite-Ca—in 1950. After synthesizing the known natural zeolites, researchers then succeeded in creating other zeolites that did not exist in nature.

As the zeolite industry grew rapidly in the late 1950s, geologists unexpectedly discovered that certain zeolites were actually abundant in large, easily mined sedimentary deposits originating with deep accumulations of volcanic ash that lithified into tuff. Percolating alkaline groundwater then altered certain aluminum-bearing minerals into zeolites. Geologists also learned that similar zeolite deposits were formed by the alteration of sediments in certain shallow marine basins.

The 1958 discovery of large zeolite deposits in Nevada triggered a worldwide zeolite-exploration rush. By 1964, geologists had discovered more than 1,000 occurrences of sedimentary zeolites in 40 nations, many of which were minable. The zeolite minerals that occur in large minable sedimentary deposits include natrolite [$\text{Na}_2(\text{Al}_2\text{Si}_3\text{O}_{10}) \cdot 2\text{H}_2\text{O}$], chabazite-K [$\text{K}_2\text{NaCa}_{0.5}(\text{Al}_4\text{Si}_8\text{O}_{24}) \cdot 11.5\text{H}_2\text{O}$], clinoptilolite-Na [$\text{Na}_4\text{K}_{1.5}\text{Ca}_{0.5}(\text{Al}_{6.5}\text{Si}_{20.5}\text{O}_{72}) \cdot 20\text{H}_2\text{O}$], erionite-Ca [$\text{Ca}_4\text{K}_2(\text{Al}_{10}\text{Si}_{26}\text{O}_{72}) \cdot 32\text{H}_2\text{O}$], mordenite [$\text{Na}_2\text{CaK}_2(\text{Al}_8\text{Si}_{40}\text{O}_{96}) \cdot 28\text{H}_2\text{O}$], phillipsite-Ca [$(\text{Ca}_{0.5}\text{NaK})_9(\text{Al}_9\text{Si}_{27}\text{O}_{72}) \cdot 24\text{H}_2\text{O}$], and ferrierite-K [$\text{K}_2\text{NaMg}(\text{Al}_5\text{Si}_{31}\text{O}_{72}) \cdot n\text{H}_2\text{O}$].

Miners use inexpensive, open-pit methods to extract the relatively soft zeolite-containing tuff. The zeolite minerals are then concentrated, separated, and purified. Natural zeolites are difficult to purify, however, and thus are best suited for general agricultural and water-purification uses. From the beginning, natural-zeolite mining faced stiff competition from synthetics which, while not inexpensive to produce, are always pure and much better suited for precision and high-tech applications.

By the 1990s, advanced analytical methods had identified dozens of new zeolite minerals and determined that many previously recognized zeolite species actually consisted of separate end-members of graded solid-solution series. Accordingly, in 1997, the International Mineralogical Association (IMA) revised its listing of zeolite minerals. Previously, the IMA had recognized 51 zeolite minerals; the revised listing totals 83 and continues to grow. In addition, researchers have currently created nearly 200 synthetic zeolite compounds that are not known to exist in nature.

Today, zeolites are the foundation of a multi-billion-dollar industry that mines and synthesizes some five million metric tons of zeolites each year. China is the biggest producer, mining and processing 3.5 million metric tons of natural zeolites annually. In the United States, mines in eight western states yield 55,000 tons of natural zeolites annually. Zeolites serve as mediums for absorption, filtration, ion-exchange, chemical catalysis, and molecular sieving in applications that touch nearly all aspects of life. To name but a few uses, zeolites are regularly employed in water and gas purification systems, as catalysts in the petrochemical and chemical industries, as radioactive-waste-removal mediums in the nuclear industries, as “slow-nutrient-release” mediums for agricultural fertilizers, for purification of medical oxygen, as “filtration-capture” mediums in virtually all laundry detergents, as additives to improve the workability and reduce the density of asphalt and cement, and as filtration mediums for aquariums and pools.

ABOUT OUR SPECIMENS

As previously noted, our specimens of thomsonite-Ca were collected at the town of Shendurni in the Jalgaon district of the state of Maharashtra in the Republic of India. Maharashtra is located in the west-

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central part of the Indian subcontinent and borders the Arabian Sea. Maharashtra's capital is the coastal city of Mumbai (formerly Bombay). With 118,000 square miles, Maharashtra is roughly half the size of the state of Texas. Jalgaon, one of Maharashtra's 34 administrative districts, is located in the north-central part of the state about 240 miles northeast of Mumbai. The Jalgaon district is roughly the size of the state of Connecticut.

The state of Maharashtra and the district of Jalgaon are famed as sources of zeolite-mineral specimens (See map in Figure 2.) These zeolites occur in the basalt of the Deccan (pronounced DECK-kenn) Traps, one of the world's largest volcanic regions. This huge formation, also known as the Deccan Plateau, has an area of 200,000 square miles (roughly the size of the states of Washington and Oregon combined) and covers the entire Jalgaon district and most of the state of Maharashtra. The Deccan Traps were formed by a massive extrusion of magma that took place at the end of the Mesozoic Era some 65 million years ago. This magma rose through long, narrow fissures and faults in the crust, extruded onto the surface and spread in nearly horizontal sheets to form basalt formations many thousands of feet thick. Interestingly, some paleontologists suggest that the extrusion of the Deccan Traps played a major role in the simultaneous global extinction of the dinosaurs.

They believe that the enormous emissions of gases and volcanic ash that accompanied the extrusions created rapid global warming and extreme climatic change, leading to the dinosaurs' demise. Originally, the Deccan Traps covered three times its present area, but weathering and erosion has since reduced its size. The current volume of the basalt in the Deccan Traps is estimated at 12,000 cubic miles.

Basalt is an extrusive igneous (volcanic) rock that forms from the solidification of magma at or near the surface. Volcanic rocks usually cool quickly and have generally smooth textures with no visible crystals (aphanitic texture) or very small crystals scattered throughout a dense groundmass (porphyritic texture). Both extrusive and intrusive igneous rocks are categorized chemically by their silica content. Basalt is a low-silica rock that contains little quartz, but large amounts of iron and magnesium minerals that impart a very dark color.

Prominent structures in basalt include flow banding, vesicles (cavities), and amygdules (cavities that fill with secondary minerals such as quartz and the zeolites). Vesicles form from gas bubbles within the flowing magma, usually near the top of the flow where steam and gases can expand in the reduced pressure. Because of the broad, flat nature of the lava flows, much of the surface and near-surface basalt in the Deccan Traps has a vesicular texture. Upon solidification of the magma, these vesicles were barren, that is, devoid of any secondary mineralization. But upon final cooling, contraction created a network of fissures and fractures through which groundwater later circulated. As this water percolated downward through the basalt, it became alkaline and dissolved certain aluminum and silica-bearing

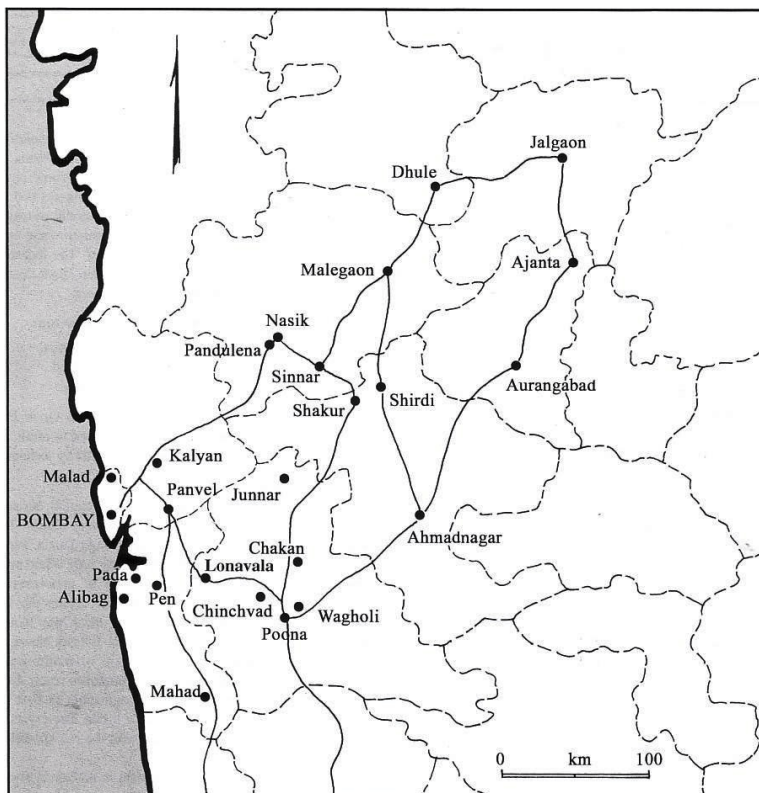


Figure 2. Map of Maharashtra state showing the most important specimen-producing districts. Map courtesy of Mineralogical Record magazine, used by permission.

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minerals. The mineral-laden groundwater then filled many vesicles and, under proper conditions of chemistry, temperature, and pressure, precipitated its dissolved mineral content as zeolite minerals, often in well-developed botryoidal, spherical, and radiating crystal forms.

Although India's Deccan Traps contain no valuable commercial mineral deposits, the basalt itself, which is hard, durable, largely inert, and dense, is a superb material for construction purposes. As the only rock readily available throughout most of Maharashtra, basalt serves as ballast and fill for road and rail beds and foundations for buildings and dams. In crushed form, it is the standard gravel additive for cement. Basalt is quarried in great quantities throughout Maharashtra. Because it is an inexpensive, low-profit commodity, it is always quarried as near as possible to where it will be used. As in other Maharashtra districts, virtually every village, town, and city in the Jalgaon district has at least one basalt quarry.

Basalt has been mined in Maharashtra for several thousand years, during which time countless superb zeolite mineral specimens have been destroyed, sad to say. Zeolite mineral specimens from India had no value until they became popular among worldwide mineral collectors in the late 1960s. Most Indian zeolite specimens are found in basalt quarries, and to a much lesser extent in excavations for irrigation canals, building and dam foundations, and wells. Specialized groups of miners and dealers now work together to satisfy the booming demand for zeolite specimens. Specimen miners are proficient in the special techniques necessary to extract intact zeolite specimens from the cavities in the tough basalt, while dealers maintain international marketing contacts. Today, zeolite specimens are considered a valuable by-product of basalt quarrying, and dealers and specimen miners often contract with individual quarries for exclusive specimen-recovery rights.

Our thomsonite-Ca specimens were recovered at a quarry in Shendurni under this collection system. The small city of Shendurni, population 12,000, is located at an elevation of 1,100 feet in the southern part of the Jalgaon district some 25 miles south-southwest of the district-capital city of Jalgaon. The city is the hub of an agricultural area that mainly produces cotton and groundnuts (peanuts). Although Shendurni has a number of basalt quarries, it had never previously been noted as a source of zeolite specimens. But shortly after a new municipal basalt quarry opened in 2004, fine thomsonite-Ca specimens were discovered in cavities in the basalt. Until this find, very little thomsonite had been found in the entire Jalgaon district! The Shendurni thomsonite-Ca specimens were first displayed at the Munich (Germany) gem-and-mineral show in 2006 and were well-received by collectors. Demand for the specimens soared after they were described in the European mineralogical journal *Mineral Up* later that year. Shendurni is now considered to be the finest Indian source of thomsonite-Ca. Shendurni thomsonite-Ca specimens are known for their distinctive reddish tint, which is caused by the presence of microscopic particles of hematite [iron oxide, Fe_2O_3]. Our ball-shaped clusters are made up of long thin thomsonite-Ca crystals, radiating out from a central core—a fascinating form for a mineral with fascinating properties!

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