

August 2008 Mineral of the Month: Mookaite Jasper

After featuring just two minerals from Australia in twelve years, we complete the triumvirate of three in a row from this mineral-rich continent with one of the best known, widely used, and colorful varieties of jasper, from the remote outback of Western Australia. This write-up will zero in on the similarities and differences between macrocrystalline quartz (amethyst, rock crystal, et al) and microcrystalline quartz (chalcedony in all its varieties, including jasper, chert, flint, agate, carnelian, chrysoprase, and many others.) The information under "Physical Properties" applies to the latter group.

PHYSICAL PROPERTIES

Chemistry: SiO₂ Silicon Dioxide, often containing small amounts of iron and manganese

Class: Silicates

Subclass: Tectosilicates

Group: Quartz

Subgroup: Microcrystalline Quartz

Crystal System: Hexagonal

Crystal Habits: Usually occurs as botryoidal or mammillary crusts. Also massive, compact, and nodular; as fillings between sand grains in sediments; in the interior of geodes; and as smooth, rounded, alluvial pebbles.

Color: White, gray, tan, brown, and black to brownish-red, red, pink, yellow, green, and blue.

Luster: Waxy and vitreous to dull

Transparency: Translucent to opaque

Streak: White

Refractive Index: 1.55

Cleavage: None

Fracture: Conchoidal to subconchoidal and irregular, brittle to tough.

Hardness: Mohs 6.0-7.0

Specific Gravity: 2.62-2.66

Luminescence: Usually none; impurities occasionally produce weak green and white fluorescence.

Distinctive Features & Tests: Chalcedony is difficult to confuse with other minerals. Best field marks are hardness, botryoidal form, low specific gravity, and range of colors.

Dana Classification Number: 75.1.3.1

NAME

The word "jasper" stems from the Persian word *yasph*, and passed through either the Hebrew word *yaspeh* or the Akkadian word *yashupu* into the Greek *iaspis* and finally, the later Latin *jaspis*.

"Chalcedony," pronounced "cal-SED-do-nie," is derived from Chalcedon, an ancient Greek city on the Strait of Bosphorus in Asia Minor. "Quartz" is derived from the Slavic word *kwardy*, meaning "hard."

Our specimens are called "Mookaite (MOOK-ah-ite) jasper," derived from the source at Mooka Station, a former sheep ranch in Western Australia. "Mooka" means "running waters" in the Australian Aboriginal language, perhaps referring to the many fresh water streams that feed nearly Mooka Creek. Spelling variations of this name include "Mookite," "Moukaite," "Mooklite," and "Mookalite."

COMPOSITION

Mookaite jasper is a variety of chalcedony, or microcrystalline quartz. Chalcedony consists of interlocked crystals of microscopic quartz and includes such common sub-varieties as jasper, agate, carnelian, chrysoprase, bloodstone, and many others—see the "Quartz Varieties Chart." In our write-up,

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macrocrystalline quartz is referred to simply as “quartz,” while microcrystalline quartz is referred to as “chalcedony.” For a detailed discussion of the genesis and varieties of chalcedony, and exactly how it differs from quartz, see the special section on “Microcrystalline Quartz.”

To understand the properties of chalcedony, it is first necessary to understand those of quartz itself. As shown by its chemical formula, SiO_2 , quartz or silica has only two elemental components: the semimetal silicon (Si), and oxygen (O). Quartz's molecular weight is made up of 46.74 percent silicon and 53.26 percent oxygen. The cation or positively charged ion in the quartz molecule, is the silicon ion Si^{4+} , which has a +4 charge. The anion or negatively charged ion consists of two oxygen ions 2O^{2-} with a collective -4 charge. The cationic +4 charge balances the anionic -4 charge to provide the quartz molecule with electrical stability.

Quartz can be categorized as either an oxide or a silicate. Chemically, quartz, as silicon dioxide, is a member of the oxides, minerals in which metals or semimetals are combined with oxygen. Structurally, however, quartz is a member of the silicates, a group in which silicon and oxygen combine with one or more metals to form structures that are based on the silica radical $(\text{SiO}_4)^{4-}$. Although quartz does not contain a metal in its composition, modern mineral-classification systems consider structure before chemical composition and thus categorize quartz as a silicate. The silicates are the largest and most abundant of all mineral classes. Silicon and oxygen are the most abundant elements in the Earth's crust, together comprising 75 percent of its total weight. The minerals of the silicate group, including their various metallic cations, make up 93 percent of the total crustal weight.

In the silica tetrahedron $(\text{SiO}_4)^{4-}$, a silicon ion is surrounded by four equally spaced oxygen ions positioned at the four corners of a tetrahedron (a four-faced polyhedron). In the silicates, silica anions join together with metallic or semimetallic cations in 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). Quartz is a framework silicate or tectosilicate, a large subclass that includes the abundant feldspar group of complex aluminum silicates containing potassium, calcium, and/or sodium.

As the most abundant mineral, quartz, in varying quantities, is a constituent of virtually all igneous, metamorphic, and sedimentary rocks. Quartz is also the most thoroughly studied mineral, and knowledge of its structure is an invaluable prerequisite to understanding those of other silicate minerals. In the quartz crystal lattice, each silica tetrahedron shares all four of its oxygen ions. Each oxygen ion bonds covalently to the silicon ion of an adjacent tetrahedron. Each silicon ion is therefore surrounded by four oxygen ions, and each oxygen ion by two silicon ions. This satisfies the -4 charge of each individual tetrahedron, so that no other ions are necessary for electrical stability. The result is the infinite, three-dimensional structure of quartz in which each balanced molecular unit is described by the formula SiO_2 .

The bonding within the quartz lattice is exclusively covalent. Because covalent bonding exerts omnidirectional strength, quartz crystals have neither a center of symmetry nor cleavage planes. Quartz's substantial hardness of Mohs 7.0 (6.0-7.0 for chalcedony) is due to both this lack of cleavage and the high bonding strength derived from close atomic packing. Despite this close atomic packing, the relatively light atomic weights of silicon (28.09) and oxygen (16.00) give quartz a low specific gravity of 2.65 (2.62-2.66 for chalcedony).

Quartz is an allochromatic mineral, meaning that its color is caused not by essential elemental components or the nature of its crystal structure, but by traces of nonessential, color-producing elements called chromophores. Pure quartz is colorless, but various impurities create a wide range of colors. As explained in “Microcrystalline Quartz,” the basic color of chalcedony is white or gray, but mineral staining

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in the interstitial spaces between its microscopic quartz crystals creates reds, browns, yellows, greens, blues, and even black.

The Dana mineral classification number 75.1.3.1 first identifies quartz as a tectosilicate or framework silicate (75). The subclassification (1) defines it by the chemical formula SiO_2 and a four-oxygen coordination in which the silicon cations are bound to four oxygen ions. Quartz is then assigned to the quartz group (3) as the first (1) and only member. Included in the subclassification (SiO_2 with four-oxygen coordination) are several other minerals that are all polymorphs of quartz. These minerals, which have identical chemistries but different crystal structures, include cristobalite (tetragonal), tridymite (triclinic), coesite (monoclinic), and stishovite (tetragonal).

MICROCRYSTALLINE QUARTZ

The term “quartz” includes both the macrocrystalline form, which consists of visible, well-developed crystals, and the microcrystalline or compact form of silica. Familiar macrocrystalline forms include amethyst, rock crystal, and the milky, smoky, and rose varieties of quartz, all of which occur as large individual crystals or groups of crystals that are transparent to translucent. Chalcedony, on the other hand, is a microcrystalline (or “cryptocrystalline”) form that is usually compact or massive. It consists of microscopic silica grains or fibrous silica crystals that can be stained a broad variety of colors and color patterns by natural mineral pigments. Because colors and color patterns vary widely, the various forms of chalcedony have acquired literally hundreds of names that are based primarily on color, color patterns, and sources. Since these varieties usually exist in graded continua, it is difficult and confusing to attempt to establish precise boundaries between, for example, chert and jasper or jasper and agate. To add to this confusion, various scientific disciplines define chalcedony varieties differently: To archaeologists, jasper is any reddish chalcedony whether or not it is rich in iron; to geologists, it is any high-iron chalcedony regardless of color.

When chemists determined the true chemical nature of quartz in 1824 (see “History & Lore”), they divided all quartz minerals into three categories: macrocrystalline, microcrystalline, and cryptocrystalline. Macrocrystalline (macro: “large”) referred to quartz with visible crystals; microcrystalline (micro: “small”) to quartz in which the crystal structure was discernible under optical microscopy; and cryptocrystalline (crypto: “hidden”) to quartz in which the crystal structure was too small to be resolved by optical microscopy. Today, quartz minerals are divided into only two categories: macrocrystalline or simply “quartz,” and “microcrystalline” or “chalcedony,” the latter referring to compact or massive forms in which individual crystals do not exceed 50 microns (0.05 millimeters) in size.

Quartz and chalcedony develop in very different ways. Quartz grows by adding silica on a molecule-by-molecule basis to form successive layers on a crystal's surface. Quartz growth takes place at high or low temperatures and pressures, but only where sufficient space enables orderly crystal development. Chalcedony, however, forms from the solidification of colloidal silica suspensions in the absence of space in the low temperatures and pressures that are typical of shallow environments. Chalcedony often forms horizontal bodies, or “lenses,” in chemical-sedimentary rocks (rocks formed by chemical precipitation).

This process begins with silica that has weathered free from silicate minerals and is carried in groundwater as microscopic particles in colloidal suspension. These silica particles eventually settle out of suspension as a water-based, amorphous (noncrystalline) silica gel. Over time, this amorphous silica gel loses most of its water to form solid masses of chalcedony composed of interlocking, microscopic crystals.

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Chalcedony differs from quartz in several important ways, the most obvious of which is crystal size. Because of its microcrystalline nature, chalcedony lacks quartz's structural homogeneity. As a result, the Mohs hardness of chalcedony ranges from 6.0 to 7.0, whereas that of quartz is precisely 7.0. Chalcedony is also usually slightly less dense than quartz. The specific gravity of quartz, which has high purity, is 2.65. However, the specific gravity of chalcedony, which can contain up to four percent impurities, varies from 2.62 to 2.66. With its homogenous crystal structure and higher purity, quartz is transparent to translucent, while chalcedony, which is less pure and nonhomogeneous, is translucent to opaque. Quartz has very little porosity, while chalcedony, with its structure of individual microcrystals, is quite porous. The structure of chalcedony varies from grain-shaped microcrystals (microgranular) to fibrous microcrystals (microfibrous), and is determined during its formation by specific conditions of temperature, pressure, and chemistry. The microgranular and microfibrous types of chalcedony exist in a graded continuum and exhibit varying degrees of porosity.

Because of this difference in porosity, quartz and chalcedony are colored in different ways. Quartz is colored mainly by a primary process in which the trace presence of chromophores in the original silica solutions imparts color to the crystals. Secondary coloration in quartz is usually limited to surface mineral staining. But chalcedony is subject to primary coloration only to a minor extent. Most chalcedony coloration is of secondary origin. Because chalcedony is porous, it is easily permeated by mineral-bearing, groundwater solutions containing the chromophoric ions of such elements as iron, manganese, and nickel. These groundwater solutions, which frequently change in temperature, pressure, rate of flow, and chemistry, can deposit minerals in the interstitial spaces between chalcedony's microcrystals to create a wide range of colors and color patterns that are often eye-catching and quite beautiful.

When formed, most chalcedony is gray, grayish-white, or tan, colors that indicate minimal chromophoric content in the original silica suspensions and colloidal gels. These colors are most common in deep chalcedony, such as that recovered by core-drilling or underground mining. But shallow deposits of chalcedony are often exposed to circulating, mineral-rich groundwater that imparts the secondary coloration that is typical of agate, jasper, and other types of chalcedonic gemstones.

*The important forms of chalcedony include **chert**, by far the most abundant, which is dull and opaque, has an irregular-to-subconchoidal fracture, and is white, tan, brown, or some shade of gray. **Flint** is a dark to near-black variety of chert. **Jasper** refers to brightly colored, usually opaque varieties of chalcedony and is often red or brown, but may also be green, blue, yellow, or vari-colored with two or more distinct colors appearing in a single specimen. **Agate** refers to translucent chalcedony that exhibits pronounced color bands or dark, branching inclusions.*

COLLECTING LOCALITIES

The jasper variety of chalcedony is abundant, widely distributed, and occurs in varying quantities in most types. Jasper sources are often poorly documented, first because they tend to occur throughout large formations where recovery is frequently not site-specific. Much jasper also weathers free of its host formations and, because of its hardness and durability, survives transport with alluvium over long distances. And chalcedony's low density does not enable it to concentrate gravitationally in alluvial deposits (placers). Thus, chalcedony varieties are often found and collected atop the alluvia of riverbeds, plains, and valleys far from their original sources. A list of significant jasper localities would number in the tens of thousands. The sources here include only those of some commercial importance.

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Our specimens of Mookaite jasper were collected at an unusual lode source—Mooka Station near Gascoyne Junction in the Gascoyne region of Western Australia, Australia. Another notable Australian source is the famed Marlborough chrysoprase mine near Capricorn in central Queensland—we're currently working on featuring lovely specimens of chrysoprase from this mine in the near future. In Mexico, Isla de Santa Catalina in Baja California Sur and many sites in Chihuahua have supplied commercial quantities of jasper. Other sources include Vancouver Island, British Columbia, and the north shores of the Great Lakes in Ontario, Canada; Bayate, Santiago de Cuba, Cuba; the Idar-Oberstein area of southwest Germany; and the Altai Mountains at the common borders of China, Russia, and Mongolia. African jasper has come from the Llorin area of Nigeria; the Nile River gravels and the Red Sea beach gravels in Egypt; and from the Mtwara region of southeastern Tanzania. In October 2001, we featured beautiful, brightly-colored Ocean Jasper from the new find in Madagascar.

In the United States, commercial quantities of jasper are collected in Oregon at the Grants Pass, Lake Owyhee, Biggs Junction, and Rogue River areas; in California at Morgan Hill in Santa Clara County, Point Bonita Beach near the Golden Gate Bridge in Marin County, and in several areas of the Mojave Desert in San Bernadino County; in South Dakota at Sioux Falls; in Idaho at Willow Creek north of Eagle in Ada County; in Missouri in the Canton area of Lewis County; in Arizona in the Joseph City and Petrified Forest National Park areas near Holbrook in Navajo County; in Nevada at the Sage Mine in Humboldt County; and in New Mexico near Quernado in Catron County. There are so many wonderful varieties of colorful jasper in the United States we can't list them all—please don't be offended if your favorite isn't mentioned here! What a wonderful idea it would be for someone to make a comprehensive list with collecting information on all the sites and to post it on a web page!

JEWELRY & DECORATIVE USES

Abundance, bright colors, workability, a fine grain that permits detailed carving and design, and the ability to take a high polish have made jasper a gemstone and decorative material since antiquity. Over the centuries, jasper has been fashioned into beads for necklaces and bracelets, and into cabochons and engraved cabochons, ring stones, cameos, tie tacks and cuff links, spheres, snuffboxes, bowls, paperweights, figurines, bookends, polished slabs, and tumbled stones. Each year, many tons of jasper are fashioned into gem forms and decorative objects. Jasper jewelry, usually mounted in silver, sells for a wide range of prices. Most gem-quality jasper is tumble-polished in irregular shapes and sold from "grab buckets" in tourist, souvenir, and rock shops. As gems, the most valuable forms of jasper are apple-green chrysoprase, red carnelian, and the vari-colored Mookaite jasper.

Jasper's natural porosity makes it easy to color-enhance. Most jasper (and agate) sold today has been impregnated with chromophoric solutions based on everything from sugar (heating sugar-impregnated chalcedony will turn it black) and organic dyes to chemical salts of iron, manganese, chromium, and copper. Chalcedony is color-enhanced by simple immersion, often in conjunction with mild heating to increase its porosity and speed the process.

One interesting use of jasper is as a material for knapping—the fashioning of arrowheads and other objects by the ancient process of flaking. Knappers sharply strike jasper with pieces of metal or other stones to flake off small pieces from conchoidal fractures. Repeated flaking shapes the jasper into detailed, delicate arrowheads and other forms that are valued as objets d'art. Knappers often heat jasper to enhance its flaking properties. Experienced knappers consider Mookaite jasper, with its varied colors and tight grain, as one of the most desirable forms of chalcedony for flaking purposes.

Because cutting and polishing is necessary to bring out its beauty, rough chalcedony is not often collected

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for purposes other than study or comparison. Among the exceptions to this are fine pieces of green chrysoprase, red carnelian, and pink or vari-colored Mookaite jasper.

HISTORY & LORE

Stone tools and weapons have been fashioned from jasper and other forms of chalcedony since the dawn of mankind. Some of the earliest known primitive stone axes recovered from cultural sites in Ethiopia's Omo Valley are fashioned from jasper. By the time of recorded history, jasper, usually as red carnelian (formerly "cornelian"), was thought to cure insomnia, promote prudence and caution, and bring its owner strength and victory in battle. In fact, many cultures associated red jasper with the blood of battle. Ancient Egyptians engraved red jasper amulets with verses from the *Book of the Dead* to assure safe passage for the deceased into the netherworld. Because wax does not adhere to its polished surface, jasper had become the preferred material for intaglios throughout the Mediterranean region by 1800 B.C. By the 1500s, extensive, local deposits of high-quality jasper and agate had made the Idar-Oberstein area, in what is now Rheinland-Phalz, Germany, the world's leading stonecutting center. When these deposits were exhausted, Idar-Oberstein gem cutters turned to using Brazilian agate, a practice that continues to our day.

Jasper is mentioned several times in the Bible. The breastpiece of judgement worn by Israel's high priest contained a jasper stone, one of the twelve gemstones that decorated the garment, each gemstone representing one of Israel's twelve tribes. In the Bible book of Revelation, jasper is used symbolically in the description of "the holy city Jerusalem," its radiance described as "like a most precious stone, as a jasper stone shining crystal-clear." The structure of this city's wall is also jasper, as is its first foundation stone. Also, in the vision giving a glimpse into God's heavenly presence, "the one seated (on the heavenly throne) is, in appearance, like a jasper stone and a precious red-colored stone." Since jasper is used to describe such glorious visions, some Bible scholars believe that the stone called "jasper" in Bible times may have been a translucent gemstone, perhaps even referring to diamond.

Medieval physicians made powdered jasper into ingestible potions to treat disorders of the kidneys, stomach, and intestines, and suggested that jasper pendants could protect their wearers against drowning, lung ailments, and scorpion bites. When engraved with a scorpion's image, jasper was thought to stop bleeding; with the image of a dog or stag, it was thought to cure demonic possession. Several Native American cultures believed that jasper could bring rain and alleviate the effects of snakebites.

When Swedish chemist Torbern Olaf Bergmann (1735-1784) first scientifically studied quartz in 1780, he discovered a chemical similarity between quartz and chalcedony, but insisted that they were different species. Furthermore, because he was unable to decompose silica, he believed that silica was itself a chemical element. This idea persisted until 1824 when another Swedish chemist, Jöns Jacob Berzelius (1779-1848), decomposed quartz into its elemental components, oxygen and a new, semimetallic element that he named silicon. After recognizing that all forms of silica consisted only of silicon dioxide and were therefore all variants of the same mineral species, scientists then began categorizing quartz varieties by crystal size in the same general system that is used today.

According to modern metaphysical practitioners, jasper is a grounding stone that balances physical, emotional and intellectual states, while instilling a deep appreciation of nature. Jasper is an alternate birthstone for the month of January. Jasper is featured on New Zealand's 5-cent stamp of 1982, Russia's the 4-kopek stamp 1963, Uruguay's 5-peso stamp of Uruguay of 1972, and Cyprus's 10-cent stamp of 1973. In testimony to its abundance and popularity as a semiprecious gemstone, "Jasper" is the name of not less than 12 towns and eight counties in the United States.

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TECHNOLOGICAL USES

When early man began forming durable, sharp tools from stone, chalcedony in its many varieties, due to its abundance, hardness, durability, and ability to form conchoidal fractures, was the most valuable of all mineral resources. Worldwide, it was the preferred material for working into knives, scrapers, cutting axes, and projectile points, and it was still being utilized by isolated, primitive cultures as recently as the early 20th century.

Chalcedony, both as rough and finished tools, was an important trading commodity to our earliest ancestors. Because of its distinctive colors, patterns, and textures that are sometimes source-specific, archaeologists have long valued chalcedony artifacts as clues to determining prehistoric trade patterns and routes. But because the visual properties of chalcedony are limited in determining sources, researchers are now developing analytical methods based on scanning-electron microscopy and oxygen-isotope analysis to positively determine the sources of chalcedony artifacts.

ABOUT OUR SPECIMENS

As noted, our specimens of Mookaite jasper were collected at Mooka Station near the town of Gascoyne Junction in the Gascoyne region of Western Australia, Australia. Australia's largest state, Western Australia has an area four times that of Texas and occupies the entire western third of the Australian continent. Because its diminutive population of only two million is concentrated near the state capital of Perth on the southwestern coast, much of Western Australia consists of vast areas of sparsely populated outback—of which the Gascoyne region is a classic example.



Figure 1. Mooka Creek. All photos courtesy of John Bennett.

Mooka Station is located 500 miles north of Perth and 80 miles inland from the coastal town of Carnarvon. With a subtropical climate and population of 7,000, Carnarvon is a center for fishing and cultivation of bananas, avocados, and mangos. The usually dry Gascoyne River ends at Carnarvon on the Indian Ocean. The Gascoyne River drainage extends inland (east) for 300 miles and is known as “the Gascoyne region,” or simply “the Gascoyne.” From Carnarvon, a recently paved, single-lane road extends eastward for 80 miles to Gascoyne Junction, a town of 100 residents that is the trading and communications hub for a vast area of arid outback. Twenty-five miles north of Gascoyne Junction via a dirt track is Mooka Station, a former sheep ranch that covers some 700,000 acres (about 1,100 square miles—picture a square 33 miles on each side). In Australia, “station” is synonymous with “ranch.”

Mooka Station is on the west side of Kennedy Range National Park, a 100-mile-long, 20-mile-wide, eroded, 1,000-foot-high plateau of red sand dunes, sandstone mesas, battlements, caves, and cliffs. The Mooka Station headquarters lies in the shadow of the Kennedy Range cliffs in a lush, green oasis watered by year-round springs flowing from a red sandstone gorge.

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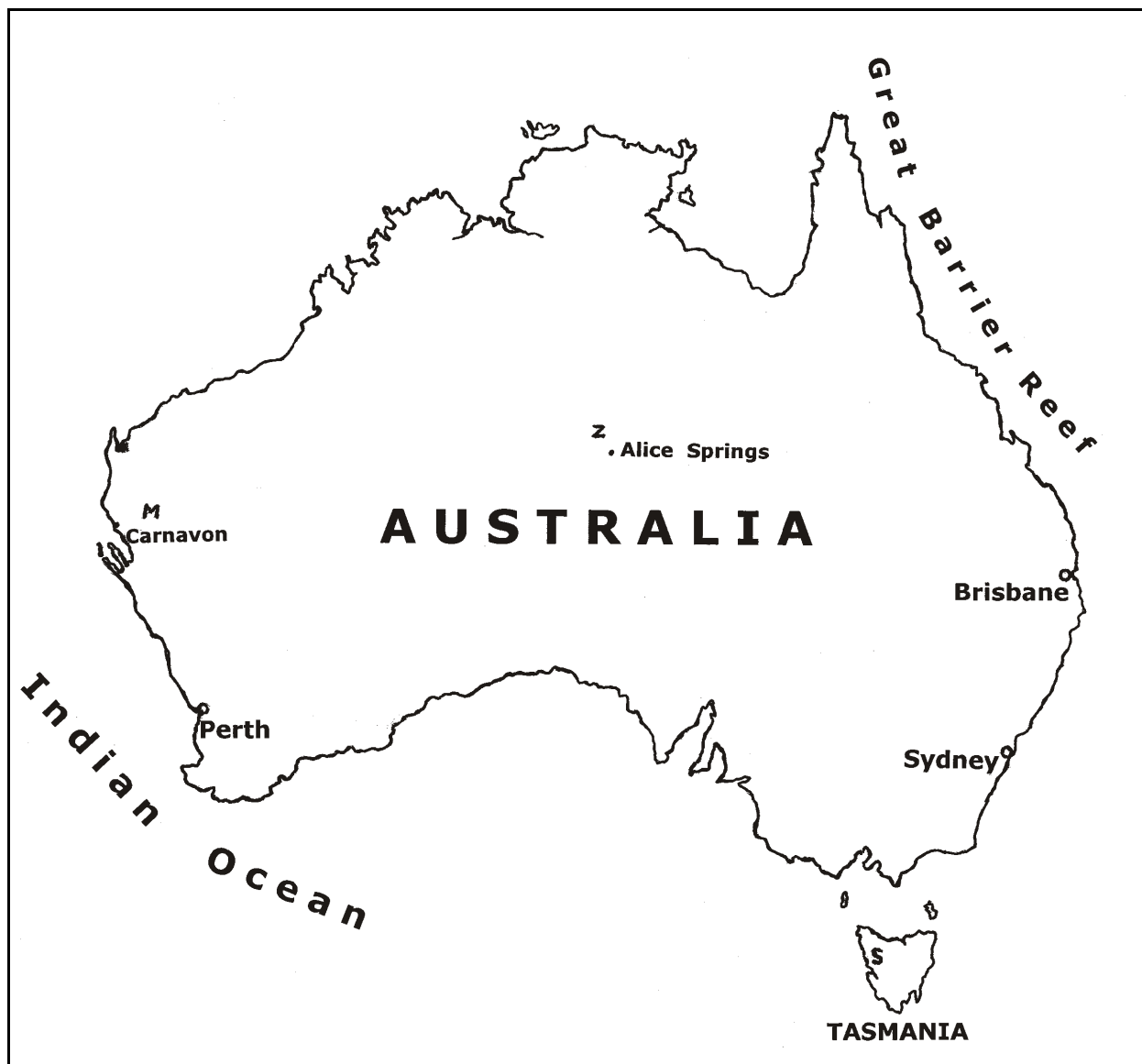


Figure 2. Map of Australia showing localities of our last three featured minerals—"Z" for zircon in center, "S" for stichtite in Tasmania, and "M" for Mookaite jasper on the left.

Mookaite jasper occurs within the Windalia Radiolarite, a lower-Cretaceous siltstone formation that outcrops across much of the Gascoyne River Basin. The Windalia Radiolarite sediments were deposited 110 to 120 million years ago by a shallow, marine sea that then covered much of the Australian continent. The origin of Mookaite jasper is linked to the unusual composition of these sediments, which consist largely of microscopic marine protozoans called radiolarians, a type of plankton with a siliceous exoskeleton. Over millions of years, enormous quantities of radiolarian exoskeletons accumulated in the sea-bottom sediments. When the seas retreated, silica from the weathering of both the radiolarian remains and the silicates of nearby rocks cemented these sediments into a durable siltstone. While all of

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the Windalia Radiolarite formation is highly silicified, some parts host horizontal lenses of nearly pure chalcedony. At depth, Windalia Radiolarite chalcedony is a medium-gray color. But nearer to the surface, the circulation of groundwater rich in iron and manganese ions has imparted to the chalcedony the bright shades of red, yellow, and brown that are characteristic of Mookaite jasper. Pretty pink and purple Mookaite jasper is occasionally found here too, and is quickly collected, transported, and sold to collectors and gem cutters.



Figure 3. A productive day collecting at Mooka Station.

Mookaite jasper occurs in several Windalia Radiolarite outcrops, but the greatest concentration, with the highest quality and brightest colors, is found on a 75-acre section of Mooka Station. The most commercially important outcrop is located at the base of a low cliff alongside a small, perennial watercourse called Mooka Creek (also

Binthabuka Creek). This outcrop has three types of chalcedony: "sunset opal," a non-gem, opaline material with a pale-yellow color adorned with swirls of pale reds and browns; a massive, gray chert; and the Mookaite jasper itself, which consists of large, rounded nodules with dark reddish centers surrounded by lighter, bright colors.



Figure 4. Loading the transport truck after a prolific collecting trip.

Mooka Station is the sole source of Mookaite jasper, which is recognized as one of the world's premier gem-quality jaspers. The first jasper leases at Mooka Station were filed in 1964. When mining commenced shortly thereafter, the informal name "Mookaite" was created for marketing purposes. Since then, the

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caretaker family at Mooka Station has periodically mined the deposit, using backhoes to dig the jasper from the creek bed and cliff. Sections of the original lease have since been sold to other mining groups, two of which remain active. Since the 1960s, hundreds of tons of Mookaite jasper have been mined and marketed. Lately, tons of Mookaite jasper have been sold and shipped to carving factories in China, used to make colorful beads, cabochons, gemstone donuts, animal carvings, and the like.



Figure 5. Sunrise at Mooka Creek—ready for another day of fruitful collecting?

From the technical mineralogist's standpoint, use of the term "Mookaite" should be discontinued, as they would prefer the use of the "-ite" suffix be reserved only for officially accepted mineral species. Unfortunately, this is probably not feasible at this point, as the suffix is so much a part of common parlance, and has been for so long, that it would take a giant effort by all of us to quit using it. Actually, it seems a shame the material wasn't called "Mooka jasper" by its first marketers, a name that seems more descriptive and more in keeping with the feeling of this exotic locality. Remarkably, the colors of sunrise seen in Figure 5 are similar to the colors of Mookaite—yellow and brown for the earth and sun; red, pink, and purple for the sky! (Switch to receiving your write-ups as PDF files via Email if you'd like to receive your write-up each month with full color photos.)

It was not our intention to feature three minerals in a row from Australia, but it has worked out wonderfully—three completely unique substances from three entirely different environments spanning the breadth of the land, each with its captivating history and singular properties! More than coincidence, we hope this signifies an abundance of glorious minerals from this untouched continent, one we hope to visit and revisit into the far future!

References: *Dana's New Mineralogy*, Eighth Edition; *Encyclopedia of Minerals*, Second Edition, Roberts, et al, Van Nostrand Reinhold Company; *2004 Glossary of Mineralogical Species*, J. A. Mandarino and Malcolm E. Back; *Mineralogy*, John Sinkankas, Van Nostrand Reinhold Company; *Gems and Jewelry*, Joel Arem, Geoscience Press; *Gemstones of the World*, Walter Schumann, Sterling Publishing Company; "Mookaite," B. Myatt, *Australian and New Zealand Gemstones*, 1972; "Geology of the Carnarvon Basin, Western Australia," D. J. Morrison, *Geology Survey of Western Australia Bulletin* 133, 1987; "Gemstones in Western Australia," R. Hocking, H. Van De Graaf, and W. Van De Graaf, *Geological Survey of Western Australia Bulletin* 172, 1994; "Gems Around Australia," H. Bracewell, *Australian Gemologist*, Volume 19, 1996; "Agates: Treasures of the Earth," *Rocks & Minerals*, Richard Dayvault, September-October 2007; "Enjoying Jasper," Curtis Handy, *Rock & Gem*, February 2002; "Mookaite: A Lithic Enigma," Andrew McLaren, *CHIPS: The National Magazine for Flintknappers*, January 2008.