

The World of Minerals

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Jade Across the Millennia—Part 1

The story of jade spans millennia and civilizations from the early European lake-dwelling Neolithic toolmakers nearly 7,000 years ago, to the present. No other gemstone has rivaled jade as a symbol of supreme cultural importance and as venerated as in the traditions of China, Mesoamerica, and among the Maori of New Zealand. While jade continues to be highly valued by modern Chinese and native Maoris, its former glory has all but vanished in the regions of Mexico, Guatemala, Belize, and Honduras once dominated by the Maya and other ancient pre-Columbian civilizations.

The Nature of Jade

When the Spanish conquistadores arrived in Mexico, they noticed the Aztecs using a green stone they called *chalchíutl*, to which were assigned curative properties, especially for kidney ailments. The Spanish, named it *piedra de ijada*, or loin stone, subsequently translated into French as *Pierre l'éjade* or *le jade*, and simply *jade* in English. Chinese stone carvings reaching the West were also called jade, but only later in the 19th century did the French mineralogist Augustine Damour recognize that jade consisted of two entirely different minerals, namely *jadeite* for the Mesoamerican mineral and *nephrite* for Asian stones. The Chinese used the word *yu* for jade to describe jade in a general sense for nephrite (and sometimes, for other similar-looking stones), and after the late 18th century, also jadeite. The name *fei-ts'ui*, named for the bright blue-green plumage of the kingfisher bird, originally applied to deep green nephrite, but since the nineteenth century also to describe the finest quality emerald-green Burmese jadeite (or Imperial jade).

Today, the term jade is still used for both *nephrite*, a tough, compact, fibrous variety of the amphibole tremolite-actinolite series, $(Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2; H\ 6-6.5, S.G. \sim 2.95)$ and *jadeite*, a pyroxene ($NaAlSi_2O_6, H\ 6.5-7, S.G. 3.34$). The tenacity and toughness of nephrite, and to a lesser degree jadeite, lent themselves well to the carving of prehistoric stone tools, jewelry and a multitude of other durable artefacts thereafter.

Nephrite

Physical properties

Nephrite is a compact, massive form of *tremolite-ferro-actinolite*, $Ca_2(Mg,Fe)_5(Si_8O_{22}) \cdot (OH)_2$, in the amphibole group, crystallizing in the monoclinic crystal system. Nephrite (Mohs H 6-6.5; S.G. 2.90-3.05) has a tightly felted texture of fine, fibrous crystals, and is one of the toughest and most durable natural materials, capable of forming a sharp edge. Unlike a diamond, which when struck by a hard object, will shatter into many pieces, natural jade generates a melodious bell-like tone—a property exploited by the ancient Chinese in creating nephrite chimes and

temple gongs. Jade hunters often exploit this property by striking large promising-looking streambed boulders with hammers while looking for jade. Nephrite characteristically possesses a fibrous texture, a vitreous to greasy-waxy luster, opaque -translucent transparency, and is very tough, although slightly softer than jadeite. These physical properties made it ideal for fabricating tools and weapons in the past. Today, it is carved into decorative art objects and inexpensive jewelry. Nephrite ranges in color from pure white when Ca-rich, to tan, russet, light to dark olive, “spinach” green, and black with increasing amounts of iron (Fig.1a, b). Bright, emerald-green chromian nephrite is very rare. Surface oxidation of Fe^{II} to Fe^{III} produces a reddish-brown rind, which skilled Chinese carvers often exploit to emphasize the color contrast and highlight certain areas of their designs (Fig. 3). Commonly associated minerals include diopside, magnetite, chromite, graphite, grossularite, apatite, rutile, pyrite, and serpentine. Minerals closely resembling nephrite and with which it may be confused include serpentine, opaque vesuvianite, green chalcedony, aventurine (quartz with tiny green fuchsite mica inclusions), and opaque hydrogrossular.

Causes of color

White	Pure tremolite, the most valued in ancient China
Off-white	Mostly tremolite, “mutton-fat” variety, also highly desirable
Green (various shades)	Fe ²⁺ (the more Fe from actinolite, the darker the color),
Gray, black	Ferro-actinolite, graphite
Red/ochre/yellow, brown	Hematite, goethite, limonite—typically rinds on pebbles, boulders; often cleverly incorporated into carving designs by skilled Chinese carvers.

Geology

Nephrite occurs in two types of geologic settings: the first, by chemical reactions between dolomites and silicic fluids associated with dolomitic marble and amphibolite schist, the second, more abundant type found in serpentinites (greenish rocks consisting mainly of serpentine minerals), as a result of reactions between serpentinite and more silicic rocks (e.g., granite, shale, chert) in hydrous solutions. Interestingly, the classic Chinese nephrite localities occur mainly in dolomitic replacement type deposits. Serpentinites occur within ophiolite belts--slabs of oceanic crust thrust up on land by tectonic plate collisions. The major sources of today’s nephrite from British Columbia, Russia, and New Zealand are of this type. Temperatures at which nephrite forms range from between 200°C (390°F) to ~400°C (750°F), at pressures corresponding to depths of less than 50 km (30 mi), representing shallower depths of formation than jadeite. These conditions are achieved during subduction of oceanic crust beneath island arcs or continental crust, or overthrusting onto continental margins.

Major Nephrite Localities

Hetian, (Khotan, Hotan), Xinjiang Province, China—noted for fine white or mutton-fat jade

Lantian jade, Xi'an City, Shaanxi Province, China

Meiling deposit, S. Liyang, Jiangsu, China

Dushan jade, Henan Province, China

Luoyan, Henan Province, China

Manasi River Valley, Tien Shan Mts., Xinjiang Province, China—green nephrite

Xiuyan, Liaoning Province, China

Wenchuan, Sichuan, China

Laiyang, Shandong, China

Eastern Sayan Mts., Siberia, Russia

South Island, New Zealand

Fraser River valley, British Columbia, Canada

Mt. Odgen, B.C., Canada

Cassiar jade fields, northern B.C., Canada

Polar Mine, near Dease Lake, and Ogden Mountain mines. Source of fine emerald-green "Polar Jade"

Kobuk River, Alaska

Jadeite

Physical Properties

Jadeite, $\text{NaAlSi}_2\text{O}_6$, is a single chain silicate in the pyroxene group, crystallizing in the monoclinic system. It is somewhat harder and denser than nephrite (Mohs H 6.5-7; S.G. 3.30-3.40), with a more vitreous luster and granular (sugary) texture of interlocking crystal grains. Because of its brighter luster, greater translucency, and broader color palette (bright mint, apple to emerald green, lavender, white, black, and varying shades of tan, yellow, russet brown, and red), jadeite enjoys a greater appeal in jewelry than does nephrite (Fig. 2).

Closely-related minerals with which jadeite may often be confused include kosmochlor, $\text{NaCrSi}_2\text{O}_6$, chloromelanite, $\text{Na}(\text{Al}, \text{Fe}^{3+})\text{Si}_2\text{O}_6$, omphacite, $(\text{Ca}, \text{Na})(\text{Mg}, \text{Fe}, \text{Al})\text{Si}_2\text{O}_6$, and maw-sit-sit. The latter is a rare gemstone, bright to dark green, often sprinkled with black patches, consisting of a mixture of minerals including kosmochlor, clinocllore (a member of the chlorite group), chromian jadeite, and albite, with minor eckermannite (an amphibole), chromite and other minerals. Maw-sit-sit only occurs in the jade mining region of northern Myanmar (Burma). Other common jadeite look-alikes or impostors include serpentine, chrysoprase, amazonite, green jasper or chalcedony, dyed marble, and crackle-quenched quartz (heated and rapidly plunged in cold water, producing cracks subsequently filled with green dye).

Impurities impart a variety of colors to jadeite. Pure jadeite is white. "Imperial green", a bright emerald hue--the most valued color--derives from traces of Cr^{3+} , whereas leek green or apple green shades come from Fe^{2+} , blue-green from Fe^{2+} and Fe^{3+} (and/or Ti), lavender from Mn^{3+} . Grey to black is produced by graphite or near black amphibole, while ochre-yellow to reddish-orange-brown jadeite is caused by goethite/limonite staining along grain boundaries or on rinds of river boulders.

Causes of Color	
White	Pure jadeite
Green (leek; apple)	Fe^{2+}
Blue-green	Fe^{2+} - Fe^{3+}
"Imperial" emerald green	Cr^{3+} (tr. kosmochlor, $\text{NaCrSi}_2\text{O}_6$), the most valued color of jadeite
Pale-dark blue	Ti (and/or Fe^{2+} - Fe^{3+} ?)
Dark green to black	Chloromelanite, a variety of jadeite with a high proportion of Fe^{3+}
Mauve, lavender	Mn^{3+} , also a highly valued color
Grey, black	Graphite, black amphibole
Red/ochre/yellow, brown	Hematite, goethite, limonite--typically as rinds on pebbles, boulders

Geology

Jadeite is actually a rock, *jadeitite*, consisting of at least 90 percent *jadeite*, $\text{NaAlSi}_2\text{O}_6$, with admixtures of lesser amounts of other minerals, including related pyroxenes, such as omphacite, kosmochlore, and aegerine, $\text{NaFeSi}_2\text{O}_6$, as well as albite, analcime, chromite, titanite, actinolite-tremolite, graphite, and mica. The presence of two-phase fluid inclusions, small veins, cavity fillings, crystal zoning, and secondary overgrowths indicates that jadeitites crystallized directly from heated, watery solutions.

Jadeitites are less widespread than nephrite because they form under a narrower set of geological conditions. They commonly occur as pebbles and boulders in streambeds, or as veins, or blocks in serpentinite belts. They may be rimmed by albitite. Associated rock types include serpentinite, blueschist (glaucofane), albitite, eclogite (garnet-omphacite), garnet amphibolite, and schist. Although jadeitites form over a similar temperature range as that of nephrite, they crystallize deeper inside the Earth, at depths of 40–100 km (25–62 mi). The glaucofane schists and eclogites, with which jadeitites are often associated, are indicative of high-pressure/low-temperature conditions. Jadeite has been described as a premier "subduction gemstone", one of a select few that can provide specific clues about plate tectonic

Major Jadeite Localities

Hpakan-Tawmaw district, northern Myanmar (Burma)

Nansibon, northern Myanmar

Motagua Valley, Guatemala: Maya Block (north of MFZ); Carrizal Grande, La Ceiba, La Ensenada, south of MFZ)

Ural Mts., Russia

Itmurundy, Kazakhstan, Russia

Khakassia, Yenisey River, Russia

Itoigawa area, Niigata Prefecture, Japan

Wakasa, Osayama, Oya, Japan

Nishisonogi Peninsula, Japan

Clear Creek, New Idria, San Benito Co., California

(MFZ = Motagua Fault Zone)

activity and geologic setting. Jadeite, therefore, is not only a highly valued gemstone, but also a useful geological signpost that marks the traces of long-vanished oceans.

China—Stone of Heaven

Jade, employed in China for over 7,000 years, has become thoroughly interwoven into the fabric of that nation's culture. The Chinese word for jade, *yu*, is written as three horizontal lines connected by a vertical line, to which a dot has been added, a character nearly identical to that of king. Hence it symbolized high rank, power, great wealth, but also morality and immortality. The *Shuowenjiezi*, an ancient text, listed the "five virtues of jade" as kindness, rectitude, wisdom, courage, and purity. Names of mountains, streams, and springs often include the word "jade." As an adjective, it often describes anything beneficial, desirable, and of high quality, for example "jade tea", "jade orchid", or a good wine as a "jade friend."

Neolithic jades included ceremonial or ritual objects, such as flat axes and blades, and personal ornaments. In general, these were highly stylized versions of ordinary tools and weapons, but not intended for everyday use. Among the oldest are a square tube with a round borehole (cong, tsung), symbolizing earth and the bi (pi)—a round disk with a hole, symbolizing heaven, a form still popular as an amulet today. Other ancient jades included arc-shaped pendants, split rings, sometimes fashioned into stylized dragons or birds. By the Shang period (1600-1046 BCE), many more animal forms, including birds, dragons, fish, domestic animals, and humans appeared, but pieces generally remained flat. Plaques, arcs, and beads were often incorporated into elaborate pendants. The widespread belief that jade possessed protective or preservative properties led to the placement of jade cicadas (a symbol of rebirth) in mouths of the dead. This belief culminated in the spectacular jade burial suits of the Western Han dynasty (206 BCE-24 CE), covering the body entirely in a suit made of small jade tiles held together by gold thread.

The hardness and toughness of jade required special carving techniques. To quarry nephrite, fires were lit next to the rock face, cold water thrown over the heated rock in order to induce cracks, and wooden wedges inserted in the cracks to pry chunks of rock loose. Raw stones were chipped and polished, later drilled using hand-driven rotary tools, and sliced. Abrasives to polish jade evolved from early use of quartz to later use of almandine garnet, corundum, and more recently, carborundum (SiC, H 9) and diamond (H 10). Amazingly, an extremely high skill level was attained, using fairly simple tools, even over 2,000 years ago. For example, a very intricate, moveable multiple-link dragon and phoenix pendant, from the early Zhanguo Period (475–221 BCE) was carved from a single piece of predominantly white nephrite with brownish markings. Techniques for working jade gradually evolved, growing more sophisticated and refined over time. Today, craftspeople employ motor-driven tools for drilling, shaping, and polishing the pieces they are creating. Some newer jade-working techniques include fashioning eggshell-thin bowls or vases, applying elaborate metal inlay designs onto smooth jade, and using a Computer Numerical Control engraving and milling machine for 2-D carving, but more complex 3-dimensional designs still require manual inputs. Designs vary from traditional to contemporary.

As time progressed, the role of ritual jade diminished, but jade still retained its significance as a symbol of authority and power. It also found increasing use in decorative or ornamental art. In later centuries, jade carvings grew into more elaborate and sophisticated, three-dimensional objects, some qualifying as small sculptures. It also gained favor as a material for scholars' writing implements. Nature served as a major source of inspiration, including all types of animals ranging from the real to purely mythological (populated by dragons, phoenixes, or qilin—single-horned gentle, protective beasts with deer-like bodies), flowers and vines, and even miniature landscapes of hermits standing in grottoes, or perched precariously on mountainside niches. Human forms and Buddhist themes were not ignored either. White or mutton-fat jade was especially prized during the Ming dynasty (1368-1644), (a period also noted for its fine blue and white porcelains), while dark green “spinach jade” nephrite and Burmese jadeite became more popular by the 19th century (during the later Qing dynasty, 1644-1911). Skilled carvers often exploited the brown or red rind of the jade pebbles or boulders (caused by natural weathering) to enhance the contrast in design elements (Fig. 3).

The Chinese also venerated antiquity. Archaic forms continued to be created many centuries later, for example, jade copies of ancient bronze ritual food vessels. Jade was also treated to make it look ancient. One method was to darken the stone by immersion in organic dyes at high temperatures. Another practice was to heat jade in boiling water to which iron oxides were added and quickly dipped in ice-cold water, in order to produce cracks into which the iron staining would penetrate. (A similar process using a green dye is still done on quartz to simulate jade, e.g., “crackle-quenched” quartz). Another way to mimic ancient tomb jade was to literally cook it. Jade buried for centuries often acquires a “patina” due to chemical alteration with ammonia from decaying bodies and soils, resulting in opaque, clouded areas. “Chicken-bone” or “burnt” jade recreates the look of tomb jade. This chalky, ivory-white opaque jade, often

riddled with tiny surface cracks, is created by heating nephrite to over 1,000°C, at which temperatures it alters to diopside, a pyroxene.

The contemporary revival

Historic Chinese jades were nearly always nephrite; Burmese jadeite was only widely introduced into China after the late 18th century. Although nephrite objects continued to be carved until the present, jadeite soon became the preferred gemstone, especially for jewelry due to its more vivid colors and higher translucency. Renewed interest in nephrite grew after the 2008 Beijing Olympic Games, when it was incorporated into the Olympic medals. The gold medal was embellished with white jade—the most highly valued color; the silver medal featured a celadon green stone, and the bronze medal a dark green “spinach” jade. The rising prices of high-quality jadeite and a reawakened pride in historic Chinese jade culture stimulated a growing demand for nephrite, especially the classic white Hetian jade and deep green varieties. Because of the inability of historic Chinese sources to supply the soaring demand, most of the dark green nephrite now comes from British Columbia and Siberia and is shipped to China. Until recently sold as cheap jewelry or tourist trinkets, the finer material is fashioned into jewelry for China’s expanding middle class, as a more affordable alternative to expensive jadeite. In addition to popular items, such as bead necklaces, pendants, and bracelets, nephrite is also shaped into small decorative carvings that echo traditional Chinese values.

Because of its long history and the smooth, soothing feel of polished jade, pendants and small carvings often feature lucky, auspicious symbols. Some popular motifs in addition to the bi signifying heaven, or dragon (imperial power, strength, natural forces—sky, earth, water) include bamboo (durability, resilience, and longevity), bat (good fortune, happiness), coin (prosperity), fo or fu dog (protection), fungus (or mushroom; longevity, immortality), gourd (fertility, protection), monkey (trickster, also protector), peach (longevity, springtime), phoenix (virtue, power, often paired with dragon—signifying wishes for a happy marriage¹), and tiger (courage, power). Younger designers may re-interpret ancient-inspired designs in novel ways, or employ modern Western techniques and gemstones. Underlying these innovations is a foundation in enduring Chinese philosophy.

Jade not only remains an important element of Chinese culture, its value as a desirable luxury item and status symbol has grown among the emerging affluent classes. Some recent astronomical auction prices rival those of the rarest, most expensive diamonds. Among the most expensive Chinese jades are the Barbara Hutton-Mdivani necklace, purchased by the Cartier Collection in 2014 for a staggering US\$27.44 million, at a Sotheby’s auction, the “Xintian Zhuren” Imperial white nephrite seal, sold at Sotheby’s in 2010 for \$15,680,467, and the “Double Fortunate” Imperial jadeite necklace of 27 perfectly matched beads sold for \$9,390,922 in 1997 at Christie’s.

An old Chinese saying that “Gold has a value; jade is invaluable” holds true, not only in China, but in Mesoamerica and New Zealand, as well. In Part 2, we will examine the utilitarian,

¹ A pair of fish also signifies “connubial bliss”).

cultural and spiritual significance that the two forms of jade had for the peoples of Mexico, Central America, and New Zealand.

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Figure 1a. Mutton-fat nephrite jade, Hotan Cultural Museum, China. (Photo credit: John Hill, June 17, 2011. Wikipedia; permission to publish under Creative Commons, [GNU Free Documentation License](https://creativecommons.org/licenses/by/4.0/), Version 1.2 or any later version).



Figure 1b. Spinach-green nephrite jade (British Columbia). (Photo credit: Manfred Winslow, August 5, 2009. Wikimedia Commons. In public domain).



Figure 2. Jadeite, polished rough, Myanmar (Mindat; <https://www.mindat.org/photo-455207.html> accessed Sept. 26, 2020).



Figure 3. White and red nephrite jade, floral design, Jin Dynasty (1115-1234 A.D.), Shanghai Museum (Wikipedia; permission to publish under Creative Commons, [GNU Free Documentation License](#), Version 1.2 or any later version).