JADEITE

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1. Introduction

Jadeite is one of the minerals that fall under the generic category of jade. The word jade is used in both English and French and came, according to the *Oxford Universal English Dictionary* (Little, Fowler, and Coulson 1955: 1057) from the Spanish word *ijada.* The Spanish referred to it as *piedra de ijada,* or colic stone. The reason for this is that when the Spanish conquered Mexico they discovered that people in Mexico powdered jadeite and mixed it with water as a cure for numerous internal disorders. The first recorded use of this term is by Nicol Monardes in a work on medicinal plants of the New World written in 1565 (Easby 1968: 7).

The two stones that are primarily categorized as jade are nephrite and jadeite. initially they were considered to be the same mineral, but in 1863 they were found to differ (Damour 1863, and see Damour 1846, 1881). Damour discovered that one variety of jade was a silicate of sodium and aluminum, whereas the other was a silicate of lime and magnesia. As a result of his findings, he (1863: 865) proposed the name *"jadéite"* for the first mineral to distinguish it from the second (i.e., nephrite). The present paper focuses on jadeite.

2. History of Jadeite

Jadeite is closely associated with two ancient civilizations, those of Mesoamerica[1] and China. Jadeite was used by most of the major civilizations in ancient Mesoamerica: the Olmec, Aztec, Maya, and so forth. It was highly prized throughout the region: "Gold did not have the same intrinsic value for Mesoamerican peoples... that is has for us...Jade was of greater value" (Noguera 1971: 268). Among the early Spanish writers of the sixteenth century, Sahagun (1963: 222) comments that "emerald green Jade... its appearance is like a green quetzal feather. And its body is as transparent and as dense as obsidian. It is precious, esteemed, valuable..." In his account of Aztec civilization, Vaillant (1965: 139-140) remarks:

> The most precious substance among the Aztecs was jade, or stones resembling it in texture and colour... The Aztecs did not have our modern esteem for gold, so the Spaniards had great difficulty in getting it at first. The Mexican Indians responded to the invaders' demands for objects of value by offering jade and turquoise, those substances most precious to themselves... Such misguided compliance was highly irritating to Cortés and his men.

[1] I use the term Mesoamerica in the present paper to refer to central and southern Mexico, Guatemala, Belize, and western Guatemala.

In fact, a number of writers have commented on the contrast in value placed on jade by the people of Mesoamerica and the views towards the stone by the Spanish conquerors. This difference can readily be seen in an account of gifts given by the Aztec ruler Montezuma and the Spanish leader Cortés:

> Cortés and Montezuma were accustomed to play each day a native game which in many ways resembles chess... It was their further custom at the close of each day's game to present each other with some gift. At the close of one day's game the Aztec monarch presented Cortés with several large discs of gold and silver handsomely worked. Cortés was greatly pleased and so expressed himself. Montezuma smiled and said: The gift tomorrow shall be such that today's gift will seem in value and preciousness, when compared with it, as no more than a single stone tile on the roadway... The royal treasurer of Montezuma brought in on a golden slaver the royal gift, four small carved jade beads. The bitter disappointment of Cortés was so great that he could scarcely conceal it" (Willard 1926: 146-147).

This is a theme that, to some extent, continues to this day in respect to the difference in views towards jadeite by Chinese and Westerners. There is an interesting sequel to the above story recounted by Vaillant (1965: 139-140) from the writings of Diaz del Castillo (from chapter 128 of his chronicles):

> During the night when Cortés retreated from Mexico, the leader, after taking his share of treasure, turned the surplus over to his troops. Many, burdened down with gold, drowned ignominiously in the canals. Diaz, however, noted Indian usage and confined himself to four jades which he was able to exchange later and which, in his words, "served me well in healing my wounds and gathering me food.

Jadeite in Mesoamerica. The story of jadeite in Mesoamerica begins with the earliest civilization, that of the Olmec. Formative Olmec civilization was centered in the present western Mexican state of Guerrero, from where it spear eastward towards the Gulf of Mexico around the state of Veracruz. The earliest Olmec pieces of worked jadeite found so far (and the oldest found anywhere in the New World for that matter) are votive celts and axes dating from around 1200-1000 BC (Stone 1993: 142). Ward (1996: 29) comments that "the Olmec carved unsurpassed human figures. Theirs are the strongest representations of human faces ever carved in jade." However, as Rands (1965: 579) notes, carved jadeite from "Preclassic horizons which can be related stylistically to this tradition are not numerous, although a number of carvings with Olmecoid features suggest the early importance of jade and jadelike stones."

Jaideite constitutes only a small portion of the green stones worked by the Olmec. The center of green stone working among the Olmec was apparently in the vicinity of the Balsas River in Guerrero State. Archaeologists have discovered a workshop near the confluence of the Amacuzac and Balsas rivers with "fragments of jadeite, silex, jasper, onyx, and quartz, as well as obsidian and

marine shells, dating to about 1000 B.C." (Griffin 1993: 206). Luckert (1976: 94-95) argues that green stones such as serpentine and jadeite were closely related to the Olmec's religious beliefs. He links the rise in the use of such green stones over darker stones like basalt to the evolution of what he refers to as the Olmec serpent cult: "The Serpent of the reform movement was green; and the Snake people of La Venta undertook no less a task than to transform their local portion of the Earth Serpent into a green one." Moreover, he believes that "if ordinary green layers of serpentine rock represented the Green Serpent's body, jades and better grades of serpentine signified the cores of the serpentine essence— the Green Serpent's bones and teeth."

The presence of worked jadeite in numerous Olmec archaeological sites has raised questions about the source(s) of the raw material. It is generally recognized that the worked jadeite found in the Gulf coast of Mexico came from somewhere else. In his discussion of Olmec trade, Coe (1968: 94, 103) refers to what he terms the "jade route" from Guerrero to the Gulf. Writing several decades ago, Adams (1977: 87) stated that Olmec jade was "probably obtained from the Balsas Valley in Guerrero (near the sacred caves of Oxtotitlan and Juxtlahuaca), from the Motagua River Valley in Guatemala..., and from other as yet unknown sources." Reviewing what was known as of the early 1990s, Garber, *et al* (1993: 213) state:

> Although serpentine sources are known for Guerrero [see Gay 1987: 33], jadeite sources apparently remain unknown. The late artisan William Spratling was rumored to have been exploiting a Guerrero jadeite source for his workshop in Taxco. If such a source exists, its location has remained a well-kept secret since his death decades ago. Thus, although Guerrero greenstone may have traveled through Middle Formative period exchange networks to Gulf Coast Olmec centers, the stone may have been serpentine rather than the jadeite Coe hypothesized.

Garber, *et al,* also review other reported sources (pages 213-214), but the only confirmed source of jadeite that is similar to that worked by the Olmec is from the Motagua River Valley, further to the south in Guatemala and within Maya territory (this site will be discussed in greater length later).

For the Maya the color green was associated with two important life-giving substances, water and maize, and the green stone was therefore viewed as having life-giving properties (Digby 1964: 10-11). Non-jadeite greenstone beads dating from around 1500 BC have been discovered within the Maya area on the Pacific coast of Chiapas (Garber, *et al* 1993: 211) and it is certainly possible that Maya were carving jadeite prior to the Olmec, but this has yet to be proven. The Maya occupied the southern states of Mexico, Guatemala, Belize, and a portion of Honduras. Blom (1934: 542) remarks that among the Maya:

> Feathers were used for personal adornment, as was also jade and gold. The brilliant tail-feathers of the 'trogan resplendens,' the vivid green of jade, were rare and therefore commanded a high price. The maize-plant was green, the forest was green. All good as well as rare things were green, and therefore the Maya considered green a sacred color, attached special value to green things; just as the Spaniards, and we do to this day, express wealth,

> abundance and luxury in gold, and more frequently in gilt... Even small slivers of jade were polished and perforated for suspension, and large pieces were carved in the shape of human faces, animals, or... shaped like a hand.

Most of Mayan jadeite objects date from the Classic period (300-1000 AD). In the Maya lowlands of Yucatan during the late Classic Period many jadeite items have been found (see Proskouriakoff 1974), but much (if not all) of this appears to have been imported, probably from the Motagua River Valley. During the postclassic period, Rands (1965: 579) states that "Maya jadeworking seems to have suffered a severe decline." Nevertheless, jade remained highly valued. Bishop Diego de Landa (1941), writing around the time of the Spanish conquest reported that jade beads were used by the Maya of Yucatan as money.

Archaeologists have been interested in discovering the source of Maya jadeite for a long time. Blom (1934: 542) wrote in the 1930s that "... the knowledge of the ancient jade-mines has been lost. There is an indication that these mines were already lost or exhausted in [ancient] Maya times." The latter belief was based on the fact that when Blom was writing archaeologists had found that relatively large pieces of carved jade were found in the older burial sites, whereas in more recent sites they tended to find "re-worked pieces—i.e., larger objects that have been cut into smaller pieces and re-carved." As will be discussed at length later, it is now believed that most, if not all of the jadeite worked by the ancient Maya came from the Motagua River Valley.

Peoples living further to the north of the Olmec and Maya, such as the Aztec and Mixtec, also valued jadeite and other green stones. Among these peoples, the colossal toad (*chalchihuitl*) was the symbol for precious stone or jade (Nicholson 1971: fig. 41, pg. 116). I have already mentioned how highly the Aztec valued jadeite. In discussing central Mexico around 600 BC, Adams (1977: 126) states the "jade was used in ear ornaments and other personal jewelry, although this was uncommon. Quite probably, the stone already had assumed its mystical and high status properties and was restricted to persons of high social rank." Further south, in Oaxaca, Adams (1977: 213) mentions archaeologists finding "some carved jades" in the tombs of Monte Alban that "are relatively simple in technique and motif. The best were imports from the Maya highlands."

Jadeite objects also have been found south of the Maya area. A relatively large number of objects have been found in Costa Rica in particular. As noted by Easby (1968: 9), "no region [in ancient Mesoamerica] produced a greater abundance of jade objects than Costa Rica, whose lapidaries were among the most skillful in pre-Columbian America." Unfortunately, relatively little is known about the people who made these figures. Jadeite objects discovered in Costa Rica date primarily from between 500 BC and 700 AD (Stone 1993: 143). The source of the jadeite found in Costa Rica appears primarily to be the Motagua River Valley in Guatemala, although some may have come from local sources as well. Stone (1993: 141) notes that, while jade objects have been found in El Salvador, southern Honduras, and Nicaragua, they are very rare. Garber, *et al* (1993:

215-219) provide a brief overview of jadeite objects from Honduras (also see Hirth and Hirth 1993). They note (page 215) that jadeite carving in central and eastern Honduras "is part of a broader Honduran stone-working tradition that developed independently of the jadeite carving found among the Maya further to the west." Jadeite appears in Honduras during the Formative Period (700 BC to 400 AD) and "the use of jadeite in public and ritual offerings reached its peak during the first part of the Classic period" (i.e., shortly after 400 AD). Its use in Honduras appears to decline later during the Classic period (which lasted until about 1000 AD) and, while some jadeite objects have been found dating from the postclassic period, they are relatively rare.

Jadeite production in Mesoamerica came to a virtual halt with the coming of the Spanish in the early sixteenth century. The Mesoamerican jadeite industry was revived in 1974 with the founding of Jades, S.A., in Antigua, Guatemala, which was established following the discovery of jadeite deposits in the Motagua River Valley (see www.jades.centroamerica).

Jadeite in China and Burma. Objects made of minerals classified generally as jade have been used in China for a very long time.[2] Durant (1954: 737) notes that "Jade is as old as Chinese history, for it is found in the most ancient graves." Jade was a symbol for the official state worship of the Heaven, Earth, and the Four Quarters. However, only a very small percentage of this jade was jadeite. In the past, the Chinese used the term *yü* for jade in general and only occasionally bothered to distinguish between *chên yu*, which was used for nephrite, and *fei-ts'ui*, which was used for jadeite. While much is made in writing about the Chinese reverence for jade, until recently this reverence was primarily for objects made of nephrite and generally not jadeite.

Initially the primary source for ancient jade by the Chinese was the K'un Lun Mountains of southeastern Turkestan and the adjacent Karakash or Black Jade River and Yurungash or White Jade River in the vicinity of the oasis of Khotan (Dohrenwend 1971: 10). Marco Polo is said to have passed through this area in 1472 and to have seen what he thought was jasper and chalcedony, but what was later considered to be jade, being collected for export to China (Palmer 1967: 11; Wills 1972: 19). Most, if not all, of what was mined at this site was nephrite. Some authors assert that there was at least some jadeite obtained by the Chinese from these sources. Thus, Norman Lewis (1952: 210) recounts: "In the original quarries in Turkestan a certain small amount of green jadeite was also found. By virtue of its rarity this green stone became practically priceless." Others, however, are skeptical. Dohrenwend (1971: 11), for instance, states categorically that "there is no evidence for jadeite in China in such early times, nor was the colder, harder stone ever loved there in the way that nephrite was." Likewise, Whitlock and Ehrmann (1949: 21) state that "for twenty

[2] I was not able to obtain a copy of the recently published book by Levy and Scott-Clark (2001), which provides new material on the history of jadeite in Burma and China, prior to completing the present paper. Their book is revied by Edmond Chin (2001), who notes that while the authors include some new material, there are also numerous errors in the book, especially in their treatment of Chinese history.

centuries... nephrite was the only jade known to Chinese lapidaries" and Wills (1972: 21) says that "at present there is no evidence that it [jadeite] was known or used in China prior to the mid-eighteenth century."

Hansford (1968: 28) agrees that jadeite does not appear to have been imported to China until the eighteenth century, when it began to be brought to China from Burma via Yunnan. Significantly, he notes that "a contemporary Chinese writer regarded it as having merely 'usurped the name of *yü'*, but the brilliant emerald-green colour of some of the finer specimens soon earned it a place in public esteem as high as that of nephrite." Hansford adds (1968: 28-29) that "an old name, *jei-ts'ui*, 'plummage of the kingfisher', which had been applied at least as early as the eleventh century to certain fine green nephrites but had passed out of currency, was revived to distinguish the new material. This is the name by which it is still known throughout China. The belief that Burmese jadeite was carved in China in much earlier times appears to rest on a confusion of the two uses of the term *jei-ts'ui"* (this point is discussed by Hansford earlier in a 1948 article). He supports this argument for the absence of jadeite prior to the eighteenth century by drawing attention to use of nephrite rather than jadeite in the crown of the empress Wan-li, who was buried in 1620. Only later was jadeite used in such royal regalia, when it largely supplanted nephrite.

A variety of sources provide illustrations of examples of Chinese jadeite. Boda (1991: 171-172) discusses and illustrates a jadeite box from the Qing court in the shape of a fish. He describes the piece in one place as "white mingled with blue in colour" and elsewhere as having a "green-white tone", but from the photograph the piece appears to be a light lavender. Bernstein (www.bernsteinjadeart.com) illustrates and describes a pair of crouching boys carved of jadeite and used as pillows (Ref. #2737). The pieces are said to date from 1780-1820. He mentions a similar pair os jadeite pillows featured in a Sotheby's auction (2 December 1976, lot 726) in Hong Kong and again in a Christie's auction (2 October 1991) in Hong Kong. According to Bartholomew (1999: 42), "the Asian Art Museum of San Francisco holds one of the world's most comprehensive and best collections of Chinese jades."[3] The collection is comprised largely of pieces collected by Avery Brundage (1887-1975). While most of the pieces in the colection are made of nephrite, a few are made of jadeite. The relative lack of jadeite pieces in the collection would appear to reflect the fact that "Mr Brundage was not interested in personal adornment in jades" (1999: 47), which is the most common use of jadeite. Bartholomew illustrates a few of the jadeite pieces in her article. These

[3] Another large collection of Chinese jade is the Herber R. Bishop collection in New York's Metropolitan Museum of Art. The collection also contains pieces of rough jadeite (as well as nephrite), about which one author (Hartman 1974: 43) commented a number of years ago that "catalogued almost seventy years ago, these jades are very much in need of updating according to current scholarship." Bishop was assisted in determining the properties of the jadeite in his collection by the mineralogist George F. Kunz. The Bishop collection and his monumental 1906 work on jade, *Investigations and Studies in Jade*, are discussed by Hartman (1974) and Bernstein (2001). Both of these articles illustrate only pieces made of nephrite from the collection.

include a cabbage vase dating from around 1900 (appearing on the cover of the magazine) and a box with melon, vegetable, and insects also dating from around 1900 (figure 14, page 48). The later is made of jadeite featuring three colors and is said to be a fine example of "the *qiaose* or 'clever use of colours' tradition" (1999: 47).

It is common in the literature to date the earliest discovery of jadeite in Burma (in the Mogaung area in the Myitkyina district) to the thirteenth century. Traditions say that these deposits were discovered by accident by a trader from Yunnan. According to the story, the trader used a piece of stone to balance a load on his mule. The stone turned out to be jadeite. This is probably nothing more than an apocryphal story, however. Hansford (1950: 45-46) casts doubt on the authenticity of story and Wills (1972: 22) refers to it as a legend with no supporting evidence. The source of this fanciful story was a Mr. Warry of the Chinese Consular Service, who accompanied a British military expedition to the mining area in 1888, two years after the British annexation of Upper Burma. Warry presented the story after his visit in a report on the jadeite mining industry, which was published subsequently by Hertz in 1912 in the *Burma Gazetteer: Myitkyina District* and again by Scott in his influential *Burma: A Handbook of Practical Information* (1921: 243). Despite the likely falsehood of the tale, it has continued to be repeated in the literature on jadeite in Burma (see Fraser-Lu 1994: 173, 185; Hughes, Galibert, *et al* 2000: 4-5).

Mr. Warry was on somewhat firmer ground when he reported that the modern trade in jadeite between Burma and China began in 1784, during the reign of the emperor Ch'ien-lung (1736 to 1796), following the ending of hostilities between the two countries. Hansford (1968: 45-46) states that after a series of unsuccessful attempts by the Chinese to subdue Burma, they were driven out in 1769. With the ending of hostilities, trade between the two countries was re-established. Warry dates the beginning of trade in jadeite to 1784, when a large number of Chinese came to Burma in search of jade. Many of those who came to search for jade died, either from malaria or as a result of hostile encounters with local groups such as the Jingpho. In addition, the route back to China from Mogaung was dangerous because of the difficult terrain and presence of bandits. In his account of jadeite mining in Burma (quoted in Hertz 1912), Warry makes the following comment regarding the loss of life among the Chinese: "In the Chinese temple at Amarapura is a long list containing the names of upwards of 6,000 Chinese traders deceased in Burma since the beginning of the present century to whom funeral rites are yearly paid. The large majority of these men are known to have lost their lives in the search for jade... Could the number of smaller traders and adventurers who perished in the same enterprise be ascertained, the list would be swelled to many times its present size." Warry discusses the early mine sites exploited in northern Burma, mentioning in particular the "Hsimu quarries" in the Uru river valley which "were first discovered in 1790" and "yielded a very brilliant jade."

Hughes, Galibert, *et al* (2000: 5) associate the acceptance of Burmese jadeite with the emperor Qianlong (also spelled Ch'ien-lung). During his reign, however, the trade in jadeite was small and it seems that the stones when brought to China at this time received only a lukewarm reception. It would seem that it took almost a century for Burmese jadeite to achieve the status of a valuable and desired stone. Field (2000: 3) notes that "it was probably due to the old empress dowager Tz'u Hsi [also spelled Wu Cixi, who in effect ruled China from 1861-1908], who loved its bright, vivid colors, that it finally reached pre-eminence as the Imperial Stone, or most precious thing, in China." In fact, prior to Wu Cixi's reign relatively few objects were fashioned from Burmese jadeite. Ward (1996: 24) writes that

> as Burma's jadeite supplies increased in the 1800s, carvings appeared. Soon jadeite animals, objects, and gems outshone nephrite. For the past two hundred years (and disregarding the 5,000 years that preceded them) jadeite has been the preeminent stone and gem within China. It seems that no one objected to the culture's central substance being supplanted by a totally different material. Perhaps calling both *yü* eased the transition.

Thus, while jade in general may have a long history in China, the history of jadeite in China should be seen as much more recent— as essentially modern.

As for the Burmese themselves, Faser-Lu (1994: 174) comments that "apart from levying duties, the Kon-baung kings [the ruling dynasty in Burma at the time] took little interest in the development of jade mining." Warry's 1888 account (quoted in Hertz 1912) of the jadeite industry discusses the system of taxation:

> In 1806 a Burmese Collectorate was established at the site of what is now the town of Mogaung... Mogaung now became the headquarters of the jade trade in Burma... The Burmese Collector imposed no tax upon the stone until it was ready to leave Mogaung, when he levied an ad valorem duty of 33 per cent... The value of jade was determined for purposes of taxation by an official appraiser. This officer, however, by private arrangement with the traders and the Collector, estimated all stone about one-third of its real value.

In fact, the Burmese kings did try to become more involved. Clearly attracted by the prospect of gaining greater revenue from the trade, the Burmese king sought to establish a monopoly over commerce in jadeite in 1866. The Jingpho responded by cutting the supply to a trickle of poor quality material and the following year the Burmese king was forced to resume the original practice of simply levying a tax. In general, throughout this period the actual mining of jadeite was in the hands of the local Jingpho. Warry comments that :

> The Kachins [Jingpho] have always claimed the exclusive right of digging at the mines. They have, however, from time to time allowed Shans to assist them, and in the early days Chinese were permitted to work certain quarries temporarily abandoned by the Kachins. The Chinese, however, found the labour severe and the results unsatisfactory, and they have now for many years contented themselves with buying stone brought to the surface by Kachins.

As Warry notes, however, the Chinese traders did not act alone when purchasing jadeite from the Jingpho: "An expert, or middleman, is nearly always employed to settle the price. These middlemen, who are without exception Burmese or Burmese-Shans, have from early times been indispensable to the transaction of business at the mines."

The modern history of jadeite mining in Burma begins in the nineteenth century, around the same time that the mineral was becoming popular in China, and was associated primarily with a site known as Tawmaw. Jadeite may have been mined earlier, however. Jade beads have been found that are associated with the Pyu civilization of Burma (roughly 200 BC to 500 AD) as far north as the Pyu city-state of Hanlin that is located near the present town of Shwebo. These are generally assumed to be nephrite or some related stone, but further research is needed. The mining was largely carried out by local Jingpho (as well as by some Shan) and the trade by Chinese. Warry, states in his 1888 account (quoted in Hertz 1912) that:

> Comparatively few Chinese actually went up to the mines; the Kachins themselves brought down most of the stone to a sand bank opposite Mogaung, where a large bazaar was held during the season... As for the mines themselves, "The Kachins [were] regarded as the absolute owners of all the stone produced in their country. This ownership was never directly called in question by the King of Burma.

Chhibber (1934: 43) provides a story that he collected from local informants about the modern origins of mining in this area: "about sixty years ago a hunter named Ninjar of Sanhka reached the site of Tawmaw while hunting, and started cooking rice on a range of stones. One of the stones cracked, and proved to be valuable jadeite." He records another story collected by a British administrator in 1907 that associates the discovery with a Jingpho hunter who was tracking a wounded elephant. After killing the elephant, he tried to knock some flesh from its tusks on a rock. One of the tusks cracked the rock, which turned out to contain jadeite.

Whatever actually happened, by the early nineteenth century the local Jingpho and others were mining for jadeite in the vicinity of Tawmaw. Hansford (1968: 46) writes that "the stone was at first extracted in the form of pebbles and boulders... from the detritus in the valleys of the Uru River and its tributaries. Warry, in his 1888 account (quoted in Hertz 1912), discusses what came to be generally referred to as the 'old mines' located adjacent to the Uru River:

> Small quantities of jade have at one time or another been discovered over nearly the whole of this tract, but the stone occurs in greatest abundance at places near to the right bank of the Uru and considerable quantities have been found in the bed of that stream. The names of the quarries most celebrated in times past for the excellence of their output are Hsimu [now Sate Mu], Masa, Mopang and Tamukan [located near Haungpa]. All these places appear to be within the boundaries given above and to lie at no great distance from one another. They have all ceased to yield jade except in minute quantities, and they are now termed the ‘old mines,’ Sanka being the latest name added to this list.
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> Sanka... was reached after a march of some seventy miles from Mogaung in a direction almost exactly north-west... Sanka is situated on the right bank of the Uru just opposite its

> junction with the Nansant stream. Some twenty years ago Sanka was celebrated for its output of fine jade, but the supply has long been exhausted, and the place is now almost deserted. I spent the greater part of a day in visiting the excavations of former years. Thousands of pits had been dug along the sides of the low hills and in the small intervening valleys. The diameter of the pits rarely exceeded ten or twelve feet at the mouth, and the average depth was about twelve feet... Sanka is the last of the 'old mines'.

The earliest account of the Burmese jadeite mines in Western sources that is mentioned by Bleeck (1908: 254) was written in 1836 by Captain Hannay, who obtained specimens of jadeite from Mogaung during his visit to the Assam frontier (Hannay 1837, and see Hannay 1857). Hannay, however, did not visit the actual mines. Dr. William Griffith (1847: 132) was the first Westerner to visit the nearby mining area. Even at that early date, he noticed that "the surface of the valley apparently at one time consisted of low rounded hillocks; it is now much broken, and choked up with the earth and stones that have been thrown up by excavating." He reported that the larger jadeite boulders were broken apart by fire. After leaving the mining area a member of his party counted a large number of people transporting jadeite rocks, the majority of them being Chinese Shan.

More substantial jadeite mining did not commence until 1881 (Hansford 1968: 46). These mines came to be referred to as the 'new mines'. Warry (1888, quoted in Hertz 1912) has this to say about them:

> The 'new mines' have produced immense quantities of stone, but none which approaches in quality that yielded by the quarries of former years. It will be convenient here to indicate briefly by points of difference between the old stone and the new. The value of jade is determined mainly by the colour, which should be a particular shade of dark green. The colour however, is by no means everything; semi-transparency, brilliancy, and hardness are also essential. Stone which satisfies these four conditions is very rare. The last three qualities were possessed to perfection by a large proportion of the old stone, but the dark-green colour was rare and often absent altogether. The new stone, on the other hand, possess abundant colour, but is defective in the other three respects, being as a rule opaque, dull and brittle in composition. These natural defects are aggravated by the injurious methods employed in quarrying the new stone. A peculiarity which gave high value to all stone found at the old mines was that [it] occurred in the form of moderate size round lumps, having often the appearance of water-worn boulders, and small enough to be detached and carried away without undergoing any rough process of cleavages on the spot. At the new mines the stone occurs in immense blocks which cannot be quarried out by any tools possessed by the Kachins [Jingpho], but have to be broken up by the application of heat, a process which, without doubt, tends to make the stone more brittle and chalk-like.
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> These defects were not fully realized the first year that the new mines were opened. The output of stone was large and the competition keen. Hitherto only men of some capital had been able to engage regularly in the trade. It had been impossible to do more than guess at the value of any old stone, for each piece was complete in itself and was usually protected by a thick outer capsule which effectually concealed the colour within. All pieces therefore fetched a high price, as any piece might on cutting prove to be of immense value. But with the opening of the new mines, stone could not be bought in fragments of any shape and size, and it was possible by the processes of washing and holding in a strong light to determine with comparative exactitude the amount and nature of the colour. The trade was

> thus brought within the means of a large number of men who had not before been in a position to take part in it. There was accordingly a rush for the new mines in 1881, and the speculation in jade reached a height not attained before. Large fortunes were made by those who had the good luck to dispose of their stone before its defects were discovered. In the second year there was a heavy fall in prices, which involved the ruin of more than one of the largest jade merchants.

The first geologist to see the jadeite mines was F. Noetling, who visited the Tawmaw area in 1892 (Noetling 1893; also see Bauer 1895). Noetling's work for a time provided the primary published source of information on the mining area. Noetling noted, however, that his survey was incomplete due to the unsettled state of the country at the time and the difficult terrain. A subsequent visit was made by A.W.G. Bleeck in 1907 (Bleeck 1908) and he provided a more detailed account of the mining industry in the region. According to Bleeck (1908: 255), jadeite was found in three localities at the time of his visit: "at Tawmaw, at Hwéka, and at Mamoa," with Tawmaw being by far the most important site. He notes (page 256) that "these mines are only worked about three months in the year form the beginning of March till the end of May; during the rains malaria stops all work" (although because the quarries north of Hweka were located at a higher elevation it was possible to commence mining a little earlier there). Hertz (1912) provides a description of the jadeite mines a short time later and lists seven mine sites in operation: Tawmaw, Ngobin, Mamon, Sabyi, Papyen, Sabwi, and Pakhan. Tawmaw is still described as "the most important of the mines," with "over fifty claims being worked" by local Jingpho. The other sites are much smaller in scale. He notes that the mining operation at Mamon is in the hands of Shan, unlike most other mines.

The initial reports by Noetling and Bleeck were superseded in the 1930s by the account of Chhibber (1934), which remains the most comprehensive published work on the area to date. Chhibber (1934: 47) reports that during the first two decades of the twentieth century the output of the Tawmaw mines went into decline: "chiefly on account of the increasing depth of the mines" and the inability of the Jinhpho to cope with this using their traditional methods. Elsewhere, Chhibber describes numerous other sites being mined, including some by more modern techniques (such as Kadon Dwin site mined by the Burchin Syndicate).

Jadeite mining in Burma was disrupted by the outbreak of the Second World War and the Japanese occupation of Burma. Travel writer Norman Lewis visited the jadeite mining area in 1951 (Lewis 1952: 211-212). At the time jadeite mining was again monopolized by the local Jingpho and all of what they found was exported to China. With the communist takeover in China, Lewis (1954: 212) predicted that "it seems likely that the jade mania may have come to an abrupt end. Production at Mogaung was entirely for the Chinese market, the stone being otherwise valueless. It is difficult to imagine that China's present rulers [the communists] would sanction this type of import." Even before then, following the 1911 revolution, there had been a decline in the jadeite market. While

there were signs of recovery during the inter-war years, Communist rule in China and continued instability in northern Burma put a damper on production and demand for jadeite. I will discuss more recent developments towards the end of the paper.

3. Properties and Identification of Jadeite

Jadeite is a silicate belonging to this group's inosilicate subdivision. Jadeite belongs to the pyroxene group of minerals within this subdivision, along with about two dozen other minerals (see Morimoto, Fabries, *et al* 1988; Hauff 1993: 85). The latter include aegirine, diopside, enstatite, and spodumene (hiddenite and kunzite). Curtiss (1993: 75) remarks that "the pyroxenes are one of the most complicated mineral groups known." Jadeite's chemical composition includes sodium, aluminum, and silicon. Jadeite's ideal composition is $NaAl(Si_20_3)_2$. It can be described as "a sodium-rich aluminous pyroxene" (www.geo.utexas, pg. 1). Jadeitic pyroxene usually is not pure (pure jadeite being indicated as Jd_{100}) and in such a state is found in only a few places in the world (discussed below). It is more typical for it to contain other pyroxenes mixed in solid solution such as diopside ($CaMgSi_2O_6$), kosmochlor ($NaCrSi_2O_6$), hedenbergite ($CaFe^2+Si_2O_6$), and aegirine ($NaFe_3+Si_2O_6$). Jadeitic pyroxene usually constitutes at least 90% to 95% of the rock that it is found in. The other minerals found in jadeite include sodic amphibole (with varying compositions: e.g., eckermannite, glaucophane, richterite, and edenite), albite, analcime, tremolite, (ilmeno-) rutile, clinochlore, banalsite, and chromite (see Harlow and Olds 1987; Htein and Naing 1994, and 1995). Ou Yang (1993) notes that jadeite may be partly replaced by fibrous tremolite or actinolite in the course of late-stage metasomatism. Such polymineralic jadeite is polychromatic and commonly is white with gray-green to blackish green specks or streaks. It is rare for this form of jadeite to be green and to exhibit relatively even color distribution. Jadeite commonly occurs with serpentine, nepheline, calcite, quartz, aragonite, glaucuphane, and vesuvianite. Jadeite's crystal system is monoclinic. It is composed of fine-grained, fibrous, highly inter-grown, interlocking crystals. Though jadeite is not very hard (measuring 6.5 to 7 on the Moh's scale), it is one of the toughest gem minerals known because of the inter-grown nature of the individual crystals. When fractured it is splintery and brittle. Jadeite ranges in appearance from opaque to translucent transparency and its luster from "greasy to pearly" (Hall 1994: 124).

Colors of Jadeite. The mineral jadeite is allochromatic and, therefore, transparent and colorless in its pure form. Even such "pure" jadeite, however, usually appears to be white as a result of the scattering of light by fractures, openings on grain boundaries, and tiny aqueous fluid inclusions. In addition to white, jadeite comes in a variety of colors. The colors of jadeite found in Burma include a variety of shades of green ranging from very pale green to emerald-green, pale blue, pale violet or

lavender, yellow, orange, burnt-sienna red, gray, and brown. Chhibber (1934: 67) provides an early description of the colors found in jadeite:

> Jadeite varies from pure white to various shades of green. Not infrequently green spots or streaks are observed in the white varieties. Other less common tints are amethystine, light-blue, bright-red, brownish and black. The bright-red and brownish tints are observed in a thin outer zone of jadeite boulders embedded in red earth, and the colour is due to the dissemination of ferruginous matter by percolating water. About one-third of an inch from the surface the red colour entirely disappears. This sections of red jadeite are seen to be stained red and yellow with hematite and limonite respectively.

Guatemalan jadeite has been found in a variety of shades of green (including emerald-green blue-green) as well as lavender, mottled white and blue, light yellow, pink, and black. There is also what is referred to as "rainbow jadeite", which features several colors.

The colors in jadeite are caused by a couple of different factors. In a few instances colors are caused by mineral staining on grain boundaries. These include red-brown to orange-brown caused by hydrous iron oxides, some dark green streaks caused an iron compound, and gray or black caused by graphite staining. Most colors of jadeite, however, are due to substitutions of transition metal ions for the fundamental Al^{3+} and minor Mg^{2+} (from diopside content) in jadeitic pyroxene and the resultant presence of residues called chromophores (see Harder 1995). The emerald-green color of "Imperial Jade" or "gem jade" is due to the presence of a small amount of chromium (Cr^{3+}). Hughes, Galibert, *et al* (2000: 6-7) note that "only a very small percentage of this minor element is required to induce the vivid color." Duller green colors as well as blue-green, bluish black, and blue-black jadeite are related to the presence of iron (either Fe^{2+} or Fe^{3+} or a mixture of the two). The darkest colors contain a relatively high percentage of iron oxide and closely resemble a pyroxene called omphacite. The term "leek green" is commonly applied to aggregates of jadeite and sodic amphiboles. According to Rossman (1974) and Ponahlo (1999), the lavender color is attributed to a Fe^{2+}—O—Fe^{3+} intervalence charge transfer in nearly pure jadeite. The mauve color in jadeite is related to the presence of manganese.

The above discussion is based largely on studies of Burmese jadeite. Curtiss (1993: 77) provides an analysis of some of the colors found in Mesoamerican jadeite (from Mexico, Belize, Guatemala, and Costa Rica) based on spectroscopic examination:

> The emerald green color is caused by the intense absorption of blue and red light by Cr^{3+} contained in a small component of ureyite in a solid solution with jadeite. Some additional absorption of blue light is from Fe^{3+}... The pale green color is caused by absorption of red light by a small amount of Fe^{3+} contained as an impurity in the M1 and M2 crystallographic sites of the jadeite. This absorption feature is much broader than the one produced by Cr^{3+}; therefore, the color produced is much more subdued. The absorption of blue light is from the presence of Fe^{3+}... The bluish green color is caused by the absence of Fe^{3+}...

In a table on the same page Curtiss associates the following colors with the presence of the certain elements: pink with manganese^{2+}, emerald green with chromium^{3+}, pale green with iron^{2+}, and brown and red with iron^{3+}.

Burmese Jadeite. Lacroix (1930) provides perhaps the earliest detailed analysis of the composition of Burmese jadeite. Thus, he describes two stones from Tawmaw as follows. The first stone is described as jadeitic-albitite. Its composition is: 59.42% SiO_2, 10.81% Al_2O_3, 10.69% MgO, 8.01% Na_2O, 4.3% CaO, and small proportions of FeO, Fe_2O_3, H_2O, K_2O, TiO_2, and MnO. The second stone is described as jadeite and amphibolite-bearing albitite. Its composition is: 66.3% SiO_2, 19.94% Al_2O_3, 11.25% Na_2O, and very small proportions of CaO, MgO, FeO, Fe_2O_3, H_2O, K_2O, and MnO. Three other stones (two from Tawmaw and one from the Kadon mine) discussed by Lacroix are categorized as amphibolites (one as amphibolite bearing chrome-jadeite). Chhibber (1934: 70), however, comments that "they are not altogether happily named" and "they are not amphibolites in the commonly accepted sense." He views them as being of "hybrid origin". The so-called amphibolite from the Kadon mine is 56.18% SiO_2, 16.97% MgO, 9.18% Na_2O, and 7.37% Al_2O_3, with smaller proportions of Fe_2O_3, FeO, MnO, CaO, K_2O, and H_2O. The second "amphibolite" contains the same elements, but in slightly different proportions: 55.82% SiO_2, 21.2% MgO, 9.12% Na_2O, and only 2.56% Al_2O_3, with somewhat larger proportions of Fe_2O_3 and H_2O, and roughly similar proportions of the other elements. The stone described as an "amphibolite bearing chrome jadeite has the following composition: 57.52% SiO_2, 13.37% MgO, 9.57% Al_2O_3, 8.83% Na_2O, 4.5% FeO, and smaller proportions of the other elements found in the first two stones.

There have been a handful of subsequent studies of the chemical compositions of Burmese jadeite specimens. One of the more recent and most comprehensive studies is that by Htein and Naing (1994). The specimens in their sample come from the mining areas of Hpakan, Lonkin, Tawmaw, Nantmaw, Whay Khar Maw, Haungpa, and Khamti and include a wide range of colors: "from white through grey to almost black, shades of green, dark green, emerald green, lavender, yellowish through brown to reddish-brown, bluish and greyish blue-green" (page 270). Portions of the samples were subjected to X-ray diffraction analysis to determine their mineral composition. The composition of monomineralic (pure jadeite) specimens include: jadeite, jadeite ± rutile/ilmenorutile, and jadeite ± chromite/magnesiochromite ± rutile. The composition of polymineralic (impure jadeite) specimens include: jadeite + edenite + richterite ± chromite, jadeite + kosmochlor ± ilmenorutile, jadeite + enstatite + tremolite, and jadeite + tremolite + edenite + richterite + kosmochlor ± ilmenorutile. About two-thirds of the twenty-five specimens are pure jadeite and the remaining one-third impure jadeite. Next, fifteen specimens were subject to wavelength dispersive examination by an X-ray fluorescence spectrometer (page 271). The values for SiO_2 range from 59.80 to 56.14, for Al_2O_3 from 24.18 to 15.34, and for Na_2O from 15.52 to

11.65 (with one specimen containing only 5.66%). Other oxides include: Cr_2O_3 (1.16 to 0.03), Fe_2O_3 (2.34 to 0.93), MgO (one with 9.88, otherwise from 3.17 to 0.01), CaO (one with 10.84, otherwise from 5.40 to 0.33), and K_2O (all <0.01). Some of the greatest variation was found in four of the specimens that were pyroxene-amphibole jades. Among the trace elements found by the X-ray fluorescence tests were Ti, Sr, Zr, Nb, Ni, and Zn (page 274). By way of conclusion, the authors note that "the present study demonstrates that jade of Myanmar may include a much wider range in mineral constituents and chemical composition than was previously recognized" (page 274).

Mesoamerican Jadeite. In his famous study of the Maya, archaeologist Sylvanus Morley (1956: 414) wrote:

> a study of Middle American jades by mineralogists of the Carnegie Institution of Washington [see Washington 1922] has shown that American jades are true jadeites, though their chemical composition differs from that of Chinese jadeite. The variation is not sufficient to place them outside the true jadeite group, but it makes them differ somewhat in appearance from Chinese jades. American jade is not so translucent as Chinese [i.e., Burmese] jade; it varies from dark green to light blue-green, through all shades of gray and into white; it is more mottled than Chinese jade.

More recently, Anna Miller (2001: 29) has noted that "although some individual pieces of Guatemalan jadeite cannot be separated from their Burmese counterparts (particularly after they are worked into jewelry), the majority of materials have distinct color and often textural differences.

In the 1950s, the Smithsonian Institution's curator of geology, William Foshag, recognized (1957: 23) that Mesoamerican artifacts generically referred to as jade could be divided into four main mineralogical forms: 1) jadeite, 2) diopside-jadeite ("a mineral species of the pyroxene group of minerals, intermediate between jadeite and diopside, essentially a silicate of sodium, calcium, magnesium, and aluminum"), 3) chloromelanite ("a mineral species of the pyroxene group of minerals, intermediate between jadeite and acmite, or jadeite, acmite, and diopside, essentially a silicate of sodium, calcium, magnesium, iron, and aluminum"), and 4) nephrite. In comparing jade artifacts from various locales around the Maya area, Foshag identified seven forms: 1) the so-called "blue" jadeite associated with the Olmec, 2) the pale greenish jadeite from the Quiche region, 3) the emerald-green to apple-green jadeite found in many Guatemalan sites, 4) a gray-green jadeite frequently used for making celts (edged implements), 5) dark green chloromelanite used for making a variety of utilitarian objects, and two other types that seem to represent gradations between other types. Bishop, Rands, and Zelst (1985) have also categorized Mesoamerican jadeites in this fashion. Harlow (1993: 27) summarizes these two systems of classification and compares them to rocks found in Guatemala (see the table at the top of the following page).

The jadeite pebble found in central Mexico mentioned above has a composition of 87% jadeite, 11% diopside, and 2% acmite (Cook de Leonard 1971: 212). Another source (Borhegyi 1971: 4) also mentions Mayan ornaments from highland Guatemala being made of albite.

Bishop Type	Foshag Type	Guatemalan Type
Motagaua Light	Types III & VI	Jadeitite
Motagua Dark	Type V	Omphacite rock
Chrome Green	-	Kosmochloric omphacite rock
Chichén Green	Type I?	Kosmochloric jadeitite
Maya Green	Type I	Kosmochloric jadeitite
Costa Rican Light?	Type II (Olmec Blue)	Jadeitite (alightly altered)
Costa Rican Dark	Type VII	Omphacite rock (Motagua-II) to black jade
Albite Light	Albite	Albitite 1
Albite Dark	Albite	Albitite 1
-	Type IV	Altered jadeitite
-	-	Albitite 2

Table 3.1: Systems of Classification of Guatemalan Jade (after Harlow 1993: 27)

Easby (1968: 15) discusses the properties of the jadeite found in Costa Rica. She compares it to that employed by the Olmec of the Gulf coast of Mexico. The Costa Rican jadeite is described as being "amorphous rather than crystalline" with an extraordinary translucence." In terms of color, she describes the colors as ranging from "bluish to sea-green hues like those of a cresting wave." The stones often have light cloudy spots and "sometimes there are flecks or veins of the deep intense emerald green that the Chinese call... imperial or jewel jade." She also mentions (1968: 16) "an almost opaque off-white jade, finely speckled and tending toward buff, gray, or green" and states that "X-ray diffraction patterns made for two examples showed them to be composed mainly of albite, with admixture of quartz and jadeite."

A relatively comprehensive study of the composition of Mesoamerican jadeite and other "green" stones is provided by Bishop, Sayre, and Mishara (1993), who utilized INAA to study the stones (they describe their sampling techniques on pages 35-37). Their sample included 155 stones collected in the vicinity of the Motagua River valley. Archaeological specimens tested are from several sites in central and northern Belize, Chichén Itzá in Yucatan, Copán and El Cajón in Honduras, and 130 pieces are from numerous localities in Costa Rica. They divide the jade samples into seven groups: 1) Motagua Light, light green color; 2) Motagua Dark, green-black color (basically omphacite); 3) Maya Green, emerald green; 4) Costa Rican Light; 5) Costa Rican Dark; 6) Chichén Green (defined in 1985 as different from jadeite found in the Motagua River Valley, but later similar jade was found in the Motagua River Valley); and 7) Miscellaneous.

They turn first to their findings related to the first three categories. The first two of these are "easily differentiated chemically from the group of samples designated Maya Green" which have "significantly higher chromium values" (page 42). The authors also point to significant differences

in the cobalt content in the three categories of stone. Overall they characterize the stones in these categories as follows (page 43):

> The Motagua Light samples can be characterized as consisting of major abundances of jadeite and albite, with occurrences of prargonite and analsite... The Motagua Dark specimens contain less abundant jadeite, major abundances of omphacite, and variable amounts of analcite. In contrast, the analyzed Maya Green samples possess abundant jadeite, trace omphacite, and relatively low abundances of albite, muscovite, and analcite.

Data are provided about the chemical composition of a number of the stones belonging to these three categories (page 45). A sample of eight Motagua Light stones have the following characteristics: 58.91% $Si0_2$, 24.6% Al_2O_3, 12% Na_2O, 1.97% CaO, 1.29% MgO, 1.01% FeO, and traces of Cr_2O_3, K_2O, and MnO. A sample of seven Maya Green stones have the following characteristics: 57.5% $Si0_2$, 20.0% Al_2O_3, 10.7% Na_2O, 4.78% CaO, 3.84% MgO, 1.20% FeO, 0.32% Cr_2O_3, and traces of K_2O and MnO. A sample of five Motagua Dark Omphacite stones have the following characteristics: 53.8% $Si0_2$, 14.4% Al_2O_3, 6.2% Na_2O, 10.36% CaO, 7.46% MgO, 2.32% FeO, 0.10% Cr_2O_3, and traces of K_2O and MnO.

On the basis of electron beam microprobe analysis the authors plot the relative jadeite composition in the various samples (see fig. 2.3, page 49). Among the findings is that: "The Costa Rican Light specimens all lie near the pure jadeite corner, and the Maya Green are close to the jadeite-omphacite boundary." Chichén Green falls in between. Later in their chapter (page 58), the authors discuss the distinctiveness of the Costa Rican samples, which have a tendency towards a bluish-green color (like the so-called Olmec pieces), from those found elsewhere. Their distinctiveness mineralogically is related to "the virtual absence of mica and the low albite content in the Costa Rican specimens."

Tests. Let us now turn to some of the tests that can be used to identify jadeite. Hobbs (1982) lists several tests: visual examination, refractive index readings, specific gravity determination, spectroscopic analysis, hardness tests, and X-ray diffraction. To this could be added the use of a Chelsea filter. In regard to the latter, it is interesting to note that while green jadeite's color is derived from the presence of chromium, it "does not show red under the Chelsea filter, nor does it do so under either LW or SW UV light" (Field 2000: 3). Under long-wave ultra-violet light "the paler coloured green and the yellow, mauve and white jadeite shows a whitish glow of low intensity, the darker coloured jadeite being unresponsive." Among the tests discussed by Hobbs, we will review all except for hardness tests since such tests are rarely used for jadeite. Hobbs (1982: 18) indicates that such tests are not very useful for jadeite and "would only help separate materials that have a hardness value that is significantly lower than jade, such as serpentine, calcite, and talc."

Turning first to visual examination, Hobbs (1982: 6-7) remarks:

> Visual examination of a jade-appearing material may yield significant identifying clues such as texture, surface luster, and fracture, as well as characteristic inclusions, evidence of dye, the presence of phenomena, and possibly other distinguishing characteristics. All these visual characteristics contribute to the typical appearance of a gemstone, thus allowing the gemologist with a well-trained eye to limit the range of possibilities quickly after an initial examination of the material. But even experts support the suppositions they make after a visual examination with standard gemological tests.

Among the characteristics of jadeite to note here concern its texture, surface luster, and fracture surface. In terms of its texture, it should be noted that jadeite is a very tough material. This is related to its internal structure. Differences in the structure of jadeite and nephrite, for example, can be seen under magnification: jadeite crystals appear as separate entities, while the crystals of nephrite appear to be woven together. This manifests itself visually, as noted by Hobbs (1982: 9), with jadeite looking granular and nephrite fibrous. Both jadeite and nephrite exhibit a slightly greasy luster, but nephrite tends to be greasier in its appearance than jadeite. Turning to the fracture surface of jadeite, Hobbs (1982: 10) describes jadeite and nephrite as exhibiting a "splintery fracture, which looks like the surface of a broken piece of wood." This characteristic, however, is more common with nephrite than jadeite. Unfortunately, several jadeite simulants also show similar characteristics. By and large, the value of visual examination is relatively limited in positively identifying jadeite. Hobbs (1982: 13) uses such terms as providing "valuable indications" and "suppositions" and concludes that these ned to be confirmed through gemological tests. We will look at the differences in appearance between jadeite and its simulants further in the section of simulants.

Jadeite's refractive index is about 1.66. Hall (1994: 124) gives it as 1.66-1.68, while Schumann (1997: 154) give it as 1.652-1.688. Field (2000: 3) reports that the mean refractive index of jadeite is 1.66 (alpha 1.654; gamma 1.667)" and notes that "this mean can be determined quite readily by the distant vision method." Read (1999: 281) states that "only [a] single vague shadow edge [is] visible on [the] refractometer at 1.66 due to [the] random orientation of crystal fibres." Hobbs (1982: 13) states that "the refractometer is one of the most helpful instruments in separating jadeite from its simulants." This is because almost all of these simulants have refractive indices that are significantly different than jadeite's. The problem is that jadeite and most of its simulants are usually cut with a round surface in such a way that their shapes make it difficult to obtain readings with a refractometer. This necessitates using the "spot technique" or "distant vision method." Hobbs (1982: 13) describes the spot technique as follows: "The spot technique requires that a portion of the curved surface be placed or held on the refractometer with a small drop of liquid, the size of which is reduced until the image that is seen without the eyepiece magnifier is only two or three scale increments."

Jadeite is doubly refractive. According to Field, the birefringence is 0.013. Other sources give somewhat different numbers: Hall (1994: 124) gives 0.012 and Schumann (1997: 154) gives 0.020.

However, Hobbs (1982: 13) warns that "it is rare to see the full spread of refractive indices listed on the property chart because" jadeite is a crystalline aggregate and "only one refractive index is easily resolved with the spot technique." To obtain a birefringence reading, Hobbs (1982: 14) recommends using the birefrengence blink technique that involves rotating a polaroid plate in front of the refractometer. This technique is illustrated and described by Hobbs (1982: 13, fig. 13).

Jadeite has a specific gravity of 3.33-3.35. Field (2000: 3) reports that "most jadeite...will remain suspended or very slowly sink in methylene iodide (di-iodomethane) that has a density of about 3.32-3.33 at normal room temperature." Hobbs (1982: 15) also recommends using methylene iodide when testing for jadeite and warns that "jadeite, and many jade-like materials, may contain impurities that will cause the specific gravity to vary. Hobbs (1982: 15) also notes that while three common jadeite simulants (grossularite, zoisite, and idocrase) have specific gravity values that can be confused with jadeite's all of them have refractive indices that are a good deal lower than jadeite's.

Spectroscopic analysis is a useful means of identifying jadeite. Moreover, as noted by Hobbs (1982: 15), "the spectroscope is helpful in that both cut and rough, as well as mounted or loose, materials can be tested." Read (1999: 281) discusses the appearance of jadeite when examined with a spectroscope (also see Hobbs 1982: 15-17; Webster 1975: 228; Walker 1991: 39-40). He states that there is a "diagnostic line in the blue; chrome-rich jadeite has a doublet in the red, and two bands in the red-yellow. Stained jadeite has a band in the orange and one in the yellow-green (plus the diagnostic line at 437 nm)." Field (2000: 3) adds additional detail:

> green jadeite shows several bands in the violet, the strongest being at 437 nm. It is intense enough to be discerned by reflected light and by transmitted light if the material is not too opaque or too dark in colour to transmit well. Naturally green jadeite also shows three chromium lines somewhat resembling steps or louvres in the red, at about 630, 660 and 690 nm; but above this is a light zone from about 670 to the end of the visible spectrum. In the "natural green" spectrum just described, there is nothing but darkness above the 690 nm band. Note however, that the band at 437 nm is present in both the natural and dyed examples.

Huang (1999) provides data on the characteristics exhibited by jadeite when examined with a Raman spectroscope:

> The Raman modes of jadeite are 292 and 328 cm^{-1} (Na-O stretching mode); 374, 416, 434 and 576 cm^{-1} (Al-O vibrational modes); 524, 700, 779 cm^{-1} (Si-O bending modes) and 887, 986, 992 and 1040 cm^{-1} (Si-O stretching modes)... There is little variation in the wave number of Raman modes with substitution of iron and chromium in jadeite. Slope of the variation is negative with increasing substitution of iron and chromium.

Jadeite is studied along with fourteen other gem minerals and Huang provides a flow chart (page 311) showing identification procedures to separate one mineral from another. We shall return to the question of identifying dyed jadeite below in the section of treatment of jadeite.

Both Hobbs (1982: 18) and Walker (1991: 41) note that the most precise test in jadeite identification involves X-ray diffraction by the powder method. However, as both authors point out, unfortunately this method is feasible only for sophisticated laboratories.

Before concluding this section, I would like to make reference to an important point made by Hughes, Galibert, *et al* (2000: 2). They note that "an understanding of jadeite is not limited to the technical or exacting, but it also requires a feeling for the cultural, textural, and ephemeral qualities that make the study of jade unlike any other in the world of gemstones." Their point reflects jadeite's very special relationship with Chinese culture, a relationship that is only rivaled perhaps by diamond's relationship with the English-speaking world.

4. Jadeite Variety Names

There are a number of names for varieties of jadeite that are based on color or other characteristics. The list below includes the most common names encounted in English.

Imperial Jadeite. In its emerald-green, translucent form jadeite is often referred to as "Imperial Jade" or "gem jade". In Burma this type of jadeite is referred to as *mya yay* or *yay kyauk.*

Guatemalan Imperial Jadeite. This term is used for kosmochloric-jadeites and kosmochloric-omphacitites with chromite crystals in their assemblages. An example of this type is the variety that is called "Chichén Green". Miller (2001: 29) comments that "the intense and highly saturated Imperial green of Burmese jadeite is not often found in the Guatemalan material." She adds that "this does not mean it doesn't exist in Guatemala, rather it simply means that at this time, ongoing exploration has failed to produce any sizeable quantity of this highly desirable color."

Emerald Jadeite. An intense, medium green color.

Yunnan Jadeite. Dark strong green jadeite that is semi-transparent to opaque. It may appear translucent when cut thin.

Chicken or Tomb Jadeite. These terms refer to jadeite that a ywllowish or brown color caused by iron oxidization.

Kingfisher Jadeite. This variety has a shade of green that is said to resemble the brilliant green plummage of the kingfisher.

Water Jadeite or Ice Jadeite. Jadeite without such chromophores as mentioned above is called "pure jade", "White jade", or "water jade". Especially fine pieces are called "crystal jade" or "ice jade". The latter name refers to the fact that such jadeite has an almost colorless interior.

Apple Jadeite. Intense to medium yellowish-green jadeite is referred to as "Apple Jade".

Moss-in-Snow Jadeite. Jadeite that is white with vivid green spots and streaks (these are called streamers).

Black Jadeite. There are in fact two types of so-called black jadeite. One of these comes from Burma, and is really gray rather than black, and the other comes from Guatemala, and is truly black.

Ou Yang and Hansheng (1999: 417-418) comment in regard to Burmese black jade that "currently the term 'black jade' may include different types of pyroxene jades and is potentially confusing for the trade." Since first appearing on the market in Burma in the mid-1990s, this type of jadeite has been used to make various forms of jewelry in Hong Kong and Taiwan, but it has not proven to be very popular. The color of this type of jadeite tends to be grayish-black rather than pure black. Since the color is said to be similar to that of black-skinned chickens, in Hong Kong it is sometimes referred to as "black-skin-chicken jadeite". It is usually found in the vicinity of rivers in the form of boulders and is relatively rare.

Ou Yang and Hansheng (1999: 418-419) describe "black jade" from Burma as being "opaque (fine grained) to translucent (coarser grained) with a vitreous lustre except in a few areas where it tends towards an oily lustre; fresh and well-polished surfaces have a vitreous lustre." Unlike black nephrite, on polished surfaces black jadeite can exhibit star-like flashes in reflected light. Ou Yang and Hansheng (1999: 419) report that its hardness on the Moh's scale is about 7, its specific gravity ranges from 3.325 to 3.333, and its RI is 1.653-1.665. It is inert under both long-wave and short-wave ultraviolet light. In terms of its composition, the authors report (page 419) that it is "essentially monomineralic, consisting of 95% jadeite and about 5% accessory minerals and black pigments." The jadeite belongs to the jadeite-omphacite-diopside pyroxene series. The color is derived from the presence of black or dark opaque dust-like materials that are associated with minute inclusions that are distributed throughout the stone. The inclusions are comprised of metallic oxides and sulphides, amorphous carbon, organic salts, water, CO_2, and various hydrocarbons.

In the case of Guatamalan "black jade", it was used in Prehispanic times to make celts and other artifacts. It is presently being used by lapidaries in Guatemala City and Antigua, Guatemala, to make various types of jewelry. Harlow and Donnelly (1989) describe its petrological features in Guatemala and Garza-Valdés (1993: 113) describes its chemical composition and related properties:

> Aegirine-augite (chloromelanite)-rich rocks, or black jade, are metamorphic rocks with a fine-grained-to-cryptocrystalline texture. The color is given by the pyroxene aegirine-augite (chloromelanite) and by taramite, a sodic-calciic amphibole ($NaCaNaMgFe_2^{2+} \cdot [AlFe^{3+}]_2Si_6Al_2O_{22}[OH]_2$)... The amphibole is markedly pleochroic in blue, brown, and violet. This rock also contains titanite, albite, analcite, grossular, and white mica.

Harlow (1993: 23) says that black jade in Mesoamerica "resembles basalt" and comments that "it is very durable... it takes a very good polish and shows little grain definition." Anna Miller (2001: 29) quotes Fred Ward about this black jadeite: "Black jadeite from the Moragua Valley area...

represents the creamiest, richest, and best black jadeite in the world, far exceeding Burma's darkest, which is gray and can only be sold as charcoal."

Chloromelanite. Damour (1863) invented the term chloromelanite to designate a variety of jadeite that was blackish green (or sometimes dark green with black spots) in color and especially rich in iron oxide (see Hobbs 1982). It is a mixture of diopside, aegirine, and jadeite and contains a relatively high proportion of iron oxide. Hansford (1968: 31) notes that in this variety of jadeite "the iron oxides commonly account for 5 to 10 per cent of the total, while in Burma jadeite of gem quality they do not exceed about 0.5 per cent." Hansford adds that this variety of jadeite was "not favoured by Chinese lapidaries, by whom it has been rarely used" and that "among the Aztecs and Mayas its use was confined almost entirely to the making of tools." Writing of Chinese jade, Hu (1976: x) describes it as being "spinach-green or dark green," and comments that it "is rare, and for practical purposes" he ignores it in his brief survey. Hughes, Galibert, *et al* (2000: 7) comment that "the term is used rather loosely by traders, who typically apply it to any dark green to black jade-like material. We discourage use of the term chloromelanite because the traditional trade usage conflicts with modern knowledge of its composition. Indeed, the name has already been discredited mineralogically, in favor of referring to the particular pyroxenes present (omphacite or aegirine-augite)."

Diopside-Jadeite. This form of jadeite can be brilliant green in color, but it is relatively opaque. The percentage of diopside in such stones ranges from 10% to as high as 50% (see Foshag 1957: 14-23). Diopside-jadeite was first described in 1922 as the material used for carving a famous pre-Columbian statue found in 1902 in San Andres Tuxtla, near the Mexican city of Veracruz. Because of the location of this statue, the stone was initially called "tuxtlite". Hansford (1968: 31) states that diopside-jadeite is found and was often carved in ancient Mesoamerica, but that it was not known or used in Burma or China.

5. Sources of Jadeite

Known sources of jadeite world-wide are relatively limited. The most important sources are located in Burma, Guatemala, Japan, and Kazakhstan. Jadeite is found in certain metamorphic rocks that have undergone metamorphism at high pressure but at relatively low temperature. More particularly, it is found in nodular or long-shaped masses in serpentinite, usually in the form of weathered boulders and cobbles in stream deposits or glacial sediment. Harlow (1993: 13-14) outlines some of the other primary geological features associated with jadeite-bearing serpentinite. He notes that "jadeites are usually a part of a larger suite of unusual rock types besides serpentinite, including albitites, blueschists, and altered eclogites, that are helpful in interpreting jadeite petrology and in recognizing or predicting its presence." In addition, "jadeite-bearing serpentinites are closely

associated with large and possibly active fault zones that are major crustal boundaries (e.g., the San Andreas Fault) and involve mostly horizontal motion" and "most jadeite rocks occur in relatively young geologic terrain, Cretaceous age or younger (less than 100 million years)." In sum, Harlow (1993: 14) argues that "these facts strongly suggest a genetic relationship between plate tectonics... and the formation and surface appearance of jadeite rock."

Burma. Most of the jadeite produced in the world at present comes from northern Burma. This has been the sole source of fine "Imperial" jadeite for several centuries. Bender (1983) describes the geology of the jadeite mining region in Burma. It is characterized by an extensive broken outcropping containing bodies of serpentinized peridotite (their age ranging from Late Cretaceous to Eocene). The serpentinites found here are surrounded by crystalline schists and plutonic rocks (such as granites and monzonites). Jadeite was formed independently of the intrusives by crystallization from hydrous fluids (there were derived by dewatering of the subducted Indian plate) that rose along fractures in the serpentinized peridotite at relatively high-pressure and low-temperature during the Tertiary formation of the Himalayas. Fluids that form in these special conditions are saturated with sodium aluminosilicates. The passage of these fluids through serpentinites generated jadeitite, albite-nephaline, and albitite dikes (jadeite being generated at higher pressure and albite at lower pressure). The dikes commonly have central zones of jadeite and outer rims of chlorite and amphibolite at the point of contact with the serpentinites (see Harlow and Olds 1987).

This region commonly is referred to as the "Jade Tract" or "Jade Land." The latter term is roughly equivalent to the Burmese term for the region: *Kyaukseinmyo.*It is a rugged plateau located over 400 kilometers north of Mandalay. The main river in the area is the Uru, which serves roughly as the eastern boundary of the Jade Tract. The most important mining area in the region is located at Tawmaw (see Chhibber 1934: fig. 1, pg. 25), about 120 kilometers northwest of Mogaung. Mining has been going on in the Tawmaw area at least since the nineteenth century and Tawnaw is a source of most major varieties and colors of jadeite. Most of the jadeite from this area comes from secondary deposits in the Uru Boulder Conglomerate. The conglomerate is exposed over an area ranging in width from three to over six kilometers (the widest point being at Mamon) and up to 300 meters thick (see Chhibber 1934). There are a number of secondary deposits located west of the Uru River, such as those at Sate Mu, Hpakangyi (adjacent to Hpakan), and Maw-sisa.

The town of Mogaung served as the primary jadeite trading center throughout most of the modern history of jadeite mining in the Jade Tract. Mogaung is located a little over 100 kilometers west of Myitkyina town. It served as a collection and storage center for rough jadeite. Here the material was graded prior to shipping. The importance of Mogaung has declined and Hpakan (also spelled Hpakant, Phakan, or Phakant) has emerged as the primary center in recent years. Hpakan lies along the Uru River some sixteen kilometers by road from Tawmaw.

The Chindwin River serves roughly as the western boundary of the Jade Tract. At present the westernmost mine near the river is located at Lai Sai. Chhibber (1934: 24) mentions a mining site "on the banks of the Chindwin river" in the Hkamti area. Hughes, Galibert, *et al* (2000: 14-15) believe that Chhibber is referring "to the Nansibon mining region":

> On an expedition to the jade mines by a group traveling under the auspices of the American Museum of Natural History in January and February 2000, four geologists and two gemologists visited the mining area called Nansibon (Namsibum, Manhsibon). It was the first recorded visit by Western gemologists to this area. Located in the Sagaing Division, about 35 km (22 miles) southeast of the Chindwin River town of Hkamti, Nansibon is a group of joint-venture tracts that extend about 2 km along a north-south trending ridge in the middle of dense jungle (central location at N25°51'24", E95°51'30" determined by GPS measurements). The deposit is a steeply inclined (60°–90°E) serpentinite boulder conglomerate in which jadeite cobbles from a few centimeters to perhaps one meter in diameter are "concentrated" in a few narrow horizons. Mining is restricted to mechanized excavation of surface exposures of the conglomerate, which disappears both north and south under Tertiary river sands and lake sediments of the Chindwin basin. Now largely unworked, Natmaw (Nawmaw, Nathmaw) is a smaller area roughly 30 km south of Nansibon, where miners have explored jadeite dikes in serpentinite. As the road there was impassable and time was constrained, the group could not visit these latter mines.
>
> According to current and retired officials from the Myanma Gems Enterprise (MGE), relative to the Jade Tract, Nansibon presently produces a large portion of the gem-quality Imperial jadeite mined in Burma, lesser amounts of other colors and "commercial" jadeite (used for carvings and bangles), and small amounts of "utility" jade (used for tiles, building veneers, and very large carvings...). During the recent visit, GEH and gemologist Robert Kane acquired a comprehensive suite of jadeite from Nansibon in colors including black and many shades of green, lavender, blue-green, "nearly blue," and "carnelian orange"; these varied from translucent to semi-translucent. They saw numerous small (2–5 mm diameter) cabochons of translucent Imperial green jadeite from Natmaw."

Mines are located to the north near Kansi (Gin Si) and near Putao (over 300 kilometers north of Myitkyina). The latter site is mentioned by Chhibber (1934: 24), who reported that the site was relatively inaccessible and the quality of the jadeite here poor. Hughes, Galibert, *et al* (2000: 15) comment that "Putao appears to produce a different jade-like material, obviously with a different origin." They report that according to "U Shwe Maik, former director of jade acquisition for MGE,... the alleged jade from Putao is actually green massive hydrogrossular (now hibschite)." The southernmost mines are near Haung Par (Haungpa). To the east of the Uru River there are mining areas at Hwehka (Hweka) and Makapin. Hwehka is about twenty kilometers south of Hpakan along the Hwe River, with Makapin located a little to the east of Hwehka. Jadeite boulders are found in these areas in conglomerate inter-layered with blue-gray sands and coal seams (see Bleeck 1908; Chhibber 1934).

A recent Mason-Kay newsletter (2000: 2) mentions that there are new mines that are producing "unusual varieties that are largely jadeite...(sometimes referred to as 'Te Lung Sing'); that is "reminiscent of a type of jadeite cut in late Ch'ing [Qing] dynasty timers and called 'coins'." The

newsletter, however, does not say where these mines are located, but they appear to be within the traditional mining region.

There is an interesting report of the discovery of a new jadeite dike in the Hpakan (Phakant) area. The dike is reported to be very large: "At 70 feet by 20 feet by 16 feet for an estimated mass of 2,000 tons, this dyke is a doozy" (*Colored Stone*, May/June, 2001, p. 120). The dike is in an area controlled by the Pa-O ethnic group (a sub-group of Karen). The local Pa-O who hold the rights to the dike are said to be charging admission to see it at present rather than mining it. A more recent report on this discovery (*Colored Stone*, November/December 2001, p. 14) places the weight of the "boulder" at 3,000 tons and quotes the deputy director of the government's Myanmar Gems Enterprise as saying that the government has not yet decided what to do about the bolder, but that it is likely the boulder will be cut up and all or part of it brought to Yangon for sale.

Mesoamerica. Researchers have long been interested in finding the sources of ancient Mesoamerican jadeite. As late as 1964 Digby (1964: 14) commented that "no large deposits of jade are known anywhere in the Maya area, though it is not improbable that such deposits were known in the Highlands of Guatemala and mined in [Prehispanic] Maya times." He mentions that a large jadeite stone weighing about 200 pounds was found in the archaeological site of Kaminaljuyu, from which fragments had been detached to make jewelry (see Kidder, *et al* 1946). Given the considerable variety in the nature of the jadeite that has been found around the Maya area and elsewhere in Mesoamerica it was considered likely that there were a number of sources. Rough jadeite was found in a couple of locations in the 1950s. Cook de Leonard (1971: 211-212) reviews the two locales where small amounts of jadeite were discovered. The first was a site in Guatemala near Manzanal, along the Motagua River in the departments of El Progresso and Zacapa, where "fine jadeite of a lichen-green color" was found (see Foshag 1955, 1957; Foshag and Leslie 1955; and Barbour 1957). The second location was a riverbed on the border of the Mexican states of Puebla and Oaxaca where an olive green jadeite pebble was found.

Continued exploration since the 1950s has led to the discovery of additional sources of jadeite in Mesoamerica. By far the most important site, however, remains the Motagua River Valley. A search in Guatemala's Motagua River Valley in 1974 by archaeologist Louise Ridinger and her husband Jay turned up not only various colors of jadeite, but also direct evidence of mining by the ancient Maya (see www.jades.centroamerica.com; Ward 1996: 29). This area now seems to have been the site where the ancient Olmec and others obtained most of their jadeite as well, although there is the possibility that at least small quantities of jadeite were obtained from other localities. Jadeite (along with albite) is found along the Motagua River Valley and the river's tributaries either in blocks of serpentinite or in pebbles. Harlow (1994) associates the presence of jadeite at this site with contact between the North American Plate and Caribbean Plate.

More extensive exploration of the Motagua River Valley has revealed numerous new sources of jadeite. Smith and Gendron (1997) ran tests on jadeite pebbles collected on the south side of the Motagua River Valley. The jadeite differed from previously analyzed jadeite samples found on the north side of the valley (where most mining activity took place initially). Of particular significance was the presence of rutile (about 2% by volume) and micro-inclusions of quartz, neither of which had been reported in samples from the north side of the valley. The significance of this find is that it broadens the range of jadeite samples found in this region and, thus, "presents an extra possibility for the geological provenancing of Mesoamerican artifacts in jade."

Although it has received far less attention, as was noted above, Costa Rica has also been an especially important source of ancient jadeite objects. Jadeite pebbles have been discovered in various riverbeds in Costa Rica, but it is uncertain where the ancient lapidaries obtained all of the jadeite that they worked (see Easby 1968: 14). Reynoard de Ruenes (1993) notes that while some of the raw material clearly came from the Motagua River Valley in Guatemala, there are also possible local sources in Costa Rica, especially in the Atlantic region (i.e., the Talamanca Valley and Limón Basin), although she is unable to offer definite proof.

The Caribbean and North Coast of South America. A few artifacts made of jadeite have been discovered in the Caribbean region, although most stone artifacts are made of other materials, such as nephrite or staetite. The jadeite objects include celts and pendants in a variety of shapes. There was a stone grinding technology associated with the Taino culture. This culture emerged around 700 AD and the height of its Classic Period was around 1000 AD. Easby (1991) provides a photograph of two small ceremonial jadeite celts from the Caribbean (one being from Jamaica) in the collection of the Metropolitan Museum of Art in New York (fig. 11, page 341). They are made of dark green opaque jadeite. She mentions another jadeite celt (fn. 13, page 370) in the collection of the United States National Museum that is from Oriente Province in Cuba. The source of the material for such artifacts is not known. However, jadeite has been discovered in the Dominican Republic (Perfit 1982) and the Guajira Peninsula of Columbia (Green, Lockwood, and Kiss 1968) and Easby (1991: 341) states that "the geology and serpentine deposits of Cuba and Jamaica might signal associated jadeite." There is no contemporary jadeite industry in this region.

Russia and Kazakhstan. Morkovkina (1960) and Dobretsov (1963) are among the earliest sources to mention jadeite in Russia (also see Dobretsov and Ponomareva 1965), but it was a number of years after these publications before jadeite began to be exploited in Russia. Writing in 1991, Frey and Skelton (1991: 265) commented that although there were reports of gem-quality jadeite being found in the Sayan region in 1978, "what has been seen on the market to date would only compare with third-rate raw jadeite stones from Burma." Both Ward (1996: 7) and Newman (1998: 98) mention jadeite being mined in Russia, but they add no details. More information is available in Hughes and Kouznetsov (2000), who visited some of the mines in August 2000.

Jadeite was discovered in Itmurundy, Kazakhstan, in the early 1970s, when the region was still part of the Soviet Union. Later, jadeite-bearing rocks were discovered by geologists in the Polar Ural Mountains in 1979. It was not until 1989, however, that Sergei Mikheev discovered a piece of stone with imperial quality jadeite in the Polar Ural Mountains and subsequently was able to attract investment from Hong Kong to commence mining at Pusyerka, located about 160 kilometers from Kharp. Writing in 2000, Hughes and Kouznetsov report that up to that time eighty-eight outcrops of jadeite had been identified in the region: "The jadeite in this area occurs in dikes within a serpentine matrix, with actinolite and phlogopite and from all appearances much material remains." The region has produced jadeite stones of varying quality, including pieces that have sold for as much as US$10,000 and are considered comparable to good quality Burmese jadeite. However, production in the Polar Urals was never large and a report in the May/June 2001 issue of *Colored Stone* magazine ("Russian Jade", page 89) quoted Richard Hughes stating that at present there was no longer any production.

Jadeite was discovered next in 1992 in Khakassia, in the Republic of Khakassia (which lies within Siberia), near the border with Mongolia. The site is about 100 kilometers from the capital of Abakan, on the banks of the Yenisey River and near the artificial lake created by the Sayano-Shushenskaya hydroelectric dam. The mine is operated by Mikhail "Misha" Khronlenko, who is described by Hughes as "Russia's biggest jade miner and exporter."[4] After crossing the lake, Hughes describes his arrival at the mine site: "Amidst a hillside open cut stood what is probably the single biggest jadeite boulder I have ever laid eyes on... Misha was beaming. 'What do you think?' he asked. 'It's incredible,' I gushed. 'Yes,' Misha answered, laughing that manic laugh: 'Every dog gets his day.'" The quality of the jadeite from Khakassia ranges from poor to medium with prices generally in the hundreds of dollars per piece. The same report in *Colored Stone* magazine cited above states that at present the Khakassia mines are the only ones operating in Russia.

Jadeite is still being mined in Kazakhstan, but it is of very low quality. Pieces sell for well under US$100.

California. Hankin (1998: 93) refers to jadeite occurring in "boulders found in California since the 1930s [that] are white, pale green, dark green, and bluish-green, but they are semi-opaque and not of such good quality as the Burmese material." Such boulders have been found in a variety of locations: San Benito country, the border of Mendocino and Trinity counties, and San Luis Obispo country. Jadeite has been found in a glaucophane schist in Sonoma country. Jadeite crystals have been discovered in near the Russian River, near Cloverdale, Mendocino County, California. While not of significant commercial interest, the jadeite in California has received a good deal of scholarly attention: see Coleman (1961); McKee (1963); Coleman and Lee (1963);

[4] The co-author of the article, Nickolai Kouznetsov, is also a jadeite trader. His Moscow-based company is Stoneflower.

Coleman and Clark (1968); Maruyama, Liou, and Sasakura (1985); Maruyama and Liou (1988); Patrick and Day (1989); Brothers and Grapes (1989); Ernst and Banno (1991); Radvanee, Banno, and Ernst (1998); and Banno, Shibakusa, Enami, Wang, and Ernst (2000).

Japan and Korea. Chihara (1991: 216) remarks that "probably the least known source of jadeite in the world is Japan." In fact, a variety of colors and qualities of jadeite is found in Japan. Initial attention focused on jadeite objects discovered in burial sites associated with the Jomon period (roughly 4000-1600 BC) by archaeologists (see Mitsuharu 1966). Chihara (1999: 9) argues that this makes "Japan the oldest jadeite culture in the world," although there are European jadeite artifacts of similar age (see below). Among the oldest items that have been found are tools and small curved pieces "rather like thickened commas and known as *magatama*, which measure about four centimeters overall in length (Wills 1972: 151; they are sometimes described as cashew-shaped). The latter appear to have been worn as pendants. There were also various shapes of beads (sphere-shaped ones known as *marutama* and small beads called *kodama*) and large flat pendants with a hole (known as *taishu*) dating from various periods. Jadeite carving appears to have died out during the latter part of the seventh century.

Early writers assumed that these objects were imported from China (along with nephrite; see Laufer 1912: 351-354), but later it was found that the source of jadeite was Japan itself. Such a source of jadeite in Japan was discovered in the Kotaki district of Niigata prefecture in 1939 (see Iwao 1953; also see Chihara 1971 on jadeite in the Omi-Kotaki area). Wills (1972: 151) comments about the jadeite found here, that although "the veins of jadeite were thin and the quality of the material not high, they would have been sufficient for a bead-making industry." Jadeite was subsequently discovered in other nearby regions in central Japan. Seki, *et al* (1960) discuss jadeite in Sibukawa district. Miyajima, *et al* (1999a, 1999b) discuss lamprophyllite and lawsonite found in lavender-colored jadeite from the Itoigawa district, Niigata prefecture. Jadaeite has also been found further south at Mt. Osa in Okayama prefecture (see Kobayashi, *et al* 1987). Chihara (1999) provides a recent and comprehensive survey of the localities where jadeite has been found in Japan. To the above localities he adds several others where some jaideite has been discovered. These include three additional sites in southwestern Japan in addition to Mt. Osa (Oya, Hyogo prefecture, Wakasa, Tottori prefecture; and Nagasaki), on the Kanto mainland, and on the northern island of Hokkaido.

Jadeite in Japan is found in the form of jadeite rocks and veins as well as jadeite-albitite veins. In the case of the latter, the inner portion is composed of albitite and quartz and the outer part of jadeite. Chihara (1999: 14-15) divides the jadeite found in Japan into three main types: 1) the Kotaki type, "the typical, quite regular zonal arragement is, from inner to outer, albitate (with or without quartz), white jadeite rock, green jadeite rock, soda rich calciforous amphibole and host serpentine"; 2) the Omi type, which shows a "distinct stratiform structure", sometimes with

alternative coarse and fine compact layers and often containing lavender colored jadeite within the rock; and 3) the Tsugaike type, this is "a white, compact jadeite associated with veins of very coarse-grained prismatic crystals of jadeite."[5] Chihara (1991: 216-217) reports that white is the most common color of jadeite encountered in Japan, with green being less common, and violet and blue colored jadeite also being encountered. Chihara (1999: 13) lists the following colors (and provides information on the mineral composition of jadeite rocks and the color and chemical composition of some of these): white, lavender, pale lavender, pale blue, pale green, green, and dark green.

The modern history of jadeite in Japan appears to begin with the re-discovery of jadeite in Niigata prefecture in 1939 (a region from where jadeite came during the Jomon period). Without going into detail, Chihara (1999: 9) states that "in 1941 and 1949 a few tons of jadeite raw material were exported to Hong Kong." Although very little of the jadeite found in Japan is of gem quality, Japanese lapidaries recently have begun carving local jadeite (especially from the Kotaki district of Niigata prefecture). The most popular items made include cabochons for rings and pendants.

Jadeite artifacts, including tools and *magatama*, have also been found in archaeological sites in southern Korea. Frey (1991b) and Chihara (1999: 9-10) report that a large number of *magatama* in particular have been found in archaeological sites from the Silla Dynasty (668-935 AD), including one tomb excavation that "yielded over 35,000 magatama made of jadeite and other stones, as well as glass" (Frey 1991b: 219). The jadeite does not appear to have come from Korea. Both Frey (1991b: 218) and Chihara (1999: 9) note that many of these artifacts have been found near the coast in an area that is not too distant from the Niigata area in Japan and believe that it is likely that these items came to Korea from Japan by sea.

Europe. Ancient specimens of worked jadeite have been found in various locations in Europe and Turkey. These generally take the form of ceremonial axes. They have been found in various parts of the United Kingdom (see Bishop, *et al* 1977; Bishop and Woolley 1978; Jones, Bishop, and Woolley 1977; Smith 1963, 1965, 1972; Woodcock, Kelly, and Woolley 1988), Italy (see D'Amico, Felice, and Mazzeo 1992; Leighton 1992; Leighton and Dixon 1992; O'Hare 1990), Netherlands (see Overwell 1983), Spain, Portugal, western Germany, France (see Compagnini and Ricq de Bouard 1993; Ricq de Bouard and Fedele 1993; Le Roux 1979), Switzerland, and Slovakia. Their composition is usually green jadeite (see Woolley, *et al* 1979). While sometimes there is a large admixture of diposide and aximite or of iron (forming chloromelanite), there are examples of a purity almost equaling that of the better quality Burmese jadeite.

There have been a number of studies of Neolithic jadeite axes from northern Italy and adjacent regions of eastern France. D'Amico, Felice, and Mazzeo (1992), for example, describe jadeite axes from Friuli in northern Italy, Ricq de Bouard and Fedele (1993) describe them from adjacent areas

[5] Chihara (1999) provides detailed analyses of the composition of a number of samples of jadeite from Japan.

of southern France, and D'Amico, *et al* (1995) provide a general survey of the region. D'Amico, *et al* (1995: 34) report that "although *jadeite* is often the dominant mineral in the jades and *omphacite* in the eclogites, the coexistence of different pyroxene compositions (Jd, Fe-Jd, Omph, Fe-Omph, sporadic Agt) is the general rule, with few exceptions." Jadeite axes have also been found to the north in Switzerland, dating to somewhere between 3500 BC and 1800 BC.

Several jadeite axes have been found in Moravia. Schmidt and Stecl (1971) describe eight of these. All of the artifacts are described as being various shades of green. On the basis of a variety of tests (including X-ray analysis), they are of "an almost mono-mineral character," being composed of pyroxene jadeite (page 143), with the possibility of "the presence of small amounts of alkaline pyroxene (e.g., fassaite type)" as well as chlorites in some specimens (pages 145, 149). These axes are associated with the Moravian Painted Pottery People stage which is included within the Lengyel culture. Schmidt and Stecl (1971: 150) also discuss the question of the source of the jadeite material. They note that nineteenth century archaeologists speculated that a local source might be found, but this did not prove to be the case. A later author, writing in 1946, argued that the material came from Silesia, but Schmidt and Stecl comment that he was in error and "confused jadeite and nephrite." While Schmidt and Stecl are unable to determine a precise place of origin, they argue that "it is very probable that [the axes] were imported from the South which provided many cultural goods."

In a more recent article, Hovorka, Farkas, and Spisiak (1998) discuss a Neolithic jadeite axe discovered in neighboring western Slovakia. The artifact is associated by the authors with the local Lengyel culture, which developed in this region between 5000 BC and 3500 BC. Ninety-five percent of the stone is composed of clinopyroxene aggregate which consists of a mixture of jadeite and omphacite. Opaque sections in the center of the axe composed of rutile. The remaining components of the stone include zoisite, light mica, and what appears to be plagioclase. There is no known local source this jadeite. The shape of the axe resembles axes found in Italy and since the western Alps is the site of what appears to be the largest source of raw jadeite in western Europe the authors postulate that the axe may have originated there.

Documented raw jadeite occurrences in Europe are very rare. The Western Alps in the vicinity of the borders of Switzerland, France, and Italy appears to be the main source of jadeite in Europe. D'Amico, *et al* (1995), Lefevre and Michard (1965), Compagnoni and Maffeo (1973), and Biino and Compagnoni (1992) describe jadeite found in the Italian portion (the Piedmonte zone) of the western Alps and Saliot (1979) describes jadeite from the French portion. D'Amico, *et al* (1995: 37) comment that "the fact that sites 300-400 km away from the western Alps, such as Trentino and Friuli, were receiving about 70% of their axes from the western Alps, implies a significant export activity, which was extended also towards other parts of Europe." While this region appears to have been a source of most of the early jadeite artifacts found in Europe, there may have been other

sources as well, but these have yet to be found and small sources may have been worked out long ago. Elsewhere is Europe, Essene (1969) describes jadeite discovered on the island of Corsica. Frey and Skelton (1991: 260) remark that the raw material found in Europe is not of gem quality and, therefore, has generated relatively little interest except among archaeologists.

Turkey. Jadeite has been found in a few locations in Turkey. Some of this jadeite is commercially exploited and exported as jade. The source of the jadeite is east of Balikesir in northwestern Turkey in what is known as the Tavsanli Zone. Okay (1984) describes this zone as a "tectonic belt of blueschist, volcano-sedimentary complex and ophiolite" that measures between fifty and sixty kilometers wide and some 300 kilometers long. Within this zone are found what Okay (1997: 835; also see Okay 1980) refers to as "jadeite—K-feldspar rocks" and notes that "unlike... classical jadeites, which occur as blocks in serpentine and have a largely metasomatic origin, jadeite—K-feldspar rocks from northwest Turkey are found as blocks in the Miocene debris flows and represent metamorphosed phonolites." He continues his description (1997: 837):

> The breccia layer consists of very poorly sorted, matrix supported blocks of blueschist, peridotite, marble and jadeite—K-feldspar rock in a mudstone/sandstone matrix. The size of the clasts ranges from 3m down to a few mm with jadeite—K-feldspar rocks forming the largest blocks... The farmers have carried most of these blocks to the margins of their fields and have used them to make stone walls. All the exported jadeite—K-feldspar rocks come from these stone walls or from the boulders in the fields.

In general appearance, the rocks are described by Okay (1997: 838) as "very tough, white, pale green to purple rocks with a fine-grained homogeneous texture."

In his 1997 article Okay analyzes eight samples (page 838). The jadeite content ranges from 34% to 85% and the K-feldspar content from 43% to none. In general, the higher the percentage of jadeite the lower the percentage of K-feldspar. Other elements found in the stones in include aegirine, lawsonite, albite (in only one of the samples), sericite, and quartz. There are also traces of monzanite, piemontite, and magnetite in some of the samples. In regard to color, Okay (1997: 839) comments that "the striking pink colour of many of the jadeite—K-feldspar rocks comes from jadeite, which is commonly pale brownish pink in thin-section. The origin of the colour if jadeite is unclear but may be related to the trace elements in the mineral."

Other Localities. The mineralogical literature contains reports of jadeite being found in a few other localities. These include the Indonesian island of Sulawesi (Roever 1955) and the Pacific island of New Caledonia (Black 1970). None of this jadeite appears to have been exploited commercially. Jadeite has been reported coming from Tibet as well, but this has not been confirmed.

Wright and Chadbourne (1970: 76) discuss the possibility of jadeite being found in the Middle East in Bibical times:

> Since jade has been found in a number of archaeological digs in bible lands, it must hve been a familiar gemstone of early cultures... *The International Bible Encyclopedia and Concordance* printed in 1908 suggests that 'jasper' as used in the Scriptures might well be translated jade in many instances. In Revelation when jasper 'clear as crystal' is mentioned, fine translucent jade could be the gem to which it refers (21:11)... Merrill F. Unger explains that considerable uncertainty is found regarding the Greek term *iaspis,* usually translated jasper. Ancient peoples likely included lovely green jade as well as several hues of translucent chalcedony as iaspis. The greek word often is used not so much to describe color or other special optical properties of the gem, but to indicate qualities of an object too beautiful to describe adequtely. The delicate hues of jade with its translucency approaching the clarity of crystal might be the highly esteemed and cherished gem of the people of Bible days.

In fact, it would seem likely that the various stones referred to as *iaspis* do not include jadeite, but are other simulants instead.

6. Mining and Cutting Jadeite

Jadeite in Burma is mined in the mountains and rivers. The center of the industry remains the Uru River valley, where the vast majority of jadeite is recovered from alluvial deposits. The jadeite from such sources is found in rounded boulders with a relatively thin outer layer and is referred to as "river jade". Jadeite traders tend to associate the best quality of rough jadeite with river jade. This is because weathering tends to remove damaged areas from the stone and the thin skin of the rough stone allows for a more accurate assessment of the quality of the jadeite within. The jadeite located in hillside sites is found in irregular chunks. This jadeite is called "mountain jade". Mountain jadeite stones usually are covered with a relatively thick outer layer that is called "mist" by Chinese traders. Jadeite dikes are the most desirable forms of deposit to discover: "It is said that to find a dike is to become an instant millionaire. For whilst ordinary miners flail away in the common soil, only rarely turning up a boulder of jade, the dike is the mother lode itself, a bridge straight to heaven" (Hughes, *et al* 1996-97). Some dikes contain only jadeite and albite. Others have a boundary on one or both sides of dark gray to blue-black amphibolite-eckermannite-glaucophan or dark green actinolite. Chhibber (1934) describes the boundary with serpentinite as being marked by a soft, green border zone that consists of a mixture of the adjacent vein minerals and chlorite, with or without calcite, actinolite, talc, and cherty masses.

There are numerous descriptions of jadeite mining in Burma from the late nineteenth and early twentieth centuries. Warry (1888, quoted in Hertz 1912), for example, provides an early description of the mining at Tawmaw:

> At the end of seven and a half miles from Sanka we emerged upon a broad plateau, some hundreds of acres in extant, the whole of which had been cleared for mining purposes. The excavations, which were in some cases of considerable depth, presented the general

> appearance of a series of limestone quarries at home. The largest quarry measured about 50 yards in length by 40 broad and 20 deep. The bottom was flooded to a depth of a few feet. It is the joint property of 120 Kachins in equal shares, one of which is held by Kansi Nawng, the principal Sawbwa of the district... There were at the time of our visit elaborate bamboo structures over some of the largest quarries for the purpose of bailing out the water. When the floor of the pit can be kept dry a few hours – and this is as a rule only possible in February and March – immense fires are lighted at the base of the stone. A careful watch must then be kept, in a tremendous heat, in order to detect the first signs of splitting. When these occur the Kachins immediately attack the stone with pickaxes and hammers, or detach portions by hauling on leavers inserted in the crack. All this must be done when the stone is at its highest temperature, and the Kachins protect themselves from the fierce heat by fastening layers of plantain leaves round the exposed parts of their persons..."

The jade mining industry in Burma has grown in recent years following a peace agreement with rebels associated with the Kachin Independence Army in February 1993 and subsequent liberalization of the mining industry. Hughes, *et al* (1996-97) remarked after a visit to the mining area in Burma in 1996, "government liberalization of the mining and trading sectors has brought renewed vigor to the quest for jade. Long-abandoned mines are being reclaimed and everywhere one looks, signs of the current renaissance are on display." Hughes discussed mining with a local Jingpho (Kachin) headman who told him that mining around his village had begun only four years previously, although the village had been there for centuries. Mining concessions are awarded by the government. While some Jingpho are engaged in jadeite mining, Hughes, *et al* (1996-97) note that most of those holding concessions are Chinese (i.e., ethnic Chinese in Burma). The jadeite-bearing boulders are evaluated by a government-appointed committee and then taxed at the rate of ten percent of the appraised value.

Chhibber (1934: 44-65) provides descriptions of various mining operations in Burma in the early twentieth century. The mines associated with some of the major dikes could be relatively extensive, with a number of shafts cut into the jadeite dikes. Elsewhere people simply search the terrain or rivers and streams for jadeite boulders. Chhibber (1934: 65) even mentions that "in places the Shans dive in the Uru *chaung* [river] in search of the precious stone."[6] Mining methods do not appear to have changed much over the years. One change noted by Hughes, *et al* (1996-97) during their 1996 visit is that, while in the past "miners employed fire and water to break away pieces of the jade," since the peace accord miners have been able to use dynamite, allowing them to blast through rock that with "a day's worth of drilling might only penetrate 12 inches."

During their 1996 visit to the jadeite mining area in Burma, Hughes, *et al* (1996-97) visited Maw-sisa, among the most active jadeite mines in the Hpakan region:

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[6] Hughes (www.cigem.ca) describes a similar scene in 1996: "During seasons when the river is high, particularly at Mamon, men dive for jade. Air is supplied via a crude air pump, something akin to a triple bicycle hand pump. While those on land furiously works the pump, the diver hops into the water and searches for jade with the plastic hose between his teeth, all the while hoping and praying those up above don't forget just who's down there."

> Maw-sisa is, in many respects, the quintessential mine, with jade recovered from alluvial deposits in the Uru river conglomerate. This formation is as much as 1000-feet deep in places, and present mining has just scratched the surface. Thus jadeite hoarders should take note--from what we could see, there is a good millennia or three's worth of material remaining to be extracted. Each mining claim is just 15-feet wide; to keep from encroaching into the neighbor's area, a thin wall of earth and boulders is left as a partition. When seen from above, the result is spectacular --several square miles of stair-step like benches, resembling nothing so much as a massive archeological dig. But diggers here do not search for mere bones or shards of pottery. Instead, they seek the Chinese holy grail, small pieces of heaven... At Maw-sisa, diggers were mining a black layer, locally termed *ah may jaw*. While jade is said to be richest in this layer, it can occur anywhere in the conglomerate. The first step in mining is removal of the overburden, *taung moo kyen* (literally 'head cap removal'). Since the overburden is also conglomerate, it may also contain jade, so the workers must search this, too. We saw people working about 50 feet into the conglomerate, which is stripped away with primitive tools. Miners were asked how often they find jade. They said it depends on luck. While some days they might find up to 25 pieces, other times they might go for days without finding anything. In terms of size, some boulders are 200 300 kg, some even as big as a house, but most are less than 1 kg.

Hughes, *et al* (1996-97) describe a somewhat different style of mining near Hweka, the center of jadeite mining in the Hweka Makabin area: "At the top of the mountain, ingenious mining pools have been excavated. When enough water accumulates, a gate is opened, allowing water to rush down and "sluice" the hillside below. Later, men will come to examine the boulders thus uncovered, looking for that special texture and feeling that sends the pulse racing--jade."

One especially interesting aspect of jadeite mining is how miners determine that a boulder in fact contains jadeite. Hughes, *et al* (1996-97) discusses this at length:

> ... miners look for something which, in the vernacular is called *yumm*, a fibrous texture. Ordinary boulders show a reflection of mica or sand, while jadeite is smooth, with *yumm*, and without particle reflections. In addition to the fibrous texture, jadeite also tends to stick slightly to one's hand or foot under water. It also has a different sound when struck with a pick, as well as having a greater heft (density) than ordinary stones. Miners also look also something called *shin*, which, from what we could gather, is the type of sheen seen on schist. Black shin is said to "damage" the stone, apparently being an indication of increased iron content (chloromelanite). They also look for the show points, where the jade color shows through the skin.

Hughes, Galibert, *et al* (2000: 11-13) provide additional descriptions of jadeite mining in Burma:

> **Dike Mining.** Unlike secondary deposits, where the miner has to determine which of the myriad boulders is jadeite, the dikes contain readily recognizable material. Historically, miners started a fire near the dike and then threw water on the rock to crack it. Today, at Tawmaw, often miners first must use backhoes, scrapers, and other earth-moving equipment to expose the jadeite dikes, or rudimentary digging to create shafts to reach them. Shafts observed [in 1997] reached depths of approximately 10–20 [meters]. Once a dike is exposed, miners use dynamite and jackhammers to break the jadeite apart and away from the country rock...

Boulder and Gravel Mining. The workings at Sate Mu and Maw-sisa are, in many respects, typical of secondary jadeite mines. The Uru Boulder Conglomerate is as much as 300 m deep in places, and alluvial mining has barely scratched the surface. It appeared from the open cuts that there is a huge quantity of material remaining to be extracted. We saw people working about 18 m down into the conglomerate, stripping it away with primitive tools.

The first step in mining the conglomerate is removal of the overburden, *taung moo kyen* (literally, "head cap removal"). Since the "overburden" (... a layer of alluvium of variable thickness followed by a pebble-gravel layer over the Uru Conglomerate) also may contain jadeite, workers must search this material, too. Each claim is only about 5 m wide; to keep from encroaching onto the neighbor's area, miners leave a thin wall of conglomerate as a partition. Eventually the walls themselves weather away; nevertheless, when seen from above, the result is spectacular – several square kilometers of step-like benches, as if an ancient city were being excavated. At Maw-sisa, diggers concentrated on mining a black conglomerate layer called *ah may jaw*, where jadeite is said to be richest.

At Hpakangyi, more than 10,000 workers excavated an area that had reached hundreds of meters deep. Waste was piled into a waiting truck, and then emptied directly into the river that bisects Hpakan. At the dump, jade pickers scrambled over the riverbank to search for jade overlooked at the source. Along the banks of the Uru River, large mounds of boulders attest to two centuries of mining. When the water level is high, the river is worked by divers breathing via crude air pumps.

Relatively little cutting of jadeite is done in northern Burma, where most of the raw material is mined. Usually traders simply bid on the rough boulders. Ward (1996: 44) refers to this as "the ultimate Chinese gem gamble." While jadeite traders commonly claim that they can predict what is inside of such a boulder through careful examination of the outside, Hughes, *et al* (1996-97) are skeptical: "anyone who has ever seen boulders sawn open can prove the lie in that old wives' tale. Even for experts, much guesswork is still involved." Chhibbner (1934: 81) notes that "sometimes before a boulder of jade is sold, if it is promising, certain portions are polished to expose clearly to view the more valuable parts of the stone." Walker (1991: 24) refers to this as being 'mawed': "that is, a flat of about 1 x 1 1/2 inches (2.5x4 cm) is cut and polished on the material in an attempt to reveal the boulder's interior colour." This is still the practice at government auctions held in Yangon. Johnson and Koivula (1998) warn that such "windows" (as they are commonly called) should be checked for artificial coatings or other tampering, which may give a false impression of the material within the stone. Sometimes the jadeite rough is simply cut in half to expose the interior. However, a great deal of care is required prior to cutting open a boulder. The cutter runs the risk of cutting through and ruining a good area. Hughes, *et al* (1996-97) note that "before cutting, the surface is carefully examined to select the best place for sawing. While it is difficult to see through the skin, some cracks can be seen. This is important, as fractures can have a dramatic impact on value. There is no specific formula for cutting--it all depends on individual judgment and the rough's features." Lee (1956) describes a more careful means of evaluating jadeite boulders that involves grinding away the skin. Hughes, Galibert, *et al* (2000) report that "alternatively, some owners gradually slice the boulder from one end (perhaps the thickness of a bangle, so that each slice can be used for

bangles or cabochons) until they hit good color. They then repeat the process from the opposite end, the top, and the bottom, until the area of best color is isolated."

Chhibber (1934: 83) briefly discusses jadeite lapidary work prior to the Second World War. He notes that, even in Burma, "the methods employed in the cutting of jadeite... are really Chinese." In Burma most cutting was done in Mandalay, although some was done at Mogaung and a very small amount at the mines themselves. Cutting jadeite in Burma was limited to "surface carving and bead-making." Otherwise more complex carving was done in China: "it appears that jade cutting and carving is a very extensive industry in China, the most important centers being Canton, Shanghai and Peking, though some cutting is done in Hong Kong also." He also mentions cutting being done in Teng Yueh in Yunnan.

With the communist seizure of power in China in the late 1940s, jadeite cutting and carving came to be centered in Hong Kong. Hong Kong remains the world center for cutting and carving jadeite. As for Burma, Hughes, *et al* (1996-97), visiting the jadeite mining region of northern Burma in mid-1996, comment: "Considering the large quantity of jade taken out of the ground in the Hpakan area and the tremendous difficulties involved in its transportation, it is surprising that so little seems to be cut on site... Other than one market just outside Lonkin, we saw no cutting in the Hpakan area. Instead, most jade is hauled out for cutting elsewhere. Mandalay is by far the biggest cutting and trading center for jade in Burma, but there is also a jade market in Mogaung." Some Burmese jadeite is also cut and carved in China and Thailand.

Within Guatemala, jadeite is currently being mined in the Motagua River Valley and it is being cut elsewhere in the country. The largest company engaged in this mining is Jades, S.A., although there are many smaller operations as well.

7. Treatment of Jadeite

The treatment of jadeite in an effort to enhance its value has a long history, but it has become an especially widespread phenomenon in recent years. With the appearance of jadeite that had been bleached and then impregnated with polymer on the market in the 1980s it became common practice to classify jadeite according to the presence and type of treatment. At first there were three categories—"A", "B" and "C" (see Fritsch, *et al* 1992, Mok 1999: 10). More recently a fourth category, "D", has been added. The "A" category essentially refers to untreated jadeite. After the surface of cut jadeite is polished it is often waxed with beeswax to fill surface pores. This is a long-standing practice and is not considered to detract from the value of the stone. Treated forms of jadeite are categorized as "B" jade, "C" jade, and "D" jade respectively.

It should be noted that the types of treatment discussed here are associated with Burmese jadeite. In the case of Guatemalan jadeite, for example, Miller (2001: 29) states that "no heat treatments or other enhancements are used in Guatemalan jadeite."

A Jade. So-called "A" jade is commonly dipped in wax to improve its luster and fill surface fractures and pits. Virtually all jadeite undergoes this process after being cut and polished. The first step of the process is to soak the stone in a warm alkaline solution for five to ten minutes in order to remove the residue remaining after polishing. The stone is removed from the solution and rinsed and dried. Next it is soaked in an acidic solution known as "plum sauce" to remove residue from the alkaline solution. Once again, it is removed and rinsed and dried. Then it is placed in boiling water for several minutes. This is said to "open the pores" of the stone and serves to bring it to the right temperature so that it will not crack when placed in the wax solution. Now the stone is ready to be placed in a solution of melted wax for anywhere from a few minutes up to several hours. After it is removed from the melted wax and allowed to cool, the stone is polished with a cloth.

C Jade. Let us turn next to the so-called "C" jade since the type of treatment associated with this type of jadeite has been around for a while. This category refers to jadeite that has been stained or dyed. Wu (1997), Ehrmann (1958), Ng and Root (1984), and Ho (1996) are among the authors who have discussed and described this method of treating jadeite in Hong Kong. Staining white stones green (particularly to an imperial jade color) or lavender is the most common practice, but stones are sometimes stained red or yellow as well. Wu (1997) notes that staining pale colored material with vegetable or other organic dyes to produce green, lavender, and orange-brown jadeite has been done in Hong Kong since at least the 1950s. Ehrmann (1958: 134-135) provides a description of the process as shown to him by one of its practitioners in Hong Kong:

> He arrived with all kinds of paraphernalia, including a small charcoal burner, various shaped bottles, tweezers, towels, wax, and a grate... The method was extremely simple. The stones had been cut encabochon from fine-quality, translucent, whitish-gray material. He heated them on a grate on top of the charcoal burner until they turned to a glossy, opaque finish. He then cooled them for about a minute and then placed them into a prepared dye solution for a short time. (Under normal circumstances, the stones are left in this dye solution for forty-eight hours.) After removal from the solution, they were rinsed in alcohol, dried on a towel and put aside. in the meantime he had heated paraffin wax very slowly in a double boiler. The stones were placed in the melting wax until they were completely covered, then removed and wiped carefully. The basic coloring dye was an acid-base dye-stuff, such as is used in dyeing cloth. In this case, he used a yellow dye and a blue dye.

Not only is jadeite dyed to increase its value, but jadeite simulants are also dyed to imitate jadeite. This appears to be a very old practice and it is likely that the practice of dyeing jadeite itself is probably far older than the 1950s as well. Goette, in his 1937 classic *Jade Lore* (reprinted in 1976), provides a brief discussion about dyeing (page 118): "Sometimes soapstone and other white substances are dyed in browns and greens in imitation of either nephrite or jadeite" and that

"specimens of white stone" are also "dyed a sickly pink." He notes, however, that "in such cases, the detection is comparatively simple, for the coloring is streaked, and apt to be darker along the veins of the stone" and, in the case of those stones dyed pink, that "no one could possibly mistake them for jade, but if they should be, certainly the buyer has little cause to complain of the vendor's dishonesty." It is apparent from Goette's discussion that the quality of dyeing has improved considerably in recent decades.

Webster (1975: 233) states that while "green-stained jadeite is prone to fade," lavender-stained jadeite does not appear to fade. Hughes, Galibert, *et al* (2000: 23), however, report that they "have seen fading in both dyed green and dyed lavender jades, but the green dyes tend to fade more readily."

Read (1999: 161) states that "most dyes can be removed with the aid of a cotton swab moistened with a solvent such as acetone." Staining can be detected through magnification as well through tests with a Chelsea filter, spectroscope, or long-wave ultraviolet light. In regard to magnification, staining is usually concentrated along grain boundaries or surface cracks rather than throughout the stone. When examined through a Chelsea filter, un-dyed jadeite will not show the red color that appears in the case of dyed jadeite (or nephrite). Read (1999: 160) reports that a spectroscope test "will usually show a tell-tale broad absorption band in the red due to the dye, and an absence of typical chromium lines in the same part of the spectrum" in the case of stained green jadeite. Mok (1999: 12) describes some material dyed green thus: "green jadeite dyed with chromium salts will show a broad fuzzy band in the red." He says (1999: 160-161) that "dyed mauve jadeite may exhibit a bright orange fluorescence under long-wave ultraviolet." Hobbs (1982) writes that a broad band from about 630 to 670 nm in the red region of the visible spectrum is considered proof of dye in green jadeite. Some of the newer dyes may also show a weaker band at 600 nm. Since stones may be only partially dyed, the entire piece should be checked. Koivula (1982) discusses jadeite that has been dyed lavender, noting that such jadeite shows orange under long-wave ultra-violet light. Field (2000: 3) remarks that "anything but a pale shade [of lavender] is immediately suspect." Webster (1975: 233) describes such stones as having a color that is "too pronounced" and that the "stones look unreal."

B and D Jade. The categories "B" and "D" jade refer to jadeite that has been bleached and then impregnated with polymer. Mason-Kay Fine Jade Jewelry refers to "B" jade as "the bad stuff" and "D" jade as "the worst stuff of all" (www.masonkay.com/whatisbjade, pg. 1). Don Kay, of Mason-Kay, is quoted as stating that "the *majority* of jade pieces seen on the market today are "B" jades" (Miller 1999: 91). Fritsch, *et al* (1992: 178) report that one of the authors of the article "saw this type of treated jadeite as early as 1984." However, widespread public knowledge of this problem did not emerge until around 1988. Writing only a few years later, Fritsch, *et al* (1992: 178) mention that "today, significant amounts of jadeite treated in this fashion are believed to have

entered the market via treatment facilities in Hong Kong and Taiwan" and comment that "in the experience of one of the authors..., as much as 90% of the jadeite sold in Taiwan has been treated in this fashion' dealers report that large amounts of this material are being sold in Hong Kong as well."

So-called "B" jade is made from jadeite that is blemished with internal stains. Basically, this is jadeite that if left untreated would be worth relatively little. Fritsch, *et al* (1992: 176) report that apparently only green and white jadeite are treated in this manner. The stone is immersed in a powerful acid (e.g., sulfuric or hydrochloric acid). The acid may be heated to increase its strength. The stone can be immersed more than once over a period of several weeks. The acid immersion leaches the sodium out of the stone and in the process removes the stains. Mason-Kay comments that "at this point, it could be said, one no longer has jadeite jade at all." The stone is then placed in a neutralizing agent. Then it is injected with a polymer with the use of a centrifuge. This process serves to completely cover the stone in a hard and clear plastic-like coating.

Fritsch, *et al* (1992: 178-180) provide a relatively detailed description of the treatment, but do not positively identify the ploymers used. Using Fourier transform infrared transmission and x-ray photoelectron spectroscopy, Quek and Tan (1998) identify the polymer as polystyrene. The authors comment (1998: 171) that polystyrene has several properties that make it suitable for impregnation: "it is hard, cheap, readily available, has low moisture absorption, is easy to fabricate and has surface smoothness and clearness." Moreover, they note that not only is polystyrene easy to use for this purpose, but "detection is extremely difficult, especially when only small amounts of the polymer are used."

Beyond the matter of fraud, there are problems with the durability of "B" jade. Mason-Kay reports (www.masonkay.com/whatisbjade, pages 1-2):

> Current research indicated that 'B' jade will, in time, become unstable and will discolor. We already know that it is not nearly as durable as natural jade, and that ordinary household detergents can break down the polymer. Whereas real jade is often cleaned with acetone..., 'B' jade completely clouds up when acetone is applied. There are reports of 'acid leak' from improperly neutralized stones (skin burns are the result). Heavy prongs or bezels can actually penetrate the weakened surface of the treated stone.

Quek and Tan (1998: 171) note that polystyrene that is used for impregation "degrades under ultra-violet light" and that "this could be the reason why some treated jadeites turn dark and have a greyish colour after some time."

Understandably, there is considerable interest in the identification of "B" jade. In her discussion of the problems facing appraisers confronted with the "B" jade problem, Anna Miller (1999: 91) remarks that identifying such jade "is destined to become the big buying and selling issue of the next decade." Fritsch, *et al* (1992: 181-182) tested jadeite for treatment by means of specific gravity. The bleached stones that they tested initially had a lower specific gravity (3.22 to

3.25) than untreated stones (about 3.32). However, some jadeites are lighter due to an admixture of amphiboles or feldspars and, moreover, later they encountered bleached stones that exhibited less difference when tested in this manner. As a result of these findings, they warn that "specific gravity provides a generally useful indication, but not proof, of 'bleaching treatment." Fritsch, *et al* (1992: 182) also tested by means of ultraviolet luminescence and found that "a bluish white to yellowish green luminescence to long-wave U.V. radiation provides a useful indication of treatment," but warn that "the reaction is sometimes faint and can easily be missed." For this and other reasons, they conclude that "this identification criterion alone cannot be considered conclusive."

"The only definitive test" that Fritsch, *et al* (1992: 186) found was infrared spectroscopy using a Fourier-Transform Infrared Spectroscope (otherwise known as FT-IR or Fourier Transform Infra-Red). The presence of a very intense group of peaks around 2900 cm^{-1} and accompanying features in the mid- and near-infrared regions is characteristic of polymer impregnation. Mok (1999: 12) notes that "because resin is [a] hydrocarbon organic substance, it will display a diagnostic spectrum under the FTIR test." Using a Fourier-Transform Infrared Spectroscope with a near-IR fiber-optic probe accessory, Gao and Zhang (1999: 306) found that this was "an effective and easy method for testing jade in various kinds of jewellery, and is particularly applicable to large samples." Unfortunately, such equipment is expensive. Miller (1999: 90-91) reports that at the time of her writing there were only two such units available for testing jadeite in North America: one owned by the GIA and the other by Mason-Kay. In Asia, she noted that the Far East Gemological Laboratory in Singapore had a unit and that several laboratories in Hong Kong had one. Mason-Kay obtained its FT-IR in 1995 and, as of early 2001, remained the only commercial firm in North America with such technology for jadeite testing.

Despite such assurances and the widespread acceptance of FT-IR testing, there are problems associated with it and there are also other possible ways of testing for treated jadeite. Tan, *et al* (1995: 475) note that "the identification of treated jadeite using infrared spectrocopy is severely limited by its response in only certain parts of the mid- and near-infrared frequency ranges and by the restriction of this measurement to specimens of thin jadeite [no more than 12 mm thick according to Quek and Tan (1997: 417)] which is not opaque to infrared transmisions." Additional problems are that FT-IR "may not be able to detect impregnation materials other than wax and polymers (Tan, *et al* 1995: 482) and it cannot be used if the stone is "already a part of a piece of closed-setting jewellery" (Quek and Tan 1997: 417). Tay Thye Sun, S. Paul, and C.M. Puah (1993) report that polymer-impregnation can also be tested by using a Scanning Electron Microscope to examine the damaged grain boundaries. However, this equipment is even rarer and more expensive to use than the Fourier-Transform Infrared Spectroscope and its findings are not unambiguous.

Tan, *et al* (1995) 475) sought to overcome the above diagnostic limitations by using X-ray photoelectron spectroscopy (XPS), which they note (page 479) "has been shown to be a useful tool

for studies of chemical compositions of polymers." With a sample of sixteen stones that included four rough pieces, five natural untreated polished stones, and seven stones that had been treated, the authors found XPS to be "a useful non-destructive technique distinguishing unambiguously bleached impregnated jadeites (B-jade) from the natural and untreated ones" (page 475). Furthermore, they note that "this non-desctructive technique has been found to be capable of determining the chemical composition of the surface of jadeite and thus can identify foreign elements present" (page 482). Once again, however, the equipment for this test is rare and expensive: "its use is severely restricted to research laboratories as the apparatus is expensive and eleborate expertise is required" (Quek and Tan 1997: 410).

Noting that the technique had been used previously in gemmology for other purposes, Quek and Tan (1997) used diffuse reflectance infrared Fourier transform (DRIFT) spectroscopy to test for B jade. The equipment used in the test included a PerkinElmer System 2000 FT-IR spectrophotometer with a fast recovery deuterated triglycerine sulphate detector and a Harrick Diffuse Reflectance Attachment (HDRA) (see pages 420-421). The authors used a sample of three wax-buffed stones, three bleached wax-impregnated stones, and four bleached polymer-impregated stones. The samples were also tested using the XPS technique. With the XPS test, Quek and Tan (1997: 420) found that it was "difficult to distinguish a wax-buffed jadeite from that which is wax-impregnated." The DRIFT test proved useful in "differentiating a natural (wax-buffed) jadeite from one which is treated, and from one which is wax-impregnated from one which is polymer-impregnated" (Quek and Tan 1997: 426). The authors point to a number of advantages to using the DRIFT technique:

> It is a relatively inexpensive and yet accurate way of differentiating natural and untreated jadeite from bleached wax- and polymer-impregnated jadeites. Also, since only the surface of the jadeite sample is tested, the thickness of the jad esample or whether it is part of a piece of jewellery is not of any consequence... In addition, the sensitivity of the DRIFT technique allows the reliable identification of the chemical composition of the surface coating of the jadeite sample.

Emphasis should be placed on the word "relatively" since this test is relatively inexpensive only when compared to the other tests discussed above and still does not allow for a truly inexpensive test available to most gemologists.

Mention should also be made of the practice of treating jadeite in order to make it appear older (i.e., to make new pieces appear to be antique). Hu (1976: xi) describes a long-standing Chinese practice: "Various acids were used to color jade, and new pieces were often buried in quicklime with dead animals for several years. This process changes their color so that imitations can hardly be detected from genuine ancient pieces." This is more of an issue with purported antique nephrite pieces, but indicates that care should be taken with supposedly older jadeite pieces as well.

8. Assembled Stones

Various types of assembled or composite pieces of jadeite appear to have been around for some time. Writing in the 1950s, Ehrmann (1958: 135, 158) describes a type of assembled jadeite triplet made in Hong Kong. The triplet is comprised of a hollow cabochon of very fine translucent white jadeite that is about 0.5 millimeter thick, a smaller cabochon that is cut to fit into the hollow one, and a piece of flat, oval jadeite that covers the bottom. The center of the cabochon is "colored with a jelly-like dye of the same color as the finest Imperial jade." The oval bottom is glued to the top and repolished. Ehrmann (1958: 158) states that "When unset, such triplets can be recognized easily by the seam on the bottom of the cabochon." But warns that once set "in the Chinese fashion (i.e., with a plate covering at the bottom of the stone, making the ridge invisible)... the result is perfect, giving the appearance of the finest quality, most expensive jadeite." A more conventional triplet was reported by the GIA in the mid-1960s "containing a green cement layer" (Walker 1991: 35).

A prominent travel guide to Hong Kong published in the 1980s warns travelers to look out for a type of jadeite triplet: "One trick of jade merchants is to sell a supposedly solid piece of jade jewellery which is actually a thin slice of jade backed by green glue and a quartz" (Clewlow 1986: 160). Webster (1975: 233) discusses what he describes as "an ingenious jadeite triplet." The process involves cementing a thin hollow cabochon top made of pale green highly translucent jadeite over a cabochon core and using green-colored cement. The base is made of a third piece of flat jadeite of inferior quality. The pieces are made of white jadeite that is stained green. Kammerling and McClure (1995) describe another version of assembled jadeite. The top of this one is made from an extremely thin piece of extremely dark green jadeite. The thinness of the jadeite allows light to pass through the stone in order to create the illusion that it is a piece of fine Imperial jade. The piece is filled with an epoxy-like substance and then mounted in such a way that the back is hidden. With some versions, the jadeite cabochon is dyed and then varnished (Koivula, Kammerling, and Fritsch 1994).

Walker (1991: 35) warns that "with adequate illlumination, a loose or unmounted jadeite triplet is easy to spot. But if the triplet is mounted in rings, earrings or cuff links, with covered backs, the separation plane is not readily visible." Testing wit a refractometer is little help with most of these triplets since they are made of pieces of jadeite. Discrepancies can often be detected under magnification. These include bubbles in the various substances used.

Hughes, Galibert, *et al* (2000: 23-24) discuss various types of assembled rough jadeite. This includes one type where the outer skin of the boulder is removed and then the surface if painted or stained green. Then the stone is immersed in chemicals which deposit a new oxidation layer on the surface. The authors note that "unlike the skin on genuine jadeite boulders, which is extremely tough and can be removed only by grinding, the fake skins are soft and easily taken off." In another

version the core of the boulder is sawn or drilled out and then a green-colored filling and reflector are inserted. The hole is covered with a mixture of epoxy and grindings from the boulder surface. Sometimes only the window of the stone is treated. This can entail breaking off a chip from the boulder, staining it green, and then replaced it with epoxy so that when a window is cut on the stone it shows the faked green color. A somewhat easier method is simply to stain the window area green.

9. Synthetic Jadeite

The American company Mason-Kay Fine Jade Jewelry states that synthetics of jadeite "are not a problem" (www.masonkay.com/jadesimulants, page 1). Read (1999: 189) reports that the General Electric company in the United States produced various colors of synthetic jadeite in 1984, but that "these synthetic jadeites were said to be the product of an experimental study, and the company has no plans for commercial production." The starting material for this synthetic jadeite "included crushed glass as well as alumina and sodium carbonate, and was processed in a high-pressure apparatus at a temperature of about 1400^{o}C" (Read 1999: 189).

10. Simulants

There are a number of stones that look similar to jadeite and that can be confused with it. In some cases such stones are used as a substitute, often with the intent to defraud. In its web-page, the Mason-Kay Fine Jade Jewelry company remarks: "Jade is probably the most mis-identified of all important gemstones. There are many minerals that have a passing resemblance to jadeite and nephrite, and they are often misrepresented as jade. The high value of jade has made it a favorite target" (www.masonkay.com/jadesimulants, pg. 1). The Department of Geology at the University of Texas-Austin web site comments:

> The name jade has been, and continues to be, applied to a variety of materials that superficially or closely resemble jade but are not composed of either jadeite or nephrite. F.T.C. regulations in this country [the United States] deem such usage unlawful, yet the practice persists, either through ignorance or otherwise. Some of the problem can undoubtedly be traced to cultural and historical differences in word usage. In China, for example, the word jade has traditionally been applied not only to nephrite and jadeite jade, but to green serpentine and soapstone (talc) whose appearance closely resemble true jade.

In his discussion of jade materials produced in Precolumbian Mesoamerica, Lange (1993a: 1) distinguishes between what he calls "cultural jade" and "social jade": "social jade characterizes those nonjade materials (quartz and serpentine among others) that were also fashioned into pendants and other forms similar to artifacts made from true jade." Many of these stones can be told apart from jadeite through careful observation and all potentially can be separated from jadeite

through use of the refractometer. Unfortunately, the form of the objects or their use in jewelry often precludes the use of a refractometer. Thus, it is often necessary to use other means of testing the stones. The following is a list of the various simulants with a brief discussion of their characteristics. The list has been derived from a variety of sources (e.g., Whitlock and Ehrmann 1949: 28-29; Read 1999: 222; Lyman 1986; Schumann 1997; Hall 1994; Hankin 1998; Koivula 1982; and Field 2000).

1) ***Agalmatolite.*** The greenish variety is often used to imitate jadeite. It is also called pagodite, pyrophyllite, and "figure stone". Webster (1975: 232) notes that "the lower density, about 2.80, confirmed by the low hardness of 2.5 on Moh's scale precludes any confusion with the jades." It is found in Finland, Slovakia, South Africa, and the United States.

2) ***Alabaster.*** Alabaster is sometimes dyed to simulate lavender jadeite (see Field 2000: 3). Its refractive index is 1.52-1.53.

3) ***Amazonite.*** Amazonite is an opaque sodium feldspar ($KAlSi_3O_8$) that is found in green and blue-green colors. Its refractive index is 1.522-1.530 (some sources give it as 1.52-1.54), its specific gravity is 2.56, and its hardness is 6. In addition to these distinguishing characteristics, Amazonite also has a different look than jadeite (or nephrite). It is found in the United States (Colorado, and hence sometimes called "Colorado Jade"), Brazil ("Amazon Jade"), India, Kenya, Madagascar, Namibia, and Russia.

4) ***Astridite.*** I have been able to find relatively little information on this stone, but Webster (1975: 232) lists it as a jade simulant. He describes it as "a chrome-rich precious stone said to be of a dark green colour with lighter coloured veins and to be a chrome-rich jadeite intergrown with picotite, quartz, opal and limonite, and to have been derived from an olivine rock." It has a density of 3.35. He states that it comes from "New Guinea", but does not elaborate as to whether this means Papua New Guinea or Irian Jaya (Indonesia). I have tried to find more information on this stone, but have found it mentioned in only one of the web-sites that I consulted. Mindat.org describes astridite as "an ornamental stone, primarily chromian Jadeite," but adds that its IMA status is "not approved", its locality is doubtful, and there are no references on the stone.

5) ***Aventurine.*** This variety of quartz (Hauff 1993: 86 describes it as quartz with fuchsite) comes in light to dark green often with metallic iridescence that is known as aventurescence. Hobbs (1982: 11) describes the fuchsite inclusions found in aventurine as densely packed round green platlets ("disc-like"). It is sometimes referred to as "Regal jade" or Imperial yu". Its refractive index is 1.544-1.553 (some sources give it as 1.54). Its specific gravity is 2.66 and its hardness 7.0. Aventurine is sometimes dyed. Webster (1975: 232) notes that it "is so manifestly different in appearance to the true jades that no confusion should arise." Aventurine is found in Mexico, Brazil, India (hence, it is also sometimes referred to as "Indian Jade"), Austria, Russia, and Tanzania.

Garza-Valdés (1993: 109) comments that "aventurine is commonly used by fakers from Taxco, Guerrero," in Mexico.

6) ***Calcite.*** Calcite is sometimes dyed green to imitate jadeite. Such a simulant is sometimes referred to as "Mexican Jade". It is relatively soft (3). It has a refractive index of 1.486-1.658 and a specific gravity of 2.69-2.71.

7) ***Chalcedony.*** Chalcedony (SiO_2) is a quartzite that comes in a variety of colors (bluish, white, gray, green, lavender, red, red-brown, and brown). The name comes from its ancient source in the Middle East: Chalcedon, in Bithynia. The stone was widely used in the ancient world "for carving seals for identification and communication" (Wright and Chadbourne 1970: 33). Its refractive index is 1.53-1.54. Its density is from 2.58 to 2.64. Its hardness is 7. Various types of chalcedony are used to imitate jade or jadeite. A blue-green variety, sometimes referred to as **chrysocolla chalcedony**, is mined in Guerrero, Mexico, and the middle Motagua River Valley, Guatemala, and also features prominently as a material for Precolumbian Costa Rican artifacts. This variety of chalcedony is commonly referred to as "jade" in Mexico and in Guatemala it is called "Guatemalita". The color of the Mexican variety is derived from chrysocolla, a copper phyllosilicate. The Guatemalan variety also may have inclusions with pyrite, galena, and calcite (Garza-Valdés 1993: 111). It has been found in Zambia and the southern Philippines. Chalcedony that has been dyed green is sometimes referred to as "Oregon Jade" or "Swiss Jade". There is a natural green chalcedony found in Zimbabwe (its color comes from chrome) that is called "chrome chalcedony" (it is also known as mtorodite or **mtorolite**; see McLean 1967, Smith 1969). **Carnelian** is a translucent, reddish-orange variety of chalcedony. Carnelian beads are widely found in archaeological sites in the Middle East (e.g., in Jordan, Israel, Iraq, and Egypt), South Asia, and Southeast Asia. The best carnelian comes from India. India was an important source of carnelian in ancient times and remains so today. Good quality carnelian also came from the deserts of Egypt and Arabia in the past. Carnelian is also found in Central and South America and was an important Precolumbian lapidary material in Panama and Colombia. Other varieties of chalcedony from Brazil and Uruguay are dyed to look like carnelian. Carnelian is sometimes used to imitate red jadeite. It can be heat treated to turn rather dull, red stones a more lively orange-red color.

8) ***Chrysoprase.*** This is a green variety of cryptocrsytalline quartz (or chalcedony). The name is derived from two Greek words, *chrusus* (signifying gold) and *prason* (the leek, in reference to its color). The color is produced by garnierite inclusions (a nickel phyllosilicate). While generally less expensive than jadeite, it is the most expensive stone in the chalcedony group. This stone can look similar to jadeite in appearance. In addition to being used in jewelry, Wright and Chadbourne (1970: 39) mention that it is occasionaly made into larger objects, Thus, Frederick the Great's palace in Potsdam contains two tables made of the stone. They also comment that it was "admired and

used by ancient peoples" and cite the example of a "stunning necklace" with chrysoprase beads found on an Egyptian mummy dating from around 1500 BC.

Crowhurst (2001: 113) states that "though lacking the toughness of jadeite, chrysoprase is often harder, more translucent, and produces better polish and luster." The green color of the two types of stone is somewhat different (the green of chrysoprase comes from nickel), especially in the case of better quality jadeite. Its refractive index, which is given as either 1.530-1.540 or 1.55 in various sources, makes chrysoprase easy to distinguish from jadeite. Its density is given as 2.6 and 3.48 in different sources. There were well known deposits in Silesia, but these were exhausted in the nineteenth century. Today it is found in Australia (and is sometimes called "Australian jade" or "Queensland jade"), Brazil, India, Kazakhstan, Madagascar, Russia, Zimbabwe, South Africa, Tanzania, Mexico, and the United States (California). Garza-Valdés (1993: 111) notes that there have been reports of Precolumbian artifacts from Guatemala being made of chrysoprase, but comments that "I have been unable to document these findings" and "have not been able to discover it in Mesoamerica."

9) ***Glass.*** There is a long history of using glass to imitate jadeite and such glass is sometimes referred to as "Metajade" as well as "Imori" or "Iimori" after the Imori Laboratory in Japan. Webster (1975: 233) writes that "a suitably coloured and opacified lead glass makes a convincing imitation of jade." Goette (1976: 120, 122) discusses the use of glass as a simulant in China in the 1930s:

> The Chinese glass worker has added his craft to the simulation of jade, generally of the emerald green jadeite, or the mixed white and green nephrite known as American green. While the disgruntled and disillusioned visitor might charge the merchant with cheating in the sale of a string of glass beads, certainly the selling of such jewellery is not based on dishonest imitation of jade. The Chinese admire their green glass, and they like to have it approximate Fei Ts'ui in hue, form and appearance. Therefore, the glass maker has directed his efforts to copying the emerald green of jadeite as closely as possible, since, as was said before, the nearer to gem itself approaches flawless, translucent emerald green glass the better it is in quality. it is a strange circle of circumstance, this meeting of glass and jade, and it has intrigues the artisan to the point of producing examples which require careful inspection to distinguish between the two.

The density of glass simulants (about 3.7) is generally higher than that of jadeite. Webster (1975: 233) also notes that "the nature of the pieces is obvious when the surface is examined by a lense for such a glass will show pit marks where included glass bubbles have been cut across." Read (1999: 283) lists the refractive indexes of various types of glass as 1.50, 1.61, and 1.46. Hobbs (1982: 11; also see Crowningshield 1973) discusses Metajade glass made by the Iimori Laboratory in Japan and notes tht "this material can be detected by its inclusions as well as by its other optical and physical properties." Under magnification, fernplike inclusions as well as gas bubbles may be seen in metajade.

10) ***Hydrogrossular or Grossularite.*** This dense opaque greenish variety of grossular garnet is sometimes called "Transvaal jade", "garnet jade", or "South African jade". Its refractive index is 1.734-1.759 (some sources give it as 1.74-1.75) and its specific gravity is 3.6-3.67. These characteristics made it easy to tell from jadeite. It is also a little different in appearance.

11) ***Jasper.*** Jasper is a type of quartz that is sometimes categorized as part of the chalcedony group and sometimes considered to be a separate group. The refractive index of the various types of jasper is approximately 1.54. There are three varieties of jasper that are sometimes used as substitutes for jadeite (in general various forms of jasper can be called "Jasper jade"): **plasma** (a 'dirty' green color, evenly fine-grained, from Oregon and sometimes called "Oregon jade"), **prase** (leek-green; sometimes called "emerald quartz"; it is found in Germany, Finland, Australia, and Scotland), and **agate-jasper** (jasper grown together with agate, dyed to look like jade, sometimes called "Swiss jade"). Goette (1976: 120) mentions "jasper from Soochow [that] is pure white, outwardly differing little from nephrite, but being too lusterless to be confused with jadeite." He notes that it is usually made into such things as boxes, ash trays and chopsticks. A highly translucent emerald green jasper found in Guatemala is called **quetzalitztli.** Hauff (1993: 86) describes it as "quartzite + Cr-mica." The color is derived "from inclusions of small crystal of chromium-muscovite" (Garza-Valdés 1993: 111). Worked pieces of its have been found in archaeological sites.

12) ***Malachite.*** Malachite is light-green to black-green. It is sometimes called "Silver Peak jadeite". While generally opaque, when thinly cut it can be translucent. It is relatively easy to separate from other green stones when in large pieces because of its striped formation. Smaller pieces, however, can be confused with other green stones. It is fairly soft (3.5-4). Its specific gravity is 3.8 and its refractive index is 1.655-1.909. Read (1999: 282) notes that malachite shows a single shadow edge at about 1.80 on the refractometer. It is found in Russia, Zaire, South Africa, Australia, Chile, Namibia, Zimbabwe, and the United States (Arizona).

13) ***Maw-Sit-Sit.*** This is a medium to dark green and semi-translucent stone that comes from northern Burma (it is sometimes spelled *mawsitsit*) and is sometimes treated as a cariety of jadeite. It is relatively soft and brittle. It comes mainly from the Maw-sit-sit vein which is located some two kilometers from Kansi at the northeastern end of the Jade Tract. Gübelin (1965a: 234) remarks that Maw-sit-sit is a "small mining field" that "belongs to the so-called Namshamaw dike, which constitutes part of the widespread outcrop mines in the jadeite-albite rocks of the vast jade region of Tawmaw." The Maw-sit-sit mine is described by Hughes, Galibert, *et al* (2000: 14) as consisting "of a narrow, vertical trench cut that is some 9 m deep. The total length of the active mining area in November 1997 was approximately 200 m." Chhibber (1934: 79) referred to it as *"hmaw sit sit"*.

Maw-sit-sit has been described in some detail by Gübelin (1965a, 1965b, 1965c). He describes (1965a: 235) its general appearance as follows: "...an opaque stone of brilliant-green color of

medium tone with a yellowish tinge. The homogenous or sometimes cloudy distribution of the color is irregularly traversed by fine veins or spotted by uneven specks and patches of a very dark-green to black alien substance." It is composed of a highly variegated inter-growth of white albite, yellowish-white clinochlore (Mg-chlorite), green-black kosmochlor, green eckermannitic amphibole, and chromian jadeite. Tiny cervices and cavities contain colorless, yellow, or white serpentine and zeolite. The hardness of Maw-sit-sit is 6. The refractive indices recorded for Maw-sit-sit are 1.52 to 1.54. Webster (1975: 230) gives its density as ranging from 2.46 to 3.15, while Gübelin (1965a: 235) gives it as 2.77. Hughes, Galibert, *et al* (2000: 7) comment that "Maw-sit-sit is a 'cousin' of jade, but because some samples contain compact centimeter-sized regions of chromium jadeite, a clear distinction from jadeite jade can be difficult." Gübelin (1965a: 229) notes that "in the West, the stone is being offered under the name 'chloromelanite,' which certainly is a misnomer, because it has nothing in common with this mineral, not even its color."[7]

14) ***Mica.*** There are a few varieties of mica that can be confused with jadeite. ***Muscovite*** is a variety of mica that is sometimes used to imitate lavender jadeite. Garza-Valdes (1993: 116) reports that chromium-rich muscovite known as **fuchsite**, which is blue-green in color, was sometimes used in Prehispanic Central America. It has a hardness of 2-2.5. He also mentions a chromium-rich phengitic-muscovite known as **mariposite** that is blue-green in color.

15) ***Nephrite.*** "Most jade on the market is composed of nephrite" (www.geo.utexas.edu, page 1). Sometimes nephrite and jadeite are sold as distinct items, but sometimes nephrite is sold as jadeite. Discussing the sale of jade in China in the 1930s, Goette (1976: 30-31) remarks that "there are hundreds of Chinese merchants in Peking, particularly among those selling modern jade jewellery and trinkets, who are totally unaware of the fact that they are dealing in two minerals. To them jade is either green or white or otherwise colored. Whether it is Burmese jadeite or nephrite from Chinese Turkestan is beside the point." Subsequently the two stones came to occupy somewhat different places in the jade market. While at the lower end of the market, the prices for both stones are comparable, the situation is quite different at the upper ends of the respective markets: while even the best rough nephrite sells for only a few dollars a pound, "gem jadeite sells for hundreds to thousands of dollars a carat" (Ward 1998: 26). Writing about so-called "Polar jade" nephrite coming out of northern British Columbia, Ward (1998: 25) states that "The Polar jade mine produces the brightest and most translucent nephrite known, making it the first nephrite to challenge jadeite as the finest jade."

While jadeite belongs to the pyroxene group of inosilicates, nephrite belongs to the amphibole group. Minerals in both groups contain iron, magnesium, silicon, and oxygen, but only those in the

[7] A recent report in *Gems & Gemology* ("Maw-sit-sit beads," vol. 37, no. 3, 2001, p. 217) analyzes "opaque bright green cylindrical carved beads" using Raman spectra. The beads turned out to contain elements of ureyite (also known as kosmochlor) and albite feldspar and, thus, is identified as maw-sit-sit.

amphibole group contain hydroxol (OH). The presence of hydroxol alters both the physical and chemical properties of the minerals. For example, while the amphiboles have prismatic cleavage at an angle of 56˚ and 124°, pyroxene have a cleavage of 87˚ and 93˚ (almost perpendicular). As a result of such differences, while nephrite looks very similar to jadeite (in fact, it can be almost impossible to tell the two stones apart by visual inspection), there are a number of different characteristics that can be measured through various tests. The most reliable simple method to tell one from another is through a specific gravity test. The specific gravity of nephrite is 2.90-3.02, while that of jadeite is 3.30-3.50. Other distinguishing characteristics include: a refractive index for nephrite of 1.60-1.641 (some sources say about 1.62) versus about 1.66 for jadeite; nephrite's double refraction (-0.017, whereas there is often none for jadeite; nephrite's different absorption spectrum of (689), 509, 490, and 460; nephrite's lack of fluorescence, unlike jadeite; and nephrite's pleochroism that is weak yellow to brown, and green.

The main sources of nephrite are in Siberia, New Zealand, Australia, Taiwan, and British Columbia (the largest producer). Nephrite from such sources is sometimes given names associated with jade: for example, "Russian jade" for nephrite from the Lake Baikal region in Russia and "Wyoming jade" for the nephrite from that state in the United States. Curtiss (1993: 73) states that "all of the archaeological and geological samples of jade from Central America and Mesoamerica that have been examined to date have been composed of the mineral jadeite... There is no known source of nephrite in Mesoamerica or Central America."

16) ***Pectolite.*** Pectolite is found in light blue and light green. It is sometimes called "Pectolite jade" or "Alaska jade". It is relatively soft (4.5-5).

17) ***Plastic.*** Webster (1975: 233) writes that "some of the plastics are made to simulate jade by their colouring, and as far as that is concerned are quite effective," but "the exceptionally low density and the ready sectility quickly distinguishes them." Hughes (1987) mentions seeing pale jadeite cabochons for sale in Mandalay that had been coated with a layer of green plastic over the upper surface.

18) ***Prehnite.*** Prehnite is found in a yellow-green color. Webster (1975: 231) comments that "the massive *prehnite* of green colour can be a most convincing jade imitation." It is sometimes referred to as "Japanese jade". Its refractive index is 1.61-1.64. Its specific gravity is 2.88-2.89 (Hauff 1993: 86, gives it as 2.87). Its hardness is 6.0-6.5. Some of its properties are close to those of nephrite, but they are quite distinct from those of jadeite. One way of separating it from nephrite and jadeite is by viewing it through a Chelsea filter. Prehnite shows a reddish tinge, while jadeite and nephrite show green. It is found in Australia, China, Scotland, South Africa, Mexico, and the United States. Prehnite has been found in the Mexican state of Guerrero. Garza-Valdés (1993: 117) notes that local miners refer to it as jade and worked pieces made into utilitarian axes have been found associated with the Mezcala culture.

19) ***Saussurite.*** This is a variety of feldspar. It is a composite of albite and zoisite, along with other minerals. Its colors include gray-green, yellow-green, moss-green, as well as variegated white and green. Webster (1975: 232) comments that it "may closely resemble some of the jades." Its refractive index varies from 1.57 to 1.70. Its specific gravity ranges from 2.80 to 3.40.

20) ***Serpentine.*** There are a number of varieties of serpentine that may be confused with jadeite or used as a substitute. The most common jadeite substitute is **bowenite**, which is sometimes called "Korean jade" as well as "gem serpentine". It ranges in color from a translucent pale green, sometimes described as apple-green, to blue-green. Sometimes bowenite is stained to look like "imperial jade". Bowenite is a little softer than jadeite (6.0) and, thus, more easily shaped. Its refractive index is 1.560-1.571 (some sources give it as 1.56 or 1.52). Its specific gravity ranges from 2.58 for lighter colored stones to 2.62 for darker ones (Hauff 1993: 86, gives the range as 2.6-2.787). It is found in New Zealand, Kashmir, Afghanistan, China (where the yellowish-green variety is sometimes called "new jade" or "Suzhou jade"), South Africa, and the United States. Other varieties of serpentine that are simulants for jadeite are: **williamsite** (an oily green, often with black inclusions; specfic gravity 2.62, hardness 4; found in Italy, England, and China), **verd antique** (a green rock, interspersed with white calcite or dolomite veins; it is easily distinguished from jadeite), **connemara** (a green rock that is an inter-growth of serpentine with marble; it too is easily distinguished from jadeite), **verdite** (Moh's hardness: 3; refractive index: 1.58; specific gravity: 2.80-2.99; light to dark green and often with yellow and red spots; found in South Africa where it is commonly used); and **ricolite** (greenish, from New Mexico).

21) ***Smaragdite.*** Smaragdite is an amphibole that comes in a deep emerald-green color. Webster (1975: 232) remarks that "the material is with difficulty distinguished from true jadeite, indeed chloromelanite may be a form of smaragdite, and it has been suggested that the material is so near jadeite that distinction is unnecessary." Its density is 3.25. It is relatively soft (5.5).

22) ***Smithsonite.*** This stone ($ZnCO_3$) comes in green and blue-green colors. It is also known as bonamite. Webster (1975: 232) remarks that it "is generally too translucent to be readily mistaken for jade... moreover, [it] has the high density of between 4·30 and 4·35; this 'heaviness' should be apparent even in a small specimen." Its refractive index is 1.62-1.849. It hardness on the Moh's scale is 4.5 to 5. It is found in the United States, Spain, and Greece.

23) ***Talc.*** Dense aggregates of talc are called **soapstone** or staetite. Blue-green varieties are used to imitate jadeite and may be called "Fujian jade", "Henan jade", "Manchurian jade", or "Shanghai jade". Its refractive index is 1.55. Its Moh's hardness is 1.0 to 1.5 and its density is 2.55-2.80. Worked pieces (e.g., small flakes) of soapstone have been found associated with Prehispanic Mesoamerican sites.

24) ***Thulite.*** The variety of zoisite called thulite is sometimes used to imitate lavender jadeite. Zoisite has a refractive index of 1.691-1.700 (some sources say 1.69-1.70).

25) ***Vesuvianite.*** It is also called idocrase. It has a refractive index of 1.70-1.723 and a hardness of 6 to 7. Garza-Valdés (1993: 117) notes that "it has a low birefringence, and under crossed polars it often shows anomalous Berlin blue." It is sometimes called "vesuvianite jade". The green variety known as **Californite**, which comes from California, is sometimes used as a jadeite substitute and may be called "American jade" or "California jade". Webster (1975: 232) warns that Californite "has a jade-like character and may pass for the genuine material, especially as the density is a little lower than the crystal idocrase and varies between 3.25 and 3.35 thus overlapping the values for jadeite." However, the refractive indexes of the two stones are different, Californite being 1.72. Hauff (1993: 87) gives Californite's specific gravity as 3.4.

Walker (1991: 31), reprints a chart from the Spring 1982 issue of *Gems and Gemology* that lists the most problematic green jadeite simulants. These are: nephrite, grossularite, Californite, saussurite, prehnite, bowenite, steatite or soapstone, aventurine (dyed), chrysoprase, glass, and calcite (dyed).

11. Grading Jadeite

The criteria for evaluating jadeite have evolved largely within China. As Hughes, Galibert, *et al* (2000: 2) comment, "jade connoisseurship is almost strictly a Chinese phenomenon." In a section on the pricing and valuation of jadeite, the web site of the Department of Geology at the University of Texas (www.geo.utexas.edu) warns that it is "a difficult subject best left to a jade expert." Over the past couple of decades a number of authors writing in English have discussed the criteria for evaluating finished jadeite (see Healey and Yu 1983; Ng and Root 1984; Ho 1996; Newman 1998; Ou Yang 1999; and Hughes, Galibert, *et al* 2000: 17-20).

Ng and Root (1984: 104-105) provide a color "Jade Master Stone Chart" that divides jadeite into fifty different categories as well as providing illustrations of more and less desirable characteristics of jadeite. Thirty-five of the categories are for green stones, five for lavender, and the remaining ten for other colors. There is a "Color Grading Scale" using letters, from "A" to "E": A = exceptional. B = very good, C = good, D = fair, and E = acceptable. In addition the stones are given numbers. In the case of green jadeite in particular, this serves as an additional means of ranking, from "A1" (which would be called exceptional imperial/emerald green jadeite) to "E7" (which would be called acceptable melon green jadeite). Newman (1998: 105) reprints a similar chart provided by Mason-Kay that has only thirty-six categories.

Healey and Yu (1983: 1670) comment in general that "through extensive experience in the trade most jade dealers have a broad consensus of opinion on how the quality of a piece of jade should be graded." Hughes, Galibert, *et al* (2000: 18) have remarked that "while a number of

fanciful terms have been used to describe jadeite, its evaluation is similar to that of other gemstones in that it is based primarily on the "Three Cs" – color, clarity, and cut (fashioning)." Adding that "unlike most colored stones, the fourth "C" – carat weight – is less important than the dimensions of the fashioned piece and that "two additional factors are also considered – the 'Two Ts' – translucency (diaphaneity) and texture." These characteristics are not judged equally, however. As noted by Miller (1999: 91), for instance: "A fine color without translucency can bring a high price, but high translucency without body color has little price." The web site of the Department of Geology at the University of Texas (www.geo.utexas.edu) adds that "design, craftsmanship and antiquity play equally important roles when evaluating carved objects."

Color. Newman (1998: 100) states that "an intense green to medium-dark tone is the most valued. As the color becomes lighter, darker, more grayish or brownish or yellowish, the value decreases." Values in descending order for other colors are: lavender, red, yellow, white, and black. Both the charts by Ng and Root and Newman/Mason-Kay are linked to tables or commentary about the relative value of the stones (these will be discussed below). The Department of Geology at the University of Texas (www.geo.utexas.edu) notes that in regard to green jadeite: "the best 'imperial green' has been likened to the color of fine emerald... Next in value are somewhat lighter shades, then lavender, dark apple green, 'forest' or 'spinach', light apple green, and dirty or spotty green."

Hughes, Galibert, *et al* (2000: 18-19) break the color components for assessing jadeite into three categories: "hue (position on the color wheel), saturation (intensity), and tone (lightness or darkness). In assessing hue, they use the example of the pure emerald-green of the highest quality jadeite: "While its hue position is usually slightly more yellow than that of fine emerald and it never quite reaches the same intensity of color, the ideal for jadeite is a fine 'emerald' green. No brown or gray modifiers should be present in the finished piece." Saturation is considered an especially important criteria for assessing green and lavender jadeite: "The finest colors appear intense from a distance... Side-by-side comparisons are essential to judge saturation accurately." They mention a related quality called *cui* whereby the color is judged to be brilliant, sharp, bright, or hot. In regard to tone, "the ideal tone is medium – not too light or too dark."

Color Uniformity. The color is uniform in the highest quality jadeite. In general the more uneven the color the lower the value, but multi-colored jadeite can be expensive when colors are strong and distinct. The most desired combinations of colors are green and lavender, green and orange, and strong green and white ("moss-in-snow jade"). The Department of Geology at the University of Texas (www.geo.utexas.edu) notes that "the most highly prized colors are those that are pure, intense, and uniform."

Transparency. This quality is also referred to as translucency. The most valued jadeite is semi-transparent (sometimes called "honey jade") or highly translucent. Increasing opaqueness results in lower values. An exception is white jade. Its price is not much influenced by this factor.

Clarity. The best fashioned jadeite is free of flaws (e.g., cracks, inclusions, cloudy areas, or spots); it is free of inclusions or other clarity defects that are visible to the naked eye. Among common imperfections are mineral inclusions (these are often dark green, black, or brown, but may be other colors as well) and white spots. Ou Yang (1999) remarks that perhaps the most serious defects are healed or unhealed fractures. These can have an considerable impact on the value of the stone—in part because jadeite is believed by Chinese to symbolize durability and perfection.

Texture. This can range from fine to coarse. The finer the better. Hughes, Galibert, *et al* (2000: 19) note that

> texture is intimately related to transparency. In the authors' experience, typically the finer the texture is, the higher the transparency will be. Further, the evenness of the transparency depends on the consistency of the grain size. Our observations also suggest that coarse-grained jadeite tends to have more irregularities, blotches, or discolorations.

Ho (1996) discusses three categories that are commonly employed for fashioned jadeite: 1) fine or "old mine", medium or "relatively old mine", and coarse or "new mine". Texture plays a key role in this categorization (which is not any longer actually associated with whether the piece in question came from one of the so-called "old mines" or the "new mines", although it did to some extent at one time). Old mine jadeite is viewed as having a higher quality, being of finer grain size, and having greater luster and translucency.

Shape. The best quality jadeite is cut into cabochons. Ovals and rounds generally are priced higher than rectangular, marquise, or pear shapes. Smooth uncarved pieces are more valuable than carved pieces.

Size. Large fine pieces are very rare and hence more valuable. Thickness is a factor. Basically cabochons smaller than 8 x 6 mm and thinner than 2 mm are worth less. Size is discussed in more detail in the next section.

Polish and Finish. The more brilliant the polish and smoother the finish the better. Hughes, Galibert, *et al* (2000: 20) remark that "polish is particularly important with jadeite. Fine polish results in fine luster, so that light can pass cleanly in and out of a translucent or semi-transparent piece." They also write that "one method of judging the quality of polish is to examine the reflection of a beam of light on the surface of a piece of jadeite. A stone with fine polish will produce a sharp, undistorted reflection, with no 'orange-peel' or dimpling visible." Field (2000: 2) has noted that the "fine granular structure of interlocking crystals that may vary slightly in hardness... gives rise to a subtly dimpled surface when the material is cut and polished," but that in recent years "the use of

diamond in the polishing process has made the dimpling much less apparent" and "also resulted in a higher polish." This makes it easier to tell older pieces of worked jadeite from modern ones.

One other factor to take into account is the recut recovery potential of a piece of jadeite that has been poorly cut or damaged. This is primarily an issue with larger pieces, such as bangle bracelets and larger beads. Finally, when examining a piece of jadeite or jadeite jewelry care should be taken to see if it has been repaired. This is especially true of bangle bracelets. The gluing can be very well disguised. DelRe (1992) mentions that ultra-violet fluorescence is a good method of detecting such repairs since the glues often fluoresce (usually appearing blue). Often, of course, the repair can simply be detected by magnification.

Grading Guatemalan Jadeite. Jades, S.A., has devised a system for grading Guatemalan jadeite that is similar to that used for Burmese jadeite. In its *Catalog 2000,* the company presents a color chart with forty-two categories, ranging from A to G across the top of the chart and from 1 to 6 down the chart (with 6 being of higher quality than 1). These are divided by color and quality and include various shades of green, white, lavender, black, and so forth. The top green stones appear on the left side of the chart under the A and are largely referred to as types of Maya imperial jadeite. Among these categories, an A4 stone is described as semi-translucent, an A5 as "medium bright semi-translucent", and an A6 stone as "intense and translucent". Within the B category is "Maya semi-Imperial" green jadeite. Other greens include "intense apple green" (which is translucent) and "pale apple green" as well as "dark green " (which is not translucent). There is also a "bright blue" that is really a bright blue-green (which is given a high grade) as well as translucent "dark Olmec blue-green" and "light Olmec blue-green" (these are graded lower). Lilac categories include "intense translucent lilac" at the top, down to "very pale lilac with white mottling" at the bottom. The top grade of black jadeite is characterized as including "galactic gold" coloring, whereas the lowest grades are merely gray, charcoal, and black.

12. Objects Made from Jadeite

Jadeite is faceted or carved for jewelry, religious, or ornamental use. As jewelry it is cut into cabochons, beads, and earrings, carved to make intaglios, and carved into rings and bracelets. It is also carved into a wide variety shapes as ceremonial or ornamental sculptures and figures. The overall quality of the stone is sometimes taken into account when deciding how to fashion rough jadeite. For example, in Hong Kong the best pieces (i.e., those that are free of white or black

streaks, fractures) are earmarked for cabochons. Material of somewhat lesser quality tends to be made into bracelets and then beads. The poorest quality jadeite tends to be used for carvings and doughnut shaped disks.

Chhibber (1934: 79-80) reviews the varieties of jadeite found at Tawmaw and the uses to which each type respectively was put at the time of his writing. First he lists four varieties of green jadeite. The most precious variety (called *mya yay* or *yay kyauk*, or elsewhere Imperial Jade), which is translucent and has a uniform "grass-green" color, and the next most precious variety (called *shwelu*), which is light green with bright-green spots and streaks, "are used for expensive jewellery such as rings, necklaces, pendants, ear-rings, brooches, etc." The third most valuable variety (*lat yay*) is clouded and is used "in making bracelets, buttons, hatpins, ornaments, drinking cups, etc." The dark green variety (known as *"hmaw sit sit"*) "is used in the manufacture of cheaper jewellery." Then he discusses two grades of white jadeite. The first (called *kyauk-atha*) is translucent, it "is used for bracelets, stems of pipes, plates, spoons, flower-pots, cups, saucers, etc." Of lesser value is a variety of white jadeite known as *pan-tha*. This variety has a brilliant white color and is largely translucent, but it is opaque to some extent. This variety "is used purely for decorative purposes, such as inlaying tables, boxes, and furniture generally." The final variety of jadeite discussed is called *kyauk amè*. This type is sometimes described as being black, but in fact is a dark green color. It is a variety of chloromelanite and contains a large proportion of iron instead of aluminum. This variety "is used for making buttons, bars for brooches, etc."

Frey (1991a) illustrates several pieces of Chinese jewelry made of jadeite dating from the nineteenth century. These include hair pins and slides, belt hooks and buckles, pendants, plain and carved bead necklaces, drop earrings, and a bangle bracelet. Most of the pieces are made of green jadeite. The bangle bracelet and plain bead necklace is a beautiful deep lavender color. One of the buckles is described as a having a "russet tone".

Goette (1976: 73) provides an interesting insight into the evolution of the ways in which jadeite was shaped during the inter-war years in response to changing market demands:

> The influx of American tourists into Peking after the [First] World War opened up an entirely different type of jade business. While the wealthier visitors bought expensive jade figures, bowls, and such large pieces, as well as emerald or jewel jade, those who did not have such expansive purses sought rings, earrings, pendants, beads and bracelets within their limited means. Likewise, during this period, the American and European population of Peking increased, and it too offered a market for the new costume jewellery. The foreign ladies brought pictures of ensembles such as the Chinese feminine taste had never known. The more inventive among the westerners began designing sets for their own adornment, and for shipment to eager American specialty and department stores. As a result, there has grown up... a mushroom trade in those articles which never existed before.

It is apparent that much of the jadeite jewelry produced today owes its origin to this period of innovation.

Cabochons. As was noted above, the tendency is to cut better quality rough jadeite into cabochons. Ng and Root (1984: 41) discuss what to look for in assessing the quality of a cabochon beyond the quality of the jadeite itself:

> First, we look for well balanced, pleasing proportions of length to width ratios which would be most useful in a ring stone. Next, the cabochon should not be too high or thick, nor be too thin. The half-moon is an ideal shape, with the height not being more than half the length... The cabochon should also have an only slightly rounded girdle, or edge, for good mounting. Moreover, the bottom of the stone should be slightly curved so as to form a well balanced lightly convex surface.

In the case of jadeite that is less transparent, the ideal in a cabochon is one cut with a flat base, since such curvature, as mentioned above, only adds to the weight of the stone without influencing its beauty. Size may also be a factor in assessing a cabochon. Ng and Root (1984: 48) comment that since people in Asia tend to be smaller than people in the West, very large cabochons "may not be as much sought after" in Asia as in the West, where "persons of larger build may well find those larger sizes the most desirable." The most common size of cabochon that is used as a standard for pricing is 14 x 10 mm. Larger sizes that may be viewed as more valuable include 15 x 11 mm, 20 x 15 mm, and 22 x 16 mm. Smaller sizes, ranging from 11 x 9 mm down, tend to be less valuable.

Ng and Root (1984: 42) also discuss the ideal way of mounting jadeite cabochons in jewelry. The cabochon should be mounted in a setting with a "small hole under the center of the stone." The hole helps to increase the amount of light returned from the stone. It also serves practical purposes in assessing the stone. It allows for the shape of the back of the stone to be examined and, in particular, to see if the stone has been hollowed out. A stone that is not mounted in this way should be examined with particular care.

In addition to oval cabochons, pieces of jadeite jewelry may also be carved into heart, marquise, pear, and teardrop shapes. Ng and Root (1984: 47) comment that the heart shape is the second most popular shape in Asia after the oval and that it too should have a rounded bottom. The ideal dimensions for a marquise cut piece is a length to width ratio of two to one. As for pear and teardrop shapes, "they must be well-tapered, cylindrical in form and pleasing in proportions."

Beads. While the jadeite used for beads tends to be of lesser quality than that found in the best cabochons, this is certainly not always the case and very fine jadeite is sometimes cut into beads. Hughes, Galibert, *et al* (2000: 20, fig. 19) illustrate a necklace (known as the "double fortunate" necklace since its owners had doubled their fortunes every time the boulder was cut) auctioned by Christie's in Hong Kong in 1997 that sold for about US$9.3 million. It featured some of the ideal characteristics looked for in a necklace: "Uniformity of a fine 'emerald' green color, superb translucency, size, and symmetry all come together." This necklace is comprised of twenty-seven beads ranging in size from 15.09 mm to 15.84 mm. They were all cut from the same portion of rough stone.

Ng and Root (1984: 66) discuss the ideal characteristics in a necklace. They begin by noting that "uniform strands are in greater demand than those which are graduated." The value of a necklace is influenced by the extent to which the beads match in terms of color and texture. Since matching jadeite beads is difficult, strands that are longer and that contain larger matching beads are especially valuable. Roundness of the beads and symmetry of the drill holes are also factors to be considered. Ng and Root warn that "beads should be closely examined for cracks." They add that there is value in older, larger beads (especially those above 15 mm in diameter) since they can be re-cut into cabochons.

Bracelets. Ng and Root (1984: 65) note that since "carving a bangle bracelet out of one entire piece of jade necessitates using up a considerable amount of precious gemstone... since quality one piece bangles may command relatively high prices." This is illustrated by a bracelet that was auctioned in Hong Kong in 1999 by Christie's and sold for US$2,576,600 (Hughes, Galibert, *et al* (2000: 21, fig. 20). The popularity of jadeite bracelets among Chinese is associated with their supposed ability to protect the wearer from ill fortune and in some instances to bring good fortune. Because of a belief that good things should come in pairs, bracelets are often made in pairs. Bracelets made from several pieces of jadeite generally are worth less than those made from a single piece. Such bracelets may be made from older, broken bracelets. Carved jadeite bracelets are usually made from poorer quality material to eliminate or hide the defects.

Pi Disks. *Pi* are round disks with a hole in the center. They are also known as *huaigu* and represent the Chinese symbol for eternity. The hole should be about one-fifth the diameter of the disk and be placed precisely in the center. Larger *pi* may be mounted and used as pendants and brooches, smaller pairs as earrings or cufflinks.

Hoop Earrings. Like bracelets, jadeite hoop earrings require a relatively large amount of rough material to make. To make them match they should be cut from two pieces of stone of the same quality and overall characteristics. Exceptionally fine earrings can fetch very high prices.

Rings. These are cut from a single piece of jadeite. One type of ring is referred to as a "saddle top ring". The top or front of this type of ring (the "saddle top") has a cabochon shape. The most beautiful part of the stone should be positioned to form the saddle since the lower part is largely hidden from view. There are also jadeite rings in the form of simple bands. These should have uniform color.

Other Shapes for Jewelry. Ng and Root (1984: 47) mention several other shapes of jadeite that is used for jewelry: round half beads (used as cabochons in earrings), short cylindrical bars (used for pins, clasps, and other decorative items), small buttons (now sometimes used in earrings and necklaces), earstud jackets (small flat circles of jade), and small doughnut shapes (used in pendants).

Carvings. As was noted early in the paper, most of the carved jade objects produced in China historically were made from nephrite and not jadeite. From the late eighteenth century onwards, however, carved objects made of jadeite began to appear in China. Today it is common practice to use lower quality jadeite for carvings. Small carvings may be used as pendants. The value of carved jadeite is determined by such factors as the intricacy of the design and the skill with which it is executed.

Mesoamerican Jadeite Jewelry. The above discussion focuses on Chinese practices. Mention should also be made of the types of objects made in ancient and modern Mesoamerica. In ancient Mesoamerica all of the items known appear to have been used by elite members of these societies either for personal adornment or for religious purposes. As Hirth and Hirth (1993: 173) note: "Objects carved from jade, jadeite, and a variety of other semiprecious materials, highly valued... and widely circulated in Mesoamerica... were used by high-ranking individuals to distinguish themselves and express their exalted social position, ability, and linkage to superior social networks." Among their functions was as a form of "'currency' used in establishing and regulating social relations within and between societies."

Hirth and Hirth (1993: 178-187) and Garber, Grove, Hirth, and Hoopes (1993: 226-229) mention that the following objects were made of jadeite by the ancient Maya (in southern Mexico, Guatemala, and Belize): beads (plain and carved), pendants, pectorals (Hirth and Hirth, page 182, "sawn into thin flat plates prior to shaping"), earflares, buttons, celts, spangles, inlays, mosaics (e.g., mosaic masks), and plaques (see Andrews 1986). There are also a variety of more esoteric items. Adams (1977: 87), for example, mentions pieces shaped like "letter-openers" that were "probably used for blood-letting in religious ritual" (also see Grove 1987). Lange (1993: 270-286) lists the following items made by jadeite in Costa Rica: whole celts, half celts, and split celts (all three commonly used as pendants); tubes (use uncertain, possibly placed in pierced septums; see Garber, Grove, Hirth, and Hoopes 1993: 229); beads; ear spools; and miniature vessels (possibly for storing narcotics for ritual use). The practice of making imitations of these pieces for purposes of deception is long-standing. More recently imitations have been made legitimately as well. The Aztec, too, made a variety of items for personal adornment out of jadeite. Among the more unusual items, Vaillant (1965: 231) mentions Aztec nobles wearing "lip ornaments" made of jadeite. He also describes (page 236) a large stone statue of the god Huitzilopochtli being "covered with a paste in which were set jade, turquoise, gold, and seed pearls."

Modern Guatemalan lapidaries make two types of item from jadeite: replicas of ancient pieces and modern jewelry. The modern items mainly consists of oval cabochons and beads. The cabochons are set in gold, silver, or gold-plate as rings, earrings, and pendants (a vareity of such items are illustrated in the Jades, S.A., *Catalog 2000*).

13. The Modern Jadeite Market

Today, as Hughes, Galibert, *et al* (2000: 2) have pointed out, jadeite is "a stone exceeded in price only by diamond." Although not often mentioned in the hype surrounding jadeite, however, it can also be a very inexpensive stone. For example, in its web-site (www.thaigem.com), Nuntiya Care Stone Co. of Thailand, offers an assortment of jadeite cabochons at ten cents a carat! Like the diamond market, the jadeite market has evolved and fluctuated considerably since the nineteenth century. The modern jadeite market has been intimately linked to political and economic conditions in China and secondarily to conditions in Burma. It can be said to have gone through several phases. The first of these is the preliminary phase which originated in the late eighteenth century. It began slowly as jadeite gained acceptance in China and then experienced something of a boom in the latter part of the nineteenth century, as jadeite achieved a high degree of popularity in China and coincided with an increase in jadeite mining in Burma following the advent of British colonial rule in the early 1880s. Hansford (1968: 46) characterizes this phase as being "very speculative, and fluctuated with political and economic changes in China."

Warry's 1888 account (quoted in Hertz 1912) of jadeite mining in Burma provides a picture of the fluctuating nature of the supply of jadeite to the market as a result of instability in Burma and China. After regular trade in jadeite between Burma and China was established in 1784 he states that only "a small but regular supply of the stone was now conveyed every year to Yunnan." Slowly the market expanded, but the history from then until the late 1880s was far from one of continual progress:

> The period of its greatest prosperity is comprised within the years 1831-40, during which time at least 800 Chinese and 600 Shans were annually engaged in business or labour at the mines..., [but] in 1841 war broke out between Great Britain and China. Hostilities first commenced at Canton and the effect on the jade trade was not long in making itself felt. Cantonese merchants no longer came to buy stone at Yunnanfu. Stocks accumulated and Yunnan traders ceased to go up to the mines.... There was a partial revival of the trade for a few years commencing with 1847, but the disturbed state of Southern China, consequent upon the Taiping rebellion of 1850 prevented a complete recovery; and with the outbreak of the Panthay rebellion in 1857 the roads leading to Yunnanfu were blocked and all business in jade came to a standstill for several years... The year 1861 witnessed a great improvement in the jade trade. From that date until now, the bulk of the stone has been carried by sea to Canton. In 1861 the first Cantonese merchants [merchant] arrived in Mandalay. He bought up all the old stocks of jade and conveyed them to China by sea, realising a large fortune on this single venture. His example was quickly followed by other Cantonese, and once more the trade in jade revived and numerous Yunnanese went up to the mines... In the autumn of 1883, Mogaung was sacked by the Kachins, and during the ensuing winter and spring there was no trade in jade. In June 1884, order having been partially restored, a Chinese syndicate represented by Li Te Su took the monopoly for three years... The up-country was still unsettled and the lessees, by arrangement with the traders, were permitted to collect duty at Bhamo instead of, as herebefore, at Mogaung. During the first two years of their term, owing to the disturbances connected with the adventurer Hsiao Chin (Hawsaing) and the

> British occupation of Upper Burma they collected little or no duty; but the proceeds of the third year left them with a margin... over and above their total expenses for the three years... The tax was then farmed out by the British Government to Loenpin, the present lessee. Matters between him and the jade merchants did not proceed smoothly... In addition to rendering himself [obnoxious] to all traders in jade Loenpin had roused the apprehension of the Kachin owners of the mines. He had made no secret from the first of his intention, not merely to collect the duty, but to get the actual management of the mines into his own hands. When the Chinese and Kachins, by way of reprisals, stopped the supply of jade for some weeks, he openly announced that this did not matter, for the English were shortly coming to put him into armed possession of the mines which he then intended to work with imported labour from Singapore. The unpopularity which Loenpin had earned among all classes interested in the jade trade culminated last December in the cowardly outrage made upon him at Mogaung, which resulted in his death.

While such events as those described above and the working out of individual mines might have led to fluctuations in the supply of jadeite reaching China, Warry comments that overall "there is no reason to think that the supply is likely to fall short of demand" since "it is probable that the jade hitherto discovered bears a very small proportion to that still concealed." As for China itself, he notes that "the demand for jade is universal throughout China" and remarks that "the price of the best stone shows no tendency to fall." Warry mentions one particularly important event in China a few years prior to his writing: "On the occasion of the Emperor Tungchih's marriage in 1872, it is said that a sum amounting to four lakhs of rupees was expended at Canton in buying jade for use at the ceremony, and a great impulse was thereby given to the jade trade in Burma."

With the coming of British rule to northern Burma, the situation there stabilized and for a time the jadeite market expanded. However, it was not long before events in China once again hurt the jadeite market. The 1911 revolution in China served to disrupt and depress the jadeite market, but it quickly recovered. Goette (1976: 52) relates this in part to increasing demand by American tourists who were "diverted from Europe to China" during the First World War (1914-1917). This served to introduce the Americans to jadeite and created a new market for the stone. While the market for jadeite among Americans and Europeans remained relatively small in comparison to the market in China, it grew during the interwar years and contributed to the overall growth in the market. Goette (1976: 52) notes that "whereas before, the stone was known abroad [i.e., outside of China] only in comparatively rare specimens of museums, or the minor pieces brought back by the more audacious travellers to far Cathay, it has now become a regular commodity in department and jewellery stores catering to the more fastidious buyers." Goette notes, however, that there is a big difference between the Chinese deep-seated love of jade and the American and European fad for it and points out (page 54) that much of what is sold to foreigners by the Chinese is of inferior quality: "This fact is illustrated by the name which practical minded Chinese merchants have given to a poor variety of light green jade. Because of its cheapness, this latter became very popular with American tourists and exporters, and it soon became known among the Chinese as 'mei kuo lu' or American green."

Chhibber (1934: 78-79) provides a glimpse of the market during the inter-war years. Based on information gleaned from "an aged, experienced dealer" Chhibber (1934: 79) states that "only about 25 per cent of the jadeite is consumed in Burma. The remaining 75 per cent is sent to China and Japan, and of this a small percentage eventually finds its way to America and Europe." Some of the rough jadeite for export was shipped from Mogaung to Rangoon and then placed on "a Chinese boat to Hong Kong, Canton, Shanghai, etc." Otherwise, "a considerable quantity of the stone is smuggled across the border, in addition to the small amount officially carried over by mules" to Yunnan. In addition to the sale of jadeite to "Chinese and Japanese ladies" as jewelry, Chhibber (1934: 79) notes that "the Chinese Government buys a considerable quantity of jadeite for making altars, sacred vessels, flower basins, etc."

Additional information is provided by Goette (1976). He reports (page 61) that in 1932 503,804 pounds of jadeite stone were officially imported to China from Burma and that the amount had fallen to 350,056 pounds the following year. Most of this jadeite was shipped initially to Hong Kong and then on to Canton, although a significant amount was also shipped directly to Shanghai and overland through Yunnan. Goette (page 66) refers to Shanghai as "the world's largest jade market due to its modern factories and foreign export business." Much of the jadeite entering China through Canton and Yunnan ended up in Shanghai. However, Canton was the primary place from where worked jadeite was subsequently re-exported to the United States and Europe. In regard to this last point, Goette notes (page 61) that "the United States is by far China's best and only large customer of newly worked jade." In contrast to the hundreds of thousands of pounds of rough jadeite being shipped from Burma to China each year, Goette (page 61) remarks that "the Burmese Customs figures for one year list 200 pounds of jade going to Great Britain and 1,000 pounds to the Straits Settlement [Malaysia and Singapore]. The latter probably was destined for Chinese merchants there." Especially interesting is what Goette (pages 61, 63) has to say about the price of rough jadeite during this period:

> Burmese customs returns for the years 1916 to 1928 indicate the phenomenal rise in value of the crude stone due to the west suddenly awakening to its loveliness. In 1916 the value of 100 pounds at the mines was roughly U.S. $45. By 1919, when the Chinese factories were hard put to meet the demands of domestic and foreign trade in face of the new popularity, the rate had increased to U.S. $135 for the same weight. The Chinese market in the following years appears to have become surfeited, and Burmese miners having watched the price drop during four years, cut production from the 1922 peak of 576,200 pounds when profits were high, to 196,100 pounds in 1928, at which time only U.S. $35 were received for 100 pounds.

The jadeite market was again severely disrupted from the late 1930s until the late 1940s as a result of the conflicts associated with the Second World War and the communist seizure of power in China. The jadeite market after the Second World War was concentrated in Hong Kong, which replaced Shanghai as the world center of jadeite lapidary work and for selling jadeite. Many of the

lapidaries from Beijing and Shanghai fled to Hong Kong following the communist seizure of power in China. Within China itself the new communist rulers left little room for commerce in such decadent luxuries as jadeite.

Hughes, Galibert, *et al* (2000: 5, 8) mention that "jadeite auctions were organized in [Hong Kong] hotels such as the four-story Tai Tung Hotel... Starting in 1967, auctions were organized by the Hong Kong Jewellery and Jade Manufacturers Association (formerly Hong Kong Jade and Stone Manufacturers Association). Some idea about how the market worked at this time is provided by V.B Meen (1962, 1963) who visited Burma and Hong Kong in 1960 with Martin Ehrmann (see Smith and Smith 1994 on Ehrmann). The account by Meen includes a description of jadeite mining in Burma as well as the jadeite market in Hong Kong. In Mogaung Meen was the guest of Li San Chiek "the big jade dealer in the area" (1962: 819, 1963: 19) From Mogaung Meen visited the mining sites around Hpakan and he describes a number of mining sites. He then discusses the marketing of rough jadeite. He notes that while sometimes jadeite roughs are auctioned in Mogaung, "most of the jade boulders are shipped to Hong Kong for cutting and carving and most auctions take place there" (1962: 835, 1963: 23). Meen (1962: 835, 1963: 23) describes a typical Hong Kong auction:

> A jade auction is unlike anything I had ever witnessed before. The dealer had taken rooms in a Chinese hotel in Hong Kong and there, the various pieces of jade rough were displayed in what I would consider relatively poor light... these boulders were of various sizes and had various number of windows cut in them. Only occasionally was a small boulder broken to expose a fresh face... Represented in the lot might be jades in several shades of green, mauve, and brown in a considerable variety of quality. Prospective buyers inspected the boulders and then retired to a group of larger rooms, reserved for the purpose, and there waited for the auction to begin.
>
> Presently, the auctioneers appeared and placed a boulder on the table... He gave the number of the specimen and a brief description of its appearance... Then he gave the price the owner was asking for it. Remember that this was probably many times what the owner really expected to get. Then the auctioneer draped a towel over his hand and walked through the group. If somebody wished to bid, he attracted the auctioneer's attention and they clasped hands under the towel. By appropriate pressures on the auctioneer's fingers, the bidder indicated his offer. Each bidder, in turn, did this until all had been taken care of. Then, the auctioneer went to the owner, who all this time was seated in his rooms with his stock of jades. If the owner did not accept the highest bid, the auctioneer returned... and started taking new bids... Eventually, of course, the sale is made or the piece is withdrawn by the owner and then a new one is offered for sale.

Ng and Root (1984: 23) provide photographs illustrating these finger signs. One of the advantages of this system for the buyer is that it keeps others from knowing what he paid for the stone.

The jadeite market suffered from another disruption in the early 1960s as a result of the military takeover in Burma in 1962. Gübelin (1964-65a: 229-30) visited the area in March 1963: "The Burmese Government, under General Ne Win,... had issued a new decree to outlaw the Chinese owners of jade mines; many jade traders had left, Mogaung was disturbingly quiet,

numerous mines were abandoned, and the country was being haunted by dangerous bands of insurgents." A short time later the mining area was closed to foreigners and it was decreed that jadeite rough was only to be sold at an annual gem emporium held in Rangoon at the Inya Lake Hotel.[8] The result was to drive most of the trade in jadeite underground. While some jadeite rough was smuggled out to Yunnan, most crossed the Thai border illegally and was taken to Chiang Mai. Chiang Mai and other northern Thai towns emerged as centers for buyers from Hong Kong. The situation for jadeite mining deteriorated even further in 1969, when the regime banned private exploration and mining of gems. The regime did not have complete control over the jadeite mining area, but its actions did result in a drop in production of jadeite and meant that little effort went into looking for new sources or significantly enhancing production at existing sites.

Lintner (1991) provides an account of jadeite mining in Burma based on a visit to the Hukawng Valley in 1987. He notes (pages 268-9) that officially the government allows jadeite mining only at Hpakan and the neighboring villages of Waje Maw and Sanchyoi, but remarks that there is a great deal of mining that takes places in other locales. At the legal mines, laborers are employed by the government and given a salary plus a commission for any high quality jade that they find. Much of the mining that occurred at the time of Lintner's visit took place in areas controlled by the Kachin Independence Army (KIA), which had occupied part of the jadeite mining area in 1963. The KIA levied a tax on those trading jadeite and issued licenses to those searching for it. Linter (1991: 270) notes that at the time of his writing this income served as "a main source of income for the KIA." Linter estimates, however, that the bulk of rough jadeite (as much as 75%) was smuggled out (especially the better quality pieces) and avoided government control or KIA taxes. He states (page 270) that "the real profit... is made when the jade reaches the Thai border, usually the first frontier point on the long smuggling route from Burma's Kachin State to Hong Kong." He says that prices for rough jadeite at the Thai border are five to ten times higher than around Hpakan (even more for high quality material). Whether being smuggled to Thailand or to Malaysia or Singapore, the trade was largely in the hands of "an elaborate network of local agents" working for various syndicates.

A new phase in the jadeite market was ushered in with the onset of significant economic reforms in China in the 1980s and subsequent rapid economic improvements not only in China, but also within overseas Chinese communities around the world. Hughes, Galibert, *et al* (2000: 8) comment that "with the introduction of free-market reforms in China in the early 1980s, the markets and workshops of China again sought fine jade. Once more, the famous jade road was opened." There have also been more recent changes on the supply side. The *Myanmar Gemstone Law* of 29

[8] The 38th Myanmar Gem Emporium was held during the second week of March 2001 in Yangon. It was reported that twenty-two bidders paid a total of US$1,291,491 for 228 lots of jade (*Colored Stone*, May/June 2001, p. 92).

September 1995 allowed private Burmese citizens to trade in jadeite and other gems. In general economic liberalization in Burma has generated more mining activity and made it somewhat easier export jadeite, although many difficulties remain.[9] Once again there are a number of markets within Burma selling rough jadeite. Kammerling, Koivula, and Johnson (1995) and Clark and Cummings (2000: 258) describe what has emerged as Burma's largest private jadeite market along Mandalay's 86th Street. Two nearby villages located south of 86th Street, Kyawzu and Minthazu, specialize in cutting, polishing, and carving jade. Trading takes place daily at several locales along the street. The best quality jadeite is sold during the late morning around the intersection of 38th and 86th streets. Other markets are to be found in towns like Hpakan, Lonkin, and Mogaung.

Increased demand for jadeite within the Chinese world over the past two decades has had an impact of prices. As Ward (1996: 45) has commented:

> Rarity skyrockets prices, and Burma's top green and lavender jadeite qualify as some of the rarest gems known. Demand for large, fine material follows Asia's economic upswings: successful businessmen spend big money on themselves and the women in their lives. Burma jadeite stands without competition as the most desirable gemstone in Asia, especially for people of Chinese heritage no matter where they live.

Prices for jadeite began to climb. As a reflection of market growth, Sotheby's Hong Kong held its first jade auction in November 1985. It was a small auction featuring only twenty-five pieces, but it represented a significant first step towards the further internationalization of the jadeite market.

Ng and Root (1984: 107) provide a table with approximate retail prices for 14 x 10 mm jadeite cabochons. The prices they present reflect the state of the jadeite market during the latter part of the 1980s. They provide prices for all of the categories of stone presented in the "jade master stone chart" that was discussed earlier. The highest price is for category "A1" or "Exceptional Imperial/Emerald" green jadeite: US$30,000 per stone and up. The next highest price is for category A2 or "Exceptional Glassy" green jadeite: US$20,000 per stone and up. Almost in the same price range is category B2 or "Very Good Imperial/Emerald" green jadeite: US$20,000 per stone. Lesser grades of "Imperial/Emerald" green jadeite are valued at US$5,000 to US$15,000 per stone and lesser grades of "Glassy" green jadeite from US$3,000 to US$10,000 per stone. Prices for "Apple Green"-"New Mine" jadeite range from US$1,000 to US$5,000 per stone and up; for "Spinach" green jadeite from US$300 to US$2,000 per stone; for "Moss-in-Snow" jadeite from US$200 to US$1,000 per stone; and for the lesser grades of "Apple Green" jadeite from US$100 to US$500 per stone. The highest grade of lavender jadeite ("A8") is US$20,000 per stone and up. The price of "Very Good" lavender jadeite is US$10,000 per stone; for "Good" lavender jadeite

[9] Elmore (2001) reports that fighting on the Thai-Burmese border that erupted in early 2001 greatly reduced the cross-border trade in gems. In addition, he cites (page 109) a Burmese gem trader who reports that there is a new tightening of controls on gem trading in Rangoon (Yangon) as well as the regime seems to be trying to re-assert its control over this industry.

US$4,000 per stone; and lesser grades US$500 to US$1,000 per stone. The price for the highest grade of red jadeite ("A9") is US$1,000 per stone and up, with the next grade valued at US$500 per stone. The top grade of honey-yellow jadeite ("A10") is US$500 per stone and up; white jadeite US$100 to US$200 per stone; and gray jadeite US$50 per stone.

Before the upward trend of the 1980s could develop further along came "B" jade at the end of the decade and a short time later there was a market crash. As noted by Mason-Kay (www.masonkay.com/whatisbjade, page 2): "When word of the new process spread, there was a loss of confidence in the jade market; jade exports from Hong Kong plummeted by as much as 50% in the years 1989-1992." Fritsch, *et al* (1992: 176) cite two 1991 reports of a "50% decrease in jadeite sales in Japan over a three-month period." Even earlier, a case is reported (pages 177-178) from Taiwan involving a jadeite bangle bracelet that sold for US$400,000 in May 1988 and then changed it appearance (loosing its luster) after only one month.

Since the "B" jade induced crash, and despite the economic crisis of the late 1990s, the jadeite market has recovered. Christie's Hong Kong has played an important role in this recovery, as has the relatively short memory of the buying public. Christie's held its first jade auction in Hong Kong in October 1994 (featuring 100 pieces). One lot in this auction, a necklace with twenty-seven beads, sold for US$3.88 million. This auction was not a fluke and before long Christie'e began holding regular biannual auctions of jadeite jewelry. Eclipsing the price paid for the necklace in 1994, in a November 1997 auction another necklace sold for US$9.3 million. Christie's itself has pointed out that out of the ten most expensive jewels it sold worldwide in 1999, five were jadeite. As noted by Mason-Kay (www.masonkay.com/whatisbjade, page 2): "Recent record-high auction results indicate that the jade market has... come back in a strong way." Such prices inspired Alkman Granitsas (2000), in a column on investing in the *Far Eastern Economic Review,* to remark that "the pyroxene mineral group has never looked so good."

There is, however, a considerable difference in the value afforded to the highest quality jadeite that is being promoted by major auction houses and lesser quality material. Granitsas (2000) reports that "top-quality jade has appreciated between 25% and 30% over the past five years, and doubled over the past ten years. And, if anything, prices are heading higher." He mentions the rumored sale of a jadeite boulder in Hong Kong in 1999 for $10 million— "making it the most expensive uncut piece of Burmese jade in the last 100 years." And comments that "A perfectly cut and polished gemstone of jadeite can fetch as much as $2 million; a similar hunk of nephrite, just $2,500."

The current jadeite market, to some extent, has taken on some of the characteristics of other speculative markets in China (and Hong Kong), but also reflects more genuine economic factors related to supply and demand. Demand is obviously the most important factor in the present market and this continues to increase. But what about the supply factor? There are no reliable statistics.

Evidence, therefore is anecdotal. There is no doubt that economic liberalization in Burma led to increased production by jadeite miners in the latter part of the 1990s. At present, however, there are rumors that supplies are diminishing. Granitsas (2000) quotes Rose Wong, director of the auction house Christie's jadeite jewelry department in Hong Kong: "The demand for top-quality jade never diminishes" and "the alluvial deposits of jade have been nearly depleted." The latter assertion is difficult to verify and is disputed by others. One should remember the report by Hughes from Maw-sisa at this point about the massive deposits he saw there. There still appears to be a lot of jadeite yet to be mined in Burma and the claims of depletion of sources of jadeite in Burma are more than likely highly exaggerated. There is a subsidiary claim that "the stock of the best-quality jade is getting smaller" (C.M. Ouyang of the Hong Kong Institute of Gemmology, from Granitsas 2000). Perhaps, but again substantiating evidence is lacking and it is likely that in the face of increasing demand for high quality jadeite there is the perception of a shrinking pool of "good-quality" jadeite, whereas the actual situation is that the supply of good quality jadeite is proving unable to keep pace with growing demand.

Official figures for anything in Burma are suspect and in the case of jadeite they do not reflect black market production. During the mid-1990s, when the government still sought to maintain its monopoly on the sale of jadeite, official production figures were: 1993-94 - 305 tonnes, 1994-95 - 347 tonnes, and 1995-96 - 335 tonnes. More recent figures are: 1998 - 1.26 tonnes and 1999 - 5.24 tonnes. It is clear that the two sets of figures are not comparable, but within each set it may be possible to discern trends. Thus, the earlier figures may reflect a degree of stability in production, while the latter figures may reflect more recent increases in production due to policy reforms. Such figures do not account for the relative quality of jadeite either, making it hard objectively to dispute claims that high quality jadeite is becoming increasingly scarce even if the overall quantity of jadeite coming on the market has grown substantially.

What are current market prices like? At the top end prices can get very high indeed. Ward (1996: 25) comments:

> Each year at gem shows such as Tucson or at large auctions in Hong Kong, some individual Burmese imperial Jade cabochons and pendants fetch more than $100,000. For a 10- to 15-carat piece much of the world views as a rock, that is a staggering price... With their devotion to this gorgeous upstart, no price seems too great for buyers who both love jade and want to emulate the last of China's emperors by wearing imperial green.

Highlighting the difference that size can make in regard to price, Newman (1998: 104) states that a very fine green cabochon measuring 18 x 13 mm "can wholesale for over $20,000," while the same quality of stone in a 8 x 6 mm size "might wholesale for over $2000." He also notes, in regard to color, that a 8 x 6 mm cabochon that is grayish-green "can sell for as little as $25" and that a top quality 13 x 10 mm lavender cabochon with intense color "may wholesale for over $2500."

The Mason-Kay company (www.masonkay.com/technical), a couple of years later than Newman, lists the range of prices for jadeite cabochons varying in size from 10 to 8 mm by 18 to 13 mm: extra fine green - US$25,000 per stone and up; fine green - US$10,000 to US$25,000 per stone; good green - US$1,000 to US$10,000 per stone; commercial green - US$100 to US$1,000 per stone; fine lavender US$5,000 per stone and up; good lavender - US$250 to US$2,500 per stone; commercial lavender - US$100 to US$250 per stone; red - US$50 to US$500 per stone; yellow - US$50 to US$500 per stone; white - US$30 to US$200 per stone; and gray - US$50 to US$200 per stone.[10] It is interesting to compare these prices with those given by Ng and Root prior to the market crash in the late 1980s. Current green jadeite prices appear to have returned to levels similar to those of the late 1980s. Lavender jadeite prices, however, remain significantly below the earlier prices, as do the prices for other colors of jadeite. During the past year or so there appear to have been some improvements at the lower end of the market. Mason-Kay company's Spring 2000 newsletter (www.masonkay.com/newsletter, pages 1-2) discusses the price of so-called water jade. The price of an average 18 x 12 mm cabochon averaged around US$100 per stone for a number of years. Recently the prices have increased to US$200 to US$300 per stone, with top quality pieces fetching up to US$1,000 per stone.

The above prices are for untreated or "A" jadeite. According to Mason-Kay, bleached or "'B' jade is about 1/10 of the value of a piece of equivalent 'A' jade" and "'C' and 'D' jade are about 1/10 to 1/50 of the value of an equivalent "A' jade" (www.masonkay.com/whatisbjade, page 2). The problem, of course, is that much of this treated jadeite is sold as if it was untreated at inflated prices.

The Mason-Kay and other prices mentioned above (and in the footnotes) reflect the higher end of the market. A great deal of the jadeite produced is of lower quality and, especially at the wholesale level, fetches much less. I have alreay mentioned the cabochons offered for sale by Nuntiya Care Stone Co. of Thailand (www.thaigem.com) at ten cents a carat. One lot of jadeite cabochons offered by the company includes a total of 27,967 carats of stones in a variety of colors

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[10] A recent issue of *The Guide* provides approximate wholesale prices for jadeite cabochons in all 36 categories and in three sizes (18 x 13 mm 14 x 10 mm, and 10 x 8 mm). It also gives prices for two different sizes of bangle bracelet, carved pendants, and two sizes of bead necklaces. The prices for 6-8 mm 18" bead necklaces, for example, include: a top price of US$20,000 and up for extra-fine green, US$200-2,000 for commercial green, US$3,000-15,000 for fine lavender, US$100-1,000 for commercial lavender, US$250-500 for red, US$200-400 for white, and US$200-400 for gray.

I looked for high quality jadeite available for sale over the internet and found relatively little with prices available. KT Limited in Hong Kong listed a number of pieces (along with photographs). These included a cabochon ring for US$85,500, several single cabochons (ranging in price from US$830 to US$6,338) and an assortment of bangles (US$180 to US$2,500), pendants (US$280 to US$15,800), and doughnut-shaped "pi" (US$450 to US$750). CherryPicked.com, which lists hundreds of loose gems, includes only a couple of pieces of jadeite. One of these is a 17.21 carat, 16.8 x 14.2 mm cabochon that is offered for US$20,789. It is described as possessing "a rare combination of color, translucency, even color distribution, clarity and size" and as being "reasonably priced".

ranging in size from 7 to 65 carats (7 x 5 mm to 43 x 32 mm) and another 10,641 carats of green stones ranging from 9 x 7 mm to 23 x 20 mm. The company also offer "translucent bright green" 21 inch stands of 8.5 to 9 mm jadeite beads for US$19.99 and US$24.99 per strand. On 31 May 2001 the company's web-site also included 146 pieces of Mawsitsit jadeite cabochons. At the top end is a 49.25 carat 35 x 23.5 mm piece for US$172.99 (about US$3.50 per carat). There are several smaller pieces around 9.5 carats (averaging around 18 x 13 mm) selling for US$28.99 (about US$3.00 per carat).

The production of jadeite jewelry in Guatemala is relatively small. The primary producer is Jades, S.A. It produces necklaces and other types of jewelry as well as replicas of ancient Maya artifacts. In contrast to Burmese jadeite, Ward (1996: 43) notes that "Guatemala green, white, and black jadeite jewelry seldom surpasses $1,000-2,000." The color chart provided in the Jade, S.A., *Catalog 2000* includes prices for 22 mm cabochons. At the top is the intense and translucent Maya Imperial (grade A6) cabochon at US$1,000 per stone. The price for an A5 Maya Imperial cabochon is US$760 per stone, and for an A4 cabochon US$500 per stone. A non-translucent dark green cabochon is priced at US$20 per stone. The highest quality "intense apple green" jadeite is listed at US$360 per stone, while lesser quality "pale apple green" is listed at US$180 per stone. A "bright blue" stone is listed at US$300 per stone, while the lesser grade Olmec blue-green stones range from US$60 to US$50 per stone. Top grade "translucent intense lilac" cabochons list for US$340 per stone, while the lower grade "very pale lilac with white mottling" lists for US$140 per stone. Black with "glactic gold" lists for $226 per stone and low grade gray, charcoal, and black for US$50 per stone.

Within Burma there are official buying channels for rough jadeite that are controlled by the military regime, but most rough jadeite is smuggled out of the country to Thailand and China. Hughes (1997) notes that "smuggling routes from Burma's gem mines to the outside world are varied and constantly changing... With the opening up of China's economy, much jade now proceeds directly from the mines in Kachin State, to Kunming, capital of China’s Yunnan province." The Burmese government holds a biannual Gems, Jade, and Pearls Emporium in Yangon. Ward (1996: 44) reports that about 500 lots of jadeite are offered for auction at this event and these are mainly sold to Chinese bidders. Only a small amount of jadeite is cut and sold within Burma. Hong Kong is the center of the jadeite market. Of lesser importance are other parts of China, Thailand, Singapore, and a handful of Western cities (usually with a significant overseas Chinese population).

Hughes (1997) briefly describes the jadeite markets in Mae Sot and Mae Sai, located on the Thai side of the Thai-Burmese border, following visits in 1996 and 1997. In general, he characterizes these markets as having an abundance of low quality gem material along with synthetics and imitations. The gem market in Mae Sot he describes as being "crowded with

vendors, all eager to service the tourists who come to purchase precious stones" and notes in the case of jadeite that it is common practice to sell "jade look-alikes from abroad" along with the real thing. As for Mae Sai, he comments:

> There is... much jade on display and Mae Sai contains two excellent jade cutting factories. The jade originates in Burma's Kachin State and has traditionally made its way to Thailand before moving on to Hong Kong and the important Chinese markets. After the 1962 Ne Win coup in Burma, jade moved south, crossing the border at Mae Sai, and from there down to Chiang Mai, where Hong Kong buyers made their purchases. Today, like many of the Burmese smuggling paths, this route is in decline. With the legalization of the gem business in Burma, much jade is simply purchased directly in that country.

By way of comparison with prices for average quality jadeite, I looked at the wholesale prices of some stones used as jadeite simulants offered for sale in Rio Grande's *Gems & Findings* catalog for 2001-2002. The company offers jadeite cabochons (page 189). Interestingly, these are not offered in its catalog for the previous year. The pieces are described as untreated and soft to medium mint green in color. A 10 x 8 mm cabochon is priced at US$5.80 and a 14 x 10 mm cabochon at US$9.05. On the same page the catalog also lists dark olive green nephrite cabochons: six pieces of 10 x 8 mm at US$5.69 and six pieces of 14 x 10 mm at US$12.05. Even less expensive are spring green aventurine cabochons (page 184): twenty pieces of 10 x 8 mm at US$7.07 and ten pieces of 14 x 10 mm at US$5.56. In contrast, the price of chrysoprase cabochons (page 185, described as untreated and bottle green in color) is higher than that for jadeite: a 10 x 8 mm cabochon is priced at US$6.25 and a 14 x 10 mm cabochon at US$14.75. As was noted above, one Thai source sells jadeite beads for US$19.99 and US$24.99 per strand (a strand of high quality 8 mm green jadeite beads might easily sell for US$1,000). The Rio Grande catalog lists the following prices for 8 mm bead necklaces made of some potential jade simulants (it does not list jadeite bead necklaces): US$7.05 for amazonite; US$10.36 for green agate (dyed); US$9.05 for dark green aventurine (dyed); US$25.60 for green nephrite; and US$100.00 for chrysoprase.

In an effort to get a better idea of the jadeite market in North America I looked at dealer directories published by two of the leading gem magazines: *Lapidary Journal* and *Colored Stone*. The *Lapidary Journal's* 1999 "Buyer's Directory" (page 89) and 2001 "Buyer's Directory" (page 116) and *Colored Stone's* 2001 "directory" (page 292) list a total of sixteen companies under the heading jadeite: 1) The Davenport Organization Hampton, NH, dport@polygon.net, jade, jadeite); 2) Florence & Larry's (Freemont, CA, larryma@uakron.edu, jadeite, rubies, sapphires); 3) Jack & Elaine Greenspan (Woody Creek, CO, hgreen9594@aol.com, charooite, diamond crystals, gem silica, jadeite, sugilite); 4) Haus Jewelry (San Francisco, CA, fax 415-863-9683, jade, jadeite, turquoise, cultured pearls); 5) Hiltary Sintered (Scottsdale, AZ, hiltary@hotmail.com, jadeite); 6) KCB Natural Pearl (San Francisco, CA, fax 415-759-8767, pearls and jadeite); 7) King's Ransom

(Sausalito, CA, kransom@pacbell.net, jadeite, opals, pearls); 8) Lambert Holdings Co., Ltd. (Hayward, CA, and Thailand, a wide variety of gems); 9) Lam's Jade Center (Los Angeles, CA, fax 213-489-4632, jewelry, jadeite, pearls); 10) Mason-Kay, Inc. (Denver, CO, jade, jadeite); 11) Pioneer Gem Corp. (Auburn, WA, www.pionwwrgem,com, all kinds of gems); 12) Matthew Ribarich (Costa Mesa, CA, while this company lists jadeite it deals primarily in imitation or costume jewels and jewelry); 13) Tim Roark Imports (Atlanta, GA, trimports@aol.com, a wide variety of gems); 14) Rock Solid Jade (Glenwood, NM, fax 505-539-2587, jade, jadeite); 15) Sicusa Gems (Miami, FL, www.sicusa-gems.com, facet@sicusa-gems.com, all kinds of gems); 16) Victor & Sons, Ltd./J.Stella & Co. (San Francisco, CA, vick&sons@aol.com, jadeite, pearls).

First a review of the characteristics of this list (excluding Matthew Ribarich). In regard to location, these companies are concentrated in the western United States: seven are in California (and all but one of these are in the San Francisco area), two in Colorado, one in Washington, one in Arizona, and one in New Mexico. Only three are found elsewhere: one in New Hampshire, one in Georgia, and one in Florida. In terms of what they specialize in selling, they can be roughly divided into three categories: those that sell only jade (nephrite and jadeite), those that sell jadeite and only a few other items (especially pearls), and those that sell jadeite as well as a wide variety of other gems. There are four companies in the first category (Davenport, Hiltary Sintered, Mason-Kay, and Rock Solid Jade). There are seven companies in the second category (Florance & Larry's, Greenspan, Haus, KCB Natural Pearls, King's Ransom, Lam's, Victor/Stella). Finally, there are four companies in the third category (Lambert, Pioneer, Tim Roark, and Sicusa).

Among the four companies in the first category (i.e., those that specialize in jade), Mason-Kay Fine Jade Jewelry is the most prominent. This is highlighted by the fact that it is the only commercial firm in North America with its own Fourier-Transform Infrared Spectroscope to test for "B" jadeite. It is interesting to note just how few companies fall into this category. Turning to the seven companies in the second category, it is worth pointing out that five of the seven are located in the San Francisco area, an area with a long association with the Asian market and itself with a large Asian population. What is striking about the third category (i.e., companies that include jadeite among a large range of gems that they sell) is, again, how few companies are listed. All three of the publications consulted list a large number of companies that sell a wide variety of gems, but jadeite is conspicuous by its absence from these lists in the case of most such companies. It is perhaps not so surprising to see Lambert Holdings Co. in the list because of its association with Thailand. The other two companies are interesting because of their rarity.

In an effort to get an idea about the jade market from dealers for whom jadeite is only one of many types of gem that they sell, I contacted Dr. Edward J. Nowak Jr. of Pioneer Gem Corporation in Auburn, Washington. His company sells a good deal of faceted gem material from South and Southeast Asia. His response was as follows (21 April 2001):

> ... over the 30 years I have been in business it [jadeite] has never been a big seller for me. It was a lot more popular 25 to 30 years ago. Now the Asian Market is the only place it really sells and the supply is VERY limited... There is a lot of dyed material around that is sold to tourists in Hong Kong at very cheap prices in the form of carvings, pendants, pins, bangle bracelets, etc. It has never been a really good seller for me so I've stayed away from it.

It would seem from the above list of companies and Dr. Nowak's response that for North America the jadeite market remains relatively limited and, I suspect, one that is focused on North Americans of Chinese descent or origin.

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Also see: *The Bulletin of the Friends of Jade.*