BROKEN 玉 BANGLE

by

Liu Shang-i ('Edward') | Richard W. Hughes

Zhou Zhengyu ('Adam') | Kaylan Khourie

editing, design & layout by Richard W. Hughes

BROKEN 玉 BANGLE

THE BLUNDER-BESMIRCHED HISTORY OF JADE NOMENCLATURE

LOTUS
new directions in GEM•ology

Bangkok, Thailand | Boulder, Colorado, USA

Lotus Publishing | RWH Publishing
Bangkok, Thailand | Boulder, Colorado, USA
E-mail: info@lotusgemology.com | Web: www.lotusgemology.com

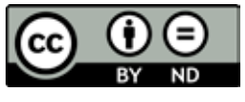
2nd edition—PDF
September 2025

Publisher's US Cataloging-in-Publication Data

Hughes, Richard W., editor
Broken Bangle | The Blunder-Besmirched History of Jade Nomenclature

ISBN 978-0-9645097-8-8 (hardcover)

Library of Congress Control Number: 2024912065



Cover photo by Wimon Manorotkul/Lotus Gemology.
Unless otherwise stated, all foreign language translations of original texts generated by ChatGPT.

The beginning of wisdom is to call things by their right names.

— Chinese proverb

Shan (善; Kindness) from the Pinde Xuan studio of Master Fan Junmin in Urumqi, Xinjiang, China, sculpted in Hetian *yù* (Chinese nephrite). Photo: Liu Renchao; size: 19 × 9 × 11 cm.

CONTENTS

Soft Power by Master Carver Zhuang Qingfang, in Burmese *fei cui* (pyroxene jade).
Photo: Zhuangjia Fei Cui; carving: 303.1 ct; size: 76.6 × 42 × 9.1 mm.

ABOUT THE AUTHORS

LIU SHANG-I ('EDWARD')
Dr. Liu Shang-i is a renowned research geologist and gemologist long engaged in the study of gem and mineral physics and mineral materials. He is a frequent speaker at gemological conferences worldwide and has published numerous articles in major journals on gems using new analytical testing methods. Liu was heavily involved with the (Hong Kong) Fei Cui Testing Methods and Laboratory Management System Development Project. He also serves as Chairman of the Gemmological Association of Hong Kong.
(gemedward@hotmail.com)

RICHARD W. **HUGHES**
One of the world's foremost experts on ruby and sapphire, Richard is the author of several books and over 170 articles. His writings and photography have appeared in a diverse range of publications and he has received numerous industry awards over the course of his 45-year career in gemology. In 2014, Richard founded Lotus Gemology with his wife, Wimon Manorotkul, and daughter, E. Billie Hughes. He is an advisor to the Fei Cui Standard Project of the Gemmological Association of Hong Kong.
(richard@lotusgemology.com)

ZHOU ZHENGYU ('ADAM')
Dr. Zhou Zhengyu is Director of the Gemology Education Center of Shanghai's Tongji University and a world authority on Chinese nephrite. He has been engaged in the teaching of, and scientific research in, gemology since 2006. The author of nine books and over 80 articles on gems and gemology, he is also one of the editors-in-chief of China's National Gemological Planning Textbooks for higher education. Adam is also the Deputy Secretary General of the Jewelry Committee of China Association for Quality Inspection.
(adamszzyu@126.com)

KAYLAN **KHOURIE**
Born in South Africa, Kaylan has a decade of advanced laboratory experience focusing on the study of diamonds and gemstones. A Fellow of the Gemmological Association of Great Britain (FGA) since 2017, he has a special interest in unique gems, rare synthetics and abnormal treatments. Kaylan's first publication after joining Bangkok's Lotus Gemology in 2023 was a detailed study of the hardness of fei cui in the *Journal of the Gemmological Association of Hong Kong*.
(kaylan@lotusgemology.com)

Feathered Man, Resting. Plaque pendant in Hetian *yù* (Chinese nephrite) by Master Fan Qiaoyun. Photo: Liu Renchao; size: 5.5 × 9 × 1.5 cm.

ACKNOWLEDGMENTS

THE AUTHORS would like to thank Shi Guanghai and Tatsuki Tsujimori for reference assistance, Ahmadjan Abduriyim, Brecken Branstrator, Edmond Chin, John Emmett, George Harlow, David Hughes, Taryn Khourie, William Larson, Stuart Robertson and Roland Schluessel for their review of the manuscript and helpful suggestions and Wimon Manorotkul, Ronnakorn Manorotkul and June Tang for photography and photo retouching. Geoff Dominy and Roland Schluessel generously provided photos.

In China, if an artist meets a rigorous set of requirements (starting with a minimum of 15 years of experience, along with at least one gold medal in the national carving competition), they can achieve the rank of Jade Carving Master. We are extremely proud to feature in these pages the magnificent work of a number of Chinese Jade Carving Masters, including Fan Junmin, Fan Qiaoyun, Ma Xiufang, Pang Ran, Shi Guixin, Tang Shuai, Wang Feng, Wu Desheng, Yang Xi, Yu Ting, Zhao Dong and Zhuang Qingfang. Hua Wenxian and Wang Han provided detailed information on many jade carving masters and their works.

Top: *Dwelling in Fuchan Mountain.* Tablets in Hetian *yù* (Chinese nephrite) by Master Pang Ran. Photo: Gao Yuan; size: 110 × 5.6 × 1.5 cm.
Above: *Cat Nap*. Sculpted in Hetian *yù* by Master Ma Xiufang. Photo: Liu Renchao; size: 6.5 × 4.5 × 1.2 cm.

SPONSORS

This book would not have been possible without the generous support of the sponsors below. The authors extend their deepest thanks to each of these companies.

Zhuang Qingfang

Founder of Zhuangjia Fei Cui, Zhuang is a jade artist and art curator, his work spanning jade carving, sculpture, space and installation art. He is passionate about exploring the ontology of materials and excels at creating imaginative realms through refined lines. This allows his pieces to engage audiences in a resonant dialogue. Zhuang's creations, rich with visual appeal, reflect his deep understanding and exploration of Oriental aesthetic philosophy, showcasing his profound artistic vision.

The Gemmological Association of Hong Kong (GAHK)

The GAHK was founded in 1979 by a group of Hong Kong-based gemologists with the objective of promoting gemology to the public and trade. Each year the Association produces a journal with articles from renowned gemologists from around the world. With significant support from CIBJO and other major stakeholders in the jade and jewellery industries, GAHK promotes the internationalization of the Fei Cui Standard.

On Tung Jewellery

Founded in Hong Kong in 1973, over the past 50 years On Tung Jewellery has become synonymous with the finest quality Burmese *fei cui*. Not only is On Tung one of the leading global *fei cui* suppliers, it is also one of the most important top quality jade rough buyers in Myanmar.

Junhao Gemology

Junhao was the first professional jewelry training institution in Shanghai and is also an overseas joint teaching center of the Gemmological Association of Great Britain (Gem-A). Since 2020, Junhao Gemology has been involved with assessing and recognizing China's National Vocational Skills Level; this involves evaluating the qualifications of candidates for the title of Jade Carving Master.

Pinde Xuan

Founded in 2002, Pinde Xuan focuses on integrating the essence of traditional culture into jade creations. The studio uses jade to express contemporary ideas, merging tradition with modern insights. Pinde Xuan also embraces various art forms and perspectives, aiming to highlight individual life values and showcase unique identities. Currently, Pinde Xuan has six independent studios and nearly 60 jade carving craftsmen, including six national-level Jade Carving Masters and 22 provincial-level masters.

Lotus Gemology

Lotus Gemology has quickly grown into one of the world's most renowned gemological laboratories. Founded in Bangkok in 2014 by Richard Hughes, Wimon Manorotkul and E. Billie Hughes, their specialty is the identification of colored gemstones, with the three founders operating from nearly a century of collective gemological and trade experience.

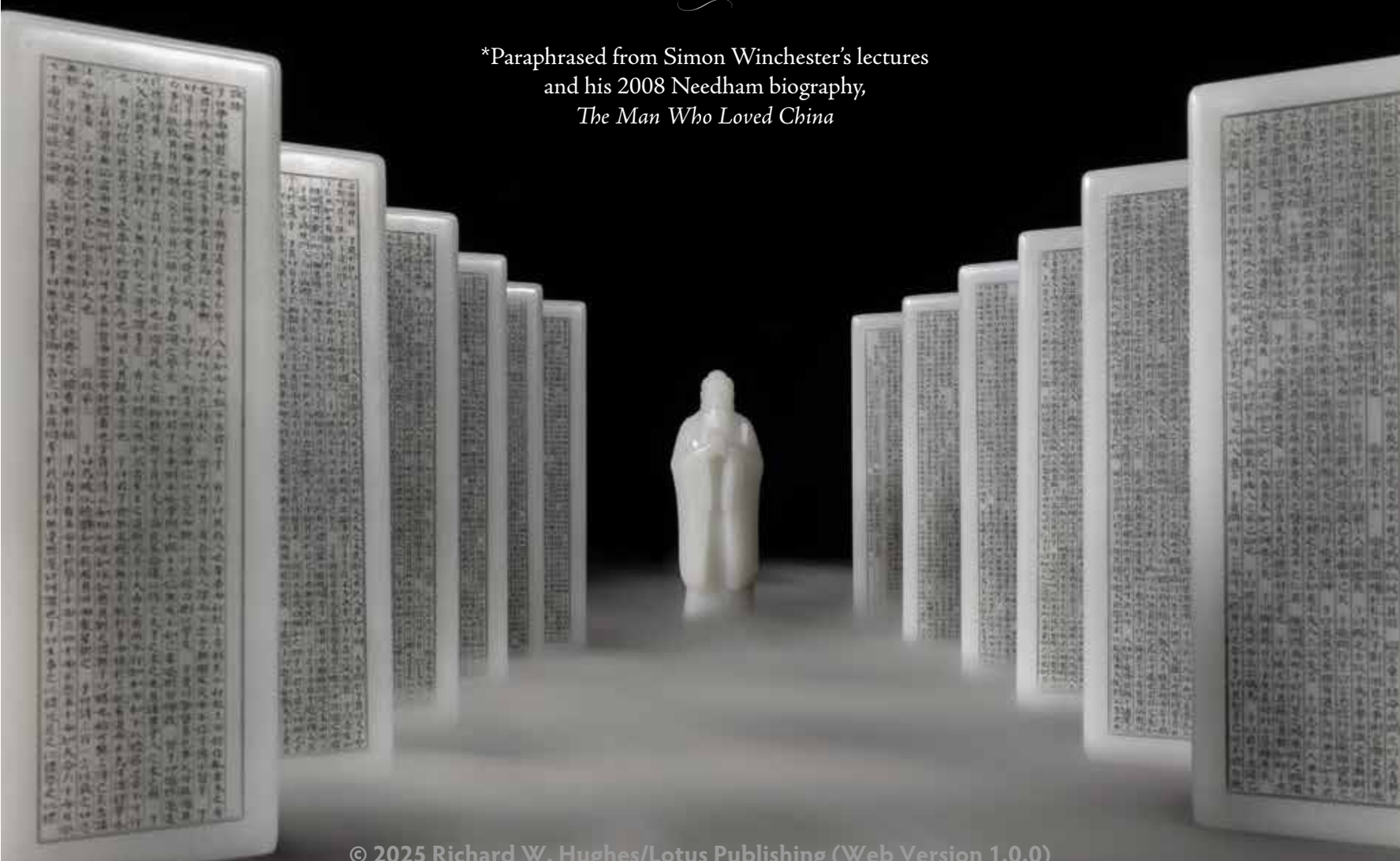
Thru the Jade Gate. *Analects*, an otherworldly composition showing Confucius and tablets of his philosophy by Master Pang Ran, sculpted in Hetian *yù* (Chinese nephrite). Photo: Cai Xurong; statue size: 17.8 × 6.1 × 5 cm.

The year was 1943. As British professor Joseph Needham prepared to depart for China for the first time, his Chinese lover, Lu Gwei-djen, admonished him:

*When you get to China, you will be like the rest of your compatriots. You think you invented everything. China has many more achievements than what you have been taught. Please keep an open mind.**

Needham went on to author the extraordinary *Science and Civilization in China* series, which currently numbers seven volumes across 27 books, eight published posthumously.

*Paraphrased from Simon Winchester's lectures and his 2008 Needham biography, *The Man Who Loved China*



OVERTURE

IN THE AUTUMN OF 2023, Edward Liu and Richard Hughes renewed their pre-pandemic friendship at a dinner hosted by the Gemmological Association of Hong Kong. When the subject of jade came up, Hughes mentioned that he had reviewed a paper for a gemological journal on Guatemalan jade. He suggested the magazine replace jadeite with *fei cui* (pronounced 'fay choy'; the traditional Chinese term for pyroxene jade), because using a mineral species name for a rock did not follow accepted mineralogical/geological nomenclature. Liu wryly smiled back and said: "I reviewed the same paper and told them the same thing."

At that dinner, a plan was hatched. We would lay out the case for why the gemological community should drop its use of jadeite and replace it with the traditional Chinese term, *fei cui*. To support this effort, we enlisted Zhou Zhengyu from Shanghai's Tongji University and Kaylan Khourie of Lotus Gemology in Bangkok.

Of course, events rarely go according to plan. Our research uncovered a previously unfathomed labyrinth of linguistic illogic, far beyond just the jadeite vs. *fei cui* question.

For those outside China, jade has long been considered "inscrutable." This is because the people most knowledgable about the Stone of Heaven pen their prose in a script unintelligible to the rest of the world. However, for the first time, machine translation today allows those unable to read Chinese to unlock this previously inaccessible storehouse of knowledge. For jade lovers, it's a wonderful time to be alive.

This small book has several purposes. First, to trace the fascinating and at times bizarre nomenclature history of jade and jade-like gem materials from early times to the present. Second, to explain to the world outside of China why the Chinese gemological community is replacing jadeite with *fei cui*, and why we believe the world gemological community should do the same. And finally, to introduce to those beyond the Middle Kingdom the magnificence of China's modern jade and stone carving culture.

What follows is not just a history of jade, but in some respects a history of mineralogy itself. Enjoy the journey. But as you do so, please heed the advice of Lu Gwei-djen — keep an open mind. For as you delve deeper into this fascinating corner of the human œvre, you might experience things that change the way *you* see the world. And that's the very definition of learning.

— Edward Liu & Richard W. Hughes
May 2024

Strive Upstream from the Pinde Xuan studio of Master Fan Junmin, sculpted in Hetian *yù* (Chinese nephrite). Photo: Liu Renchao; size: 7.5 × 3 × 1.2 cm.

Past is Present. Ancient secrets in stone exposed in black Burmese *fei cui* by Master Zhuang Qingfang. Photo: Zhuangjia Fei Cui; size: 1977.15 ct; 135 × 83.9 × 37.6 mm.

Introduction to Jade in China

ALTHOUGH GEMS such as diamond, ruby and sapphire entered Chinese culture comparatively recently (ca. 2000 years ago), the history of jade stretches back far longer — as much as 10,000 years. Jade's antiquity contributes an aura of eternity to this gem. In ancient China, jade was used for tools, weapons, and ornaments. Confucius praised the stone as a symbol of righteousness and knowledge.

Yù[1] (玉), the character for jade, is one of the oldest in the Chinese language. Its pictograph is thought to have originated in 2950 BCE, when the transition from knotted cords to written signs supposedly occurred. According to the French Sinologist Abel-Rémusat:

> The name *yù*, which the Chinese give to the stone that is the object of our research, appears to be very old. It is found in the *Li Ji* (Li-Chi), in the chapter "Feng Yi" (Feng-i), in the part of the verse book entitled *Er Ya* (Erh-Ya), and even in the *Yi Jing* (I-Ching) (in the explanation of the hexagram 'ting'). The character representing this word was originally made of three horizontal lines, intersected by a perpendicular line, which symbolized, according to Xu Shen (Hsu Shen), three precious stones on a string. Only at the time of the Qin (Ch'in) Dynasty [221–207 BCE] was the drop or dot, which is to be found at the right of the modern versions of this character, added.
>
> — M. Abel-Rémusat, 1820
> *Histoire de la ville de Khotan*

According to modern usage, the base character represents "king" — *wáng* (王) — meaning "the one who joins heaven and earth." In the Chinese character, the top horizontal stroke represents heaven, the bottom, earth, and the center, humanity, with a vertical stroke connecting the three domains. As humans reside between heaven and earth, and because the Chinese regarded their realm to be the center of civilization (surrounded by less civilized 'barbarian' peoples), thus China became the central or "Middle Kingdom." The Chinese character for middle is 中 (*zhōng*).

By adding an additional short stroke to *wáng* (王), the *yù* character depicted the king holding purity (玉) — depending on the interpretation, a drop of water, or a stone in the king's hand. Modifying the character by another three strokes to place it within shelter — *gài* — *yù* becomes the character *bǎo* (宝) representing "preciousness" and value itself. Indeed, even the Chinese characters for "China" (*Zhōngguó*, or 'Middle Kingdom') incorporate the *yù* radical (中国), testifying to the intimate relationship between *yù* and China. So tightly bound to Chinese culture is *yù* that it is considered the link between the human realm and heaven. Thus its title: *Yù* — Stone of Heaven.

Since ancient times, *yù* (nephrite; amphibole jade) has been found in a number of places within China's borders. Roughly 3000 years ago, material (locally called *kash tishi*) began to be collected in the Kunlun Mountains and the rivers that descended into the oasis kingdom of Hetian (a.k.a. Hotan or Khotan) in what is now China's Xinjiang Uyghur Autonomous Region (U.A.R.).

Because of its near white ('mutton fat') color, Hetian *yù* soon became the standard against which all other *yù* were compared. River pebbles also featured brown to orange oxidation rinds that carvers utilize in their designs. Today river pebbles of Hetian *yù* fetch huge prices if they are of the coveted mutton-fat color, such as the piece shown opposite.

In comparison to Hetian *yù*, the history of *fěi cuì* (pyroxene jade) in China is far shorter. Contrary to what has been often reported in 20th century accounts, there are no known *fěi cuì* deposits in China. All the *fěi cuì* traded and carved in China up until the 20th century is thought to have originated in Myanmar. Archaeological digs in Myanmar have found *fěi cuì* carvings that date back possibly as far as 200 CE, but anecdotal reports about the gem in China do not appear until the 13th century (Hertz, 1912).

The situation changed during the reign of Qianlong (1733–1796), fifth emperor of the Qing Dynasty. Qianlong became obsessed with jade after the death of his wife, Fucha, in 1748. Seeing samples of *fěi cuì*, he demanded to know where they had come from and was told the bright green gems came from Miandian (Myanmar), a barbarian tributary kingdom to the south.

During the years 1765–1790, Qianlong dispatched a series of armies, culminating in imperial troops led by some of his best generals, to try and conquer the mines, only to be repeatedly beaten back by wild headhunting Kachin tribes, Burmese and Shan armies and impenetrable malarial jungles. Eventually an accommodation was reached. Chinese traders would be allowed to encamp on the plains at Mogaung, where Kachin traders would bring the jade out of the hills to them. Thus began a regular trade in *fěi cuì* from Myanmar to China.

— Based on Hughes, 2022
Jade | A Gemologist's Guide

1 Accents are used when Romanizing the Chinese script to help separate words with different tones from one another. Thus the Romanized *yù* may have several different meanings depending on the tone. Except in this Introduction, for simplicity's sake, we have dropped the accents from *fei cui* throughout the book.

The Gate of All Wonders from the Pinde Xuan studio of Fan Junmin, sculpted in mutton-fat *yù* (nephrite) from Hetian in western China. Unlike *fěi cuì*, where emerald green is the most expensive color, when it comes to Chinese *yù*, the white color fetches the highest price. River pebbles get a premium, as the weathering process removes imperfections. In addition, surface staining expands the carver's color palette. The carving at right shows Laozi (Lao Tsu) leaving China on his water buffalo. Laozi (b. ~571 BCE) was the founder of the Taoist philosophy. Photo: Liu Renchao; size: 12 × 5 × 1.5 cm.

The Search for a Unicorn

…every translator should remember the Italian proverb "traduttore traditore," "the translator is a traitor," for every language has its own shape and structure which do not match those of any other.

— Patricia P. Tahill, introducing her 1989 translation of Damigeron's De Virtutibus Lapidum

ONE OF THE greatest challenges in writing about jade is the very word itself. The Chinese and English languages simply do not have one-to-one equivalents for what we are trying to describe.

Take the number "five," for example. It exists in every language, and its meaning is identical everywhere—that is true one-to-one correspondence. But with the English word "jade," no such Chinese equivalence exists.

Expecting a perfect match between the two languages is sometimes like chasing a unicorn—looking for something that does not exist.

Eugene Nida directly spoke to this problem:

> Since no two languages are identical—either in the meanings attached to their symbols or in how those symbols are arranged—there can be no perfect correspondence between them, and therefore no completely exact translation. While a translation may come reasonably close to the original in overall impact, it cannot replicate every detail precisely. As Constance B. West (1932:344) aptly put it, "Whoever takes upon himself to translate contracts a debt; to discharge it, he must pay not with the same money, but the same sum." This underscores that some degree of interpretation by the translator is unavoidable. Indeed, as D.G. Rossetti remarked in 1874 (Fang 1953), "A translation remains perhaps the most direct form of commentary."
>
> Nida, E. (2000) Principles of correspondence. In *The Translation Studies Reader*, edited by L. Venuti, London: Routledge, pp. 126–140.

In the West, "jade" generally refers to a gem rock composed mainly of either pyroxene or amphibole minerals. Chinese has no "jade." Instead, there is a term *yù* (玉), which covers a vast number of carving stones. Hetian *yù* roughly aligns with nephrite; *fěi cuì* refers specifically to pyroxene jade. But *yù* includes not only nephrite and *fěi cuì*, but also agate, jasper, carnelian, lapis lazuli, turquoise, Dushan *yù,* Tianhuang stone, chicken-blood stone and many more.

Fěi cuì is often treated as a separate category, something so special as to deserve it's own word. While it definitely falls under the *yù* category, it is considered redundant to say *fěi cuì yù*. Thus *fěi cuì* is used by itself.

Yù in Chinese functions a bit like "pearl" in English. Despite obvious differences, the term includes freshwater pearls, saltwater pearls, nacreous and non-nacreous pearls—even so-called "elephant pearls." We accept the term's breadth without confusion, knowing full well that in "pearl" markets you may be shown many types of pearls. *Yù* is similar, covering a broad range of materials. As we say in Thailand, same same, but different.

Thus, in China *yù* refers to gem materials that share fundamental virtues or traits, something Confucius famously compared to the best qualities in humans:

- Beauty (subject to one's taste)
- Toughness, allowing intricate carving (the tougher the better; should not be too brittle; can vary in hardness)
- The ability to take a reasonable polish (varies to a degree)

Because few in the outside world speak or read Chinese, asking a Chinese seller in English if any ornamental stone is "jade" will likely get you a "yes." Not because the seller is trying to cheat you, but because they may not be aware of the exact name in English. So if it's a type of *yù* in Chinese, that gets poorly rendered as "jade" in English.

Because China controls 90% or more of the world's jade trade, the odds that they will alter their definition of *yù* to match the Western definition of "jade" is probably at the "found a unicorn" end of the betting scale.

As this book is written in English, the text will use "jade" in the narrower, Western sense: a gem rock consisting primarily of either amphibole jade (nephrite) or pyroxene jade (*fěi cuì*).

Yù is a much broader, more expansive concept. We've carefully chosen the pieces shown here with that in mind, demonstrating that the sum of *yù* is not just "jade," but more, much more.

If the above sounds confusing, fret not. We are only getting started.

BROKEN 玉 BANGLE

THE BLUNDER-BESMIRCHED HISTORY
OF JADE NOMENCLATURE

1

BROKEN BANGLE

THE BLUNDER-BESMIRCHED HISTORY OF JADE NOMENCLATURE

> The nomenclature of jade undoubtedly ranks as one of the "Babel Towers" in the gemological dictionary.
>
> — Mark Chou, 1987, Dictionary of Jade Nomenclature

JADE IS NOT the name of a specific mineral, but more an umbrella term for tough translucent rocks, often but not always green, that are carved and polished into decorative objects and/or used in jewelry.

When many of us think of jade, we think of China, for without question the Chinese relationship with jade is bound more tightly to this stone than any other in the history of human civilization, with a history dating back nearly 10,000 years. But the truth is that jade's significance stretches around the globe and spans much of human history. While the word *yù* (玉; jade) holds a special place in China, jade also has a significant connection to cultures far beyond the Middle Kingdom. Pyroxene jade's use in Japan (known today as *hi sui*) is believed to date back nearly 7,000 years and it was also treasured by the Olmecs as early as 1800 BCE. The Polynesians who settled New Zealand in approximately 1250–1350 CE also valued jade, a stone they called *pounamu* (Hughes, 2022; Nanjing Museum, 2023).

CHALCHIHUITL • LOIN COIN

Even though jade (both the amphibole and pyroxene types) was found in, and worked by, prehistoric Europeans for utilitarian purposes, after metals were discovered, the use of jade ceased on that continent and the very knowledge of its existence disappeared. Thus, ornamental jade was not generally known in Europe until the "discovery" of the New World in 1492 (Hardinge, 1961).

Within decades of Columbus landing in the Americas, the Spanish found the natives in Central America and México trading and wearing irregular-shaped (kidney-shaped?) beads that the Nahuatl termed *chalchihuitl* (*ya'ax chin hun* in Mayan), named after the plumage of the male resplendent quetzal bird (Figure 1.4 on page 28) (Pendergast, 1999). While some writers have

Figure 1.1. Jade is unusual in that two different mineral families fall under its umbrella. The photo shows a sculpture in Hetian *yù* (Chinese nephrite or 'amphibole jade') by Chinese Master Carver Wu Desheng (left; 8 cm high), along with a Burmese *fei cui* (pyroxene jade) Guanyin, the "Perceiver of all Sounds" or "Goddess of Mercy" (courtesy of Kiarttichatra Intarungsee; 4.7 cm high). These are shown together with Heinrich Fischer's *Nephrit und Jadeit* (1875, 1880), the first monograph on jade ever to appear in a Western language, and Charles Hardinge's *Jade: Fact and Fable* (1961). Photo: Ronnakorn Manorotkul/Lotus Gemology; books and nephrite: Lotus Gemology Collection.

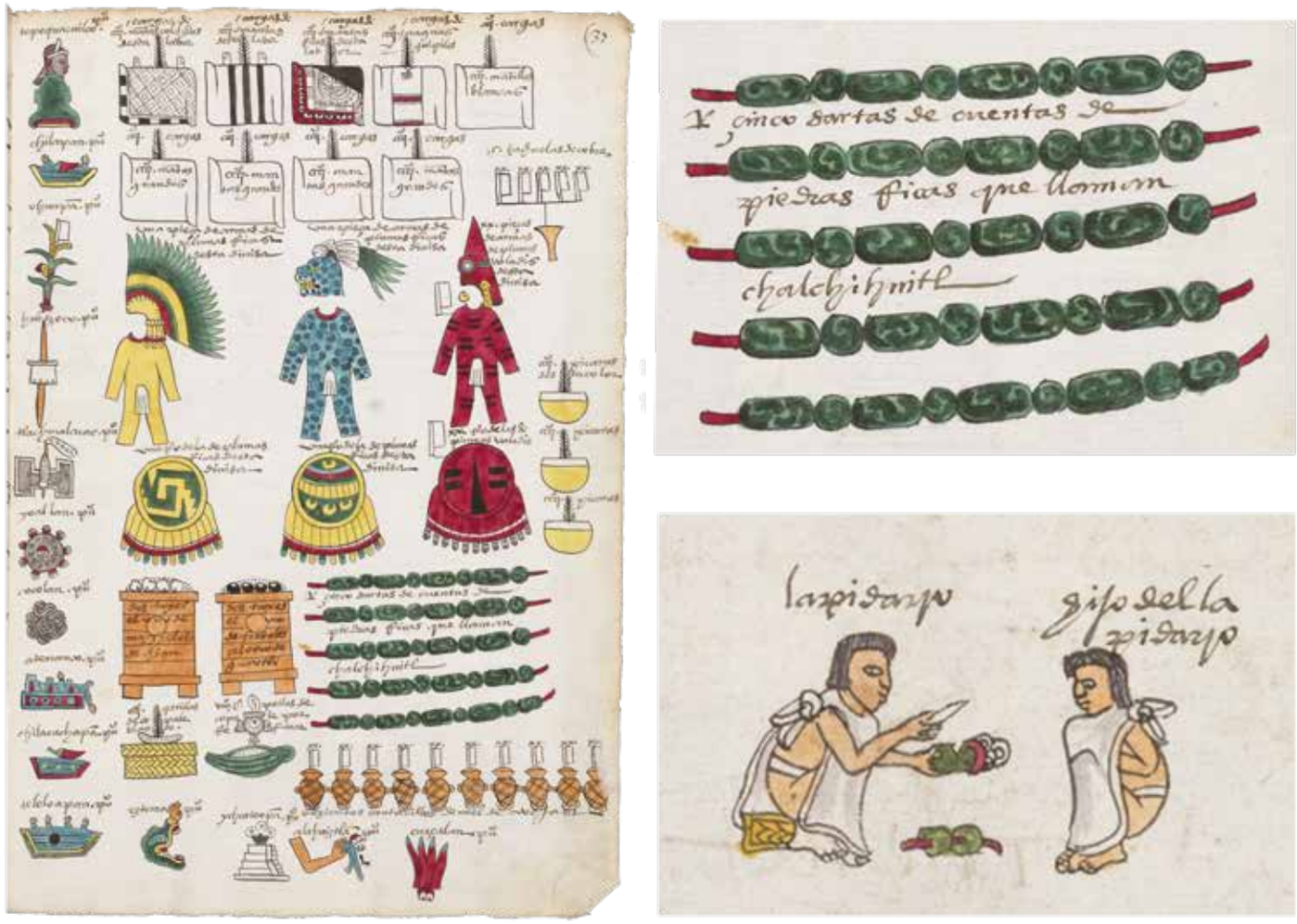


Figure 1.3. Folio images from the *Codex Mendoza*, which dates to ca. 1541–42. Compiled by Spanish clerics in México City, it was meant to inform King Charles V about the people and productions of his freshly conquered New World colonies. Consisting of 71 folios, the original is on display at Oxford University's Bodleian Library in the UK. The illustration above left (Folio 37) shows tribute items demanded by the Aztec rulers from subjugated tribes. Note the magnified view (above right) showing "five strings of beads of fine stones called greenstones (*chalchihuitl*)." Apparently due to their shape and the fact that the natives wore them on strings around their waists, breasts and foreheads, the Spaniards assumed that *chalchihuitl* had medicinal use in treating kidney disease. Below right, a father teaches his son lapidary arts, such as bead making with a green stone that is likely *chalchihuitl* (Folio 70r). Translations from Berdan et al. (1997).

stated that the Aztecs told the Spanish that the stone could cure ailments of the spleen, kidney, and liver (Kovacevich, 2011), neither we nor Mottana (2012) have been able to locate direct evidence of that. In any event, the Spanish assumed them to be of medicinal use for the kidneys; thus, the stones soon became known in Europe as *piedra de la yjada*.

When the Spanish physician Nicolás Monardes' book on New World medicine (Figure 1.5 on page 29) was translated into Latin in 1574, *piedra de la yjade* was rendered as *lapis nephriticus* (stone for/of the loins or

Figure 1.2. Mayan *chalchihuitl* head ornament from the Copan archaeological site in western Honduras (ca. 600–900 CE). Carving and photo: Cleveland Museum of Art; size: 7.7 × 3.8 cm.

Figure 1.4. In Mesoamerica, the most precious of all commodities was not gold, nor emerald, but a brilliant green pyroxene jade termed *chalchihuitl*, named after the vivid plumage of the male resplendent quetzal bird. Photo: Ondrej Prosicky/iStock.

kidneys) (Monardes, 1565, 1574; Murray, 1900).[1] The European misunderstanding that *chalchihuitl* could help treat kidney ailments was an early mistake in the saga of jade nomenclature, but as readers will soon learn, it was far from the last.

1 *Lapis nephriticus* itself is derived from ancient Greek λίθος νεφριτικός (*líthos nephritikós*) or νεφρός λίθος (*nephrós líthos*). *Nephriticus* comes from *nephritus*, which refers to kidney disease (Fischer, 1875; Bishop, 1906).

The first part of the thinges that

bee hotte of complexion, it doeth heate them more then is conuenient, and so they cannot drinke it, and moste of all if that their Liuer be very hotte, for that it heateth too much.

In womens diseases as well of the Mother, as of colde humours, it worketh good effectes, and doeth meruellously dissolue windes. And in persons that bee subiect to manie euilles, and especially of Reumes, and olde greefes and diseases caused of the euill humours, if they runne this course, with the continuance thereof, they shall receiue manifest profite and benefite, and it doeth heale all deseases whiche they neuer thought to be healed of. The complexion thereof is hotte and drie, well neere in the seconde degree. All these waters must be giuen in Sommer, or in the ende thereof: it is better that the season exceede in heate then in colde.

¶ Of the blood Stone, and of the Stone

for the diseases of the Stone of the Kidneies and Reines.

Of the blood stone.

THEY doe bring from the new Spaine twoo stones of greate vertue, the one is called the Stone of the Bloode, and the other is a Stone for the desease of the Stone in the Kidneis and Raines, The Blood Stone is a kinde of Iasper of diuers colours somewhat darke, full of sprincles, like to blood, being of colour redde, of the which stones the Indians doe make certaine Hartes both greate and small.

The vse thereof, bothe here and there, is for all fluxes of blood in what partes soeuer it bee, of the Mose, or of the Menstrues, or of the Piles, and of Woundes, or of that which is cast out at the mouth. The stone must bee wette in colde water, and the sicke Man must take it in his right hande, and from time to time wette it in colde wa-

ter.

are brought from the West Indias. Fol.19.

In this sort the Indians doe vse them. And as touching the Indians, they haue it for certayne, that touching the same stone, in some parte where the blood runneth, it doeth restrayne, it and in this they haue greate trust, for that the effect hath beene seene. It doeth profite also hauing it holden, hanged, or tyed in the same parte where the blood runneth, so that it touch the flesh. Of this stone wee haue seene great effectes, in staunching of blood. And some that doe suffer the Hemeroidall fluxe, haue remedied themselues with making Ringes of this stone, and wearing them continually vpon theyr fingers. And likewyse in the Menstruall fluxe of women.

The stone for the disease of the gravel & stone in the kidnies or reines.

The other Stone, which is for the disease of the stone in the Kidneies or Reines, the finest of them are like vntoo *Plasma* of *Esmeraldes*, which are lykened to greene with a Pilkishe colour, the greatest are the best: they bring them made in diuers formes and fashions, for so the Indians had them in old tyme, some lyke to fishes, other like to the heads of byrds, other like to billes of Popingaies, other lyke to round Beadstones, but all pearsed through, for that the Indians did vse to weare them hanging for the effect to take away the grief of the stone or stomacke: for in those twoo sicknesses it sheweth maruellous effects.

The chief vertue that it hath, is in the paine of the stone in the Kidneis and Reines, and in expelling of Sande and stone. In so much that a Gentleman which had one of them heere, the best of them that I haue seene, hauing laid it to his arme, it made him to expell and cast out much sande, insomuch that many tymes hee doeth take it away, for that hee thinketh that it doeth hurte him for to voide so much, and in taking it away, hee ceaseth to voyde any from him: and when hee feeleth the paine of the stone, laying it too againe, it doeth take it away incontinent, with expelling of much Sande and small stones. I haue seene it carried to persons that haue beene afflicted with greate griefe, and

Figure 1.5. Section of the first English translation of Nicolás Monardes' book on medicinal substances from the New World. Monardes (right), a noted physician in Seville (Spain), writes that in the New World, kidney-shaped stones (termed *chalchihuitl* by the natives and later proved to be pyroxene jade) were drilled so that they could be worn across the body and used medicinally for kidney diseases. He dubs the gems *piedra de la yjada*. This is later translated to Latin as *lapis nephriticus* ('stone for the kidneys') (Monardes, 1565, pp. 40–43; 1571, p. 67). Monardes never visited the New World, relying on informants who brought back plants and other substances said to have curative powers (including the 'holy herb,' tobacco, which he promoted as a cure-all for many diseases).

If we needed further evidence that the terminology of jade represents a masochistic exercise in illogic, witness the following deep dive into the origins of the English word "jade" itself, penned in the year 1900 by J.A.H. Murray, a noted British lexicographer and philologist.

"THE ORIGIN OF this word remained a mystery until it was pointed out by Prof. Max Müller, in the *Times* of January 15th, 1880, that it was the same word as Spanish *ijada*; or *yjada* in *piedra de ijada*, a descriptive appellation given to it in the sixteenth century, in accordance with a belief long entertained that it possessed the virtue of curing pain or disease in the iliac region (*ijada*, late L. **iliata*). For the same reason Latin writers of the sixteenth and seventeenth centuries called it *lapis nephriticus*, and modern mineralogists *nephrite*. It has not, however, been yet shown how the Spanish *ijada* became *jade* in French and English, nor how the French jade is a noun masculine against Spanish *ijada* and Italian *iada*. This is, I suppose, one reason why French etymologists have not accepted Prof. Max Müller's identification, so that in the new 'Dictionnaire Général' of Hatzfeld and Darmesteter, as in that of Littré, the derivation of *jade* still stands "origine inconnue." This link in the history of the word can now be supplied. Through the kindness of Dr. C.A.M. Fennell my attention was recently called to two passages in the English translation of 1657 of the 'Letters of Voiture,' in which "l'ejade" and "the ejade" are applied to a stone which the context indicated to be jade. On seeing these it was natural to infer that *l'ejade* must be simply taken over from the French original, and that probably the word would there be found to be, as it ought to be, feminine. On turning to the 'Lettres de M. Voiture' both expectations have been verified. The word is *l'ejade*, and it is feminine. Mlle. Paulet had sent Voiture a jade stone with the hope that it might cure him of his malady, and in letter xxiii. (ed. 1665, p. 47) he says, "Ainsi pour ce coup, *l'Ejade* a eu pour vous un effet que vous n'attendiez pas d'*elle*." In letter xiii. (p. 102) he says, "Je voy bien qu'il me faudra chercher des remedes plus solides que celuy de l'Ejade." These are rendered by Davies (ed. 1657, letter xxiv., p. 37), "So that for this time, *L'Ejade* hath had for you an effect which you expected not from it"; letter xiii., p. 79, "I perceive there must be found out for me some more substantial remedies than the Ejade [misprinted, by splitting the *d*, *Ejacle*]." The date of these letters is 1633. They show that *l'ejade* was already in vogue in France as a curative agent; but the word was new and strange, and its actual form uncertain, so that *l'ejade* feminine came to be ignorantly written *le jade* masculine, in which form it appears in the first quotation in the 'Dictionnaire General' in 1667. The anomalous masculine gender of the word in modern French is thus explained. *Le jade* is a bungled writing of *l'ejade*, and the bungle has not only decapitated the word, but changed its gender. In English we have no evidence that *ejade* ever passed beyond the pages of J. Davies's translation of Voiture. Our next quotations for the word are of 1727, also from French, and in the decapitated form *jade*. The quotations from Voiture's letters had not been supplied by any readers for the 'New English Dictionary,' and it is due to Dr. Fennell's clever "spotting" of them that this interesting link in the English — and still more in the French — etymology of the word has been supplied. There are no doubt many other cases in which the key to an etymological puzzle lies enshrined in a single passage.

—— J.A.H. MURRAY, 1900
The Athenæum, Oct. 20, p. 513

Figure 1.6. *Mirror, Mirror. Blue water* Burmese *fei cui* jade carved by Zhuang Qingfang.
Photo: Zhuangjia Fei Cui; size: 202.15 ct; 68.5 × 38.4 × 9.8 mm.

"PRECIOUS stones are not found in the beautiful polished and brilliant condition in which they are sold by venders. They are originally rough, without appearance of beauty, and are carried from the fields and villages. There are persons who know where precious stones grow because, wherever the latter are, they exhale, at dawn, a vapor-like delicate smoke. Another sign indicates the place where precious stones are hidden, especially in the case of those called *chalchihuitls*. Wherever these are the grass which grows above is always green, for the reason that these stones continually send forth a cool and moist exhalation.

Wherever this is the stones are to be found in which the *chalchihuitls* are formed.

—— *Friar Bernardino de Sahagún, 1585*
The Florentine Codex
(as quoted by Nuttal, 1901)

Figure 1.7. *Stepping Stone* by Master Zhuang Qingfang. Burmese *fei cui*. Photo: Zhuangjia Fei Cui; size: 615 ct; 11 × 7 × 3.5 cm.

COLUMBUSED

EUROPE REDISCOVERS JADE

2

COLUMBUSED

EUROPE REDISCOVERS JADE

Gold is the most precious of all commodities.

— Christopher Columbus

THE OCCIDENTAL Industrial Revolution (ca. 1760–1840) brought tremendous advances in analytical chemistry. Prior to that, mineralogy was mostly descriptive, with classifications based on appearance (color, shape, etc.). But when scientists began to decipher the chemical makeup of minerals, the number of new species exploded, including two that fell under the category of what we now call jade.

In 1845–46, the French mineralogist, Alexis Damour (Figure 2.2), analyzed a milky white piece of "jade" cut in India (but thought to come from China; see Figure 2.3) and found it to be composed of minerals that fell into the tremolite-actinolite series of the amphibole group. Damour assumed the stone was the same as the *chalchihuitl* from the New World, which was trading in Europe as "nephrite" (the descendent of the Latin name *lapis nephriticus* — 'stone for the kidneys'). Thus he applied the name nephrite to the amphibole jade.

Figure 2.2. French chemist Augustin Alexis Damour (1808–1902). Damour was responsible for the first modern analyses of nephrite and jadeite and the naming of jadeite. Photo: Public domain.

Figure 2.1. *Resurrection* by Master Zhuang Qingfang. The lotus flower is a Buddhist symbol of purity and perfection, growing like a jewel out of murky water, yet remaining uncontaminated. In the same way, Buddha is born into this world, yet remains above it. Burmese *fei cui*. Photo: Zhuangjia Fei Cui; size: 306.65 ct; 58 × 71.2 × 11 mm.

Figure 2.3. Chinese *yù* (nephrite) from Western China fashioned in India. When Damour analyzed a Chinese "Oriental jade" cut in India, he named the stone "nephrite" in the mistaken belief that it was the same as the *chalchihuitl* from the New World. From Bishop's *Investigations and Studies in Jade* (1906, Vol. 1, p. 206–207).

In his 1846 paper, Damour states:

> The generic name "jade" has been given to mineral substances that — exhibiting certain physical characteristics such as hardness, tenacity, and compact structure — have been, however, relatively little studied in terms of their composition. Three types have been established: ancient or axinian [axe type] jade, Saussure's jade, and nephritic jade or oriental jade. The first two, judging by their appearance, seem to belong to composite rocks; but oriental jade, due to its constant homogeneity and overall characteristics, has always been considered by mineralogists as constituting a distinct mineral species.… The first known analysis of this substance was carried out by Mr. Karsten; more recently, Mr. Rammelsberg provided a second analysis whose results do not agree with those obtained by Mr. Karsten. I thought that oriental jade deserved to be studied again, and it is for this purpose that I undertook the analysis, the results of which I will now present…
>
> According to its composition, gravity, hardness, and fusibility, oriental jade is closest to tremolite; if this opinion is adopted, oriental jade will be classified in collections under the name compact tremolite.
>
> — Alexis Damour, 1845
> *Analyse du Jade blanc; réunion de cette substance à la Trémolite*
> [Analysis of white jade; the joining of this substance with tremolite], p. 1382

Here we find one of the critical roots of problematic jade nomenclature. Damour clearly knew what rocks were, as he correctly identified "ancient or axinian jade" and "Saussure's jade" as rocks. But due to the apparent homogeneous nature of the "oriental jade" he considered it to be a mineral species. In addition to Damour mistakenly identifying white nephrite as a unique mineral species (tremolite), he also equated the term "nephrite" (which was associated with kidneys in the New World *chalchihuitl*) with "Oriental jade," a Chinese rock of an entirely different type ***that had absolutely nothing to do with curing kidney disease***.

Figure 2.4. Eggshell-thin nephrite jade vase sculpted by Master Yu Ting. Photo: Boguan Culture; size: 20 × 9.3 × 7.2 cm.

Damour continued his studies on jade with an 1863 paper (and if you are not yet wary, you should be), where he analyzed bright green jade looted by French soldiers in the 1860 sacking of the Summer Palace outside Beijing (Damour, 1863):

> In recent years, following the French expedition in China, samples of a substance worked in different shapes have arrived in Paris. The substance is known as green jade because it usually has an apple-green color quite like that of the chrysoprase; one can see also samples with a slightly darker tone approaching the color of an emerald. Due to its agreeable aspect, and probably also to its rarity, this jade is more sought after than the previous one [oriental jade = nephrite] and the smallest samples have considerable commercial value. I thought that there was a need to determine if this material differed from the white jade solely by its color or if the green jade should not be distinguished by more important mineralogical properties.… (p. 861)
>
> Based upon what has been shown, I think that there is good reason to classify the green jade as a separate species attached to the family of wernerites [now part of the scapolite series]. I therefore propose to name it jadéite, in order to distinguish it from the white jade, which would remain in the family of amphiboles. (p. 865)
>
> — Alexis Damour, 1863
> *Notice et analyse sur le jade vert: Réunion de cette matière minérale à la famille des wernerites*
> [Notice and analysis of green jade: Union of this mineral material with the wernerite family]

While Damour's 1863 paper does not mention *fei cui* (variously transliterated as *feitsui*, *fei tsui*, *fei ts'ui* or *fy-tse*), the Chinese name for the stone, in 1865 he published a two-part article on jade axes where it is stated:

> **Jadeite Occurrence.**
> Carved objects made from this material, currently found in collections, primarily originate from Central Asia, especially China. Jadeite is found in a mountain called Yù-Sin (Jade Mountain) located in the province of Zhejiang, near the border with Jiangxi. The local inhabitants refer to this mineral species as *fy-tse*. I received this information from a Chinese merchant based in Paris.
>
> — Alexis Damour, 1865
> *Sur la composition des haches en pierre trouvées dans les monumemts celtiques et chez les tribus sauvages*
> [On the composition of stone axes found in Celtic monuments and among wild tribes], p. 364

Thus by 1865, there is no question that Damour knew what the gem was called in China. Now on a *nouveau nom* roll, he also coined the term "chloromelanite" to describe Fe-rich dark green forms of *fei cui* (then termed jadeite by Damour). Interestingly enough, Damour actually refers to chloromelanite as a rock in this paper.

The noted American geologist/explorer Raphael Pumpelly (1837–1923) echoed Damour in 1866 where he explicitly equated jadeite with *fei cui* (*feitsui*):

> The mountains of Southern Yunnan seem to abound in precious stones.
>
> The working of beautiful stones into objects of ornament, forms an important branch of industry in several of the large cities. Jade of various colors, serpentine, steatite, and dendritic marbles, are made into an endless variety of household ornaments. Topaz, aqua-marine, pink turmaline, opaque sapphires, jadeite* (*Feitsui*), lapis-lazuli, sungurshï, a mineral similar to turquois, rock-crystal, garnets, and many other precious and semi-precious stones, are carved, with great labor and patience, in very intricate forms. Several snuff bottles carved out of blue corundum were seen, the cavity being very small at the neck, and enlarged symmetrically and polished in the interior.
>
> **Feitsui* is, perhaps, the most prized of all stones among the Chinese. The *chalchihuitl*, a precious stone of the ancient Mexicans, as I have seen it in a mask preserved in the museum of Pract. Geol. in London, and in several ornaments in the collection of Mr. Squiers in New York, is, apparently, the same mineral. This fact is the more remarkable, as there is no known occurrence of this mineral in America.
>
> — Raphael Pumpelly, 1866
> *Geological researches in China, Mongolia, and Japan, during the years 1862 to 1865*, p. 118

Pumpelly, for whom the mineral pumpellyite is named, spent three years in China, Japan, Mongolia and Siberia.

As the 19th century drew to a close, Western mineralogy had made critical errors in naming not just one, but both types of jade. But there is still more to come.

Figure 2.5. A lovely Burmese *fei cui* lotus, sculpted by Master Zhuang Qingfang. Photo: Zhuangjia Fei Cui; size: 258 ct; 40.2 × 44.6 × 22.7 mm.

Figure 2.6. Burmese *blue water fei cui* sculpted by Master Zhuang Qingfang.
Photo: Zhuangjia Fei Cui; size: 481 ct; 140 × 85 × 20 mm.

DECONSTRUCTION

THE MINERALOGY OF JADE

3

DECONSTRUCTION

THE MINERALOGY OF JADE

> The magic powers of Heaven and Earth are ever combining to form perfect results; so the pure essences of hill and water become solidified into precious jade.
>
> — Yü Shuo [Discourse on Jade] by T'ang Jung-tso (Bishop, 1906)

WHILE IN CHINA there were traditionally many rocks that were considered types of "jade," today the world gemological community has trimmed that down to two — *yù* (nephrite, or amphibole jade) — and *fei cui* (pyroxene jade). While both are metamorphic in origin, the manner of formation and locations where they are found are different.

WHAT IS JADE?

Since ancient times China had what became known as the "four great jades." These were:

- Hetian jade (nephrite) from Hetian (a.k.a. Hotan, Khotan), Xinjiang Uyghur Autonomous Region.
- Xiuyan jade (nephrite/serpentine) from Xiuyan County, Liaoning Province (Figure 3.2 on page 48).
- Dushan jade from Nanyang City, Henan Province, a rock composed mainly of anorthite and zoisite that was mined as early as 6000 BCE.
- Turquoise from Yunxian County, Hubei Province.

Figure 3.1. Both *fei cui* (pyroxene jade) and Hetian *yù* (Chinese nephrite) are found as weathered boulders in alluvial deposits. Such "river jade" is more highly valued for two reasons. First, carvers can utilize the surface staining in their designs. Second, alluvial jade is generally of higher quality because the weathering breaks away fractured areas, leaving the pure portion of the stone intact. *Fei cui* carving by Master Zhuang Qingfang. Photo: Zhuangjia Fei Cui; size: 307.85 ct; 76.6 × 48.4 × 16.5 mm.

"Jade" stones shared certain characteristics. All were aggregates, either micro- or cryptocrystalline. Hard enough to take a fine polish, they were mostly translucent after finishing. However as time passed by, one reigned supreme — the gem we now call nephrite.

YÙ (NEPHRITE JADE)

During Neolithic times, nephrite jade was sourced in northeastern China (Xiaonanshan culture, 7100–6500 BCE; Xinglongwa culture, 6200 BCE; Hongshan culture, 4700–2200 BCE). Jade was also produced from deposits in the Ningshao area in the Yangtze River delta (Liangzhu culture, 3300–2250 BCE), among other places.

Later, a stone called *kash tishi* by the Uyghurs was discovered in the White Jade (Yurungkash) and Black Jade (Karakash) rivers near the town of Hetian (Khotan) in what is now western China's Xinjiang U.A.R. (Laufer, 1912). From these deposits comes a creamy white to greenish to black nephrite jade, with the most valuable being near white. Today, this "mutton fat" jade from Hetian is considered the finest in the world, with the highest prices being paid for white stones from the rivers.

Figure 3.2. *A Siren's Song.* This incredible piece is carved from Xiuyan jade by Master Tang Shuai. One of the oldest Chinese jade deposits, Xiuyan is in Liaoning Province, near the border with North Korea. Here, *yù* (nephrite) occurs in intimate contact with serpentine and carvings may include both types of rock in a single piece. However gemological convention is to bless the nephrite as "jade," but turn the serpentine into a toad. This demonstrates one of the major problems of applying a "mineral-based" system of gem identification to a gem rock such as jade. In gemology, it's important to look at "wholes," not just "parts." Photo: Richard W. Hughes/Lotus Gemology; size: ~30 cm high.

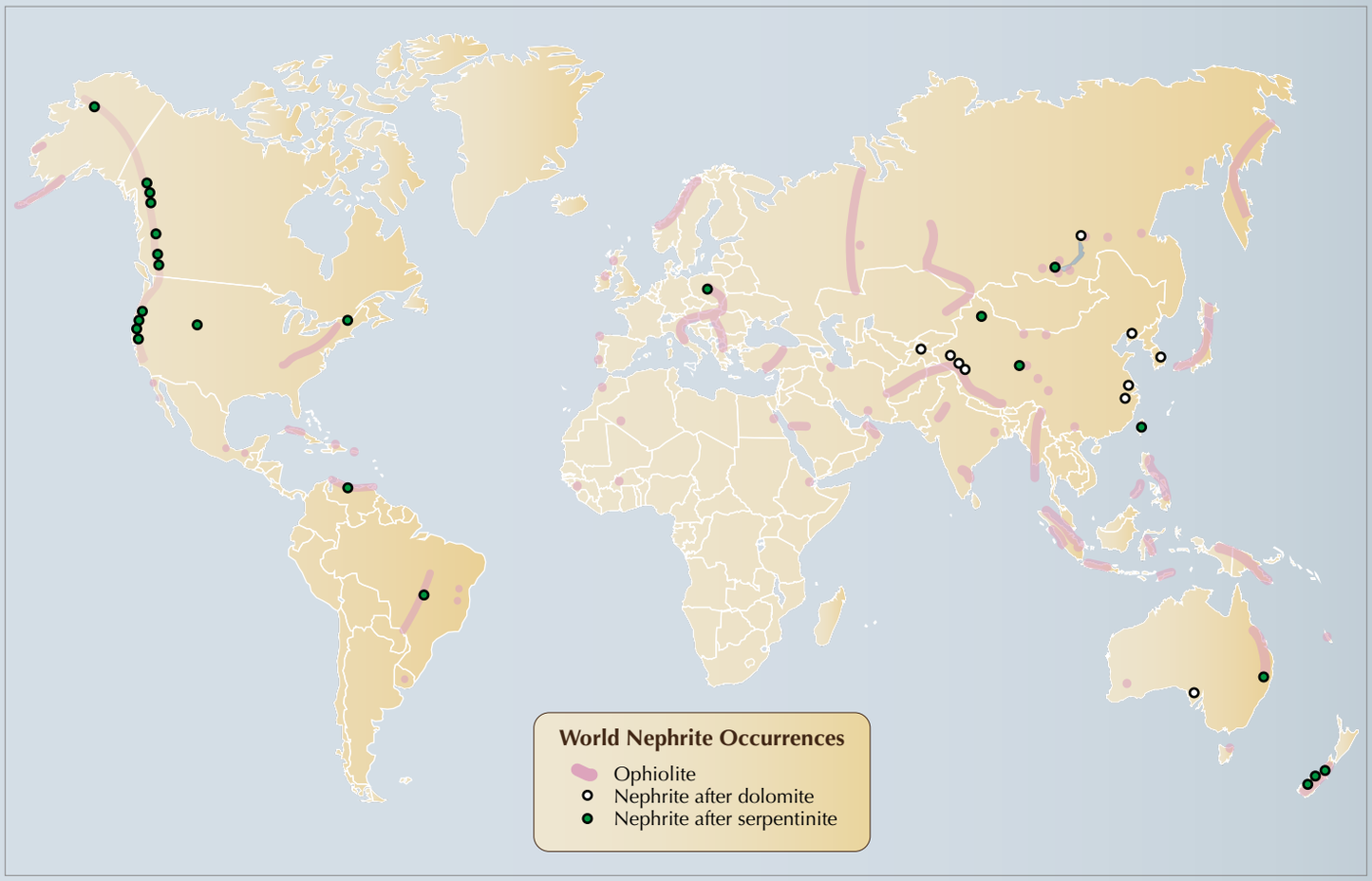
Nephrite is much more abundant than *fei cui*, both in terms of amount and the number of geological occurrences (literally countless). It is the classic jade of China, but has been used by many peoples from Neolithic times, first for tools, then for ceremonial and decorative carvings as well as jewelry.

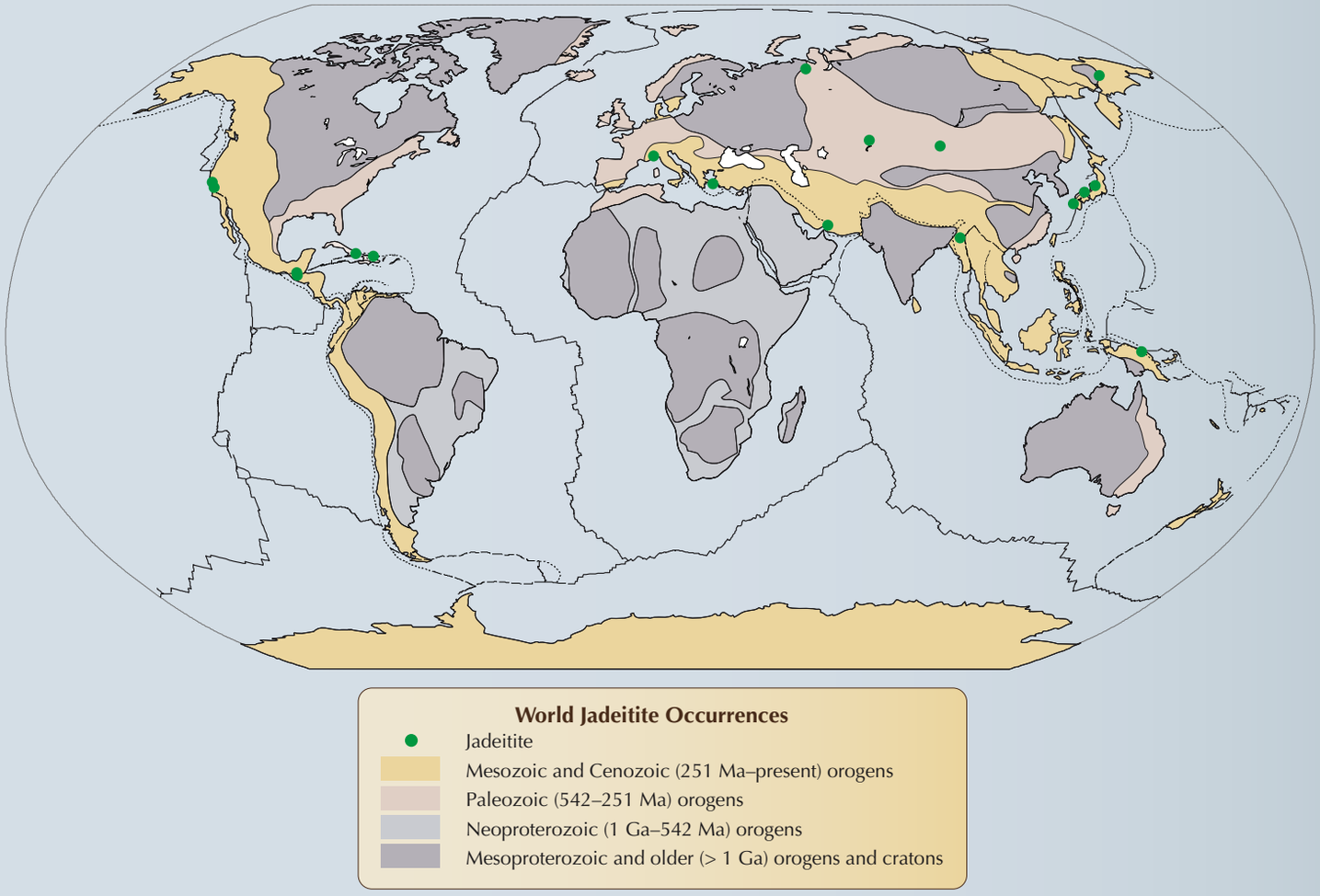
Nephrite is a rock composed mainly of:

- Tremolite (more common): $\square Ca_2Mg_5(Si_8O_{22})(OH)_2$
- Actinolite (less common): $\square Ca_2(Mg_{4.5-2.5}Fe_{0.5-2.5})Si_8O_{22}(OH)_2$

In both types, fibers of the amphiboles form a felted mass that imparts tremendous durability. So much so

Figure 3.3. Nephrite and jadeitite occurrences around the world. After Harlow, 2014; Harlow et al., 2015; & Harlow (2022).





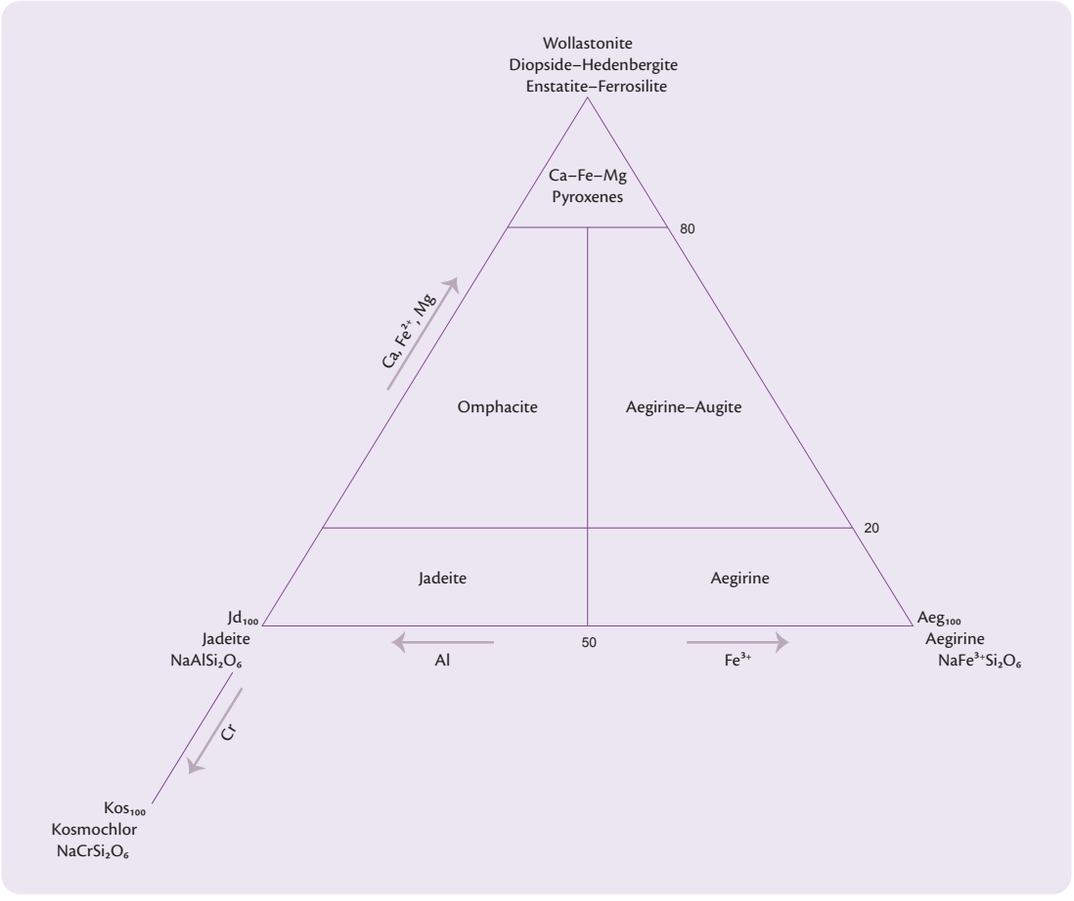


Figure 3.4. Clinopyroxene classification diagram (after Morimoto et al., 1988).

that nephrite is the toughest naturally-occurring material found on earth.

The texture also constrains the geological environment in which nephrite can form. Conditions at rock boundaries where metasomatism occurs enables chemical mixing and growth of many crystals simultaneously. There are two basic geological settings:

1. Replacement of dolomite ($CaMg(CO_3)_2$ in dolostone) by silica-rich fluids derived from crystallizing granitic intrusions. This setting produces the highly sought-after "mutton fat" white jade.
2. Metasomatic reaction or replacement at the boundary between serpentinite and a silica-rich rock such as a granite, a quartz-bearing sedimentary rock (typically a graywacke, sandstone or chert).

The distribution of most nephrite occurrences are shown in Figure 3.3 (based on Harlow, 2022).

FEI CUI (PYROXENE JADE)

In the Qing Dynasty (1644–1914 CE), a white-to-bright green jade appeared in China, sourced from mines in Upper Burma (Hertz, 1912). The Chinese understood this material was different from the Hetian jade, and named the vivid stone *fei cui* (翡翠) or kingfisher jade (Hughes, 2022).

Unlike nephrite, *fei cui* forms in the subduction zones along continental margins, where rocks undergo metamorphism under high pressure, but relatively low temperatures. When one tectonic plate sinks beneath another, rocks and water are driven into Earth's mantle. The escaping water, rich in dissolved minerals, ascends through cracks in the rocks. As it travels through these

fissures, it deposits jade, gradually blocking them. When another tectonic event occurs, new cracks form or old cracks reopen. More mineral-rich water flows through, depositing additional layers of jade. This process repeats multiple times. Literally millions of earthquakes must have been involved to create large jade deposits (Harlow, 2022).

While the mineral species jadeite was first described by Damour in 1863 as being related to wernerite (a sorosilicate), it took decades before it was properly placed into the pyroxene group, a complex array of rock-forming chain-silicates (inosilicate). Split into orthorhombic (orthopyroxenes) and monoclinic (clinopyroxenes) subgroups, the latter alone currently has 28 species (Mindat.org). Two clinopyroxenes of specific note are omphacite and kosmochlor, both of which have been found to intergrow with jadeite in gem samples of *fei cui*. Research into jade over the past few decades has shown that *fei cui* from Myanmar, Russia, Guatemala, Japan and other countries consists not only of jadeite, but also other pyroxene mineral combinations.

Kosmochlor

The Gemological Institute of America's Vincent Manson first made the link between jade and kosmochlor (then termed ureyite) when he found it in maw sit sit, a related Burmese ornamental rock occurring in intimate association with *fei cui* at the Myanmar mines (Manson, 1979). Later, Hong Kong-based gemologist Ouyang Chiu Mei discovered that *fei cui* samples themselves contained kosmochlor (Ouyang, 1984). Further research showed that omphacite is also present in many *fei cui* materials (Zheng & Zheng, 1998; Liu et al., 2010 & 2011; Ouyang et al., 2011; McClure, 2012; Harlow, 2014).

Chemical analyses have revealed that a complete isomorphous series exists between three pyroxene minerals — jadeite, kosmochlor and omphacite (Figure 3.4). In jadeite, when Cr replaces Al, a green color results; as the Cr content increases, the color becomes more intense. When it becomes deep green, the Cr content is so high that it merges into the kosmochlor end member.

Furthermore, Al can be replaced by Fe and Mg, and Na can be replaced by Ca, forming omphacite. Both jadeite and omphacite have similar physical properties (Deer et al., 2006). Major and minor mineral components in *fei cui* are detailed in Table 3.1 on page 52.

Understanding Omphacite

Omphacite has a convoluted nomenclatural history (Clark & Papike, 1968) due to its complex chemistry and intermixing with jadeite and/or kosmochlor. Previous descriptions of chloromelanite (no longer in use) generally match the current parameters for omphacite (Dana & Ford, 1932). Simply put, omphacite is a clinopyroxene with thorny chemistry/structure. While it has the general chemical formula (M2)(M1)[Si_2O_6], the M2 cation site can feature either Ca^{2+} or Na^{+}, while the M1 cation site can host either Al^{3+}, Mg^{2+} or Fe^{3+}. The composition is intermediate within the jadeite [$NaAlSi_2O_6$]—diopside [$CaMgSi_2O_6$]—aegirine [$NaFe^{3+}Si_2O_6$] series. There may also be minor substitution with other cations such as Fe^{2+}, Ti^{4+} and Mn^{2+}. Specific chemical parameters have been stated by Morimoto et al. (1988) and are illustrated in Figure 3.4.

Although not an end member, omphacite is classified as a distinct mineral because it has a different crystal structure when compared to its related clinopyroxene members (Matsumoto et al., 1975). The space group symmetry depends upon its specific composition. Intermediate compositions have the space group P2/n, whereas the omphacites with compositions closer to diopside or jadeite end members have the space group C2/c (Deer, Howie & Zussman, 1992). The different space groups

Table 3.1. Mineral Components of *Fei Cui* and their Properties[1]

Essential Minerals	IMA Formula	RI (Range)	Specific Gravity	Mohs Hardness[2]	Typical Volume %[3]
Jadeite	$NaAlSi_2O_6$	1.640–1.692 (1.66 spot)	3.24–3.43 (3.34 average)	6.5–7	Generally greater than 80%; although it may be difficult to determine, *fei cui* should have around 50% or more of these three pyroxene minerals
Omphacite	$(Ca,Na)(Mg,Fe,Al)Si_2O_6$	1.662–1.723	3.16–3.23	5–7	
Kosmochlor	$NaCrSi_2O_6$	1.74–1.78	3.51–3.60	5.5–6	
Minor Minerals					
Amphiboles					5–20%
Richterite	$Na(Na,Ca)Mg_5(Si_8O_{22})(OH)_2$	1.615–1.636	3.1	5–6	
Eckermannite	$NaNa_2(Mg_4Al)Si_8O_{22}(OH)_2$	1.605–1.634	3.02	5–6	
Magnesio-arfvedsonite	$\{Na\}\{Na_2\}\{Mg_4Fe^{3+}\}(Si_8O_{22})(OH)_2$	1.660–1.664	Unmeasured	5–6	
Feldspar					
Albite	$Na(AlSi_3O_8)$	1.528–1.542	2.60–2.65	6–6.5	
Other Minerals					
Nepheline	$Na_3K(Al_4Si_4O_{16})$	1.529–1.542	2.55–2.66	5.5–6	
Accessory Minerals[4]					
Rutile	TiO_2	2.605–2.901	4.23	6–6.5	Usually less than 1%
Zircon	$Zr(SiO_4)$	1.925–2.015	4.6–4.7	7.5	
Garnet	$X_3Z_2(SiO_4)_3$ X = Mg, Ca, Fe^{2+}, Mn^{2+}, etc. Z = Al, Fe^{3+}, Cr^{3+}, V^{3+} etc. Trace amounts of Sn may replace Fe^{3+}	1.71–1.88	3.6–4.3	6–7	
Apatite (Fluorapatite)	$Ca_5(PO_4)_3(Cl/F/OH)$	1.631–1.646	3.1–3.25	5	
Chromite	$Fe^{2+}Cr_2O_4$	2.08–2.16	4.5–4.8	5.5	
Magnetite	$Fe^{2+}Fe^{3+}{}_2O_4$	2.42	5.175	5.5–6.5	
Molybdenite	MoS_2	?	4.62–4.73	1–1.5	
Amorphous Substances					
Amorphous carbon, organic materials					Traces
Supergene Minerals					
Clay minerals: Kaolinite, chlorite, serpentine; **Hydroxides:** Limonite; **Oxides:** Hematite					Traces

1. All properties except pyroxene hardness values from Mindat.org.
2. Hardness values for pyroxenes from Khourie (2023).
3. There is no exact point where *fei cui* is no longer *fei cui*. While mineralogy might draw the line at 50% or more jadeite/omphacite/kosmochor, such a number is arbitrary and in practice the difficulty of compositional testing means many determinations are guesswork. Visual methods where obvious impurities are seen may be of some utility, along with RI and SG measurements.
4. There are a number of other minerals that have been found associated with *fei cui*. These include nyböite, katophorite, glaucophane, winchite, vesuvianite, titanite, celsian, hyalophane, cymrite, zeolites, banalsite, analcime, Ca-thomsonite, pectolite, allanite, phlogopite, graphite, quartz, diaspore and pyrite.

are related to the cation ordering (Brenker, Prior & Müller, 2002).

Omphacite's Relation to Jadeite and Kosmochlor

Jadeite and kosmochlor (formerly known as ureyite) are more closely related to each other than they are to omphacite because their substitutional cations occur in only the M1 site and are solely homovalent: $Al^{3+} \rightarrow Cr^{3+}$. Nevertheless, omphacite is still found in association with jadeite and kosmochlor (Shi et al., 2012; Franz et al., 2014).

ENTER THE ROOSTER

Since the start of the millennium, China's economic boom led to a dramatic rise in demand for *fei cui*. This caused the prices for fine green *fei cui* to explode,

Figure 3.5. Select Chinese *Fei Cui* Varieties
Top Left: *Dry green fei cui* cabochon. Photo: Tang Chor Man (June); specimen: Liu Shang-i; size: 23.6 × 18.3 × 7.5 mm.
Top Center: *Inky green fei cui* carving of Guanyin sitting on a lotus flower. Photo: Liu Shang-i; size: 47 × 36 × 4 mm.
Top Right: *Black rooster fei cui* pendant. Photo: Ronnakorn Manorotkul; specimen: Lotus Gemology; size: 36 mm.
Bottom Left: *Icy fei cui* Guanyin head carving. Carving: Zhuang Qingfang. Photo: Zhuangjia Fei Cui; size: 46.39 g; 70.9 × 37.2 × 11.4 mm.
Bottom Center: *Floating flower fei cui* bangle bracelet (right). Photo: Yan Ge, courtesy of Roland Schluessel; size: ~72 mm.
Bottom Right: *Oily green fei cui* Zhongkui (Taoist deity) carving. Photo: Ronnakorn Manorotkul; specimen: Lotus Gemology; height: 52 mm.

increasing demand for other previously overlooked types, such as the *icy*, *black rooster, dry green* and *inky green* varieties (Figure 3.5). When gemologists took a new look at these specimens, they found that jadeite was not necessarily the dominant mineral (Fan et al., 2014; Liu et al., 2015; Ouyang et al., 2017).

This should not have been a surprise, as *fei cui* is no different than other gem rocks such as lapis lazuli, where varying amounts of the main constituents (lazurite, haüyne, calcite, pyrite, etc.) are found in different pieces and from different origins (Figure 4.6 on page 76).

Darker *fei cui* jades in particular were found to be polymineralic. For example, the major mineral constituent in the *dry green* variety generally tests as kosmochlor (Ouyang, 1984; Liu et al., 2015). *Inky green fei cui* frequently tests as omphacite (Ouyang, 2000), while jadeite appears to be the dominant mineral in the *black rooster* variety (Yan et al., 2009; Ouyang et al., 2016).

Surface vs. Thin-Section Testing

IT SHOULD BE NOTED that with non-transparent materials such as *fei cui*, all the various testing methods can produce only surface estimates. While surface testing can give one a rough idea of mineral composition, it may not be an accurate reflection of an entire specimen's content. In this sense, rock testing is far less precise than testing single crystals. Obviously thin-section testing is more accurate, but entails sawing off a slice of the specimen, and any results would only apply to that section, not to the entire stone.

In contrast to this, single crystals are far more homogeneous and thus their characterization is much easier.

Within petrology, a petrographic modal point count method is commonly used to determine the major constituents in a thin section of a rock using a polarizing microscope. Barnes (2022) states that "the rigorous identification of all the phases present is only possible using polarization microscopy of thin sections and electron microprobe analysis, which is unfeasible for gem samples." Other methods like X-ray powder diffraction, cathodoluminescence imaging (Harlow & Sorensen, 2005; Ouyang, 2000), backscattered electron (BSE) and elemental imaging under scanning electron microscope (SEM), 3-D mapping of microRaman spectroscopy and LA-ICP-MS can also be useful for mineral species identification, but they are either destructive or test only sample surfaces. Surface measurements may not reflect the actual situation inside the gem.

Possible solutions to this problem involve either using non-destructive X-ray diffraction (XRD) to identify the presence and amount of mineral species in a sample, or 3-D Synchrotron Radiation X-ray microcomputed tomography (SR-CT) with micro-fluorescence mapping. Such advanced instruments are expensive and not commonly available in gemological laboratories. We also must remember that little testing at this advanced level has been performed. Similar to trace element analysis to determine gem origin, as more specimens are tested, the data picture may become less, rather than more, clear.

At the current time, it is virtually impossible to reconstruct the real picture of mineral composition and spatial distribution of complex inhomogeneous aggregates of *fei cui*. **Because of this, current *fei cui* testing guidelines in Hong Kong and China do not require detailed compositional analysis, either for general business or gemstone testing.**

We have heard speculation that these guidelines were made deliberately "loose" to allow the sale of low-grade materials under the *fei cui* umbrella. Nothing could be further from the truth. The guidelines are broad because *fei cui* is a rock (not a mineral species!), and such rocks have wide variation in composition. China's Fei Cui National Standard importantly stresses that the **mineral aggregates should have "arts & crafts value"** (Zhang, 2017). This is to prevent non-gem qualities from being sold as *fei cui*.

In recent years, it was also discovered that some intense to vivid green *fei cui* specimens formerly thought to be pure jadeite are in fact intergrowths of jadeite, omphacite and/or kosmochlor (Liu et al. 2010, 2011; McClure 2012). This includes the *thunder* variety widely traded in the 1980s.

HEAVY METAL • ADVANCED INSTRUMENTS

Infrared (FTIR) and Raman spectroscopy, SEM-EDS (Scanning Electron Microscope + Energy-Dispersive X-Ray Spectroscopy) and EPMA (Electron Probe Micro Analyzer) chemical analyses revealed that in some specimens the dominant mineral tests as omphacite.[1] Moreover, some traditional *fei cui* varieties like the *oily green*, *inky green* and *floating flower* types often consist of jadeite and omphacite in paragenesis (formed together) (Figure 3.5). Some even test as omphacite for the dominant mineral (Fan et al., 2014).

Variable Pressure Scanning Electron Microscopy (VPSEM) with Backscattered Electron (BSE) Imaging

To understand the spatial distribution of *fei cui*'s mineral composition, non-destructive Variable Pressure Scanning Electron Microscopy (VPSEM) with Backscattered Electron (BSE) imaging was used.[2] Minerals that contain elements of higher atomic numbers appear brighter in BSE images. Using this technique, *fei cui*'s mineral grain size can be measured, the textural relationships among minerals can be examined (even when of similar appearance), and the amounts of jadeite, omphacite, kosmochlor, and other constituents such as chromite, feldspar and clinoamphibole can be roughly estimated.

1 X-Ray Diffraction (XRD) also revealed that the structure (space group) of omphacites in some *fei cui* samples is P2/n (but not C2/c), with a characteristic diffraction peak at d=0.5017 nm (reflection index HKL: -1 0 1). The regular arrangement of cations in the crystal structure indicates that the omphacite grains crystallized in a relatively low-temperature stable environment.

2 This method has the advantage over EPMA in that the specimens do not require a coating, thus not requiring cleaning after testing.

Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS)

SEM-EDS was also employed to provide a qualitative and semi-quantitative chemical analysis of each individual mineral in complex intergrowths and mineral zoning within the samples. Combining these two approaches identifies the presence of jadeite, omphacite, kosmochlor, chromite and amphibole minerals. Their spatial distributions at the surface regions of the sample can also be estimated.

THE GEM LAB DILEMMA

The quantification of jade compositions is sometimes possible with spectroscopic tests on homogeneous *fei cui*, especially for certain high-quality gems. But other specimens may present problems. Franz et al. (2014) pointed this out in their excellent and comprehensive article:

> Raman or FTIR spectroscopy of larger analytical areas may yield mixed spectra that are not useful for identification, especially for samples that were not previously investigated microscopically and with microprobe analysis.
>
> — Franz et al., *Journal of Gemmology*, 2014
> A comparative study of jadeite, omphacite and kosmochlor jades from Myanmar, and suggestions for a practical nomenclature

Since the beam size or excitation spot of microRaman (or FTIR) spectroscopy is generally small enough to identify individual microminerals within a sample, Franz et al. (2014) suggested systematic testing on a point grid. Twenty points were proposed on the surface of medium-grained samples (and even more for heterogeneous and fine-grained specimens), with the specimen being labeled either "jadeite jade," "omphacite jade" or "kosmochlor jade" according to which mineral is most abundant.

However, the complex intergrowth texture and chemical inhomogeneities of *fei cui* may still cause inconsistent results using this multi-point testing technique. Traceability and repeatability of the test results present a serious problem when minerals show little to no visual differentiation under the microscope. In addition, when microcrystal grains are smaller than the beam size and resolution of microRaman spectroscopy (resolution approx. 1–2 μm), such spectra may produce inconsistent results and lead to misleading conclusions (Figure 3.13).

Another issue is that there is no clear agreement regarding exactly what the volume percentage of the three essential pyroxene minerals (jadeite, omphacite or kosmochlor) and the percentage of the dominant mineral within the material is necessary for a gem to be called *fei cui*. Harlow (2014, p. 312) stated that "Jadeitite [the rock] is generally defined as consisting of ~90 vol.% pyroxene, with the average pyroxene containing at least 90 mol.% jadeite." Ouyang (2000) suggested that the essential minerals in *fei cui* (jadeite, omphacite, kosmochlor) should be greater than 50 vol.% and minor minerals less than 40%.

In closing, it must be stressed that, in the authors' opinion, adopting such advanced compositional testing requirements would make identification far more difficult (or completely impractical) in most gemological laboratories. This is why trade regulations in China (including Hong Kong), do not require detailed compositional analysis. It is not just impractical, but would constitute a serious barrier to trade. Thus it would violate one of the major reasons for the existence of gemology — the facilitation of trade in gems and jewelry.

It should also be remembered that there are "measurements" and "accurate measurements." The two are not necessarily equivalent.

CASE STUDIES

The following pages give examples of advanced analyses of several different types of *fei cui*, chosen to illustrate the sometimes hidden complexity of certain samples.

OUR FIRST Case Study involves samples of *thunder fei cui* (Figure 3.6 and Figure 3.7) and a court bead believed to originate from the Qing Dynasty (Figure 3.8). Older analyses suggested that each specimen consisted of jadeite jade. However, reexamination with more advanced techniques showed that both types tested as omphacite for the major component, with smaller amounts of kosmochlor and jadeite respectively. In Figure 3.8, omphacite crystals appear as a light gray background (e.g. due to Ca, Fe) while jadeites are a darker gray (due to Na and Al). Due to their relatively high amount of Cr and Fe, kosmochlors appear bright gray in the BSE images. Omphacite jade has always been part of the *fei cui* œuvre, as demonstrated by the Qing Dynasty piece. The material hasn't changed, only the sophistication of the testing methods.

Figure 3.6. The *Thunder* Variety of *Fei Cui*
Thunder fei cui rough (left; 94 × 57 × 24 mm) and a carving (right; 74.0 × 38.9 × 22.9 mm) from the same material. The mineral composition was identified using Raman spectroscopy. White areas mainly produce jadeite spectra, while the green and yellow areas produce spectra of omphacite; dark green spots produce spectra of kosmochlor/Cr-jadeite. Photos & specimens: Liu Shang-i ('Edward').

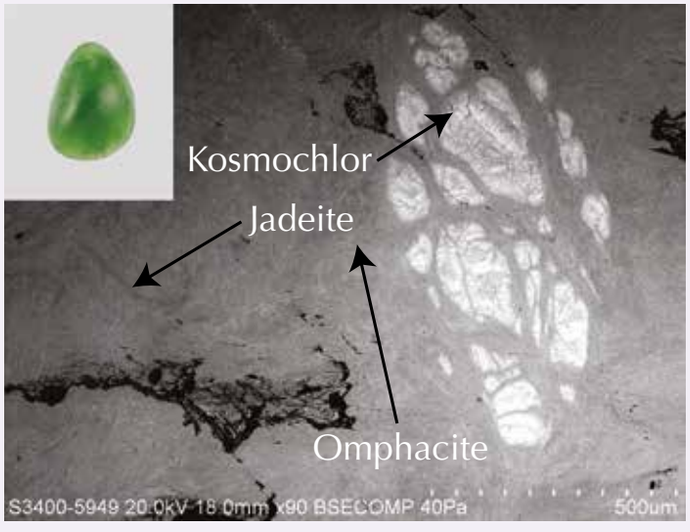


Figure 3.7. *Thunder Fei Cui*
Backscattered electron (BSE) image of a *thunder fei cui* sample composed of intergrowths of omphacite, kosmochlor and jadeite. Specimen, photo and imaging: Liu Shang-i ('Edward'); size of gem: 12.3 × 10.1 × 3.6 mm.

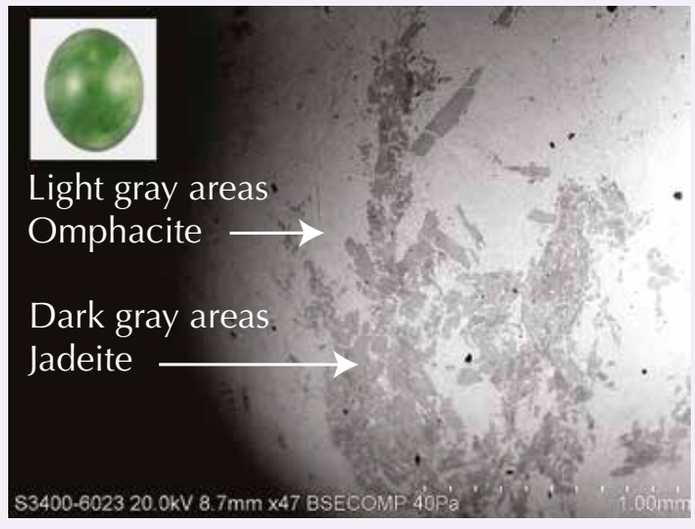


Figure 3.8. Qing Dynasty Court Bead
Backscattered electron (BSE) image of a Qing Dynasty court *fei cui* bead, composed of an intergrowth of jadeite and omphacite. Specimen: Eddie Fan. Photo and imaging: Liu Shang-i ('Edward'); size of gem: 10.3 × 8.3 × 4.3 mm.

CASE STUDY 2 • DARK *OILY GREEN FEI CUI*

CASE STUDY 2 deals with a dark *oily green* sample that appeared to be relatively homogeneous when examined under the gemological microscope and at low SEM magnifications. However, when a select area was further enlarged (BSE image) and examined using Energy Dispersive Spectroscopy (EDS) chemical analysis, it showed a complex interlocking structure of both jadeite and omphacite. In such a situation, standard FTIR or microRaman spectra might suggest the specimen was more homogeneous than it actually is.

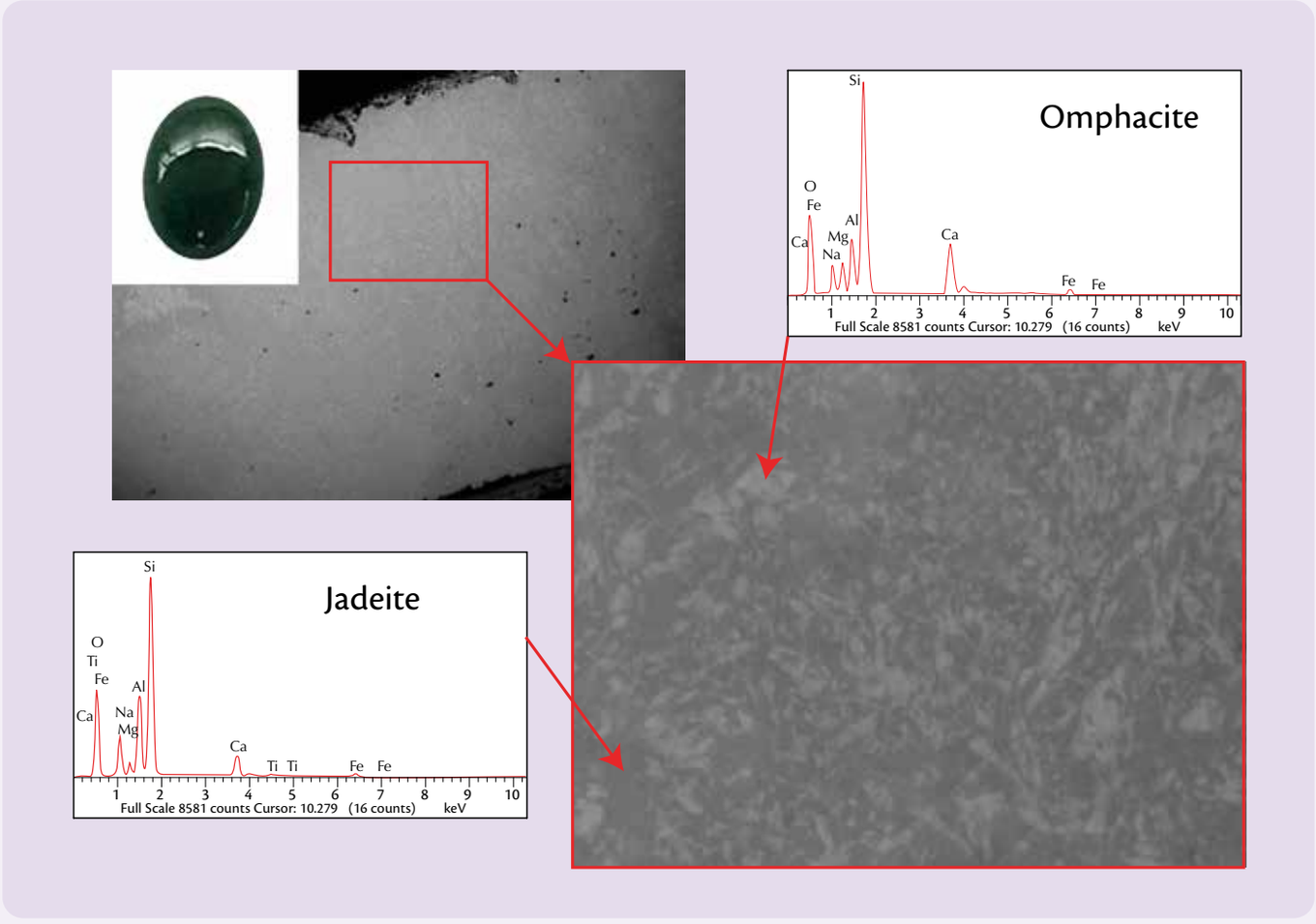


Figure 3.9. Dark *Oily Green Fei Cui*
An interlocking micromineral texture of two *fei cui* minerals (jadeite and omphacite) inside a dark *oily green* sample (inset photo) imaged using SEM-BSE and EDS chemical analyses (light gray areas: omphacite; dark gray areas: jadeite). Specimen, photo, imaging and spectra: Liu Shang-i ('Edward'); size of gem: 15.6 × 12.2 × 4.9 mm.

CASE STUDY 3 deals with a high quality *fei cui* sample. Our investigations produced similar results to Franz et al. (2014), showing that most high-quality gems (pale to vivid color, semi-transparent, fine texture) test as relatively homogeneous and monomineralic at the surfaces.

On the other hand, semi-translucent to opaque darkly colored specimens are usually inhomogeneous, with complex textural and chemical zoning. BSE images of some dark green samples revealed that the three essential minerals of *fei cui* may form in different textures and with complex intergrowth structures (Figure 3.14) (Shi, 2009; Franz et al., 2014; Hpone-Phyo Kan-Nyunt, 2014; Liu et al., 2015).

A Problem

The sometimes complex and heterogeneous nature of *fei cui* makes individual mineral grain recognition difficult. When such grains differ in color, such as in the *thunder* variety shown in Figure 3.6, they can often be identified using spectroscopic tests (FTIR or Raman spectroscopy). However, if mineral grains of different composition do not show obvious differences in appearance, this becomes more difficult, and calls into question both the repeatability and traceability of random point testing results.

Take the example shown in Figure 3.10. Infrared spectroscopy initially suggested a layer of jadeite on top and omphacite at the bottom, even though no visual differences were seen. Testing on the side revealed a spectrum that was initially suspected to be the transition spectrum between jadeite and omphacite.

However, when we used backscattered electron (BSE) imaging and merged the images together using the "overlay images" technique with a Photoshop layer mask, an entirely different picture emerged. The distribution of different minerals on the surface layer (top and bottom) of this fine quality vivid green sample was revealed (Figure 3.11). Areas that tested as omphacite appeared light gray, while those testing as jadeite appeared darker gray (Fan et al., 2014; Liu et al., 2015).

The assembled overlay images suggest this sample consists mainly of omphacite (light gray background), with little veins and patches of jadeite (dark gray).

As a result, when tested by FTIR near the center on top, a jadeite spectrum was obtained. Another point on the reverse produced an omphacite spectrum. Mixed jadeite and omphacite FTIR spectra were acquired on the sample's side. As one can clearly see, when dealing with such a specimen, random testing may lead to incorrect conclusions.

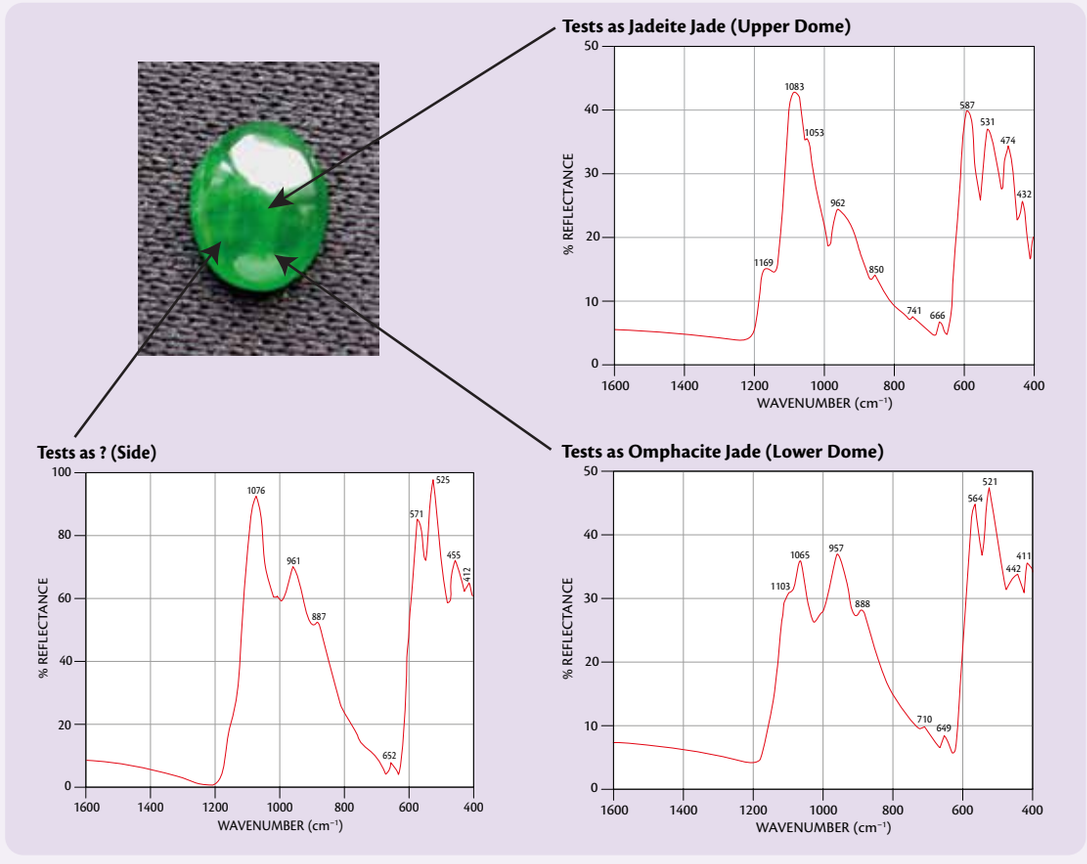


Figure 3.10. High-Quality Vivid Green *Fei Cui*

Random spot collection of FTIR spectra in different places on this *fei cui* gem produced inconsistent results. Under the gemological microscope, the major mineral constituents showed similar appearances, colors, lusters, and textures. Photo, spectra & specimen: Liu Shang-i ('Edward'); size: 11.1 × 8.3 × 5.9 mm.

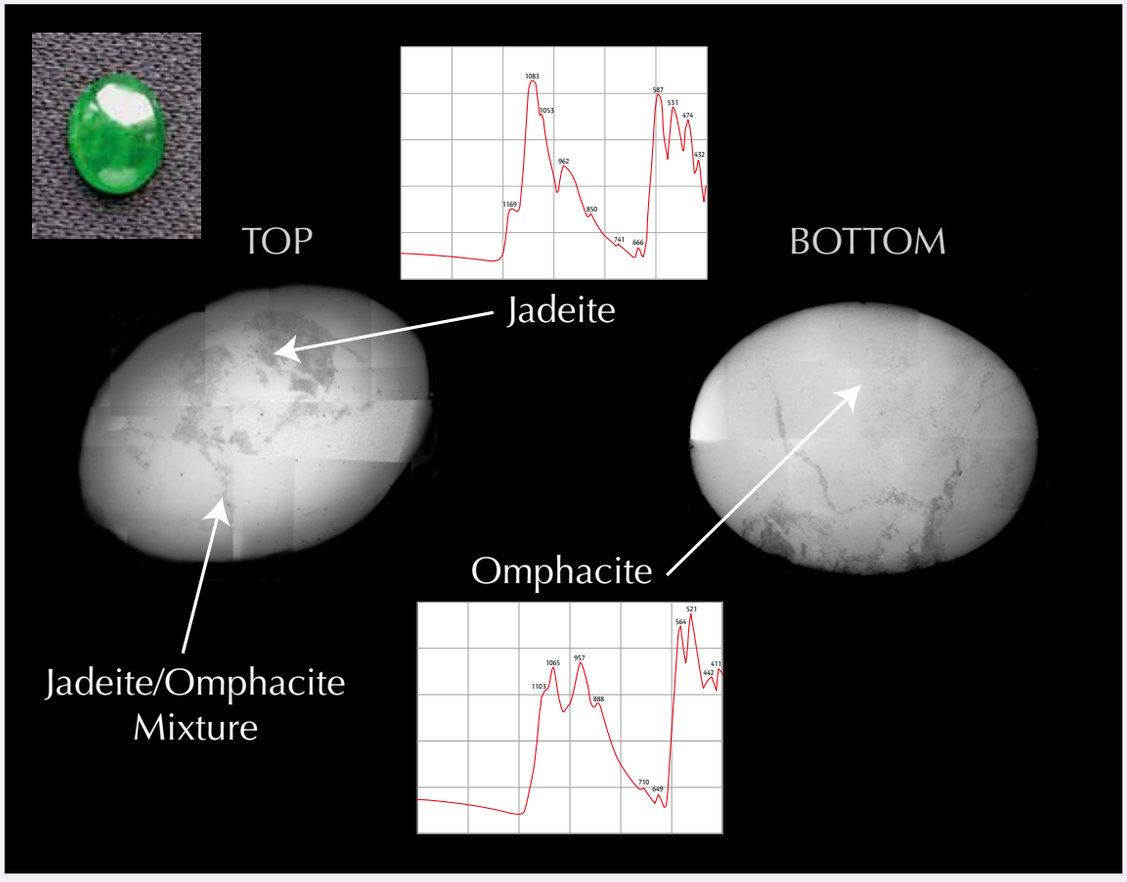


Figure 3.11. High-Quality Vivid Green *Fei Cui*

Low magnification BSE overlay images of the same fine-quality bright green *fei cui* sample as Figure 3.10. Both the top view (left) and bottom view (right) of this double cabochon are shown. This sample was tested by conventional FTIR spectroscopy before using VPSEM. Imaging, spectra, and photos: Liu Shang-i ('Edward').

THE *dry green fei cui* variety has long been investigated (Ouyang et al., 1984) and typically tests as kosmochlor for the dominant mineral. This variety displayed the most complex polymineralic composition and zoning structure of *fei cui* under the SEM (Shi, 2009; Franz et al., 2014; Liu et al., 2015). Many specimens are inhomogeneous and polymineralic, and were found to contain coarse-grained kosmochlor, chrome jadeite, clinoamphibole (i.e. richterite, eckermannite), magnetite and chromite. Some even formed in association with maw sit sit, albite and celsian feldspar (mostly out of the range of *fei cui* with lower SGs). A zoned structure was commonly found where radiating kosmochlor rims crystallized around chromite grains at their cores (Figure 3.12). With the aid of microRaman spectroscopy, EDS and elemental mapping, dark green to black clinoamphiboles were identified as chromium-bearing magnesio-arfvedsonite, which is distributed in the outer rings, and fills fractures, around kosmochlor grains (Figure 3.12).

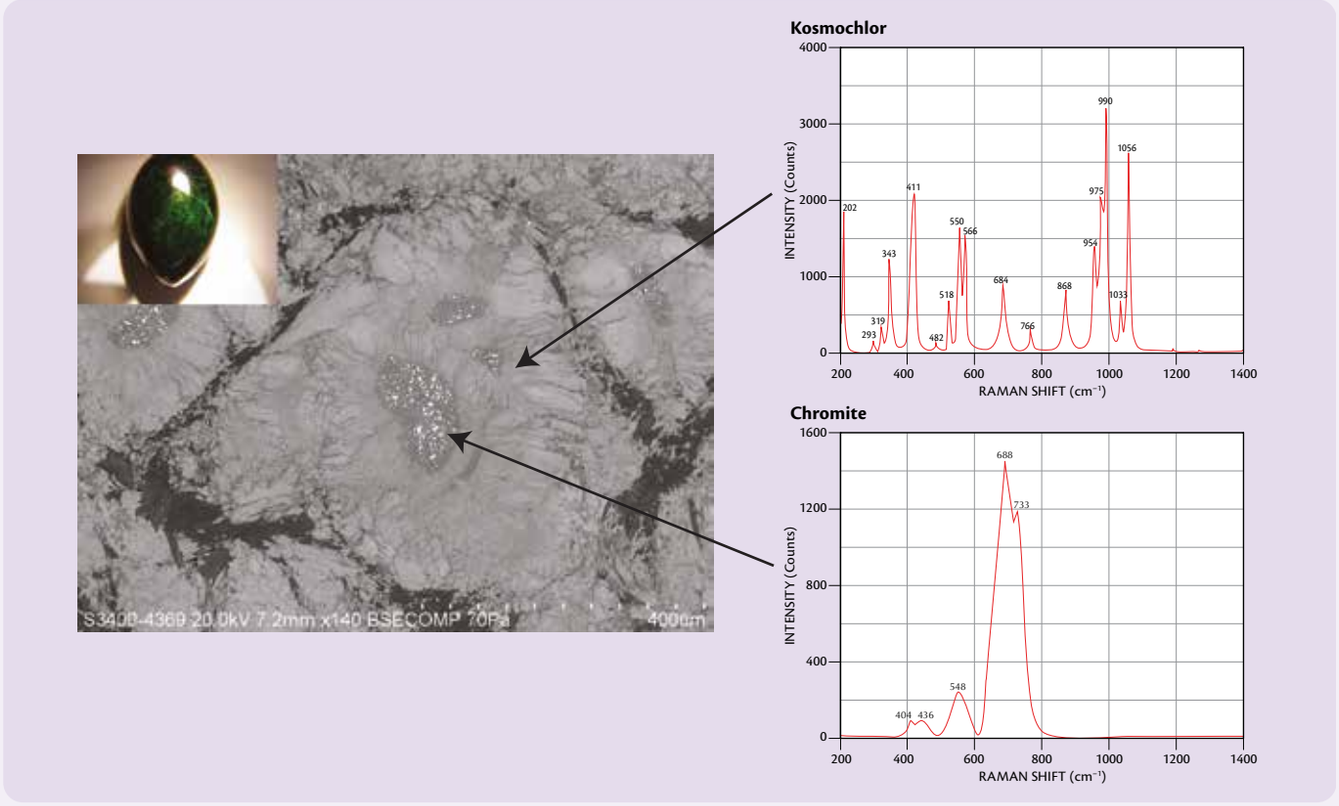


Figure 3.12. Dark Green *Fei Cui*

Backscattered Electron (BSE) image of a dark green *fei cui* sample (inset photo). It shows a concentrated mineral compositional zoning. Chromite grains are surrounded by radiating kosmochlor with black clinoamphibole distributed along the outer rim of the kosmochlor. The Raman spectra of kosmochlor and chromite were examined under the VPSEM-SCA system. Photo, imaging, spectra, and specimen: Liu Shang-i ('Edward'); gem size: 21.6 × 13.5 × 8.2 mm.

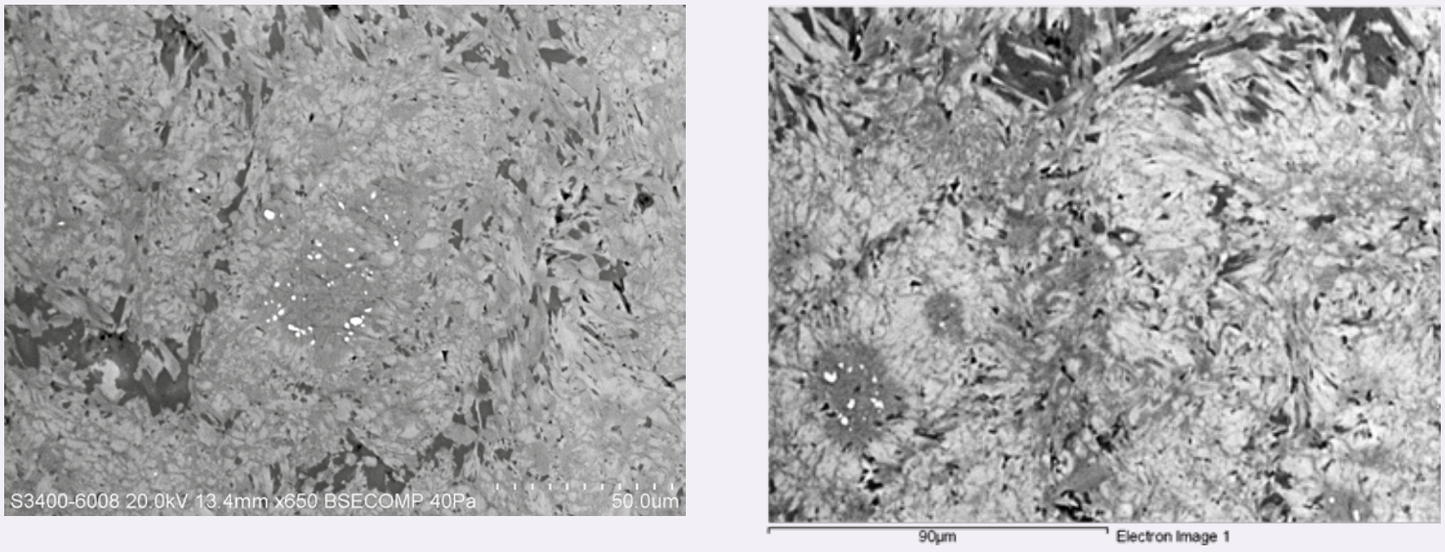


Figure 3.13. BSE Images of Dark Green and *Dry Green Fei Cui*

Left: BSE image of a dark green *fei cui* sample. Crystal grains are generally less than 10 µm, with some exceptionally small crystals less than 1 µm (e.g. the white chromite grains in the middle of the image). Imaging: Liu Shang-i ('Edward').

Right: BSE image of a dark *dry green* variety *fei cui* sample. Kosmochlor and chrome jadeite microcrystals form complex textures (crystalloblastic, mylonitic and metasomatic) and structures (interlocked, radiated and concentrated) inside the sample. Some microcrystals are extremely fine, with grain sizes smaller than 1 µm. Imaging: Liu Shang-i ('Edward').

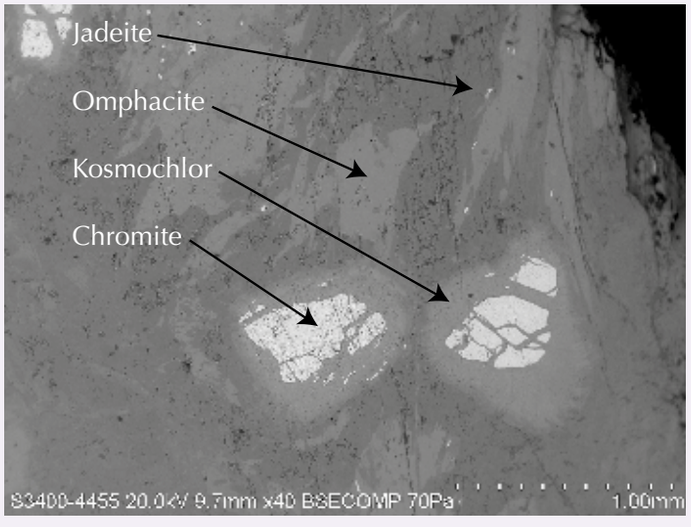


Figure 3.14. Dark Green *Fei Cui*

Three essential minerals (jadeite, omphacite and kosmochlor) formed an intergrowth of textures in this *fei cui* sample imaged with SEM-BSE. Imaging: Liu Shang-i ('Edward').

Rocks vs. Minerals

THE ENGLISH TERM "rock" is derived from the Old English word "rocc," which originally referred to any large, coarse stone. Over time, its usage evolved to encompass various types of natural solid aggregates found in the Earth's crust. The scientific understanding of rocks has developed through disciplines such as geology, mineralogy, and petrology, which study their composition, formation processes, and properties.

The first Western book to use the word "rock" in its geological sense was Georgius Agricola's *De Natura Fossilium* [On the Nature of Fossils] in 1546. Agricola's work marked a significant milestone in the development of mineralogy and laid the foundation for the systematic study of rocks and minerals in Europe. The term "rock" was used in this text to describe various geological formations and materials found in the Earth's crust.

According to Price and Walsh (2005, p. 9): "Rocks are naturally-occurring consolidated substances, which may be made up of minerals, other rock pieces, and fossil materials, such as shells or plants." Shipley (1948, p. 194) adds that rocks: "…may consist of a single component, such as limestone, or of two or more minerals (Krauss and Hunt, 1920). Lapis lazuli is a rock of the latter kind."

Thus, rocks may contain at least two different minerals, but some are "monomineralic," containing just one (Figure 3.15). There is no sharp division. Generally, if there is an aggregate of crystals, it's safe to call it a rock.

A mineral has a specific definition. It must meet the following criteria:

- Naturally occurring
- Inorganic
- A definite crystal structure
- A defined chemical composition (that can vary within certain limits)

Minerals are defined by well-developed scientific criteria that are considered by the International Mineralogical Association's nomenclature committee (Nickel et al., 1987; Mills et al., 2009). They carefully weigh whether a substance qualifies as a mineral, and their findings are generally accepted by mineralogists around the world. Color varieties, such as ruby, sapphire or emerald, are not allowed.

Geologists also have a similar group, the International Union of Geological Sciences. Their Commission on Systematics in Petrology looks at rocks to decide on their classification (Fettes & Desmons, 2007).

Gemology differs in that commercial interests play an important role and thus things like color varieties are common. There is no international body that blesses the names of gems. Thus, the gemological world does not conform to the same scientific rigor as mineralogy or geology.

We don't want to leave readers with the impression that it's all wine and roses in the world of mineralogy and petrology. They also have to deal with old terms and logical inconsistencies. But at least they have an agreed-upon process to handle nomenclature questions.

Gem labs operate in a hybrid environment, sitting in between the mineralogical and gem trading communities, employing science and mineralogical terminology, and yet also considering commercial interests. This is a major cause of nomenclatural differences from one lab to another. Attempts to harmonize gemological nomenclature have been largely unsuccessful.

Some may wonder why rocks should not be named after minerals. The answer is simple — to tell them apart. If a rock and mineral share the same name, there is no way to know if the mineral or the rock is being discussed. This is why rocks are given unique names compared with minerals.

Figure 3.15. Marble vs. Calcite
Red spinel in a marble matrix from Myanmar's Mogok Stone Tract. Marble is a rock, not a mineral species. We would never call it calcite, even if the marble specimen is entirely made of that mineral because then there would be no way to tell the mineral and rock apart. Photo: Wimon Manorotkul; specimen: William Larson Collection; size of spinel crystals: approx. 1.5 cm.

Figure 3.16. Of Goose and Gander

Top row (left to right): Lapis lazuli, maw sit sit, jasper. Center row (left to right): Unakite, nephrite (amphibole jade), seraphinite. Bottom row (left to right): Sannan skarn, *fei cui* (pyroxene jade), maw sit sit. Of the gems shown here, only *fei cui* is typically analyzed to break down its mineral components. If such analyses are deemed important for *fei cui*, why aren't all other gem rocks treated in the same manner? Photos: Ronnakorn Manorotkul; specimens: Lotus Gemology; images not to scale; sizes range from 8 to 660 ct each.

Figure 3.17. *Seeking Heaven* by Master Zhao Dong. Burmese lavender *fei cui*. Photo: Zhuangjia Fei Cui; size: 273.5 ct; 50 × 36.5 × 9 mm.

FEI CUI

A MISTY HISTORY

4

FEI CUI

A MISTY HISTORY

The kingfisher's kingdom is a puzzle, its pieces scattered across the land.

— M.C. Beaton, Death of a Kingfisher

FEI CUI (翡翠) is the Chinese word for both the kingfisher bird and pyroxene jade. Where and when did this word originate and how did a green gem take the name of a bird that is decidedly turquoise hued?

Mentions of the word *fei cui* in China date back at least 2500 years. The literal translation is "red-green," with *fei* denoting red and *cui* green. In the distant past, *fei cui* was most often associated with the vividly colored feathers of the bird of the same name, but today *fei cui* pulls double duty, also being used as the name of pyroxene jade. This chapter examines the path from feather to *fei cui* (the gem).

Tian Tsui to *Fei Cui*

For over 2000 years, the Chinese have crafted a special type of ornament or jewelry called *tian tsui* (点翠) (Figure 4.2). The literal meaning is "dotting with kingfisher" and it is created by carefully stripping kingfisher (halcyon) feathers (Figure 4.1) into hairlike filaments. These are dragged through glue and then placed side-by-side on a silver base, forming the famous *tian tsui* ornaments. A huge array of objects has been created with this decoration, everything from delicate jewelry and hairpins (Figure 4.2) to wall screens, chairs, sofas, quilts, fans and capes (Jackson, 2001).

Since such feather usage predates any mention of *fei cui* as a stone, it suggests the term first described a bird and only later a type of stone/jade. However, the picture is clouded by the fact that there are no kingfishers with emerald-green feathers; most are a vivid turquoise blue. Indeed, it is entirely possible that the first gem to be so named was turquoise, but we currently find no evidence for that. Hansford (1948) stated:

> The character *pi*, as in *pi yü*, may mean dark blue as well as dark green…[11]
>
> [11] The use in Chinese writings of names of colours having vague meanings, and particularly of words which may mean either green or blue, is a frequent cause of ambiguity.
>
> — S. Howard Hansford, 1948
> Jade and the Kingfisher, *Oriental Art*, Vol. 1, No. 1, p. 15

Figure 4.1. A beautiful male kingfisher (*Alcedo athis*) perching on a branch, displaying its turquoise-colored plumage and red breast. In Chinese it is known as *fei cui* (翡翠), from which pyroxene jade takes its name. Photo: Thawats/iStock.

Figure 4.2. *Tian tsui* (点翠) or "dotting with kingfishers," is a style of Chinese art over 2000 years old. Artists use tiny filaments of the iridescent blue feathers of kingfisher birds as an inlay for fine art objects and adornment, from hairpins, headdresses, and fans to panels and screens. Photo: *Tian tsui* feather jewelry featuring an *icy* type *fei cui* cabochon in the center by Wang Xinyu. Jewelry size: 90 × 55 mm.

In Chinese (and many other languages), certain color terms are broader than their English counterparts. Here, *cui* can apply to both green and blue. In fact, color scientists use the term GRUE to indicate green+blue because the phenomenon is common in many cultures (Xu, 2007, p. 15). *Cui* was thought to originally refer to a bird with long plumage (Xu, 2007, p. 189).

Spring and Autumn Period (770–476 BCE), Eastern Zhou Dynasty

The kingfisher first crops up in Chinese history in 530 BCE, with this statement (Jackson, 2001):

> The Thane of Ch'u arraying himself on a snowy evening in a fur cap, halcyon (*fei cui*) cloak and leopard slippers.

Han Dynasty (206 BCE–220 CE)

From the Han dynasty forward, references to *fei cui* are common, most often as ornaments that are decorated with halcyon feathers (Jackson, 2001). Historian Ban Gu (32–92 CE) in his *Ode to the Capital Xidu* used *fei cui* to

Figure 4.3. *Fei cui* plaque by Master Zhuang Qingfang. Photo: Zhuangjia Fei Cui; carving: 303.1 ct; 76.6 × 42 × 9.1 mm.

Table 4.1. Chronology of Chinese history[a]
Among complex civilizations, China is the oldest continuously surviving one. The Chinese name for China, 中国 (*Zhōngguó*), means middle or central kingdom, a term that dates to the earliest part of its history. Thousands of years ago, China consisted of multiple independent states before being unified by an emperor.

Period/Dynasty	Common English Name	Time Span
Before Common Era (BCE)		
Neolithic Period	Neolithic Period	Circa 10,000 years ago–2070
Bronze Age	Bronze Age	Circa 2000–0
Xia Dynasty	Xia Dynasty	2070–1600
Shang Dynasty	Shang Dynasty	1600–1046
Xizhou Dynasty	Western Zhou Dynasty	1046–771
Chunqiu Period	Spring and Autumn Period	770–476
Zhanguo Period	Warring States Period	475–221
Qin Dynasty	Qin Dynasty	221–207
Xihan Dynasty	Western Han Dynasty	206 BCE–8 CE
Common Era (CE)		
Donghan Dynasty	Eastern Han Dynasty	25–220
Sanguo Period	Three Kingdoms Period	220–265
Xijin Dynasty	Western Jin Dynasty	265–316
Dongjin Dynasty	Eastern Jin Dynasty	317–420
Nan-bei Dynasty	Period of the Northern and Southern Dynasties	420–589
Sui Dynasty	Sui Dynasty	581–618
Tang Dynasty	Tang Dynasty	618–907
Wu-dai-shi-guo Period	Period of the Five Dynasties and Ten Kingdoms	907–960
Beisong Dynasty and Liao Dynasty	Northern Song [Sung] Dynasty and Liao Dynasty	960–1127
Nansong Dynasty and Jin Dynasty	Southern Song Dynasty and Jin Dynasty	1127–1279
Yuan Dynasty	Yuan Dynasty	1271–1368
Ming Dynasty	Ming Dynasty	1368–1644
Qing Dynasty	Qing Dynasty	1644–1911
Republic of China	Republic of China	1912–1949
People's Republic of China	People's Republic of China	1949–present

a. Modified from Yi, F. (2001) *A Brief Chinese Chronology*. Beijing: Heritage Press, 267 pp.

describe a prosperous scene in the capital of the Han dynasty (Zheng, 1994):

> *Fei cui* and *huo qi* are sparkling like crystals.

Zhang Heng (a.k.a. Chang Heng, 78–139 CE) of the same era used a similar expression in his book of the same title (Zheng, 1994):

> *Fei cui* and *huo qi* are adorned with beautiful jade.

The term *huo qi* refers to beads made from colored gemstones. This suggests that Zhang was speaking about a vividly colored gem (or possibly a kingfisher feather-decorated ornament), rather than the bird itself.

Northern and Southern Dynasties (420–580 CE)

Minister and poet Xu Ling's (507–583 CE) masterpiece, *Preface to the New Ode to the Jade Terrace*, contains this statement (Mu, 2012):

> The box made of glass for holding inkstones is always with you, and the writing brush box made of *fei cui* is always in your hands.

Figure 4.4. Wish Granted
A magnificent *fei cui* "*ruyi*" (如意; 'as desired') pendant. The *ruyi* scepter design was inspired by the long-living lingzhi mushroom that symbolizes immortality. Nowadays, the *ruyi*, which is commonly carved in jade, means "as one wishes" or "may all wishes come true." The *ruyi* evolved from the *ju-i*, or scepter of Buddhist principles. Photo and specimen: On Tung Jewellery; size: 172.15 ct; 60.78 × 37.07 × 10.64 mm.

This clearly describes *fei cui* as a material, rather than a bird, but it could also be a box decorated with kingfisher feathers.

Tang Dynasty (618–907 CE)

In the Tang dynasty, poet Chen Zi'ang (a.k.a. Ch'en Tzu-ang, 661–702 CE) penned his *Encounter* series. The 23rd poem includes this phrase (Wang, 2020):

> *Fei cui* [kingfishers] nest in the South Sea islands.
> Male and female in vermillion-colored groves.
> How would they know the minds of fair ladies
> Who cherish them far more than gold?
> Their bodies slain in the land of the burning sun;
> Their feathers cast in a dark corner in a jade hall.
>
> — Ch'en Tzu-ang (661–702 CE)
> Translated by Rita Aero (from Jackson, 2001)

This statement confirms that over 1300 years ago at least one meaning of *fei cui* was as a bird.

Figure 4.5. *Dualism*. Future gazing at the past looking at the future. Burmese *fei cui* by Master Zhuang Qingfang. Photo: Zhuangjia Fei Cui; 60.62 g; 76.6 × 42 × 9.1 mm.

Figure 4.6. Lapis Lazuli vs. Lazurite
A rock is not the same as a mineral species, which is why the names of rocks do not match the dominant mineral they contain. Lapis lazuli is the rock name for the mineral aggregate typically composed of lazurite, haüyne, nosean, sodalite, calcite and pyrite. By itself, lazurite forms dark blue crystals (top left), but when combined with the other minerals mentioned, the bright blue color of lapis lazuli results. Top left: Lazurite crystal (a mineral) in marble (a rock) from Sar-e-Sang, Afghanistan. All other pieces shown are polished and rough lapis lazuli. The small pear shape is cut lapis lazuli from Mogok, Myanmar (2.08 ct). Other specimens are from Afghanistan (oval: 23.57 ct; trapeze: 17.56 ct). Lazurite crystal (approx. 2.5 cm) courtesy of Vincent Pardieu and rough lapis lazuli (160 g) courtesy of Simon Dussart; all specimens part of the Lotus Gemology reference collection. Photo: Ronnakorn Manorotkul/Lotus Gemology.

Song Dynasties (960–1279 CE)

Three centuries later, the great polymath Ouyang Xiu (1007–1072 CE) wrote the following in his *Returning to the Field Record* (Lin, 2003):

> My family owns a jade poppy [罌: vessel with a small mouth and large squat belly] with an ancient and exquisite shape. It was first obtained from Mei Shengyu, who believed it to be green jade. When I was in Yingzhou, I once showed it to General Deng Baoji, who was an old retainer of the Zhenzong dynasty. He recognized the vessel and said, "This is a precious artifact called *fei cui*. The treasures are all stored in the Yisheng treasury, which has a *fei cui* pendant. Thus, I know how to recognize *fei cui*."

This demonstrates that by the Song Dynasties, *fei cui* jade had entered the palace realm and/or spread among officials and literati. Bishop (1906) includes a similar version of this story (Vol. 1, p. 60).

Ming Dynasty (1368–1644 CE)

In the Ming Dynasty, geographer and explorer Xu Xiake (1587–1641) authored a major work describing his travels across China. In his travelogue, Xu stated (Xu, 1985):

> I see many merchants in Yongchang trading gemstones, amber, and green stones.

Yongchang is the old name for Baoshan City and is located at the border of Yunnan (southern China) and Myanmar. Gemstones and amber are well-known products from Myanmar, and thus it is not unreasonable to speculate that "green stones" probably refers to *fei cui*, sourced from the nearby Kachin State mines.

A man named Pan Sheng was later mentioned in Xu Xiake's description:

> Although Pan Sheng is still a student, he frequently travels to Myanmar and keeps Burmese goods at his home. At one time, a palace attendant was ordered to visit him and demand green jade, and Pan Sheng felt so distressed that he deliberately avoided the attendant.

In the above passage, the word "green jade" sounds like it was used to refer to pyroxene jade, which resembled the green *yù* (amphibole jade) in ancient China. This suggests that people's views on pyroxene jade gradually changed, where eventually it was compared with *yù*, which had a previous history of thousands of years.

Qing Dynasty (1644–1911 CE)

Ji Yun (a.k.a. Ji Xiaolan or Chi Yün; 1724–1805 CE), was a noted Qing scholar who, among many other accomplishments, compiled the first modern Chinese book catalog, the *Annotated Bibliography of the Four Treasures*. Ji described pyroxene jade in his *Notes of Yuewei Caotang* (Ji, 2018):

> The Yunnan *fei cui* jade was not treated as jade at that time. People thought it was just a stone like the dull yellow Lantian jade and used "jade" as a suffix. But now it has become a precious jade, with prices far exceeding those of real jade (*yù*).

Dr. Sun Laichen of the California State University, Fullerton published a detailed analysis of the word *fei cui* as it applies to pyroxene jade from Myanmar and has found that it appeared in Yunnan no later than 1719 (Sun, 2011).

Sidney Howard Hansford (1948 CE)

Among the first Western authors to take a serious academic interest in jade was S. Howard Hansford (1899–1973). One of his first publications on the gem was a detailed examination of the history of *fei cui*. In it he stated:

> It may be thought that the name of the plumage of the kingfisher is not a very appropriate one for a stone distinguished by its brilliant emerald green colour. No doubt the choice of the name was dictated primarily for its association with a famous dark-green jade of Sung [Song] times, which had in fact resembled the back feathers of at least one species of the bird, *Halcyon smyrnensis*. The new *fei-ts'ui*, moreover, had one claim of the name not possessed by the old. Its most distinctive colour, next to the green, is a brilliant russet red, almost identical with that of the birds' under-feathers, and not represented among the varied hues of Khotan nephrite. These two colours, the red and the green, are together regarded as characteristic of modern *fei-ts'ui*, and are distinguished as *hung fei*, "red *fei*" and *lü tsui* "green *tsui*".
>
> — S. Howard Hansford, 1948
> Jade and the Kingfisher, *Oriental Art*, p. 17

Dualism

In summary, the above passages demonstrate that *fei cui* was used in two ways. One was in reference to the kingfisher bird and/or its feathers, and another for a type of jade. Ji Yun's description from the Qing period showed that when pyroxene jade first appeared, its lack of history precluded it from being in the same league as ancient *yù*. But the Qing court and nobility's enthusiasm for the vivid colors of *fei cui* soon pushed its value higher than *yù*. Like mushrooms after a rain, pieces of *fei cui* jade began to appear in the royal collection.

It is clear that no later than 1719 in the Qing Dynasty, *fei cui* was used to describe pyroxene jade produced in Myanmar. Damour, the mineralogist who coined the name jadeite in 1863, wasn't even born at the time.

Like a cloud-shrouded Chinese mountain landscape, the exact contours of the word are hazy. We cannot confirm with certainty whether the ancient *fei cui* jade is the same as our modern pyroxene jade — chances are it was not. But the historical record demonstrates that, in addition to being the name of the kingfisher bird, at least a thousand years ago the term *fei cui* also referred to a type of ornamental gem. And by the time of Damour, that gem was clearly pyroxene jade from Myanmar.

Today *fei cui* is used in China for any pyroxene jade, no matter what the country of origin, identical to other gem rocks such as lapis lazuli.

BAN GU
(班固; 32–92 CE)

Born into one of the most distinguished families of the Eastern Han Dynasty, Ban Gu's father, Ban Biao, wrote *Biography of the Records of the Grand Historian*. Ban Gu believed that his father's research and descriptions were not detailed enough, but supplementing them brought him into conflict. In 62 CE, he was falsely accused of writing national history without permission and was imprisoned. His younger brother Ban Chao (a general who conquered the Western Regions during the Han Dynasty), rushed back to the capital to plead with the emperor. After reading Ban Gu's history, the emperor was conquered by his literary talent and authorized Ban Gu to conduct historical research under official auspices. The result was China's first chronological history, *The Book of Han*. Ban Gu is famous as an historian, lyricist and Confucian theorist. His compilation, *Bai Hu Tong Yi*, collected the great achievements of Confucian studies through his era.

ZHANG HENG
(张衡; a.k.a. CHANG HENG, 78–139 CE)

Sometimes referred to as China's Ptolemy, Zhang Heng was an astronomer, mathematician, inventor, geographer, cartographer and writer during the Eastern Han Dynasty. Zhang made indelible contributions to the development of astronomy, mechanical technology and seismology for the *Shangshu* [*Book of Documents*], one of ancient China's "Five Classics." In recognition of his outstanding scientific contributions, the United Nations Astronomical Organization named the Asteroid 1802 "Star of Zhang Heng." Living nearly two thousand years ago, one of his great inventions was a seismoscope, a device to detect earthquakes.

XU LING
(徐陵; 507–583 CE)

Xu Ling was a minister and poet of the Liang and Chen dynasties in the Southern dynasty. He is best known as the compiler and editor of the poetry anthology *New Songs from the Jade Terrace*. Xu Ling was also proficient in calligraphy.

CHEN ZI'ANG
(陳子昂; a.k.a. CH'EN TZU-ANG, 659–702 CE)

In the early Tang Dynasty, he was a writer, poet and poetry theorist who served as a Deputy Minister of Supervision. Chen Zi'ang proposed the poetic proposition of achieving innovation in retro. His representative works include 38 pieces of *Encounter*, and *Song of Ascending Youzhou Terrace* is hailed as a timeless masterpiece in classical poetry.

OUYANG XIU
(歐陽脩; 1007–1072 CE)

A Northern Song Dynasty politician, writer and historian, Ouyang Xiu formerly served as the Crown Prince's Young Master. He was a leader of the poetry and literature reform movement in the Northern Song Dynasty, earning a great reputation for his works and ranking among the "Eight Masters of the Tang and Song Dynasties" and the "Four Great Writers of the Past." As an historian, Ouyang was in charge of creating the *New Book of Tang* and independently wrote the *New History of the Five Dynasties*.

XU XIAKE
(徐霞客; 1587–1641 CE)

Ming Dynasty geographer, traveler, explorer and writer. Early in life Xu Xiake displayed an aptitude for learning, and devoured both poetry and books. He was particularly passionate about maps, classics and geography. Xu Xiake's life was full of ambition, traveling across the provinces of China. In his later travels to southwest China, he wrote *Diary of a Zhejiang Tour*, *Diary of a Jiangyou Tour*, *Diary of a Chu Tour* and so on. After his death, these works were compiled into the *Travel Notes of Xu Xiake*. Xu Xiake made extraordinary achievements in geography and other fields, and is considered one of the world's pioneers in scientific exploration of geological landforms. Xu recognized that the Jinsha River network formed the true headwaters of the Yangtze River, correcting a mistake that had existed since Confucius. He also discovered that the Mekong and Salween rivers were separate drainages.

JI YUN
(紀昀; a.k.a. JI XIAOLAN or CHI YÜN, 1724–1805 CE)

Qing Dynasty scholar, writer, and official. Served as Minister of Rites and Associate Grand Secretary. Ji Yun had exceptional intelligence and talent. Throughout his life, he read extensively and excelled in poetry and parallel prose, especially in textual research on historical allusions. Penned by Ji in 1789–1798, *Notes of Yuewei Caotang* is one of the three most popular works of the Qing Dynasty.

SIDNEY HOWARD HANSFORD
(1899–1973 CE)

One of the first Western authors to take a serious academic interest in jade was S. Howard Hansford. He studied under renowned sinologist W. Perceval Yetts and succeeded him as professor of Chinese Art and Archeology at the University of London. Although his teacher's specialty was Chinese bronzes, Hansford soon developed a serious interest in Chinese jades. Working for his family's business in the 1930s, he took advantage of that time to visit and photograph Beijing jade carvers at work (Hughes & Hoffman, 2020). One of his first publications on jade was a detailed examination of the history of *fei cui*. His 1950 book, *Chinese Jade Carving*, is considered a classic of Western scholarship on jade.

Notes on Chinese Names

THROUGHOUT THIS BOOK, Chinese names are generally rendered as they are in the Chinese language, with the family name first, followed by the given name. Thus for Mao Zedong, the surname is Mao, while the given name is Zedong. Often Chinese family names are a single syllable, while given names are two. Chinese who have frequent contact with foreigners sometimes choose an English first name so it will be more easily remembered.

Figure 4.7. *Wanderings*. Engraved and inked (but unfinished) Burmese *fei cui* plates by Master Zhuang Qingfang. Photo: Zhuangjia Fei Cui; size: 8 × 5 × 1.1 cm.

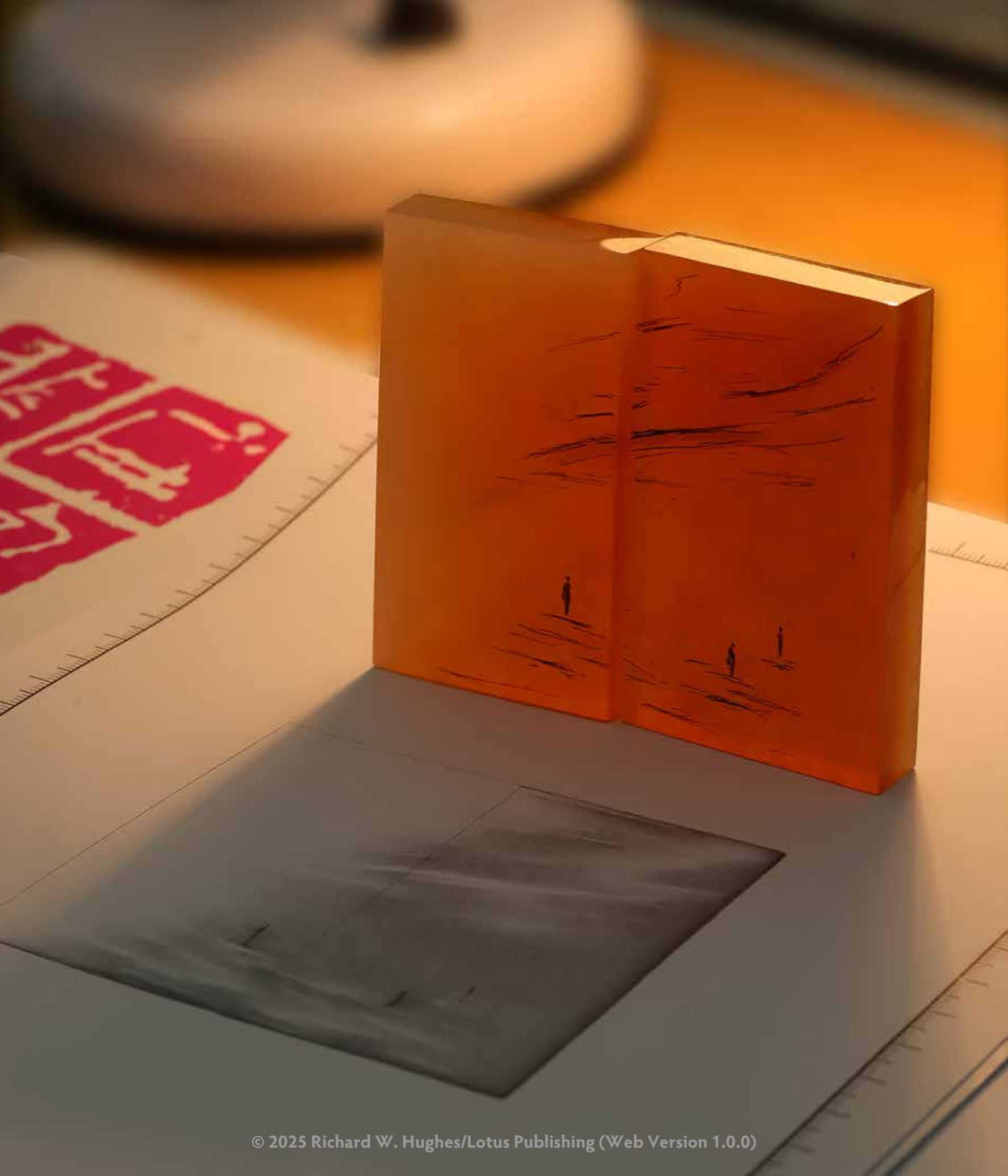


Figure 4.8. *The Path.* Master Zhuang Qingfang with his lavender *fei cui* creation.
Photo: Zhuangjia Fei Cui; size: 13.4 × 2.4 × 1.9 cm.

CODA

FROM JADEITE TO FEI CUI

5

CODA

FROM JADEITE TO FEI CUI

The past is never dead. It's not even past.

— William Faulkner, Requiem for a Nun

BY THE END of the 19th century, developments in petrographic microscopy started to bear fruit. According to Schuh:

> Giovan Battista Amici devised a polarizing microscope around 1830, and instruments of this sort came into common use for petrographic and crystallographic work in the second half of the century.… The development of the petrographic microscope near the end of the 19th century facilitated rapid advances in mineralogy and geology. Early studies in France and Germany elucidated the identification of important rock-forming minerals, including the feldspar, amphibole, pyroxene, and mica group minerals. Rocks could thereafter be classified based on trace mineral constituents, and fine-grained rocks which were previously intractable could also be classified by microscopical studies.
>
> — Curtis P. Schuh, 2007
> *Mineralogy & Crystallography: On the history of these sciences from the beginnings through 1919*, p. 414

Thus, at the opening of the 20th century, mineralogists had the tools to understand the correct nature of *fei cui*. And some of them did. Witness the following from the pen of the famous French mineralogist, Alfred Lacroix (Figure 5.2):

> In 1863, A. Damour demonstrated that the very tough substances, previously referred to as "jade" and sought after in the Far East as a gem or material for art objects, belong to two different minerals: nephrite, a variety of calc-magnesian amphibole (either tremolite or actinolite), with a specific structure, and another species, the most precious one, which he called jadeite, an aluminum and sodium silicate that later was classified within the group of pyroxenes.
>
> At that time, microscopic study to verify the homogeneity of the minerals under examination was not known. In reality, while there is indeed a pyroxene with the theoretical composition $NaAl(SiO_3)_2$, which can contain varying amounts of calcium and magnesium silicates through isomorphous mixing, the significant variations in chemical composition revealed by the analysis of specimens qualified as jadeite result from their lack of homogeneity. Instead, they were composed of rocks in which jadeite played an unevenly significant role.
>
> As a result, just as there is a chemically well-defined mineral called dolomite, and also dolomites (rocks composed of dolomite), one must also distinguish the mineral jadeite from jadeitites, rocks of which jadeite is the essential constituent. Many [current] uncertainties regarding the mineral jadeite stem from the fact that this distinction was not always made in the past.
>
> — Alfred Lacroix, 1930
> *La jadeite de Birmanie; les roches qu'elle constitute ou qui l'accompagnent, composition et origine*
> [Burmese jadeite: The rocks it forms or accompanies, their composition and origin], p. 216

Figure 5.1. Earthworks
A superb imperial *fei cui bi* (disc). The *bi* is an ancient symbol in Chinese culture, representing the sky revolving around a central axis, a sign of the divine heavens. Photo and specimen: On Tung Jewellery; size: 31.8 ct; 28.7 mm diameter.

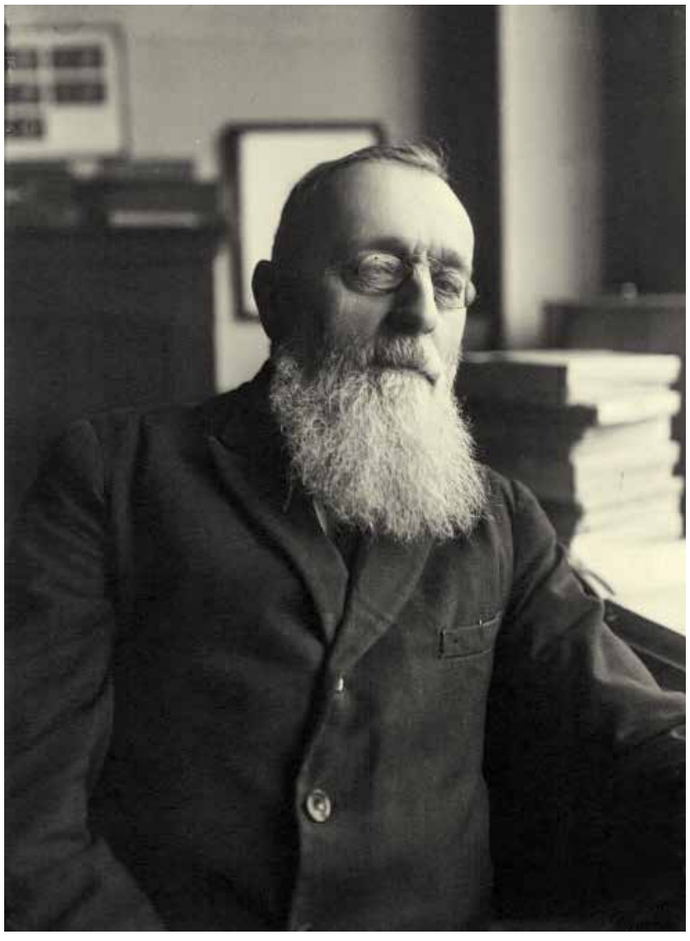


Figure 5.2. Alfred Lacroix (1863–1948), the famous French mineralogist. Best known for his massive three-volume work on the minerals of Madagascar (Lacroix, 1922, 1923), he was widely traveled, and those journeys included parts of Asia. Lacroix pointed out in 1930 that using a species name (jadeite) was not appropriate for a gem that was a rock. Sadly, that message never entered the mainstream gemological world. Photo: Public domain

Figure 5.3. Bausch & Lomb petrographical microscope manufactured ca. 1902. By the turn of the 20th century, mineralogists had the tools to understand that pyroxene jades were rocks, but sadly this never filtered across to the gemological world, resulting in the improper use of jadeite to describe the gem. Photo: Allan Wissner/Antique-Microscopes.com

Further down the memory hole, we find the following:

> This series of rocks belongs evidently to the general group of jadeite jades, but differs from the usual jadeite of Burma and other sources of Chinese jade in two important particulars: the constant presence of large or considerable amounts of diopside with the jadeite in the pyroxene; and the presence of much albite in most of the series, either wholly in solid solution in the pyroxene, or partly so ("occult") and in part separately crystallized. The series, thus, extends from pure **tuxtlite** (diopside-jadeite, 1:1) to nearly pure albite.
>
> Further discussion of these points cannot be undertaken here, for lack of space; but it is suggested that this series shows such well-marked general and serial characters as to be deserving of a special name. That here proposed is **mayaite** which recalls the ancient nation who used and valued it, and which may distinguish it from the more widely known Burmese jadeite jades (with little or no diopside or albite). Purely jadeite jade seems to be unknown from, or at least is of very rare occurrence in, Middle America.
>
> — Henry S. Washington, 1922
> *The jades of Middle America*, p. 325

THE CASE FOR CHANGE

In 1953, Charles Hardinge wrote a short paper on jade nomenclature, one that brought a pointed reaction from the famous gemologist, B.W. Anderson:

It seems to me that as there are so many Jadeologists to-day that any fact connected with either mineral would be of some interest to quite a number of people, even if their primary interest was not perhaps mineralogical. I am not concerned in the very least about any confusion that may arise if my submission is correct; a fact is a fact, and if I am correct any confusion there may be started 90 years ago owing to a slip-up on the part of a mineralogist. Surely there is no reason for any mineralogist to-day to blush for a slip-up on the part of a professional ancestor three or four generations ago; it provides yet another example of the wonderful foresight of the Author of the ten commandments when he laid down:— "and visit the sins of the fathers upon the children unto the third and fourth generation." That any confusion will be caused is extremely unlikely I should imagine. I have only raised the matter in the hope of getting a definite decision one way or the other.

B.W. Anderson writes:—

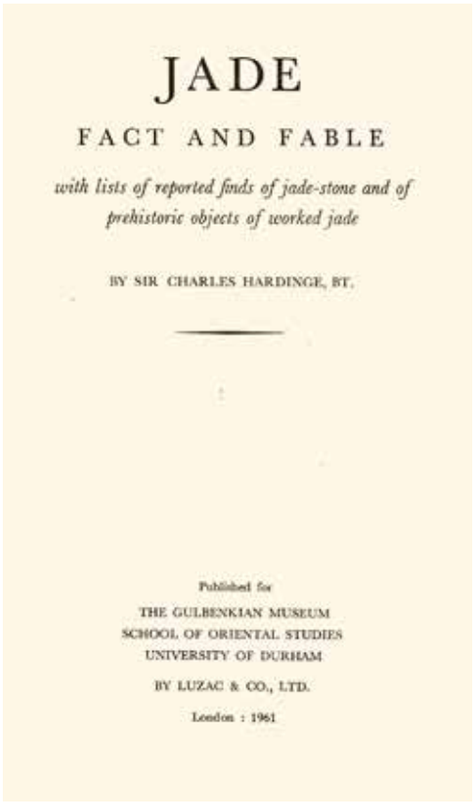
…The point I want to make is that, whichever of these terms is used, the meaning is clear, even where they are logically, historically, or geographically incorrect: and clarity of meaning is the one really important thing about a name.

— Charles Hardinge, 1953
Jade: A problem in nomenclature,
Journal of Gemmology, pp. 114–115

While it hurts to say this about such a distinguished gemologist, we would disagree with Anderson. Language matters and correcting wrong language — particularly in a field that is at least partially reliant on science — is important. While replacing nephrite with *yù* (or another term) is probably a lost cause, at least the name for this rock is not a mineral species. In contrast, the name jadeite is still being misused. But the discovery of omphacite in *fei cui* gives us a rare opportunity to correct a mistake in two directions. Adopting *fei cui* as the name for the pyroxene jade rocks not only repairs a historical mistake in science, but it also works to our advantage in the commercial world, providing us with a wonderful and evocative name for one of the world's most treasured gems.

Hardinge, in his later small volume *Jade • Fact and Fable* (1961) (Figure 5.4) forcefully makes the case for change:

I hope the reader will forgive me if I have tried his patience by my insistence on the impropriety of applying ridiculous, misleading and confusing names to two noble and beautiful gem-stones, of calling *yü* or *pounamu* "nephrite", and *chalchihuitl* or *fei-ts'ui* "jadeite". The first,


JADE

FACT AND FABLE

with lists of reported finds of jade-stone and of prehistoric objects of worked jade

BY SIR CHARLES HARDINGE, BT.

Published for
THE GULBENKIAN MUSEUM
SCHOOL OF ORIENTAL STUDIES
UNIVERSITY OF DURHAM
BY LUZAC & CO., LTD.
London : 1961

Figure 5.4. Title page of Charles Hardinge's book, *Jade • Fact and Fable*. The author was a jade collector and wrote a paper and this small book arguing for a reform of jade nomenclature.

the most precious material known to the Chinese throughout most of their history, and for them a symbol of beauty, nobility and purity, has never been associated by the Chinese, or by anyone but the nineteenth century mineralogists, with kidneys. On the other hand, the earliest jade to come to the notice of Europeans in historical times, the *piedra de yjada* of the Spanish navigators, from which our word "jade" is derived, the stone treasured above all others by the ancient Americans, deserves a better fate than to be dubbed "jadeite", a name suggesting an imitation or substitute for something finer or scarcer. Both stones, in fact, have been insulted by this curious and deplorable reversal.

— Charles Hardinge, 1961
Jade • Fact and Fable

Figure 5.5. From *Yù* to *Fei Cui*
Left: Hetian *yù* (Chinese nephrite) horse pendant sculpted by Master Shi Guixin. Photo: Liu Renchao; size: 9 × 7 × 2 cm.
Right: Glassy Burmese imperial *fei cui* bamboo pendant. Photo and specimen: On Tung Jewellery; size: 116 ct; 52.85 mm length.

CHOICES

> To change is always seeming fickleness. But not to change with the advance of the science, is worse; it is persistence in error…
>
> —— James D. Dana, 1850, announcing the revision of his mineralogical system, p. 5

When omphacite was discovered by gemologists in fine quality *fei cui*, many labs quickly adjusted their nomenclature to reflect this (McClure, 2012; Krzemnicki, 2013). This clearly demonstrates that change is possible, even with a name such as jadeite that has been in gemological use for so long. Now that it has been shown that *fei cui* is a rock rather than a mineral species and that absolute determination of the various components in some samples cannot be done reliably without destroying the specimen, we hope that labs will adopt nomenclature that correctly reflects the current understanding. Words change. Geology used to be called "geognosy" and Rose channels in corundum used to be called boehmite needles. Nomenclature changes as our knowledge expands.

Considering the above evidence, from where these authors sit, gemological labs and the gem trade face four potential choices, as follows:

- Do nothing. Continue to misuse the mineral species name jadeite for what is clearly a rock whose major constituents often consist of three different pyroxenes.
- Call the rock jadeitite, omphacitite or kosmochlorite, a path that requires destructive testing because none of our current instruments can measure much below the surface of the gem.
- Rename the gem. Recognize that jadeite is not appropriate and coin a new term for this pyroxene jade rock.
- Adopt the name *fei cui*, bringing the nomenclature in line with what is done in China, which has not just an extensive history with the stone, but is also by far the largest consumer of it.

Figure 5.6. Chang Huang-Chao (章鸿钊, Zhang Hongzhou, 1877–1951) was a Western-educated scientist who authored *Shih Ya, Pao Shih Shuo: Lapidarium Sinicum*, the first major Chinese book on rocks and minerals from the standpoint of both Eastern and Western science. It contains much of interest, including material on jade. Chang also authored an important paper on jade (Chang, 1922), which concluded with this statement: "I have always been of the opinion that for such mineralogical terms, the study of nomenclature must be guided by historical research. This is the reason why my *Lapidarium Sinicum* was written." Chang was one of the founders of the Chinese Geological Society and was elected its first president. The mineral hungchaoite was named in his honor. Photo: Public domain

CONTRARIAN VIEWS

What About the Collectors?

The authors have heard various objections to the replacement of jadeite with *fei cui*. One is that "collectors want to know exactly what it is." Collectors are a tiny segment of the market. We see no reason to create onerous

testing requirements based on the perceived needs of such a small market segment, particularly when there currently exists no test that can accurately determine the absolute composition of this rock without destroying it. Just imagine what level of testing would be required if gemologists needed to determine to which of the 41 species a tourmaline belongs (and tourmalines are single crystals). *Fei cui* is a rock. Multiply the difficulty a thousand-fold or more.

This has not stopped some from suggesting that gemologists test each *fei cui* specimen in no fewer than twenty places, or even more if the piece is fine grained (Franz et al., 2014). Thus, a necklace with 100 high-quality beads would require an incredible ***minimum*** of 2,000 spot tests under this protocol.

As we previously demonstrated, random spot testing has the potential to yield inconsistent results — not only amongst labs — but even when the same specimen is tested in the same lab on different occasions. And all this effort for what? So that we can say what the relative surface composition is, with no guarantee that the rest of the specimen is the same?

In the end, if collectors want advanced analyses of their specimens, there is nothing to stop them from seeking it out, but we do not believe such analyses should be the baseline of testing. Just because a hospital has a surgery ward should not mean every patient gets treated there.

Once again, jade is a rock. Due to the allochromatic nature of jadeite, near-colorless and lavender specimens are relatively monomineralic, but establishing the exact level of homogeneity is not a trivial task in other colors. In certain cases, it is not even possible without destructive testing. Even where it may be feasible, it is time-consuming and expensive and, thus, not practical for either gem labs or appraisers.

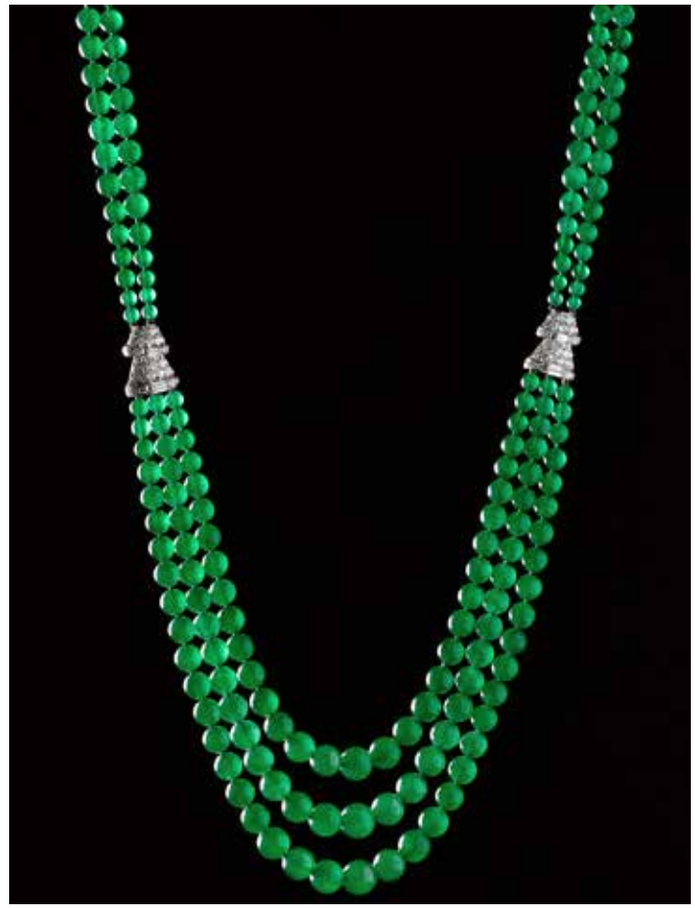


Figure 5.7. A three-strand necklace of high-quality *fei cui* beads. Some gemologists have suggested that proper characterization would require a minimum of twenty spots tested on each bead. One can easily see that this would be a nightmare for virtually all gem labs. Photo: Tino Hammid; Geoff Dominy Collection.

Quality Control

Another excuse for not adopting *fei cui* that we have heard is that, due to the potential expense of certain pieces, this demands a higher level of testing. Note that breaking down *fei cui* according to its mineral components is meaningless in terms of quality analysis. There are high-quality samples that test as dominant jadeite and some that test as dominant omphacite. Gemologists frequently choose indirect testing as a way of describing quality, and this often leads to poor outcomes. Tests for cobalt in spinel and copper in tourmaline are two

prime examples. Not unlike geographic origin testing, the presence or absence of a chromophore is no guarantee of quality, which needs to be judged visually (Hughes, 2023).

Hardness Differences?

The hardness difference between jadeite and omphacite is yet another reason cited for the necessity of separating "jadeite jade" from "omphacite jade" and "kosmochlor jade." However, due to the intricate mineralic zoning (along with many other factors), it is difficult to ascertain whether a rock rich in one mineral is harder than one rich in another. Therefore, it is not surprising that inconsistent hardness values have been reported in the literature for *fei cui* mineral components.

It is exceptionally rare to find single crystal jadeite (Liu et al., 2020), omphacite or kosmochlor samples in sizes large enough to do sufficient hardness testing. We must also remember that all single crystals exhibit directional hardness differences.

Theoretical calculations can be made as to which minerals should be harder than others, but the complex intermixture of these minerals and their growth environments mean that individual physical properties might not be directly comparable to collective physical properties.

Hardness is a function of the bond types present at the point of contact and their resistance to deformation. Bond strength is determined largely by bond length (anion-cation distance), valency and bonding type. Many variables impact determining a material's hardness and the measurement method plays a large role in the results.

Just as spectroscopic methods are based on point analyses (mapping is required for a bulk determination and still requires a high spatial resolution), hardness testing is reliant on the point (or line) being measured. There is also a large possibility that more than one grain (that may not be homogeneous with the surrounding grains) will form part of the measurement. This is obviously not ideal for making tangible determinations.

For more information on the hardness of *fei cui*, see Khourie (2023). Keep in mind that the softest directions in jadeite, omphacite and kosmochlor are below the hardness of quartz (7). ***As quartz is the hardest component of dust in the air, this means all three types of pyroxene jade***

Hard vs. Soft Jade[1]

WE WOULD certainly be amiss if we left readers with the impression that jade nomenclature blunders are strictly a Western skill. When it comes to jade there is absolutely no discrimination. Witness the following (and we are seriously not making this up):

In 1890, the noted Japanese geologist and professor Bunjiro Koto published a small book entitled 鉱物字彙 [Vocabulary of Mineralogical Terms in the Three Languages • English, German, and Japanese]. Koto had studied geology in Leipzig and Munich and was one of the first Japanese geologists trained abroad. In the book, Koto translated jade as:

- Jade (Jadeite). Kö-gyoku. Jade (Jadëit)..... 硬玉
- Nephrite. Nangyoku. Beilstein[2] (Nephrit)..... 軟玉

The Japanese characters are borrowed from Chinese and translate as "hard jade" and "soft jade" respectively. Except that these terms did not exist in China at the time. While each type of jade was being both fashioned and heavily traded in China, the tiny differences in hardness between jadeite (6.5–7) and nephrite (6–6.5) were considered inconsequential.

This is where the real fun begins. Apparently Zhang Hongzhao, a Chinese geology student in Japan, came across Koto's book. He saw that jadeite was called *ying yù* ('hard jade') and nephrite was termed *ruan yù* ('soft jade'). He thus imported these mistranslated terms back to China. In 1921, Zhang wrote a geology book himself in Chinese where he misapplied the terms *ruan yù* and *ying yù* to Hetian *yù* and *fei cui*, This is how "soft jade" and "hard jade" entered the Chinese jade lexicon. Sadly, the practice continues through the present day.

1 Based largely on the publication of Koto (1890) and accounts of Zhang & Yuan (2017) and Shi et al. (2019).

2 *Beilstein* in English is actually "ax stone."

Figure 5.8. Just three of the colors of *fei cui* from Myanmar. These miniature Buddha pendants by Wang Junyi sold for HK$4,366,000 (US$557,363) at Tiancheng's 14 June 2015 auction in Hong Kong. Today *fei cui* jade is one of the world's most expensive gems. Photo: Tiancheng International; Buddhas approx. 4 cm in height.

Figure 5.9. Sushi, or raw fish + rice + seaweed?
Culture matters, not just the raw materials of which something is made. *Fei cui* has a traditional heritage in China stretching back hundreds of years, long before Damour's first analyses. Metaphor courtesy of Kent Wong; photo: Givaga/iStock; sushi size: 35 mm diameter.

will develop microscopic scratches over time, eventually losing their polish if not well cared for.

BORDER WARS

There is no precise point where *fei cui* is no longer *fei cui*. While mineralogy might draw the line at 50% or more jadeite/omphacite/kosmochor, such a number is arbitrary and in practice the difficulty of compositional testing means many determinations are guesswork.

Most of nature involves analog systems, where change takes place gradually along a curve. However, classification systems are digital, with category changes occurring in discrete steps. This creates unavoidable conflicts at the boundaries. We see this in diamond grading, in separating green beryl from emerald or pink sapphire from ruby; we see it wherever hard boundaries exist.

In former times, it was simple. All pyroxene jades were called "jadeite." Then omphacite and kosmochlor were identified in *fei cui* and by trying to determine the exact composition, gemologists not just multiplied the number of boundaries, but created the need for exceptionally advanced testing of every specimen, with no guarantee that the "results" would be accurate. Is this progress?

When crafting definitions, we should be wary about creating more boundaries and always ask if they are necessary. Is there a corresponding gain that justifies the added complexity? After all, the gem itself has not changed, only our understanding at the most minute level.

SWEATING THE SMALL STUFF

Gemologists spend much of their working lives staring into a microscope. This microworld thus becomes reality, where tiny features take on exaggerated reality. The danger here is that a feature of virtually no "big picture" importance becomes something that must be tested for. At this point, gemology loses the plot.

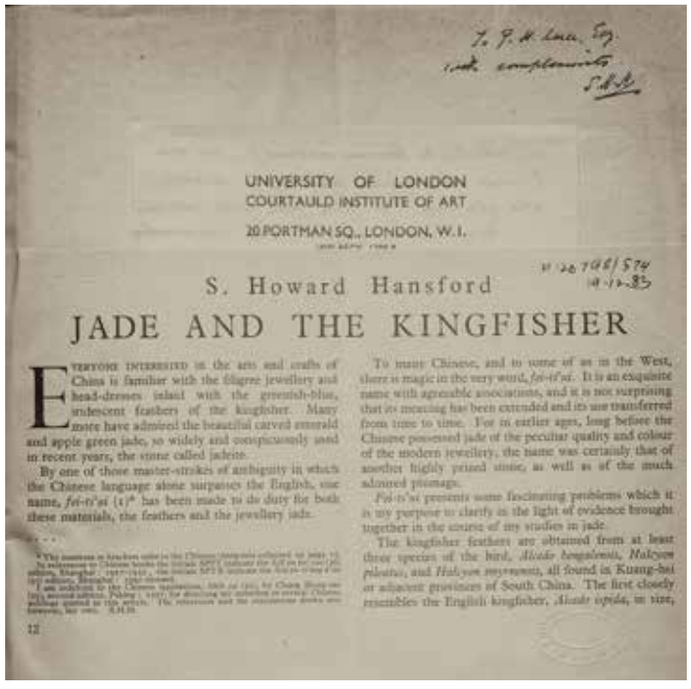
Unlike pure sciences such as chemistry, physics, mineralogy and crystallography, gemology's quest is not wisdom for wisdom's sake, but knowledge with a purpose, to be an honest broker in support of a commercial transaction (Emmett & Hughes, 2010). Unlike mineralogy, gemology would not exist without commerce. Requiring the determination of the relative pyroxene components is not only impossible for many *fei cui* specimens, ***but diverges from the way in which all other gem rocks are currently treated***.

Even if a miracle occurs and a magic instrument appears that can analyze the exact mineral component composition of entire *fei cui* specimens, we must ask why? Why would we want to do this? Other than profits for gem labs, what is gained?

Did we mention that *fei cui* is a rock? Again, no other gem rocks are dealt with in this way. From maw sit sit through sanan skarn and lapis lazuli to jasper and a host of other gem rocks, a simple name is applied.

The replacement of the term "jadeite" with *fei cui* does not go against modern mineralogy, but supports it, because the mineral name jadeite has been misapplied to this rock for over 150 years.

Traders could benefit greatly from a move to *fei cui*, as well, since the term is understood by the overwhelming majority of the buyers. Imagine the ads: "*The timeless beauty of fei cui — jade of the kingfisher*" versus "*The timeless beauty of omphacite (not jadeite, not a disease).*"


UNIVERSITY OF LONDON
COURTAULD INSTITUTE OF ART
20 PORTMAN SQ., LONDON, W.1.

S. Howard Hansford

JADE AND THE KINGFISHER

Figure 5.10. Title page of S. Howard Hansford's "Jade and the Kingfisher" from 1948, one of the most important English-language resources on the origin of *fei cui*.

CODA

When the authors set out to correct what appeared to be an obvious mistake in jade nomenclature, we had no idea of the twisted path this would take us down. As we researched the subject, we were continually shocked by the sheer number of mistaken, discombobulated or misappropriated terms that we encountered.

We will leave readers with the following final thoughts:

> Everyone interested in the arts and crafts of China is familiar with the filigree jewellery and head-dresses inlaid with the greenish-blue, iridescent feathers of the kingfisher. Many more have admired the beautiful carved emerald and apple green jade, so widely and conspicuously used in recent years, the stone called jadeite.
>
> By one of those master-strokes of ambiguity in which much the Chinese language alone surpasses the English, one name, *fei-ts'ui* has been made to do duty for both these materials, the feathers and the jewellery jade.
>
> To many Chinese, and to some of us in the West, there is magic in the very word, *fei-ts'ui*. It is an exquisite name with agreeable associations, and it is not surprising that its meaning has been extended and its use transferred from time to time. For in earlier ages, long before the Chinese possessed jade of the peculiar quality and colour of the modern jewellery, the name was certainly that of another highly prized stone, as well as of the admired plumage.
>
> —— S. Howard Hansford, 1948
> Jade and the Kingfisher, *Oriental Art*, p. 12 (see Figure 5.10)

In the mid-1800s, the famous American mineralogist James Dwight Dana completely tore up his Latin-name based classification system for minerals:

> This treatise, in the present edition, has undergone so various and extensive alterations, that few of its original features will be recognized. The science of Mineralogy has made rapid progress in the six past years; chemistry has opened to us a better knowledge of the nature and relations of compounds; and philosophy has thrown new light on the principles of classification. To change is always seeming fickleness. But not to change with the advance of science, is worse; it is persistence in error: and, therefore, notwithstanding the former adoption of what has been called the "Natural History System," and the pledge to its support given by the author, in supplying it with a Latin Nomenclature, the whole system, its classes, orders, genera, and Latin names, have been rejected; and even the trace of it, which the synonymy might perhaps rightly bear, has been discarded.
>
> —— James Dwight Dana, 1850
> *A System of Mineralogy*, 3rd edition, p. 5


Report N° SAMPLE
LOTUS GEM
Page 1 of 4
9 May 2024
LABORATORY FINDINGS
Description: 1 Loose Stone
Weight: 1.75 ct
Dimensions: 7.34 x 7.89 x 3.59 mm
Shape: Oval
Cutting Style: Cabochon
Crown: Cabochon
Pavilion: Low Cabochon
Transparency: Translucent
Color (Daylight): Green
Saturation: Intense
Tone: Medium
Enhancements: A Jade (untreated)
NOTES
"Fei cui" (翡翠) is the traditional Chinese term for pyroxene jade, which is a mixture of jadeite, omphacite, and kosmochlor. Originally named after the plumage of the kingfisher bird, it now applies to all colors.
ID
NATURAL FEI CUI JADE
ORIGIN
Fei Cui Jade
Fei cui jade is mainly produced in Myanmar's Kachin state, but is also found in Guatemala, Russia, Kazakhstan, Japan, Italy, and the USA.
Verify this report by referencing Report No. SAMPLE with PIN No. SAMPLE at LotusGemology.com
Lotus Gemology
Silom 19 Building, Suite 411 • 45/1 Soi 19, Silom Rd.
Bangkok 10500 • Thailand
Tel: +66 2 117 3616
info@lotusgemology.com • www.lotusgemology.com
LOTUS

Figure 5.11. Sample Lotus Gemology report for *fei cui* jade, showing the wording that appears on the report.

Dana followed the evidence. So should we. This isn't East vs. West. It's not about a European or a Chinese view, nor an aversion to employing the best scientific methods. Rest assured; the authors are not Luddites. This is about using words in the best possible way. While a broken bangle can never be made whole, we do have the ability to change our nomenclature. If we craft our definitions with careful consideration of science, history *and* culture, they should be durable. Hopefully as durable as jade.

POSTSCRIPT

One final point. The meaning of *amphibole*. This is so fitting. It was named in allusion to its group members' chameleon-like variations in composition and appearance. Amphibole is derived from the Greek — for *ambiguous* (Haüy, 1801). And hornblende? It's from German, from "horn," an old miner's term for dark minerals with no ore value, and "blende," which means "to deceive."

NOTE

All the gemological reports issued by Lotus Gemology since 1 July 2023 replace the term jadeite with *fei cui* (Figure 5.11). Future editions of *Jade | A Gemologist's Guide* will do the same.

Questions and Answers about Fei Cui

Why has Lotus Gemology stopped using the term jadeite on its reports?

Since 1863, gemologists have generally labeled pyroxene jades under the clinopyroxene species jadeite. Jadeite has now been depreciated because we understand that the gem previously termed "jadeite" (or 'omphacite') is not a single mineral species, but a rock mainly composed of three different pyroxenes — jadeite, omphacite and kosmochlor. There are no tests that can determine the relative percentages of each end member of an entire stone without destroying the specimen. In addition, other gem rocks like lapis lazuli, maw sit sit and sanan skarn are not analyzed to determine the percentages of their component minerals. Thus we have adopted the traditional term for the gem that has been used in China for over two centuries, *fei cui* (翡翠). *Fei cui* is an umbrella term for pyroxene jade gems and has been legally approved in China (including Hong Kong) (GAHK, 2016).

Why have you chosen a Chinese word as a replacement for jadeite?

Fei cui is not a replacement, but rather the original Chinese word for this precious gem, a word that has existed for over a thousand years. The word "jadeite" is actually a newcomer, being coined by Alexis Damour in 1863. Since using a mineral species name as the exact same name for a rock does not follow accepted protocol, and since the Chinese are by far the largest consumers of the material, we believe it is appropriate to reinstate the Chinese name.

Doesn't *fei cui* mean green in Chinese?

It actually means red (*fei* — 翡) and green (*cui* — 翠), from the plumage of the kingfisher bird. As modern mineralogical analysis progressed, it became apparent that the base material of *fei cui* (a pyroxene rock) came in many different colors.

The eminent American gemologist, George F. Kunz, described it in 1888–89:

> Jadeite, or imperial jade or "feisui," as it is variously known, is generally white, with splashes or spots of a rich green, almost rivalling the emerald for vividness.
>
> — George F. Kunz, 1888–89, *The Art Amateur*, Volume 20, Nos. 1–3, p. 3

Already by the year 1904, the definition had been extended, as the following statement from the noted orientalist, Stephen Wooton Bushnell shows:

> …fei ts'ui originally applied to the emerald green variety, is now extended to all other jadeites…
>
> — Stephen Bushnell, 1904, *Chinese Art*, Volume 1, p. 137

This is no different from sapphire, where the original definition (blue corundum) was extended to include all colors other than red (ruby).

Why are some labs able to specify when a specimen is jadeite or omphacite or kosmochlor?

The complexity of the interwoven nature of the various pyroxene species is not revealed by standard gemological testing. Instruments such as Raman and FTIR may produce spectra that resemble one of the three species, but studies done with backscattered electron microprobe reveal that even areas that appear to be homogeneous under light microscopy can still be intergrowths of tiny crystal grains of various species. Thus there is no easy way of determining composition using spectroscopy. Gemology needs to acknowledge that this gem is a rock, not a single mineral species, in the same way that lapis lazuli (a rock) is not lazurite (the dominant species in the rock). Geologists do not call *fei cui* jadeite, they call the rock jadeitite (or omphacitite or kosmochlorite, depending on which species they believe dominates). The reason mineral names are not used for rocks is so that the two can be separated from one another.

If geologists call these rocks jadeitite (or omphacitite or kosmochlorite), why doesn't Lotus Gemology use those terms?

Because that requires thin-section petrographic analysis or other destructive techniques. In addition, we do not believe those terms are nearly as eloquent sounding as *fei cui* (kingfisher jade). And finally, we are a gem lab, not a geology lab. If we were a geology lab, we would use "red corundum" instead of "ruby."

Fei cui is difficult for non-Chinese to pronounce. Isn't there a more easily pronounceable word that could be used?

It's actually quite simple, it's pronounced "fay choy." Champagne is far more difficult to pronounce for native English speakers, but people have learned how to do it. For those who have trouble, they can simply call it "kingfisher" jade, which is the meaning in Chinese.

Can the name *fei cui* be used for treated stones?

Yes. Just as rubies don't stop being rubies when they are treated, *fei cui* doesn't stop being *fei cui* when it's treated. All treatments are clearly stated on our reports.

There are many gem aggregates that are named after the dominant mineral. What's wrong with that?

We don't believe it is a logical argument to cite wrongly named gems in defense of wrongly naming gems. The reason the current problem with pyroxene jade nomenclature has arisen is because gem labs did not fully understand the nature of *fei cui*, and thus began incorporating omphacite/kosmochlor on their reports, treating stones like mineral species rather than rocks. This forced a reexamination of pyroxene jade nomenclature and allows us at this time to correct an error from 150 years ago.

When, Where, Why, Who & Haüy

WHEN IT COMES to gemological nomenclature, jade takes first prize for the sheer number of missteps, starting early and continuing to the present day. For example, no other mineral-based gem name allows for two entirely different materials from unrelated species to fall under its umbrella. And it doesn't end there. Even the word "jade" itself is based on an error (see page 31).

If we want to have nomenclature that makes sense, we need to understand where we came from and where we went wrong. What follows is a timeline of jade (and jade-like material) nomenclature, detailing the various twists and turns that led to the current situation. See Hughes (2022) for all unreferenced entries.

Before Common Era (BCE)

36–35,000 Nephrite axes are found in Upper Palaeolithic sites in Japan. This is the earliest known use of jade (Takashi, 2012).

22,000 Jade is worked in the Lake Baikal region of Russia (Komissarov, 1998).

8000–7000 Amphibole jade (nephrite) is first worked in China (Nanjing Museum, 2023). At some point, the Chinese label the stone *yù* (玉). The character is one of the oldest in the Chinese script, and only slightly modified from the character for "king" (王), signifying its importance.

7100–6500 Xiaonanshan *yù* jade culture develops in northeast China.

6200 Xinglongwa *yù* jade culture develops in Inner Mongolia.

6000 Pyroxene jade, today locally termed *hi sui*, is worked in Japan.

3800–2700 Hongshan *yù* jade culture appears in China's Liaoning Province.

3300–2250 Liangzhu *yù* jade culture develops in Zhejiang Province, along the southeast coast of China.

3000–1200 Sanxingdui *yù* jade culture appears in China's Sichuan Province.

2000–1900 Qijia *yù* jade culture appears in China's Gansu Province.

1800 Pyroxene jade is worked by the Olmecs in Central America (Hughes, 2022). The gem later becomes known to the natives as *chalchihuitl*.

1250 The Māori discover and begin working amphibole jade (*pounamu*) in New Zealand.

200 Nephrite (*yù*) from Khotan (Hetian) in what is now Xinjiang U.A.R. is traded with eastern China.

Common Era (CE)

50 Greek physician Pedanius Dioscorides describes a stone called λιθος οφιτης, where the Greek οφις means "serpent" (Hintze, 1897; Faust & Fahey, 1962).

200–800 The Pyu city-state of Sri Ksetra (Hmawza) develops in Myanmar. Excavations from this site reveal *fei cui* ornaments and carved elephants (Duroiselle, 1930).

11th Cent. The term *fei cui* as applied to jade (rather than the kingfisher bird) makes its first appearance in China (Bishop, 1900).

1250–1350 Polynesians settle New Zealand, discovering a type of jade (nephrite/serpentine) that they term *pounamu* ('greenstone') (Hughes, 2022, p. 142).

1272–73 Marco Polo passes near the famous *yù* deposits near Hetian (Khotan) and mentions "There are rivers in this country, in which quantities of jasper and chalcedony are found" (Yule & Cordier, 1920). From this point on, *yù* is termed "jasper" by European writers. This misimpression continues for hundreds of years.

1518–19 Spaniards led by Juan de Grijalva begin to explore the gulf coast of present-day México. They are the first Europeans to encounter jade in the New World. A year later, Motecuhzoma Xocoyotzin (Moctezuma II) dispatches his ambassador Pitalpitoque to meet Hernán Cortés with a gift of jade beads (Diaz del Castillo, 1908–1916; Helferich, 2012).

1540–1585 Fray Bernardino de Sahagún authors the *Florentine Codex*, which mentions *chalchihuitl*, a highly valued gem from the New World (Sahagún, 1950–1982; see Vol. 11, pp. 221–231).

1546 Georgius Agricola latinizes "οφις" ('serpent') to *serpentaria*, from where our modern word serpentine is derived (Agricola, 1546; Hintze, 1897).

1565 Nicolás Monardes, a noted physician in Seville (Spain), writes that in the New World, kidney-shaped stones (termed *chalchihuitl* by the natives and later proved to be *fei cui*) were drilled so that they could be worn across the body and used medicinally for kidney diseases. He dubs the gems *piedra de la yjada*. This is later translated to Latin as *lapis nephriticus* ('stone for the kidneys') (Monardes, 1565, pp. 40–43; 1571, p. 67). Monardes never visited the New World, relying on informants who brought back plants and other substances said to have curative powers (Boxer, 1963).

1647 De Laet suggests that *lapis nephriticus* is different from jasper (Laet, 1647), but *yù* continues to be called jasper by many European writers, including Abel-Rémusat, who wrote about Khotan in 1820.

1719 The term *fei cui* is first applied to pyroxene jade from Myanmar (Sun, 2011).

1758 Axel von Cronstedt (the geologist who named nickel) describes *lapis nephriticus* in his Swedish mineralogy, *Försök Till Mineralogie* [Attempts at Mineralogy] (Cronstedt, 1758).

1774 Abraham Gottlob Werner publishes *Von den äusserlichen Kennzeichen der Fossilien* [About the External Characters of Fossils, or of Minerals], where *lapis nephriticus* is shortened to *nephrit* (Werner, 1774). This is the first known use of the term nephrite. Werner's was the first chemical classification of minerals and became the basis for modern mineralogy.

1784 Hostilities between China and Burma end. For the first time *fei cui* from Myanmar begins to enter China in quantity (Hertz, 1912).

1789 Werner creates the name "hornblende" for dark green to black silicates (Mindat.org).

1789 "Tremolite" is coined by Johann Georg Albrecht Höpfner (Höpfner, 1789; Roth, 2006).

1794 The earliest mention of "actinolite" is by Richard Kirwan (in various spellings) in his 1794 book *Elements of Mineralogy*.

1796 René Just Haüy coins the term "pyroxène" from the Greek words for fire (πυρ) and stranger (ξένος) because of its presence in a glassy or vitreous lava (Haüy, 1796). The original mineral is believed to be what is now called augite.

1801 Haüy creates the word amphibole to replace hornblende (Haüy, 1801).

1812–15 *Omphazit* (omphacite) is first described by Hoffmann (1812) and Hoffmann & Breithaupt (1815).

1820 Abel-Rémusat publishes *Histoire de la ville de Khotan*, the first detailed description of Chinese *yù* (re: jaspis) published in a Western language (Abel-Rémusat, 1820).

1822 George T. Bowen analyzes a piece of apple-green "nephrite" from Rhode Island. Its composition turned out to be different from nephrite. Eventually it became a variety of

serpentine, named "bowenite" by J.D. Dana in 1850 (Bowen, 1822; Dana, 1850).

1843 Schaffhäutl publishes the first accurate analyses of nephrite (Schaffhäutl, 1843).

1845–46 Damour analyzes amphibole jade specimens cut in India, but probably from western China (known in China as *yù*) and confuses them with *lapis nephriticus*, New World stones believed to be a medicine for the kidneys (Damour, 1845, 1846). Damour thus incorrectly classifies *chalchihuitl* as nephrite.

1863 Damour incorrectly identifies *fei cui* as a mineral instead of a rock and names the new "mineral" jadeite (Damour, 1863).

1865 Damour coins the term "chloromelanite" for a dark green Fe-rich *fei cui* (Damour, 1865), but now calls it a rock. In fact, the name was remarkably similar to "chloromelane," already given in 1823 to a serpentine-group mineral later titled "cronstedtite" (Breithaupt, 1823).

1875, 1880 Heinrich Fischer publishes *Nephrit und Jadeit*, summarizing virtually all the Western knowledge on jade up to that date (Fischer, 1875, 1880).

1890 Japanese geologist Bunjiro Koto mistranslates nephrite into *nangyoku* = *ruan yù* = "soft jade" and jadeite into *kö-gyoku* = *ying yù* = "hard jade," according to their slight differences in hardness (Koto, 1890). Those Chinese terms (*ruan yù* and *ying yù*) are later imported to China, causing many Chinese to misapply the terms to Hetian *yù* and *fei cui*, a practice that sadly has remained common to the present (Zhang & Yuan, 2017; Shi et al., 2019).

1897 Laspeyres first describes kosmochlor (Laspeyres, 1897).

1906 Bishop's *Investigations and Studies in Jade* is released. This lavish two-volume set contains extremely important essays on the jades, but still treats both as minerals rather than rocks (Bishop, 1906; Figure 23).

1930 Lacroix correctly describes *fei cui* from Myanmar as a rock, terming it jadeitite, while lamenting that it should have been so labeled decades before (Lacroix, 1930). Sadly, the fact that *fei cui* is a rock never makes its way into the gemological lexicon.

1946 Nils Sundius coins the term "ferroactinolite" (Sundius, 1946). He also discredits the term "ferrotremolite" previously proposed by Alexander Newton Winchell in 1933.

1966 Neuhaus reveals ureyite to be identical to the previously identified kosmochlor (Neuhaus, 1966); ureyite is eventually depreciated by the IMA.

1978 The IMA depreciates nephrite as a mineral species, recognizing that it is a rock composed mainly of actinolite (Leake, 1978; Nickel et al., 1987).

1979 Manson identifies ureyite (kosmochlor) in maw sit sit from Myanmar (Manson, 1979).

1984 Ureyite (kosmochlor) is also identified in *fei cui* from Myanmar (Ouyang, 1984).

1998 Omphacite is first identified in *fei cui* (Zheng & Zheng, 1998). Since most gemologists still did not understand that *fei cui* was a rock composed of several pyroxenes, they did what gemologists had historically done and attempted to separate *fei cui* specimens into "jadeite" and "omphacite" mineral species (McClure, 2012).

2015 VPSEM-Raman coupled study of *fei cui* demonstrates that the integration of omphacite and kosmochlor crystals with jadeite is much tighter than previously understood. As one magnifies some specimens, areas previously thought to be homogeneous are found to be far less so. This makes determining the composition extremely difficult unless the specimen is tested with destructive methods (Liu et al., 2015).

2016 Hong Kong adopts nomenclature that uses *fei cui* for the rock that is pyroxene jade, dropping the incorrectly used species names of jadeite, omphacite and kosmochlor (GAHK, 2016).

2019 CIBJO considers the proposal to replace "jadeite" with *fei cui* for all pyroxene jades (Liu, 2020).

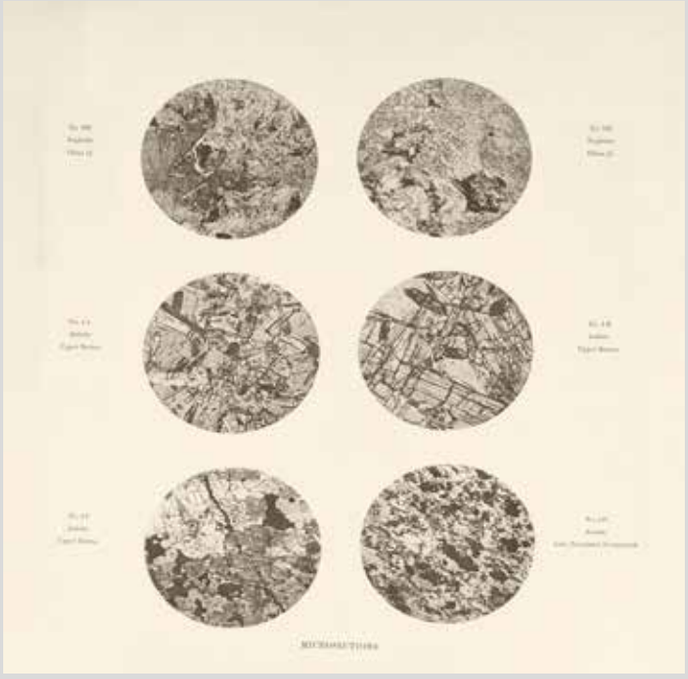


Figure 5.12. Microsections labeled nephrite and jadeite from Bishop's *Investigations and Studies in Jade* clearly show that these are rocks (mineral aggregates) rather than single crystals. All seven "jadeite" sections spread across three plates in the book were clearly rock aggregates. And yet Kunz treated each as a mineral species in his essay in the same book. From Bishop (1906, *The Bishop Collection: Investigations and Studies in Jade*, Vol. 1, pp. 88–89).

Notes

Historically, minerals and gemstones were frequently named before sophisticated analytical techniques were available. Thus, the development of new analytical techniques has resulted in the depreciation of certain mineral/gem names. The authors are not advocating for the depreciation of the names jadeite, omphacite and kosmochlor; we are simply advising that those names only be applied to single crystals whose identity can be proved. As *fei cui* jade is a rock (i.e. polycrystalline) and it cannot be analyzed grain-by-grain, the relative mineral species percentages cannot be accurately determined. Even specimens that appear homogeneous based on current analytical methods may not be; more sophisticated testing techniques may produce different results.

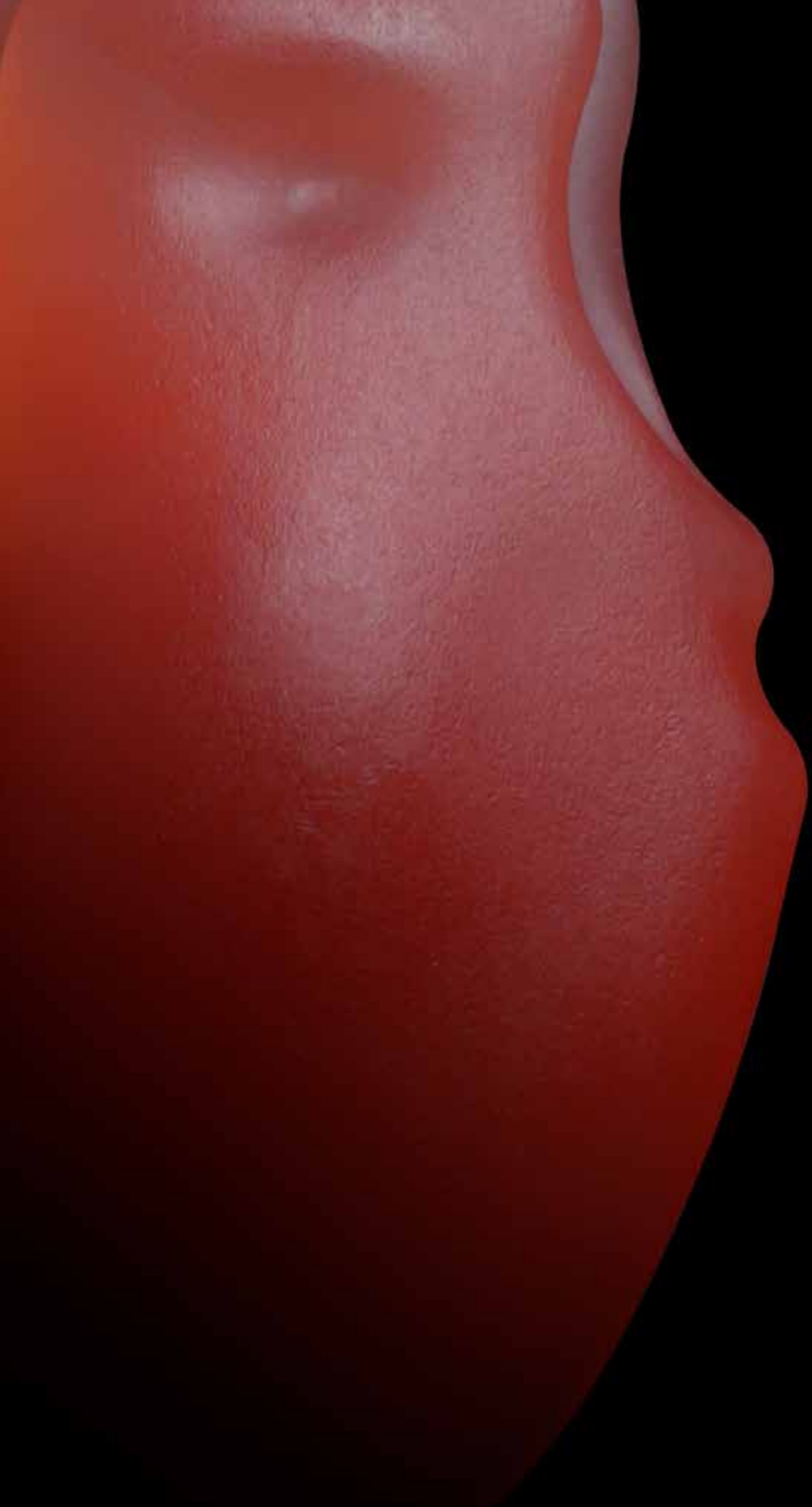


Figure 5.13. *Simple Mind*. Carnelian pendant by Master Zhuang Qingfang. Photo: Zhuangjia Fei Cui; size: 58 × 24.5 × 11.2 mm.

In the 1960s and 70s, the Chinese government opened new factories training students in traditional handicrafts. But unlike the past where carving skills were handed down within the family, students from art schools were recruited. This was step one in the genesis of China's contemporary jade movement.

Part Two involved Lin Tze-Chuan. An archaic jade trader from Taiwan, his business was suffering because it was often impossible to separate genuine artifacts from fakes. Thus he decided to move in a new direction.

Lin noted the mainland factories turning out rote work based on traditional designs, and approached the best carvers with an offer. Come work for him at far better wages, but under one condition. While they would be free to develop their own styles, he would suggest the subject matter. Lin, who was widely traveled, possessed a keen aesthetic sense and when fused with talented jade sculptors, this birthed an explosion of artistic jade and stone sculpture. Jade carving would never be the same.

Throughout this book we have offered a curated selection of the work of some of China's best carvers. As you can see, there is really nothing like it anywhere else in the world. China's carvers don't just work in jade, but also materials like the beguiling figure on this page, sculpted in carnelian.

While China's Jade Culture stretches back some 10,000 years, today's carvers are completely reinventing the medium of gem sculpture in mind-blowing ways.

For jade lovers, it's a wonderful time to be alive.

WORKS CITED

6

ATHENAEUM

WORKS CITED

Books are the training weights of the mind.

— Epictetus [ca. 50–135 CE]

Abel-Rémusat, J.P. (1820) *Histoire de la ville de Khotan, tirée des annales de la chine et traduite du chinois; Suivie de Recherches sur la substance minérale appelée par les Chinois pierre de Iu, et sur le Jaspe des anciens*. [History of the City of Khotan, drawn from the annals of China and translated from Chinese; Followed by Research on the mineral substance called by the Chinese 'pierre de Iu' and on the Jasper of the ancients] [in French]. Paris: L'Imprimerie de Doublet [Sections on jade translated into English in the *Bulletin of the Friends of Jade*, 1980, Vol. 1], 239 pp.

Abs-Wurmbach, I. and Neuhaus, A. (1976) Das System $NaAlSi_2O_6$ (Jadeit) – $NaCrSi_2O_6$ (Kosmochlor) im Druckbereich von 1 bar bis 25 kb bei 800°C [The system $NaAlSi_2O_6$ (jadeite) – $NaCrSi_2O_6$ (kosmochlor) in the pressure range of 1 bar to 25 kb at 800°C] [in German]. *Neues Jahrbuch für mineralogie*, Vol. 127, pp. 213–241.

Agricola, G. (1546) *De Natura Fossilium (Textbook of Mineralogy)*. Trans. by Bandy, M.C. and Bandy, J.A., New York: Geological Society of America Special Paper 63, 1955, 240 pp.

Barnes, G.L. [2018] Understanding Chinese jade in a world context. *Journal of the British Academy*, Vol. 6, pp. 1–63.

Barnes, G.L. (2022) *Tectonic Archaeology: Subduction Zone Geology in Japan and its Archaeological Implications*. Oxford: Archaeopress, 554 pp. (see p. 341).

Berdan, F.F. and Anawalt, P.R. (1997) *The Essential Codex Mendoza*. Berkeley: University of California Press, 148 pp.

Bishop, H.R. (1900) *Jade*. New Jersey: privately published, Mershon Company Press, 378 pp.

Bishop, H.R. (1906) *The Bishop Collection: Investigations and Studies in Jade*. New York: The Bishop Collection, 2 Vols., 277, 293 pp.

Bleeck, A.W.G. (1908) Jadeite in the Kachin Hills, Upper Burma. *Records, Geological Survey of India*, Vol. 36, Pt. 4, pp. 254–285, pls. 35–38, 3 figs.

Bowen, G.T. (1822) Analysis of a variety of nephrite from Smithfield, R.I., *American Journal of Science*, 1st Series, Vol. 5, pp. 346–348.

Boxer, C.R. (1963) *Two Pioneers of Tropical Medicine: Garcia d'Orta and Nicolás Monardes*. Lecture Series No. 1, London: Welcome Historical Medical Library, 36 pp.

Breithaupt, A. (1823) *Vollständige Charakteristik des Mineral-Systems* [Complete Characteristics of the Mineral Systems] [in German]. Dresden: Arnoldischen Buchhandlung, 294 pp.

Brenker, F.E., Prior, D.J. and Müller, W.F. (2002) Cation ordering in omphacite and effect on deformation mechanism and lattice preferred orientation (LPO). *Journal of Structural Geology*, Vol. 24, No. 12, pp. 1991–2005.

Bushnell, S.W. (1904) Chapter VII. Carving in jade and other hard stones. In *Chinese Art*, London: Victoria and Albert Museum, 2 Vols., jade, see Vol. 1, pp. 134–151; jewelry, see Vol. 2, pp. 88–91.

Chang, H.T. (1921) *Shih Ya, Pao Shih Shuo: Lapidarium Sinicum: A study of the rocks, minerals, fossils and metals as known in Chinese literature* [in Chinese]. Peking: Geological Survey of China Memoirs, Series B, No. 2, May; 2nd ed. 1927, Series B, No. 2, December, 432 pp.

Chang, H.T. (1922) Jade, its historical value to the Chinese people and its nomenclature. *Acta Geologica Sinica—Bulletin of the Geological Society of China*, Vol. 1, No. 1–4, March, pp. 40–43.

Chou, M. [周志仁著] (1987) *Dictionary of Jade Nomenclature* ["玉"名稱辭典] [in English and Chinese]. Hong Kong: privately published, 150 pp.

Clark, J.R. and Papike, J.J. (1968) Crystal-chemical characterization of omphacites. *American Mineralogist*, Vol. 53, No. 5/6, May–June, pp. 840–868.

Cronstedt, A.F. (1758) *Försök Till Mineralogie* [Attempts at Mineralogy] [in Swedish]. Stockholm: Tryckt uti Wildiska Tryckeriet, 251 pp.

Cronstedt, A.F. (1780) *Axel von Kronstedts Versuch einer Mineralogie* [Axel von Kronstedt's Attempts at Mineralogy] [in German]. Trans. by Werner, A.G., Leipzig: 254 pp.

Figure 6.1. *Textualism.* Tablet by Master Pang Ran. Hetian *yù* (Chinese nephrite). Photo: Cai Xurong; size: 100 × 70 × 15 mm.

Damigeron and Tahill, P.P. (1989) *De Virtutibus Lapidum or the Virtues of Stones*. [in English and Latin], Translated by Tahill, P.P., Seattle, WA: Ars Obscura, reissue of 2nd century B.C. lapidary, vii, 75 pp.

Damour, A. (1845) Analyse du Jade blanc; réunion de cette substance à la Trémolite [Analysis of white jade; association of this substance with tremolite] [in French]. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Vol. 21, 22 December, p. 1382.

Damour, A. (1846) Analyse du jade oriental, réunion de cette substance à la Trémolite [Analysis of Oriental jade, the association of this substance with tremolite] [in French; trans. into English by Herbert Giess in the *Bulletin of the Friends of Jade*, 1994, Vol. 8, pp. 47–50]. *Annales de Chimie et Physica*, Series 3, Vol. 16, pp. 469–474.

Damour, A. (1863) Notice et analyse sur le jade vert: Réunion de cette matière minérale à la famille des wernerites [Notice and analysis on green jade: Association of this mineral substance with the family of wernerites] [in French; trans. into English by Herbert Giess in the *Bulletin of the Friends of Jade*, 1994, Vol. 8, pp. 51–54]. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Vol. 56, 4 May, pp. 861–865.

Damour, A. (1865) Sur la composition des haches en pierre trouvées dans les monumemts celtiques et chez les tribus sauvages [On the composition of stone axes found in Celtic monuments and among savage tribes] [in French]. *Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Vol. 60–61, pp. 313–321; 357–368.

Damour, A. (1881) Nouvelles analyses sur la jadeite et sur quelques roches sodifères [New analyses on jadeite and on some sodiferous rocks] [in French]. *Annales de Chimie et de Physique*, Series 5, Vol. 24, pp. 136–144.

Dana, E.S. and Ford, W.E. (1932) *A Textbook of Mineralogy*. New York: John Wiley & Sons, 851 pp.

Dana, J.D. (1850) *A System of Mineralogy*. New York: G.P. Putnam, 3rd edition, 711 pp. (see p. 265 for bowenite).

Deer, W.A., Howie, R.A. and Zussman, J. (1992) *An Introduction to Rock-Forming Minerals*. Harlow, UK: Longman Scientific & Technical, 2nd ed., 696 pp.

Díaz del Castillo, B. (1908–1916) *The True History of the Conquest of New Spain* [English translation of *Historia Verdadera de la Conquista de la Nueva España* written in 1568]. Trans. by Maudslay, A.P., London: Hakluyt Society, 5 Vols., 396, 343, 38, 395, 463 pp. (Vol. 1 see pp. 47, 52; Vol. 2 see pp. 33, 67, 137–138, 257).

Duroiselle, C. (1930) Excavations at Hmawza. In *Annual Report of the Archaeological Survey of India • 1926–27*, Marshall, J., ed., Calcutta: Government of India Central Publication Branch, pp. 171–181.

Emmett, J.L. and Hughes, R.W. (2010) Gemology in the 21st century • Betwixt two worlds. *The Guide*, Vol. 29, No. 1, pp. 1, 4–7.

Fan, E., Liu, E. and Tsui, T. (2014) New findings in fei cui bring new opportunities [in Chinese and English]. *Journal of the Gemmological Association of Hong Kong*, Vol. 35, pp. 14–19.

Faust, G.T. and Fahey, J.J. (1962) *The Serpentine-Group Minerals*. Geological Survey Professional Paper 384-A, 92 pp. (see p. 3).

Fettes, D. and Desmons, J., ed. (2007) *Metamorphic Rocks | A Classification and Glossary of Terms*. Cambridge: Cambridge University Press, 256 pp.

Fischer, H. (1875) *Nephrit und Jadeit* [Nephrite and Jadeite] [in German]. Stuttgart: E. Schweizerbart'sche Verlagshandlung (E. Koch), 1st ed. (2nd ed. 1880), 409 pp.

Frampton, J. (1577) *Joyfull Newes out of the New-found Worlde*. London: Bonham Norton, English translation of Monardes' 1565 and 1571 books, 197 pp. (see folios 19–20).

Franz, L., Tay, T.S., Hänni, H.A., Capitani, C., de, Thanasuthipitak, T. and Atichat, W. (2014) A comparative study of jadeite, omphacite and kosmochlor jades from Myanmar, and suggestions for a practical nomenclature. *Journal of Gemmology*, Vol. 34, No. 3, July, pp. 210–229.

Gemmological Association of Hong Kong (GAHK) (2016) *Standard Methods for Testing Fei Cui for Hong Kong*. Hong Kong: Gemmological Association of Hong Kong, unpaginated (~46 pp.).

Hansford, S.H. (1948) Jade and the kingfisher. *Oriental Art*, Vol. 1, No. 1, pp. 11–17.

Hardinge, C.E. (1953) Jade: A problem in nomenclature. *Journal of Gemmology*, Vol. 4, No. 3, July, pp. 112–117.

Hardinge, C.E. (1961) *Jade • Fact and Fable: With Lists of Reported Finds of Jade-stone and of Prehistoric Objects of Worked Jade*. London: Gulbenkian Museum, University of Durham, vii + 67 pp.

Harlow, G.E. (2014) The geology of jadeite deposits. In *Geology of Gem Deposits*, Groat, L., ed., trans. by Québec: Mineralogical Association of Canada, Short Course Series, Vol. 44, pp. 305–340.

Harlow, G.E. (2022) Rock 'n' Roll • The Geology of Jade. In *Jade | A Gemologist's Guide*, Hughes, R.W., ed., Boulder, CO: Lotus Publishing, pp. 54–69.

Harlow, G.E., Tsujimori, T. and Sorensen, S.S. (2015) Jadeitites and plate tectonics. *Annual Review of Earth and Planetary Sciences*, Vol. 43, No. 1, pp. 105–138.

Harlow, G.E. and Sorensen, S.S. (2005) Jade (nephrite and jadeitite) and serpentinite: Metasomatic connections. *International Geology Review*, Vol. 47, No. 2, pp. 113–146.

Haüy, R.J. (1796) Extrait du Traité élémentaire de minéralogie que le Citoyen en Haüy s'occupe de rédiger [Extract from the Elementary Treatise on Mineralogy that Citizen Haüy is working on compiling] [in French]. *Journal des Mines*, No. 28, Second Trimestre, Nivôse, Pluviose, Ventôse an V., pp. 249–334, 3 plates.

Haüy, R.J. (1801) *Traité de Minéralogie* [Treatise on Mineralogy] [in French]. Paris: Chez Louis, 4 vols. + atlas.

Helferich, G. (2011) *Stone of Kings: In Search of The Lost Jade of The Maya*. Guildford, CT: Lyons Press, 304 pp.

Hertz, W.A. (1912) *Burma Gazetteer: Myitkyina District*. Rangoon: Superintendent, Govt. Printing and Staty., Volume A, reprinted 1960, 193 pp., map.

Hintze, C.A.F. (1897) *Handbuch der Mineralogie, Vol. 2, Silicate und Titanate* [Handbook of Mineralogy] [in German]. Leipzig: Verlag von Veit und Comp., 960 pp. (serpentine, see p. 763).

Hoffmann, C.A.S. and Breithaupt, A. (1811–1818) *Handbuch der Mineralogie* [Handbook of Mineralogy] [in German]. Freiberg: Craz und Gerlach, 4 Vols., omphacite, see Vol. 2, Part 2, 322 pp.

Höpfner, A. (1789) Ueber die Klassifikation der Fossilien in einem Schreiben des Herausgebers an Herrn Dr. Karsten in Halle [About the classification of fossils in a letter from the editor to Dr. Karsten in Halle] [in German]. *Magazin für die Naturkunde Helvetiens*, Vol. 4, pp. 255–332.

Hpone-Phyo Kan-Nyunt, Kwok, B. and Chan, S.-L. (2014) The Use of FTIR and Raman spectroscopy in the testing of fei cui: Jadeite, omphacite and kosmochlor. *Journal of the Gemmological Association of Hong Kong*, Vol. 35, pp. 29–38.

Hughes, R.W. and Hoffman, E.J. (2020) Hidden Treasure • Collecting the literature of jade. *Arts of Asia*, Vol. 50, No. 3, May–June, pp. 76–87.

Hughes, R.W., ed. (2022) *Jade | A Gemologist's Guide*. Boulder, CO: Lotus Publishing, 534 pp.

Hughes, R.W. (2023) Describing color: A fool's guide. *GemGuide*, May/June, pp. 1–7.

Jackson, B. (2001) *Kingfisher Blue • Treasures of Ancient Chinese Art*. Berkeley, CA: Ten Speed Press, 227 pp.

Jacquemart, A. (1863–64) Collection d'objets d'art de M. le Duc de Morny [Collection of art objects of Mr. the Duke of Morny] [in French]. *Gazette des Beaux-Arts*, Vol. 15, 1 November, pp. 393–419; Vol. 16, 1 January, pp. 28–50.

Ji, Y. (2018) 阅微草堂笔记 [*Notes of Yuewei Caotang*] [in Chinese]. Beijing: Huawen Publishing House, 616 pp. (see p. 407).

Karsten, D.L.G. (1800) *Mineralogische Tabellen mit Rücksicht auf die neuesten Entdekkungen* [Mineralogical Tables with Respect to the Latest Discoveries] [in German]. Berlin: 79 pp.

Khourie, K. (2023) The hardness of fei cui • A gemmological perspective. *Journal of the Gemmological Association of Hong Kong*, Vol. 44, pp. 45–57.

Kirwan, R. (1794) *Elements of Mineralogy*. London: J. Nichols. For P. Elmsy in the Strand, Vol. 1, Second, 510 pp. (see pp. 159, 267, 343, 388, 496).

Komissarov, A.S. (1998) The ancient jades of Asia in the light of investigations by the Russian archaeologists. In *East Asian Jade: Symbol of Excellence*, Tang, C., ed., Hong Kong: Chinese University of Hong Kong, Vol. 2, pp. 250–279.

Koto, B. [小藤文次郎] (1890) 鉱物字彙 [Vocabulary of Mineralogical Terms in the Three Languages • English, German, and Japanese] [in Japanese]. Tokyo: 敬業社 [Keigyo Sha], Maruzen, 131 pp.

Kovacevich, B. (2011) The organization of jade production at Cancuen, Guatemala. In *The Technology of Maya Civilization: Political Economy and Beyond in Lithic Studies*, Braswell, G.E., Chinchilla, O. and Hruby, Z.X., ed., London: Routledge, Chapter 13, pp. 149–161.

Kraus, E.H. and Hunt, W.F. (1920) *Mineralogy: An Introduction to the Study of Minerals*. New York: McGraw-Hill, 561 pp.

Krzemnicki, M.S. (2012) Jade, stone of "gods": Terms, concepts & certification. *Facette*, pp. 8–11.

Krzemnicki, M.S. (2013) *A Western Look on Fei Cui and Jadeite Nomenclature*. 21 pp.

Kunz, G.F. (1888–89) The Cabinet • Talks with Experts • VI. Mr. George F. Kunz on art works in jade and other hard stones. *The Art Amateur*, Vol. 20, Nos. 1, 3, pp. 3–4, 51–52.

Kunz, G.F. (1906) Jade as a mineral. In *The Bishop Collection: Investigations and Studies in Jade*, New York: The Bishop Collection, 2 Vols., pp. 69–197.

Lacroix, A. (1930) La jadeite de Birmanie; les roches qu'elle constitute ou qui l'accompagnent, composition et origine [Jadeite from Burma; the rocks it constitutes or accompanies, composition and origin] [in French]. *Bulletin de la Société Française de minéralogie*, Vol. 53, pp. 216–254.

Laet, J., de (1647) *Antvverpiani De Gemmis et Lapidibus libri duo; Liber de lapidibus* [Two Books by Antwerp on Gems and Stones; Book on Stones] [in Latin]. Leyden: Lugduni Batavorum, [64] 210 pp.

Laspeyres, H. (1897) Die steinigen Gemengtheile im Meteoreisen von Toluca in Mexico [The stony inclusions in the meteoric iron from Toluca in Mexico] [in German]. *Zeitschrift für Krystallographie und Mineralogie*, Vol. 27, pp. 586–600.

Laufer, B. (1912) *Jade: A Study in Chinese Archaeology and Religion*. Chicago: Field Museum of Natural History, Publication 154, Anthropological Series, Vol. X, 370 pp.

Leake, B.E. (1978) Nomenclature of amphiboles. *American Mineralogist*, Vol. 63, No. 11–12, pp. 1023–1052.

Lehmann, J.G. [1766) Historia et examen chymicum lapidis nephritici. [The History and Chemical Examination of Nephrite Stone]. [in Latin], *Novi Commentarii Academiae Scientiarum Imperialis Petropolitanae*, Vol. 10 for the Year 1764, pp. 381–412; RWHL*.

Lehmann, J.G. and Krůníz, D.J.G. [1768) Geschichte und chymische Untersuchung des Nieren (Gries) Steines, (Lapis Nephriticus.). [History and chemical examination of the kidney (gravel) stone, (Lapis Nephriticus)]. [in German], *Neues Hamburgisches Magazin*, Vol. 23, pp. 403–442; RWHL.

Lin, Q. [林清] (2003). 归田录 [Returning to the Field Record] [in Chinese]. Edited from the 1060 CE original by Ouyang Xiu [欧阳修]; Xi'an: Sanqin Publishing House, 168 pp. (see p. 155).

Liu, S.I. (2020) A milestone as "fei cui" enters the international arena ["翡翠"邁進國際舞臺的里程碑] [in Chinese with English abstract]. *Journal of the Gemmological Association of Hong Kong*, Vol. 41, pp. 71–75.

Liu, S.I., Man, K.Y., Seneewong-Na-Ayutthaya, M. and Jakkawanvibul, C. (2023) Geographic origin determination of fei cui: A comparison of high-quality green fei cui from Myanmar, Guatemala, and Italy. *Proceedings of the 37th International Gemmological Conference*, Tokyo, 23–27 October, pp. 171–173.

Liu, S.I., Ouyang, C.M. and Ng, F.Y. (2015) The application of VPSEM-Raman coupled system in studying fei cui. *Proceedings of the 34th International Gemmological Conference IGC*: Vilnus, Lithuania, pp. 76–79.

Liu, S.I. and Peng, M.S. (2010) A study of a new emerald green (Old Mine variety) omphacite fei cui [in Chinese]. *Acta Mineralogica Sinica*, Vol. 30 (Supplement), Proceeding of the National Conference of Mineral Science and Engineering 2010, Fujian, China, pp. 26–28.

Liu, S.I., Peng, M.S. and Chan, W.C. (2011) Gemmological and mineralogical studies of omphacite [in Chinese]. *Proceedings of the Annual Conference of the Chinese Society for Mineralogy, Petrology and Geochemistry*, Guangzhou, pp. 28–29.

Liu, Y., Guo, L., Ding, T., Han, W., Huang, J., Zhu, F. and Lu, T. (2020) The gemmological characterisation of a "single crystal jadeite" [in Chinese with English abstract]. *Journal of the Gemmological Association of Hong Kong*, Vol. 41, pp. 77–83.

Luo, M.R., ed. (2016) *Encyclopedia of Color Science and Technology*. New York: Springer, 2 Vols., 1284 pp.

Manson, D.V. (1979) Recent activities in GIA's research department; clarification of composition of Maw-sit-sit. *Gems & Gemology*, Vol. 16, No. 7, Fall, pp. 217–218.

Matsumoto, T., Tokonami, M. and Morimoto, N. (1975) The crystal structure of omphacite. *American Mineralogist*, Vol. 60, No. 7–8, pp. 634–641.

McClure, S.F. (2012) *The Jadeite/Omphacite Nomenclature Question*. GIA News from Research, Gemological Institute of America, Carlsbad, CA, 10 April, 2 pp.

Milburn, O. (2020) Featherwork in early and medieval China. *Journal of the American Oriental Society*, Vol. 140, No. 3, pp. 549–564.

Mills, S.J., Hatert, F., Nickel, E.H. and Ferraris, G. (2009) The standardisation of mineral group hierarchies: Application to recent nomenclature proposals. *European Journal of Mineralogy*, Vol. 21, October, pp. 1073–1080.

Mindat.org (2023) *Clinopyroxene subgroup*. https://www.mindat.org/min-7630.html, accessed 5 December 2023.

Mitchell, R.S. (1979) *Mineral Names: What Do They Mean?* New York: Van Nostrand Reinhold, see pp. 107, 176, 177.

Monardes, N. (1565) *Dos libros. El vno trata de todas las cosas que traen de nuestras Indias Occidentales, que siruen al vso de medicina, etc.* [Two books. The first deals with all the things that they bring from our West Indies, that serve as medicine, etc.] [in Spanish]. Seville: Casa de Alonso Escriuano Impressor, 276 pp. (see pp. 40–43).

Monardes, N. (1571) *Segunda parte del libro de las cosas que se traen de nuestras Indias Occidentales, que siruen al vso de medicina: do se trata del tabaco, y de la sassafras, y del Carlo Sancto, y de otras muchas yeruas y plantas, simientes, y licores, q[ue] agora nueuamente han venido de a quellas partes, de grandes virtudes, y marauillosos effectos* [Second part of the book of the things brought from our West Indies, which are used for medicine: which deals with tobacco, and sassafras, and Carlo Sancto, and many other herbs and plants, seeds, and liquors, which have now come again from those parts, with great virtues, and marvelous effects] [in Spanish]. Alonso Escriuano, impressor, 96 pp. (see p. 67).

Monardes, N. (1574) *De simplicibus medicamentis ex Occidentali India delatis, quorum in medicina usus est* [Of the Simple Drugs Brought from the West Indies, of which are used in Medicine] [in Latin]. Antuerpiae: Ex officina Christophori Plantini, Architypographi, 245 pp.

Monardes, N. (1574) *Historia medicinal de las cosas que se traen de nuestras Indias Occidentales* [Medicinal History of the Things Brought from Our West Indies] [in Spanish]. Seville: Alonso Eferiuano, earlier editions in 1565 and 1569; trans. into English by John Frampton in 1577 as *Joyfull News out of the Newe Founde Worlde*, 206 pp.

Morimoto, N., Fabries, J., Ferguson, A.K., Ginzburg, I.V., Ross, M., Seifert, F.A., Zussman, J., Aoki, K. and Gottardi, G. (1988) Nomenclature of pyroxenes. *American Mineralogist*, Vol. 73, No. 9/10, September–October, pp. 1123–1133.

Mottana, A. (2012) Mineral novelties from America during Renaissance: The "stones" in Hernández' and Sahagún's treatises (1576–1577). *Rendiconti Lincei. Scienze fisiche e naturali*, Vol. 23, pp. 165–186.

Mu, K. and Guo, D. (2012) 魏晋南北朝文论全编 [Complete Compilation of Literary Theory of the Wei, Jin, Southern and Northern Dynasties] [in Chinese]. Shanghai: Shanghai Far East Publishers, 528 pp. (see p. 487).

Murray, J.A.H. (1900) The etymology of jade (the mineral). *Athenæum*, Vol. 2, October 20, p. 513.

Nanjing Museum (2023) 玉潤中華 中國玉器的萬年史詩圖卷 [An Epic of Chinese Jade for 10,000 Years] [in Chinese with small English sections]. Jiangsu: Jiangsu Phoenix Literature and Art Publishing, 488 pp.

Neuhaus, A. (1968) Über Kosmochlor (Ureyit) [On Kosmochlor (Ureyite)] [in German]. Mineralogical Society, London, *Papers and Proceedings of the Fifth General Meeting of the International Mineralogical Association*, Cambridge, UK, August 30–September 3, 1966.

Nickel, E.H. and Mandarino, J.A. (1987) Procedures involving the IMA commission on new minerals and mineral names, and guidelines on mineral nomenclature. *American Mineralogist*, Vol. 72, pp. 1031–1042.

Nida, E. (2000) Principles of correspondence In *The Translation Studies Reader*, Edited by Venuti, L., London: Routledge, pp. 126–140.

Nuttall, Z. (1901) Chalchihuitl in ancient Mexico. *American Anthropologist*, Vol. 3, No. 2, pp. 227–238.

Ouyang, C.M. (1984) A terrestrial source of ureyite. *American Mineralogist*, Vol. 69, pp. 1180–1183.

Ouyang C.M. (2000) 翡翠全集 [*Jadeite Jade*] [in Chinese]. Hong Kong: Cosmos Books Ltd., 2 vols., 511 pp.

Ouyang, C.M. (2016) Gemmological characteristics & significance of "Ink & Wash" and "Black Rooster" fei cui. *Journal of the Gemmological Association of Hong Kong*, Vol. 37, pp. 78–81.

Ouyang, C.M. and Li, H. (1999) Review of recent studies on black jadeite jade. *Journal of Gemmology*, Vol. 26, No. 7, July, pp. 417–424.

Ouyang, C.M. and Ng, F.Y. (2012) Nomenclature and classification of fei cui (pyroxene jade). *Proceedings of the 3rd International Gem and Jewelry Conference (GIT 2012)*, Gem and Jewelry Institute of Thailand, Bangkok, 12–16 December, pp. 240–243.

Ouyang, C.M. and Qu, Y.H. (1999) Characteristics of western Sayan jadeite jade deposit in Russia [in Chinese]. *Journal of Gems & Gemmology*, Vol. 1, pp. 5–11.

Ouyang, C.M., Yen, H.K., Ng, F.Y. and Chan, S.Y. (2011) Nomenclature and classification of fei cui (pyroxene jade). *Proceedings of International Symposium on Jade*, Beijing: Peking University, pp. 23–34.

Pendergast, D.M. (1999) Dressed to kill: Jade beads and pendants in the Maya lowlands. *BEADS: Journal of the Society of Bead Researchers*, Vol. 10–11, pp. 3–15.

Price, M. and Walsh, K. (2005) *Rocks and Minerals*. London: Dorling Kindersley, 224 pp.

Pumpelly, R. (1866) Geological researches in China, Mongolia, and Japan, during the years 1862 to 1865. *Smithsonian Contributions to Knowledge*, Vol. 15, No. 202, January, 128 pp. (see pp. 117–118 for 'feitsui' and 'jade').

Rammelsberg, C.F. (1869) Beiträge zur Kenntniss der Constitution mehrerer Silikate [Contributions to the knowledge of the constitution of several silicates] [in German]. *Zeitschrift der Deutschen Geologischen Gesellschaft*, Vol. 21, pp. 84–99.

Roth, P. (2006) The early history of tremolite. *Axis*, Vol. 2, No. 3, pp. 1–10.

Sahagún, F.B. (1950–1982) *Florentine Codex: General History of the Things of New Spain*. Trans. by Anderson, A.J.O. and Dibble, C.E., Santa Fe, NM: School of American Research, 12 Vols., see Vol. 11, 1963, *Earthly Things*, pp. 221–231.

Saussure, H.B., de (1779–96) *Voyages dans les Alpes* [Travels in the Alps] [in French]. Neuchâtel: Samuel Fauche, 4 Vols., 540, 641, 531, 594 pp.

Saussure, T., de (1806) Analyse du jade [Analysis of jade] [in French]. *Journal des Mines*, Vol. 19, No. 111, March, pp. 205–218.

Schaffhäutl, C. (1843) Chemisch-mineralogische Untersuchungen [Chemical-Mineralogical Investigations] [in German]. *Annalen der Chemie*, Vol. 46, No. 3, pp. 325–347.

Schuh, C.P. (2007) *Mineralogy & Crystallography: On the history of these sciences from the beginnings through 1919*. Unpublished manuscript: 406 pp.

Shi, G., Harlow, G.E., Wang, J., Wang, J., Ng, E., Wang, X., Cao, S.M. and Cui, W. (2012) Mineralogy of jadeitite and related rocks from Myanmar: A review with new data. *European Journal of Mineralogy*, Vol. 24, No. 2, pp. 345–370.

Shi, G., Wang, X., Chu, B. and Cui, W. (2009) Jadeite jade from Myanmar: Its texture and gemmological implications. *Journal of Gemmology*, Vol. 31, No. 5–8, pp. 185–195.

Shi, G., Zhang, X., Xu, L. and Li, X. (2019) "软玉 "一 词由来、争议及去"软"建议 [Origin and controversy of the term "软玉 (Ruan Yù soft jade)" and a proposal to remove the word "软 (Ruan soft)" from "Ruan Yù"] [in Chinese with English abstract]. *Earth Science Frontiers*, Vol. 26, No. 3, pp. 163–170.

Shipley, Robert M. (1948) *Dictionary of Gems and Gemology*. Los Angeles: Gemological Institute of America, 4th ed., 260 pp.

Sun, L. (2011) From baoshi to feicui: Qing-Burmese gem trade, C. 1644–1800 In *Chinese Circulations: Capital, Commodities, and Networks in Southeast Asia*, Edited by Tagliacozzo, E. and Chang, W.-C., Duke University Press, pp. 203–221.

Sundius, N. (1946) The classification of the hornblendes and the solid solution relations in the amphibole group. *Sveriges Geologiska Undersökning*. Vol. 40, No. 4, pp. 36.

Takashi, T. (2012) MIS3 edge-ground axes and the arrival of the first Homo sapiens in the Japanese archipelago. *Quarternary International*, Vol. 248, 18 January, pp. 70–78.

Tsujimori, T. and Harlow, G.E. (2017) Jadeitite (jadeite jade) from Japan: History, characteristics, and perspectives. *Journal of Mineralogical and Petrological Sciences*, Vol. 112, pp. 184–196.

Wang, L. (2020) 陈子昂集 [Poem Collection of Chen Zi'ang] [in Chinese]. Nanjing: Phoenix Publishing House, 154 pp. (see p. 38).

Washington, H.S. (1922) The jades of Middle America. *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 8, No. 11, pp. 319–326.

Werner, A.G. (1774) *Von den äusserlichen Kennzeichen der Fossilien* [On the External Characters of Fossils, or of Minerals] [in German]. Trans. by Carozzi, A.V., Leipzig: Crusius, 302 pp. (nephrite p. 206, 242).

Winchester, S. (2008) *The Man Who Loved China*. New York: HarperCollins, 317 pp.

Xu, H. (1985) 徐霞客游记校注 下 [Xu Xiake's Travel Notes] [in Chinese]. Kunming: Yunnan People's Publishing House, 1323 pp. (see pp. 970–1020).

Xu, W. (1994) *A Study of Chinese Colour Terminology*. Australian National University: PhD thesis, 256 pp.

Xue, H.-y., Chen, T. and Li, Z.-g. (2020) 危地马拉与缅甸含绿辉石翡翠的矿物学对比研究 [Mineralogical comparison between omphacite-bearing jadeite from Guatemala and that from Myanmar] [in Chinese with English abstract]. *Acta Petrologica et Mineralogica*, Vol. 39, No. 4, July, pp. 481–494.

Yan, R., Qiu, Z., Dong, C. and Li, L. (2009) 世界几个主要翡翠产地墨翠标型特征初探 [A preliminary study of typomorphic characteristics of different kinds of black jadeite jades in the world] [in Chinese with English abstract]. *Acta Petrologica et Mineralogica*, Vol. 28, No. 3, pp. 292–298.

Yi, F. (2001) 中国历史年代简表. [Chinese Historical Chronology Table]. [in Chinese], Beijing: 文物出版社 [Cultural Relics Publishing House], 267 pp.; RWHL.

Yule, H. and Cordier, H. (1920) *The Book of Ser Marco Polo*. London: Murray, 3 Vols., 3rd edition, 1929, 462, 662, 161 pp.

Zhang, B.L. (2017) 珠宝玉石名称 [Gem Nomenclature] [in Chinese]. Standardization Administration of China, Beijing: 18 pp. (see p. 1).

Zhang, L. and Yuan, X. (2017) Discussion on accurate Chinese translations of "nephrite" and "jadeite". *International Journal of Information and Education Technology*, Vol. 7, No. 9, September, pp. 707–711.

Zheng, C.-S. and Zheng, K.-W. (1998) 缅甸翡翠发现新类型—含绿辉石翡翠及其鉴定特征 [The discovery of a new type of Burmese fei cui: Omphacite jade and its identification characteristics] [in Chinese]. *Chinese Gems & Jades*, Vol. 1, pp. 5–7.

Zheng, J. (1994) 全汉赋 [Collected Rhymes/Prose of the Han Dynasty] [in Chinese]. Zhijiang Publishing House: Taipei, 353 pp. (see p. 98).

Figure 6.2. *Shake Me, Skyscraper.* The magical world of Master Yang Xi, rendered in Hetian *yù* (Chinese nephrite). Photo: Yang Xi; sizes (left to right): 2.8, 8.5 and 28.5 cm high.

INDEX

BROKEN BANGLE

INDEX

Index notes: Chinese names feature the surname (family name) first, followed by the given name. Minerals are listed by the mineral group name.

Ripples. Burmese *fei cui* pendant by Master Zhuang Qingfang.
Photo: Zhuangjia Fei Cui; size: 53.7 × 53.6 × 10.9 mm.

N

O

P

Q

R

S

Mr. Natural, China style.
Sculpted in Hetian *yù* (nephrite) by Master Wang Feng. *Amazing Man Series: Picasso*.
Photo: Liu Renchao; size: 5.5 × 4 × 1.5 cm.