Ancient jades map 3,000 years of prehistoric exchange in Southeast Asia

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We have used electron probe microanalysis to examine Southeast Asian nephrite (jade) artifacts, many archeologically excavated, dating from 3000 B.C. through the first millennium A.D. The research has revealed the existence of one of the most extensive sea-based trade networks of a single geological material in the prehistoric world. Green nephrite from a source in eastern Taiwan was used to make two very specific forms of ear pendant that were distributed, between 500 B.C. and 500 A.D., through the Philippines, East Malaysia, southern Vietnam, and peninsular Thailand, forming a 3,000-km-diameter halo around the southern and eastern coastlines of the South China Sea. Other Taiwan nephrite artifacts, especially beads and bracelets, were distributed earlier during Neolithic times throughout Taiwan and from Taiwan into the Philippines.

Austronesian languages | electron probe microanalysis | nephrite trade | Southeast Asian archaeology | Taiwan

Artifacts of nephrite (jade)[k] have been reported in great variety and large numbers from many Neolithic and Bronze–Iron Age archaeological sites in China, Taiwan, and northern Southeast Asia (especially Vietnam and the Philippines). Many appear to be relatively local in origin, in terms of both raw material and style. But within the broad range of material represented, archaeologists have long been aware that two very specific and fairly standardized forms of nephrite ear ornament occur across a very large region, extending from Taiwan through the Philippines, East Malaysia, central and southern Vietnam, and as far southwest as eastern Cambodia and peninsular Thailand [see supporting information (SI) Table 1]. These two forms are the so-called lingling-o[l] penannular earring with three pointed circumferential projections (Fig. 1 *A–C*) and the double animal-headed ear pendant (Fig. 1*D*) (1–3).

The three-pointed lingling-o is the most widespread form of jade ornament in Southeast Asia, with examples being reported from southeastern Taiwan, the Philippines, Sarawak, central and southern Vietnam, central and southern Thailand, and eastern Cambodia, as listed in Fig. 2 and located in Fig. 3. All of these exquisite ear ornaments share very close similarities in style, manufacturing technology and size, being ≈30–35 mm in diameter. The distribution of the double animal-headed ear pendants is similar: Lanyu Island (off southeastern Taiwan), Philippines, central and southern Vietnam, and central Thailand. Radiocarbon dates suggest an age range from 500 B.C. to 500 A.D. for both of these remarkable artifact types in Southeast Asia (SI Table 2), thus placing them within a period of late prehistoric indigenous social complexity and interregional interaction, contemporary with later Zhou to Han Dynasty China and with early trade from India but before the intensive Indian religious, philosophical, and architectural influence that became established during the later first millennium A.D. (4–6).

Archaeologists have long noted the widespread occurrences of these and other jade ornaments in Southeast Asia. In the 1940s, Japanese archaeologist Kano Tadao (7) recognized four types of jade earrings with circumferential projections that he believed originated in northern Vietnam, spreading from there to the Philippines and Taiwan. Beyer (8), Fox (3), and Francis (9) also suggested that the jade artifacts found in the Philippines were of mainland Asian origin, possibly from Vietnam. In Taiwan, it was generally believed that all prehistoric jade artifacts were exotic, until the 1997 Raman spectroscopy sourcing study by Tan and his colleagues (10). This confirmed that the jades from Beinan, the largest excavated collection from Neolithic Taiwan, were of raw material from the Fengtian source in eastern Taiwan. Visual examination had already suggested this, because Fengtian nephrite is often a distinctive translucent green and has black spots in its texture.

Results

This article focuses on the three-pointed lingling-o and animal-headed pendants (see *SI Text*). To determine the geological sources of the materials used to make these artifacts, we have undertaken a series of mineral analyses using an electron probe microanalyzer (EPMA) at the Institute of Earth Sciences, Academia Sinica, Taipei. This technique, applied with wave-length dispersive spectrometers (WDS-EPMA), has been used to construct a mineralogical database for several nephrite deposits, including Fengtian in Taiwan and other green nephrites from East Asia and the Pacific (China, Siberia, Japan, Australia, New Caledonia, New Zealand, and British Columbia), as well as white nephrites from China, Luzon (Philippines), Russia, and Korea. Criteria have been proposed to identify Fengtian nephrite based on the mineral chemistry of both the nephrite matrix and the zinc (Zn)-chromite inclusion

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[k]Jade is a term used in the broad sense of a hard and shiny stone, applied to two monomineralic rocks termed jadeitite and nephrite in gemology and geology. Both jadeitite and nephrite occur in metamorphic rocks, but their chemical compositions are different. Jadeitite is composed of jadeite (sodium clinopyroxene), whereas nephrite is composed of tremolite and/or actinolite (calcium amphibole). All studied Neolithic and Iron Age jade artifacts from Taiwan, the Philippines, and Vietnam are of nephrite.

[l]A double animal-headed pendant was found in place on the skull of a burial at Giong Ca Vo in southern Vietnam. ref. 2, Fig. 29.1. In the 1940s, American archaeologist H. Otley Beyer noted that some of the jade ear pendants he encountered in the Batangas area were similar in shape to the metal pendants worn ethnographically by the Ifugao, Bontoc, and Kalinga peoples in the Northern Luzon Cordillera region, who termed them lingling-o. The term is now used widely to refer to a general class of earrings with projections, but in this article, with Fox (3), we refer only to the specific three-pointed form in jade.

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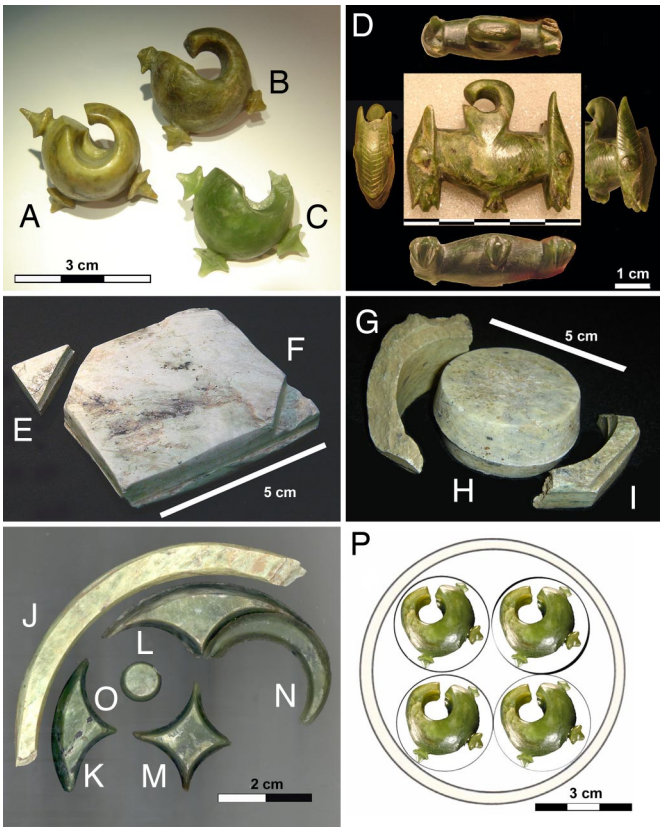

Fig. 1. Green nephrite jade ornaments and manufacturing debitage. (*A–C*) Nephrite lingling-o penannular earrings with three pointed circumferential projections. (*A*) Go Ma Voi, Vietnam (Institute of Archaeology, Hanoi). (*B*) Uyaw Cave, the Tabon Complex, Palawan, Philippines (National Museum of the Philippines, Manila). (*C*) Duyong Cave, the Tabon Complex, Palawan, Philippines (National Museum of the Philippines, Manila). (*D*) Double-headed animal nephrite ear pendant from the Philippines (collection of Ramon Villegas, Manila). (*E–O*) A suggested manufacturing sequence for lingling-o ear pendants, as reconstructed from discarded raw material recovered at Pinglin, eastern Taiwan, and Anaro, Itbayat Island, northern Philippines (these pieces do not come from a single manufacturing event). Stage 1: *E* is a triangular discard from a cut square preform ≈1 cm thick (*F*), the intention being to shape an octagonal blank (see *I*); from Pinglin, eastern Taiwan. Stage 2: *G* and *I* represent the first bracelet to be drilled from an octagonal blank, in this case, ≈2 cm thick, leaving a round core (*H*). Presumably, the original bracelet outer diameter exceeded the diameter of available bamboo drills, hence this method of manufacture, allowing the projecting corners to be ground off to give the bracelet a round exterior; from Pinglin. Stage 3: *J* represents a second (or perhaps third) bracelet drilled from a large core; from Pinglin. Successive bracelet and flat ear ring removals could have continued from this point, until the remaining core became too small to use. Stage 4: Items *K–O* all come from Anaro, Itbayat, northern Philippines. We infer that some large discs produced by large bracelet manufacture were brought to Anaro from Taiwan, each to become the blank for four lingling-os, drilled in quadripartite fashion (*P*). *O* is a drilled core from the center of a lingling-o; *K–M* are discards from around and between the smaller drilled circles. *N* is part of a much thinner ring drilled out to help delineate the projections, which were probably drilled finally at 90° to the axis of the core and finished by manual shaping (see *A–C*).

minerals (11). For the artifacts, many of them precious museum antiquities, a low-vacuum scanning electron microscope (LVSEM) equipped with an energy dispersive x-ray spectrometer (EDS) offers a completely noninvasive analytical technique (12, 13). So far, mineral analyses have been carried out on 144 jade artifacts from 22 archaeological sites in Taiwan (Taiwan proper, Penghu, Ludao, and Lanyu) and 27 sites in Southeast Asia (Philippines, Sarawak, central Vietnam, and southern Thailand). One hundred sixteen specimens from 38 sites have already been confirmed as being of Taiwan jade (SI Tables 3–7).

As shown in Fig. 4 *A–E*, the compositions of these 116 jade artifacts can be identified as tremolite and/or actinolite in the Ca-amphiboles, with Mg/(Mg+Fe) ratios <0.93. Based on their chemistry and fibrous textures, all of these artifacts and associated jade manufacturing waste materials are of nephrite. The chemical compositions of their matrices are within the ranges of Fengtian nephrite. Chromites (Cr-rich spinels), black in color, can also be detected as inclusion minerals on the surfaces of most specimens, and these chromites contain zinc in amounts equivalent to Fengtian nephrite (Fig. 4*F*). The results indicate that all were made of nephrite raw material from eastern Taiwan.

Further EPMA sourcing studies have been undertaken on a range of other, variously colored nephrite artifacts excavated from the Philippines and Vietnam. These results indicate that both countries have thus-far unlocated nephrite sources, used for the manufacture of artifacts since the Neolithic (14) (Fig. 4 *C* and *E* and SI Table 7). However, the mineral chemistry of these artifacts is clearly different from that of Fengtian nephrite. Although it is impossible for us to determine the range of chemical variation for every nephrite source in the Asia–Pacific region, given that the locations of many are completely unknown, we feel justified in claiming a very high level of confidence from the matrix and inclusion analyses reported here that the Fengtian nephrite has been reliably characterized.

Discussion

The Fengtian jade artifacts that we have analyzed belong to two phases in Southeast Asian archaeology; the Neolithic in Taiwan (≈3000–500 B.C.) and the Philippines (≈2000–500 B.C.) and the Early Iron Age in a much vaster region across the South China Sea between 500 B.C. and 500 A.D. In Taiwan itself, tools and ornaments made of Fengtian nephrite have been found in >108 sites dating from the early Neolithic to the Iron Age (≈3000 B.C. to 500 A.D.) (15).

Although not the main focus of this article, nephrite adzes, bracelets, bell-shaped beads, and tubular beads are widespread in both Taiwan and the Philippines. Many of these come from Neolithic contexts within Taiwan. Those from Philippine contexts are similar to specimens in Taiwan, and all analyses so far have traced their nephrite to Fengtian. For instance, a Fengtian nephrite bracelet from Nagsabaran, northern Luzon, dated between 1800 and 1500 B.C., falls in width and diameter within the ranges for 24 jade bracelets dated 2300–1600 B.C. from Youxianfang in southwestern Taiwan (16). Possibly, some of the Neolithic green jade items found in the Philippines were transported as finished goods from Taiwan during this earlier phase.

After Neolithic migrants settled Luzon from Taiwan ≈4,000 years ago (4, 17–21), the export of Fengtian nephrite from Taiwan into the Philippines continued for >2,500 years, until well into the Iron Age. This has recently been determined from three separate archaeological assemblages (Sunget, Anaro, and Savidug—see Fig. 3) in the Batanes Islands, between Taiwan and Luzon, each with Fengtian nephrite present at many dates between 1000 B.C. and 500 A.D. (22). However, the circumstances of manufacture and the scale of the trade both changed dramatically during the Iron Age (≈500 B.C. to 500 A.D.).

During this time, the ear pendants described above appeared in an extensive region of Southeast Asia, although only one has so far been found in Taiwan itself—a three-pointed lingling-o from Jiuxianglan in southeastern Taiwan. This situation suggests an export of "blanks" to further regions where artisans manufactured artifacts tailored to local taste. This scenario is supported by a presence of slate cutting tools and pieces of worked Fengtian nephrite, including drilled-out cores, annular rings, rectangular cut pieces and recycled artifacts, in several Iron Age habitation sites in Southeast Asia. These cut nephrite fragments often indicate that lingling-o or animal-headed ear pendants were being made locally by using Fengtian nephrite blanks.

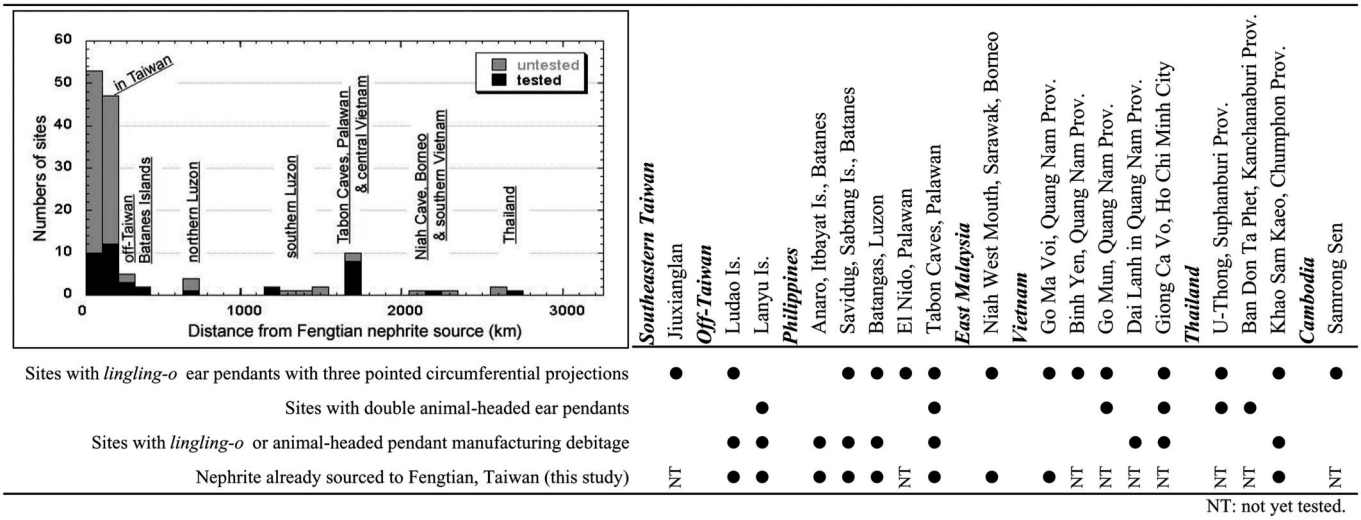

Fig. 2. Sites with nephrite artifacts in Southeast Asia.

Where were the blanks initially manufactured? The Pinglin workshop in eastern Taiwan, located close to the Fengtian nephrite deposit, was regarded by Kano as the largest ancient jade workshop in Southeast Asia (23). It has very large surface quantities of grooved and drilled jade discards, including drilled-out cores and incomplete or deficient ornaments and tools (Fig. 1 *E–I*). Recent excavation indicates that Pinglin was used initially during the Middle Neolithic (≈1500 B.C. or earlier) and later during the Late

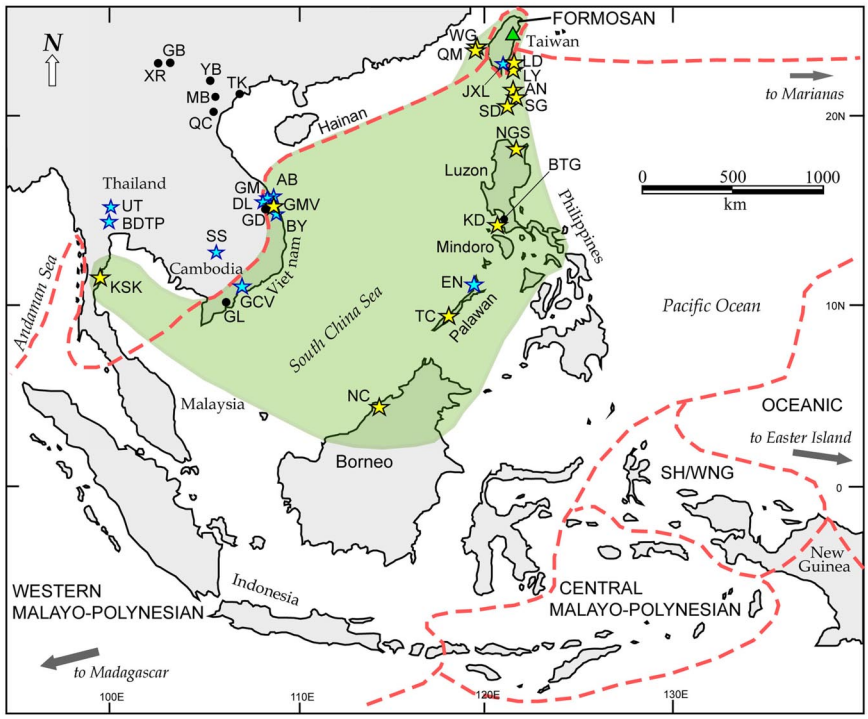

Fig. 3. The distribution of Taiwan nephrite artifacts in Southeast Asia. The green zone represents the currently known distribution of Taiwan nephrite artifacts. The green triangle locates the Fengtian nephrite deposit. Yellow stars represent sites outside Taiwan with positively identified Fengtian nephrite artifacts (Taiwan itself has >108 jade-bearing sites, and these cannot be shown individually). Blue stars represent sites with jade artifacts of possible Fengtian origin, based on visual examination but not yet demonstrated in terms of mineral chemistry. Black circles represent sites that have identified nephrite of non-Fengtian origin. Identified Fengtian and possibly Fengtian nephrites: WG. Liyushan, Wangan Islands; QM, Nangang, Qimei Islands, Penghu Archipelago; JXL, Jialulan, eastern Taiwan; LD, Yugang and Guanyindong, Ludao Islands; LY, Lanyu High School Site, Lanyu Islands; AN, Anaro, Itbayat Islands; SG, Sunget, Batan Islands; SD, Savidug, Sabtang Islands; NGS, Nagsabaran, Cagayan Valley; KD, Kay Daing, Batangas; EN, Leta-Leta and Ille Caves, El Nido, Palawan; TC, Tabon Caves, Palawan; NC, Niah Cave West Mouth, Sarawak; AB, An Bang; GM, Go Mun; DL, Dai Lanh; GMV, Go Ma Voi; BY, Binh Yen (these five sites in Quang Nam Province, central Vietnam); GCV, Giong Ca Vo, Ho Chi Minh City; SS, Samrong Sen, Cambodia; UT, U-Thong, Suphanburi; BTDP, Ban Don Ta Phet, Kanchanaburi; KSK, Khao Sam Kaeo, Chumphon. Identified non-Fengtian nephrites: BTG, Uilang Bundok and Pila, Batangas; TK, Trang Kenh; YB, Yen Bac; MB, Man Bac; QC, Quy Chu; GB, Go Bong; XR, Xom Ren; GD, Go Dua; GL, Giong Lon. The red dashed lines enclose the major Austronesian language subgroups according to Blust (17) (SH/WNG, South Halmahera/West New Guinea).

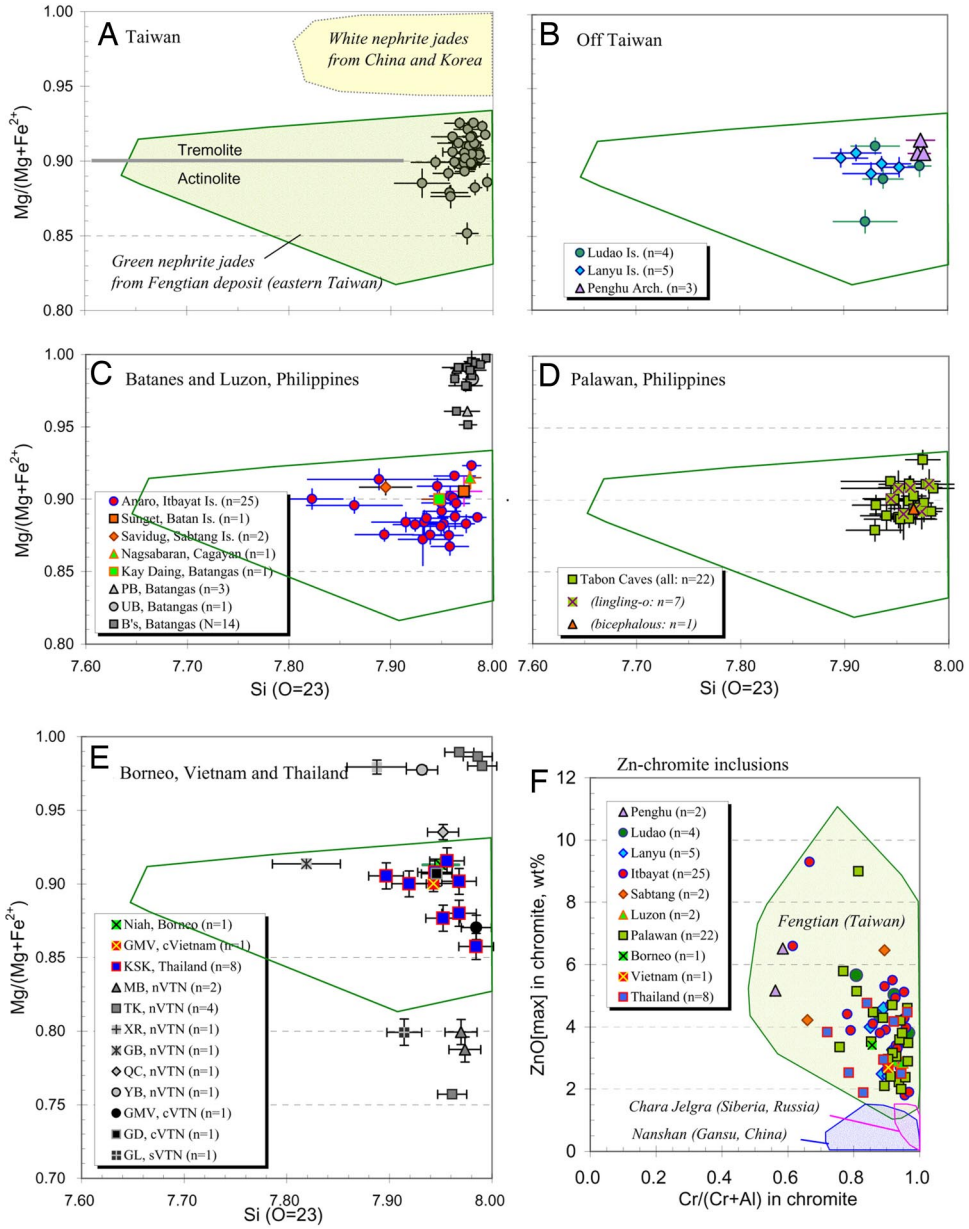

Fig. 4. Chemical compositions of nephrite jade artifacts. (*A–E*) Chemical compositions of the nephrite jade matrices of studied artifacts from Taiwan (*A* and *B*), the Philippines (*C* and *D*), and Borneo, Vietnam, and Thailand (*E*). The *x* and *y* axes represent, respectively, Si (atoms per formula unit on the basis of 23 oxygen) and Mg/[Mg+Fe^{2+}] ratios, with the ideal chemical formula of calcium amphibole ($Ca_2[Mg,Fe]_5[Si,Al]_8O_{22}[OH]_2$). Relative standard deviations (1σ) of measurements are shown as error bars. (*A*) Symbols represent the WDS-EPMA results for 42 artifacts from 17 Taiwan sites. The upper shaded area encloses the chemical compositions of white-colored nephrite jade deposits from China (Liaoning, Xinjiang, Gansu, and Jiangsu Provinces) and Korea (Chuncheon) (11–13). The lower shaded area represents the chemical compositions of green nephrite jade raw materials from the Fengtian deposit (eight hand specimens) and a nearby riverbed (nine hand specimens) in eastern Taiwan (11). The chemical boundary between tremolite and actinolite is marked by the Mg/(Mg+Fe) ratio of 0.90 (SI Table 3). (*B–E*) Analytical results obtained by the noninvasive LVSEM-EDS technique. The enclosed areas delimit the range of chemical compositions for Fengtian green nephrite jades. (B) Yugang and Guanyindong on Ludao Island, Lanyu High School on Lanyu Island, and Liyushan (Wangan Island) and Nangang (Qimei Island), Penghu Archipelago (12 artifacts from five sites, SI Table 4). (*C*) Anaro on Itbayat Island, Sunget on Batan Island, Savidug on Sabtang Island, Nagsabaran in the Cagayan Valley, and Kay Daing in Batangas, northern Philippines (30 artifacts from five sites) (SI Tables 4 and 5). The white nephrite (tremolite) artifacts from Uilang Bundok (UB: 1 adze) and Pila (PB: 3 adzes) in Batangas, and 12 adzes and two preforms from H. Otley Beyer's 1940s Batangas collection in the National Museum of the Philippines, are shown as gray symbols. In terms of their mineral chemistry and archaeological contexts, the white nephrites in the Philippines are probably of local origin (14) (SI Table 7). (*D*) Tabon Caves, Palawan (22 ornaments from nine sites: see SI Table 6). Seven lingling-o penannular earrings with three pointed circumferential projections and a single bicephalous (double-headed) animal ear pendant are plotted. (*E*) Artifacts from Niah Cave (Sarawak), Go Ma Voi (GMV) (central Vietnam), and Khao Sam Kaeo (KSK) in peninsular Thailand are represented here, including the lingling-o penannular earrings with three pointed circumferential projections from Niah and GMV (10 ornaments and worked pieces from three sites: see SI Table 4). White to green nephrite artifacts from northern Vietnam (MB, Man Bac; TK, Trang Kenh; XR, Xom Ren; GB, Go Bong; QC, Quy Chu; YB, Yen Bac), from central Vietnam (GMV; GD, Go Dua), and from southern Vietnam (GL, Giong Lon), shown by gray and black symbols, are not of Fengtian nephrite in terms of their mineral chemistry (see SI Table 7). (*F*) Chemical compositions of zinc-bearing chromite ($[Mg,Fe,Zn][Al,Cr]_2O_4$) inclusions in the surfaces of nephrite artifacts, analyzed by the noninvasive LVSEM-EDS technique. Symbols represent the value for zinc oxide (ZnO in wt %) and the Cr/(Cr+Al) ratio for each artifact. Because the chromite in Fengtian nephrite jade bears significant amounts of zinc (2 to 11 wt % in ZnO) (11) in comparison with the other possible nephrite (actinolite/tremolite) jade sources tested (Chara Jelgra, Siberia and Nanshan, Gansu), the Zn content provides a good clue for the identification of Fengtian nephrite.

Neolithic (≈800 B.C. to 150 A.D.) (24). The Pinglin workshop might have been a major producer of the jade blanks found in Taiwan and the Philippines, but no complete three-pointed lingling-o or animal-headed pendants have ever been found there.

The sites that contain manufacturing fragments that appear to be from three-pointed lingling-o ear pendants, or closely related forms, are Youzihu on Ludao Island and the Lanyu High School site on Lanyu Island, both off southeastern Taiwan, Anaro on Itbayat Island and Savidug on Sabtang Island (Batanes), and sites in Batangas Province in southern Luzon. In Vietnam, unfinished animal-headed ear pendants are reported from Dai Lanh in Quang Nam Province, and nephrite blocks possibly intended for making similar pendants are reported from Giong Ca Vo, southeast of Ho Chi Minh City. From Khao Sam Kaeo in peninsular Thailand, there is at least one recycled Taiwan Neolithic adze that was being worked into an animal-headed pendant when discarded (SI Table 1). These distributions are consistent with a multilocal manufacture of these ear pendants, despite the raw material origin from Fengtian.

Recently, cut Fengtian nephrite fragments, some interpreted as discards from the manufacture of lingling-o earrings, have been excavated in layers dated between 500 B.C. and 50 B.C. in the defensive hilltop habitation site of Anaro on Itbayat Island in the northern Philippines (22, 25). Anaro is the most important workshop found so far in the Philippines because it illustrates the full reduction sequence for making these artifacts (Fig. 1 *J–N*). Slate knives, both rectangular and pointed, the latter reworked from Taiwan slate projectile points, were found here with the nephrite fragments. Slate is common in the central mountain range of Taiwan but absent in volcanic and raised coral landscapes such as the Batanes and Babuyan Islands and Luzon. This indicates that these slate tools were also imported from Taiwan, where such knives and points are very common. At Anaro, they were used for grooving the nephrite before snapping, as in the Pinglin workshop in Taiwan.

Experimental archaeology indicates that jade manufacture required not only high levels of skill, but also considerable labor input. For example, 8 hours of sawing using a stone knife and sand will cut a groove only 11-mm deep, and 1 hour of drilling using a hollow bamboo with sand and water will cut only 10 mm below the surface (26). So far, no iron tools that can be associated with nephrite working have been identified in Southeast Asia.

We suggest that the ear pendants of Fengtian nephrite in Southeast Asia (outside Taiwan) were made by a small number of highly skilled and perhaps itinerant jade craftsmen using stone cutting tools and perhaps bamboo drills. During the Iron Age, such jade craftsmen, with or without the help of transporting middlemen, carried or acquired their raw materials from Taiwan, then traveled and/or resided along the shorelines of the South China Sea to produce extremely uniform jade ear ornaments to suit the demands of local elites. The most extensive evidence for such trade postdates 500 B.C., by which time the use of jade in Taiwan itself was already in decline (15).

In general, the quantity of Fengtian nephrite decreases with distance from the source, with sites on the eastern coast of Taiwan having the highest quantities (Fig. 2). However, the combined distributions of the two kinds of ear pendant discussed here do not follow this trend and, instead, correspond closely with the distributions of many important but very far-flung Austronesian-speaking populations in early history (e.g., Formosans, Filipinos, Chams of southern Vietnam, and Borneo Dayaks). For instance, although northern Vietnam is closer to Taiwan than southern Vietnam, positively identified artifacts of Taiwan nephrite have never been found there. All come from Sa Huynh sites (500 B.C. to 100 A.D.) in coastal central and southern Vietnam, mostly in association with jar burials, bronze bracelets, bells and small vessels, iron tools, and glass and carnelian beads, all paralleled quite closely in early Metal phase jar burial assemblages in the Philippines and northern Borneo (4). The Sa Huynh culture is regarded as ancestral to the Chamic-speaking (Austronesian) ethnic groups of central and southern Vietnam in historical times, whereas the Dong Son of northern Vietnam is geographically associated with Tai and Mon-Khmer (Austroasiatic, including Vietnamese) speaking groups (27).

It is thus interesting to note that the site of Khao Sam Kaeo in peninsular Thailand, which does have Fengtian nephrite, is located in a Thai-speaking area today. However, in addition to Taiwan nephrite, it has also yielded pieces of worked mica similar in chemistry to mica from Mindoro Island in the Philippines. Pottery found quite close to Khao Sam Kaeo in Ko Din Cave on Samui Island in the Gulf of Siam is identical in form to Iron Age pottery excavated from Kalanay Cave in the central Philippines (28).

This sourcing study of ancient Fengtian jade has revealed a remarkable pattern of pre-Indic communication across a vast area of mainland and island Southeast Asia. However, we freely admit that this sourcing study of ancient jade in Southeast Asia has only just begun; both Vietnam and the Philippines, in particular, have other nephrite sources of unknown location that were exploited in prehistory, and it is possible that some of these materials were also traded over long distances. Indeed, one nephrite lingling-o with three projections from the Sa Huynh culture site of Go Dua in central Vietnam (Fig. 3; SI Table 7) is of non-Fengtian origin, based on its inclusions. We are now extending our research to try to identify the several different nephrite sources in Vietnam that were also used for manufacturing many of the lingling-o and animal-headed pendants found on the Asian mainland.

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1. Loofs-Wissowa HHE (1982) *J Hong Kong Archaeol Soc* IX:57–76.
2. Reinecke A (1996) *Beiträge Allgemeinen Vergleichenden Archäol* 16:1–51.
3. Fox RB (1970) *The Tabon Caves* (National Museum, Manila), pp 126–129.
4. Bellwood P (1997) *Prehistory of the Indo-Malaysian Archipelago* (Univ of Hawaii Press, Honolulu).
5. Higham C (2002) *Early Cultures of Mainland Southeast Asia* (River Books, Bangkok).
6. Bellina B, Glover I, (2004) in *Southeast Asia: From Prehistory to History*, eds Glover I, Bellwood P (RoutledgeCurzon, London), pp 68–88.
7. Kano T (1946) in *Studies in the Ethnology and Prehistory of Southeast Asia I* (Yajima Shobo, Tokyo), pp 227–234 (in Japanese).
8. Beyer O (1948) in *Philippines and East Asian Archaeology and Its Relation to the Origin of the Pacific Islands Population* (National Research Council of the Philippines, Manila), pp 44-45; 61–71.
9. Francis P (2002) in *Asia's Maritime Bead Trade: 300 B.C. to the Present* (University of Hawaii Press, Honolulu), p 203.
10. Tan LP, Lien CM, Yu BS (1997) *Bull Dept Anthropol* 52:211–220 (in Chinese).
11. Iizuka Y, Hung HC (2005) *J Austronesian Studies* 1:35–79.
12. Iizuka Y, Hung HC, Bellwood P (2007) in *Scientific Research on the Sculptural Arts of Asia*, eds Douglas J, Jett P, Winter J (Archetype, London), pp 12–19.
13. Iizuka Y, Bellwood P, Hung HC, Dizon E (2005) *J Austronesian Studies* 1:83–108.
14. Hung HC, Iizuka Y, Yui TF, Santiago R (2006) *Field Archaeol* 10:79–103 (in Chinese).

15. Hung HC (2004) *Bull Indo-Pacific Prehist Assoc* 24:57–70.
16. Tsang CH, Li KT, Chu CY (2006) *The Excavation of Dao Ye Site in Tainan Science Park* (Academia Sinica, Taipei), p 474 (in Chinese).
17. Blust R (1984–1985) *Asian Perspectives* XXVI:45–67.
18. Pawley A (2002) in *Examining the Farming/Language Dispersal Hypothesis*, eds Bellwood P, Renfrew C (McDonald Institute for Archaeological Research, Cambridge, UK), pp 25–74.
19. Gray RD, Jordan FM (2000) *Nature* 405:1052–1055.
20. Diamond J, Bellwood P (2003) *Science* 300:597–603.
21. Hung HC (2005) *J Austronesian Studies* 1:109–133.
22. Bellwood P, Dizon E (2005) *J Austronesian Studies* 1:1–33.
23. Kano T (1946) *Studies in the Ethnology and Prehistory of Southeast Asia I* (Yajima Shobo, Tokyo), pp 217–221 (in Japanese).
24. Liu YC (2003) in *Prehistory and Classical Civilization—Papers from the Third International Conference on Sinology (History Section)*, ed Tsang CH (Academia Sinica, Taipei), pp 1–44 (in Chinese).
25. Hung HC, Iizuka Y, Bellwood P (2006) in *Uncovering Southeast Asia's Past*, eds Bacus E, Glover I, Pigott V (National Univ of Singapore, Singapore), pp 203–215.
26. Huang JQ, Chen J, Yao QD, Lu WB, Qian J, Zhou GT (2003) in *Manufacturing Technology of Prehistoric Jade*, eds Qian XH, Fang JN (National Taiwan Museum, Taipei), pp 157–188 (in Chinese).
27. Bellwood P (1992) *in The Cambridge History of Southeast Asia*, ed Tarling N (Cambridge Univ Press, Cambridge, UK), Vol 1, pp 55–136.
28. Solheim WG (1964) *Asian Perspect* 8:196–210.