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# Metal Tools and the Transformation of an Oceanic Exchange System

ABSTRACT

The introduction of European technologies transformed some key aspects of traditional Pacific Island lifeways and exchange systems. One of the most dramatic changes was the replacement of shell and stone tools with those made from iron. As European explorers and traders ventured throughout Micronesia, metal commodities became highly sought after by indigenous peoples. An example of metal tools replacing traditional technologies is presented to explain how this culture contact ultimately changed one of the most famous exchange systems in the Pacific—the quarrying of stone money by Yapese Islanders in the Palau archipelago. The first iron tools ever found in excavation at a stone money quarry site are discussed in relation to their role in changing this unique interisland exchange system during the 18th and 19th centuries.

> "Afterward our men began to give them nails, which the Indians liked so well that they desired nothing else after that."
>
> ~ Miguel Lopez de Legazpi, landing in Guam on 21 January 1565

> "the Indians cam out of their canoas, with fish, coquos, bonnanas, rootes, sugarcane, to barter for old pieces of yron: sometimes they might number two hundred of these canoas, with two, three, or five men in each, all crying Hiero, Hiero, that is Yron, Yron (i.e., iron, iron) …"
>
> ~ Olivor van Noort globe circumnavigation on 16 September 1600 (Lévesque 1993:104)

As Europeans explored Oceania they encountered a mosaic of cultures and traditions. The contacts that ensued led to dramatic changes to the lifeways of native peoples, although the degree of change to traditional cultures varied greatly depending on several factors such as time of contact, the colonial power involved, proximity to shipping lanes, resources available for exploitation and trade, and the kinds of relationships secured with local groups. In many cases, newly discovered islands were noted in ship logs and mapped but were ignored until decades later. Others, like Guam, the first Micronesian island discovered by Europeans, were visited frequently and became centers of trade and supply (Hezel 1983; Barratt 1988; Lévesque 1992; Rogers 1995). Whenever there was prolonged contact between Europeans and Pacific islanders, goods and services were inevitably traded and quickly transformed the technological repertoire of indigenous groups (Hezel 1983; Rogers 1995).

One of the things most desired by Pacific Islanders was iron. Iron implements were more durable and stronger than traditional stone, bone, and shell implements. Iron hatchets and chisels decreased the time spent constructing canoes or houses, while iron bowls and pots retained heat better and were less prone to thermal breakage than traditional ceramic vessels (Descantes 2001). Because of these qualities, iron implements were often traded for by the natives, not only in Micronesia (Hezel 1983) but also in other parts of the Pacific (see McBryde 2000 for the importance of iron hatchets to Australian aborigines). It is clear that wherever and whenever iron was introduced, it began to transform the way islanders conducted their daily activities, albeit at different levels of intensity.

Archaeologists working in the Pacific Rim region are addressing the technological transformations that took place as a result of these culture contacts, including those societies that may not have been in direct contact with explorers and colonialists. Anthony Graesch (2001:261) noted, "[e]xpanding research to include such societies where possible is essential to our task of evaluating diversity in the varied circumstances of early historic cultural interaction." In trying to determine the changes that took place when Europeans (or their technologies) arrived, archaeologists can observe permutations in artifact assemblages from stratified deposits. In many cases this is difficult if archaeological materials cannot be joined with other sources of information or if time-sensitive artifacts are absent. In the case of Micronesia, it is especially rare to find an instance where the use of tools for a specific function changed and was documented before and after contact. Part of this problem stems from

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the poor preservation of artifacts (including iron) in tropical environments, incomplete ethnohistorical descriptions, and a dearth of studies dedicated to documenting the kinds and degrees of indigenous technological change that took place at the onset of European discovery.

The transition of traditional tool use to that of iron is explored in one of the most famous but understudied exchange systems in Oceania—the Yapese quarrying of stone money in Palau, Western Caroline Islands. These "money" disks were the heaviest objects ever transported over open ocean by Pacific Islanders and represent one of the few cases where limestone was quarried or exchanged in Oceania (Fitzpatrick 2001, 2003). Because archaeological evidence and historical descriptions of the Yapese carving and transporting their stone money exist before and after contact, the integration of data from recent excavations makes this exchange system ideal for examining how traditional practices changed or were altered when Europeans arrived.

An historical background is provided on this exchange relationship and several iron tools are documented, the only ones that have ever been found in direct association with Yapese stone money quarrying activities. Although metal was reported to have been used by the Yapese in historical accounts, iron tools recovered from the Metuker ra Bisech site in Palau are the first archaeological evidence for their use in stone money production. Stone money found at historic period quarries in Palau is compared with pieces documented from museum collections that were carved prior to and after the arrival of Europeans. Along with ethnohistorical accounts, oral traditions, and radiocarbon dating, these comparisons help to assess the degree of technological change over time and place the finds into an interpretable chronological sequence. This research has ramifications for understanding changes in local technological developments and how iron and other European technologies succeeded in transforming indigenous exchange systems and lifeways in Oceania over a period of several hundred years.

## Yapese Stone Money Quarrying

Oral traditions and ethnohistorical accounts describe Yapese stone money quarrying in the Palau Islands, located more than 400 km southwest of Yap (Figure 1). Yapese tradition states that a navigator named Anagumang first discovered the stone in a Palauan cave and ordered his men to cut it into the shape of a fish and then into a crescent moon. Karen Nero's [1995] ethnographic research on Palauan-Yapese linkages indicates that Anagumang and Fathaan (another navigator) were in competition to bring money back to Yap. It was after this first stone was brought to Yap that it became highly prized, creating a demand for more (de Beauclair 1971:185).

Oral traditions describe how stone money (*rai*) was quarried after the initial trip(s). A number of expeditions were apparently carried out by Fathaan and Anagumang long before Europeans arrived, and Outer Islanders from the coral atolls east of Yap became increasingly involved in later quarry expeditions, primarily as navigators (Fitzpatrick 2003c). Palauan oral traditions suggest that the Yapese only had access to those quarries under the control of specific Palauan villages with which they had some affiliation. This access was arranged with gifts of exotic foodstuffs, glass beads (Florencio Gibbons 1998, pers. comm.), which were part of the standard Palauan monetary system (de Beauclair 1963; Smith 1997), and other valuables such as shanks of sennit cord.

Oral traditions document the use of shell tools to carve disks of limestone into circular or ovoid shapes prior to European contact. In the late 1800s, George Le Hunte (1883:25) noted that he found "no less than a hundred Yap natives at Pelew [Palau]" occupied in cutting these stones and drilling holes in the center with a reef stone used as a fire-drill (de Beauclair 1971:188) so that timbers could be placed through this hole and sailed back to Yap. Shell adzes (*gi*) and reef stones (coral rock) were used in conjunction with burning wood to drill holes in the limestone—the fire would in a sense weaken the stone, and a coral rock tool would be twisted and "drilled" to create the hole. "Many exceeded six feet in diameter and were proportionally thick, having a large hole in the centre through which a log of wood is passed and this when laid across two canoes is sufficient to support the stone in transit" (Le Hunte 1883:25).

Most accounts suggest that the disks quarried before European contact were relatively small

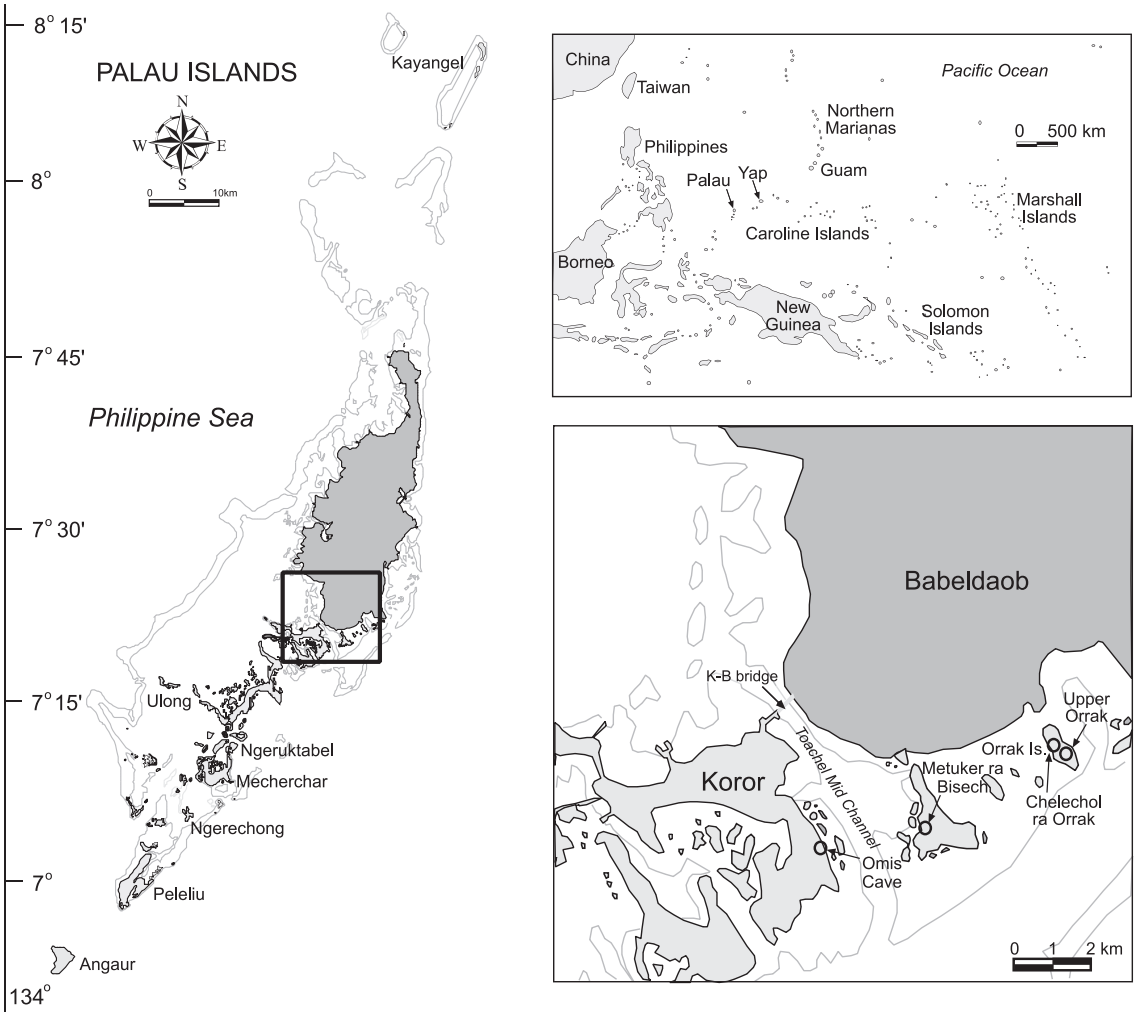


FIGURE 1. Map of Palau with inset of research area. (Drawing by Scott M. Fitzpatrick, 2005.)

(usually less than 1.0 to 1.5 m wide) and roughly hewn. The holes were biconical, non-symmetrical, and tapered toward the center from both sides (Figure 2). Paul Einzig (1966:37) reports that the scarcity (nonindigenous to Yap), cost of production (for example, labor and tribute to Palauans), and risk (heavy loads transported overseas) all influenced the value of stone money and that the value also "depends largely on its size measured in spans, which in Yap means the stretch of the index finger and thumb." Whether this last statement was true prior to European contact is unknown, although it is clear that size was one factor in determining value. Inez de Beauclair (1971:187) notes, "a piece of stone money is valued according to its material, size, shape, history, and mode of transportation." Disks brought back to Yap became symbols of wealth, status, and power. Stone money today is still considered valuable and used as a medium for exchange in Yap, although the disks are not always moved; instead, ownership may be transferred. Transactions involving the exchange of stone money may take place, for example, at the birth of a child, a marriage ceremony, or other gift occasions. Disks are often placed in front of stone platforms (*dayif*), young men's houses (*faluw*), community meetinghouses (*pebaey*), or along trails (Hunter-Anderson 1983: 45–47,50,58).

When Europeans arrived, traditional methods for producing stone money began changing with the

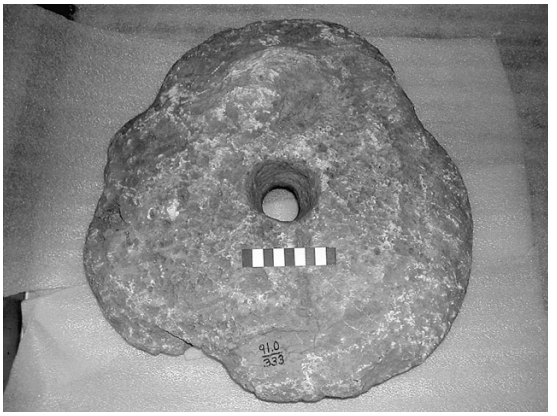


FIGURE 2. Stone money disk. (Photo by Scott M. Fitzpatrick; courtesy of the Thomas Burke Museum, University of Washington, Seattle.)

introduction of iron tools and the use of larger ships to transport disks back to Yap. The German firm Godeffroy out of Hamburg was one of the earliest European powers to influence Yap and Palau. Johannes Kubary (1889), a Pole employed by Godeffroy who lived in Palau and Pohnpei, made several visits to Yap, the first of which was in 1870. He wrote of the different Yapese stone money forms, their transport, and the value placed on them in both Yapese and European terms (Gillilland 1975). Another smaller trading company from Hamburg, called Hernsheim, also established a branch in Yap and eventually took over Godeffroy's operations in the Pacific when the firm declared bankruptcy in 1879. Despite the best efforts of German interests in the late 1800s to initiate the trade of copra (dried coconut meat) and other products, few made any headway with the Yapese in establishing a trading outpost, despite repeated attempts by administrators to organize native laborers. It was with the aid of other foreigners that trade was eventually established when they became directly involved with stone money production.

The most notable character participating in this trade was Captain David Dean O'Keefe, an Irish-American who in the late 1800s had quickly left Savannah, Georgia, on the *Belvidere* after he was involved in a fight with a drunk insubordinate sailor who O'Keefe mistakenly thought he had killed. After sailing into the western Pacific, O'Keefe was shipwrecked somewhere near Yap in December 1871 (Hezel 1983:263). As the only survivor of the ship, he was nursed back to health by the Yapese, and he stayed there for several months. Disliking his immediate situation, O'Keefe made his way to Hong Kong on a passing Godeffroy company steamer in early 1872 but returned several months later with a Chinese junk he named *Katherine* after the wife he had left in Georgia (Hezel 1983:265). After the collapse of the Celebes Seas Trading Company and some failed trading ventures, he then devised a business plan that would eventually ensure him extreme wealth, status, and power on Yap.

O'Keefe negotiated with several Yapese chiefs to haul laborers to Palau and bring stone money back to Yap in exchange for a set amount of copra based on the size of each disk measured in hand spans. In 1872, the Yapese began traveling to Palau on O'Keefe's ship, resulting in a thriving business for O'Keefe. He would then sell his goods in Asian markets, return to Palau to fetch the stone money cargo, and then bring the disks back to Yap.

Many visitors noted O'Keefe's influence, including a Japanese ship in 1890 that mentioned O'Keefe, along with another American (probably a man named Crayton Holcomb, proprietor of the *Bartola*), as helping the Yapese in the transfer of laborers and stone money between Palau and Yap (Matsumura 1918:164). Historical records indicate that O'Keefe literally brought thousands of stone money pieces from Palau, and perhaps Guam, which he then traded for copra. Other minor and short-lived players in this trade, including Eduard Hernsheim and Holcomb who arrived in 1874 (Hezel 1983:268), soon became involved. By the late 1800s Yap was inundated with stone money. The forced expulsion of O'Keefe and a ban placed on interisland voyaging by German administrators near the turn of the 20th century collapsed the lucrative transport of stone money between Palau and Yap and, for all intents and purposes, ended one of the most storied accounts of Pacific Island exchange ever documented.

An inventory by the Japanese during their administration in the 1930s counted 13,281 disks, although de Beauclair estimated that by 1965 this number had been reduced by half due to typhoons, flooding, and the use of disks for anchors, defensive walls, and other general purposes during WW II (Gillilland 1975:

11). According to Yapese oral traditions, this trade network thus succeeded in lowering the value of stone money brought by larger ships, making the earlier money that was carved and transported using traditional technologies more valuable (Gillilland 1975). With the introduction of metal tools and other European technologies (larger ships, chains, etc.) and the concomitant increase in the labor pool, which resulted in more highly sophisticated infrastructure development at quarry sites (for example, stone architecture for moving disks overland, wooden scaffoldings) (Fitzpatrick and Diveley 2004), the value of stone money became diminished over time even as their sizes grew larger, a case of inflation as it were.

Although oral traditions (Kubary 1889; Nero [1995]) and ethnohistorical reports (Kotzebue 1821; Cheyne 1852; Le Hunte 1883) provide valuable data on how stone money production and exchange evolved over time, they suffer from a lack of tangible evidence with which to test these accounts. Archaeological investigations at several quarry sites as part of the Palau Stone Money Project, initiated in conjunction with the Palau Bureau of Arts and Culture (formerly the Division of Cultural Affairs), were designed to discover when stone money quarrying began, whether there were periods of intensification, and if artifactual evidence could be found to substantiate the oral traditions and ethnohistory (Fitzpatrick 2001, 2002a, 2003a, 2003b, 2003c). Excavation and extensive radiocarbon dating at three Yapese stone money quarries provide clues into the historic transformation process; iron tools found in association with quarrying activities at the Metuker ra Bisech site suggest that metal played a pivotal role in transforming this exchange system.

## Geographical and Archaeological Setting

All of the Yapese stone money quarries in Palau known thus far are located in the limestone Rock Islands between Babeldaob's southern fringe and northern Koror (Figure 2). Stone money disks have been found in other parts of the archipelago, but no other quarries. This is probably a result of inadequate sampling rather than geographical preference by the Yapese.

Four quarries in Palau have been investigated since 1998. Two of these quarries are coastal cave sites (Chelechol ra Orrak, Omis Cave), and two are found inland at higher elevations (Metuker ra Bisech, Upper Orrak). Results from survey and excavation indicate that the coastal sites are multicomponent with evidence for early Palauan habitation dating back from 2,300 to 3,000 years ago (Fitzpatrick 2001, 2002a, 2003b) and then later period Yapese stone money production. Although each site has an abundance of material associated with quarrying activity and habitation, including unfinished or broken stone-money disks, limestone debitage, stone architecture, and faunal remains, the Metuker ra Bisech site provides the best overall evidence so far for documenting the technological and cultural transformations that occurred after European contact.

The Metuker ra Bisech site is located in the Ngerusar portion of Airai State, a few kilometers across the Toachelmid Channel from Koror. The site has extensive caves, rock shelters, and architectural features, including stone platforms, walls/alignments, and mounds (Figure 3). One finished and two unfinished stone-money disks were recorded in 2000. The completed disk (Feature 1) measures 3.0 m in diameter, 50 cm thick at the center, and 30 cm at the edges. Weight was calculated for this specimen using an average thickness of 0.4 m ($\Pi \times 1.5^2$ (radius$^2$) $\times$ 0.4 m) $\times$ 2.7 (specific gravity of calcite), which equaled 7,630.2 kg or 7.6 metric tons. This piece of stone money, although within the larger range of disks known to exist, is still not the largest; another piece more than 3.3 m in diameter was located on a hillside in dense jungle near the site. Several others about 4.0 m in diameter are also known to exist in Yap (Figure 4).

Because Metuker ra Bisech is located within a jagged and topographically complex karst environment, stone construction was necessary for moving large disks. These stone features, including mounds, platforms, walls, and alignments, probably served many functions—steps, support mechanisms, tracks or pathways, and structures for loading disks, laborers, and/or supplies. In the interior sites, stone work for moving disks would have required additional forms of support such as wooden rollers for flatter surfaces and open areas, wooden or bamboo scaffolding for more dramatic changes in slope, and armatures to "sandwich" the

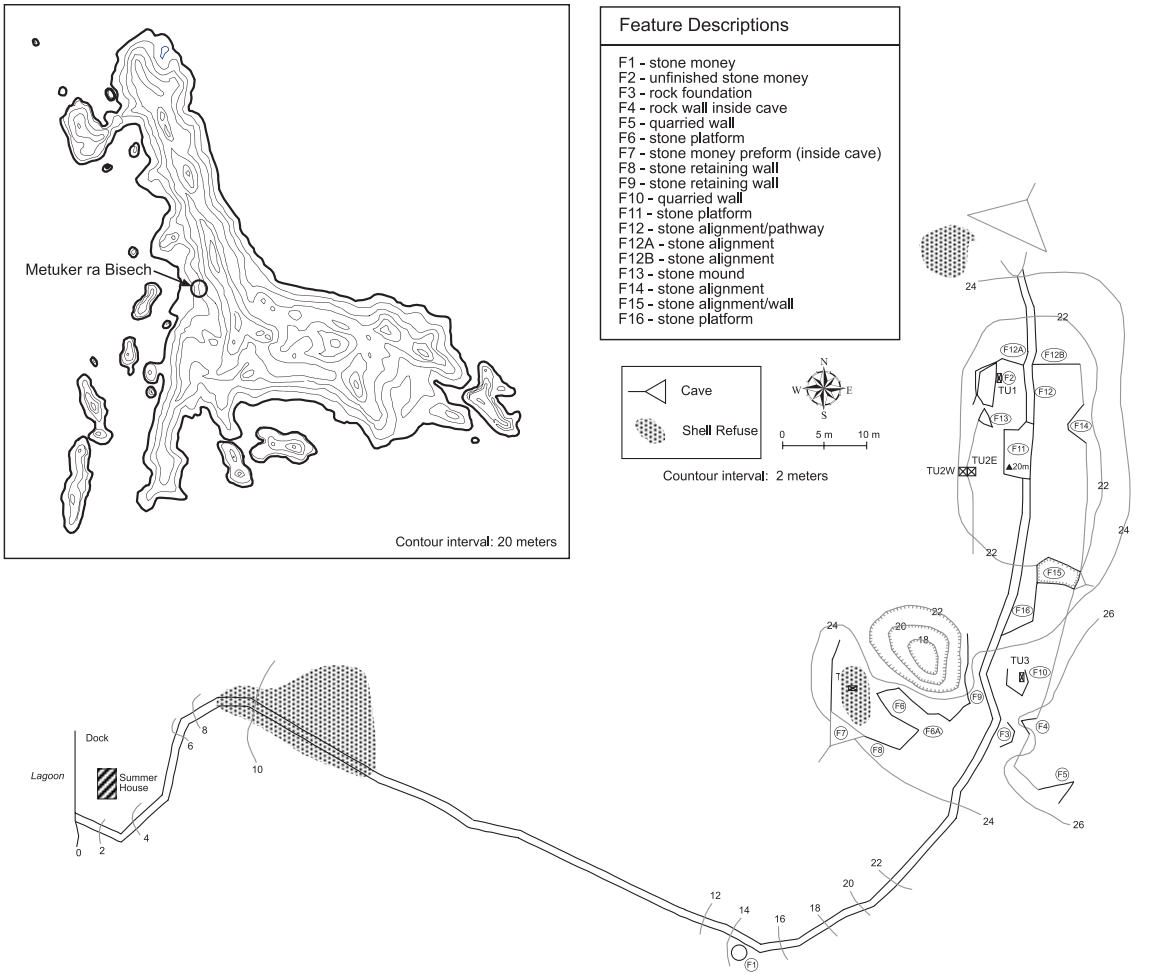


FIGURE 3. Metuker ra Bisech site map. (Drawing by Scott M. Fitzpatrick, 2005.)

disks so that their edges were fully protected. Unfortunately, poor preservation in the tropical environment prevents a more detailed analysis of all the possible types of support mechanisms used, although historic photographs from the German South Seas Expedition in 1908–1910 show wooden poles erected for scaffolding at stone money quarry sites in Palau and as canoe or house structures (Müller 1917), suggesting that similar strategies were employed in the past (see Fitzpatrick 2003c; Fitzpatrick and Diveley 2004 for further discussion on transporting issues). Nonetheless, if experiments elsewhere in the world reflect the true nature of stone transport, it is fairly clear that moving these disks would have presented quite a challenge to quarry workers who probably numbered in the hundreds (Heizer 1966:827; Ayres and Scheller 2002; Fitzpatrick and Diveley 2004).

Four test units were excavated at the site (one 2.0 x 1.0 m; three 1.0 x 0.5 m). Most of the artifacts recovered during excavation were limestone flakes and chunks (~7,000 pieces), the obvious remnants of stone money disk production (Fitzpatrick 2003d). The only other artifacts recovered were two iron blade tools, one resembling a hatchet and the other a hoe, found in Test Unit 2W (west), which lay adjacent to a buried rock wall/foundation (Figure 5). A pick-like tool was found on the surface in a smaller cave near the site. Several large shellfish midden deposits were also discovered in and around the caves. One of the 1.0 x 0.5 m excavation units (Test Unit 4) placed near the

FIGURE 4. Stone money disk (Feature 1) at Metuker ra Bisech. (Photo by Scott M. Fitzpatrick.)

entrance of a large cave near the site's southern boundary revealed shellfish fragments from 24 discrete taxa (Fitzpatrick 2003a).

Due to dense vegetation and rough karst topography, the exact dimensions of Metuker ra Bisech are difficult to determine. Preliminary results indicate that the site is quite large (~2,500–3,000 $m^2$), although more work is required to determine the exact relationship smaller features found away from the site may have with Yapese quarry constructions.

## Radiocarbon Chronology

Forty-nine radiocarbon dates (44 AMS and five conventional) have been obtained so far from stone-money quarries in Palau. One of the difficulties in associating dates with Yapese quarrying activities is that the stratigraphy in upper levels (~0–30 cm) tends to be highly mixed, especially in the smaller cave sites (Omis Cave, Chelechol ra Orrak). This can best be attributed to the Yapese quarrying stone money in a smaller, more restricted area where large quantities of debitage and stone money needed to be moved or shifted around to make way for further carving activities, thus distributing earlier, non-Yapese deposits (Fitzpatrick 2001). Despite these problems, the suite of radiocarbon dates from quarry sites suggests that stone money manufacture took place before European contact (Fitzpatrick 2002a).

Seven shell and charcoal specimens from Metuker ra Bisech were AMS radiocarbon dated in an attempt to discern when stone money quarrying began at the site. The dates range from about A.D. 1700 to the later historic period. If it is assumed that these dates are contemporary with the iron tools, this would suggest that metal was in fact introduced prior to the first major recorded contact of Palau in 1783 by Captain Wilson on *The Antelope*, and that the Yapese were bringing this exotic resource into Palau explicitly for stone money manufacture.

Of the three quarry sites excavated so far (Chelechol ra Orrak, Omis Cave, and Metuker


FIGURE 5. Rock wall/foundation in Test Unit 2W. (Photo by Scott M. Fitzpatrick.)

ra Bisech), only Metuker ra Bisech appears to have been used exclusively during the historic period. The other sites are multicomponent with evidence of Yapese quarry activities (limestone debitage) intermixed with Palauan artifact assemblages dating back as early as ~400 cal. B.C. at Omis Cave (Fitzpatrick 2001) and 1000 cal. B.C. at Chelechol ra Orrak (Fitzpatrick 2002a, 2003b). In contrast, radiocarbon dating of charcoal and shell samples and evidence of metal tool usage from Metuker ra Bisech indicates that it was only used as a stone money quarry probably beginning about the early-18th century (Figure 6) (Fitzpatrick 2002a).

## Artifact Descriptions

The three metal artifacts recovered from Metuker ra Bisech are made of iron and were slightly corroded on the exterior when collected. To gather more accurate measurements, a majority of the corrosive encrustations were removed from the artifacts using a wire brush. This was not attempted with the pick because it was fragile and larger encrustations were minimal.

The "hoe" blade was recovered in Test Unit 2W. It is thin, roughly rectangular, has a hafting fixture, and measures 14.6 cm long, 12.3 cm wide, and 2.3 cm thick (Figure 7). Its shape suggests that it could have been used for prying, splitting, or lifting stone. The "hatchet," also from Test Unit 2W, is rectangular and has a slot through the center for hafting with a wooden shaft. It is 11.3 cm long, 8.1 cm wide, and 2.6 cm thick (Figure 8). This tool was probably used for hacking and shaping limestone into a preform shape prior to more detailed carving and abrasion. The pick is long and narrow, semi-triangular with a small hole at the base through which a hafting pole or stick could be inserted. It is 23.2 cm long, 4.4 cm wide, and 3.4 cm thick. The tip is mashed, most likely a result of repeated blows against limestone rock (Figure 9). Unfinished stone money disks in the final stages of production of shaping and polishing often bear the scars of chipping and gouging for which these pick-like implements would have been ideal.

Iron tools are found in archaeological deposits elsewhere in Micronesia (Intoh and Leach 1985: 106,108), but compared to prehistoric materials they are rare. Relatively little attention has been paid to these artifacts. There are thus few reported iron tools in western Micronesia from which to make good comparisons, although

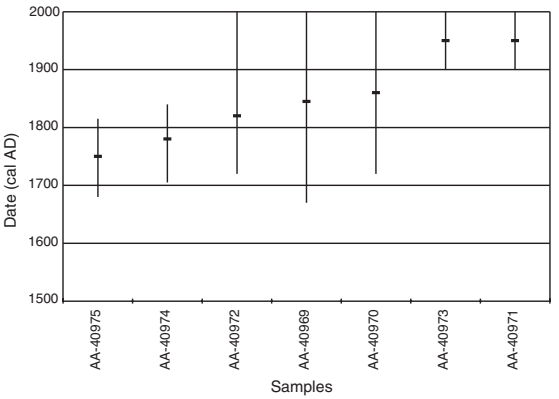


FIGURE 6. Radiocarbon Chronology of Metuker ra Bisech (samples calibrated at 1 sigma; see Fitzpatrick 2002a).

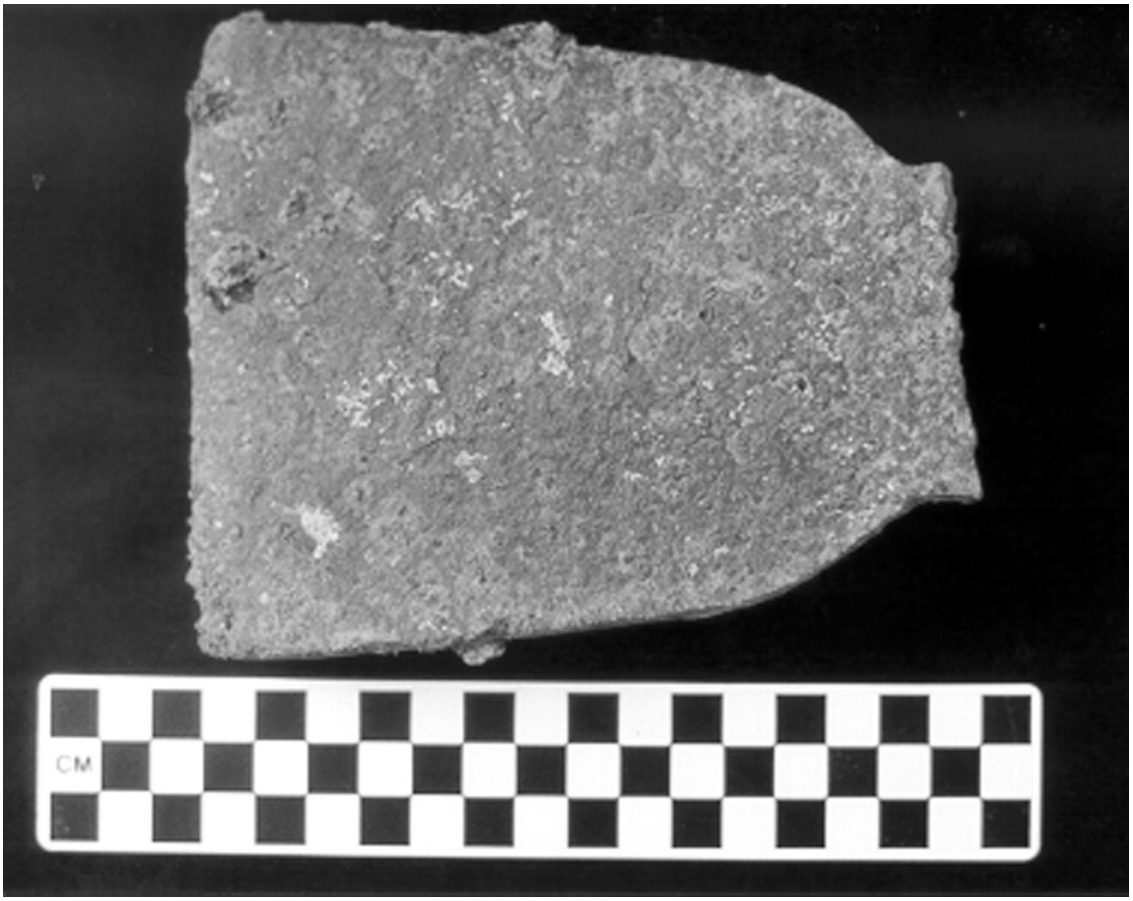


FIGURE 7. Metal "hoe" blade. (Photo by Scott M. Fitzpatrick.)

tools were apparently distributed widely by the Spanish, especially during the late-18th and early-19th centuries (see Descantes 2001 for discussion of metal pots replacing ceramic ones in Yap). Unfortunately, because of the paucity in research, it is difficult to determine whether iron tools similar to the ones found at Metuker ra Bisech were commonly used by other Micronesian peoples and for what tasks. Hatchets, hoes, and picks served a number of functions for both Europeans and native Pacific peoples during this time. Their direct association with lithic debitage at a stone money quarry suggests these artifacts, despite their absence in the archaeological literature, support the ethnohistorical records and oral traditions that describe the tools being important for the Yapese in their drive to produce stone money and the iron being highly sought after by Micronesian peoples.

## Desire for Iron in the Caroline Islands

Many early accounts from Europeans traveling through Micronesia in the early 1500s and 1600s testify to the desire by indigenous groups to acquire iron tools and other objects. The first known contact with western Micronesians took place when Ferdinand Magellan sighted Guam on 6 March 1521. After a violent attempt at imposing his will on the native population (including killing several Chamorros and burning huts as retaliation for stealing a skiff), he reported that the very next day they exchanged provisions for Spanish goods, particularly iron (Rogers 1995:7). A few years later on 4 September 1526 an expedition under the command of Fray Garcia Jofre de Loaisa landed on Guam, but he stated that the Indians "possess no iron tools, performing their work

FIGURE 8. Metal “hatchet” blade. (Photo by Scott M. Fitzpatrick.)


FIGURE 9. Metal pick. (Photo by Scott M. Fitzpatrick.)

with stones" (Carano and Sanchez 1965:43). It is possible that they had either lost the iron tools obtained during Magellan's stay or that this expedition encountered a different group of Chamorros. It is clear that repeated contacts by the Spanish in the Marianas throughout the 16th century, including Miguel Lopez de Legazpi in 1565, brought heavy trade, including iron implements that became increasingly important to the natives. Robert Rogers (1995:16) reported that during Fernandez de Quirós's landing at Guam in 1596 several Chamorros "were killed by an arquebus (a portable matchlock gun), owing to a matter of a (stolen) piece of cask hoop. Iron was still worth dying for among Pacific Islanders seventy-five years after Magellan's crossing." Annual landfalls in the Marianas by the Spanish traveling between Mexico and the Philippines throughout the 17th century led to a dependence by the Chamorros on trade with these ships to "replenish their knife blades, adzes, and fishhooks" (Rogers 1995:41).

It was also widely known in Chuuk (Truk), for example, "that European iron was desired, and contended for, throughout the sixteenth century" (Barratt 1988:22). "[I]n 1787, a group of Lamotrekians deliberately planned a trading voyage to Guam, not to barter for turmeric, shell belts, and tortoise-plate, as formerly, but to obtain iron and iron articles" (Barratt 1988:23). "This was the first such expedition since the Spanish-Chamorro Wars halted trade between the islanders" (Rogers 1995:85). Shortly thereafter, Joseph Arleguí y Leóz, the governor of Guam from 1786 to 1794, sponsored a trading venture to Lamotrek in 1788 with the Lamotrekians led by Luís de Torres, a Guam-born *sargento-mayor*. They were to trade iron, but the expedition never reached its destination. People on Lamotrek assumed they had been killed by the still-feared Spanish and did not attempt a return to Guam (Rogers 1995: 85). For the most part, Carolinians traveling to Guam "were pleased. . . . by the collection of iron objects which they consciously assembled … This hoard included iron hatchets, iron bars, and common nails" (Barratt 1988:21). These descriptions mirror those in other parts of the Pacific such as Australia where Isabel McBryde (2000:250), for example, describes metal hatchets and other iron pieces that "moved rapidly at least a hundred kilometers ahead of the frontier, to the surprise of explorers."

Voyaging to the Marianas and outer islands by Micronesians in search of iron continued during the following centuries. "[L]ater eighteenth-century and early nineteenth-century trade trips to acquire Spanish ironware on Guam were the predictable (if not entirely successful), culmination of the islanders' longing for iron …" (Barratt 1988:22). Iron became so highly regarded in the later historic period that "Spanish trade goods from Guam [which] had been looked upon as luxuries—were growing almost commonplace within the Yapese and Trukese atoll networks. Value systems (were) modified" (Barratt 1988:25). Francis Hezel (1983:39), describes the fascination and desire for iron by Micronesians who landed in the Philippines as castaways and were brought to the village of Samar where they encountered Spanish settlements:

> . . . [N]othing impressed them more than the iron tools they saw. When on one occasion they were brought by the parish priest to watch the construction of a trading vessel, their eyes bulged and they clucked in astonishment at the variety of iron tools that were being used. The Carolineans were already well aware of the superiority of iron to the shell and coral from which they fashioned their own tools. They had carried with them on their voyage to Samar a bar "of only a finger's length," a treasured keepsake perhaps from an earlier canoe voyage to the Philippines or the Marianas, and were most eager to obtain more. "Our yearning for iron," as an islander aptly expressed it to Father Victor Walter some years later, "is as strong as your longing for heaven." When each of them was presented with a piece of metal by the priest, their delight knew no bounds. So fearful were the Carolineans of having their precious gift stolen that they laid the metal under their heads whenever they slept.

Christophe Descantes (2001:235) suggests, "[d]uring early contacts between the sixteenth and nineteenth centuries the introduction of exotic materials became 'entangled' in a prestige-goods economy with the Yapese imbuing value into rare metal goods, initially including metal pots." There are few examples of where this has happened, and a general lack of archaeological evidence exists for changes that took place within Micronesian societies after European contact. Fortunately, the quarrying of stone money in Palau by Yapese Islanders

provides an excellent opportunity using these sets of data to examine the technological transformations that took place after contact.

## Stone Money Production

Some of the difficulties in determining how iron tools and other objects actually affected the production of stone money and exchange behaviors lies in (1) the reliance on oral traditions and ethnohistorical accounts whose descriptions may have gaps or inaccuracies in reporting and translation; (2) pinpointing the exact time that iron came into frequent use for quarrying; and (3) archaeologically documenting the technological changes that took place in disk manufacture (shape, size, quality). Each of these issues is discussed separately below in an attempt to refine the nature and timing of probable technological transformations that occurred in stone money manufacture as a result of European intervention.

### Oral Traditions and Ethnohistorical Accounts

Oral traditions indicate that stone money disks were carved and transported using traditional technologies (shell and stone tools, canoes and rafts) prior to European contact. Ethnohistorical reports (Cheyne 1852; Le Hunte 1883) support these descriptions, although few details exist about what specific tools were used before iron. As noted earlier, de Beauclair (1963) describes the use of shell adzes and reef stones as fire-drills for early stone money production. Cora Gillilland (1975:10–11) remarks that there are many differences in the size, shape, and quality of disks found at museums around the world (see inventory and photographs in Gillilland 1975:37–75).

> Relative to the overall number there were probably few made with these early tools. Before the use of iron the surface of the stones was polished with pumice. The surface texture and appearance of *rai*, vary greatly. The change in tools and techniques of quarrying over the years may explain these differences. (Gillilland 1975: 10 after de Beauclair 1963).

Specific European accounts of the Yapese and their stone money do not appear until the early- to mid-19th century when colonial powers began sending exploratory and trading expeditions to the region (Kotzebue 1821; Cheyne 1852; Müller 1917). The first recorded European sighting of Yap was probably by Alvaro de Saavedra Ceron's ship the *Florida* on 1 January 1528. He named it "Islas de los Reyes" in honor of the feast day (Hezel 1983: 14–15). The Yapese were apparently cautious and rarely interacted with the Spaniards during their eight-day stopover before heading to the Philippines. Sixteen years later, Ruy Lopez de Villalobos visited two islands, most likely Fais and Yap, and was greeted in Spanish, much to his surprise. Whether these western Carolinians had simply remembered the greeting from Villalobos's earlier trip or had been in regular contact with the Philippines is unknown (Hezel 1983:19). It is likely that the Yapese became aware of metal utilitarian goods (for example, pots) by the 16th century due to these sporadic voyages (Lessa 1962; Descantes 2001:233). More frequent contacts with Yap and the surrounding islands took place in the 1790s as British and Spanish trading ships sought out goods, especially bêche-de-mer (sea cucumber or sea slug) and copra to trade with China. The first major European contact with Palau came much later in 1783 with the wreck of the British ship *The Antelope* under the command of Captain Henry Wilson, although brief and sporadic contacts did take place earlier by the Spanish (Hezel 1983:43,63).

Although the Yapese had probably acquired iron before the Palauans, given what is known of historical contact records, it has been suggested that Palauans had better access to iron than the Yapese in the early 1800s (Gillilland 1975:9). This may have been a result of Koror's suitable port that encouraged shipping and trade with various European powers, especially the British (Ehrlich 1984). Thus, the introduction of iron tools to Yap probably occurred sporadically in the 1500s or 1600s and in Palau by at least the late 1700s. Overall, oral traditions and ethnohistoric accounts suggest that before European contact stone money was carved using traditional technologies and that sometime in the 1700s, or perhaps slightly earlier, these methods were primarily, if not completely, replaced with iron tools.

## Chronology of Iron Use in Stone Money Quarrying

Calibrated ranges of radiocarbon dates and the presence of metal artifacts at Metuker ra Bisech indicate that intensive stone money quarrying was only taking place at the site about post-A.D. 1650 (but probably closer to the early or mid-1700s), with no evidence of prior human occupation. Two finished but broken disks found at the site are quite large (more than 3 m in diameter), finely abraded, extremely smooth, and very symmetrical. Along with the discovery of iron tools, the evidence suggests that Metuker ra Bisech was quarried by Yapese Islanders only after European contact in the region when iron became more readily available but before the European discovery of Palau in 1783. This coincides with what is described by oral traditions and ethnohistorical accounts. Access to iron probably increased after the British landing in Palau, and it could have potentially become an item of exchange between the Palauans and Yapese.

The data collected from two other stone money quarries, Omis Cave and Chelechol ra Orrak, provide a murkier chronological picture of Yapese quarry behavior. No metal tools were found during excavations at either site, although an axe blade was found on the surface near a cave on Orrak Island (Rita Olsudong 2000, pers. comm.). Radiocarbon dating indicates that these two sites are multicomponent and were used for a period of several thousand years for activities unrelated to stone money quarrying (Fitzpatrick 2002a, 2002b). Of the three sites excavated so far, Metuker ra Bisech is the only quarry that was used solely during the historic period. It is likely that the other two sites were also used during this period, but determining exactly when quarry activities took place is more difficult to ascertain because of engineering tasks (stone work construction, quarrying) that have extensively mixed the soil (Fitzpatrick 2001).

## Documenting the Effects of Technological Change

Little research in Oceania focused on discovering what kinds of technological changes took place as a result of European contact and how this affected specific indigenous social and exchange systems. Determining how European artifacts functioned in a traditional native culture is a necessary part of examining how culture contacts operated. As Kent Lightfoot (1995:207) noted, "The synergism of multi-ethnic interactions may have fostered innovations in the technology, raw materials, and forms of 'native' artifacts—significant changes in material culture that may be overlooked unless detailed comparisons are made with precontact assemblages."

Despite the lack of research in western Micronesia dedicated to examining the technological transformations that took place with native groups at contact, studies along the southern California coast do provide some comparative insights into historic period transition processes. Douglas Bamforth (1993), for example, studied household assemblages of a mission period site on Mescalitan Island in the Goleta Slough near Santa Barbara, dating from the period just before Spanish contact to its later abandonment in 1803. Analysis of the artifactual assemblage suggested that the inhabitants had regular access to metal tools but still continued using stone tools for certain activities like fishhook manufacture and fish processing. There were several technical changes that occurred with the introduction of iron implements. These included (1) the near replacement of stone bead drills with ones made from iron, (2) the loss of bifacial stone knives (metal knives were the most common tools found in Chumash burials from an historic cemetery), and (3) the replacement of stone tools for woodworking with iron axes and adzes (Bamforth 1993:66). It is interesting to note that iron needles became the preferred tool of the Chumash for perforating shell beads.

Graesch (2001:279–281) further elaborates on iron needle use by Chumash groups for drilling beads, which provides a good, albeit smaller, comparison with that of stone money production. He proposes several identifying markers on Olivella shells, including minimum perforation diameter, perforation shape, and width of the bevel inside the perforation that can help differentiate between perforations made with iron or stone tools. He surmises that the Chumash adopted iron needles for this task based on these drill signatures, despite the absence of the artifacts in archaeological assemblages due to poor preservation. As a result, beads were

more symmetrical, had cylindrical perforations, and were produced in greater quantities.

Using Chumash beads as a comparative measure, how can the kinds of technological changes that took place with stone money quarrying by the Yapese in Palau be observed and documented with relatively few artifacts to guide the way? Although only a few completed stone money disks have been found in situ at quarry sites that are useful for making a comparison, there are definite distinctions between ones that are known to have been carved after European contact and others found in museums worldwide. These differences include shape, size, quality, and perforation type.

Four completely finished stone money disks have been recorded in Palau thus far with at least 13 others in various stages of production. These finished disks are circular to ovoid, range from approximately 2.0 to 3.3 m wide, are finely shaped and abraded (with highly polished crystalline facets), and have symmetrically cylindrical perforations (Figure 10). It is difficult to accurately assess what the final shape and size would have been for the other unfinished disks. Most are still embedded in flowstone deposits, half-moon in shape, and range from about 1.0 to 4.0 m in diameter. The beginnings of perforations are absent on nearly all of these preforms with the possible exception of one at Omis Cave (Fitzpatrick 2001).

FIGURE 10. Perforation of the stone money disk (Feature 1) at Metuker ra Bisech (note the symmetry and fine abrasion of hole compared to Figures 1 and 2; scale = 10 cm across). (Photo by Scott M. Fitzpatrick.)

As a means for comparison, stone money specimens were examined at the Thomas Burke Museum (University of Washington, Seattle), the Museum of Ethnology (Osaka, Japan), and the Etpison Museum (Koror, Republic of Palau). Although the provenience of specimens at the Etpison Museum is questionable and not described in the displays, almost all of the stone money disks at the Burke Museum and the Museum of Ethnology were obtained in the early to mid-1900s and record from whom the objects were collected. Most of the disks are semi- or roughly circular, in the smaller size range (usually less than 1.5 m in diameter), roughly shaped and abraded (not finely polished), and have biconical perforations that taper from the outside inward (Figure 11). A specimen on display at the Museum of Ethnology in Japan exhibited a similar trend. Three stone money specimens at the Burke Museum are quite small (ranging from 8.5 to 12.2 cm in diameter and 0.63 cm to 0.76 cm in thickness) and exhibit extraordinarily fine polishing and symmetry (Catalog ID numbers: 2001-58/15, 2001-58/16, and 2001-58/17). They are described in the accession as "model" stone money and were collected by Dr. Sheila C. Bills and her husband who was a captain stationed in Guam from 1962–1964. They apparently traveled extensively throughout Micronesia and collected many different objects. The exact provenience of these disks is unknown, although they are not likely to be precontact nor very valuable. After closer examination it was evident that they were likely representations of stone money carved during modern times.

It is not clear why these presumably more valuable disks were sold or given to non-Yapese individuals. Transaction records for most specimens are incomplete. It is possible they were no longer considered valuable, their ownership was "lost" during the Japanese occupation, or they were more highly sought after by collectors and explorers because these particular disks were smaller and easier to transport.

Despite the small sample size in our study, the specimens recorded at stone money quarries in Palau, compared to those in the museums, support the suggestion (using the available evidence) that disks, like Chumash shell beads, could be produced in greater quantities, with better precision and quality, and with perforations that were smaller and

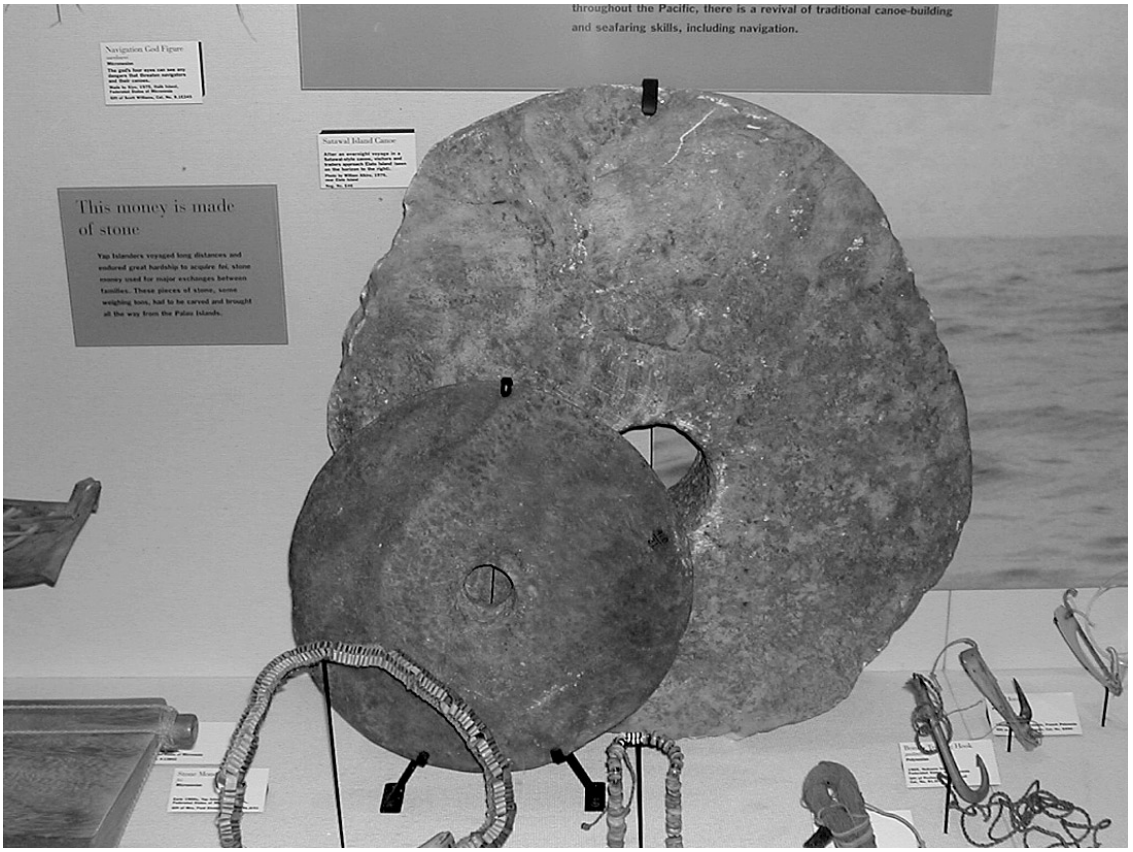


FIGURE 11. Stone money disks. (Photo by Scott M. Fitzpatrick; courtesy of the Thomas Burke Museum, University of Washington, Seattle.)

more cylindrical because of iron tools. Due to the sheer size of stone money disks during the historic period, the disks would have been impossible to carry with poles. Instead, the disks were probably transported by placing them in a protective armature and moved by lifting and sliding on rollers, using stonework, timbers, and scaffolding. The perforations, although still an integral part of stone money design, were essentially nonfunctional from a carrying standpoint—they simply continued drilling the holes as part of cultural convention, a trademark that had been passed down in the manufacturing process for centuries. As experiments moving megaliths have shown, once a stone reaches five tons, it is easier to drag than lift (Ayres and Scheller 2002; Fitzpatrick and Diveley 2004).

Another trait that appears related to the introduction of iron for producing stone money is an increase in the size of disks over time, which was also possible with the advance of metal technology and transport on larger European or Chinese-style ships. These diagnostic traits distinguish stone money carved with traditional tools of shell and/or stone with that of iron. Despite the increase in size of disks during historic times, the effects of European contact on stone money production eventually led to its devaluation. In many respects, this portion of the Yapese economic system became inflationary, although earlier disks were and are still considered extremely valuable.

## Concluding Summary

With the evidence collected so far at Metuker ra Bisech and other Yapese stone money quarries, several conclusions can be made regarding stone-money disk manufacture through time as it relates to introduced iron technology:

1. Early disks (those quarried before European contact) were carved using traditional tools such as shell or stone adzes. These disks were smaller and more roughly hewn. Many of the specimens brought to museums worldwide exhibit this trend, while ones at Metuker ra Bisech do not.
2. After the introduction of iron, stone money disks became larger, were more finely carved and abraded, but were often considered less valuable than those produced using traditional technologies because of a decrease in risk and effort in the historic period. Although it is likely that some disks in the larger range (~2.0 m+) were quarried using traditional means and that the carving process was slowly refined over time to produce better and larger disks, these were probably rare. The overall trend was that stone money disks became increasingly larger through time. A survey dedicated to conducting an inventory of stone money in Yap should take these and other traits into consideration when attempting to determine its antiquity.
3. According to oral traditions and ethnohistorical accounts, stone money disks were initially perforated so that they could be carried with a pole. Given their weight, it would have been extremely difficult, if not impossible, for larger disks to be carried using a pole or timbers without great risk of injury or stone breakage. It is likely then that the perforations became less functional through time but still fashioned as part of cultural convention.
4. Iron tools and the use of European ships, especially those under the control of Captain O'Keefe, transformed stone money quarrying. The effect of this culture contact and technological advance would have been to quickly and dramatically transform the carving and transport of stone money by these easier, faster, and more efficient means. Higher quantities were produced by larger groups of quarry workers in shorter periods of time. This assumption is supported by the archaeological evidence, ethnohistoric accounts, and oral traditions. The associated infrastructure required for moving disks (wood or bamboo scaffolding and armatures) would have also been constructed and implemented with greater ease and efficiency.
5. Inland quarry sites, where the largest and best examples of stone money disks appear, were probably quarried predominantly or even exclusively during the historic period as evidenced by $^{14}C$ dates and the size and quality of disks found at the sites. The engineering requirements for transporting larger disks would have necessitated iron tools and devices such as chains and levers. Further research focused on locating additional quarry sites in the archipelago and experimental studies will provide new data for analyzing the extent, type, and chronology of stone money production and transport.

In many respects the three artifacts described above are not unusual and were reported as trade items in the historic era of Micronesia. Although some may lament the fact that there are only three artifacts used in this study to examine changes that occurred to indigenous peoples during the historic period, these iron tools are extremely rare. When placed within the context of an important regional exchange system that existed before European contact, their importance is amplified. The iron tools found at the Metuker ra Bisech stone money quarry in Palau are the only direct evidence of tools of any kind being used in the carving of stone money. Oral traditions and ethnohistorical accounts testify to traditional technologies in Micronesia as being replaced after contact. The same could be said for stone money disk production.

Although the results and interpretations presented here are preliminary, continued investigations in the Palauan Rock Islands will improve the data existing about Yapese stone money quarrying and the cultural and technological transformations that took place through time. This is necessary not only for developing models of prehistoric and historic period interaction spheres but also to determine the extent of influence and change Europeans had on indigenous cultures in Oceania. It is hoped that future archaeological research in Micronesia can be more fully dedicated to

examining historically known exchange systems and the effects culture contact had on network participants. As Lightfoot (1995:200) duly notes,

> . . . any historical anthropological study that attempts to understand the long-term implications of culture contact must consider the archaeology of pre-contact contexts. . . . Without the prehistoric perspective, one cannot undertake comparative analyses of cultural transformations that took place before, during, and after European contact and colonialism.

Because of their small size and the vast distances between them, Europeans often ignored or found it difficult to locate many Micronesian islands. Interisland contacts between Micronesian societies was commonplace and persisted for centuries, leading to a variety of traditional and European goods being exchanged during the historic period, even though many islanders might never have been in direct contact with Europeans. Documenting the transfer and use of these goods archaeologically has great implications for helping understand how traditional societies in Micronesia changed over time and what were the technological, social, political, and economic transformations that took place. Some transformations, as in the case of stone money production, seem to have been mutually beneficial to each of the parties involved in their search for status, power, and wealth over a period of several centuries.

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