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The First Documented Prehistoric Gold–Copper Alloy Artefact from the West Indies

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Intensive excavations at Maisabel, a large ceramic-age site on the north coast of Puerto Rico, revealed a series of occupations spanning 12 centuries, from roughly 100 BC to AD 1200. In one of the early deposits, dating to the Hacienda Grande period, a small fragment of metal was recovered. Analysis by energy dispersive spectrometry revealed that the metal artefact is an alloy of gold and copper, with an overall weight composition of roughly 55% copper, 5% silver and 40% gold. This combination of elements is a product of smelting and is not a naturally occurring alloy. Objects made from gold–copper alloys were widely recorded in the ethnohistoric reports on the Taino Indians at Contact. However, prior to the Maisabel project, not one occurrence of this alloy has been reported from an archaeological context in the West Indies.

Keywords: GUANÍN, GOLD–COPPER ALLOY, ENERGY DISPERSIVE SPECTROMETRY, BACKSCATTERED ELECTRON MICROSCOPY, SCANNING ELECTRON MICROSCOPY, DIGITAL X-RAY MAPPING, EARLY CERAMIC AGE, WEST INDIES.

Introduction

In 1492 Christopher Columbus and his colleagues arrived in the New World. Thinking that they had made it to the Far East, they began questioning the Amerindians of the Bahamas as to sources of gold, pearls and spices. These Indians indicated that Columbus would find what he was looking for in lands to the east of the Bahamas. Eventually, Columbus came to the island of Hispaniola (present day Haiti and Dominican Republic), where he encountered the complex chiefdoms of the Classic Taínos. He believed that he had found the fabled land of Cipango (Japan). Columbus and other observers noted that the Taíno Indians treated objects made from gold with great reverence (Las Casas, 1951; Columbus, 1959; Oviedo, 1959). The Indians referred to gold-fabricated ornaments as *guanín*.

Upon analysis of gold objects, the Spanish found that they were in fact alloys of copper and gold: "Most of the wrought gold possessed by the Indians is base, containing copper.

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They make it into jewels and ornaments with which the men and women adorn their bodies. In fact, it is the thing which they esteem and prize above all others" (Oviedo, 1959: 107). Although gold and copper were available locally, especially in the central mountains of Hispaniola, the conquistadores indicated that the Taínos did not produce alloys themselves, but received smelted metals, through trade, from South America (Sauer, 1966: 61).

Until recently, the archaeological evidence for the use of *guanín* was non-existent. The chronicles suggest that objects fabricated from gold were reserved for use by the chiefs and others of their class (Rouse, 1948: 527). Limiting access to scarce and desirable resources is one method for monopolizing power and high status (Helms, 1988).

In his review of metal-working among the Taíno Indians of Hispaniola, Vega (1979) observed that locally available gold and copper were used in making ornaments. A small handful of artefacts fabricated from pure forms of these materials have been recovered from sites in Haiti, Dominican Republic, Puerto Rico and Cuba (Miguel Alonso, 1949; Vega, 1979: Tables 2 and 3). There seems to be a consensus among archaeologists and ethnohistorians that the alloy, *guanín*, was imported from South America. Vega (1979: 37) observes that it is possible for gold, copper and silver to be found as a naturally-occurring alloy. He defers, however, to the consensus opinion that the alloy used by the Taínos was probably brought from South America into the Antilles, suggesting, following Rivet & Arsandaux (1946), Guyana as a potential source.

A further problem noted by Vega is that no examples of *guanín* have been recovered archaeologically (Vega, 1980: 488). It is likely that the Spaniards sent much of the gold, pure and in alloy form, to Spain, where it was melted down. Nonetheless, it would be helpful to substantiate ethnohistoric observations with archaeological data when discussing the use of *guanín* by prehistoric groups.

In this paper we describe the first documented occurrence of *guanín* recovered archaeologically in the West Indies. One of us (PES) directed the excavation of a large ceramic-age site, called Maisabel, which is located on the north central coast of Puerto Rico (Figure 1). Radiocarbon dates and ceramic styles indicate that the site was occupied continuously for roughly 1200 years, from 100 BC to AD 1200 (Siegel, 1990, 1991).

The initial occupants of Maisabel established the basic ground plan of the village, which was elaborated upon by succeeding groups. The core of the village, spatially and socially, is represented by a cemetery. Burials from all occupations are present in the cemetery (Siegel, 1991: Table 2). Surrounding the cemetery is a series of five middens arranged in a horseshoe configuration. Siegel has argued elsewhere that these middens and the cemetery, combined, represented a cosmological, social and political focal point for the settlement occupants (Siegel, 1989: 197–201). The most elaborate items retrieved during the excavation are derived from the middens surrounding the cemetery. In two of the middens, the density of cultural material is so great as to produce discernible mounds; these are referred to as "mounded middens" (Figure 2). The fragment of metal under discussion in this paper was found in Mounded Midden 1.

Mounded Midden 1

Mounded Midden 1 is a large circular feature 70 m in diameter and nearly 2 m high. A long L-shaped trench was excavated through the center of this midden. Based upon artefact styles, Mounded Midden 1 dates primarily to the Hacienda Grande complex of the Cedrosan Saladoid subseries. However, the Cuevas cultural complex is also represented in this midden. Carbon samples in good cultural context reveal a continuous spread from roughly 170 BC to AD 480. Calibrating the dates using the method devised by Stuiver & Becker (1986) extends the range from 349 BC to AD 640 (2 sigmas).

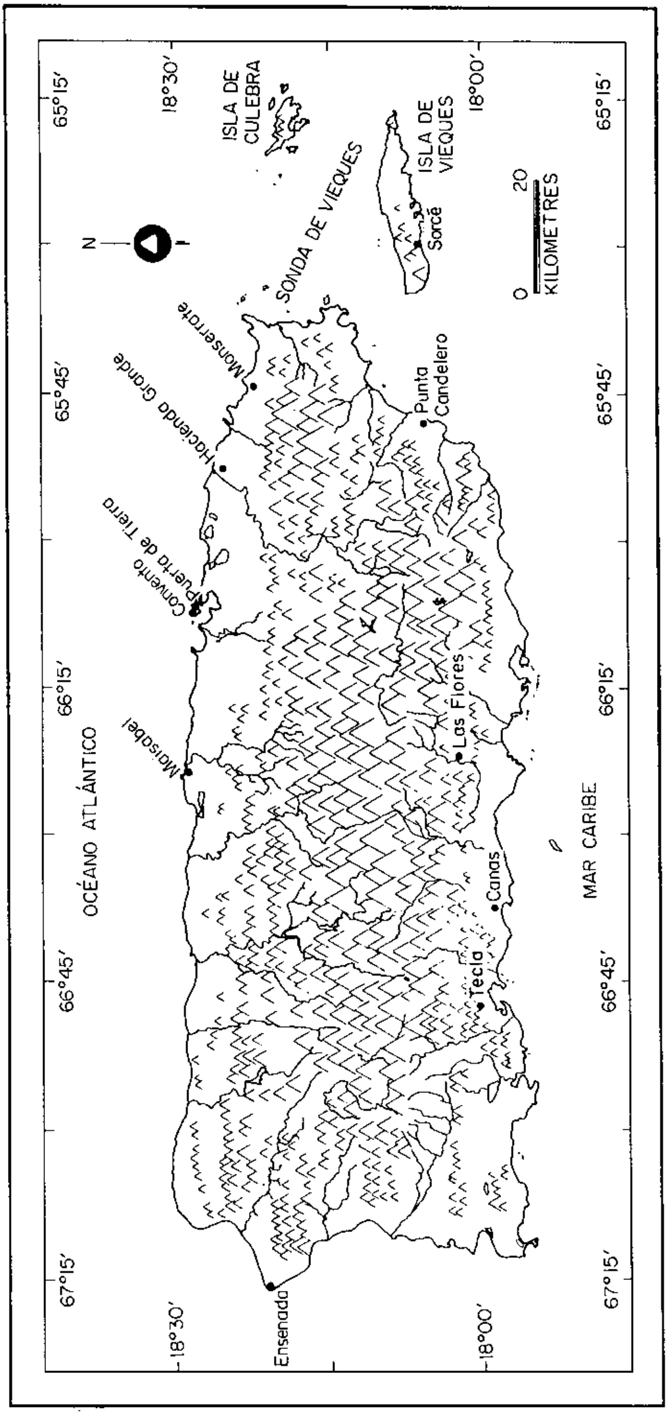
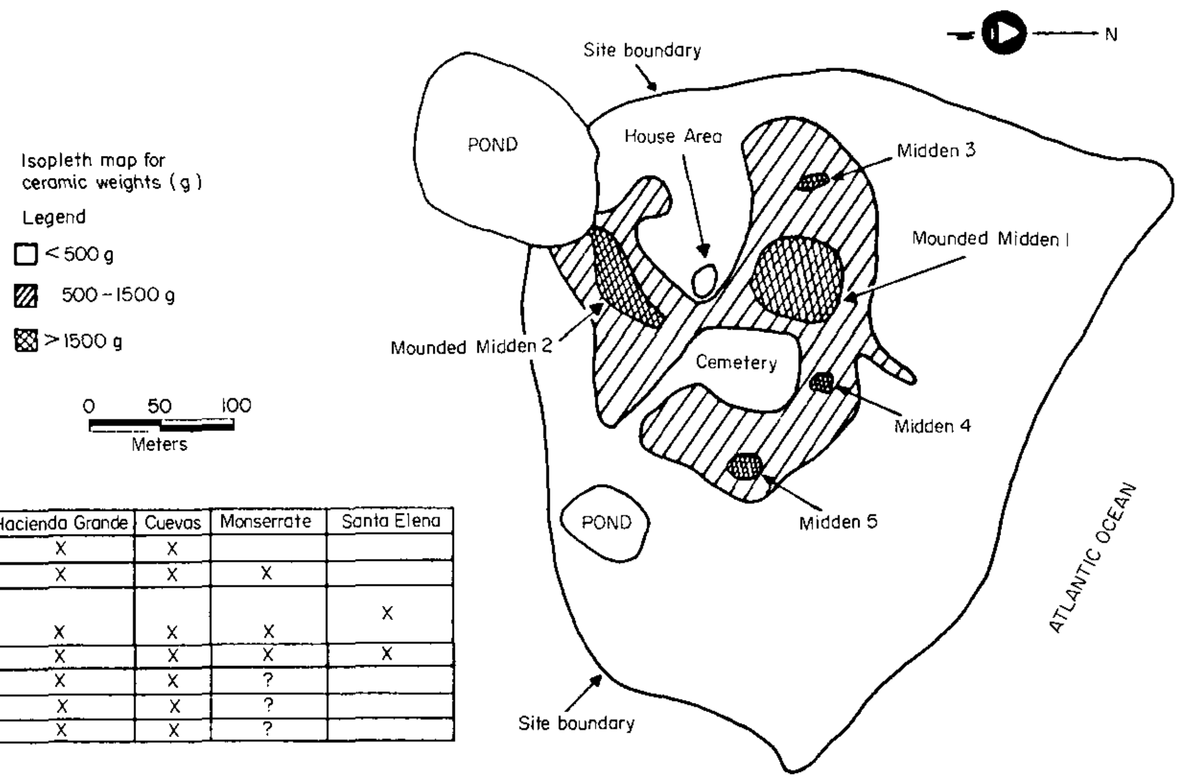


Figure 1. Map of Puerto Rico showing the locations of the known early Saladoid sites. The perimeter of the island is defined by a flat coastal plain and the interior is mountainous.



	Hacienda Grande	Cuevas	Monserrate	Santa Elena
Mounded Midden I	X	X		
Mounded Midden 2	X	X	X	
Macroblock House w/ditch Other features	X	X	X	X
Cemetery	X	X	X	X
Midden 3	X	X	?	
Midden 4	X	X	?	
Midden 5	X	X	?	

Figure 2. The Maisabel site showing the distribution of prehistoric pottery, by weight, recovered from test pits. The major site sections are labelled. The inset chart gives the chronological affiliations of the site sections.

In the first level of a 2 × 2 m excavation unit, N106W10, a small flake of hammered metal was recovered (Figure 3). It is 10 mm long, 7 mm wide, 0·2–0·4 mm thick and it weighs 0·115 g. The object was clearly part of a larger flat artefact that was perhaps round or oval (Figure 3). One of us (KPS) analysed the specimen by energy dispersive spectrometry (EDS) to determine its elemental composition.

Materials and Methods

A Kevex 8000 energy dispersive spectrometer on a Cameca SX50 microprobe was used to examine the metal fragment. The specimen was examined with a 2nA 25keV electron beam. Digital X-ray maps were produced with a pixel size of 0·125 μm using data generated by the EDS. These X-ray maps illustrate the spatial relationships between the various elements in the sample, although to some extent they also reflect its surface topography (see for instance the scratch in the upper right-hand portion of the X-ray maps [Figures 5–8]). A series of points was selected for analysis by searching for flat areas of the specimen that were relatively free of dirt adhering to its surface. Backscattered electron images of the artefact revealed both bright (high average atomic number) and dark (low average atomic number) areas, indicating that the composition of the specimen was not homogeneous. The various areas were analysed by EDS.

Polishing the surface flat would allow for more accurate measurements, but given the destructive nature of this procedure and the importance of the artefact we decided not to do this. At this stage of research, a qualitative determination is more important than precise quantitative assessments. The analyses were compared to standards of pure gold (Au), pure silver (Ag) and pure copper (Cu).

Results

Surface topography, mapped by secondary electron images (Goldstein *et al.*, 1981), showed the surface to be gouged and scratched in places and to be generally pitted. The uneven nature of the surface contributed to the inconsistent quality of the quantitative elemental analyses.

Viewing the specimen by backscattered electron micrography, which maps average atomic density (Goldstein *et al.*, 1981), reveals that portions of the surface were interrupted by numerous large dark and smaller bright areas. These areas of atypical atomic density were not readily recognizable by surface topography alone. Spectra of the dark areas indicated the presence of varying amounts of silicon, aluminum, potassium, calcium and iron, all typical components of clay. In some cases, clay particles were seen adhering to the specimen; in others, the clay appeared to be embedded in the surface (Figure 4). The presence of clay is indicated by the bright areas in Figure 5. Analysis of 26 points of the specimen matrix yielded a mean composition of 53·5 weight % copper (SD = 0·9), 4·8 weight % silver (SD = 0·3) and 40·1 weight % gold (SD = 0·5). These weight percentages total 98·3% owing to the specimen surface roughness. Analysis of 13 points from four selected high gold areas revealed a composition different from the matrix. As expected, gold was high, with a mean weight % of 66·6, followed by copper (23·0 mean weight %) and then silver (1·0 mean weight %). The specific values vary across high gold areas; however, the pattern is the same (Table 1). The metal artefact clearly is composed of gold, copper and silver (Figures 6–8). The overall weight composition of the piece is roughly 55% Cu, 5% Ag and 40% Au. There are inclusions within the matrix that are considerably higher in gold and correspondingly lower in copper and silver (Table 1).

Discussion

Energy dispersive spectrometry, combined with three microscopic imaging methods (scanning electron, backscattered electron, and digital X-rays), has determined, for the

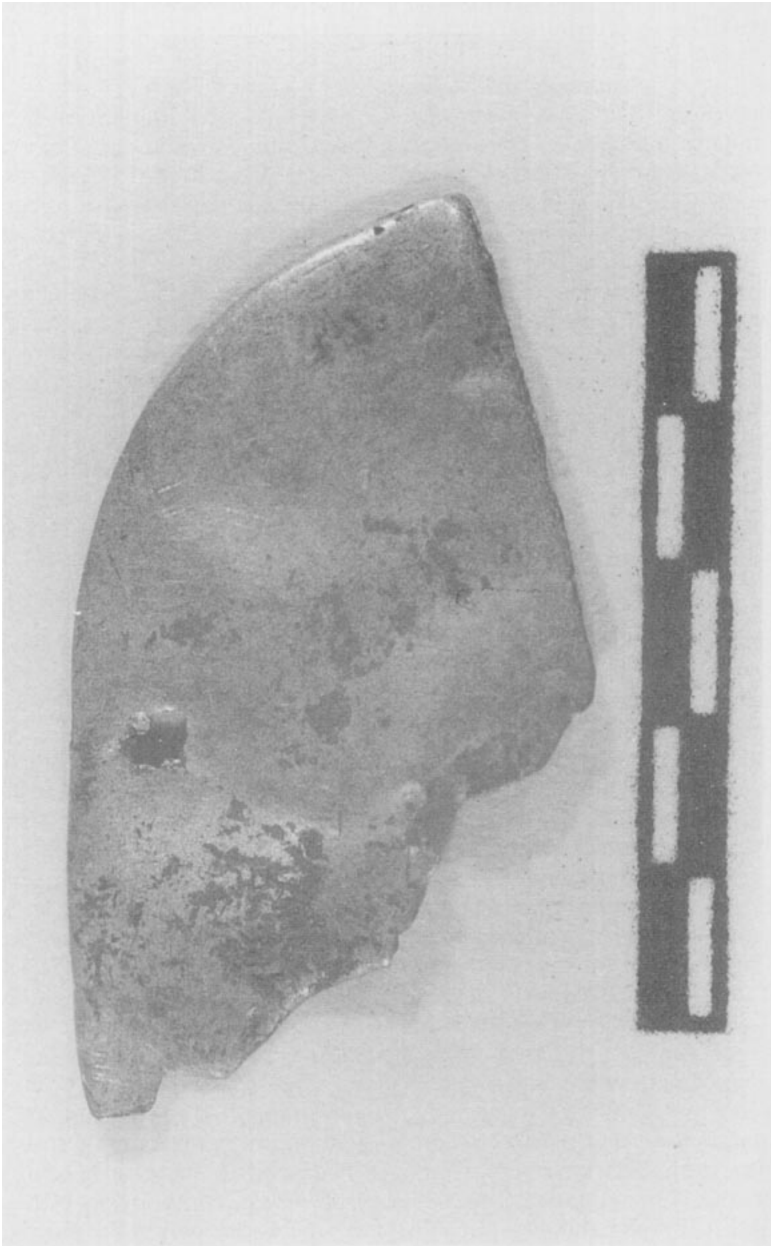


Figure 3. Top view of the *guanin* fragment. The scale bar is 1 cm long.

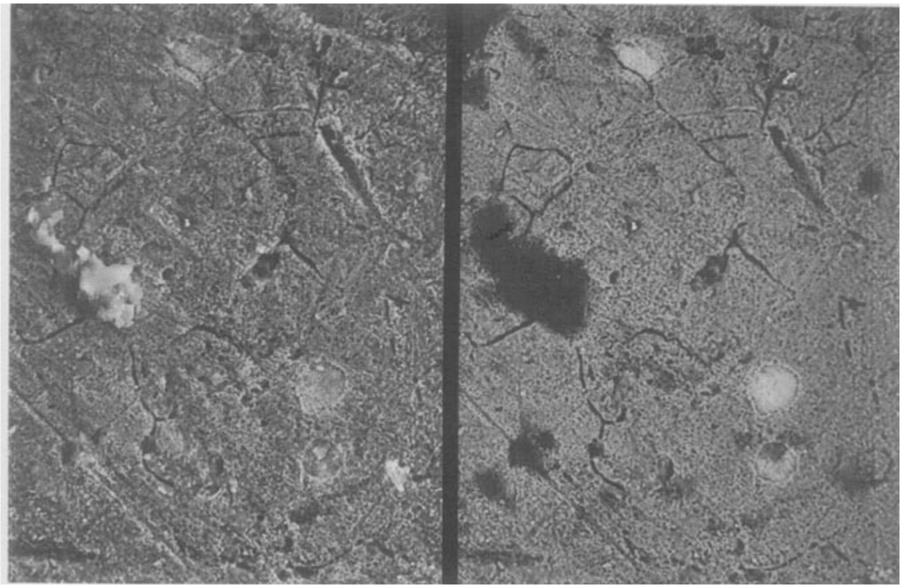


Figure 4. Two photographs showing the same location. Each photograph displays an area 52 µm wide. The secondary electron image (left photograph) maps the surface topography of the specimen. Notice the scratched and gouged appearance. A clay particle is seen adhering to the surface, at the left side of the photograph. The backscattered electron micrograph (right photograph) shows the clay particles and the scratches as dark areas. Bright areas have higher atomic numbers than dark areas. The small high gold areas are the brightest spots. (Figures 5–8 are digital X-ray maps for the same area as in this Figure.)

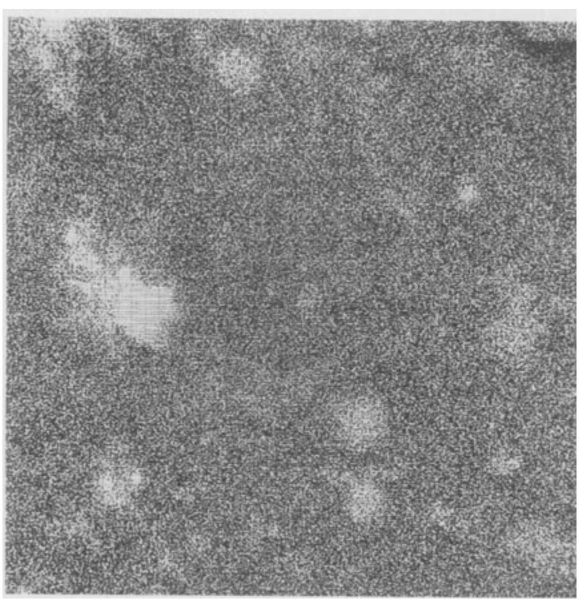


Figure 5. Digital X-ray map for silicon distribution. The bright areas, showing high silicon content, reflect clay particles adhering to or embedded in the surface. The area of magnification is 64 µm on a side.

Table 1. Percentage distribution, by weight, of the elements in the metal fragment

Sample location	Cu	Ag	Au
Matrix	54·8	4·9	40·1
Matrix	54·0	5·0	39·8
Matrix	54·4	4·7	40·6
Matrix	53·9	4·5	40·0
Matrix	52·8	4·5	39·3
Matrix	51·9	4·7	38·7
Matrix	51·6	4·1	40·1
Matrix	52·8	5·2	39·9
Matrix	52·3	5·1	39·1
Matrix	53·9	5·3	40·0
Matrix	53·8	4·8	40·1
Matrix	53·0	4·7	39·8
Matrix	53·8	4·9	40·5
Matrix	53·4	4·8	40·0
Matrix	54·0	4·5	40·6
Matrix	53·5	5·1	40·4
Matrix	54·3	3·9	40·2
Matrix	54·7	4·8	40·9
Matrix	54·0	4·6	40·6
Matrix	54·5	4·5	40·5
Matrix	53·1	4·5	39·6
Matrix	52·4	4·7	39·7
Matrix	52·6	5·0	40·2
Matrix	53·4	4·3	40·5
Matrix	53·4	4·5	39·9
Matrix	52·4	4·9	39·4
Matrix: mean	53·4	4·7	40·0
Matrix: SD	0·8	0·3	0·5
High gold area (1)	15·9	0·0	72·1
High gold area (1)	14·0	0·0	73·3
High gold area (1)	12·3	0·0	73·6
High gold area (1)	11·2	0·0	75·3
High gold area (1):			
mean	13·3	0·0	73·6
SD	2·0	0·0	1·3
High gold area (2)	20·3	0·1	68·4
High gold area (2)	12·5	0·1	72·2
High gold area (2)	10·9	0·0	73·7
High gold area (2)	11·0	0·7	72·6
High gold area (2):			
mean	13·7	0·2	71·7
SD	4·4	0·3	2·3
High gold area (3)	37·4	3·3	58·8
High gold area (3)	34·7	3·0	60·6
High gold area (3)	44·2	3·8	51·5
High gold area (3):			
mean	38·8	3·3	57·0
SD	4·8	0·4	4·8
High gold area (4)	40·1	0·9	52·1
High gold area (4)	33·6	0·1	60·3
High gold area (4):			
mean	36·8	0·5	56·2
SD	4·5	0·5	5·8

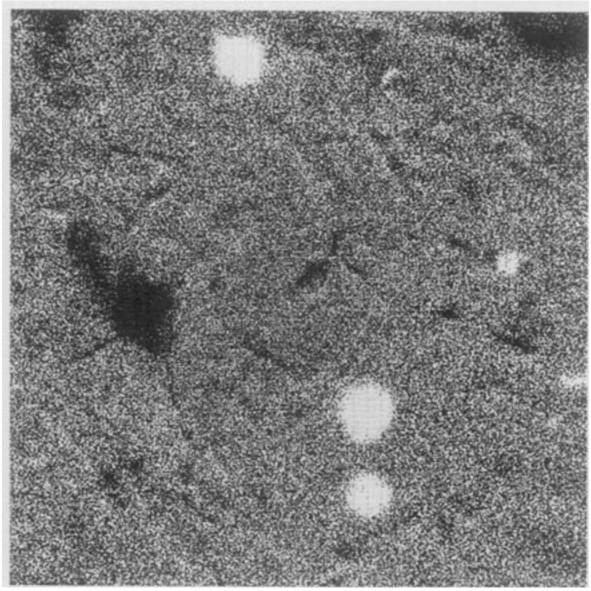


Figure 6. Digital X-ray map for gold distribution. The high gold areas show up as very bright spots within the specimen matrix. The area of magnification is 64 μm on a side.

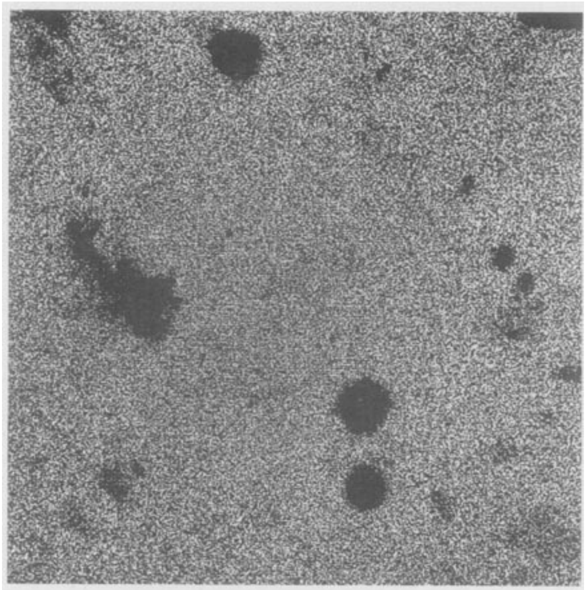


Figure 7. Digital X-ray map for copper distribution. In this photograph, the matrix appears brighter than the high gold areas. This is because there is considerably more copper in the matrix. The areas of high gold are relatively low in copper content. The area of magnification is 64 μm on a side.

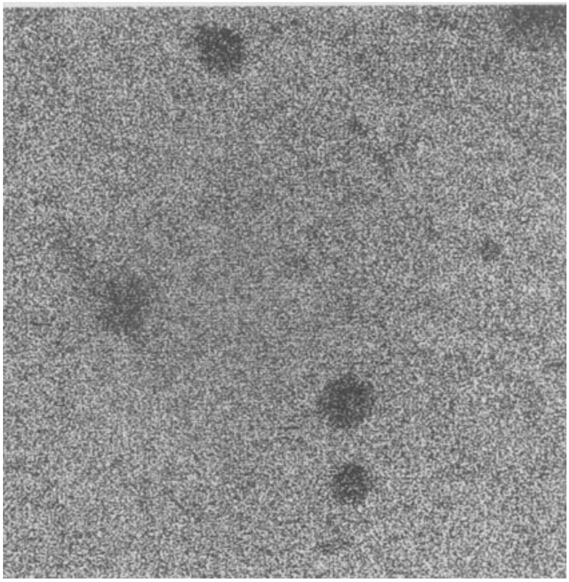


Figure 8. Digital X-ray map for silver distribution. Silver is present in much smaller amounts than gold and copper. Like copper, it is most prevalent in the specimen matrix, thus imparting a brighter appearance to that region. The area of magnification is 64 μm on a side.

first time, that *guanin* was used by prehistoric peoples in the West Indies. Prior to this analysis, our information on the subject was derived solely from ethnohistorical sources.

The elemental composition of the *guanin* fragment suggests that the piece was made by smelting, rather than being a naturally occurring alloy. Native gold is frequently found with silver. If it contains 5–15% silver it is referred to as argentian gold. Native gold with 20% or more silver is called electrum gold. The Maisabel specimen, with a mean Ag content of 4%, approaches the lower range of argentian gold. Native gold with copper (cuprian gold) contains 0·10%–20% Cu. Native copper–gold compounds are not found with more than 3% Au. Our sample contains roughly 55% Cu and 40% Au, thus it is unlikely to be a natural alloy. (In discussing prehistoric Andean alloyed artefacts called *tumbagas*, Lechtman noted that the concentrations of gold and copper found in them could not have occurred naturally: "Copper–gold alloys are not usually the products of the smelting of a naturally occurring mixture of minerals. ... To make a copper-gold alloy, one normally has to add one metal to the other and melt them together" [Lechtman, 1979: 30].) In addition, native gold does not contain percentage amounts of both silver and copper. (See Boyle [1979] for an extensive discussion of gold and its mineralogy.) The overall composition of the Maisabel specimen indicates that it was not hammered out from some form of native gold. The high gold inclusions may be the result of incomplete melting of the original native gold, or perhaps an insufficient smelting time for the combined elements to reach a homogeneous composition.

It is conceivable that more copper originally was present in the piece. Alloys with copper frequently suffer from corrosion, especially when buried in moist soil (Root, 1961: 253–254). The pitted appearance of the Maisabel specimen may be a product of copper corroding out of its surface.

It is important to note that the specimen of *guanin* was found in a Hacienda Grande-period deposit. In addition to artefact styles of this complex, a sample of carbon located near the *guanín* yielded a date of ad 140 ± 60 (Beta-14993, calibrated AD 70–374, 2 sigmas). This suggests that *guanín* had a long history of use in Puerto Rico (and undoubtedly Hispaniola) prior to Contact in the 15th century AD. The question still unresolved is whether Hacienda Grande peoples produced the alloy themselves or imported it from South America. To date, no kilns or ovens have been recovered archaeologically in the West Indies that could be used to attain the high temperatures necessary for melting gold or copper (1063°C and 1084°C respectively [Root, 1951: 77]). This negative evidence, however, may very well be a product of excavation strategy; until recently excavations in the West Indies have focused primarily on the thickest midden deposits to the exclusion of other settlement areas.

A possible specimen of *guanín* was found in one of the Hacienda Grande deposits at the Sorcé site on Vieques (Chanlatte Baik, 1984: Plate 45-A). Chanlatte refers to this flat hammered object as gold, although based on surface colouration we suggest that it is an alloy of gold and copper. If this is the case, then we have two occurrences of *guanín* recovered archaeologically, both from early ceramic-age deposits.

There is evidence that the Saladoid groups of the West Indies participated in far-flung trade networks, which included at least northern South America. Pendants, amulets and beads made from such non-local stones as amethyst, aventurine, quartz, beryl, peridot, and garnet have been found in numerous Saladoid deposits. Suggested sources for some of these materials are Brazil, Guyana, Venezuela, and Colombia (Harrington, 1924; Vescelius & Robinson, 1979; Chanlatte Baik, 1984; Boomert, 1987; Cody, 1991). It is likely that in addition to rocks, other materials flowed through the trade networks. Within the framework of systematic trading, it is conceivable that *guanín* was another product of exchange (Boomert, 1987: 38; Whitehead, 1990). This assertion remains to be demonstrated, however, with further archaeological research combined with geological source studies.

Finally, alloys similar to the Maisabel specimen, referred to as *tumbagas*, are documented for northern South America and portions of Central America (Root, 1949, 1961; Easby, 1956; Pérez de Barradas, 1958; Stone & Balser, 1958; Lechtman, 1979; Lothrop, 1979; Reichel-Dolmatoff, 1988). Root observed that many artefacts fabricated from *tumbaga* were derived from hammered sheets (Root, 1961: 249). He argued that a chronological sequence of metal artefacts could be established based on metallurgical techniques, including the relative percentages of gold and copper in alloyed objects (Root, 1961: 252–256). According to Root, *tumbagas* with 45% or more copper tended to be employed by groups more frequently in later time periods than earlier ones (Root, 1961: Figures 5, 6). Reichel-Dolmatoff recently disputed this observation based on the lack of reliable radiocarbon dates and poor recovery methods of the metal artefacts (Reichel-Dolmatoff, 1988: 15).

The major findings of the present study are two-fold: (1) The use of *guanín* in prehistoric Puerto Rico has been documented archaeologically. (2) *Guanín* has a long antiquity prior to the late prehistoric and Contact-period Taíno chiefdoms, providing support for the argument that there was an in-situ process of culture change from the early to late ceramic age.

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