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Mass spectrometric analysis of ancient Maya greenstone artifacts from Pacbitun, Belize

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ABSTRACT

The advent of high mass resolution mass spectrometry and matrix-assisted laser desorption/ionization has presented an opportunity for pursuing determination of elemental compositions and structural characteristics of jade and jade-like materials and, in so doing, permit ready and precise identification of such materials. A pair of Early Classic period (ca. 250–600 CE) Maya carved, greenstone pendants (Specimens A and B) from the site of Pacbitun (Belize), together with a tourist-type green pendant (Specimen KMM) from British Columbia (Canada), have been examined by Fourier transform ion cyclotron resonance mass spectrometry (FTICR-MS) to obtain mass spectra, with high mass resolution, of ions produced by matrix-assisted laser desorption/ionization (MALDI). Specimens A and KMM were subjected also to inductively-coupled plasma mass spectrometry (ICP-MS) to determine the principal metallic elements present. Such analyses provide a detailed elemental characterization of jade and jade-like materials; high mass resolution mass spectra permit unambiguous identification that should prove useful in future technical and comparative analyses of similar Maya greenstone artifacts. The methods may also prove useful, commercially, for authentication studies undertaken by museums and other institutions.

1. Introduction

The ancient Maya archaeological site of Pacbitun is located in the Cayo District of western Belize (Fig. 1). The site is about 240 m above sea level, in a region which straddles the rolling hills between the Mountain Pine Ridge and the tropical forest covered lowlands of the Upper Belize River Valley (Fig. 2). First reported in the 1970s, Pacbitun was excavated extensively in the late 20th century by Paul F. Healy (1988, 1990a, 1992), Healy and Emery (2014) and Healy et al. (1995, 2004, 2007, 2008) and, more recently, by Terry G. Powis (2010, 2015, 2016) and Powis et al. (2009). Based on the findings of these multi-year investigations, it is evident that the site was inhabited very early in Maya history, ca. 900 BCE, and flourished during the Maya Classic Period (ca. 300–900 CE), before being abandoned like many other lowland Maya centers during the so-called Classic Maya Collapse (Demarest et al., 2004).

The central part of the site lies atop a partly artificial, east-west acropolis of limestone, and is marked today by over 40 large masonry structures surrounding five major plazas (Fig. 3). The site Epicenter includes multiple temple-pyramid constructions (Plaza A), the palaces of the royal court (Plazas B and C), and an early ballcourt (Plaza E). There are several elevated, paved causeways (*sacbeob*) which radiate outward to other monumental architectural complexes. The Epicenter is also marked by the presence of the broken remains of at least 20 stone monuments (13 stelae and 7 altars, to date). Most of these monuments are plain, but two (Stela 6 and Altar 3) are carved with ornate imagery (likely depictions of early site rulers in ceremonial regalia) and hieroglyphic texts (Healy, 1990b; Helmke et al., 2006; Skaggs et al., 2017). Both of these fragmented carved remains have imagery which dates to the Early Classic period (ca. 250–600 CE), a time when Pacbitun clearly was a wealthy and influential Lowland Maya political center.

In 1986–1987, project excavations focused heavily on Structure (Str.) 1, the largest and tallest architecture at the site. Standing 12 m above Plaza A, Str. 1 was trenched axially, penetrating as much as 8 m into the core of the structure, exposing a series of earlier, smaller, encased buildings, representing at least five major phases of construction. Of special interest was an elite Maya burial associated with Phase 3, and the Early Classic period. Labeled Burial (BU) 1–6, the grave was located on the primary axis (west face) of Str. 1, below a stair. It held the skeletal remains of two adult individuals, one male (the primary individual) lying on his back (dorsal) in an extended position, head to the south, and a second individual, female, who likely was placed originally

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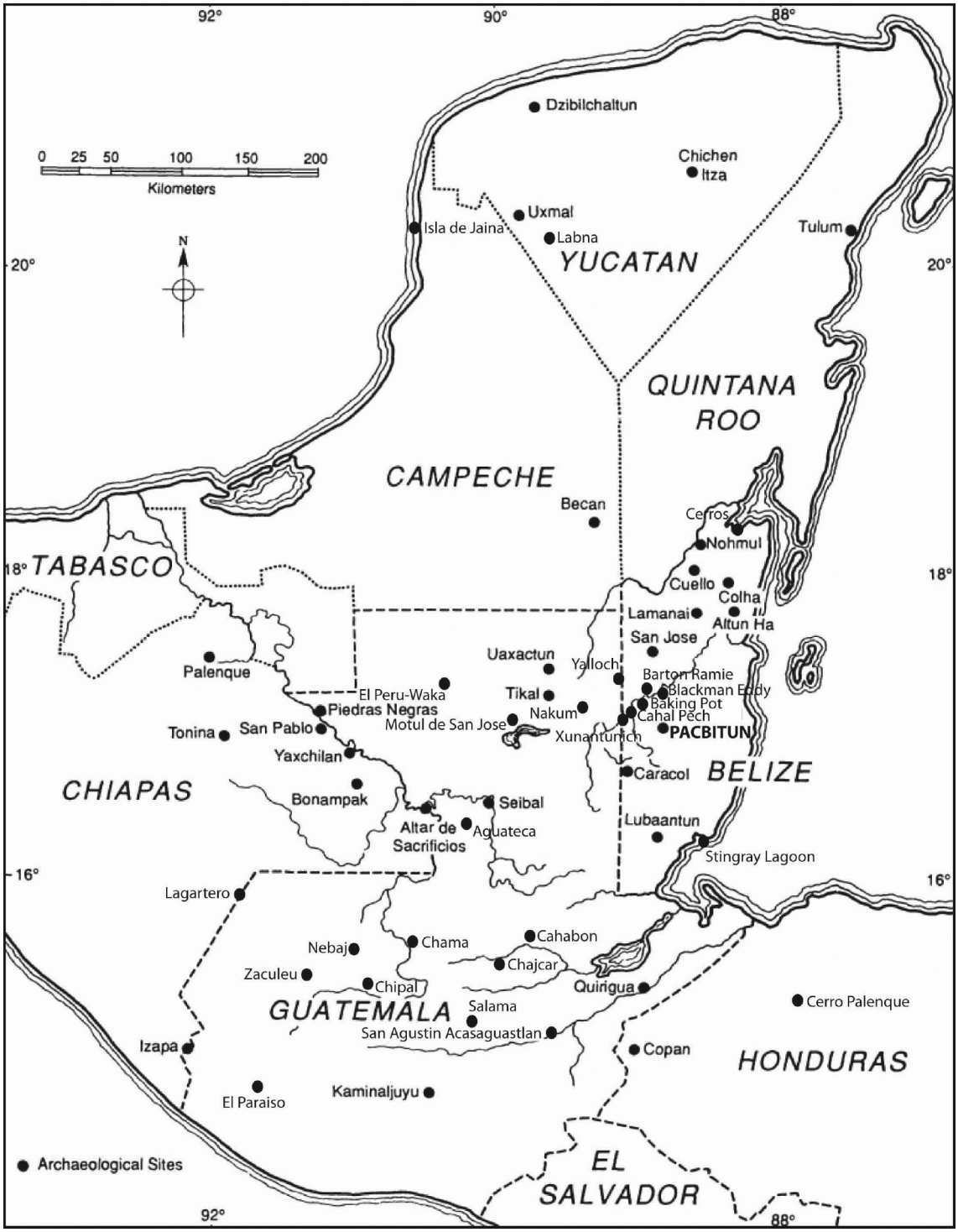

Fig. 1. Map of Belize, detailing location of the Maya site of Pacbitun.
(Courtesy of K.F. Cheong)

in a seated position (Helmuth, 1989). The grave bore features defining it as an elaborate crypt, about 2 m long and 1 m tall. The burial chamber was covered with 16 large roofing stones, atop which the Maya had placed dense layers of thousands of chert flakes as a ritual funerary cover and grave marker.

The central location, quality of workmanship, style of grave construction, and massive covering of flakes indicate the burial was that of a prominent Pacbitun individual and accompanying consort or slave. BU 1–6 contained an array of funerary offerings, including 11 slipped and painted ceramic vessels (3 dishes, 6 bowls, 1 jar and a vase), a polished slate (or possibly volcanic stone) mace, as well as two carved shell (likely *Strombus gigas*) disks, and a matching pair of drilled and decorated greenstone ornaments (possibly pendant earrings). Based on the architectural stratigraphy of Str. 1, the distinctive vessel forms, and the style of decoration on one polychrome vessel, BU 1–6 is dated to the Early Classic period. This pair of beautifully carved, greenstone objects found in BU 1–6 is the focus of our study and paper. The primary research question was: Could inductively-coupled plasma mass