Chemical paste characterization of Late Middle Preclassic-period ceramics from Holtun, Guatemala and its implications for production and exchange

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Abstract
This study uses type: variety-mode classification, digital stereomicroscopy, and Neutron Activation Analysis (NAA) to characterize the paste composition of Late Middle Preclassic-period pottery at the site of Holtun, Guatemala. The sample consists of 98 sherds including unslipped utilitarian ware, slipped serving ware, and Mars Orange fine paste serving ware. NAA reveals four paste composition groups that approximate types produced through type: variety-mode classification and paste groups recognized by digital stereomicroscopy. The analysis suggests a pattern of production in which unslipped utilitarian vessels, slipped serving vessels, and Mars Orange fine paste serving vessels were produced using different paste recipes. While unslipped utilitarian vessels and slipped serving vessels may have been produced and consumed locally, Mars Orange fine paste serving vessels were likely produced in or around Holtun but consumed more widely. Results of this research suggest the Late Middle Preclassic-period ceramic economy at Holtun was characterized by incipient specialized production, and exchange of at least one ceramic ware. These results advance our understanding of Late Middle Preclassic-period ceramic production and exchange at Holtun, and inform the study of the development of socio-political complexity in the Maya lowlands.

1. Introduction
The Middle Preclassic period (1000–300 BCE) witnessed the development of complex society in the Maya lowlands. Previous and more recent investigations have revealed the origins of monumental architecture, long distance exchange of jade and obsidian, social hierarchy, and organized ritual during the Middle Preclassic (Doyle, 2012; Inomata et al., 2013; Hammond, 1995; Rice, 2015; Traxler and Sharer, 2016). Despite this research, there are few studies that focus on Middle Preclassic-period ceramic economy, and no published studies on ceramic production using compositional data. This is unfortunate, as previous study in the Maya lowlands using multiple forms of paste composition analysis have allowed archaeologists working on ceramics from the Classic and Postclassic periods to reconstruct ceramic production and exchange systems, as well as infer networks of socio-political interaction (Bishop and Rands, 1982; Cecil, 2013; Foias and Bishop, 1997; Halperin and Bishop, 2016; Neff, 1989; Reents-Budet et al., 1994; Reents-Budet et al., 2004; Ting et al., 2015).

In order to address this gap, the authors undertook a study to characterize the paste composition of Late Middle Preclassic-period pottery at Holtun, Guatemala using type: variety-mode classification, digital stereomicroscopy, and Neutron Activation Analysis (NAA). The sample consisted of 98 sherds of unslipped utilitarian ware, slipped serving ware, and Mars Orange fine paste serving ware. Digital stereomicroscope analysis and NAA revealed discrete paste composition groups that approximated types produced through type: variety-mode classification. These analyses indicated a pattern of production in which unslipped utilitarian vessels, slipped serving vessels, and Mars Orange fine paste serving ware were produced using different paste recipes. While unslipped utilitarian vessels and slipped serving vessels may have been produced and consumed locally, Mars Orange fine paste serving vessels were produced using different paste recipes. While unslipped utilitarian vessels and slipped serving vessels may have been produced and consumed locally, Mars Orange fine paste serving vessels were likely produced in or around Holtun but consumed more widely. Results of this research suggest the Late Middle Preclassic-period ceramic economy at Holtun was characterized by incipient
specialized production, and exchange of at least one ceramic ware. These results advance our understanding of Late Middle Preclassic-period ceramic production and exchange at Holtun, and inform the study of the development of socio-political complexity in the Maya lowlands.

2. Archaeological background

Geographically, the Maya lowlands encompass the department of Peten Guatemala, Belize, eastern Mexico including parts of the states of Chiapas, Tabasco, Campeche, Quintana Roo, and Yucatan; and a portion of western Honduras (the state of Copan). Chronologically, the Middle Preclassic period spans approximately 700 years from 1000 to 300 BCE, with sites seeing occupation most frequently during the Late Middle Preclassic (600–300 BCE). It is during this time that multiple forms of settlements appear in the lowlands ranging from communities like Cuello (Hammond, 1999), K’axob (McAnany and Lopez Varela, 1999), and Chan (Robin, 2013) in Belize, to larger centers like Nakbe (Hansen, 1998), Seibal (Inomata et al., 2013), Cival (Estrada-Belli, 2006), and Tikal (Coe, 1965) in Guatemala, as well as Cahal Pech in Belize (Awe et al., 1990). Archaeological investigation of architecture, burials, artifacts, and landscapes at these sites reveal incipient, and in some cases established, signs of socio-political complexity including two or three-tiered settlement patterns, monumental architecture, specialized production, long distance exchange of hard stone, and unequal access to material, social, and political resources (Doyle, 2012; Estrada-Belli, 2010; Hammond, 1999; Hansen, 2001; Inomata et al., 2015; Rice, 2015; Traxler and Sharer, 2016). While typological analysis of ceramics has aided archaeologists in establishing site-wide chronologies and inferring interaction during the Late Middle Preclassic period (Callaghan and Neivens de Estrada, 2016; Culbert, 1993; Forsyth, 1989; Gifford, 1976; Kosakowsky, 1987; Sabloff, 1975), to date there are no published data on compositional studies of lowland Maya Late Middle Preclassic-period ceramics that can tell us specifically about production and exchange. One of the goals of the Holtun Archaeological Project was to perform compositional analyses on a sample of Late Middle Preclassic-period ceramics to create a database for this kind of material, begin formulating a model of Late Middle Preclassic ceramic production and exchange, and relate ceramic production to the development of socio-political complexity at the site.

Holtun, Guatemala has been the focus of investigations since 2010 (Kovacevich et al., 2012). The archaeological site of Holtun is an intermediate sized civic-ceremonial center with documented occupation beginning in the Late Middle Preclassic through Terminal Classic periods (600 BCE–900 CE) (Fialko, 1999, 2002, 2011; Kovacevich et al., 2012; Ponciano, 1995). The site is situated approximately 35 km southwest of Tikal and 12.3 km to the south of Yaxha (Fig. 1). The formal site consists of a monumental epicenter built atop a karstic hill positioned along a roughly northeast-southwest linear axis (Fig. 2). The approximate area of the epicenter is 970 × 815 m. The epicenter consists of 12 main groups and 86 structures all showing evidence of stone construction (Guzman, 2015). Major monumental architecture includes a Middle Preclassic period E-Group, Late Preclassic Triadic Group, ballcourt, stone-enclosed causeway, and various patio groups of stone architecture. Due to the presence of Late Middle Preclassic-period architecture and occupation, Holtun has yielded a significant sample of well-stratified ceramic material dating to the Late Middle Preclassic period that can be used for compositional analysis.

3. Materials and methods

3.1. Archaeological samples

The materials for this study consisted of 98 samples of archaeological ceramics from eight contexts dating to the Late Middle Preclassic-period...
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