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The floating gardens of Chan Cahal: Soils, water, and human interactions

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ABSTRACT

Ancient Maya wetland agriculture has been studied since the 1960s, but there are still too few multiproxy excavations to adequately portray this phenomenon. This paper builds on multidisciplinary and multiproxy research near the ancient Maya site of Chan Cahal, near Blue Creek, Belize, with two new excavations, four new cores, 22 new AMS dates, and a new review of the site's water chemistry and archeology. A long-term study of the site's water chemistry has shown its pervasive impacts on wetland formation and limits to agricultural uses. We argue that a reservoir in the midst of the wetlands became inundated above a paleosol during the earliest Maya occupation in the Middle Preclassic, was dredged out during a time of population expansion sometime in the Late Preclassic to Early Classic, and was filled again with 'Maya clay' during and after the Classic period. Vibracores through two wetland fields and one canal corroborated our earlier model of Preclassic through Classic inundation of a paleosol by peat formation, flood sands, clay deposition, and gypsum precipitation. These cores produced new evidence for field and canal construction starting in the Late Preclassic. A later addition was a platform added at the very end or after the main occupation ended in the Terminal Classic. A new excavation at Sayap Ha on the Coastal Plain wetlands 7 m lower than Chan Cahal experienced a similar history of inundation and aggradation. Here, Maya farmers reclaimed these wetlands with canals and raised fields late in the Late or Terminal Classic and abandoned them soon thereafter. The Sayap Hah fields thus parallel the BOP fields 9 km south since both were built and abandoned at a late stage. As a comparison with other wetland field studies, the stable C isotopes of soil humin through soil profiles showed a strong Classic period to present influence of C_4 species at Sayap Hah and an increase in C_4 inputs in the upper 25 cm at both Sayap Hah and the Chan Cahal platform, perhaps due to tropical pasture grasses prevalent here for the last 50 years.

1. Introduction

Indigenous agricultural use of wetlands in the Americas spanned 80° in latitude from North to South America and over millennia, yet we have few studies on the formation and chronology of these fields and how they worked (Luzzadder-Beach and Beach, 2009; Beach and Luzzadder-Beach, 2013). Scholars have been studying Ancient Maya wetland agriculture systems since the 1960s and have published widely divergent views about their chronology, existence, formation, and importance to Maya civilization (Sluyter, 1994; Pohl et al., 1996; Berry and McAnany, 2007; Beach et al., 2009, 2011, 2013; Luzzadder-Beach et al., 2012; Kennett and Beach, 2014). One ancient Maya wetland field system well known in the scientific literature is Chan Cahal, which has iconic landscape features with clear and arresting rectilinear fields and canals (Figs. 1–5). Our goals in this study were to synthesize the archeology of Chan Cahal, expand beyond Chan Cahal into the different environment of the coastal plain, and test two conspicuous features in the Chan Cahal wetland fields: a hypothesized platform and a central reservoir. This article refines our model of Chan Cahal's wetland field system using evidence from four new cores, two new excavations, twenty-two new AMS dates, and new carbon isotopic evidence as well as a synthesis of past excavations and water and soil chemistry. These lines of evidence reveal newly discovered wetland fields at lower elevations on the Coastal Plain and new features with both earlier (Late Preclassic) and later (Terminal or Post Classic) chronologies for the Maya use of these fields.

1.1. Background: previous model of Chan Cahal wetland fields

The Chan Cahal wetland field model grew out of multiple field and canal excavations that were up to 3 m deep and 20 m long, many chemical tests of soils and water, paleoecology proxies from pollen and phytoliths, and artifacts (Beach et al., 2009, 2013). This work traced sediment from the contributing escarpments and groundwater and into the fringing wetlands at the base of these escarpments. From upland slopes and sinks, we traced erosion in alluvial fans, terraces, sinkholes, floodplains, and the coastal plain. We also traced sediment sources from groundwater by determining solute loads in water sources with the key elements of calcium and sulfur varying from trace to saturation

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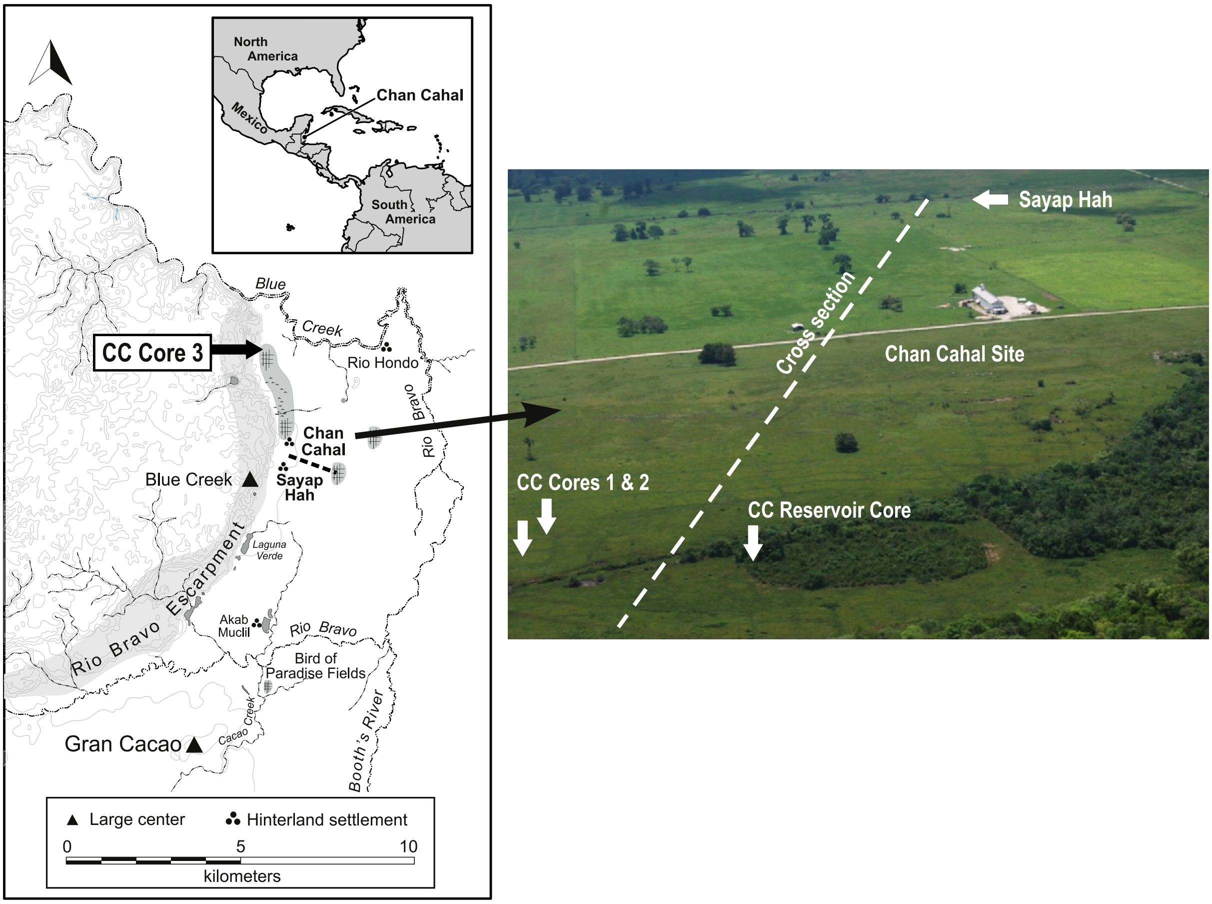

Fig. 1. Map of the Chan Cahal site and region.

levels (Luzzadder-Beach and Beach, 2009; Beach et al., 2009). The upland soil sinks indicated stable soil formation up through the Archaic period (c. 3 ka) before land use change created episodic erosion in the uplands and aggradation in depressions during the Maya Preclassic and Classic periods (c. 3 to 1 ka; Table 1 for periods) (Beach et al., 2009).

Wetland field formation at Chan Cahal had five stages (Fig. 2). At first, the upland plain at the foot of the Rio Bravo escarpment was a dryer agricultural zone from the Archaic period before 4000 BP (Table 1) based on the presence of *Zea mays* and other cultivars from nearby dated layers (Beach et al., 2009). Second, the plain was progressively inundated from the late Archaic period to the Late Preclassic about 2000 BP. We interpreted the stage of a rising water table to be in the Preclassic period based on the formation of organic soils (Histisols) above mineral soils (Vertisols). Third, sometime from the Late Preclassic to Classic period, the landscape aggraded with carbonate sands, gypsum precipitation, and sedimentation from upslope erosion. Fourth, sometime in the Classic period, Maya farmers built canals into the fields and also built them up from piling canal sediments onto the fields. We base the chronology of canal building mainly on the terminus ante quem AMS dates of infill into the canals, which start at the bottom largely in the Late and Terminal Classic Period around 1100 BP (Luzzadder-Beach et al., 2012). The fills of the fields are more mixed with most of them decreasing in age upward. Because most of the excavations showed more recent dates upward in the field profiles, we have hypothesized that these were mainly drained fields (not raised fields built from older, lower sediments) with the primary function of draining away excess water. The fifth stage is the canal fill after abandonment, dated by multiple sequences from the Late Classic to present. In the current work we refine this model with new evidence from surrounding fields and canals, a platform, a central reservoir, and a new archeological synthesis.

2. Area description

This region receives about 1500 mm of precipitation of which 80% falls from June through December (Beach et al., 2009). The area has the udic soil moisture regime on well drained slopes and hydric soil moisture regime in wetlands, and the soil temperature regime is isohyperthermic with monthly mean temperatures ranging from 26 to 32 °C (van Wambeke, 1987). The January–May dry season limits tree species diversity in this region to 30–60 tree species per hectare (Hartshorn, 1988; Brokaw et al., 1993), and the area of Chan Cahal has two main natural ecosystems: upland forest and wetland forest with a transition zone in between. There are also some tracks of wet savanna near the research area (Bridgewater et al., 2002).

Chan Cahal lies in the southern fringe of the Yucatan peninsula, a carbonate platform built from Jurassic through Paleogene period shallow ocean sediments. These carbonates emerged from the sea by the late Oligocene when geomorphic agents began to sculpt the landscape (King et al., 2003). The bedrock is back-reef, lagoonal limestone (Brennan et al., 2013; King et al., 2004; Vinson, 1962), known in this region as the El Cayo or Santa Amelia groups of the Lower Eocene (Flores, 1952; Vinson, 1962). The Rio Bravo escarpment is the easternmost prominent scarp within stair stepped topography formed by tension faulting that ranges from Belize to Guatemala's Peten (Dunning et al., 2002). The region is a fluviokarst environment controlled by karst weathering of carbonate strata and stream erosion forming mogote ridges and hills and a wide variety of karst sinks aided by variations of