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Earliest direct evidence of monument building at the archaeological site of Nan Madol (Pohnpei, Micronesia) identified using ^{230}Th/U coral dating and geochemical sourcing of megalithic architectural stone

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ABSTRACT

Archaeologists commonly use the onset of the construction of large burial monuments as a material indicator of a fundamental shift in authority in prehistoric human societies during the Holocene. High-quality direct evidence of this transition is rare. We report new interdisciplinary research at the archaeological site of Nan Madol that allows us to specify where and when people began to construct monumental architecture in the remote islands of the Pacific. Nan Madol is an ancient administrative and mortuary center and the former capital of the island of Pohnpei. It was constructed over 83 ha of lagoon with artificial islets and other architecture built using columnar basalt and coral. We employed geochemical sourcing of basalt used as architectural stone and high-precision uranium-thorium series dates (^{230}Th/U) on coral from the tomb of the first chief of the entire island to identify the beginning of monument building at Nan Madol in AD 1180–1200. Over the next several centuries (AD 1300–1600) monument building began on other islands across Oceania. Future research should be aimed at resolving the causes of these social transformations through higher quality data on monument building.

Archaeology has documented the independent invention of hierarchical societies among Neolithic farmers a number of times during the Holocene (Earle, 2002), frequently through studying the construction of monumental scaled religious architecture (Moore, 1996; Trigger, 2007). The construction of large burial architecture for the political elite is considered especially strong evidence of the authority of powerful leaders. On the remote islands of the Pacific, monumental architecture has proved a valuable metric in documenting chiefdoms and pre-modern states in the era just prior to European contact (Kirch, 1990, 2000, 2010; Kolb, 1994; Hommon, 2013). It has however been much more difficult to use this same line of evidence to examine the origins of hierarchical societies in the region in part due to a lack of well-dated direct evidence of monument building.

The earliest evidence of hierarchical societies and monument building on Pacific Islands come from two culture areas – Western Polynesia and Eastern Micronesia (Fig. 1). Early settlement in both areas began at 1550–1050 BC (3500–3000 cal yr BP) (Burley et al., 2010, 2012; Carson, 2014). The founding populations of these islands did not build large burial architecture out of durable materials. Polynesia's earliest monuments were built in Tonga and are dated by ^{14}C to AD 1320–1390 (630–560 cal yr BP, Wk-33583, coconut endocarp) (Clark and Reepmeyer, 2014), with other ^{14}C dates on unidentified charcoal from tombs associated with the ruling chiefs (Tui Tonga) used to estimate monument building as early as AD 1210–1260 (740–690 cal yr BP, Wk-18773, Wk-18784, Wk-18774, Wk-18775, Lapaha Site, Burial J09) (Clark et al., 2008). In Micronesia, an archaeological proxy for the area's first chiefs – ^{14}C dates on the start of an annual religious ceremony on the island of Pohnpei – date to AD 1200–1300 (relevant ^{14}C dates are on unidentified charcoal, 739–665 cal yr BP, SI-90 and 679–574 cal yr BP, Beta-9688) (Athens, 2007). Newly reported research on the

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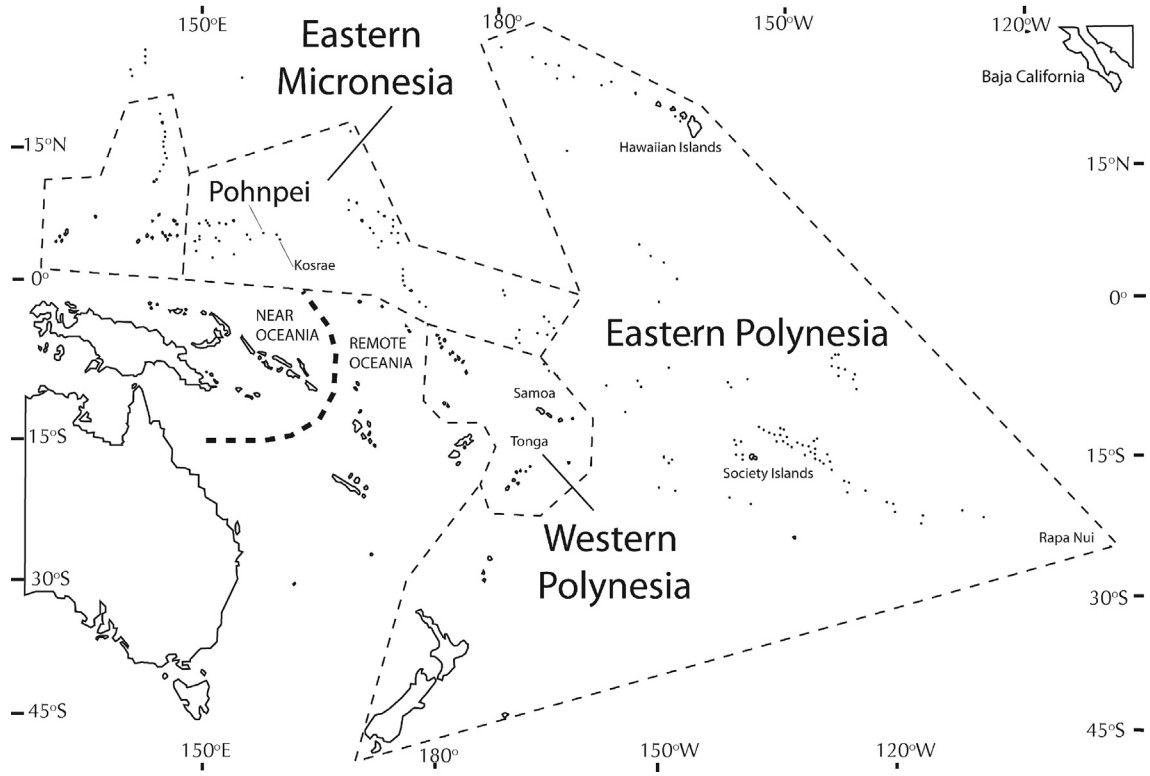

Fig. 1. Pacific Islands with archaeological evidence of monumental architecture. This map shows islands and island groups where archaeological evidence for the construction of monumental architecture in the pre-European contact era has been well documented: Eastern Micronesia (Pohnpei, Kosrae), Western Polynesia (Tonga, Samoa), and Eastern Polynesia (Hawaiian Islands, Society Islands, Rapa Nui). Following on previous studies of monuments (Smith, 2004; Clark and Martinsson-Wallin, 2007), we exclude Pacific Island fortifications, whose chronology has been discussed by Field and Lape (2010).

Micronesian island of Kosrae found mortuary construction as early as AD 1310 (640 ± 6.5 yr, Sample #42, Lelu Site, Burial Insol-1) based on a high-precision ^{230}Th/U date on coral (*Symphyllia* sp.) used as building material (Richards et al., 2015). In sum, our best evidence for the *terminus post quem* for the invention of hierarchical society in Oceania is AD 1300–1400, with less secure evidence for an earlier onset of monument building in AD 1200–1300.

Here we present new interdisciplinary research that pushes our earliest secure evidence of monumental architecture in the islands of the Pacific back more than a century. On the island of Pohnpei in Eastern Micronesia is the well-known site of Nan Madol (Hanlon, 1988); the largest archaeological site in Micronesia (McCoy et al., 2015). Nan Madol is an administrative and mortuary site built on artificial islets that stretches over 83 ha of shallow coral reef and was the center of the Saudeleur polity (Fig. 2). We used a portable x-ray fluorescence (XRF) to geochemically match columnar basalt stones used as architectural building material to their natural sources and ^{230}Th/U dates to determine the construction chronology of a tomb that oral histories identify as the resting place of the first chief to rule the entire island. Our results indicate that by AD 1180 (771 ± 7 yr, *Acropora* sp., Sample C-1) massive stones were being transported from a volcanic plug on the opposite side of the island for the construction of the tomb, and by AD 1200 (747 ± 6 yr, *Acropora* sp., Sample C-13), the burial vault had its first internment. This was followed in the next several centuries (AD 1300–1600) by the onset of monument building on other islands across Oceania (Kirch and Sharp, 2005; Clark and Martinsson-Wallin, 2007; Sharp et al., 2010; Kirch et al., 2015, Martinsson-Wallin et al., 2013). Future research should be aimed at determining the cause of this major turning point in the development of hierarchical societies on Pohnpei and why it was followed by new traditions of monument building over the next several centuries.

Archaeology of Pohnpei Island

Pohnpei is a high volcanic island in the Caroline Islands of Eastern Micronesia (Fig. 1). With a land area of 334 km^2 it is orders of magnitude larger than neighboring atolls and three times the size the next largest high volcanic islands in the group (Truk, 121 km^2; Kosrae, 111 km^2). At the time of regular European contact in the 19th century it is estimated to have had a population of 25,000 (Hanlon, 1988). The local language, Pohnpeian, is classified within the Oceanic language group (Shutler and Marck, 1975) but with a number of documented borrow words from Polynesia (Geraghty, 1994). The island was likely originally settled from the Southeast Solomon or Vanuatu island groups by people who had a Late Lapita ceramic tradition (Athens, 1990). The date of settlement has been estimated at AD 1 (1950 cal yr BP), but the current earliest ^{14}C date of human activity dates to AD 80–200 (1870–1750 cal yr BP) (Athens, 1990). Recent paleoenvironmental coring has highlighted the difficulties in recognizing the true age of settlement (Athens and Stevenson, 2012). Further, we note that although these dates are not in dispute, and fall within the pattern of initial island settlement of Eastern Micronesia, all published radiocarbon dates from archaeological deposits on the island fail to meet one or more of best practices criteria in terms of chronometric hygiene standards (e.g., failure to select short-lived plant taxa, not reporting the taxonomic identity of charcoal, greater than 10% error on ^{14}C dates, poor laboratory quality, and inadequate information on context especially in the case of unpublished gray literature reports) (Spriggs and Anderson, 1993; Rieth and Athens, 2013).

Pohnpeian oral traditions describe two major turning points in the island's political history. The first is the unification of the island's three districts and dozens of clans in to a single polity under a new ruler called the *saudeleur*, meaning the Lord of Deleur,

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