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# THE GEOARCHAEOLOGICAL CONTEXT OF TWO IRON AGE SITES IN NORTHEAST THAILAND

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## Introduction

This article reviews the geoarchaeological context of prehistoric settlement in the Upper Mun river valley, northeast Thailand (Fig. 1). It introduces the author's PhD research and then places this in the contexts of past research in this region and current research undertaken by members of the 'Origins of Angkor Archaeological Project' (OAAP) at Otago University, Southern Cross University, New South Wales and the Thai Fine Arts Department (Boyd 1997; Boyd *et al.* 1998, 1999; Chetwin 1998; Domett 1998; Higham and Thosarat 1997, 1998; O'Reilly 1997, 1998a,b, 1999; Rivett 1999; Talbot 1998; Tayles *et al.* 1998). The OAAP is the most recent collaborative research project co-directed by Charles Higham (Otago University) and Rachanie Thosarat (Thai Fine Arts Department). The OAAP aims to define and date the prehistoric sequence of moated settlements in the Upper Mun river valley (Fig. 1) to understand the nature of societies prior to the transition to state in mainland Southeast Asia (Higham and Thosarat 1997:1). Excavations were undertaken at eight sites in order to assemble sufficient information to chart social, economic, technological and environmental change from the Bronze Age (*c.* 1500 BC to AD 500) up to, and if possible, into the Proto-Historic era (*c.* AD 500-800).

## Location

The Upper Mun river valley, centred around the town of Phimai (Fig. 1), has been inhabited for more than three millennia (from *c.* 1500 BC). Phimai served as a foci for Khmer settlement, administration, commerce and religion from roughly AD 1000 to 1300. This valley is located in the southwest portion of the Khorat Plateau. The Plateau itself is made up of the smaller

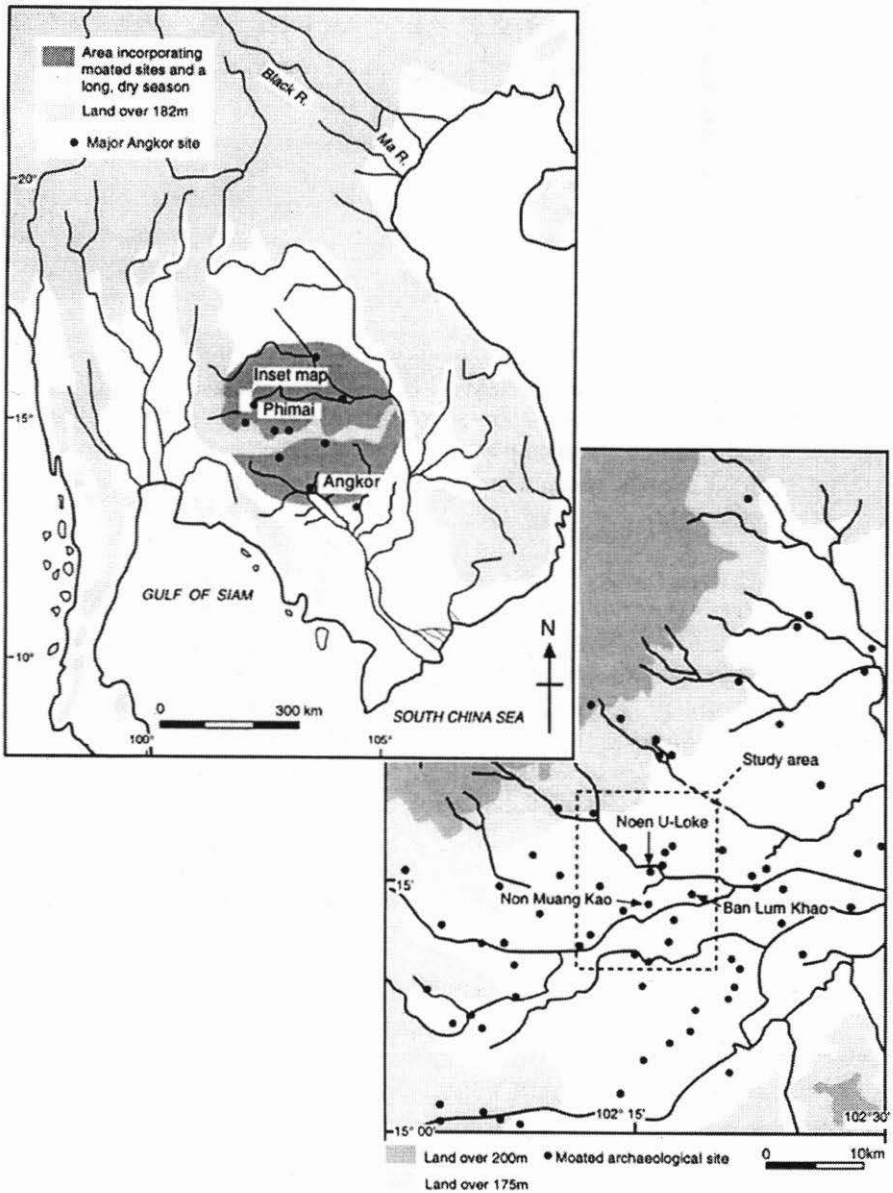


*Figure 1. Map of Northeast Thailand and the OAAP study area (Source: Higham and Thosarat 1998)*

Songkhram Basin in the north and the larger Khorat Basin in the south. The Upper Mun river valley forms the upper catchment for the Mun River. The Mun and Chi rivers form the main arterial waterways draining much of the Khorat Basin. Together they are a major feature of a landscape otherwise characterised by low interfluves, alluvial floodplains drained by many single-channel sinuous streams, salt domes, oxbow lakes, ancient river courses and hummocky loess uplands. This basin is tectonically controlled and tilts gradually to the east where the Mun river drains into the Mekong River. The Mekong River forms the northern and eastern boundaries of the Khorat Plateau, while the Petchabun Range forms the western and the Dang Raek mountain range forms the southern most boundary. The Petchabun Mountain range provide rich sources of copper ore, while sandstone, siltstone and marble are available in the Dang Raek mountains and the plateau is rich in salt and lateritic iron.

**Research Outline**

Over the last two decades there have many significant advances in our understanding of prehistoric cultural developments over much of Mainland South East Asia (Barnard and Bulbeck 1996; Higham 1989, 1996; Glover 1989; Glover, *et al.* 1992; Smith and Watson 1979; Wheatley 1983). The same can be said of the Upper Mun river valley, northeast Thailand. Even though this is "one of the best documented [cultural] sequences on the Khorat Plateau" (Higham 1996: 219) a holistic understanding of the cultures responsible for the large moated settlements and temple-centres in this area from *c.* 1500 BC to AD 1300 is only now emerging.

It has been proposed, in light of recent field work, that environmental and climatic parameters now need to be built into discussions regarding the establishment, histories, evolution and abandonment of Iron Age settlements in northeast Thailand (Boyd *et al.* 1999:2-3). A study of landscape and climatic evolution within this same period is currently being realised (Boyd 1997; Boyd *et al.* 1998; 1999). However, the visibility of such processes at the site level remains to be investigated in this region, although two studies of site formation in southern Thailand have been undertaken (Aitken 1992 and Boyd 1998).

With this in mind, it is the author's intention to first, investigate the formation history of two Iron Age sites from the Upper Mun river valley, namely, Noen U-Loke and Non Muang Kao (Fig. 2). Site formation here refers to the history of an archaeological deposit from a *geoarchaeological*


*Figure 2. Aerial view of Noen U-Loke (top) and Non Muang Kao (bottom). Source: Higham and Thosarat 1997, 1998.*

perspective (Rapp and Hill 1998). That is, the source of sediments (cultural or noncultural) comprising an archaeological site, the way in which these are transported and deposited at the site and their subsequent modification as a result of environmental and cultural activities (Schiffer 1987). Hence archaeological sediments offer a unique glimpse into the interaction of past ecological and humanistic processes.

Noen U-Loke and Non Muang Kao (as discussed below) were excavated in the 1996-1998 field seasons of the OAAP. Documenting the formation history of these sites enables us to model the temporality of the immediate environment of these sites and the temporality of cultural formation processes at these sites. Emplacing these models within the context of broader climatic, environmental and cultural coevolution will allow us to view issues of prehistoric settlement inception, chronology, evolution and abandonment in northeast Thailand from a geoarchaeological perspective.

In the review that follows several themes emerge that point to the coevolution of several variables in this region; these include evolution in climate, environment and cultural complexity. It is argued that these processes may be reflected in the formation of the Iron Age sites. In controlling for these variables it should be possible to assess not only human-environment interactions at the site level in this part of Thailand, but also the localised nature of occupation and changes in both of these over time.

## Previous and Current Research

Recent geological research indicates significant climatic evolution has occurred over the last three millennia in northeast Thailand. Likewise, recent geoarchaeological research suggests coevolution in environment (both bio-physical and geo-physical) and settlement patterns. While archaeological evidence points to significant impacts upon the environment by human activities such as salt making and iron smelting, the evidence itself also points to increasing complexity over the duration of the Iron Age.

### Climatic change

Regional geology indicates substantial climatic change from the early Holocene onwards with marked fluctuations in humidity and run-off occurring during the period of Iron Age occupation (Bishop *et al.* 1996; Michael 1982; Nutalaya *et al.* 1987; Nutalaya 1989; Udomchoke 1989). Climatic conditions prior to the Iron Age were slightly more arid than at present. This was due to windblown sand deposits over the Khorat Plateau area (Boonsener 1977;

Chong 1988; Udonchoke 1989). Flood deposits from various localities around the Mun River floodplain suggest that a wet cycle persisted from the early to the late Iron Age before a return to seasonally arid conditions characterising the present (Saturagsa 1987; Chong 1988; Natalaya *et al.* 1989; Udomchoke 1989). One author suggests that this phase was characterised by frequent and often catastrophic flooding leading to the widening of the floodplains of the Mun and Chi rivers (Natalaya *et al.* 1989). Catastrophic flooding has many implications for the archaeology of this area - the possibility of buried Neolithic settlements (which are noticeably absent), effects of flooding on the inception, evolution and abandonment of settlements and also on settlement patterns.

### Environmental change

It is now a known fact that the landscape at the time of both Bronze Age and Iron Age settlement differed markedly from that of the present. Interpretations of aerial photography, sediment mapping, pollen and morphological studies indicate that there appears to be significant variation in the regional environmental conditions associated with the moated sites of northeast Thailand (Boyd 1997; Boyd *et al.* 1998, 1999). This work suggests several periods of palaeodrainage characterised by differing locations and morphology than at present. There is a noticeable difference in drainage between recent sinuous single-string channels and an older phase comprising broad belts of sinuous multi-string channels or anastomosing channels.

Patterns derived from aerial photograph interpretation and morphology suggests that sites are critically linked to the later drainage system associated with now-extinct rivers (Fig 3). These rivers represent vastly different climatic and environmental conditions from the present (Boyd *et al.* 1999). Underlying the present concentric 'moat' land-surface exist buried channels. These appear to increase in age closer to the archaeological mound, to the extent that channels at the mound margins tend to date the late Iron Age at the oldest, while those furthermost from the mound represent more recent events dating to historic or earlier periods. Section morphology of these channels indicate that they are usually small low-flow channels set in wide shallow flood-flow style channels (*ibid.*:2). The 'moated' sites of the Khorat Plateau were first discussed by Williams-Hunt (1950). They gain their name from the concentric ditch and embankment earthworks that surround them. Since this time the term 'moat' has become strongly associated with ideas of water control and agriculture (Moore 1986, 1988; O'Reilly 1999; Quaritch-Wales 1957; Welch 1984, 1985; Welch and McNeill 1990, 1991). This work

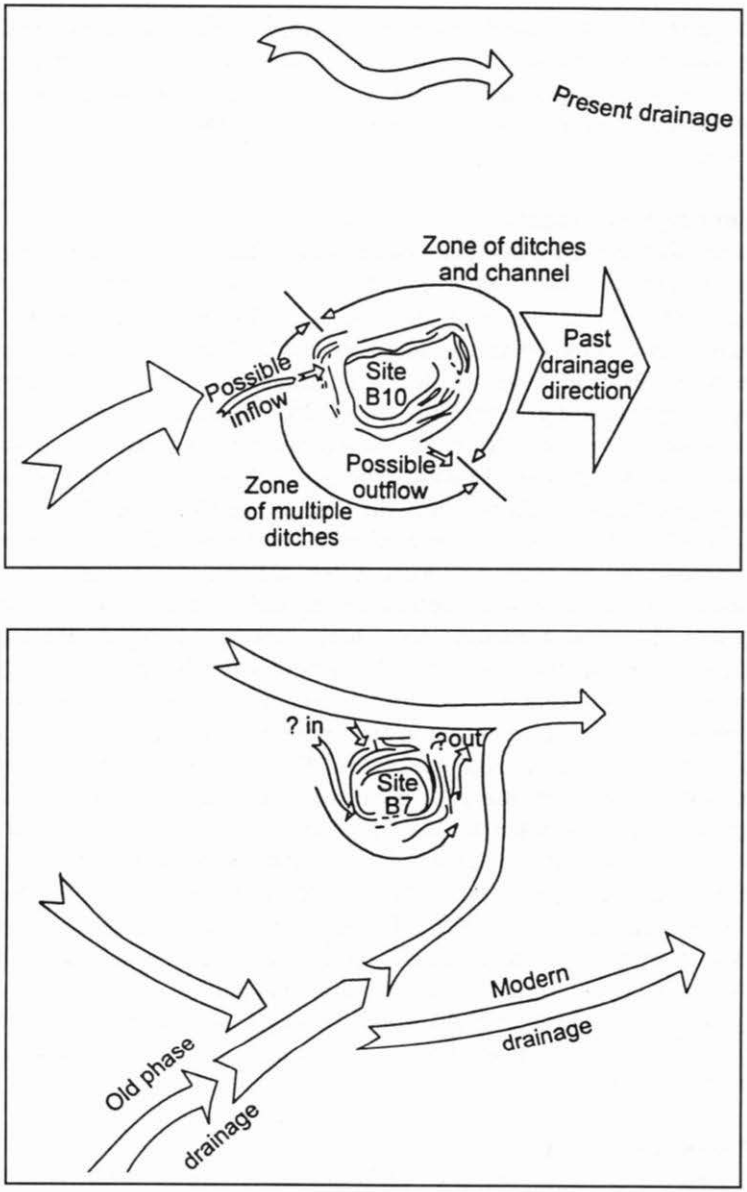


*Figure 3. The sites of Non Muang Kao (Site B10) and Noen U-Loke (Site B7) in relation to ancient and modern rivers (source: Boyd et al. 1999)*

by Boyd *et al.* (1998, 1999) questions the very role of these structures and the rigour of interpretations based in the 'moat' dynamic. A change in the fluvial regime and gradual infilling and migration of these ancient river channels may represent one reason for the abandonment of sites in the Late Iron Age.

### Anthropogenic impacts

Regional archaeological evidence indicates significant anthropogenic impacts upon the environment (Kealhofer 1996; Penny *et al.* 1996). Vegetation change and the occurrence of charcoal in sedimentary cores from Lake Kumphawapi (Penny 1998) and Southern Thailand (Maloney 1991) suggest there is widespread evidence for anthropogenic related land clearance between approximately 12,000 BC - 4000 BC. Kealhofer (1996) maintains that it is possible to argue that widespread occurrence of firing and vegetation change could be attributed to natural factors such as marked fluctuations in worldwide climatic conditions since the onset of the Holocene (Zhan 1994 in *ibid.* 1996). However, climatic change critically affected vegetation distribution, but it does not account for patterns of burning in some sequences, nor the type and diversity of vegetation from the Mid Holocene onwards. These same impacts have been noted at locations throughout Thailand including southern-central Thailand (Kealhofer and Piperno 1994; Maloney 1991) and central Thailand (Cremaschi *et al.* 1990). Cremaschi *et al.* (1990) argue that extensive iron smelting be but one cause of vegetation change during the Iron Age in central Thailand. In a recent study of settlement patterns and place in prehistoric communities around Phimai, Rivett focuses on salt making as an major economic and social activity (1999:82-89). He eludes to the significant impacts such an activity has on the environment, at least in terms of deforesting large tracts of land to support salt brine reduction (*ibid.* 88). He estimates that to keep one furnace operational over a year would require up to 400 $m^2$ of forested land, and that 400 $km^2$ surrounding one site in his study area could have been deforested within 100 years. Rivett (1999) shows how important salt making in the dry season was for these communities and that it played a big part in the structure of prehistoric settlement.

### Archaeology

Increasing complexity of the archaeological record reflects cultural trajectories from the Bronze Age through the Iron Age and into the Historic era. Within the Upper Mun river valley surveys and excavations of the moated sites around Phimai were initially devoted to defining and dating the

cultural sequence of this area (Parker 1966; Solheim and Gorman 1966; Welch 1984, 1985; Welch and McNeill 1991). Solheim and Gorman (1966) conducted the first of these in the area of Phimai and this resulted in the excavations in the inner sanctuary of the Khmer temple Prasat Hin Phimai (Solheim 1965 in Solheim and Ayers 1979) and in the southeast corner of the ancient town walls of Phimai (Parker 1966). These excavations were significant for two reasons. First, they revealed evidence of Khmer settlement superimposed over an earlier Iron Age occupation; and second, the ceramics recovered from the Iron Age layers belong to a tradition (eponymously named Phimai Black) with a radius of up to 50 km around Phimai. The earliest dates for this tradition are suggested to lie between 500 BC and AD 100 (Solheim and Ayers 1979:68, 77). The widespread distribution of Phimai Black among other artefact types provides some evidence for regional exchange during the Iron Age (Welch 1989). There were no Neolithic sites represented in Solheim and Gorman's surveys, nor in the later surveys conducted over the floodplain, floodplain margins and uplands around Phimai by Welch (1984, 1985) and Welch and McNeill (1991).

The work of Welch (1985) is the first tentative step towards assessing the development of cultural complexity in the Phimai region. Welch suggests that a trend towards centralisation occurred early in the Iron Age, when sites such as Iron Age Phimai grew larger and agriculture developed to lessen the impacts of a unpredictable weather patterns. However there were problems in methodology and sample number which are discussed below. Later surveys by Welch and McNeill (1990, 1991) assessed site distribution, size, the relationship of site location to landscape topography and changes in these variables through time, but this time with a larger sample - 334 prehistoric sites within a 300 $km^2$ area of Phimai. These varied in size from 1 to 56 ha., with 30 sites over 19 ha. Two of these sites were excavatedÐ Ban Tam Yae and Non Ban Kham the dates from which give the framework presented below (Welch and McNeill 1990). Tamyae pottery (named after Ban Tamyae) provided the first evidence for pre-Phimai tradition settlement of the region prior to 500 BC. Unfortunately, this work never accessed a temporal picture of landscape evolution in which spatial variations of topography, soil and settlement could be emplaced. It would appear that their work is built on an assumption that the environment is static at least from the Bronze Age onwards (cf Moore 1986, 1988, 1992 for the same criticism). Spatial analysis of settlement patterns by Rivett (1999:76-80) suggest that site distribution does not reflect the distribution of soils as those above suggest, but rather all resources, including soils, water, and salt.

On the basis of dates from the excavations at Ban Tamyae, Welch and McNeill (1991) suggest that initial settlement occurred around 1000 BC. There follows three phases of settlement - the Tamyae Phase (1000-600 BC), the Prasat Phase (600-200 BC) and the Phimai Phase divided into the Classic (200 BC- AD 300) and the Late Phimai phase (AD 300-600). In the earliest phase, settlements were represented by a small number of sites distributed across the alluvial plain, in what they (*ibid.* 1991) refer to as the most desirable natural locations for rice cultivation. Four times as many sites were found corresponding to the Prasat phase. These were still concentrated on the alluvial plain, but some sites were found in the low terrace and upland zones. It is during the Phimai Phase that they suggest that expansion well and truly got under way. Fifty-three sites correspond to the Phimai Phase, with a continued expansion into the upland areas.

Excavations at Ban Prasat and Noen U-Loke by members of the Thai Fine Arts Department at Ban (Phommanodch 1991; Wichikana 1991) provided confirmation of a pre-Phimai tradition settlement. Burials recovered from the former contained beautiful trumpet shaped pots, and bronze ornaments used in mortuary activities. These eponymously named ceramics have a similar distribution to that of Phimai Black. Iron Age burials at both sites contained both bronze and iron goods, carnelian, agate and Phimai Black wares.

The most recent survey and excavations of moated sites was undertaken in this region by members of the 'Origins of Angkor Archaeological Project' (discussed above). Excavations at Ban Lum Kao, a Bronze Age moated site slightly west of Ban Prasat, began in December 1996 (Higham and Thosarat 1997). Natural substrate was reached at 1.7 m. The stratigraphic sequence began with a layer occupational materials such as pits containing organic remains, including fish, shellfish, mammalian bones, turtles and ceramics. The second layer contained 111 Bronze Age inhumation graves. This cemetery is relatively homogenous, occupants were interred in rows with the majority of interments following a north-south orientation with little evidence of patterning based on gender and age and temporal distribution of wealth (OÕReilly 1999:230, 269). Investigations into skeletal biology by Domett (1998) found males and females were affected differently by environmental and possibly social factors. Females had a lower life expectancy than males and the mortality rate was particularly high in young adult females compared to males of the same age. Different dental and skeletal pathologies were suggested to indicate possible gender based divisions of labour and resource allocation. Layer three follows with late Bronze age occupation (O'Reilly

1999:2). Five dates from this site cluster between 1435-1000 BC, making this the earliest Bronze Age site known in the area and placing settlement further back than Welch and McNeill (1991) propose. O'Reilly's analysis of mortuary ritual at Ban Lum Kao yeilded no evidence for entrenched hierarchy (*ibid.* 275).

Simultaneously, excavations at Non Muang Kao commenced by Dougald O'Reilly and Nigel Chang (O'Reilly 1997). Non Muang Kao is a 50 ha. mound rising 4 m above the present land surface. The mound comprises of three meters of culturally deposited materials and was located near to a major water way and ringed by two concentric moats. It appears that Non Muang Kao was continuously occupied for a period of 4-500 years and ceramic data and radio carbon dates place this entire stratigraphic sequence (of four layers) during the Ion Age (O'Reilly 1998a:145). The site saw a variety of use, including mortuary activities, industry and habitation (*ibid. 146*). Artefacts contained in the mortuary ritual included a range of Phimai Black ware, glass and agate beads and iron and bronze jewellery (*ibid.* 1998b) Much of the ceramics at this site were Phimai Black ware. A significant find were a total of ten clay floors. O'Reilly suggests they may represent work areas or threshing floors, or the floors of a dwelling or mortuary structure (O'Reilly 1998a. 147).

The third excavation, and to date the largest in this area, at Noen U-Loke was excavated by Higham and Thosarat (Higham 1998). A 15 x 14 m square was located next to one of the excavations by Wichikana (1991). Natural substrate was reached at this Iron Age 12 ha. site at 4.85 m. Fifteen radiocarbon dates place occupation between *c.* 800 BC to AD 400. Again much Phimai Black pottery was encountered as well as 125 inhumation graves, iron sickles and hoes, knives, and arrowheads, bronze bangles, rings, belts and toe rings, lead, silver and gold ornaments, agate beads and pendants, glass beads and carnelian beads. Pits throughout the sequence yielded much organic remains including charred rice, mammalian bones, fish, fresh water and swamp shellfish and pottery. The presence of iron bloom and slag indicates that iron smelting and casting may have been one industrial activity at this site. Many burnt clay structures were recovered, though use, whether domestic or industrial still remains uncertain (Chetwin 1998).

The final excavations to date in the Phimai region were those of Talbot (1998), adjacent to the inner sanctuary of the Khmer temple. Talbot excavated a 4 x 7 m unit to a depth of 4.5 metres in order to examine the

cultural context of the temple's construction. Initial layers reflect Khmer construction, containing lateritic fragments and sandstone from the construction of the buildings comprising the temple. The foundations of the temple contained clay with embedded prehistoric pottery and iron slag, layered with sterile sand and charcoal lenses. Underneath this a layer of redeposited decorated bricks eluding to an older structure since destroyed and perhaps used as foundation material (*ibid.* 1998). The lower most layers contained clay with embedded fragments of Phimai Black.

## Summary and Conclusion

Climatic and environmental evolution during Holocene saw changes in regional geology and hydrology; anthropogenic dynamics perceivably fostered significant impacts of the flora and fauna; and archaeological data points to increasing cultural complexity from the end of the Bronze Age through the Iron Age and on into the Historic era. On-site sediments should reflect all these processes, and careful analysis of sediment source and site formation processes should enable environmental and cultural modelling of Noen-U-Loke and Non Muang Kao. The manner in which these sites have evolved will in part reflect human agencies (ie., the use of sediments as resources) and in part reflect the natural conditions such as greater or less wind activity. All these factors have a bearing upon the continuity of human activity, and ultimately may have been responsible for the inception of these sites and their abandonment. An analysis of site formation processes of Noen U-Loke and Non Muang Kao will help to link the off-site geoarchaeological work of Boyd and colleagues with the on-site archaeology of Higham and colleagues. Together this builds a picture of not only the immediate environment of these sites, but cultural and noncultural processes involved in the inception, chronology, evolution and abandonment of archaeological communities as viewed from the locale of the archaeological deposit.

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