

## PROJECT SUMMARY

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### Overview:

Funding is requested for a multidisciplinary investigation into the operational mechanisms facilitating expansion of medieval states through a detailed study of control over iron production within the Angkorian Khmer Empire (9th to 15th c. AD), the most influential polity in SE Asian history. Previous research on Angkor, the UNESCO World Heritage site in Cambodia, has emphasized its sudden decline over equally dynamic processes enabling its rise to become the largest pre-industrial center on earth. Combining traditional field techniques with metallurgical, botanical and archaeomagnetic analyses, the Industries of Angkor Project (INDAP) is the first project to investigate how Angkor managed to rapidly extend its influence between the 11th and 13th centuries. Specifically, this phase of INDAP seeks to determine whether control or increased access over Phnom Dek, the largest source of iron ore in Cambodia, facilitated two important phases of Khmer expansion ? military conquest and consolidation ? evident through historical records and regional masonry temples. Intensive analysis and comparison of metallurgical remains around Phnom Dek are proposed to determine if the Khmer relied on this single source and if there is evidence of direct imperial control over production. A global issue at the core of this study is whether iron enables empire-building.

The research objective will be investigated through consideration of three interrelated questions: 1) is there a scalar intensification of Angkorian iron production within the Phnom Dek region? 2) does production at Phnom Dek show source restriction, technological standardization and imperial incorporation indicative of direct control by the capital? 3) is there a correlation between the evidence for iron production and proxies of iron usage (temple building or episodic warfare) during the period of Khmer expansion? To address these questions intensive field survey collection and excavation of slag mounds will provide metallurgical data for compositional analyses and 3-D modelling. Multiple dating techniques will be used to identify temporal fluctuations in production. Botanical remains will be recovered to identify fuel regimes and quantification sandstone used in temples and inscription events will provide proxies of iron use. Sample analysis will be conducted at leading institutions and collated within the overall research program. In combination, the results will provide a dynamic history of resource control and potential use that will become the benchmark for understanding the successes of the Khmer elite.

### Intellectual Merit :

Documenting the politico-economic processes and material evidence that enabled Angkor's growth is an extremely important contribution to global science and Cambodian national heritage. Our approach offers the first comprehensive investigation of the role of iron as critical mechanism in pre-modern imperial expansion. Integration of archaeometallurgical techniques within well-established theoretical frameworks of craft production and control are used to identify the degree of influence over primary resources. Lack of evidence of control may also point to the presence of ethnic minority smelting communities. Development of iron consumption proxies from historic and architectural evidence is a unique and necessary step to compensate for poor preservation of iron objects. The method and results will create synergies with the study of other crafts (ceramics, precious metals) as well as broader processes of state formation and decline.

### Broader Impacts :

This project will provide archaeological training on field methods, analytical techniques and social theories of production to US and Cambodian students and officials. Working with Cambodian NGOs, Ministries and museums we will develop educational pamphlets for rural villagers and museum displays about the significance of Angkor's iron heritage, the role of ethnic minorities, and conservation of hardwood forests under threat by local development projects. We also seek to develop low-cost approaches for archaeometallurgical survey and an effective analytical protocol to be used within a laboratory in the Chicago region. At the end of the grant period we will generate three databases (metallurgical technology, archaeomagnetic intensity curve for SE Asia, wood and charcoal reference collection) that will generally available and have broad, immediate scientific significance.