Searching for the Neolithic Interactions across the Taiwan Strait: Isotopic Evidence of Stone Adzes from Mainland China

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ABSTRACT

Analysis of the Sr-Nd-Pb isotopic ratios of the stone adzes of the Damaoshan site in mainland China provide fresh evidences for studying the interactions across the Taiwan Strait during the Neolithic era, and supports the Taiwan Strait is the original center for innovation of the Austronesian seafaring cultures.

Key Words: Taiwan Strait, Damaoshan, Stone adzes, Neolithic period, Sr-Nd-Pb isotope

INTRODUCTION

The interactions across the Taiwan Strait during the Neolithic period have been widely recognized as essential for understanding the Neolithic beginning and cultural changes in Taiwan (Chang 1995; Sung 1980; Tsang 2002). The sea-level rising in early Holocene separated Taiwan from the mainland coast with an open sea of at least 130 kilometers, indicating the exchanges between them had to involve seafaring. It is also believed these cross strait voyaging, together with the seafaring activities on the mainland coast, represent the beginning of the Austronesian seafaring culture (Bellwood 1997; Rolett, Jiao and Lin 2002).

Archaeologists have devoted a significant amount of effort to comparing artifact styles between mainland southeast China and Taiwan, in hopes of finding evidence for interregional contacts in prehistory (Bellwood 2006; Chang 1995). Stylistic similarities of stone adzes and the similarity of pottery decorations have long been observed, and these shared cultural traits are generally taken as indicators for cultural diffusion or population migra-

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tions from the mainland China to Taiwan (cf. Chang and Goodenough 1996). Recently, geochemical techniques such as XRF were also applied to study the provenance of stone adzes, providing tangible evidence for the exchange networks between southwestern Taiwan and the Penghu Archipelago (Rolett, Chen and Sinton 2000; Tsang and Hung 2001).

In comparison, hard evidence for the direct contacts between mainland China and Taiwan during the Neolithic era have until recently remained lacking. We applied the geochemical techniques to study stone adzes of the previously excavated major Neolithic sites in Fujian Province, China, but the result does not provide evidences of cross Taiwan Strait exchanges (Rolett, Jiao and Guo, in press). Interestingly, our analysis of the newly discovered stone adzes at the Damaoshan site in Fujian Province suggested that either the Penghu Archipelago or the Niutoushan area on the Fujian coast is possible source for the Damaoshan adzes (Guo et al. 2005). This study suggests a more accurate sourcing of the Damaoshan stone adzes has a good potential for shedding new lights on understanding the exchange networks in the Taiwan Strait. In order to further discriminating these two possible sources, we conducted isotopic analysis of the Damaoshan stone adzes.

Scholars have been using major or trace elements to determine the sources of stone tools. In some cases, particularly in some Pacific islands, these approaches have been proved useful to study prehistoric contacts (Weisler and Sinton 1997). However, it should be pointed out due to the fact that the major and trace element contents of some volcanic rocks have considerable differences among them, they may not be the most diagnostic markers of the original magma on the continent. Our previous study of the Damaoshan stone adzes suggests that in the particular geological circumstances of the Taiwan Strait, the comparison of the major and trace elements produced by XRF and ICPMS is not capable for further discriminating the two possible sources (Penghu Islands vs. Niutoushan). From the geochemical perspective, it has been well recognized that Sr-Nd-Pb isotopic ratios are much better diagnostic markers of the original magma, because these ratios are not subject to change during the subsequent fractionation events, and the isotope-pair cannot be fractionated by processes controlled by crystal-liquid equilibria (Rollinson 1993). Therefore, for the purpose of our sourcing study, the Sr-Nd-Pb isotopic ratios are much more effective geochemical fingerprints to determine the original source.

Indeed, the result of our new analysis demonstrates that the Damaoshan stone adzes Sr-Nd-Pb isotopic ration consistently cluster closely with the Penghu basalts, a relationship that does not exist with the Niutoushan basalts, indicating they must have derived from the Penghu Islands. This study in the first time provides tangible evidences for supporting direct exchanges between mainland China and the Penghu Archipelago, thus offering fresh data for investigating the beginning of the Austronesian seafaring.

ISOTOPE ANALYSIS OF THE DAMAOSHAN STONE ADZES

The Damaoshan site is located on the Dongshan Island in southern Fujian Province, China (Figure 1). It is about 150 kilometers to the west of the Penghu Archipelago, and

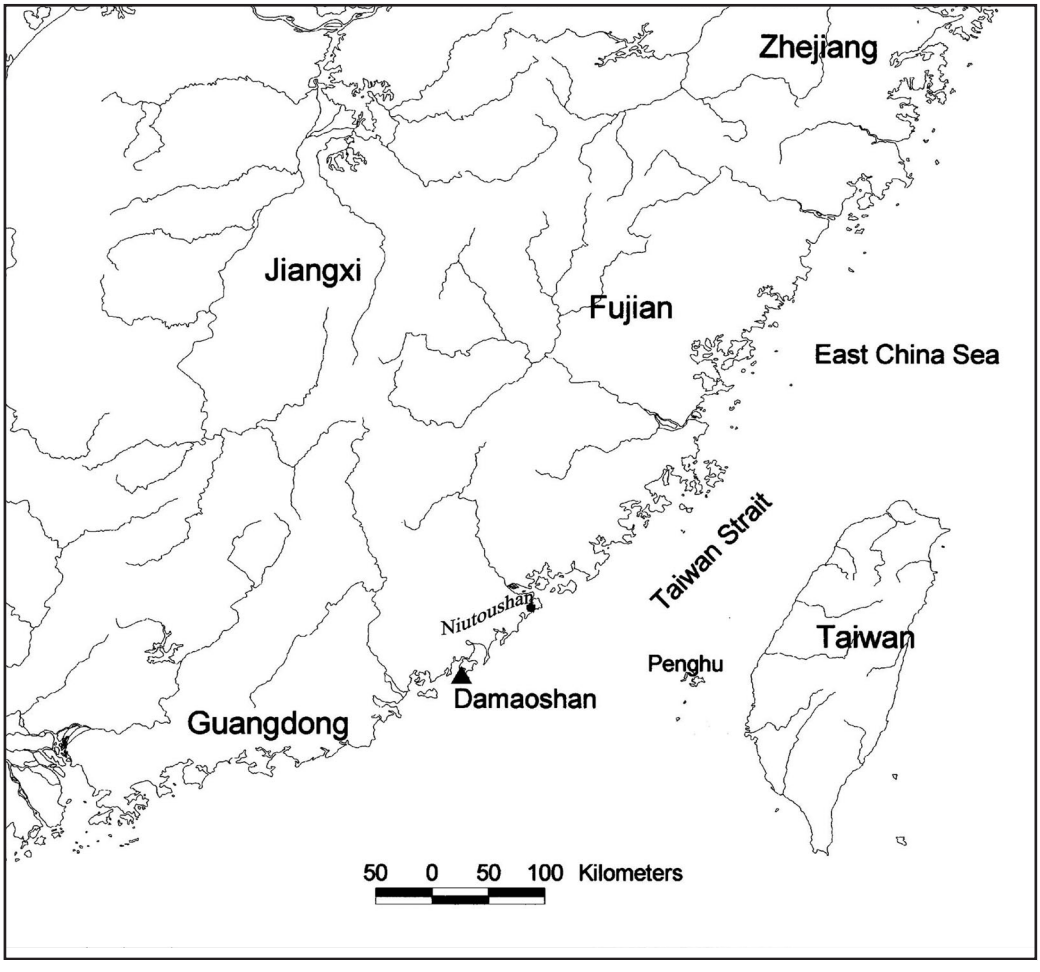

Figure 1: Location of the Damaoshan site

about 200 kilometers to Taiwan. Our archaeological excavations at this site found a large number of pottery, marine shells, fish bones, terrestrial animal bones and a considerable number of stone adzes. The age of the Damaoshan site has been dated to around 4300-5000 B.P.(Jiao 2007).

Our sourcing study involves isotopic composition analysis of five broken adzes of the Damaoshan site (Table 1).All the stone adze samples were found in situ during excavation. Our previous petrographic analysis, in combination with the major elements, has identified that three of the adzes were made of basalts and two of them were made of basaltic andesites (Guo et al. 2005).

Geological survey suggests there are no basaltic rocks on the Dongshan Island, indicat-

Table 1. Sr-Nd-Pb isotopic compositions of the Damaoshan stone adzes

Sample No.	$^{87}Sr/^{86}Sr \pm 2\sigma$	$^{143}Nd/^{144}Nd \pm 2\sigma$	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$
DMS-6	0.703611 ± 9	0.512967 ± 10	18.689	15.546	38.748
DMS-7	0.703741 ± 9	0.512938 ± 7	18.546	15.561	38.654
DMS-9	0.703716 ± 11	0.512936 ± 9	18.678	15.559	38.674
DMS-5	0.703760 ± 7	0.512959 ± 6	18.763	15.558	38.680
DMS-4	0.703777 ± 8	0.512988 ± 8	18.735	15.562	38.773

ing the raw materials for making these adzes must have brought in from areas out of the island.Therefore, by finding the original sources of these basaltic adzes, we can identify the contacts between the Damaoshan people and their outside world.

Geological studies suggests that Cenozoic basaltic rocks, mainly of basanite, basalt, trachy-basalt and basaltic andesite, are sparsely distributed in few areas on the southeast coast of mainland China and the island of Taiwan. The published geological data indicate that the closest basalt and basaltic andesites to the Damaoshan site are distributed in the Penghu Archipelago and at the Niutoushan area of southeastern Fujian, and our previous comparison of the major oxide elements and trace elements suggests that these are likely the two sources for the Damaoshan stone adzes (Guo et al. 2005) (Figure 1).

We compared our data (Table 1) with samples from most of the regions with basaltic rocks in mainland Southeast China and Taiwan (Figures 2, 3, 4). The Sr-Nd-Pb isotopic ratios of the basaltic rocks from these areas have been published previously (Chung et al. 1995; Lee 1994; Tu et al. 1991; Zhu and Wang 1989; Zou et al. 2000). The result shows that Sr-Nd-Pb isotopic compositions of the Damaoshan stone adzes cluster consistently together with those of the Penghu basalts. On the other hand, the basalts from the mainland areas, including those of the Niutoushan area, are so different from the Damaoshan adzes that they do not have any consistent relationship. This pattern demonstrates strongly that the source of these five Damaoshan adzes is in Penghu Islands, an archipelago about 150 kilometers away in the Taiwan Strait.

Macroscopic examination of all other excavated adzes at the Damaoshan site indicates that most of them are made of similar raw materials with these five analyzed samples, implying they are likely derived from Penghu too. This high frequency of presence of the Penghu raw materials at the Damaoshan site testifies that volcanic rocks from the Penghu Archipelago had been exported westward to the coastal area of mainland China, suggesting that the Damaoshan people had intensively engaged in interactions with the people of the Penghu Archipelago.

DISCUSSION

The results of this study in the first time provide tangible evidences to examine the direct contacts between mainland China and the Penghu Island across the Taiwan Strait

during the Neolithic era. Archaeological investigations indicate that the Penghu Archipelago was widely populated by people whose life oriented towards sea during the period of 4000-5100 B.P. (Tsang 1992). Studies suggest that Qimei Island, the most southern island in the Penghu Archipelago, provided many stone tool materials for southwestern Taiwan during the late Neolithic period (Rolett et al., in press; Tsang and Hung 2001). The fact that there were significant amounts of imports of artifacts or raw materials from Penghu to the Damaoshan site on mainland coast of China demonstrates the people of these two regions were closely connected with each other. It also testifies the existence of an efficient seafaring skill developed by these people. It is believed that the Neolithic peoples on both sides of the Taiwan Straits were proto-Austronesians (Chang & Goodenough 1996), and their voyaging across open sea of at least 150 kilometers in the Taiwan Strait was the beginning of the great Austronesian seafaring.

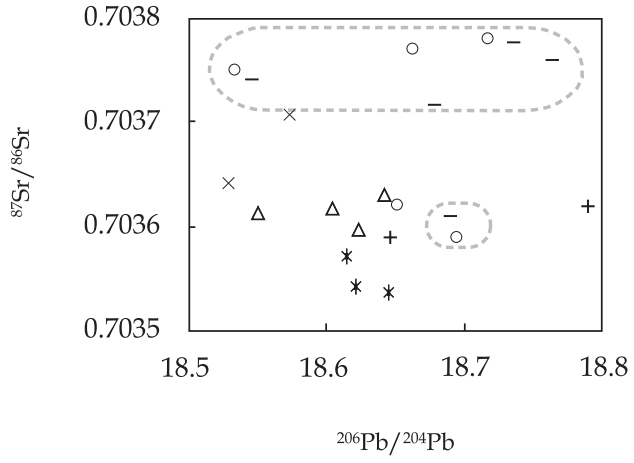

Figure 2: Comparison of the ratios of $^{206}Pb/^{204}Pb$ with $^{87}Sr/^{86}Sr$. Inside the gray dashed lines are the samples of Damaoshan stone adzes and the Penghu basalts.

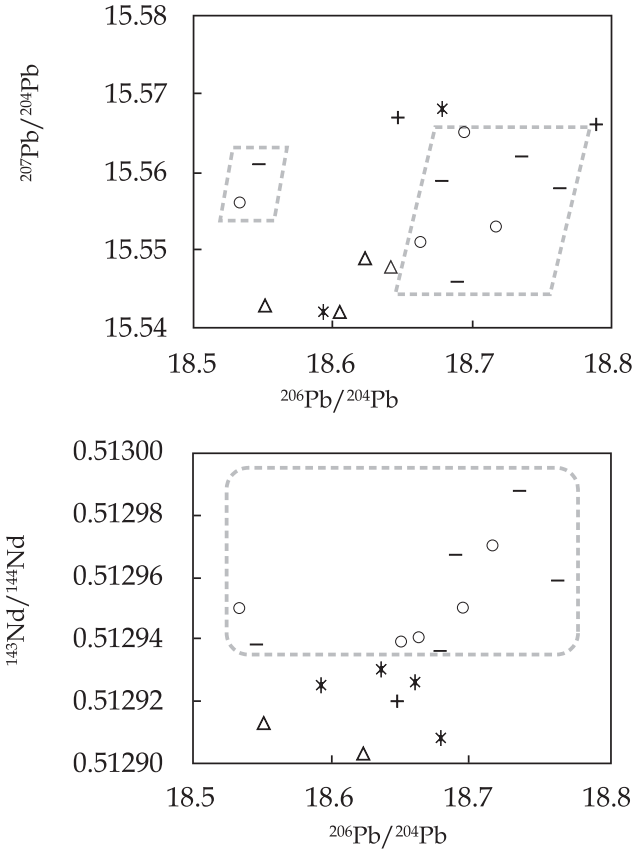

Figure 3: Comparison of $^{206}Pb/^{204}Pb$ with $^{207}Pb/^{204}Pb$. Middle: comparison of $^{206}Pb/^{204}Pb$ with $^{143}Nd/^{144}Nd$.

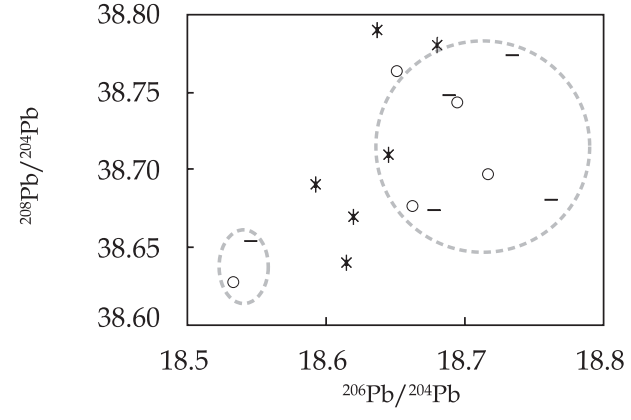

Figure 4: Comparison of $^{206}Pb/^{204}Pb$ with $^{208}Pb/^{204}Pb$.

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對臺灣海峽新石器時代交流的研究
——來自中國大陸石錛的同位素證據

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本文通過對來自中國大陸大帽山遺址石錛的Sr-Nd-Pb同位素比值的研究，揭示了在新石器時代台灣海峽兩岸存在石器交流，證實台灣海峽是南島語族航海文化的發源地。

關鍵字：臺灣海峽，大帽山，石錛，新石器時代，Sr-Nd-Pb同位素