Rise and decline of ancient salt industry revealed by Na and Ca concentrations in sediments at Zhongba site, Chongqing

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Abstract: Based on dynastic period division and AMS\(^{14}\)C dating performed on the sedimentary layers at Zhongba and Yuxi sites, and also the analysis of Na, Ca and Mg of 201 sedimentary samples from Zhongba site and that of Ca and Na in 47 sedimentary samples from Yuxi by using an inductively coupled plasma–mass spectrometry (ICP), we found that there were 35 time periods when the contents of Ca and Na were reversely correlated, i.e. whenever the content of Ca was the highest, the content of Na was the lowest, and vice versa. Among them, there were 21 time periods when the content of Ca was the highest, and Na was the lowest, indicating that there were about 21 prosperous periods of ancient salt production at Zhongba site since 3000BC. Other 14 time periods with the peak values of Na while the low values of Ca indicate 14 declined periods of salt production at Zhongba site since 3000BC. The conclusion obtained from the reverse relationship between Ca and Na contents in this paper is consistent with that “the salt production at Zhongba site started in the new stone age, developed in the Xia and Shang dynasties, reached at the heyday in periods from the Western Zhou to the Han Dynasties, maintained stable to develop in the Tang and the Song dynasties, and gradually declined after the Song Dynasty because the sea salt were conveyed into Sichuan region, however, still had production in the 1970s–1980s”, educed from archeological exploration. All the above mentioned results indicate that there is a reverse relationship obviously between the contents of Na and Ca in sediments at Zhongba site for ancient salt production, which can be used to reveal the process of rise and decline of ancient salt industry at Zhongba site.

Keywords: Zhongba site; Zhongxian County; reverse relationship between contents of Na and Ca; rise and decline of early salt production

Received: 2008-03-25    Accepted: 2008-06-15
Foundation: The Key Project of National Natural Science Foundation of China, No.90411015; University Doctoral Foundation of China, Grand No.20050284011; The Prior study project for Key Basic Scientific Issue of Nanjing University, Grand No. 0209005206; Open Foundation of the State Key Laboratory of Loess and Quaternary Geology from the Institute of Earth Environment, CAS, No.SKLLQG0503; Foundation of Modern Analyses Center of Nanjing University, No.0209001309
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1 Introduction

In recent years, significant progress on development of ancient salt industry and man–land relationship from the Neolithic Age onwards revealed by the research results of archeological sites has been made (Zhu et al., 2005; Sun et al., 2007; Rowan et al., 2005; Li, 2004; Liu, 2004). Authors of this paper (Zhu et al., 2005) have ever acquired a criterium to identify ancient fluvial strata at Zhongba site, the most typical site with continuous times lasting at least for 5 ka in the Three Gorges Reservoir area, by using techniques of dating, and based on the analysis results of proxies, such as chemical compositions of heavy minerals and micro-morphology of ostranite, granularity, magnetic susceptibility, Rb/Sr ratio, etc. Sun et al. (2007) estimated the occurrence time of early salt production at Zhongba site by analyzing the chemical composition of samples from the walls of vessels. Until now, archeological investigations of early salt production at Zhongba site have mainly completed by Sichuan Provincial Institute of Archeology, School of Geography and Oceanic Science of Nanjing University, Department of Archeology and Museology of Beijing University, University of California, Los Angeles (UCLA), Department of Scientific History and Archaeometry of University of Science and Technology of China, State Light Industry Well Salt Quality Supervision and Check Centre in Zigong City, etc. (OSSSPIA and ZCRCA, 1995; SPIA, OTGCCB and ZCRCA, 2001; Sun and Luo, 2002; Sun, 2003; Rowan, 2004; SPIA, OTGCCB and ZCRCA, 2001; Zhu et al., 2003; Rowan, 2003). A first archeological excavation aimed specially at early salt production at Zhongba site was conducted by Sichuan Provincial Institute of Archeology, Department of Archeology and Museology of Beijing University, and University of California, Los Angeles (UCLA) in 1999, which was completed until 2002.

Compared with archeological investigation in common cultural relics, ancient salt industry seems more difficult due to that salt can hardly remain in strata of the site. Taking the Three Gorges Reservoir area for example, up to now, three experience-based inferences have been frequently employed to identify salt industry sites during the stage of ancient salt production using pottery vessels, which include that firstly deposits of these sites are similar in form to salt production sites in other countries; secondly its ceramics and pottery vessels are similar in form and composition to salt production pottery from other regions of the world; and thirdly the site laid aboard the producing area of brine resources (Sun, 2003). However, the above-mentioned methods are currently short of proof from experimental science. Moreover, because no findings can be available for analogy to vessels such as small bottom and pointed-bottom jar lets and gallipots, which were popularly used during the late times of the Neolithic Age, experience-based inference is incapable at the present time. Therefore, the purposes of this paper are: firstly to acquire representative chemical elements in strata of Zhongba site by using method of laboratory experiment, and secondly to go further into the correlation between contents of Na and Ca which may be employed to reveal the rise and decline of ancient salt industry at Zhongba site. Following this consideration, and on the basis of the well-established time frame of strata by archeological dating, we collected 201 soil samples from strata of No.T0102 exploration pit at Zhongba site for salt production, and 47 soil samples from strata of Yuxi, a non-salt production site, and then we examined the chemical components of these samples by using an inductively coupled plasma–mass spectrometry (ICP) from 2002 through 2005. In the following sections, main