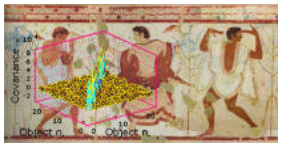

A Chemometrics Approach to Fit Past and Present Production in the Banda Area (Ghana)

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Abstract

Combining the information obtained with Neutron Activation Analysis (NAA) and Chemometrics has made examining the origin of clay samples from abandoned and contemporary clay pits possible. SIMCA has been applied in order to unequivocally determine the geographical origin of diverse archaeological samples found in the Banda Area (West-Central Ghana). The data set (Das Dores Cruz data set) was taken from the University of Missouri web page. Classification models obtained by SIMCA showed a classification ability of 100% and a prediction ability of 97.7%. Thanks to these class models, the origin of the samples could be determined.

Introduction

The Banda Traditional Area is located in the Northwest end of the Brong-Ahafo region (West-Central Ghana), right South from the Black Volta [1]. The Das Dores Cruz data set [2] has been used in order to asses the changes and continuity through time of the ceramics in the Banda Area. This data set contains NAA information on ceramics and clays from the historical sites of Makala Kataa and Kuulo Kataa, on ethnographic ceramics from Dorbour, Adadiem (red) and Bondakile (green), as well as on ceramics from abandoned pits near Bui, Bongase and Sabie (blue) (Figure 1). Previous publications have tried to classify these samples without success because their data analysis was not suitable. In our work, we propose applying SIMCA, after performing a Principal Component Analysis (PCA), in order to clearly determine the geographical origin of the samples.

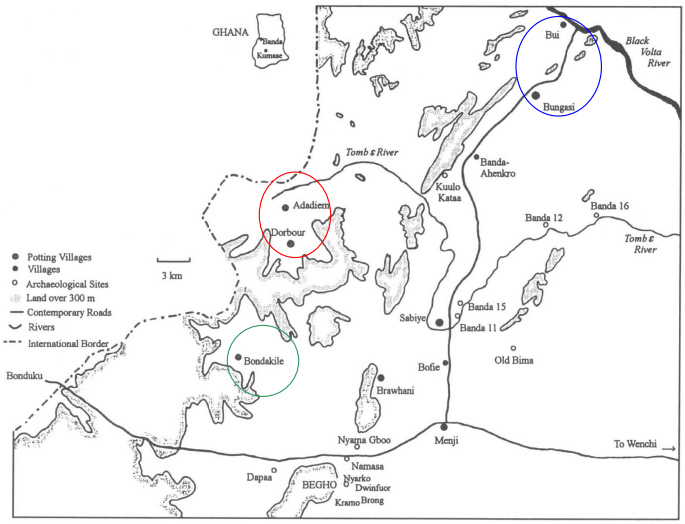

Fig. 1; Map of the Banda traditional area.

Materials and methods

Chemical characterization of the samples by NAA was performed at the Missouri University Research Reactor. Two hundred and thirty one samples were analyzed: 113 from Makala Kataa and 74 from Kuulo Kataa; 14 from Bui, Bongase and Sabie (East Side Group); 22 from Dorbour and Adadiem (West Side Group) and 8 from Bondakile (Bondakile Group). In this analysis thirty three elements have been determined.

PCA and classification analysis by SIMCA were performed by using V-Parvus software [3].

Results

After completing a Principal Component Analysis of the NAA results for the samples, three different groups were obtained based on their geochemical signatures (Figure 2). On the one hand, Bui, Bongase and Sabie samples fell into one group, the East Side group. On the other hand, samples from Dorbour and Adadiem fell into another group, the West Side group. Finally, samples coming from Bondakile had its own group, the Bondakile group. Once PCA had been performed, we proposed applying SIMCA [4]. This technique allows for performing class modeling, so that we can clearly determine the geographical origin of the samples found in the historical sites of Makala Kataa and Kuulo Kataa (Table I).

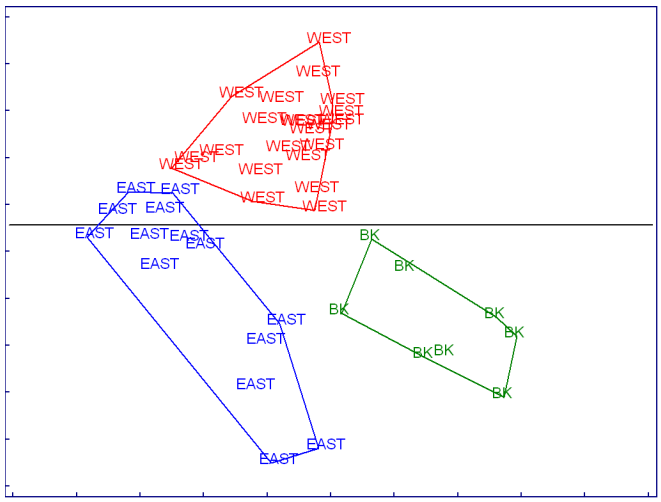

Fig. 2; Principal component analysis of the samples: East Side group, West Side group and Bondakile group.

The classification models obtained by SIMCA showed a classification ability of 100% and a prediction ability of 97.7% with a mean sensitivity of 84 % and a specificity of 100% for the three categories.

Moreover, after applying SIMCA, it could be proven that not all of the ANN variables (elements) were as important as the others in terms of geographical classification. The elements ordered by discriminant power are (from biggest to smallest): Zn, Sc, Cr, Mn, Th, Hf, Na, V, Ta, Sb, Ca, Co, Lu, Sr, Fe, Zr, U, Nd, Ce, As, La, Al, Yb, Ni, Cs, Eu, Sm, Rb, Ti, Ba, K, Tb, Dy.

Table I. Results of the Neutron Activation Analysis: number of samples from each origin.

ORIGIN	Kuulo Kataa	Makala Kataa
East	66	63
West	1	28
Bondakile	7	22

Conclusions

SIMCA has proven to be a powerful technique for the class modeling of archaeological data. By applying this technique finding out the discriminant power of the compositional elements of the samples is possible. Moreover, SIMCA allows for knowing the exact geographical origin of the samples. In the case of the ceramics from the Banda Area, most of the samples found at Kuulo Kataa and Makala Kataa fit the actual production of the East region. Therefore, in the past, producers obtained the materials mainly from the East side of the Banda hills.

References

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