

## PIXE Contribution for an Elemental Composition Database of Phoenician Pottery from Kharayeb Site

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The study the ancient Phoenician cult place of Kharayeb, in the rural hinterland of Tyre, southern of Lebanon, dated to the Iron Age and Hellenistic periods is particularly helpful in evaluating the complexity and variability of the so called "Hellenism" and of "Greek cultural influences" in the Phoenician world. PIXE analytical technique was used to characterize the elemental composition of several artefacts from this archaeological site, mainly figurines and some artisanal objects, as well as from two another archaeological sites, Jemjim and Tyre which is the prestigious city of antiquity, located at the eastern Mediterranean coast. Furthermore, the resulted PIXE information helped to understand if the figurines were locally produced or imported from the coast and how was the process of production connected to the sanctuary.

The elemental composition of the archeological ceramics was determined by using proton beam of 3 MeV and 13  $\mu\text{C}$  of integrated charge on the samples placed in a conventional in-vacuum PIXE chamber of the 1.7 MV tandem Pelletron accelerator of the Lebanese Atomic Energy Commission. Thus, it was possible to determine more than 20 elements in one spectrum (i) Na, Mg, Al, Si, S, P, Ca, K, Ti, Mn and Fe as major and minor elements, and (ii) V, Cr, Ni, Cu, Zn, Ga, As, Rb, Sr, Y, Zr, Nb, Ba and Pb as trace elements. Then, a hierarchical cluster analysis was performed, using a multivariate statistical software code, to group together objects having comparable elemental compositions, using the concentration of the the most abundant chemical elements determined by PIXE (12 to 15 elements). The resulted data showed a compositional similarity between the samples of the Hellenistic period with the samples from Tyre, the coastal site. In fact, Tyre is a historical site, known for its long time prosperity as an important center of ceramics production and maritime trade for several centuries (IV B.C. till XIII A.D.). This suggests that most of the figurine samples from Kharayeb are produced in Tyre and the other samples could be imported from other areas in the country. However, the main characteristic of most of the samples is the unusual high calcium content which characterizes the geological area surrounding the 3 archeological sites (Tyre, Jemjim and Kharayeb). Finally, the existing database on excavated pottery form coastal sites in Lebanon (mainly Roman and Byzantine) is now consolidated with Phoenician artefacts.

PIXE analyses with multivariate statistical methods were used to compare and to reveal characteristic groups. PIXE technique contributed to establish a first database of chemical composition of Phoenician pottery, which will enlarge the existing database that is currently only related to archaeological pottery from coastal sites in Lebanon. Therefore, this work will be used for any future archaeological study on Phoenician pottery in the Phoenician colonies in the Mediterranean basin, highlighting the trade routes at that time.

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