PROVENANCE STUDY OF QUMRAN POTTERY BY NEUTRON ACTIVATION ANALYSIS

Ph.D. Thesis

MÁRTA BALLA

BUDAPEST
2005
Introduction

Scientific research of the most outstanding find of the 20th century, the Dead Sea Scrolls, is a challenge for the 21st century as well. As a result of academic efforts of the last fifty years the complete edition of the texts is available, Khirbet Qumran is excavated, just as the caves in the cliffs and the marl spur. Archaeological, historical and palaeographical investigations led to an “opinio communis” concerning the date, origin and importance of the finds. Nevertheless, Qumran evokes innumerable questions, much more than we can answer reliably.

Part of these questions cannot be answered by the own methods of humanities. Science provides a different and less subjective approach. Within the past few years there has been a significant shift in the research interest from classical archaeology to applying scientific techniques in an attempt to better understand the ancient monastic community living in Qumran between 200 BC-70 AD.

In most of the research studies focusing on Qumran the main goal has always been to establish a connection between the finds of the settlement with those of the caves. Pottery can provide the best evidence for proving the contact, as the same unique ceramic types were discovered in the building complex and in the caves. The study of pottery is always a powerful way to look into the life of early civilizations. One can get a view into the technological level of pottery practice of a given population, but one may learn about the development of trade, or simple human interaction between groups of people. Taking these into consideration, it seemed to be a logical step to study the ceramic material at Khirbet Qumran and the surrounding caves, by identifying specific characteristics of pottery which give definite answers concerning their provenance: chemical composition.

Instrumental Neutron Activation Analysis has been applied to Qumran ceramics with a primary objective of establishing the chemical composition of potteries that can be traced to site-specific manufacture centres and so translated into trade patterns and interregional contacts.

Provenance studies of pottery have started at the Institute of Nuclear Techniques in the early 80s, initiated by the late János Bérczi. With his supervision, in my MS, MA diploma works and my Thesis for university doctorate I worked on the theoretical and practical aspects of the implementation of the method.
Objectives

Reliable scientific information must be based on results produced by an analytical technique, which has an appropriate accuracy, precision, sensitivity, resolution power and fitness of purpose to be applied to the archaeological problem.

On the other hand, results of scientific provenance studies are irrelevant in themselves. Where a vessel comes from is of limited value, unless it can be interfaced with an existing social and economic structure and basic forms of human behaviour.

The scope of the work summarized in the Dissertation was:

- to perform strategic (resource implementation) and applied (resource utilization) research and development in the field of Instrumental Neutron Activation Analysis, to fit the technique to provenance studies of archaeological ceramics

- to implement operational research, supporting investigations to improve the performance and traceability of analytical work

- to accomplish a scientific approach to understand material culture with an archaeologically coherent research design

- to trace the Qumran pottery by its chemistry to their place(s) of manufacture

- to establish the relation between the pottery found in the Qumran settlement and the surrounding caves

- to study what pottery was locally made and which was brought in from elsewhere to establish the cultural interactions with people near to or remote from Qumran.
**Methods of analysis**

To determine the chemical profile of Qumran potteries and related materials, with a special emphasis on trace element abundances, instrumental neutron activation analysis has been applied. INAA is a well-automated measuring technique, which assumes a simultaneous, selective and sensitive determination of trace elements, at the same time ensuring the objectivity, reliability and reproducibility required by the task.

To help place the derived analytical data into archaeological context, different procedures of multivariate statistics have been applied. Principal Component Analysis, an iterative classification treatment and different significance tests were used to achieve the partitioning of the data-set.

**New results**

1. To make the existing knowledge on the analytical technique available in the Radiochemistry Laboratory of the Institute of Nuclear Techniques for utilization for the multi-element analysis of archaeological ceramics, to fit it to the special technical and practical resources, a kind of “strategic” research was carried out, and the optimal and standardized conditions of INAA were determined as follows [1] [2]:

   Irradiation channels with the highest thermal neutron flux were chosen and spatial and spectral variations of the neutron-flux were monitored; by independent experiments k-factors for the most important (n,γ) reactions and γ-ray energies of the resulting isotopes were determined; a systematic analysis of different clays, as well as archaeological ceramics of different dates, pastes and fabrics was performed to define the most informative elements; sampling technique, necessary and sufficient sample masses, the optimal number of samples, monitors and standards per batches were defined; timing protocols were set, counting geometry was fixed; on different ceramic types homogeneity studies were performed.
2. Applied researches have been performed to demonstrate the full potential of the technique by elaborating -based on the experiences of several successful contributions [3] [4]- a Standard Operation Procedure for the analysis of archaeological ceramics, that comprises the pottery-optimized analytical protocol, the estimation of the uncertainty budget of the measurements, performance capabilities of the technique and the validation of the method in a quality control/quality assurance system [5]. Analytical results were successfully tested in several international intercomparison exercises.

3. An archaeologically coherent research process has been performed for tracing Qumran pottery to their place(s) of manufacture. In a clearly formulated archaeological context, based on the information coming from exegesis, historical research and archaeological evidence, definite questions have been posed and answered by scientific means [6] [7]. The following major archaeological conclusions have been drawn:

- As a result of systematic analyses of samples of impeccable Qumran provenance, Qumran’s local chemical fingerprint has been defined.

- Analysis of clay and ceramic samples from other sites of the Dead Sea region provided reference data to help workshop assignment.

- A comprehensive set of 166 samples of Qumran pottery, representing a variety of styles including the unique scroll jars, found in the settlement as well as the caves was analysed and classified by statistical means. The analysis of these samples resulted in a data-bank of ceramic materials, comprising the chemical profile of different pottery types of Qumran and the Dead Sea region, in the time period of 200 BC-70 AD.

- Results of analysis proved, that the previous theory, that the whole pottery assemblage were manufactured at the site is insupportable. It was possible to
determine five chemically different groups of pottery and to localize their probable provenance. It was determined, that only about 33 percents of the analysed pottery were produced locally, in Qumran. A relatively large part of pottery has connection with Jericho, another bigger group of vessels have a chemical fingerprint of the Hebron (Beit ‘Ummar) type Motza Clay, while there are quite some pottery wares enlightening a possible Edom/Nabatea connection.

- The idea, claiming that pottery serves as a connecting link between the settlement and the caves has been corroborated, there is no difference in the chemical composition between the pottery from the settlement and that of the caves.

- Based on the analysis of sherds with inscriptions (ostraca) a new evidence, connecting the settlement to the habit of scribal activity, and by this to the caves has been provided [8] [9].

- The question of the settlement’s closeness has got a different new light: through the ceramic material a diverse interrelation proved to be traceable, not only with sites and people near to Qumran, but also with people of the Eastern side of the Dead Sea.

4. I managed to combine different methodological and intellectual approaches in a successful multidisciplinary study. Combining classical archaeology, nuclear analytics and multivariate statistics provided new, complex and more accurate information on this unique collection of our cultural heritage.
Publications related to the Ph.D. work:


[8] Gunneweg, J., Balla, M. (2003). Possible Connection Between the Inscriptions on Pottery, the Ostraca and Scrolls Found in the Caves, In Khirbet Qumran and


Further publications


**Conference Proceedings**


Gunneweg, J., Balla, M. (2002). How Instrumental Neutron Activation was Helpful to Identify Scribes Activities at Qumran in Connection with the Dead Sea Scrolls, 33rd International Symposium on Archaeometry, Amsterdam, the Netherlands, p. 91.

