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The Development of Archaeological Sciences: Perspective from the Israel Antiquities Authority

Yotam Asscher

Israel Antiquities Authority



■ Introduction¹

Archaeology is a field in humanities that involves the study of human behavior in the past based on the materials preserved. It involves field work and careful observation and documentation of findings, defining the stratigraphy and contexts in which the findings were found, and inferring from these human activities. Archaeology has evolved from a field of research that was subordinate to the “rules” of history, anthropology, or art history, into an independent discipline while establishing its own research methods and discussion topics. The ‘new archaeology’ starting in the 1930’s but flourishing in the 1960s and 1970s provided the discipline with a more holistic view that integrated the humanities and the natural sciences. The post-processual school of the 1980s and 1990s provided archaeology with the critical approach and discussions of culture-dependent phenomena. Both emphasized the need for a comprehensive systemic look at cultural and historical processes while conducting an in-depth analysis of the archaeological finds using the scientific method.

The recognition that the analysis of material finds could not be based solely on style and form, penetrated archaeology as early as the middle of the twentieth century, but over the years the approach changed. The beginning of the process involved the understanding that, for example, ancient metal vessels cannot be discussed solely by their shapes, style, and distribution in space, without going into the depths of their metallurgy. Bones and plant remains, etc., as well as the use of the powerful radiocarbon dating technique developed in the late 1940s, also required the involvement of experts in the field of natural sciences. As a result, archaeologists found themselves increasingly turning to the help of experts from other disciplines. However, it soon became clear that the interpretation of the findings often suffered from poor communication between the expert, who lacks education in archaeology, and the archaeologist who lacks education in the appropriate scientific field. About this time the term ‘archaeometry’ appeared in the archaeological discourse referring mainly to areas of research involving fields from natural sciences that provide quantitative data and statistical tools. In most cases, the areas of archaeometric research were not defined according to the nature of the findings or the archaeological research questions, but according to the analytical method used, for example, neutron activation analysis (chemical analysis), metallography (metals analysis) and petrography (mineralogical analysis).

1 I would like to thank prof. Yuval Goren and Steve Weiner for their comments and input on this paper.

Since the archaeological science school was mainly interested in the development of the methods and their applications, and less in the cultural aspects of the material examined, the work of formulating the research questions remained in the hands of the archaeologist. The type of questions that were referred to the scientists by the archaeologists were mostly dealing with the specific material from their excavations, and therefore the research in the laboratories was sometimes eclectic and site-dependent. Despite this, in the 1960s and 1970s some archaeometric research laboratories were established in archaeology departments. This led to the exposure of students of archaeology to analytical methods, and with time graduate studies included specialized analytical methods in their doctoral research that were more question driven rather than site-dependent and commissioned by the archaeologist.

Around the 1980s, most institutions replaced the term archaeometry symbolizing a shift in the conception of the combination of archaeology and science. The sub-field became known as 'archaeological science'; a term that was used to describe the wide-ranging archaeological questions that were addressed using the scientific research method. The archaeological scientist should have knowledge and understanding both in archaeology and in the scientific field in which he specializes. The laboratory also serves as an academic center whose areas of responsibility include ongoing teaching in its field of practice, as part of the academic syllabus and for the purpose of guiding research students and training them in the appropriate theoretical and analytical fields. One weakness still existed, namely that many archaeological scientists were not actively involved in excavations. They thus could not appreciate the strengths and weaknesses of each excavation, and as analyses were carried out on samples collected from the site, many potentially important findings were overlooked. Both problems could be solved by having some analytical instrumentation available on-site that could provide results in minutes or hours. This information could then be used to adapt the sampling and if necessary the excavation strategy.

Starting in the 1980's archaeological scientists set up field laboratories that could help characterizing materials in situ (Goren 2014, Weiner 2010). These field laboratories often included optical microscopes, infrared spectrophotometers (FTIR), Raman spectrometers (especially in conservation and paintings characterizations), and X-ray fluorescence (XRF) spectrometers (Fig. 1); instruments from geological and chemical laboratories that provide chemical, morphological and mineralogical information on various materials on-site. Archaeological scientists could then influence strategies of excavations, deciding on where to focus the efforts and how to sample as well as possible. To be effective the sample preparation should be rapid enough to allow obtaining information on site without holding up the

excavation progress too much. In addition, rapid sample preparation and analysis helps gather information in locations where due to the laws in specific countries samples cannot be exported from the archaeological site or from collections in museums. Weiner (2010) used the term “microarchaeology” to describe this on-site field laboratories/off-site research activity.

Portable instrumentation in field laboratories varies greatly in analytical power, sampling approach, and applications. There is a clear differentiation between methods that extract information on the bulk material (the entire volume of the material), and methods that only investigate the surface properties, depending on the penetration of the probe that can range between several microns to hundreds of microns. Methods that probe bulk material require removing materials from the context or fragment, ranging from a few milligrams (minimally-destructive testing) to hundreds of grams (destructive testing). When the methods probe only the surface, there is no need for removing materials (non-destructive testing, i.e. NDT). In recent years, NDT are becoming popular in studies of cultural heritage in collections and museums, due to the sensitivity of removing materials of cultural significance (Goren et al. 2019). In some cases, there is a good correlation between surface and bulk properties. For example, characterizing pottery using a portable handheld XRF (NDT) can help cluster the samples chemically, showing a correlation with bulk chemical analysis based on neutron activation analysis (NAA), a large scale destructive method. There is an intermediate approach using samples that require a milligram or less of material (that can barely be seen by the naked eye) for analysis. This includes sampling for mineralogical examinations by thin-sections analysis (petrography) of small-scale pottery fragments, using a novel method developed in Israel (Goren 2014), and for FTIR analysis. This is referred to as minimally destructive (MDT) (Goren et al. 2011).

The implementation of analytical methods in archaeology have influenced the research on cultural heritage, during its treatment and conservation. Traditionally, conservators and curators were collecting artifacts of cultural significance in the museum environment to be studied further in the faculties of natural sciences. The need to involve material scientists is shared among archaeologists, curators, conservation scientists, and many other people involved with the investigation of cultural heritage. Analytical methods applied in cultural heritage develop rapidly, covering a wide range of questions related to archaeology, conservation and art history (Artioli 2010). As archaeologists, and because analytical methods are developed in the natural sciences, conservators and curators collaborate with material scientists on questions in conservation, since the background of the researchers in humanities lacks deep understanding physics, mathematics, chemistry, biology, and Earth sciences. In time, material

scientists who specialize and research questions in conservation, have formed a new sub-field known as 'conservation science'.

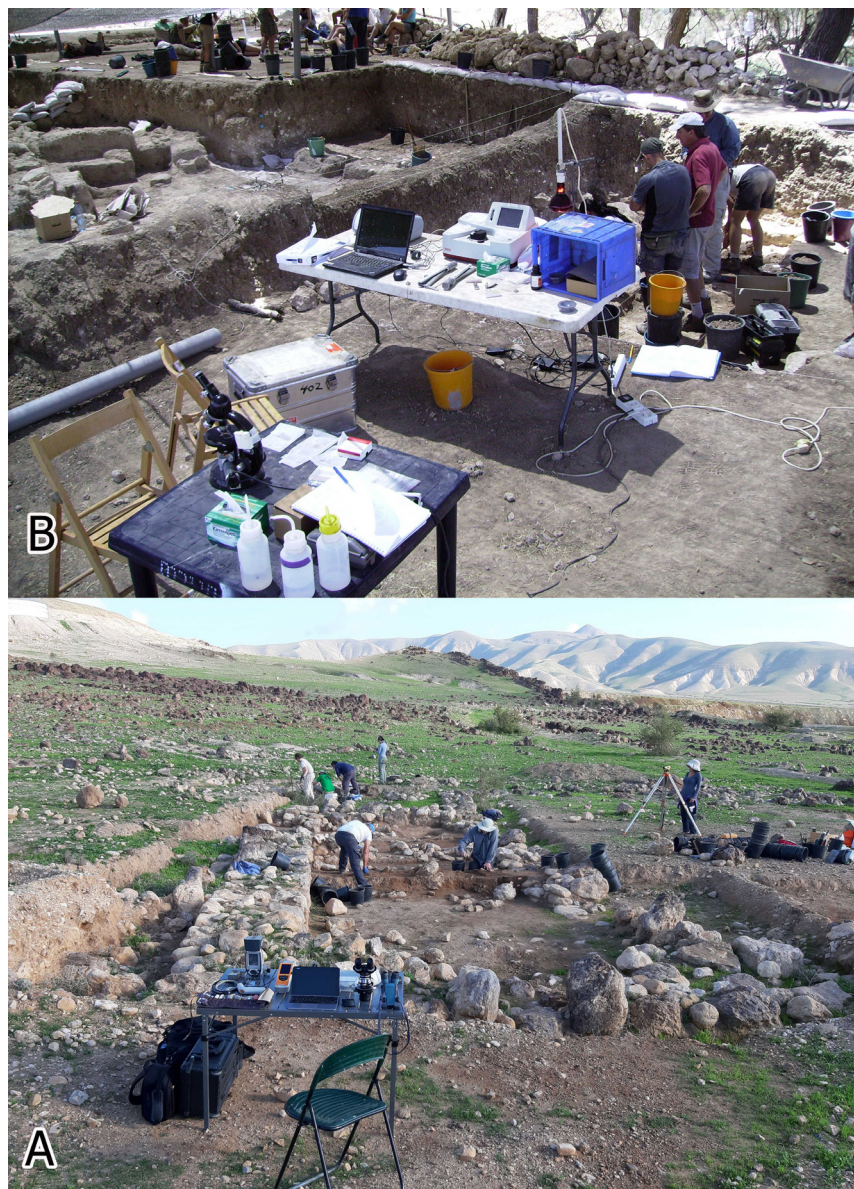


Fig. 1. View of field laboratories in academic excursions.

A) Ben Gurion University field laboratory at Fazel (courtesy of Yuval Goren), showing a portable cross-polarizers microscope, Raman and XRF spectrometers.

B) Weizmann Institute of Science field laboratory at Tel es-Safi/Gath (courtesy of Steve Weiner), showing a cross-polarizers microscope and Fourier transform infrared spectrometer (FTIR).

The Israel Antiquities Authority (IAA) is a government institute that excavates, manages, and curates much of Israel's archaeology. The IAA is responsible for most of the rescue excavations, and then conserves many of the special finds prior to storage and display, and conducts research on their significance. Much of the interactions between IAA archaeologists, conservators and curators with material scientists is within academic laboratories where the analytical instrumentation and databases are located. With time, more and more scientists find their way to IAA rescue excavations, conservation laboratories and IAA's collections. In most cases, the analytical instrumentation is delicate and is restricted to the laboratory environment, so sampling would be first conducted in rescue excavations or conservation projects, and later analyzed back in the lab.



Fig. 2. View of the IAA mobile field laboratory in Yavneh during the excavation season of 2020. A) showing the interior of the lab with portable instrumentation such as microscopes and spectrometers. B) a general view of the vehicle, including instrumentation of a digital microscope and a fiber optic reflectance spectrometer (FORS).

Until recently, field laboratories that specialize in analytical methods were limited to academic institutions. But today, archaeological and conservation scientists have access to diverse analytical methods necessary for the IAA's activities using a dedicated vehicle with a range of portable instrumentation. This vehicle is used for rescue excavations and conservation projects (Figure 2). Rapid examinations on-site for archaeological and conservation questions, narrows down the research questions that could be investigated further in academic frameworks. These archaeological and conservation scientists work in the field and rescue excavations, and not only do they need to translate the archaeological questions to experiments or measurements within a scientific methodological framework, but also need to have enough background and knowledge in understanding the archaeological site to know where and how to sample. These researchers specialize in exploring micro-remains in situ in the archaeological record, bringing their scientific background to study materials within their geological landscape, distinguishing between geological and anthropological activities, characterizing biological remains in situ, in addition to analyzing the material culture.

In this 22nd book of "City of David: Studies of Ancient Jerusalem", two examples of very different analytical methods that were applied as collaborations between specialized laboratories and excavations and conservation works of the IAA. The first example includes non-portable instrumentation (magnetometer) that measures the magnetic signal that is encapsulated in minerals of well-defined archaeological contexts, in a field of research named archaeomagnetism (Shaar et al. 2018). This method enables reconstructing the earth's magnetic field, which varies over time and space, but requires removing large-scale bulk samples for these examinations, hence it is a destructive method. Scientists from earth sciences developed and applied this method, in addition to the field work that was done by sampling on-site. Using this method, a reconstruction of a destruction event was achieved, by looking into the changes of the magnetic orientation of collapsed floor fragments, relative to today's magnetic pole. The sampling requires removing large sections of material in situ, recording the magnetic orientation of the samples in their depositional orientation. This is considered a destructive sampling method, that needs laboratory know-how and training in field work. The second example is the use of a portable based instrumentation (ground penetrating radar, i.e. GPR), that probes electromagnetic reflections from structural anomalies for high-resolution imaging of the shallow subsurface, in a field of research named active remote sensing. GPR is a non-destructive geophysical technique that maps and characterizes differences between structural characteristics (Shamir et al. 2018). Scientists

from earth sciences also developed and applied this method on-site, conducting field work. The instrument might be easy to use on-site, but rigorous mathematical treatments of the data limit the use of this technique by field archaeologists. Using GPR the scientists reconstructed the building techniques of the western wall, looking into the sizes of stone in the wall, and the fill behind them. These examples reflect a fruitful collaboration between specialized laboratories, material scientists who solve archaeological questions, and field archaeologists.

The future of archaeological and conservation sciences in the IAA encapsulates the different modes of operation between field work and specialize laboratories in natural sciences. The collaboration between academic scientists who come to visit the site, sample, measure back in the lab, and interpret the results will continue in the different activities of IAA's research. In addition, in house archaeological and conservation scientists will promote internal examinations of materials distinguishing between geological and anthropological activities, previous conservation efforts, researching biological remains in situ, in addition to analyzing the material culture. The different modes of operation require coordination and collaboration with a network of specialized laboratories that are interested in cultural heritage. Together, the different academic laboratories and IAA archaeological and conservation activities, a new sub-field known as 'heritage science' is established in a framework of national effort. The different academic laboratories are in contact with the portable field laboratory that operates in archaeological and conservation projects, that uses on-site measurements to narrow down the questions that require further examination. The network of laboratories allows coordination, a standardization of reporting analytical results, communication between field work and laboratories, and awareness of who can do what, which goes well with the growth of networking in archaeological and conservation sciences in Europe and the rest of the world.

■ Bibliography

Artioli 2010

Artioli G., *Scientific Methods and Cultural Heritage: an Introduction to the Application of Materials Science to Archaeometry and Conservation Science*, Oxford.

Asscher and Goren 2016

Asscher Y. and Goren Y., A Rapid On-Site Method for Micromorphological Block Impregnation and Thin Section Preparation, *Geoarchaeology* 31(4): 324-331.

Asscher et al. 2020

Asscher Y., van Zuiden A., Elimelech C., Gendelman P., Sharvit J., Secco M., Ricci G. and Artioli G., Prescreening Hydraulic Lime-Binders for Disordered Calcite in Caesarea Maritima: Characterizing the Chemical Environment Using FTIR, *Radiocarbon* 62 (3): 527-543.

Goren et al. 2011

Goren Y., Mommsen H. and Klinger J., Non-Destructive Provenance study of Cuneiform Tablets Using Portable X-Ray Fluorescence (pXRF), *Journal of Archaeological Science*, 38 (3): 684-696.

Goren 2014

Goren Y., The Operation of a Portable Petrographic Thin-Section Laboratory for Field Studies, *New York Microscopical Society Newsletter*, (September): 1-17.

Goren et al. 2019

Goren Y., Ben-Yosef E., Centola F., Fossé

C., Katzir Y., Mirão J., Sha'ar, R., Vassal Y. and Schiavon N., Conservation Science and Ethics in the Analytical Studies of Clay Cuneiform Tablets from Ancient Near Eastern Archives, *Proceedings IMEKO International Conference on Metrology for Archaeology and Cultural Heritage, Florence December 4-6*: pp 59-67.

Shaar et al. 2018

Shaar R., Hassul E., Raphael K., Ebert Y., Segal Y., Eden I., Vaknin Y., Marco S., Nowaczyk N. R., Chauvin A. and Agnon A., The First Catalog of Archaeomagnetic Directions from Israel with 4,000 Years of Geomagnetic Secular Variations, *Frontiers in Earth Science* 6: 164.

Shamir et al. 2018

Shamir O., Goldshleger N., Basson U. and Reshef M., Laboratory Measurements of Subsurface Spatial Moisture Content by Ground-Penetrating Radar (GPR) Diffraction and Reflection Imaging of Agricultural Soils, *Remote Sensing*, 10 (10): 1667.

Shapira and Asscher 2021

Shapira I. and Asscher Y., Analysis of Plaster from the Winepress Complex at Tel Yavne, At *Tel Yavne, Area A*
https://www.hadashot-esi.org.il/Report_Detail_Eng.aspx?id=25883&mag_id=133

Weiner 2010

Weiner S., *Microarchaeology: Beyond the Visible Archaeological Record*, Cambridge.