Shedding Light on Iron Age Hebrew Ostraca via Modern Imaging and Computational Technologies

Shira Faigenbaum-Golovin, Arie Shaus, Barak Sober,
Anat Mendel-Geberovich, Eli Piasetzky, and Israel Finkelstein

Our interdisciplinary project aims to advance the fields of epigraphy and palaeography through the incorporation of modern methods that pertain to applied mathematics, computer science, statistics, and physics. The research focuses on Iron Age Hebrew ostraca that stem from various sites across Israel and Judah. Since no readily available imaging apparatus and computerized analysis algorithms specifically tailored for the First Temple period inscriptions exist, the necessary technologies have been developed by our team in-house. The central goals of our research endeavor are:

- The acquisition of the most legible images of the ostraca
- The production of automated facsimiles
- A handwriting analysis of the ostraca

Among the results of our project is a marked improvement of the legibility of several ostraca, via low-cost multispectral imaging procedure (published in the Journal of Archaeological Science). A particularly striking product of our methodology is the discovery of a hitherto invisible text on the verso of the thoroughly studied Arad 16 ostracon, unnoticed for half a century (published in PLOS ONE). This revelation demonstrates the need for multispectral image acquisition for both sides of all ancient ink ostraca. Moreover, at least in sites where the recovery of ostraca is likely, we recommend employing multispectral techniques for screening newly unearthed ceramic potsherds, prior to their disposal.

Another outcome of our project is a handwriting comparison between 18 texts of the Arad corpus. The newly devised algorithm reconstructs the ancient letters, extracts their features, and performs a handwriting comparison.

The results (published in PNAS) indicate at least six different authors across the Judahite military chain of command ca. 600 BCE. This implies a high literacy rate within Judah's administrative apparatus before the kingdom's destruction by Nebuchadnezzar in 586 BCE.
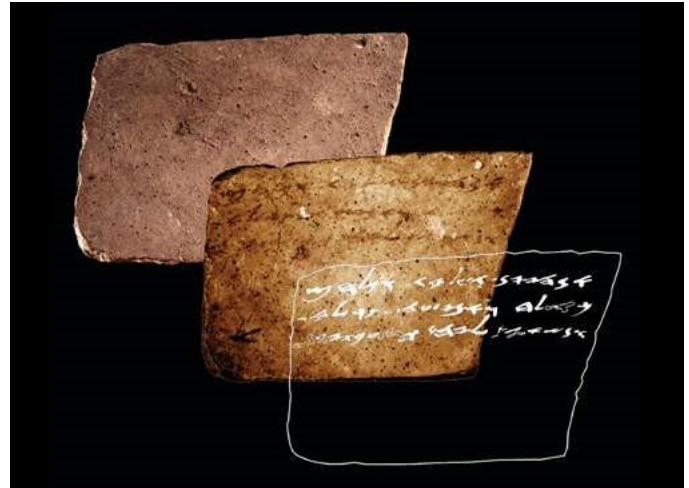
The verso of Arad 16: Revealed through low-cost Multispectral Imaging (Photo by Michael Cordonsky; Graphics by Noa Evron)

To learn more, visit: www-nuclear.tau.ac.il/~eip/ostraca

References

S. Faigenbaum, B. Sober, A. Shaus et al., "Multispectral images of ostraca: Acquisition and analysis", *Journal of Archaeological Science* 39.12, 3581-3590, 2012.

S. Faigenbaum-Golovin, A. Shaus, B. Sober et al., "Algorithmic handwriting analysis of Judah's military correspondence sheds light on composition of biblical texts", *Proceedings of the National Academy of Sciences* 113.17, 4664-4669, 2016.

S. Faigenbaum-Golovin, A. Mendel-Geberovich, A. Shaus, B. Sober, et al., "Multispectral imaging reveals biblical-period inscription unnoticed for half a century", *PLOS ONE* 12.6, e0178400, 2017.
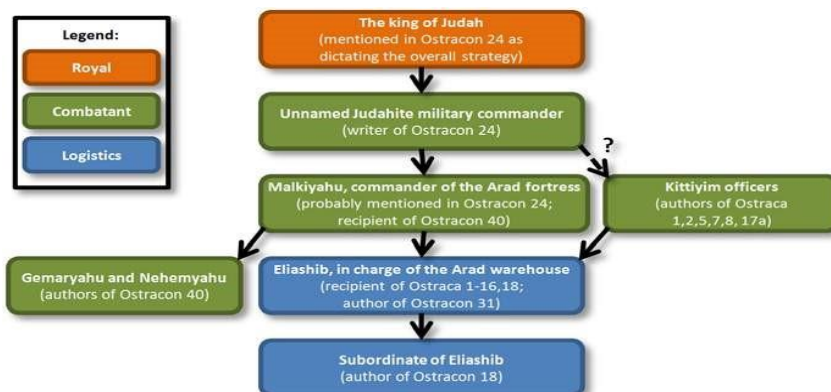
Reconstruction of the Hierarchical Relations between Authors and Recipients in Arad Inscriptions: Based on the algorithm's results, most of these officials were literate (Graphics by Shira Faigenbaum-Golovin, Arie Shaus, and Barak Sober)