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THE FACEM ONLINE DATABASE: STATE OF RESEARCH (2011-2020) AND NEW PERSPECTIVES

Abstract: The 'Fabrics of the Central Mediterranean' (FACEM) database (www.facem.at) is an online collection of fabrics of Greek, Punic, and Roman pottery manufactured in the Mediterranean from the 6th to the 2nd centuries BCE. Designed in 2011 at the University of Vienna for interdisciplinary provenance studies of ceramics, it offers a web-based information system committed to open access publication of results on ceramic fabric analysis. This paper gives an overview of more than a decade of research edited in FACEM and new developments in view of changing standards in digital humanities.

Keywords: provenance studies of ceramics, web-based open access publication, interdisciplinary research, Mediterranean Archaeology.

1. The development of FACEM and the wider research context

identifying the provenance of ancient ceramics is one of the major topics in archaeology (Gliozzo, 2020). A reliable provenance attribution of archaeological objects and their link to well-defined reference groups from production sites, combining archaeological and archaeometric analysis, can be used to reconstruct distribution patterns and ancient trade networks. For instance, it provides valuable information about imports of ceramic artefacts or commodities, such as transport amphorae, which have been widely produced and distributed (Lawall, 2014, pp.152-155). Moreover, the origin of ceramics allows to trace cultural contacts between ancient communities from different geographical areas. Finally, the characterisation of ceramic objects, adopting an interdisciplinary method, permits a profound understanding of their production process and technology, closely related to the socio-economic history of the manufacturing site (Cuomo di Caprio, 2017).

The origin of some ceramics, such as decorated fine ware, might be easily inferred by the stylistic analysis of their decoration. Similarly, in some cases, the provenance of amphorae can be established through the epigraphic study of their stamps. However, the bulk of any archaeological assemblage consists of undecorated pottery, whose provenance cannot be determined by conventional archaeological methods, as the same vessel shapes may have been produced for a long time and in several workshops. By contrast, archaeometric analysis, comprising petrographic and chemical analysis combined with geological prospection of raw materials (Whitbread, 2001; Xanthopoulou et al., 2020, p. 74), bears the potential to identify the provenance of ceramics, even if they are not decorated or stamped. Archaeometric analysis, however, is expensive and can only be applied to a restricted number of samples. This raises the broader question of how to adequately determine the provenance of pottery – and common ware in particular – found on an archaeological excavation. To address this issue, archaeologists have developed a method based on 'ceramic fabrics'. This method involves the description of the main features of pottery, including the inclusions and colour of the ceramic body (Peacock, 1977; Orton et al., 1993; Gassner et al., 2014a; https://facem.at/project/about.php#method). These characteristics can be used to describe ceramic fragments in hand specimen (e.g., macroscopically) or with a binocular microscope. Pottery with the same characteristics belongs to the same ceramic fabric and, therefore, has the same origin.

The idea to develop the online database FACEM as a means to identify the provenance of ancient ceramics was initiated by Verena Gassner, Maria Trapichler, and Babette Bechtold from the Department of Classical Archaeology at the University of Vienna in 2011. In collaboration with Kurt Schaller, a specialist in Cultural Heritage Computing, they followed the shift to web-based archaeological data repositories that started in the mid-1990s (e.g., Archaeology Data Service (https://archaeologydataservice.ac.uk/about/), tDAR (https://www.tdar.org/), POTSHERD: Atlas of Roman Pottery (https://potsherd.net/home/), ceraDAT (Hein & Kilikoglou, 2012), or the Levantine Ceramics Project (https://www.levantineceramics.org/)). Using a binocular microscope, the FACEM team defined fabrics from different pottery wares, including undecorated pottery, black glazed ware, and transport amphorae from southern Italy and Sicily, dating from the 6th to the 2nd centuries BCE.

To verify the proposed provenance of ceramic fabrics and define solid reference groups, archaeometric analysis and investigations on clayey raw materials have been carried out by Roman Sauer (Gassner et al., 2003; Gassner & Sauer, 2009; Gassner et al., 2014b), by Giuseppe Montana, Luciana Randazzo (Montana & Randazzo, 2015; 2018; 2024; Montana et al., 2020; 2022; 2024), and by Alberto De Bonis (De Bonis, 2018; De Bonis et al., 2020). Essential parts of the results of this interdisciplinary research are published on FACEM and represent a coherent and standardised publication of ceramic fabrics with the following advantages:

1. Ceramic fabrics are documented on FACEM with high-quality colour images (fig. 1). This allows users to quickly compare pottery finds with published ceramic fabrics. Due to the limited extent and high printing costs, especially for high-resolution colour images, conventional printed books cannot achieve this goal;

fig. 1. Screenshot of ceramic fabrics from amphorae produced in the the Bay of Naples.

2. A web-based publication can be quickly updated, expanding and integrating previously edited results. Thus, unlike static datasets that are released once as a final publication, web-based publications, such as FACEM, are a very efficient medium for the continuous presentation of research results;
3. A web-based publication also offers many opportunities for peer-to-peer communication and collaboration and the creation of a research network;
4. Scientific results published in FACEM's web-based repository comply with the Open Access Policy that is mandatory for many funding bodies, such as the Austrian Science Fund (FWF).

The main focus of FACEM's research group and their partners in the first two releases (2011, 2012) was on fabrics of various ceramic wares, including transport amphorae, from Elea/Velia, Poseidonia/Paestum, and the Gulf of Naples (Cuma, Pithekoussai, Naples), supplemented for Elea/Velia in 2015 in the fourth release. In 2018, the seventh release added new data for pottery production at Poseidonia/Paestum and the plain of Salerno from the sites at Pontecagnano or Fratte. The second emphasis was on the fabric analysis of southern central Mediterranean (mainly Sicilian) amphorae consumption sites of the 7th-3rd centuries BCE (releases 3-5, 8) and the characterisation of transport vessels produced in western Sicily.

2. Using FACEM – case studies on transport amphorae

As of 2024, FACEM hosts a large amount of ceramic fabrics from ongoing and finished research projects (Hasenzagl & Borgers, 2023). About 30 institutions worldwide have collaborated to expand the FACEM repository, providing pottery sherds from approximately 80 archaeological sites in the Mediterranean, most of which are located in present-day Italy, and, to a lesser extent, in Spain, Malta, Tunisia, Albania, Greece, and Turkey.

Users can search through numerous fabrics and select them according to different criteria, including production site, consumption site, pottery ware (e.g., amphorae, black glazed ware, ceramic building materials), and chronology (e.g., Greek, Punic, Roman era), facilitating fabric data for their research.

Each fabric is labelled with a tripartite alphanumeric code, including information on the production site or region (e.g., BNAP = Bay of Naples) and the pottery ware (e.g., A = Amphora) it belongs to. This unique code permits users to bookmark or cite specific ceramic fabrics. The standardized description of each fabric is based on the composition of the inclusions and colour of the ceramic body. This is accompanied by several images at different magnifications, information about the object (e.g., vessel typo-chronology), and context (i.e., archaeological site of discovery), as well as by a map visualising the geographical distribution of the ceramic fabric examined.

Observations on ceramic fabrics are also linked to publications, which can be downloaded from the website. Some of these publications focus on the origin of ceramic fabrics, while others discuss the occurrence of ceramic fabrics on various

sites, permitting insight into their distribution and trade. The following case studies illustrate the progress of research through fabric classification of transport vessels.

Production sites of western Greek Amphorae in southern Italy

A notable example of the impact of fabric analysis was a project focused on identifying production sites of western Greek amphorae in southern Italy from the 6th to the 2nd centuries BCE. For a long time, this large and complex group of transport amphorae, produced in a wide area from the western coast of Albania and northern Greece to southern Italy and to the Gulf of Lion and the Iberian Peninsula, had been attributed to various 'types' with a very divergent terminology and was only recognized as one coherent class at the beginning of the 21st century. It was the merit of J.-Ch. Sourisseau, who did a thorough study of this class, developed a comprehensive terminology and placed the various types in a well-founded chronological sequence (Sourisseau, 2011). However, it became clear that a classification based on the morphological development of vessel and rim shapes was insufficient to identify the provenance of these vessels. Only the introduction of the concept of fabric, combined with archaeometric analyses, made it possible to define a conspicuous number of production sites or areas in southern Italy and to follow – at least partially – the typo-chronological evolution within these production sites (Gassner, 2003; 2015; 2024; forthcoming). It also allowed quantitative analyses of large assemblages of amphorae as a basis for studying economic relations in this area.

Transport amphorae produced in Greek, Phoenician-Punic, and native western Sicily (late 8th-3rd century BCE)

Another example is the international and interdisciplinary provenance studies that have significantly advanced the characterisation of the western Sicily's main amphorae series from the Archaic to early Hellenistic period. The overall results of these investigations represent a milestone in understanding regional economic development (for the far-reaching significance of the establishment of amphora production in antiquity: Sourisseau, 2011) and commercial interaction among Greek, Phoenician-Punic, and native communities in this frontier region (Spatafora, 2018) on the western edge of the island.

A large part of this research was edited in the FACEM releases 3, 4, 5, and 8 (2013-2015, 2020), providing detailed insights into ceramic fabrics, diachronic morphological repertoires, and distribution patterns of 10 western Sicilian amphorae series. By introducing petrographic data in release 5, the publication of minero-petrographic analyses of representative samples from each assemblage has significantly enriched the database. Additionally, single items edited in FACEM have been hyper-linked to open access and peer-reviewed publications which discuss the same objects (e.g., https://facem.at/him-a-1).

The results of this research have been summarised in fig. 2, offering multiple viewpoints for further studies (see contributions of Bechtold, Corretti, Montana, and Riehle in the references). In the framework of the present paper, we highlight only two issues, which connect data to the investigations of the international scientific

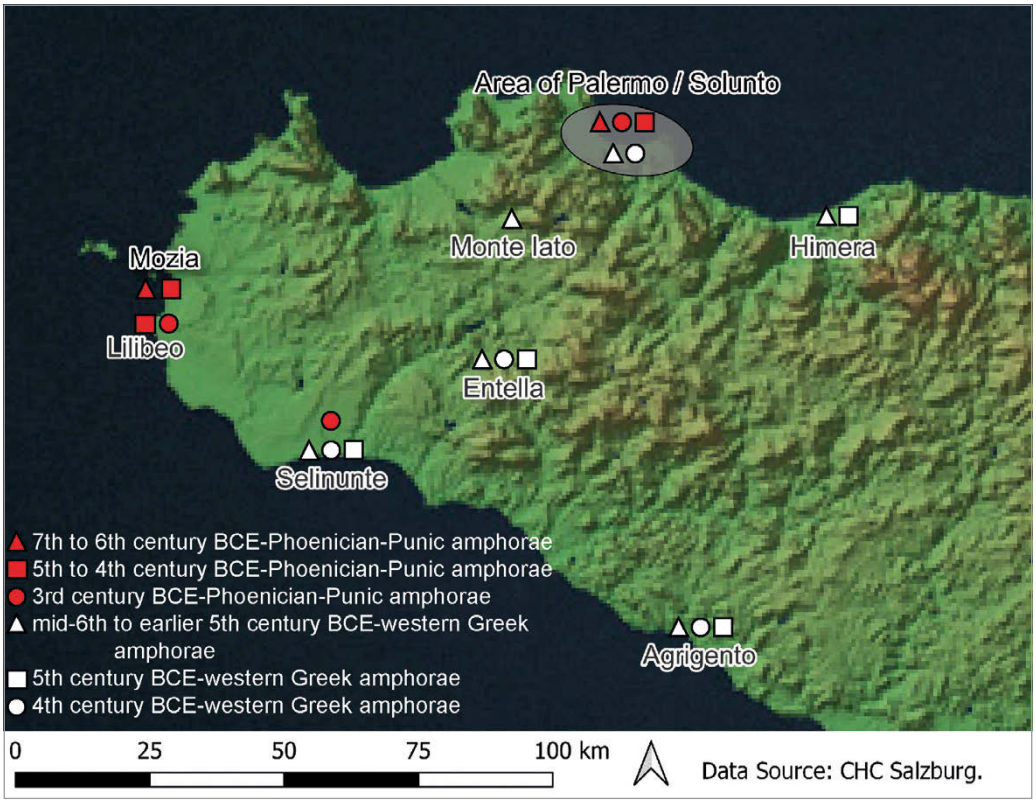

fig. 2. Western Sicilian amphorae productions published in FACEM (as to 2024): a diachronic survey (@ R. Lampl).

community. First, the aforementioned characterisation of the Sicilian amphorae series has allowed the identification of extra-regional exports scattered across the Mediterranean and documented on Jerba (Ben Tahar, 2021, pp. 68-69), in Corinth (Fantuzzi et al., 2020, p. 10), and in coastal Latium (Jaia & De Dominicis, 2020, pp. 755-757). Secondly, ongoing interdisciplinary studies on a selection of western Greek amphorae found in Terravecchia di Cuti, a hill site located in the frontier area between the *chorai* of Arigento and Himera, led to the identification of a previously unknown minor northwestern Sicilian series (Bechtold & Burgio, 2024, p. 216). This stimulating outcome underlines the potential of amphorae analysis for further investigations of socio-economic interaction between native and colonial Greek communities during the Archaic-Classical period (Vassallo, 2010).

3. Future perspectives and revision of FACEM

The results of the presented case studies on transport amphorae highlight the potential of interdisciplinary and freely available pottery repositories and research tools, such as FACEM. They help in tracing the regional and supra-regional distribution of

different pottery wares and in addressing socio-economic and cultural aspects through the study of fabrics. We believe that by including a broader range of pottery wares as well as by widening the geographical framework to the entire Mediterranean and the timeline to the Late Roman period (until the 7th century CE), the use of FACEM will gain further relevance. Currently, two projects focus on ceramic fabric analysis of coarse ware and tableware.

The first project is an interdisciplinary study of coarse ware from the Pontine region in southern Lazio, Italy, that addresses the question of the region's position within local, regional, and wider central Mediterranean networks between the 4th and 1st centuries BCE. Its first objective is to reconstruct the production technology and provenance of coarse ware from several sites in southern Lazio. To achieve this, an integrated compositional approach is adopted, combining mineralogical analysis (thin section petrography, X-ray diffraction) with chemistry (wavelength dispersive X-ray fluorescence, scanning electron microscopy). The second objective is to shed light on the integration of southern Lazio into broader production and trade networks, by comparing the results with previous data on coarse ware prevalent in the region at that time.

The results indicate that the coarse ware studied was produced with red-firing clay and fired in an oxidising atmosphere at a low temperature (< 900 °C). Differences among the coarse ware exist in the paste recipes (e.g., intentionally added temper). The composition of the coarse ware suggests that the majority was produced locally at the sites of *Satricum* (present-day Borgo Faiti), Fregellae, and Nemi, even if this is not always supported by evidence for workshops. The results further indicate a lively trade in coarse ware from the Alban Hills and the Tiber Valley, north of Rome, suggesting that the study region was integrated into the marketing of pottery that was predominant in Lazio between the 4th and 1st centuries BCE. Changes in regional trade seem to have taken place when ceramic production at *Satricum* ceased in the 3rd century BCE and potters began producing coarse ware in other settlements, including *Forum Appii* and *Norba* (present-day Norma) (Borgers & Diosono, in press; Borgers et al., 2023; Borgers & Fischetti, 2023).

The second project, conducted by Carina Hasenzagl, focuses on 1st to 7th century CE African *terra sigillata*, also known as African Red Slip Ware (hereafter ARS). It was produced in the regions of modern-day Tunisia, Algeria, and Libya and is abundantly documented at many archaeological sites. In addition to already established classification criteria, i.e., type-variety typologies (e.g., Hayes-types) and the so-called Italian system (A, C, D, E, F, G, etc.), the definition of ARS fabrics with a combination of petrographic analysis allows to investigate ARS distribution patterns regarding both chronology and exact provenance (e.g., Hasenzagl, 2019; Hasenzagl & Capelli, 2019; 2021). A multi-site perspective with selected ARS assemblages (Hasenzagl, 2022) from different inner-African and Mediterranean consumption sites (e.g., Carthage, Ampurias, Marseille, Rome, Velia, Ephesos) generally provides data to trace the distribution of ARS made at a specific production centre (e.g., El Mahrine, Oudna, Pheradi Maius, Sidi Marzouk Tounsi, Djilma). However, a variety of fabrics with so far unknown provenance also attests to the high number of workshops producing ARS and the complexity of reconstructing regional and supra-regional (maritime) trade networks and their changes over time.

The project on ARS serves as another case study on applying fabric analysis to tableware, similar to the research on black glazed ware and *terra sigillata* from the Bay of Naples in the FACEM database. It also connects to the website's research on Punic pottery from the Carthage region, offering possibilities to study production zones in North Africa diachronically.

The data gathered in these studies on coarse ware and tableware will be added to the ceramic fabric collection in the next release of FACEM. Given the planned chronological and geographical expansion of the repository, the original name 'Fabrics of the Central Mediterranean' will be changed to 'Fabrics of Ancient CEramics in the Mediterranean', keeping the established and known acronym.

Due to the steadily increasing research data, however, FACEM, like other dynamic web-based resources, faces rapidly changing technical requirements, as well challenges in adhering to FAIR (i.e., Findable, Accessible, Interoperable, and Reusable) principles (Wilkinson et al., 2016). So far, FACEM adheres to the these principles, since its research data are *Findable* (e.g., via the permalink https://facem.at), *Accessible* (i.e., open and freely, without restrictions on the date of publication), *Interoperable* (i.e., a formal and standardised protocol common to pottery studies is used for the presentation of research output), and *Reusable* (i.e., they are licensed CC BY-NC-ND 3.0 AT) (https://facem.at/project/impressum.php).

Going forward, the FAIR principles of *Findability*, *Accessibility*, and *Reusability* are not a challenge for FACEM; however, adherence to the principle of *Interoperability* will be. The reason is that FACEM's technical framework is outdated, inevitably jeopardising long-term availability and reusability of its published data.

FACEM's current technical framework adopts LAMP, an open-source Web platform that uses LINUX as the operating system, Apache as the Web server, MySQL as the relational database management system, with an offline Microsoft Access database, and PHP as the object-oriented scripting language. The web application further includes AJAX components for client-side scripting, and NASA-SRTM data are used to produce maps to visualize the geographic occurrence of the ceramic fabrics described. Now, 13 years after the launch of FACEM, however, Desktop SQL office database products, including Microsoft Access, providing a graphical user interface to help set up relationships and form queries, have become notoriously fragile, and are inefficient in handling large databases. Moreover, collaboration by multiple users on a single database is a challenge (https://o-date.github.io/draft/book/arranging-and-storing-data-for-the-long-haul-databases.html).

To address these issues, the 'Remaking FACEM' project was developed in close collaboration with the IT-Support for Research Department of the Vienna University Computer Center. In the course of this project, the IT-Support Team will assess FACEM's technical structure, taking into account long-term preservation, FAIR data principles and IT security. They will also implement several enhancements to the prevailing software that will significantly improve the quality and functionality of FACEM. More specific suggestions for implementations include: 1) Update the source code of the current PHP version, which is pivotal for IT security; 2) Implement features that enable direct data changes on the web, which not only eliminates the need for Microsoft Access, but also improves data interoperability and reusability;

3) Develop an interface with a repository to store data according FAIR principles, ensuring long-term data retention; and 4) Ensure long-term preservation of research data from the FACEM repository in the University of Vienna's central repository 'Permanent Hosting, Archiving and Indexing of Digital Resources and Assets' (PHAIDRA) (https://phaidra.univie.ac.at/). This technical update aims to adapt FACEM to the rapid developments in digital humanities, so that this web-based repository remains an important and indispensable tool for identifying provenance and reconstructing trade of ancient ceramics in the Mediterranean (Bellelli, 2018).

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