Chemical composition of early ceramics from Thessaly, Greece

Abstract
Some 1300 samples of early ceramics from Thessaly were analysed by WD-XRF to distinguish possible local groups and to get information on production and distribution. The analyses covered styles from Early Neolithic (Protoseskło) to Late Neolithic (Classical Dimini and Otzaki) as well as Mycenaean pottery. The analysed sherds mainly represented surface finds from sites in the eastern and western Thessalian plains but also included pottery samples from excavations at Sesklo, Dimini, Soufli Magoula, Platia Magoula Zarko, and Makrychori 2.

Description
Between 1979 and 1992 Neolithic pottery samples from Thessaly were analysed as part of a project "Frühe Keramik Thessaliens", with financial support from the German Volkswagenstiftung. The material was sampled in several series. It comprised Neolithic to Mycenaean pottery from sites in the eastern and western Thessalian plains, including e.g. the famous sites Sesklo, Dimini, Achilleion, and Servia. Most sherds are surface finds collected during numerous surveys by various people and stored in the museum in Larissa. They were analysed to determine compositional groups and their possible correlation to sites. This, however, turned out to be feasible only for stratified coarse pottery which was not widely exchanged like the painted or slipped fine wares. The bulk of the fine wares had been produced at many, though unidentified, sites. An exception is the technologically very special type of grey-on-grey ceramic for which a provenance from a limited region in the northeast corner of the western plain was probable by comparison with geological clay samples. Stratified material was included from excavations in Soufli Magoula, Platia Magoula Zarko, and Makrychori 2. Only a small part of the data has been published, including pottery of the beginning of the Late Neolithic and of the Mycenaean periods. Analyses of earlier phases and many analyses of Late Neolithic Otzaki and Classical Dimini styles, however, are not published. Analyses of clay used by traditional potters in Thessaly in the early 1980s and geological clay samples collected during various campaigns gave an idea of the geochemical variation of clay from Sesklo and from the eastern and western Thessalian plains. The results of analysis carried out on 147 clay samples are not included in this stage of the databank.
Remarks on the columns in Metadata: All samples are unequivocally identified by their Lab.-No. Any digits after the four digits of the laboratory numbers indicate a second analysis of the same powder (1, 2) or of a second fragment of the same sherd (A, B). Many of the samples were also examined in thin sections (see 'other analysis' column), which are now stored in the Museum in Larisa together with the remaining fragments of the analysed sherds. A photographic record was made of nearly all sherds, and this is now also kept with the sherd descriptions in Larisa. Information listed in the columns 'object', 'object type' and 'ware' is cited after publications or after initial finds descriptions by the 'object dispenser' made in the field and may not always be correct. The 'site' and the 'layer' columns also records in which box the finds are held in the museum in Larisa; any given layers identify samples from excavations. Some of the coordinates of the find spots are not precise or unknown. All coordinates correspond to World Geodetic System (WGS) 1984. The column headed 'dating' gives only approximate dates, for surface finds of fine wares deduced from the object type and ware.

Publications:
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During some phases of the study, or for parts of the project, the following specialists were also involved:
Fréderique Thiercelin (archaeologist), Claude Björk (archaeologist), Mies Wijnen (archaeologist), Cressida Ridley (archaeologist), Peter Schubert † (petrologist), Renate Nöller (mineralogist), Bryan Feuer (archaeologist). Anette Rother (mineralogist) wrote her diploma thesis at Freie Universität Berlin in 1987 on part of the laboratory studies.

Applied method of analysis (WD-XRF):

All analyses, except nos. 1-221, were made on ignited powders. Losses on ignition (l.o.i.) generally are given. For easier comparison the sum of major element oxides is normalised to 100%. The sum of the original measurement, however, is given (for erroneous sums below 95% or above 105% a correction should also be considered for trace elements). Samples are prepared by pulverising fragments weighing mostly 2-4g having first removed their surfaces and cleaned the remaining fragments with distilled water in an ultrasonic device. The resulting powders, after drying at 105°C, are ignited at 900°C (heating rate 200°C/h, soaking time 1h), melted 1:4 with a lithium-borate mixture (Merck Spectromelt A12) and cast into small discs for measurement. This data, therefore, is valid for ignited samples but, with the losses on ignition (LOI) given, may be recalculated to a dry basis. Measurements are made using a Philips PW1212 and, after 1980, a PW1400 WD-XRF-Spectrometer. The precision, expressed as coefficients of variation, for major elements generally is better than 1%rel; for trace elements this rises up to 20%rel for low concentrations. The trace elements Cu, Y, Nb, La, Ce, Pb and Th are measured with poorer precision. Accuracy is based on calibration using more than fifty certified international standard reference samples and on control by exchange of samples with other laboratories. Maximum deviations for major and trace elements (>100 ppm) generally are between 5 and 10rel%. The data of the major elements are given as weight per cent oxide in the usual geochemical order. The trace elements are given as ppm (µg/g) in the order of their atomic numbers.

In cases where only few powder was available 0.1g was melted together with Merck Spectromelt A10 using a higher dilution, smaller glass discs and a particular calibration. Because of the high dilution, some trace elements then could not be determined with sufficient precision and are not reported.

Institutions:
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Keywords
chemical analysis, WD-XRF, Neolithic pottery, Mycenaean pottery, Thessaly, Sesklo, Dimini