Micro-Computed Tomography for the analysis of Japanese pottery

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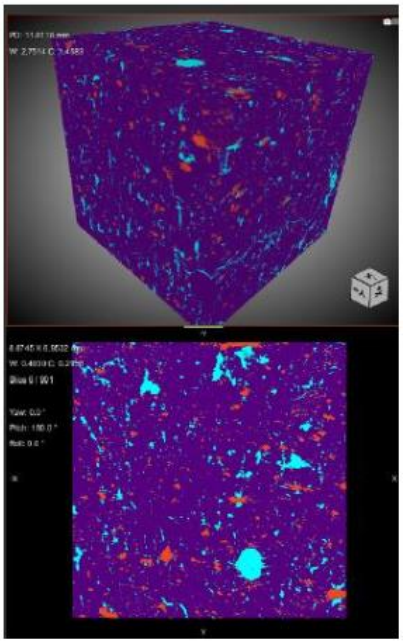
In the framework of the BeArchaeo European project, the archaeometric analysis of different kind of materials coming from several Japanese archaeological sites have been carried out. Among them, X-ray imaging has been applied to characterise pottery fragments: radiography for a first screening and Computed Tomography (CT) analysis for a complete volume reconstruction, 3D rendering and segmentation.
CT revealed to be useful to distinguish different characteristics of the sample (e.g. minerals, porosity, etc.): usually these results are obtained with a high spatial resolution in an invasive way by means of a Scanning Electron Microscope (SEM), while using CT these results can be obtained in a non-invasive way, even if with a lower spatial resolution. For this purpose, tomographic acquisition of the central part of every sample was performed (Local Tomography) to reach the maximum possible resolution in the final CT reconstruction. From this analysis it is possible to visualize internal porosity of the material (voids size and their directionality) and principal mineral components that can give valuable information on manufacturing and execution techniques of the artifact.
In order to obtain the best possible results, a methodology for processing the tomographic data has been developed and tested, which involves several steps of correction and processing of raw and intermediate images to remove artifacts that could afflict CT analysis, the so called "ring artifacts".
In the reconstructed tomographic images, the different ceramics components are clearly visible with different grey levels according to the material density and composition, since the grey level variations are due to the different X-ray attenuation coefficient of the present elements and their atomic packing, giving an indication of the chemical composition in a non-invasive way. Higher density areas, composed of more heavy chemical elements, are visible as brighter areas, while dark areas indicate the presence of voids and porosity that extends over the entire investigated volume. Areas with an intermediate grey level represent medium density material, such as other types of minerals or inclusions and the ceramic matrix.



The three-dimensional visualization of the CT images is usually performed to qualitatively characterise the microstructure of the sample. In this case threshold-based method for segmentation was used: different grey level correspondent to the different materials presents are separated and different colours are virtually assigned to each of them.
Linking the information obtained by the invasive techniques (petrographic examination, SEM-EDS, XRF, XRD etc..) with the one obtained by means of CT, it is possible to propose some correlations with different inclusions inside the fragments.

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