

Spectroscopic and X-ray studies on bead decorations of celtic fibulae

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Bead decorations on celtic fibulae from late La-Tène times [1] provided by Kreismuseum Bitterfeld, Landesmuseum Stuttgart, Naturkundemuseum Leipzig and Landesamt für Denkmalpflege und Archäologie Sachsen Anhalt/Halle are suggested to reflect coral sources related to trade roads from the mediterranean sea to central Europe [2]. Because of doubts [3, 4, 5]. about coral attributions to fibulae from Gräfenhainichen (1), Hänichen (1), Kleinkorbetha (2) and Langenau (4), we systematically studied the beads regarding their biotic and abiotic carbonate characteristics. The resulting data are used for archaeological attributions as well as references to check bead materials of fibulae implying geological settings, celtic settlements and geographical aspects.

Non-destructive phase analysis was carried out by locally high resolved μ -XRD2-measurements with a BRUKER D8-Microdiffraktometer using Co radiation[6]. To get additional informations not only about a possible organic content in the beads by Raman-spectroscopy [7,8], μ -Raman analyses were done using a Renishaw inVIA- μ -Raman microscope at the University of Tübingen and Dilor XY 800 at the University of Leipzig respectively. Supplemental non-destructive 3D μ -CT and μ -XRF analyses reveal information about the interior structure and the main chemical composition of the beads and the whole fibula. For comparison purpose also destructive X-ray powder diffraction measurement were carried out. To get an fast overview regarding the chemical composition 3D-data were collected with a novel X-ray color camera [9,10]. Because of comparison reasons, not only fibula beads, but also recent red and white corals as well as abiotic mineral calcites and aragonites were studied.

The data on chemical composition and mineral phases of the calcites are consistent and show $MgCO_3$ -contents between 0.0 and 16.0 % which are directly related to abiotic and biotic nature of the calcite [5]. Also shifts of the carbonate bands in the Raman spectra could be correlated with the Mg contents and are in good agreement with the XRD and XRF data. Additionally, Raman analysis allows the identification of organic matter, typical for coral beads and a clear evidence for biotic carbonates. The combination of methods described above, therefore allows a clear non-destructive differentiation between coral and non-coral materials.

The results lead to a distinction of fibulae from the southern and central part of germany implying different bead materials due to abiotic and biotic proveniences deducable from trade road from the Baltic and Mediterranean Sea. In addition to the carbonate based decorations also non carbonate materials could be clearly distinguished on the fibula possibly from restorations of about 1900[11].

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