Geophysical Research Abstracts
Vol. 20, EGU2018-6923, 2018
EGU General Assembly 2018

Multi-scale water distribution imagery in building heritage using Electrical Resistivity Tomography (ERT) and Infra-Red Thermography (IRT): Application to Gallo-Roman masonry submitted to water-table rising periods

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The archaeological site of Vaux-de-la-Celle, located at 60 km North-West of Paris, is an outstanding example of Gallo-Roman heritage in France. The site concentrates various structures built between de 2nd and 4th century AD. Specially, the theatre, that could accommodate ten thousand people and the temple partially erected with three Nymphaeum (ceremonial bath). This archaeological site is remarkable for the magnificence of the vestiges and also for the hydrogeological context related to its location within a valley where the water table reaches level of the surface. The Temple structure is constructed at the lowest part of the valley with its foundations in direct contact with the vadose zone where the water table fluctuates. This particular condition provides the basis of the study case that concerns fluctuations of the water content and distribution within the porous materials and its impact regarding salt weathering.

Water distribution in a masonry is a determining factor in the frame of the salt weathering processes. The aim of this study concerns the application of a Non-Destructive Technic (NDT) that allows to determine the water distribution within the building masonry, in particular the Electrical Resistivity Tomography (ERT) and Infrared Thermography (IRT) method. The ERT method enables to image the spatial and/or temporal variation of the electrical resistivity related to the water and salt content distribution within the structure while IRT provides the boundary limit conditions by the means of surface thermograms.

Experiments in the lab are performed in order to analyse the electrical response of the materials. Indeed, the electrical resistivity of the materials is measured at different degrees of saturation, going from dried state to complete saturation. In addition, a water capillary imbibition test is performed on a stone core of a limestone rubble from the archaeological site. During the imbibition test the changes of the physical proprieties concerning the electrical resistivity and surface temperature are monitored by applying the ERT and IRT methods. The imagery methods are combined with numerical models to have a better understanding of the capillary rise phenomena. Finally, this methodology is applied on a wall of the Gallo-Roman temple of the archaeological site in order to survey the evolution of water saturation within the masonry with agreement to environmental variations such as water-table fluctuations.