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Anthropogenic carbonate deposits: a new tool for environmental studies and archaeology

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Our understanding of ancient people quite underestimates their awareness of nature and their profiting from natural resources. Human beings continuously expand their knowledge by learning something new that is somehow astonishing, especially if one considers how our ancestors tunnelled for mining without advanced technological tools, or organised water management in semi-desert areas under harsh environmental conditions. Ancient water structures are one of the elements within which anthropogenic carbonate deposits form, while archiving history of the first cultures. These carbonate deposits prove us how our ancestors took conscious decisions while supplying water to a settlement. The calcareous deposits within ancient water structures throughout the Mediterranean show the general preference of karst sources. Carbonate deposits of Roman aqueducts were examined using multidisciplinary methods such as trace and major element analyses, stable carbon and oxygen isotope analysis, while microstructural characteristics and crystal orientations were determined by EBSD method. Carbonate deposits inside the aqueduct channels form as a result of changes in flowing water level, velocity, temperature and geochemistry and usually sedimentation rate is 1mm per year. Coarse-grained, elongated crystals form during the wet season under fast flow and fine-grained, micritic fabric forms in the dry season under slow flow conditions. Relatively high porosity within the fine-grained layers is attributed to more biological activity due to the prevailing favourable conditions during the warm season. There were clearly some periods when the Roman engineers maintained their water supply system on a regular basis, which caused some kind of anthropogenic layers, but otherwise deposits are regularly laminated and can have a thickness of 80 cm representing 800 years. Moreover, abrupt changes in the sequence of lamination can be a signal of natural hazards such as earthquakes or floods.

Yet, carbonate deposits from the ancient water-lifting devices and watermills have started to be used as a proxy material to determine the size and nature of their construction in ancient times. By doing so, many watermills and water lifting devices can be reconstructed with the help of their incrustations. Recently we have become involved with a project to investigate the oldest and largest industrial watermill complex from Barbegal (Arles), France to see how the Romans maintained this machine to bring profit to the Roman economy. The first analyses of stable carbon and oxygen isotopes have shown us their working principle and their years of activity, which can show eventually how the Roman economy changed in the course of their use. We have observed about five years of activity, which proves continuous use, most likely to answer the flour needs of the people of Arles. In another study, at the Baths of Caracalla, carbonate deposits from an underground-located mill will be used to determine the origin of the source water of the watermill there.

The dating of carbonate deposits from both aqueducts and water machines is quite challenging but there are some promising methods to give an age to the deposits. Firstly lamina-counting seems to be ideal for deposits with annual lamination, especially from the Eastern Mediterranean where the climate show a seasonality with wet winters and dry summers. The next step is to compare carbonate deposits from different regions of the Greco-Roman empire to see how geographical conditions played a role in the formation of laminated carbonate deposits from ancient aqueducts.