

# Bioremediation for the Conservation of Petroleum-Contaminated Stone Monuments

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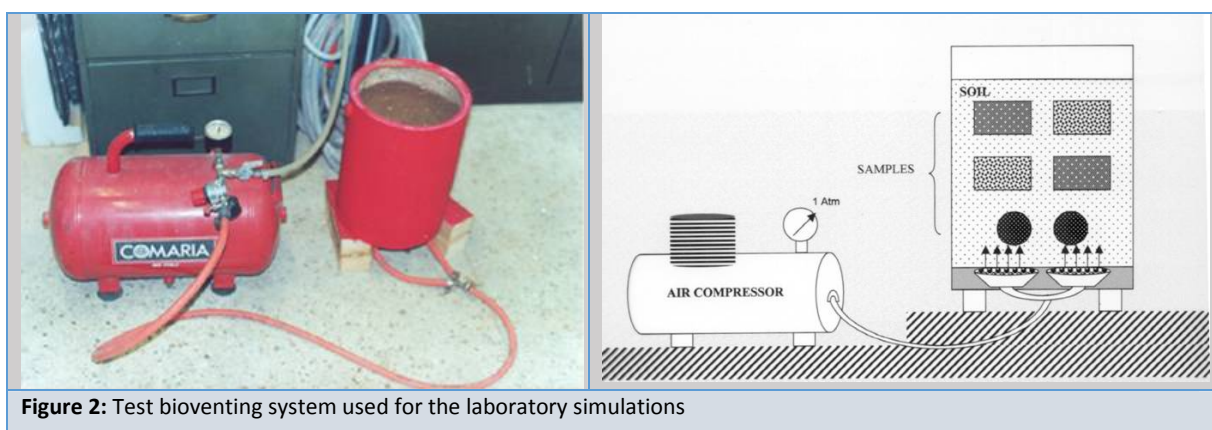
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Efforts made in the conservation of cultural heritage are having to draw increasingly on a wider range of technologies in order to deal with both natural and anthropogenic risk factors. Recent research undertaken to determine the influence of environmental pollution on cultural resources has focused on the potential effects of chronic petroleum leakage on the subterranean parts of stone monuments. Whilst previous work has concentrated largely on the effects of air pollution on building stones, little has previously been done to consider the effects of underground pollution. Present work has therefore considered the sources of petroleum pollution, migration routes, and the effects of such pollution on and within the stone, as well as future conservation management policies.

The main aim of the research was to assess available methods with the potential to be used in the protection of monuments subjected to chronic petroleum pollution. Existing methodologies concerning the reduction of hydrocarbon content within both soil and groundwater were assessed, and criteria established for the appropriate treatment of subterranean stonework. The method identified as most appropriate was bioventing, where air is used to stimulate indigenous micro-organisms having the ability to transform hydrocarbons into harmless by-products.

Three types of limestone were shown in laboratory work to be weakened by immiscible mixtures of water and petroleum when present in the pores of the stones. Bioventing treatment was shown to reduce the hydrocarbon content of the stone by 75% after a 60-day treatment. The rate of biodegradation was significantly higher than when no treatment was administered.



**Figure 2:** Test bioventing system used for the laboratory simulations

## Publications from research

COLSTON, B., KLIIFA, M. AND WATT, D. (2006). Investigation of bioremediation for the conservation of petroleum-contaminated stone monuments, *AIC Annual Conference, Research and Technical Studies*, June 2006, Rhode Island, USA.

KLIIFA, M., COLSTON, B. AND WATT, D. (2003). Evaluating the use of bioremediation techniques in the conservation of hydrocarbon-contaminated stone monuments. In: Townsend, J.H. (Ed.), *Conservation Science 2002*. Archetype, London, 135–40. ISBN: 1-873132-88-3.