# Pyrosequencing analysis of bacterial diversity in Chernobyl contaminated trenches

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Following the Chernobyl nuclear disaster, contaminated soils, vegetation and other radioactive debris were buried *in situ* in trenches. It is now well known that micro-organisms play an essential role in contaminant mobility in soils. In the case of radionuclides, the interactions engaged could retain or induce their transfer from the trenches. However, radionuclides might also exert toxic effects on the micro-organisms and hence reduced their role in the transfer. This study focused on the impact of a radioactive environment on bacterial community's diversity with an underlying question: did a chronic radioactive exposure lead to the extinction of bacterial diversity?

To address this issue, a pyrosequencing-based analysis of 16S rRNA genes was conducted on radionuclides contaminated and non contaminated control samples. The huge diversity obtained by this technique was illustrated by an average of 19,000 sequences per sample, with 963 genera and 39 phyla represented. The 4 most predominant phyla, detected in all samples, were *Chloroflexi*, *Proteobacteria*, *Acidobacteria*, and *Verrucomicrobia*. Some phyla, as *Thermotogae*, were clearly more represented in control samples and seemed to be sensitive to radioactivity. Those results refined the conclusions previously given based on genetic fingerprinting method (DGGE) on the same samples [1]. Results indicated that a long term exposure to radionuclides did not lead to extinction of bacterial diversity in Chernobyl T22 trenches soils. A statistical analysis (principal component analysis) of the pyrosequencing data evidenced however a clear distinction of bacterial community between contaminated and control samples.

The pyrosequencing data will permit the selection of a bacterial model among a collection of 250 heterotrophic aerobic cultivable isolates provided from these contaminated and non contaminated areas. This model strain will be further used for laboratory experiments to study interactions with some radionuclides of the trenches ($^{137}$Cs, U, $^{90}$Sr).

[1] Chapon *et al*. (2011) *Applied Geochem* (in press).

# Sr isotopes reveal new insights about the source of turquoise at the Aztec Templo Mayor

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Turquoise [$CuAl_6(PO_4)_4(OH)_8•4H_2O$] was highly valued in late Postclassic Mesoamerica (900-1521 CE), especially by the Mixtecs and the Aztecs, who used it as part of elaborate mosaics and other ceremonial and status objects. Because turquoise mineralization in North America is primarily restricted to the present day southwestern United States (U.S.) and northern Mexico, archaeologists have identified these regions as likely sources of turquoise found thousands of kilometers away in archaeological sites across Mesoamerica. However, despite more than a century of speculation about acquisition of turquoise by Mesoamericans through long-distance trade networks with the Southwest U.S., no geochemical data has been published in support of this idea.

To address this question, we use Pb and Sr isotope geochemistry to investigate the geologic origin of turquoise found in multiple offerings throughout the Aztec Templo Mayor in Mexico City. We directly compare the isotopic ratios obtained for Templo Mayor turquoise to the isotopic signatures of turquoise samples from over 16 areas of turquoise mineralization in the southwestern U.S. and northern Mexico. Initial results indicate that the Sr isotopic signature of at least some of the turquoise from the Templo Mayor ($^{87}Sr/^{86}Sr < 0.706$) is distinct from the isotopic signatures of all turquoise samples (n=200) examined from the southwestern United States and northern Mexico ($^{87}Sr/^{86}Sr > 0.706$).

Turquoise is a supergene mineral that forms in the oxide zone and it acquires trace amounts of Pb and Sr through weathering processes associated with its formation. It particular, it often forms from the weathering of igneous rocks rich in copper, phosphorous, and aluminum, and is commonly precipitated in the open spaces and fractures of such rocks. We tentatively interpret the unique and relatively unradiogenic Sr isotopic signature of turquoise from the Templo Mayor to indicate the turquoise was mined from a source or sources in Mexico. This provisional interpretation is supported by (1) the empirical contrast between $^{87}Sr/^{86}Sr$ ratios of turquoise from Templo Mayor and the $^{87}Sr/^{86}Sr$ ratios of turquoise from the southwestern U.S., and (2) the existence of igenous rocks with similar Sr isotope ratios ($^{87}Sr/^{86}Sr<0.706$) within the Mexican Volcanic Belt and the Sierra Madre Occidental which could theoretically host small pockets of turquoise mineralization. This interpretation implies the Aztecs did not have to acquire turquoise through interregional trade networks with the Southwest and thus provides fundamentally new insights into the nature of proposed long distance interactions between these areas.