

## Studies of Biofilms in Yellowstone National Park and Violins of the Cremona Masters by Mobile NMR

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Compact NMR instruments have evolved from mobile stray-field sensors to benchtop spectrometers suitable for nondestructive material testing and small-molecule research, respectively [1-3]. They employ permanent magnets and work at magnetic field strengths, which are considered to be low today, but were considered normal and even high in the past. Stray-field relaxometers like the NMR-MOUSE [4] detect the dynamics of small molecules in materials, for example, water in building materials like mortar and wood or solvent molecules in paint layers [5]. We have adapted the NMR-MOUSE developed over two decades ago to operate with a car battery and an electric generator in locations without access to the electric power grid. This enabled us to analyze the asphalt quality of roads [6], ancient frescoes in excavation sites [7], and biofilms in Yellowstone National Park. The biofilm studies were motivated by the challenge to identify films in the protected areas of hot springs, where bacteria proliferate with genetic information that may help to shed more light on the early evolution of life. Moreover, some of the famous master violins of the Amati, Guarneri and Stradivari families were analyzed in the Museo del Violino in Cremona and the Ashmolean Museum in Oxford as part of the MOLAB activities of the IPERION-CH project of the European Community. We found, that in addition to the thin varnish on the outside, thicker layers exist on some violins underbeath the varnish and sometimes also the inner surface. This poses the question if these layers result from wood treatment by the original violin makers, by later restoration work or from wood degradation.



**Figure 1.** Setting up the measurement of a depth profile through the Cremonese violin made by Antonio Stradivari in 1715.



**Figure 2.** Setup for measuring a depth profile into a biofilm at a runoff of the octopus hot spring in Yellowstone National Park.

### References

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