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High-resolution, large-scale 1k Hz LIBS imaging of Tyrolean cave bear teeth

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Reconstructing elemental distributions in fossil hard tissues is essential for understanding biological processes, environmental conditions, and post-depositional alteration in paleontological materials. Teeth grow incrementally, similarly to tree rings, and can archive changes in diet and environment, making them valuable targets for spatially resolved elemental analysis. Elemental imaging methods based on laser ablation (LA) are particularly attractive for such studies, as they enable multi-element analysis with minimal sample preparation. However, most LA methods/instrumentation are limited to small sections of samples. Here, we present the potential for high-speed (up to 1k Hz) Laser-Induced Breakdown Spectroscopy (LIBS) to obtain high-resolution elemental images of ~35k year old fossil cave bear teeth that were discovered in Kufstein located in Tyrol, Austria.

LIBS has become a very popular technique for spatial determination of trace and major elements. LIBS offers the ability to measure C, H, O, N, and F which is often difficult or unattainable by LA – inductively coupled plasma-mass spectrometry (LA-ICP-MS). All these aspects make LIBS an attractive complementary technique for LA-ICP-MS, providing an expanded elemental coverage and extending the dynamic range (e.g., sub ppb up to wt.%). For larger samples, for example ≥ 10 cm, standard laser ablation chambers may not be ideal, as cutting of samples into smaller sections may be required.

Quantitative elemental images of two different cave bear teeth were produced for Ca, Na, F, Li, Sr, and Ba using a 1k Hz 193 nm LIBS system. Longitudinal and transverse cross sections were imaged at 50 µm and 10 µm resolution, respectively. Elemental distributions and profiles will be shown for the enamel, dentine, and pulp cavity regions of the teeth. Sr and Ba show correlation across the tooth microstructures, whereas Li shows a more heterogenous distribution within the tooth.

