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High-resolution analysis of trace elements in encrusting coralline red algae by laser ablation ICP-MS

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Coralline red algae constitute an ideal biogenic marine climate recorder owing to their common occurrence in mid- to high latitude oceans and their continuous growth. Encrusting coralline red algae have great potential as paleoclimate archives because they deposit spatially fixed annual growth increments in a high Mg-calcite skeleton and can reach ages of up to several hundred years. Here we present high-resolution Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) trace elemental analyses (Mg, Sr, Ba, U) from several coralline red algal specimens of the genus Clathromorphum, collected from the North Atlantic and North Pacific Oceans, that display average growth rates of around 300μm/year. Elemental ratios (Mg/Ca, Sr/Ca, Ba/Ca, U/Ca) were measured in sub-monthly resolution for up to 65-year long segments of coralline red algal growth. Several overlapping transects were analyzed in order to assess the robustness of the proxy data. The reproducibility is excellent and LA-ICP-MS measured Mg/Ca ratios were validated by comparison to electron microprobe data. In addition, data accuracy was tested by comparison to solution ICP-OES data from a bulk sample manually removed parallel to the laser ablation and electron microprobe transects. In particular, algal Mg/Ca ratios show a high degree of correlation with local seawater temperature on different timescales, providing further evidence for the temperature dependency of algal Mg/Ca variations and their use as a valuable paleothermometer. Hence, this study demonstrates the feasibility of extracting high-resolution geochemical signals from encrusting coralline red algae (such as Clathromorphum sp.) using laser ablation ICP-MS. This analysis technique allows rapid continuous sampling of the algal surface with unprecedented resolution and provides a valuable tool for future analysis of algal-derived environmental records.