

Short-pulse LA-MC-ICP-MS analysis of Sr isotopes: Application to the quasi “non-destructive” differentiation between saltwater pearls and freshwater pearls - IAG Early Career Researcher Medal Lecture

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A rapid, minimally destructive method for *in situ* determination of Sr isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) using short-pulse laser ablation multi-collector inductively coupled plasma mass spectrometry (LA-MC-ICP-MS) coupled with linear regression calibration is presented (Fig. 1). The ablation lasts only one second, causing minimal surface damage ($\sim 7\ \mu\text{m}$ depth, $60\ \mu\text{m}$ diameter), representing a 97% reduction in sample consumption compared to conventional ns-LA methods (50 s ablation) (Fig. 2). A carbonate matrix reference material for Sr isotope analysis (GIC-P, containing approximately $470\ \mu\text{g g}^{-1}$ of Sr), fabricated from pressed pearl nanopowder, has been developed for data quality control and validation. Analysis of GIC-P using the proposed short-pulse LA-MC-ICP-MS method yielded results consistent with thermal ionization mass spectrometry (TIMS) values. This method is ideal for analysing valuable jewellery samples, as it ensures minimal destruction, high throughput, and cost efficiency while maintaining accuracy and precision, with intermediate precision quantified at better than 0.0004 (2s). When applied to market samples originating from China, Japan, French Polynesia, and the South Pacific, the method confirms that saltwater pearls exhibit $^{87}\text{Sr}/^{86}\text{Sr}$ ratios consistent with modern seawater (~ 0.7092), whereas freshwater pearls show higher and more variable ratios (0.7102–0.7135 in this study), reflecting their growth environments in the freshwater of the middle and downstream regions of the Yangtze River, China. This distinct isotopic difference provides a reliable geochemical tool for differentiating between saltwater and freshwater pearl origins.

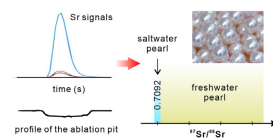


Fig. 1 one second by fs-LA-MC-ICP-MS for pearl differentiation

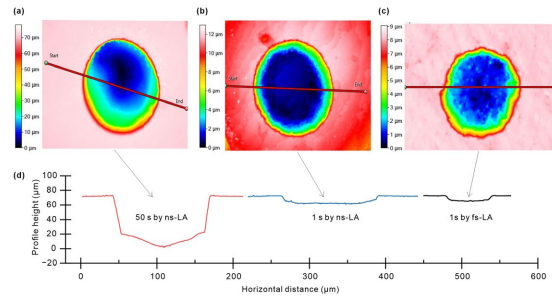


Fig. 2 Ablation pits created by different ablation protocols: (a) conventional 50-second ablation; (b) short-pulse ablation (ns-LA, 120 μm spot size, 10 Hz frequency); (c) short-pulse ablation (fs-LA, 60 μm spot size, 10 Hz frequency); (d) corresponding depth profiles (white light interferometry).