



Advancing Quaternary Geochronology: Impact of Sample Preparation and Analytical Techniques on Natural Radioactive Dose Assessment in Stream Sediments

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In Quaternary geochronology, accurately estimating natural radiation exposure is crucial for dating materials using Electron Spin Resonance (ESR) and Optically Stimulated Luminescence (OSL). Traditional methods like gamma and alpha spectrometry, despite their utility, are limited by sample size requirements and time inefficiency, especially in low-radiation contexts. This study explores the efficacy of Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) and Plasma Mass Spectrometry (ICP-MS), including both Quadrupole (ICP-QMS) and High-Resolution (HR-ICP-MS), for analyzing uranium, thorium, and potassium concentrations in sediments.

We compared various acid digestion methods using standard hot-blocks, microwave digestion, and single cell microwave technology on Sediment Reference Materials (NIST BRS 8704, OREAS 24d). Potassium detection was more accurate with ICP-OES (96% precision) than ICP-QMS (80%). In contrast, HR-ICP-MS significantly outperformed ICP-QMS in measuring uranium and thorium (U and Th recoveries of 99% and 94% vs. 83% and 81%, respectively). Moreover, microwave-assisted digestion methods showed slight advantages in uranium and thorium recovery.

Our findings suggest that a four-acid microwave-assisted digestion, combined with potassium measurement via ICP-OES in radial mode and uranium and thorium quantification using HR-ICP-MS, offers the most accurate and time-efficient approach for natural dose determination in sediment dating. This methodology is particularly relevant for cave, river, and stream sediments even with expected low uranium levels.