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Unraveling anthropogenic impact on Mawmluh Cave Speleothems: Insights from high-resolution analysis of aragonite formations

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Geochemical anomalies within speleothems serve as crucial indicators of environmental changes. While research predominantly focuses on calcite-dominated formations, understanding the significance of aragonite is essential for a comprehensive grasp of past climate dynamics. This study presents high-resolution records, based on ^{230}Th/U dating, stable isotopes (δ^{13}C) and trace elements analysis in recent aragonite growth lamina near the calcite top in three speleothems from Mawmluh Cave, Meghalaya, India. Covering a total of 163 years (2022 to 1859 CE), the research explores the environmental impact on the cave system, especially in relation to nearby industrial activities. Laser Ablation-Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) was utilized to analyze trace elements (e.g., Mg, Sr, Ba, U, P, Y, Pb, Al, Th, etc.) in the recent aragonite growth lamina. Detected trace elements (Pb, Zn, Mn, etc.) at trace concentrations, alongside current δ^{13}C values, may be linked to emissions from a nearby cement plant and open-cast mining activities, acting as potential indicators of anthropogenic influence. All three speleothems displayed transitions from calcite to aragonite near the top, suggesting a significant alteration in the cave system over time, potentially induced by human activities. Anthropogenic factors may contribute to this transition, with specific elements acting as key markers. Future studies on the geochemical signatures of aragonite formations promise to fill existing gaps, offering a nuanced perspective on paleoclimatic and paleoenvironmental conditions.

Keywords: speleothems, aragonite formations, trace elements, stable isotopes, anthropogenic impact, Mawmluh Cave.