Hidden Archive in Karst: Geochronological Evidence of Miocene Volcanic Activity in Quaternary Deposits (Plitvice Lakes and Bosiljevo, Croatia)

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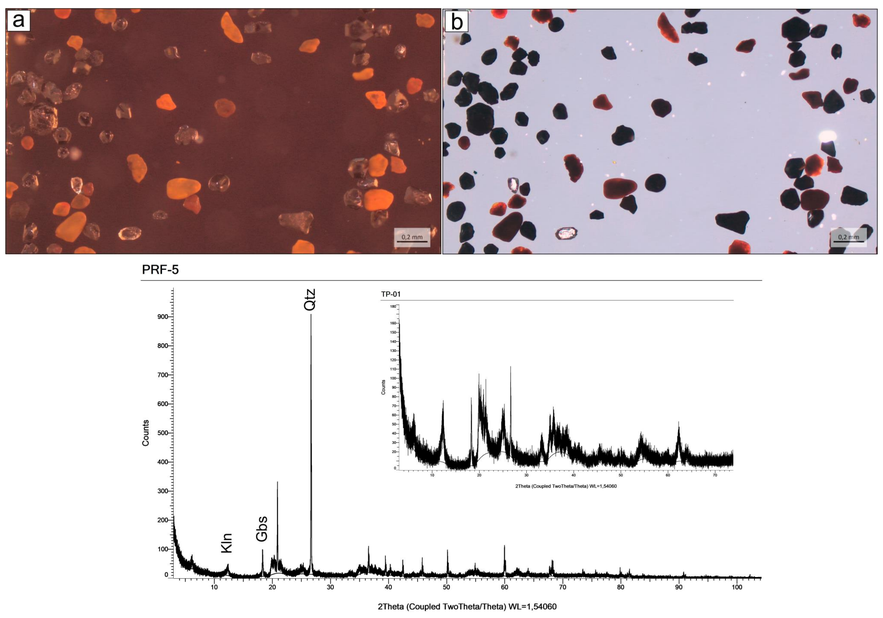
INTRODUCTION

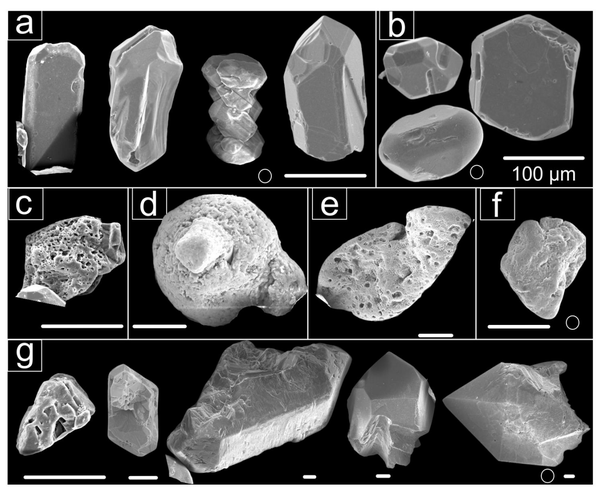
Recent investigations of Quaternary outcrops at Bosiljevo and Plitvice Lakes, Croatia, have provided new insights into the role of karst environments as depositional archives for terrestrial sediments. These red, clay-rich deposits in karst terrains capture siliciclastic inputs and preserve valuable records of environmental history. To investigate the origin and depositional history of these materials, we conducted X-ray diffraction (XRD), heavy mineral analysis, scanning electron microscopy (SEM), and U-Pb zircon geochronology (LA-ICP-MS) on samples from three sites.

RESULTS

Plitvice Lakes:

- Mineral analysis of heavy mineral fraction reveled dominant lithic, opaque idiomorphic minerals and idiomorphic zircons, while light mineral fraction is dominantn by quartz.
- SEM analysis reveals idiomorphic zircons, ilmenite, bauxitic lithics, and idiomorphic quartz (in larger fraction).
- XRD analysis identifies the presence of gibbsite, kaolinite, and quartz
- - All off these data indicate volcanic source of the material.

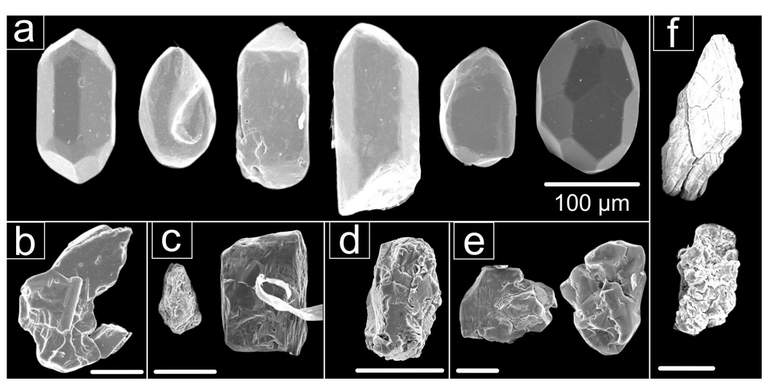




Plitvice Lakes (PRF-5C, TP-01 sample): a) zircons; b) Fe-Ti oxide; c) Lithich – dolomite; d,e) Lithich – Al, Si, Fe – oxide; l – silicate; f) Fe – oxide; g) quartz. Measurement scale is 100 µm

Bosiljevo:

- Mineral analysis of heavy mineral fraction reveled dominant opaque minerals, while light mineral fraction is dominant by quartz.
- Both rounded and idiomorphic zircons were found in BOS sample with spinel, Al-silicates, and Ti-oxide are visible on SEM analysis. XRD analysis identifies the presence of kaolinite, illite and quartz
- These minerals indicate a mixed provenance of the deposits, with both volcanic and detrital contributions.

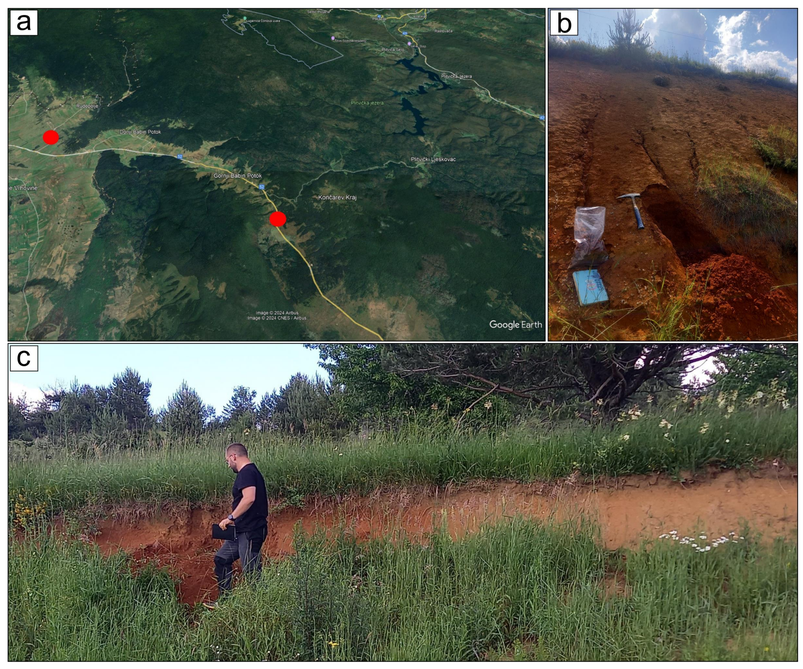


Bosiljevo (BOS sample): a) different zircon morphology; b) Al – silicate; c) Ti – oxide; c) Cr-spinel; e) Si – oxide; f) Ca- phosphate. Measurement scale is 100 µm

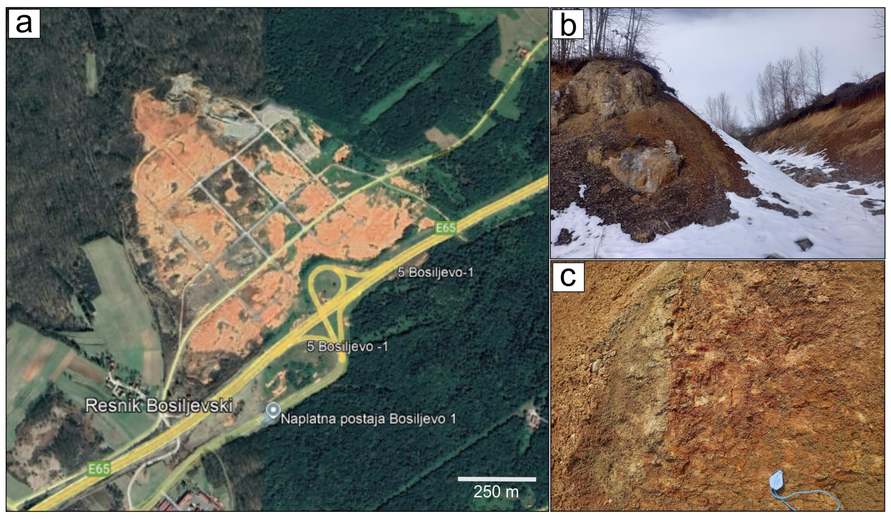
DISCUSSION AND FUTURE STUDY

The distinct mineralogical and geochronological profiles recorded at Plitvice Lakes and Bosiljevo highlight the potential of karst deposits to capture diverse volcanic and sedimentary histories. The Plitvice materials, enriched in gibbsite and kaolinite, represent a well-preserved Miocene volcanic record, whereas the Bosiljevo site, with its diverse mineral assemblage and broad zircon age spectrum, points to a complex mixture of volcanic and detrital sources. Future research could expand sampling across other karst locations to map the extent of volcanic deposition from regional eruptions more comprehensively. Additionally, more precise zircon dating could help link specific eruptions to these deposits, potentially capturing details of events that may have been erased in more proximal areas by subsequent volcanic activity.

LOCATION



Plitvice lakes location: a) SW area of Plitvice Lakes National Park with red dots maring sampling sites; b) PRF 5 site with cleared area of PRF 5c horizon; c) TP-01 sampling site

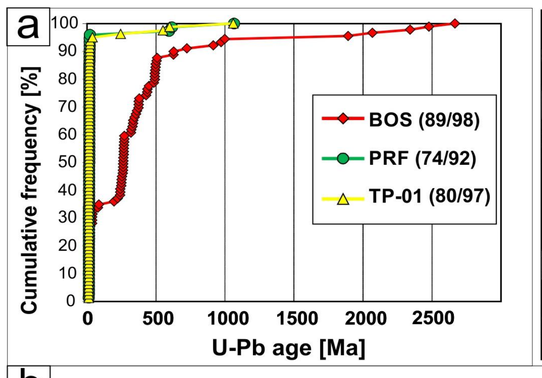


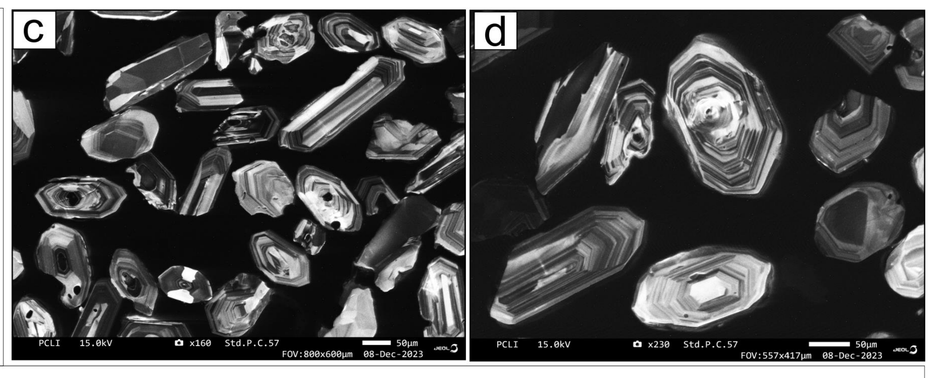
Bosiljevo location: a) area of Bosiljevo site; b) Jurassic limestone with quaternary deposits on top; c) sampling microsite

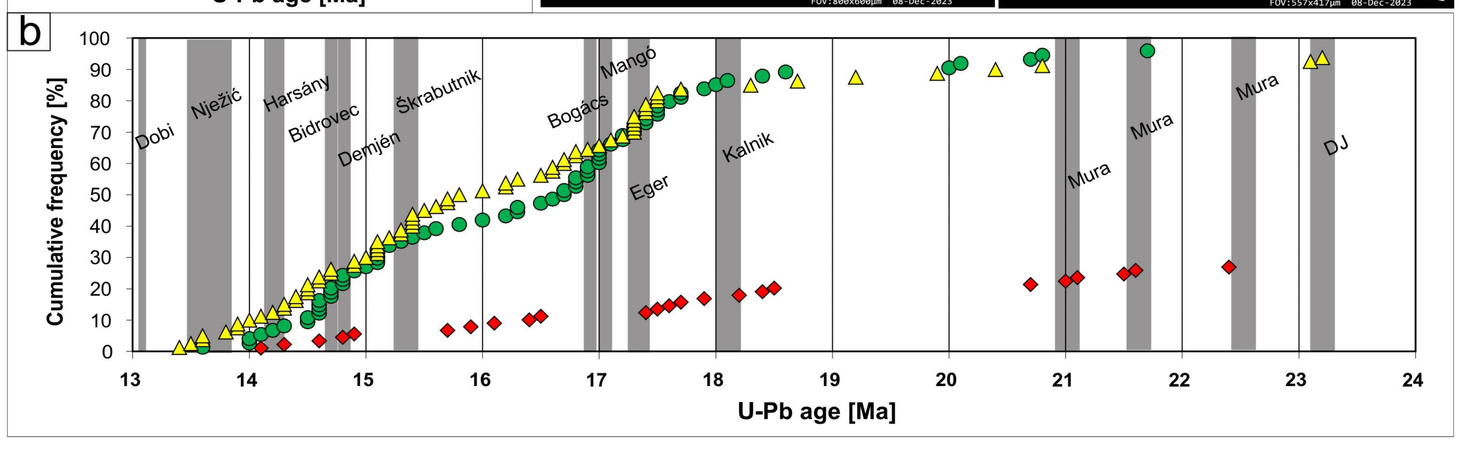
RESULTS

U-Pb zircon geochronology using LA-ICP-MS:

- Plitvice Lakes samples (PRF-5C, TP-01) show similar distribution of zircon ages = corelatived
- Bosiljevo sample wide zircon age distribution: Ordovician, Triassic, Late Cretaceous, Eocene and Miocene
- **Miocene zircon ages** show correlation with major known volcanic eruption of Carphatian –Pannonian region.
- Evidence of these volcanic eruptions has been documented in Sinj and Livno basins, but the Bosiljevo and Plitvice Lakes deposits reveal an even wider range of acidic volcanic events from the region, suggesting a continuous trapping of volcanic material in these karst environments over time.







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