ACADEMIA EUROPAEA

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FROM KNOWLEDGE TO ACTION APPLICATION

Title: **Isotope hydrological data in supporting the sustainable management of the thermal aquifer at Băile Herculane, Romania**

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Category: From Science To Society & From Barriers to Bridges

Problem (max. 50 words): The current shift in the climate system requires better knowledge of how thermal aquifers respond to such changes, to promote their sustainable use. In addition, the unpredictability of infiltration events lead to cooling of thermal water.

Unmet Need (max. 50 words): Knowledge of the infiltration age of thermal water(s) and the mixing of modern rainwater fraction (thermal/cold component) is a necessity for the sustainable (balneological) management of the Băile Herculane thermal spa and the possible exploitation for energy production. Stakeholders should be informed of the risk of resource depletion or alteration.

Project Description (max. 200 words): The Cerna Valley karst system drains a mix of modern and paleowater from varying depths and flow paths, feeding the Băile Herculane thermal spa, already used in Roman times. The thermal aquifer was studied over the past decades using mostly traditional hydro(geo)logical and hydro-chemical methods. Within a parallel, more complex Romanian-Hungarian project, hydrochemical data from both the thermal aquifer and from its recharge area are being used to study the response of the thermal aquifer to climate change in the recent past.

In this proposal we will use tritium and radiocarbon measurements from thermal springs and deep wells to estimate the young water fraction and the age of the paleowater component via integrated evaluation in conjunction with already available hydrochemical data. Tritium, produced mainly by during thermonuclear weapon testing indicates modern recharge, and allows for the calculation of rates of renewal. Radiocarbon dating extends age estimates to thousands of years, revealing deep paleowater contributions. Combined isotopic analyses improves assessments of aquifer sustainability and vulnerability to overexploitation. This will inform sustainable management policies for Băile Herculane, ensuring balanced spa operations, protecting public health, and preserving ecosystems. Additionally, they offer a model for geothermal resource management under evolving climate conditions.

Hypothesis (25 words): The dynamics of the freshwater component (residence time <10 years) of thermal waters, susceptible to climate change, can be calculated using tritium and radiocarbon data.

Implication for Practice (50 words): The age of subsurface waters is critical to understanding recharge dynamics, residence time, and sustainability — especially for geothermal exploitation or conservation planning via sustainable extraction policies. The project translates the complex geochemical findings into actionable decisions across key outcome domains. Final output: top-tier publication, e.g. Nature Water.

Implication for Research (50 words):

Framing the research as a pan-European project, we leverage a common methodology ensuring the sustainable use of thermal water resources under changing (warm/dry) climate conditions. It can

serve as a model for similar thermal water-regions across Europe: Topusko (HR), Bagni di Lucca (IT), Piešťany (SK), Buda thermal-karst (HU), Eger-Rift (CZ).