

MOBILITY AND LIFE HISTORIES IN THE ALPS UNDERSTANDING PREHISTORIC SOCIAL STRATEGIES IN MOUNTAIN ENVIRONMENT

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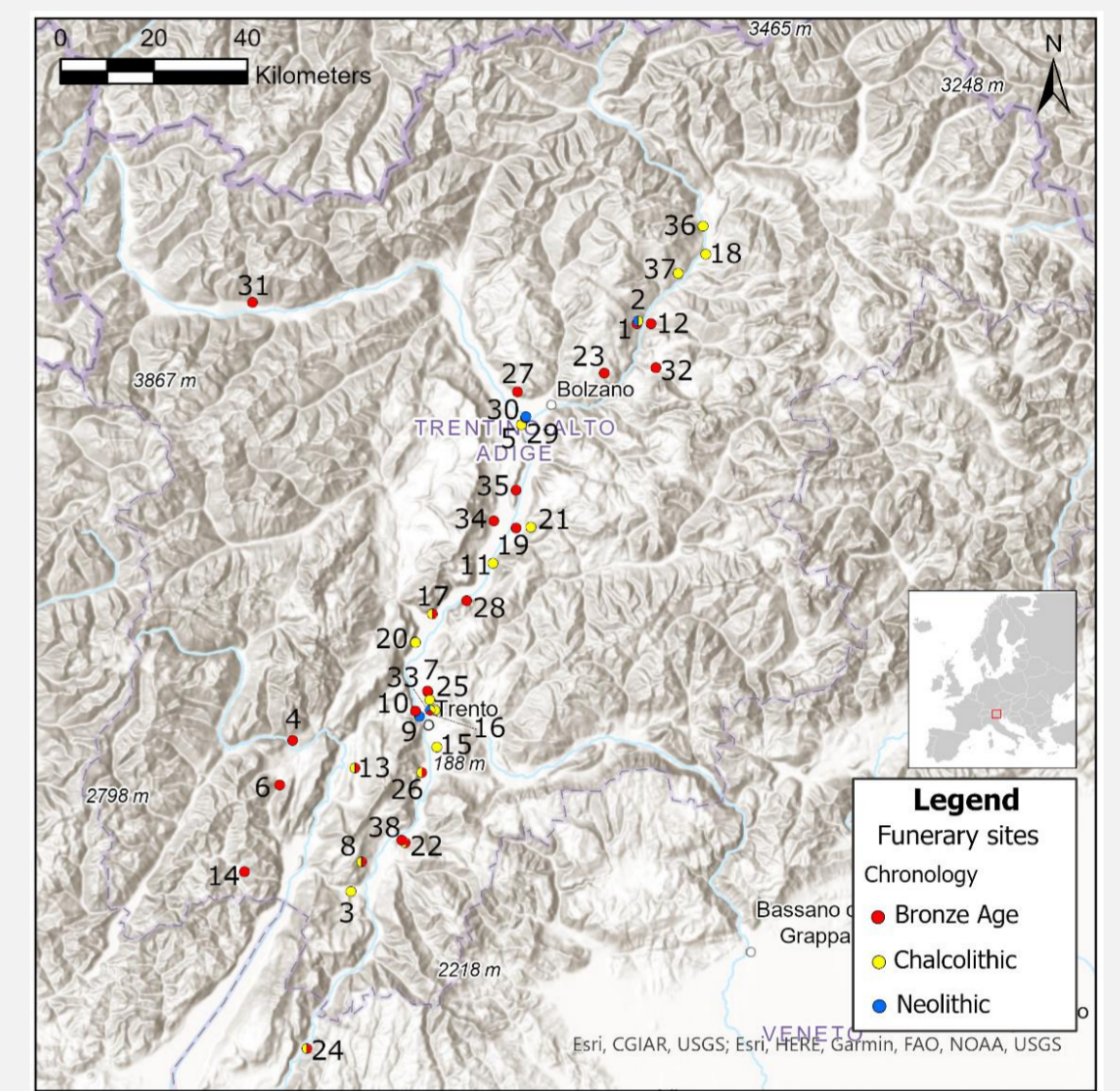
Several hundred sites dating from the 5th to the 2nd millennia BC have been identified in the eastern Italian Alps making them one of the best archaeologically-mapped regions among the European mountains. However, despite the large amount of residential and productive prehistoric sites, only few funerary contexts have been unearthed, and even fewer human remains have been studied using state-of-the-art bioarchaeology. Prehistoric burials found in the eastern Italian Alps represent a unique and exceptional source of information that can provide crucial knowledge on past human mobility and life histories in mountain environment. During this 4,000-year time span an increase of social complexity and an intensification of exchange networks are documented in this region, a buffer zone between the Mediterranean and the central Europe, crossed by major north-south routes (Adige-Eisack valleys), that implied an intensive movement of people, objects, and ideas.

The EU-funded MOLA project aims to integrate Alpine Landscape Archaeology with state-of-the-art bioarchaeology and spatial modelling to understand how social strategies influenced human mobility and life-histories from the Neolithic to the end of the Bronze Age in mountain environment with a particular focus on the eastern Italian Alps. To achieve this research goal an innovative methodology based on the combined analysis of strontium ($^{87}\text{Sr}/^{86}\text{Sr}$), oxygen ($\delta^{18}\text{O}$), and sulfur ($\delta^{34}\text{S}$) isotope ratios in prehistoric inhumed and cremated ($^{87}\text{Sr}/^{86}\text{Sr}$ only) human remains from the area and period under study is used. Additionally, a high-resolution bioavailable strontium isoscape will be developed by sampling modern vegetation in the eastern Italian Alps. These data will be coupled with data from Landscape Archaeology of the uplands on human-environment interactions (stratigraphic excavations, surveys, geomorphology, etc.) to shed light on social strategies and possible gender differences behind individual and collective mobility and life histories in the eastern Italian Alps during the Neolithic, the Chalcolithic, and the Bronze Age.

Introduction and research questions

In prehistoric times, the eastern Italian Alps (eIA) (i.e. the Dolomites, the Atesina region, and the Venetian Prealps) constituted a geographic barrier between Central Europe and the Mediterranean, which, despite its imposing nature, has been crossed by humans since the Mesolithic. Large Adige and Eisack valleys ending with accessible mid-altitude mountain passes (Reschen and Brenner) constituted obliged passage paths for north-south fluxes of people, objects, and ideas. The importance of the eIA began during the Neolithic (5300-3400 BC) as a result of the exploitation of lithic resources (chert), particularly abundant in the Monti Lessini, leading to the rise of a supra-regional exchange network. From Late Chalcolithic (3rd millennium BC onwards) the supplying of rich copper deposits, mainly in the Valsugana Valley, further enhanced the relevance of the Atesina region. Mining and smithing activities increased in the 2nd millennium BC. The exploitation of metallic and lithic resources became factors of economic growth that made the Alps a crucial area at a European scale.

Despite the high number of archaeological traces distributed in a wide range of mountain environments that would suggest widespread human occupation and land use throughout the eIA, prehistoric burials are clustered along the Adige and Eisack valleys. In these areas, social interactions with non-local individuals were arguably enhanced due to this obliged passage zone. At present, little is known on mobility dynamics and life histories of the individuals buried in such a geographical sector. In fact, the lack of isotopic studies on this unique osteoarchaeological heritage has left many blank pages in our understanding of complex social dynamics. The MOLA project tackles key-questions such as: did the exploitation of lithic resources in the Neolithic and of copper ores in the Chalcolithic-Bronze Age determine variations in mobility patterns of individuals buried in the eIA? Do we distinguish gender differences in their mobility and life histories? Was their catchment area for food production (agriculture and animal husbandry) linked to the raw material sites or bound only to the main valleys? How can this information be used to reconstruct social strategies in mountain environment?



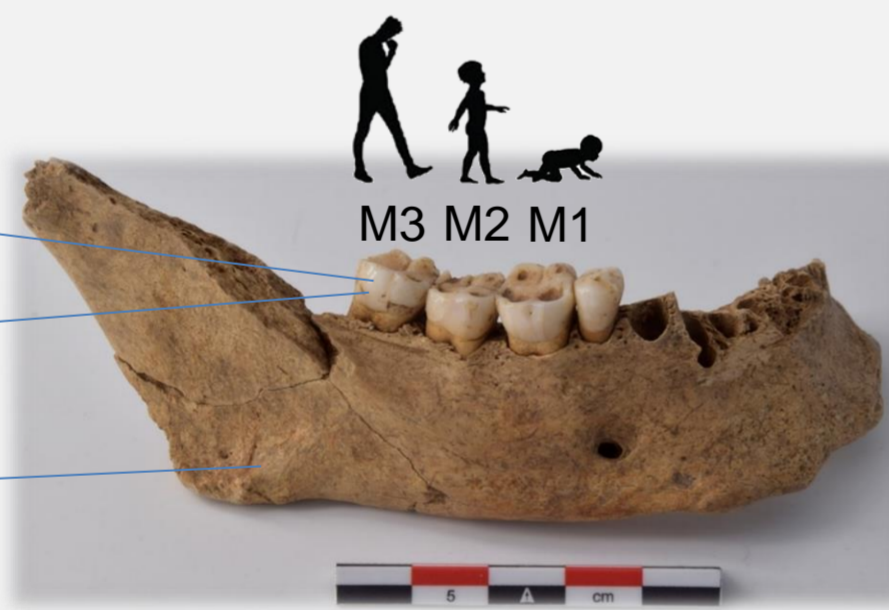
Prehistoric burial sites studied in the MOLA project; sites with cremated remains are in italic: (1) *Barbiano/Barbian-Ex* Casa di Ricovero, (2) *Barbiano/Barbian-fondo* Gosiner, (3) *Bersaglio di Mori*, (4) *Calferi di Stenico*, (5) *Colterenzio/Schreckbach-Vorhölle*, (6) *Fiavè*, (7) *Gardolo di Mezzo*, (8) *Grotte di Castel Como*, (9) *La Vela*, (10) *La Vela Valbusa*, (11) *Laghetti di Egna*, (12) *Laior-Novale di Sotto (S. Caterina)*, (13) *Lasino-Riparo del Santuario*, (14) *Ledro*, (15) *Madonna Bianca*, (16) *Martignano loc. villa Menghin*, (17) *Mezzocorona-Borgo Nuovo*, (18) *Millan-proprietà Stockner*, (19) *Montagna/Montan-Pinzon (Castelfeder)*, (20) *Nogarole II-III-V*, (21) *Ora/Auer-Kiechlberg*, (22) *Paludei di Volano*, (23) *Renon-Collalto Zaberbach*, (24) *Riparo di Peri*, (25) *Riparo Marchi*, (26) *Romagnano Loc.*, (27) *S. Genesio/Jenesien-Greifenstein-Hang*, (28) *Salomo/Salurn-Dos de la Forca*, (29) *Sigmundskron*, (30) *Sigmundskron/Castel Firmiano*, (31) *Silandro/Schlanders-Talele*, (32) *Siusi/Seis-via Valzura*, (33) *Solteri*, (34) *Termeno/Tramin-Badl*, (35) *Vadena/Pfatten-Maso Stadio*, (36) *Varna/Vahm-Circonvallazione*, (37) *Velturo/Feldthurns-Tanzgasse*, (38) *Volano-San Rocco*.

Methods: isotope bioarchaeology in inhumed and cremated human remains

Oxygen, sulfur, and strontium isotope ratios ($\delta^{18}\text{O}$, $\delta^{34}\text{S}$, $^{87}\text{Sr}/^{86}\text{Sr}$) will be measured in prehistoric inhumed and cremated (Sr only) individuals from 38 burial sites. For inhumed skeletal remains, $\delta^{18}\text{O}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ will be measured in tooth enamel from the 1st, 2nd, and 3rd permanent molar crown, which initiate and end mineralization at different ages, while $\delta^{34}\text{S}$ will be measured in bone collagen. Sampling three molars allows to test human mobility at three stages of childhood. For cremated remains, only fully calcined bone fragments are used for Sr isotope analyses. Life history of the cremated individuals is obtained by sampling skeletal elements with different bone turnover rates, such as the petrous part of the temporal bone, which records the isotopic signature of childhood (Harvig et al. 2014), fragments of cranium and diaphysis, which record the last ca. 10/20 years of life history, and fragments of ribs that correspond to the last ca. 4/7 years of life history. Human remains with uncertain chronological information will be radiocarbon dated.



$^{87}\text{Sr}/^{86}\text{Sr}$
 $\delta^{18}\text{O}$
 $\delta^{34}\text{S}$



slow Bone turnover fast

Petrous bone Diaphysis Cranium Rib

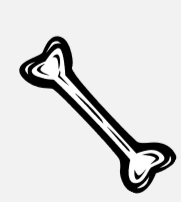


$^{87}\text{Sr}/^{86}\text{Sr}$

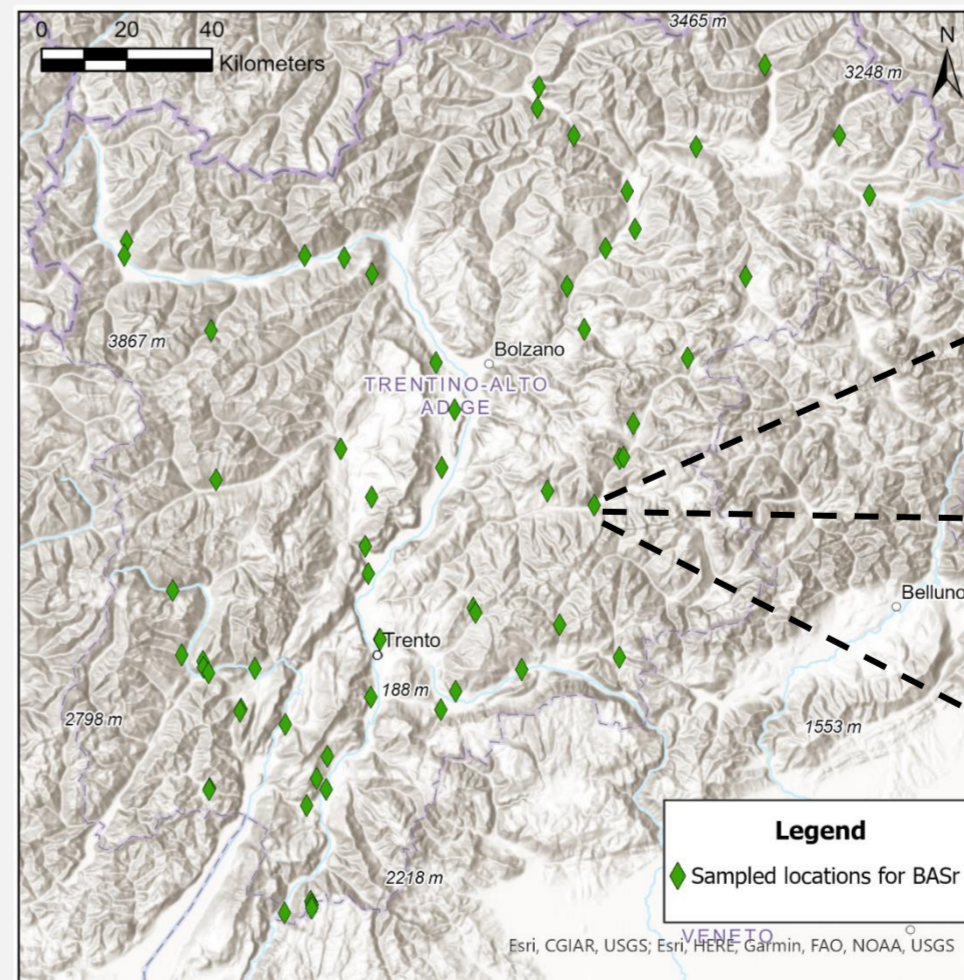


Developing a high-resolution local BASr isoscape and local S baselines

Modern plant samples (186; i.e. 3 samples from 62 locations following Snoeck et al. 2020) have been collected from distinct geological formations of the eIA, targeting locations in the proximity of the studied funerary sites, coeval settlements, and areas of potential ancient crops. Urbanisations and agricultural lands have been avoided to ensure that no modern contamination affects measured values. At each sampling location, grass, shrubs and trees have been collected within a 10 m² area to avoid sampling micro-habitats. The high-resolution biologically available Sr isoscape will be produced with R software by statistical modelling empirical data with random forest regression algorithm as in the Sr isoscape of Western Europe (Bataille et al. 2018).



S isotope baselines for the valleys in the eIA will be produced by sampling faunal remains, mainly from pigs and cattle, coeval to the sampled individuals from the funerary sites under study.



Statistical and geospatial modelling

The innovative triple sulfur-oxygen-strontium isotopes probabilistic geographic assignment for non-cremated individuals, much more powerful than the traditional single/double isotopic assignment, will be based on the high-resolution BASr isoscape and the available $\delta^{18}\text{O}$ (Giustini et al. 2016) and $\delta^{34}\text{S}$ (Bataille et al. 2021) isoscapes and baselines. Statistical analysis of isotopic data will be performed in Rstudio. One of the challenges of data processing is the more precise geographic assignment of inhumed individuals, based on Sr, O and S isotopes, compared to that of cremated individuals based only on Sr values. The modelling code using the isoOrigin package in RStudio and the results interpretation will be adapted to take this into account. Variations in mobility patterns and land use will also be investigated using the ArcGIS platform. Interpretation of results will consider local archaeological narratives.

Credits and collaborations:

- Institute for Mummy Studies - Eurac Research (Bolzano/Bozen).
- Ufficio Beni Archeologici della Soprintendenza per i Beni culturali della Provincia autonoma di Trento.
- Ufficio Beni Archeologici della Soprintendenza provinciale ai Beni culturali della Provincia autonoma di Bolzano.
- Soprintendenza ABAP (Archeologia Belle Arti e Paesaggio) per le province di Verona, Rovigo e Vicenza.

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