



Stable isotope bioarchaeological atlas from the post-Soviet space

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Abstract. Results of stable isotope analyses from 435 locations in the countries of the former USSR were collected from 114 papers presenting the results of their research and compiled in two datasets stored in the IsoArcH database. The literature research was conducted using Google Scholar, Web of Science and Science Direct using keywords both in English and in other relevant languages, such as Russian, Ukrainian, Azerbaijani, Georgian or Kazakh. The datasets contain information on the originating site, including GPS coordinates, information on the samples (as available) such as source of origin, dating and details of deposition, and results of stable isotope analysis, namely the measurements of carbon ($\delta^{13}\text{C}$), nitrogen ($\delta^{15}\text{N}$), oxygen ($\delta^{18}\text{O}$), sulphur ($\delta^{34}\text{S}$) strontium ($^{87}\text{Sr}/^{86}\text{Sr}$) and lead ($^{206}\text{Pb}/^{204}\text{Pb}$). All source articles are connected to relevant data within the datasets. This compilation can serve as a comprehensive source for further research as well as a reference set for the geographical and temporal area.

1 Introduction

The importance of isotopic data in archaeology, anthropology, environmental sciences and forensics is considerable, particularly with the increasingly poll of such resources, as it can be utilised in follow-up/secondary research. This extends the utility of isotopic data far beyond its original scope. Access to results and measurements covering larger geographical areas, as well as chronological phases, is crucial for well-contextualised (meta-)research of populations across space and time, and opens the possibilities for broader scientific collaboration and deeper understanding of larger contexts. Isotope data originating from countries of the former Soviet space had been somewhat obscured from outsiders, despite the relative frequency of the research focus. This is generally due to the combination of difficulty of access, represented often by language barrier, and the absence of many of the works in databases conventionally used by non-Russian-speaking researchers. Furthermore, there has been no comprehensive, georeferenced synthesis of the data done that the authors are aware of, which created a blank space on the map of isotopic data in bioarchaeological research.

The presented collection is an aggregation of isotopic carbon, nitrogen, oxygen, sulphur and strontium data from 114 papers published in English or Russian. There are isotope analysis results for 3 369 samples recovered at 435 locations that can be seen in Figure 1; the samples come from sites in modern day Ukraine, Georgia, Armenia, Turkmenistan, Uzbekistan,



- 30 Tajikistan, Kyrgyzstan, Kazakhstan and Russia. The time range of the collection spans from 129 000 BP to the 19th century AD, with the addition of some modern gastropods (from 2018).

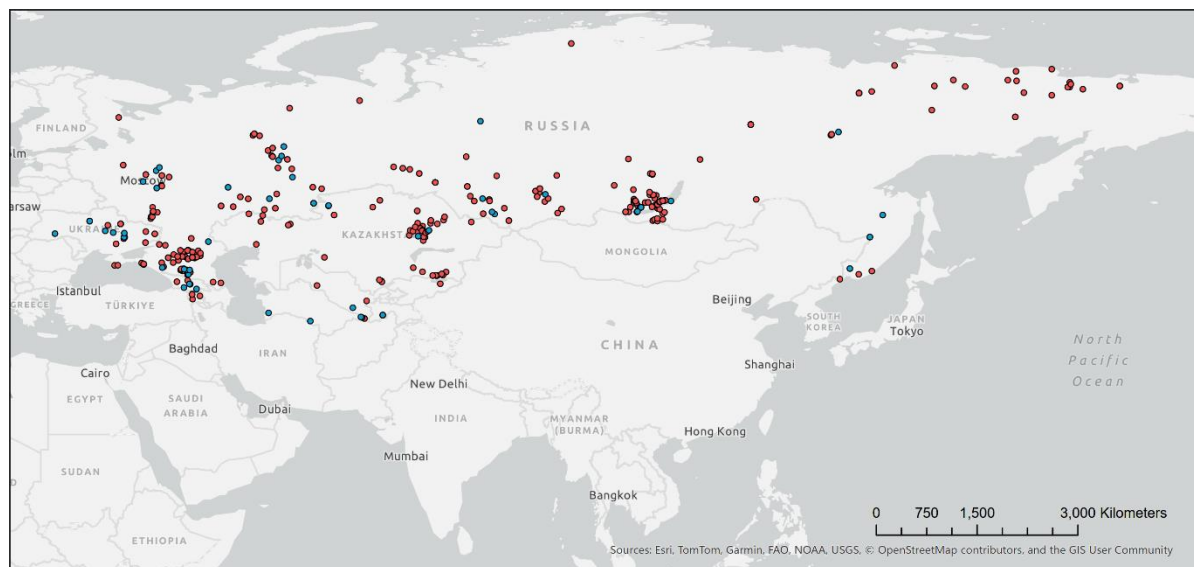


Figure 1: Map showing all the locations included in the datasets with approximate (red) and exact (blue) geo-referencing. The map was designed and developed by ERSI | Powered by ESRI.

One dataset was compiled as a part of a research effort of one of the authors (A.H.) that assessed dietary and mobility trends in the Black sea region (Hagarová, 2023) while the other (by M.G.) aimed to gather principally non-English speaking material from post-Soviet countries (Gorbulina and Salesse, 2025). Both compilations grew out of a broader community effort within IsoArch, rather than from a standalone data-gathering exercise. Data acquisition was initiated through an IsoArch fellowship scheme, which supports students sponsored by the IsoArch association. This support enabled students to engage directly with data collection and curation, and subsequently develop their work into thesis projects. Both the fellowships and the resulting thesis were hosted at the Department of Anthropology, Faculty of Science, Masaryk University. Together, this process strengthened student training while contributing substantively to the expansion and long-term sustainability of the IsoArch database. As the use of isotope data cements its place in (bio)archaeological and anthropological research, the increasing amount of results offers further and deeper analyses and comparisons, as well as more detailed context, both archaeological and environmental. The IsoArch database, and the datasets contained within, serve both as a repository and a starting point for such efforts. This compilation substantially improves the discoverability of existing isotope data, as many of the journals included in the datasets are primarily of local or national importance and are often overlooked by the international research community or appear inaccessible due to language barriers for both search and use. Beyond aggregation, discoverability is enhanced through systematic georeferencing, which is frequently absent from the original publications, the standardization and romanisation of site names, and the provision of a clear pathway from national-language literature to the English-speaking research community.



2 Methods

50 2.1 Data Collection

The literature research was conducted between winter 2022 and summer of 2023. Combinations of keywords were used for an initial search carried out using Google Scholar, Web of Science and Science Direct in English, Russian, Ukrainian, Georgian, Azerbaijani, Armenian and Kazakh. The keywords included names of regions or historical/modern day countries of interest (e.g., USSR, Russia, Ukraine, Georgia, Armenia, Azerbaijan, Kazakhstan, Siberia, Caucasus), “isotope analysis”
 55 or “isotopes”, and either “archaeology”, “human bone” or “bone”. As papers discussing the problematics were discovered, the search was further expanded by following references to works cited therein. In the included literature are published papers, book chapters and conference proceedings. No grey literature (e.g., diploma theses, dissertations, reports) was included in the datasets. The final compilation consists 114 articles that range from 2000 to 2022 and are from 86 different first authors (Alekseev et al., 2022; Alexandrovskaya et al., 2009; Amirkhanov, 2022; Ankusheva et al., 2021; Babenko et al.,
 60 2022; Barrett et al., 2022; Berdnikov et al., 2017, 2020; Berdnikov and Goriunova, 2022; Bocherens et al., 2014; Bryukhova, 2019; Budd et al., 2020; Chagarov et al., 2019; Chechushkov and Epimakhov, 2021; Dobrovolskaya and Tiunov, 2011; Dobrovolskaya et al., 2020; Druzhinina et al., 2019; Epimakhov et al., 2020; Everill et al., 2021; Fleming et al., 2018; Gerling, 2015; Haruda et al., 2020; Haverkort et al., 2008; Herrscher et al., 2021; Hollund et al., 2010; Iacumin et al., 2004; Katzenberg et al., 2012, 2009; Khubanova et al., 2017; Kirillova et al., 2015; Kleshenko et al., 2021; Knipper et al., 2020;
 65 Kradin et al., 2021; Kroll et al., 2022; Krylovich et al., 2020; Kunikita et al., 2017, 2013; Kuptsova and Evgenyev, 2022; Kuzmin et al., 2021; Kuznetsov et al., 2019; Ledogar et al., 2019; Lillie et al., 2011, 2003, 2017; Lillie and Jacobs, 2006; Lillie and Richards, 2000; Losey et al., 2020, 2018, 2016, 2013; Macāne et al., 2019; Madden et al., 2018; Marchenko et al., 2016, 2015; Matuzeviciute et al., 2015; Meadows et al., 2020; Messenger et al., 2015; Milella et al., 2022; Motuzaite Matuzeviciute et al., 2016; Murphy et al., 2013; Nikitin et al., 2010; Nomokonova et al., 2013; Papin and Svyatko, 2020, 2018; Piezonka et
 70 al., 2013; Poshekhonova et al., 2019; Ramsey et al., 2014; Richards et al., 2001; Romanova et al., 2019; Rose et al., 2022; Rountrey et al., 2007; Salazar-García et al., 2021; Samorodova, 2021; Saveliev et al., 2020; Scharlotta et al., 2018a, 2018b; Scherbakov et al., 2018; Schulting et al., 2018, 2015; Shergin and Ivanov, 2019; N. Shishlina et al., 2014; Shishlina et al., 2020, 2016b, 2016a, 2012, 2018, 2017, 2009, 2007; N. I. Shishlina et al., 2014; Shishlina, 2014; Silaev et al., 2019; Solodovnikov, 2022; Svyatko et al., 2017, 2013; Szegeda et al., 2013; Tishkin et al., 2018; Tur et al., 2017; Van Der Haas et
 75 al., 2018; Vasilyev et al., 2021, 2017; Velivetskaya et al., 2016; Ventresca Miller et al., 2021, 2020, 2019a, 2019b; Waters-Rist et al., 2016, 2014, 2011; Weber et al., 2016, 2011; White et al., 2021; Yavorskaya et al., 2015; Zubova et al., 2017). In total, the sample collection includes 1 318 animal samples, 1 941 hominin samples (anatomically modern humans and Neanderthals), 57 samples of archaeological plants and 53 samples of organic residue (pottery) across seven general time periods defined by the authors (Palaeolithic before 10 000 BC, Neolithic until 2 500 BC, Bronze Age until 1 000 BC, Iron
 80 Age until 500 BC, Antiquity until 500 AD, Middle Ages until 1492 AD, Early Modern Period until 1900 AD and Modern for



recent samples). The visual overview of the frequency of the samples across these time periods can be seen in Figure 2. The datasets contain over 8,000 isotopic measurements together with associated elemental analyses.

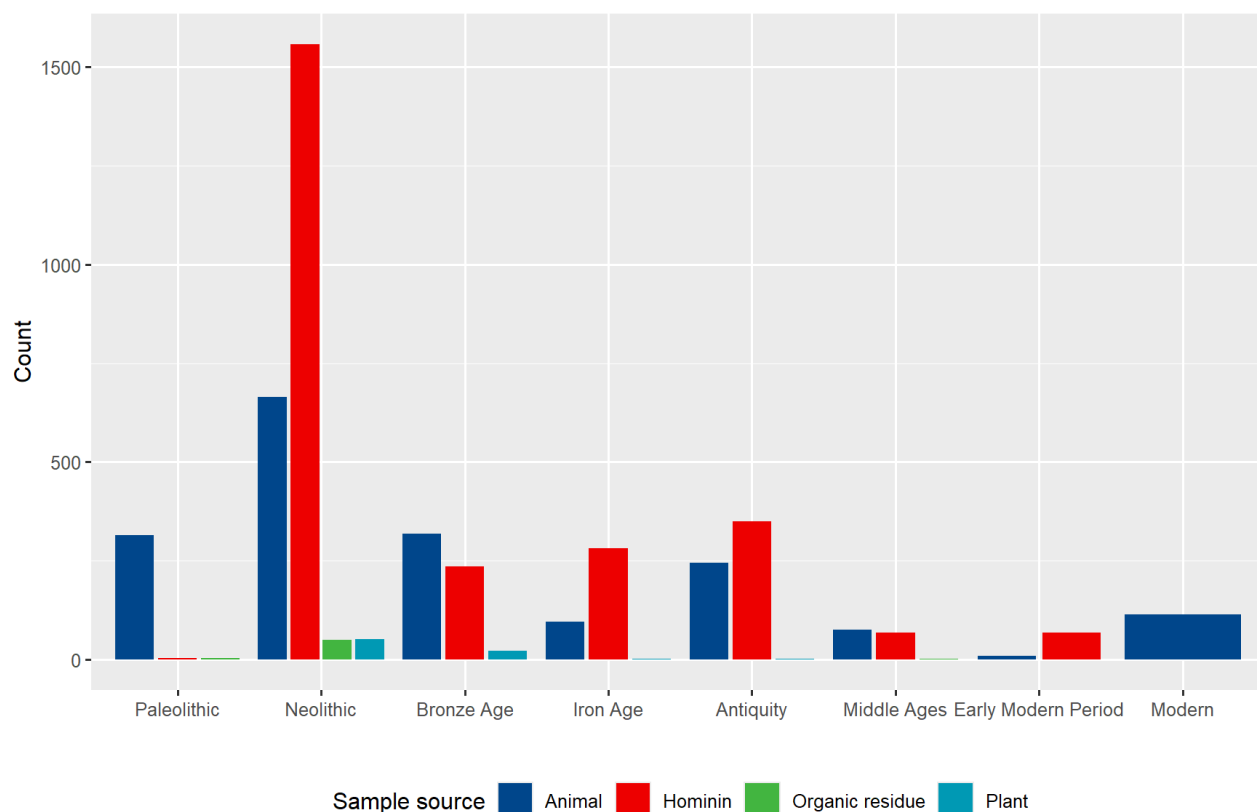


Figure 2: Barplot showing the spread of samples from different sources across time periods.

Papers with $\delta^{13}\text{C}$ results generated as part of AMS radiocarbon (^{14}C) dating procedures were excluded from the dataset, as these measurements are primarily intended for isotopic fractionation correction and are not directly comparable to dedicated stable isotope analyses. Available values of collagen quality criteria, such as C:N, C:S or N:S ratios, were included and no negative selection was made based on the quality of the presented results. All data included in the datasets is reported exactly as it is in the original papers with no further optimisation or modifications. The cumulative count of measurements (not individual instances of various elemental analyses) can be seen in Figure 3.

2.2 Data Processing

The data was imported into an IsoArcH form, either through copy-paste of tables or by manual copying, from the source articles, along with sample references. The structure of the form flows from information on reference (source paper) and

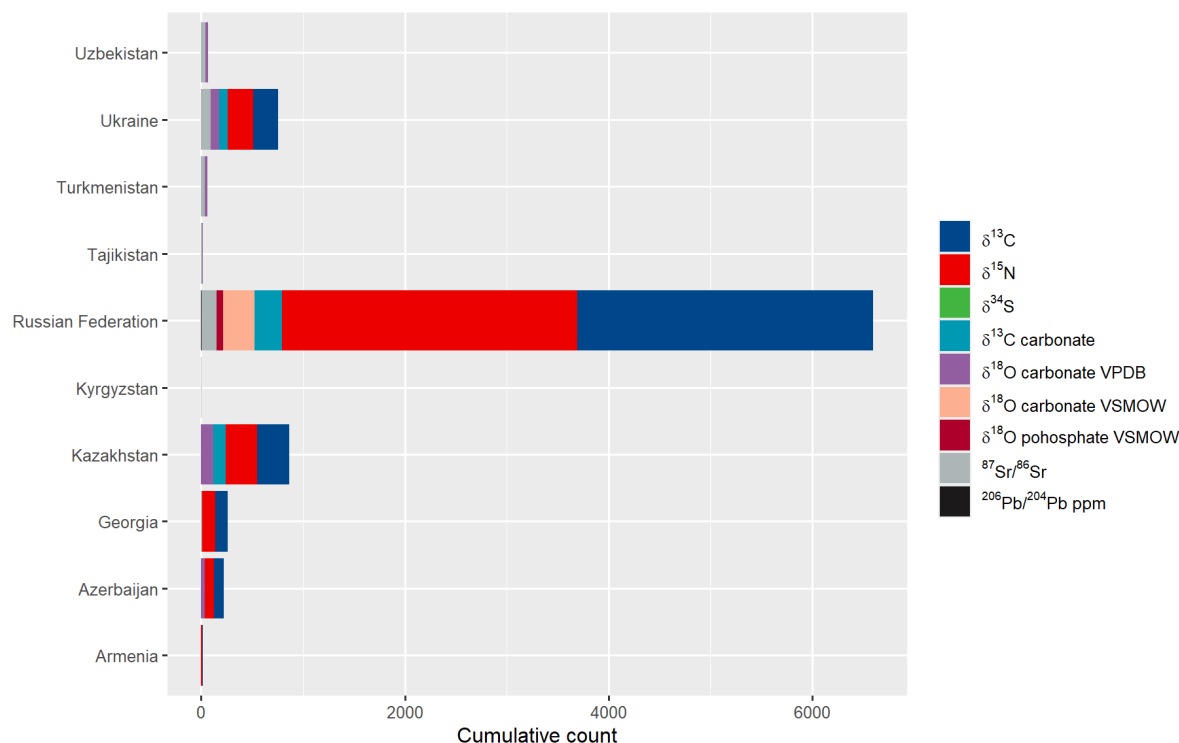


Figure 3: Barplot showing the types of measurements, ordered by samples' countries of origin.

location/site (with GPS coordinates, as available) to the characteristics of the samples and finally the results of isotopic analyses. All geographic coordinates are reported in the WGS84 reference system. The majority of coordinates were ultimately attributed by the authors, with variable precision, on the basis of information provided in the source publications and complementary web-based searches. This is reflected in the IsoArch record form, where GPS coordinates are given in two categories: exact and approximate. Radiocarbon data and measurements, as well as measurements accompanying isotope analysis (such as %C and %N) are also included in the resultant datasets as available in the source material.

Descriptive data regarding source of origin (human/animal/plant) and respective taxonomy, sample details (e.g., type of bone or tooth), dating, state of the remains, type of burial, specifics of the site, etc., was usually extracted from the text in the absence of any tabularised summary (this data migration was the most time-consuming and over-all challenging part of the compilation and was, along with the initial search, by major share done by the Russian-speaking author, M.G.).

For publication and summary, the data was further processed in RStudio (Posit team, 2026) using dplyr (Wickham et al., 2014), tidyverse (Wickham, 2016), ggplot2 (Wickham et al., 2007), reshape2 (Wickham, 2010) and paletteer (Hvitfeldt, 2018) packages.



2.3 Data Validation

All data were compiled manually on a record-by-record basis from original published sources, with analytical values and associated metadata extracted directly from tables, figures, and text. Extracted data were standardized at entry using IsoArch data entry forms and controlled vocabularies to ensure consistent formatting. In many cases, source articles were available only as non-OCR PDF files, requiring direct visual extraction of tabulated values and increasing the risk of transcription errors. Each record was entered into the IsoArch system and double-checked by the same compiler to minimize transcription and encoding errors. Two independent compilers (A.H. and M.G.) contributed to data entry. The complete dataset was subsequently reviewed by an independent reviewer (K.S.) to assess overall consistency, homogeneity of encoding, and to identify potential entry anomalies.

Finally, the dataset was parsed using the IsoArch validator. Automated validation combines schema-based checks with structured manual review. All submitted datasets are validated against a dedicated JSON Schema that formalizes the IsoArch data model and enforces compliance with data types, controlled vocabularies, and mandatory fields. An internal JavaScript library built on the AJV validator implements additional quality controls, including detection of duplicate records, validation of cross-field logical consistency, and enforcement of conditional dependencies between fields. These automated procedures identify structural errors and inconsistencies prior to ingestion into the database.

Manual validation is subsequently performed by curators to assess semantic coherence, plausibility of values, and consistency between analytical data and associated metadata. Records failing automated or manual checks are returned to contributors for correction before integration. Together, these validation steps ensure that datasets entering IsoArch meet consistent technical and semantic quality standards and support reliable reuse and interoperability.

3 Results

The collected data is presently publicly available in the IsoArch database in two separate datasets. The majority of the data was published in 2025 as “A landmark compilation of stable isotope data from archaeological contexts in the post-Soviet space” (Gorbulina and Salesse, 2025). A smaller portion is incorporated into a different dataset that was published two years prior, “Compilation of carbon, nitrogen, oxygen, sulphur and strontium stable isotope data from the Mesolithic to the Late Modern period in the Black Sea area”. As outlined, it focuses on the area around the Black Sea, including the Caucasus and the coastal areas of Ukraine and Russian Federation (Hagarová and Salesse, 2024). For both datasets, an XLSX file is provided containing all pertinent data referenced, summarised and categorised in accordance with IsoArch policies, as well as a RIS file containing a comprehensive bibliography of literature included in the dataset.

The data are available for direct download from the landing page as two compiled datasets and can also be queried through the IsoArch v3 web interface (<https://explorer.isoarch.org/>) using a specific set of filtering options. The compiled dataset encompasses a wide range of isotopic systems and archaeological contexts. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotope measurements constitute the majority of the records, whereas $\delta^{18}\text{O}$, $\delta^{34}\text{S}$, and $^{87}\text{Sr}/^{86}\text{Sr}$ analyses are less frequently represented. The geographical



distribution of measurements is uneven, with Russia, Ukraine and Kazakhstan contributing the largest number of records. This diversity highlights the extensive spatial, chronological, and analytical coverage represented within the compilation.

140 **Code, data, or code and data availability**

Data described in this manuscript can be accessed at the IsoArch database (<https://isoarch.org>) (Plomp et al., 2022; Salesse et al., 2018) under the following DOIs: 10.48530/isoarch.2023.005, 10.48530/isoarch.2025.003. Direct access to the datasets is available at <https://doi.org/10.48530/isoarch.2023.005>, <https://doi.org/10.48530/isoarch.2025.003>. Datasets are licenced under the Creative Commons Attribution 4.0 International licence (CC BY 4.0).

145 **Author contributions**

A.H. and M.G. carried out the literature research and data collection, compilation, transcription, scrubbing, annotation and formal corrections. K.S. supervised that process and subsequently reviewed the finalised datasets. A.H. prepared the manuscript with contributions and revisions from K.S.

Competing interests

150 The authors declare that they have no conflict of interest.

Disclaimer

Beyond the present compilation effort, users of these datasets are requested to consult and cite the original sources to ensure traceability and proper attribution.

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