NFDI4Objects
Research Data Infrastructure for the Material Remains of Human History

TRAIL 3.4:

Georesources in human history: the life cycle of lead from Roman Cartagena

Partner **Lead**: Deutsches Bergbau-Museum Bochum (Thomas Stöllner), Ruhr-Universität Bochum (Thomas Stöllner)

Members: University of Cologne (Helmut Brückner), Curt-Engelhorn-Centre of Archaeometry (Roland Schwab), University of Tübingen (Roland Schwab), Deutsches Bergbau-Museum Bochum (Sabine Klein, Michael Bode), Ruhr-Universität Bochum (Sabine Klein), Frankfurt Isotope and Element Research Center (FIERCE), Goethe University Frankfurt (Sabine Klein), State Museums, Prussian Cultural Heritage Foundation, Coin Cabinet Berlin (Bernhard Weisser), Verbundzentrale des GBV (VZG), Abteilungsleitung Digitale Bibliothek (Frank Dührkohp), Kiel University (Matthias Renz), Constance von Rüden

External members: Universidad Murcia (Sebastiano Ramallo, María Milagrosa Ros Sala, José Miguel Noguera); German Archaeological Institute, Madrid Branch (Dirce Marzoli)

Contact Thomas Stöllner / Thomas.stoellner@bergbaumuseum.de

Summary

In this TRAIL, we will develop an online service, Georesources in Human History. The service will) integrate various collections of legacy data and data bases and link them using semantic technologies. The TRAIL will address analytical data, i.e. geoarchaeological data from fieldwork- (link to TA1.); sample and artefact collections (TA 2); laboratory analytics (TA 3; laboratory machines, standards and protocols); storage (TA 5; OpenScience repository). Lead and its isotopes are used extensively in geoarchaeology and provenance studies, but no overarching repository exists that unites various approaches from environmental studies to material science. The TRAIL will create a

complex data - and interface model for integrating analytical data from various sources, based on a model data set (lead from the Roman lead- and silver- producing region around Cartagena). Experts of the TA3 community will also create and test simple evaluation interfaces for use by different research communities.

Description

The TRAIL aims to develop storage (StoS), software application (SaS), data (DaS) and discovery (DiS) services using MyCoRe and in cooperation with TA5, ultimately to create an online research service for archaeologists, archaeometrists and material scientists who use "Georessources". In archaeometric research, various standards and protocols are in use, so laboratory standards will be harmonised with the geochemical standards of NFDI4Earth.

Lead (Pb) can be used as a case study for other metals, such as copper (Cu) and tin (Sn), as well as noble metals, such as gold (Au) and silver (Ag). Natural lead consists of four stable isotopes, the primordial, 204Pb, and the radiogenic nuclides 208Pb (ca. 52.4%), 207Pb (ca. 22.1%), and 206Pb (ca. 24.1%). Their ratios in ore deposits vary depending on the time of ore formation. This makes the deposits distinguishable by their lead isotope composition. In conjunction with the trace element pattern of the ores, each deposit has its own geochemical fingerprint. This principle applies to all metal-rich mineralisation, including Cartagena lead deposits. It can be used to trace the lifecycle of lead from mining and extraction to production, networks and trade routes. Carthago Nova and its environs were the main producers of silver and lead in the Mediterranean region and beyond (2nd and 1st centuries BCE). Lead and silver extraction and smelting had a serious impact on Cartagenan ecosystems, polluting land and water.

As Cartagenan lead was widely used, it is an important trace -marker that has been analysed in diverse projects and contexts. Historians (epigraphy), archaeologists and natural scientists have produced a whole range of data which the TRAIL will harvest and link by interfaces. This will create a large interoperable data repository for scientists, data -curators (from museums), university teachers, students and public bodies (heritage offices) to use in the long term.In order to harvest it, the data on Cartagenan lead needs to be evaluated. We do this according to the geochemical standards drawn from NFDI4Earth on a five-point scale: 1 = excellent; 2 = good ; 3 = fair ;4 = sufficient; 5 = insufficient. The evaluation committee will consist of a specialist in each of the major categories: resource archaeology (Thomas Stöllner), archaeology (Sebastiano Ramallo), geoarchaeology (Helmut Brückner), geochemistry and isotope chemistry (Sabine Klein), ancient history and artefacts (Bernhard Weisser).

Recent databases differ in research focus and discipline-specific needs, and therefore are developed based on different standards: (1) extensive and more general geo-databases (e.g., GEOROC/ mindat.org, global whole rock compilation, Gard et al. 2019); (2) smaller regional databases (e.g., the Spanish lead isotope database IBERLID, García De Madinabeitia et al. 2021; connections to NFDI4Earth); (3) laboratory-owned isotope databases (e.g., reference lead isotope data bases of project-related ores and metal such as the Corpus Massarum Plumbum Romanarum, at the Deutsches Bergbau-

Museum Bochum). Especially the very recently released prototype of GlobaLID (Westner et al. 2021, Klein et al. 2021, submitted) promises to be, in the future, a global and FAIR lead isotope database of reference ores combined with an interactive application and with special focus on archaeoemtric users. It is hence a perfect example in the sense of sharing experience with this project on constructing such databases very closely oriented on the needs of the target scientific community. To enable reusability of older analytical and field data, we will also draw from the experience of the geoarchaeology-based CRC 806 Our Way to Europe, which integrated both natural sciences and humanities, and the database developed by Prof. Georg Bareth and his team (esp. Dr. Willmes), University of Cologne. Heterogeneous data sets from environmental, (geo/marine) archaeological, geoscientists metallurgical, historical (inscriptions) and object-based investigations have to be integrated.

The most important task of this TRAIL is to define interfaces between various types of digital data, data origins and copyrights and to create metadata standards (specifications and blue paper). To do this, we will use the URI -concept for linking features and artefacts (TA3) in coordination with TA6. The TRAIL will integrate several work groups and archives to develop a standard for all kinds of lead- related georesources in (geo)archaeological data sources.

Relevance

The TRAIL harvests and systematises existing digital and analogue data in various laboratories and institutions and contextualises them, integrating cross-domain -data for a wider use in the vast field of archaeometry and resource-oriented archaeology. Within the TRAIL, partners will use their own devices and solutions to test the online service to ensure quality management of the data within it.

We expect the georesources service to be widely used by researchers, students, university teachers and data -curators of large research and museum collections. The service will integrate field data, artefact and sample collections, and may be connected to other repositories and web -services by suitable interfaces in N4O. Proprietary analytical meta-data may be connected to smart -lab -tools in NFDI4Chem (to be negotiated) and larger geoscience data repositories within NFDI4Earth.

The TRAIL will comply fully with the FAIR principles. All partners are committed to the principles of FAIR data. The online research service, Georesources in Human History will make data findable, reusable and interoperable with other data- and discovery -services in N4O. The online service will be able to integrate material science aspects of georesources from other archaeological data services; this will be a quantum leap forward to harmonise these data and to enable broader accessibility.

Deliverables

The TRAIL makes two contributions. First, multidisciplinary collection of FAIR data and their meta-data contextualisation. Different types of data will be combined using the minimum metadata standards developed in the TRAIL (blue paper). Second, based on

the MyCoRe framework, in cooperation with TA5, we will create a long-term storage solution for an online service, Georesources in Human History. A possible partner shall be the GFZ Potsdam, which currently hosts GlobaLID.

Statistical analysis shall be used to evaluate and improve the data -interfaces and metadata -standards in collaboration between TA3, TA6 and the master's programme in Raw Material and Economic Archaeology at Ruhr-Universität Bochum, where training tools will be developed to foster the use of the online service in universities.

Work plan

Topics	**Months**											
	1	2	3	4	5	6	7	8	9	10	11	12
Kick-off meeting: introduction of deliverables and responsibilities												
Data integration concept; clarification of data origins and data conditions; clarification of storage service; discussion of ontology used (see DBM prototype)												
After 3 months: 1st milestone meeting **After 3 months: 1st milestone meeting** Discussion and evaluation of concepts/start implementation												
Work on data and discovery service tools; data harmonisation												
After 9 months: 2nd milestone meeting Evaluation of data quality by the expert committee; evaluation of concept for discovery tools												
Plan for providing services: DaS; DiS; StoS and SaS; Georesources in Human History online service												

FAIR[1]	F1: RDA-F1-01M, RDA-F1-01D, RDA-F1-02M, RDA-F1-01M, RDA-F1-02D; F2: RDA-F1-01M, F3: RDA-F3-01M / A2: RDA-A2-01M / I1: RDA-I1-01M, RDA-I1-01D, RDA-I1-02M, RDA-I1-02D, I3: RDA-I3-01M, RDA-I3-01D, RDA-I3-02M, RDA-I3-02D, RDA-I3-03M, RDA-I3-04M / R1: RDA-R1-01M; R1.1: RDA-R1.1-01M, RDA-R1.1-02M, RDA-R1.1-03M; R1.2: RDA-R1.2-01M, RDA-R1.2-02M; R1.3: RDA-R1.3-01M, RDA-R1.3-01D, RDA-R1.3-02M, RDA-R1.3-02D
TRAILS	keine

[1] Nach Tabelle 1 von Bahim, C., Casorrán-Amilburu, C., Dekkers, M., Herczog, E., Loozen, N., Repanas, K., … Stall, S. (2020). The FAIR Data Maturity Model: An Approach to Harmonise FAIR Assessments. Data Science Journal, 19(1), 41. DOI: http://doi.org/10.5334/dsj-2020-041 cc by 4.0