Unit for Surveying & Geoinformation
& Institute of Archaeologies, University of Innsbruck

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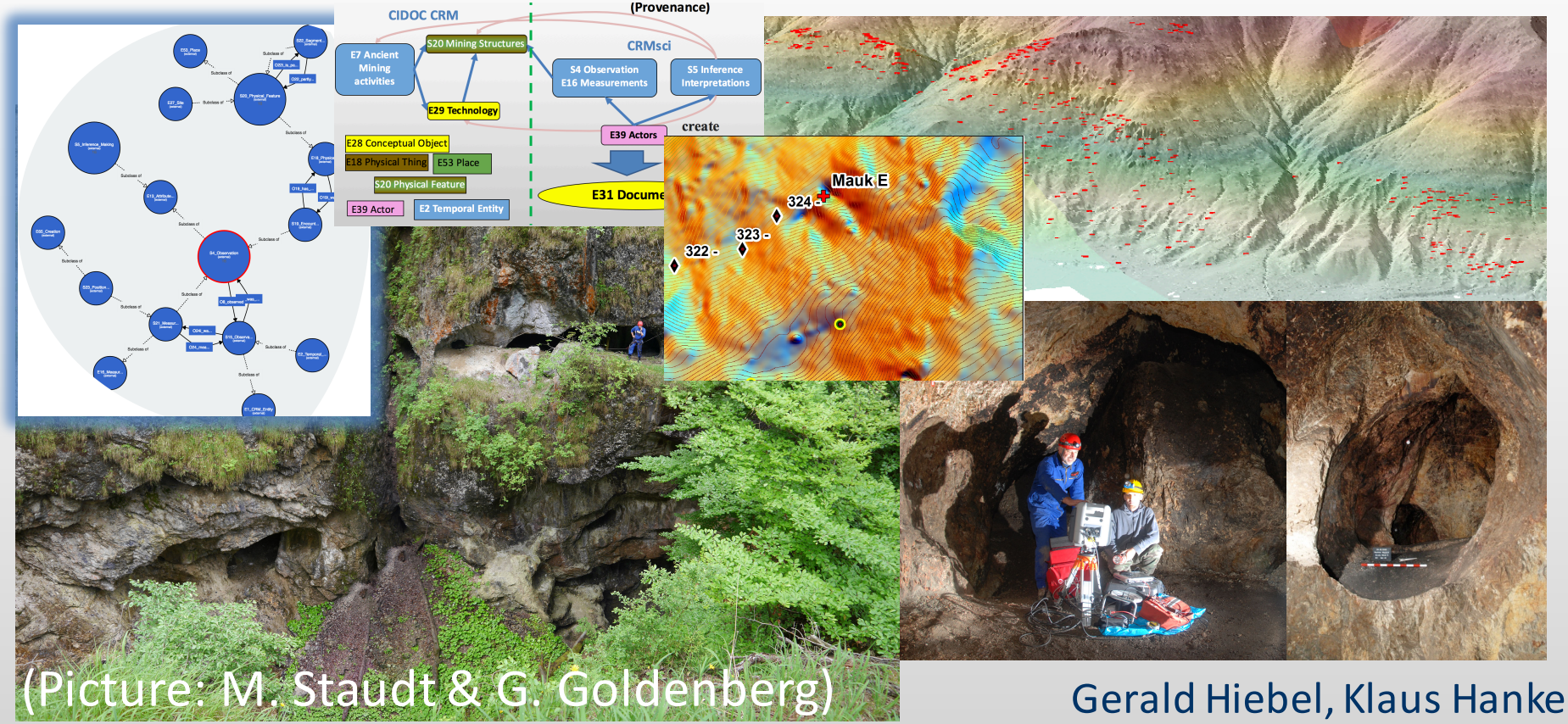
Research Center HiMAT

Digital Prehistoric Mining Archaeology



(Picture: M. Staudt & G. Goldenberg)

Gerald Hiebel, Klaus Hanke

Gert Goldenberg, Caroline O. Grutsch, Markus Staudt, Manuel Scherer-Windisch

Overview

- Introduction: Mining Research at the University of Innsbruck
- Open Research Data for Mining Archaeology
- FAIR (Findable, Accessible, Interoperable, Reuseable) Data Principles
- Applying FAIR to Mining Archaeology
  - Cultural Heritage Standards (ISO): CIDOC CRM ontology
  - Semantic Web Standards (W3C): SKOS, RDF
- Outlook: Information Integration for Prehistoric Mining Archaeology

Introduction

Research Center HiMAT (History of Mining Activities in the Tyrol and adjacent areas): Interdisciplinary research on mining activities from prehistoric to early modern times involving 10 disciplines started in 2007 with the FWF Special Research Programm HiMAT lasting five years

DACH-Project (2015-2018):
"**Prehistoric copper production in the eastern and central Alps - technical, social and economic dynamics in space and time**"
Goal: reconstruct the development and influence of three mining districts of supra regional significance, their economic dynamics and the manifold interrelations within the network of alpine metal producers

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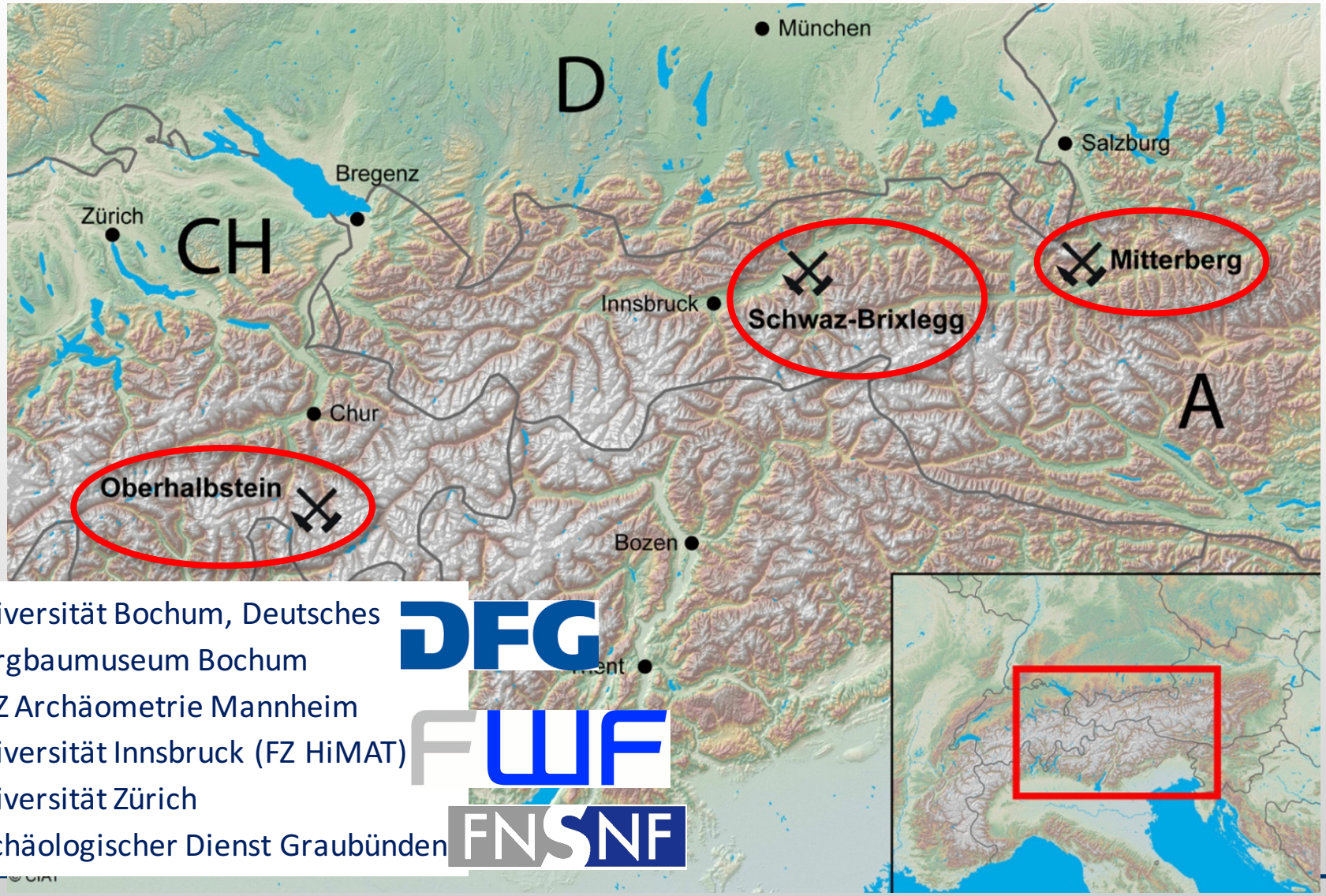
DACH-Project Areas



D Universität Bochum, Deutsches Bergbaumuseum Bochum
CEZ Archäometrie Mannheim
A Universität Innsbruck (FZ HiMAT)
CH Universität Zürich
Archäologischer Dienst Graubünden

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Austrian Science Fund (FWF):
Open Research Data Pilot (ORD)
Digitale Publication of Research Data

Goal: the ORD pilot aims to create *role models for open research data* with the goal of open research data becoming the norm for all FWF projects in the future.

Funded Project (2 years):
Open Research Data for Prehistoric Mining Archaeology
Goal: Transform and digitise the data of the Austrian project part of "*Prehistoric copper production in the eastern and central Alps*" to make them open and reusable for the scientific community
Include Data of the FWF Special Research Programm HiMAT
Start of project: March 2018

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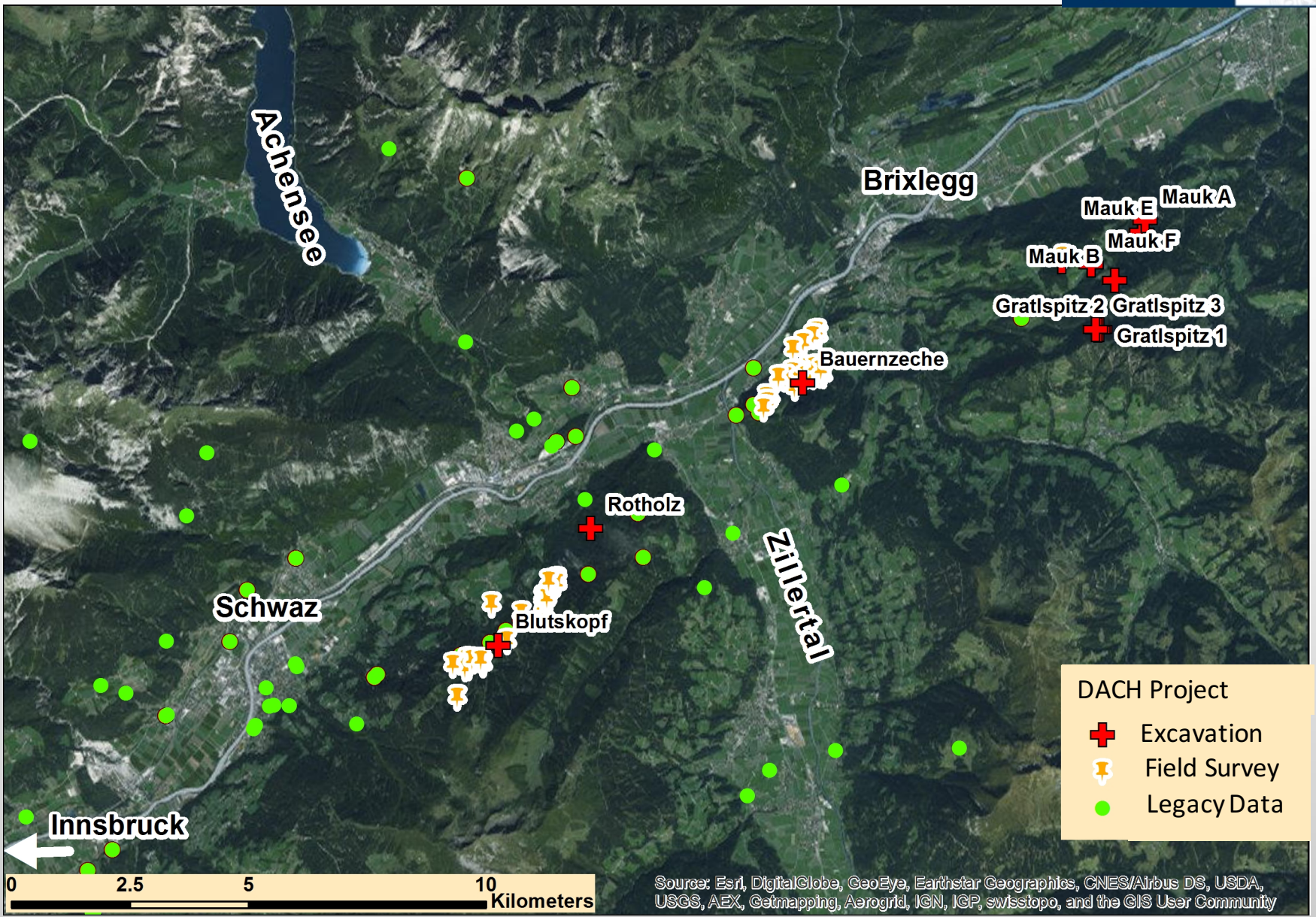
Data from DACH Project - Archaeology



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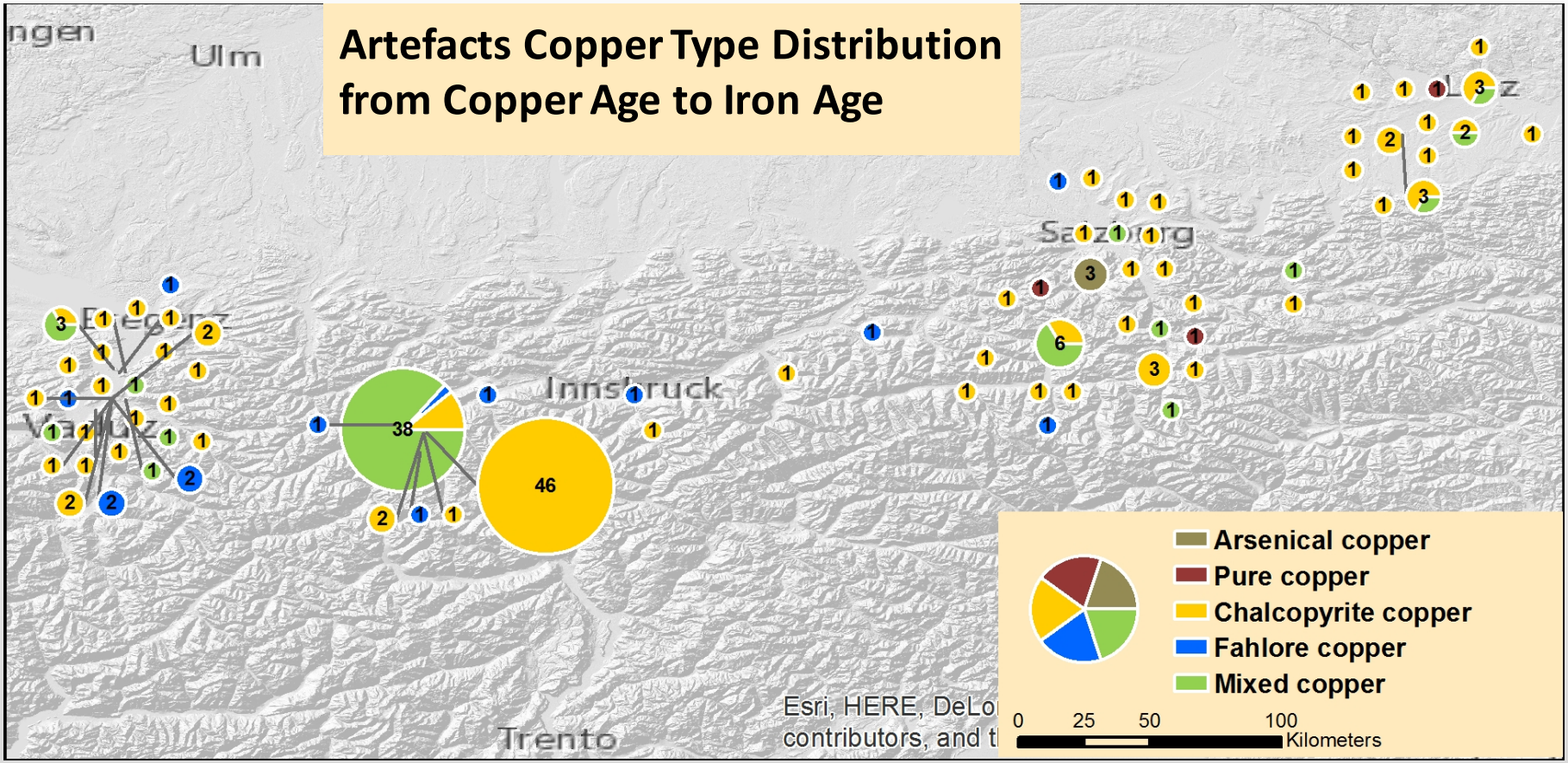
Data from DACH Project - Metallurgy



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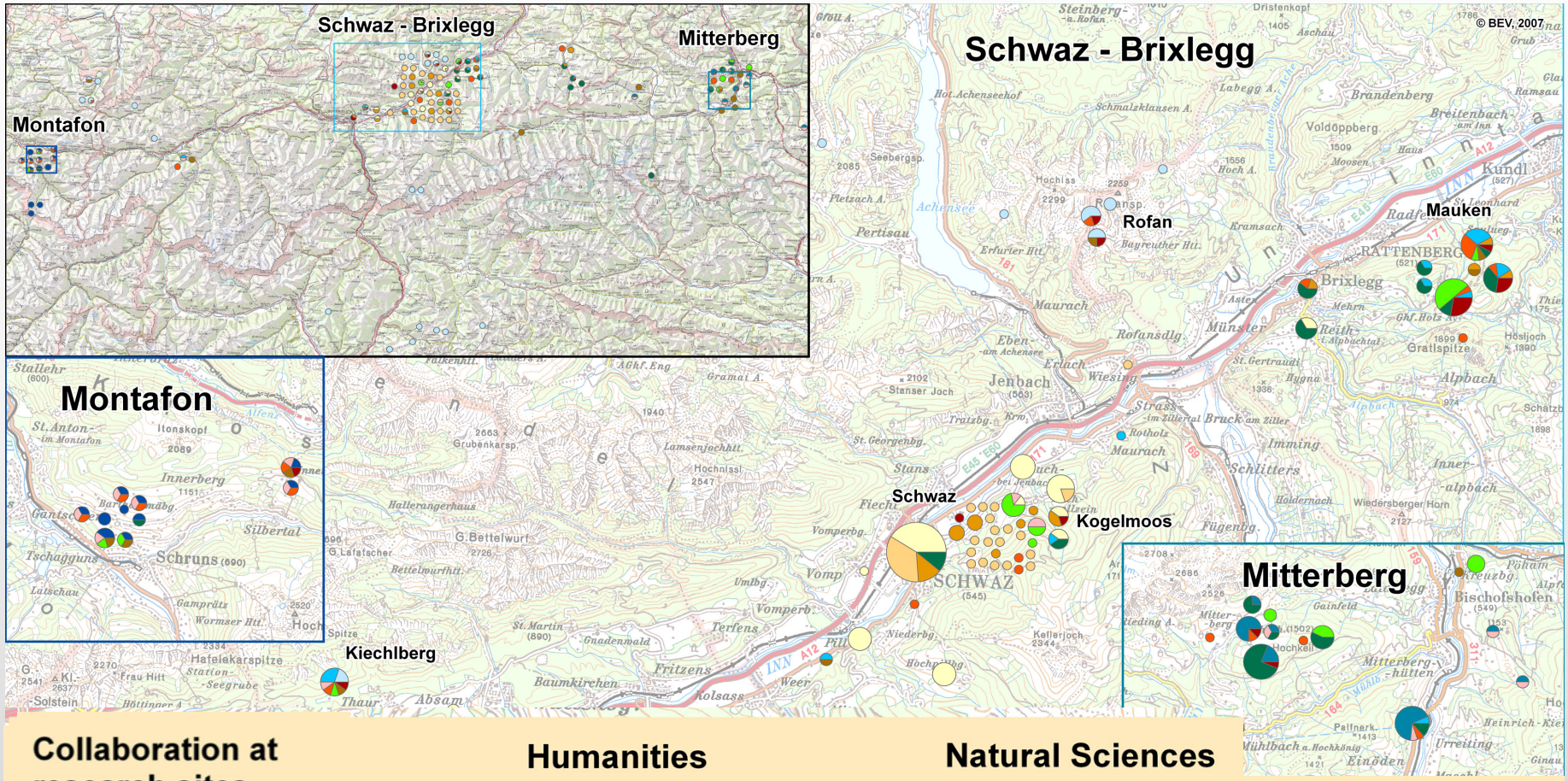
Data from Special Research Programm



Collaboration at research sites

46

7

1

Humanities

- History
- Linguistics
- Ethnology
- Archaeology

Natural Sciences

- Metallurgy
- Mineralogy
- Botany
- Archaeozoology
- Dendrochronology
- Surveying & Geoinformation

Methodology to create Open Research Data

The FAIR Guiding Principles for scientific data management and stewardship (Wilkinson et al. 2016)

- **To be Findable:**
- F1. (meta)data are assigned a globally unique and persistent identifier – **URIs (Uniform Resource Identifiers)**
- F2. data are described with rich metadata (defined by R1 below)
- F3. metadata clearly and explicitly include the identifier of the data it describes
- F4. (meta)data are registered or indexed in a searchable resource
- **To be Accessible:**
- A1. (meta)data are retrievable by their identifier using a standardized communications protocol – **http, https, ftp**
- A1.1 the protocol is open, free, and universally implementable
- A1.2 the protocol allows for an authentication and authorization procedure, where necessary
- A2. metadata are accessible, even when the data are no longer available

Methodology to create Open Research Data

The FAIR Guiding Principles continue

- **To be Interoperable:**
- I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation. **– RDF (Resource Description Famework)**
- I2. (meta)data use vocabularies that follow FAIR principles

  SKOS (Simple Knowledge Organization System) encoded
- I3. (meta)data include qualified references to other (meta)data
- **To be Reusable:**
- R1. meta(data) are richly described with a plurality of accurate and relevant attributes
- R1.1. (meta)data are released with a clear and accessible data usage license
- R1.2. (meta)data are associated with detailed provenance **– CIDOC CRM**
- R1.3. (meta)data meet domain-relevant community standards **– CIDOC CRM**

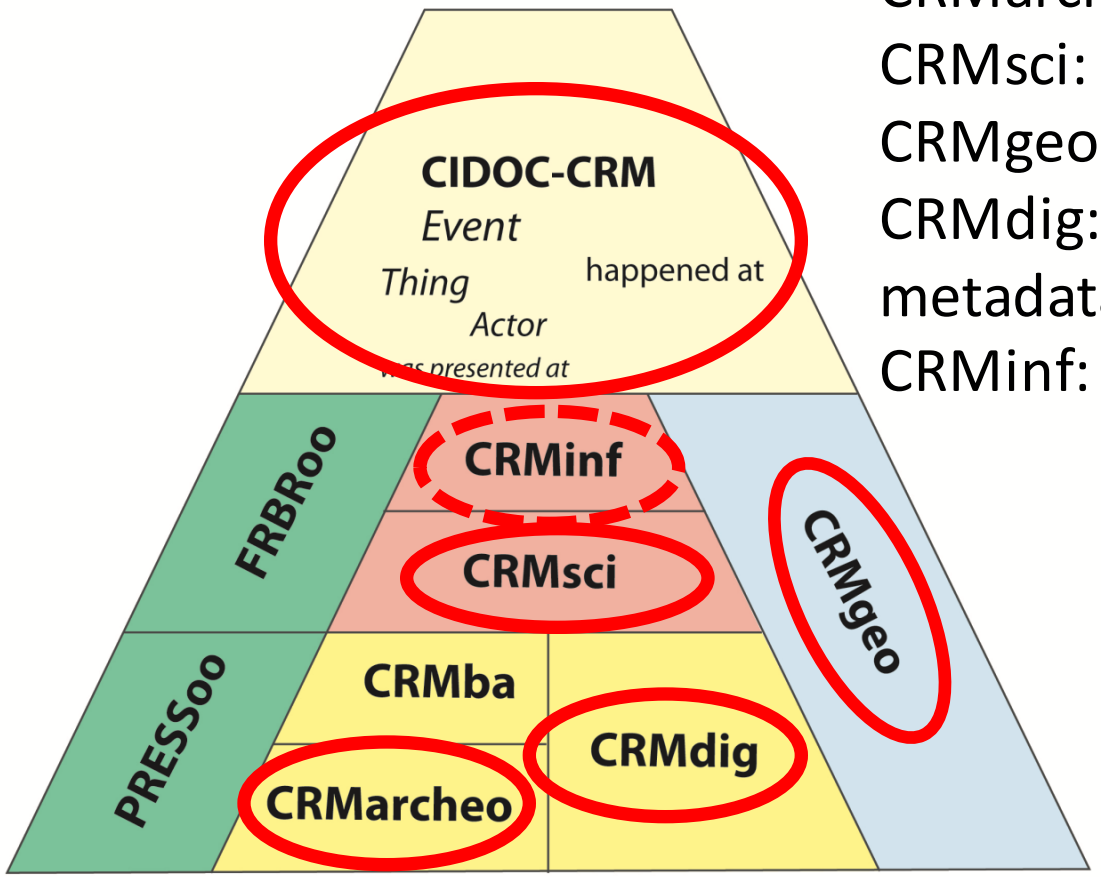
The CIDOC Conceptual Reference Model (CIDOC CRM)

- a **core ontology** describing the underlying semantics of Cultural Heritage Information curated by museum disciplines, archives and libraries.
- Recognized **ISO Standard** since 2006 (ISO21127:2006)
- Used in **ARIADNE** (Advanced Research Infrastructures for Archaeological Dataset Networking in Europe) to represent archaeological data
- extended with **CRMarchaeo** to model archaeological excavations in the course of ARIADNE

FAIR R1.2, R1.3

CIDOC CRM for Open Data in mining research

CIDOC-CRM family of Models



FAIR R1.3

CRMarchaeo: Excavation model
CRMsci: Scientific observation model
CRMgeo: Spatiotemporal model
CRMdig: Model for provenance metadata

FAIR R1.2

CRMinf: Argumentation model

CIDOC CRM CONCEPTUAL REFERENCE MODEL

Ancient Activities and relations

CIDOC CRM

FAIR R1.3

CRMsci

Research Activities and Information Sources (Provenance)

FAIR R1.2

CRMarchaeo

Ancient Mining activities

Ore extraction around 700 BC

Mining Structure Mauk E (underground mine)

-Wood sample

Observations

Mauk E Excavation

Measurements

Dendrochronology

Surveying

Interpretations

Ore extraction from 720 – 707 BC

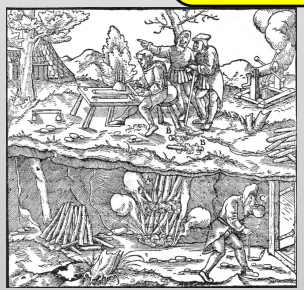
Fire setting technology used

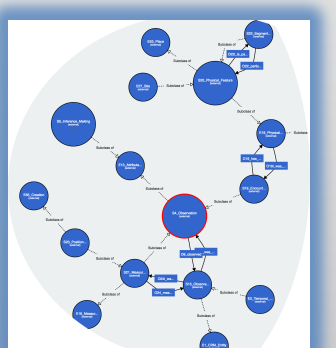
Actor

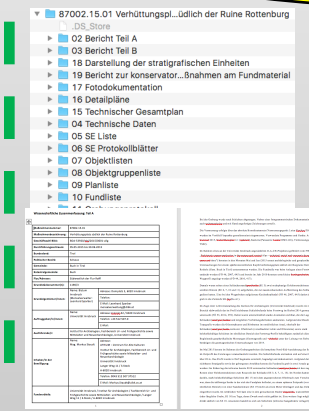
CRMdig, CRMgeo

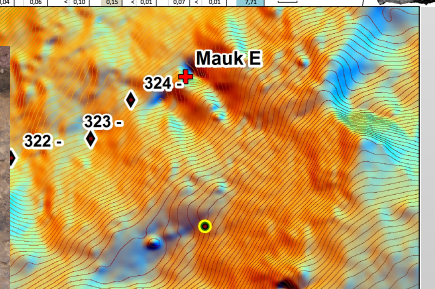
Documentation

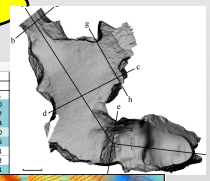
Technology Fire Setting











Thesaurus for Ancient activities, created things

Human activity (E7)

Activity Period
- Bronze Age
- Iron Age
- Mediaval Times

Mining Activities
- Extraction
- Benefication
- Smelting

Settlement

Burial

Physical Feature (S20)

Mining Structures
- Extraction
  - Adit
  - Underground mine
  - Open cast mine
- Benefication site
- Smelting site
  - Furnace
  - Roasting bed

Technology (E29)

Extraction
- fire setting
- Hammer & gad

Benefication
- washing
- crushing

Smelting technique

SKOS - Simple Knowledge Organisation system :
W3C -Standard to support the use of knowledge organization systems (KOS) such as thesauri, classification schemes

FAIR I 2

RDF: a way to encode data in triples using URIs

FAIR I1

S20 Physical Feature → E55 Type

P2 has type

FAIR A1

Subject: <http://www.uibk.ac.at/himat/himat_source/Pirkl/S20/1> FAIR F1
Predicate: <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
Object: <http://www.cidoc-crm.org/cidoc-crm/S20_Physical_Feature>

Subject: <http://www.uibk.ac.at/himat/himat_source/Pirkl/S20/1>
Predicate: <http://www.cidoc-crm.org/cidoc-crm/P2_has_type>
Object: <http://www.uibk.ac.at/himat/E55/175390>

Subject: <http://www.uibk.ac.at/himat/E55/175390>
Predicate: <http://www.w3.org/2004/02/skos/core#prefLabel>
Object: ”Underground mine"@en

Subject: <http://www.uibk.ac.at/himat/himat_source/Pirkl/S20/1>
Predicate: <http://www.w3.org/2000/01/rdf-schema#label>
Object: “Mauk E”

“Mauk E”

S20 Physical Feature

Underground mine

Triple Store

Outlook: Information Integration for Prehistoric Mining Archaeology

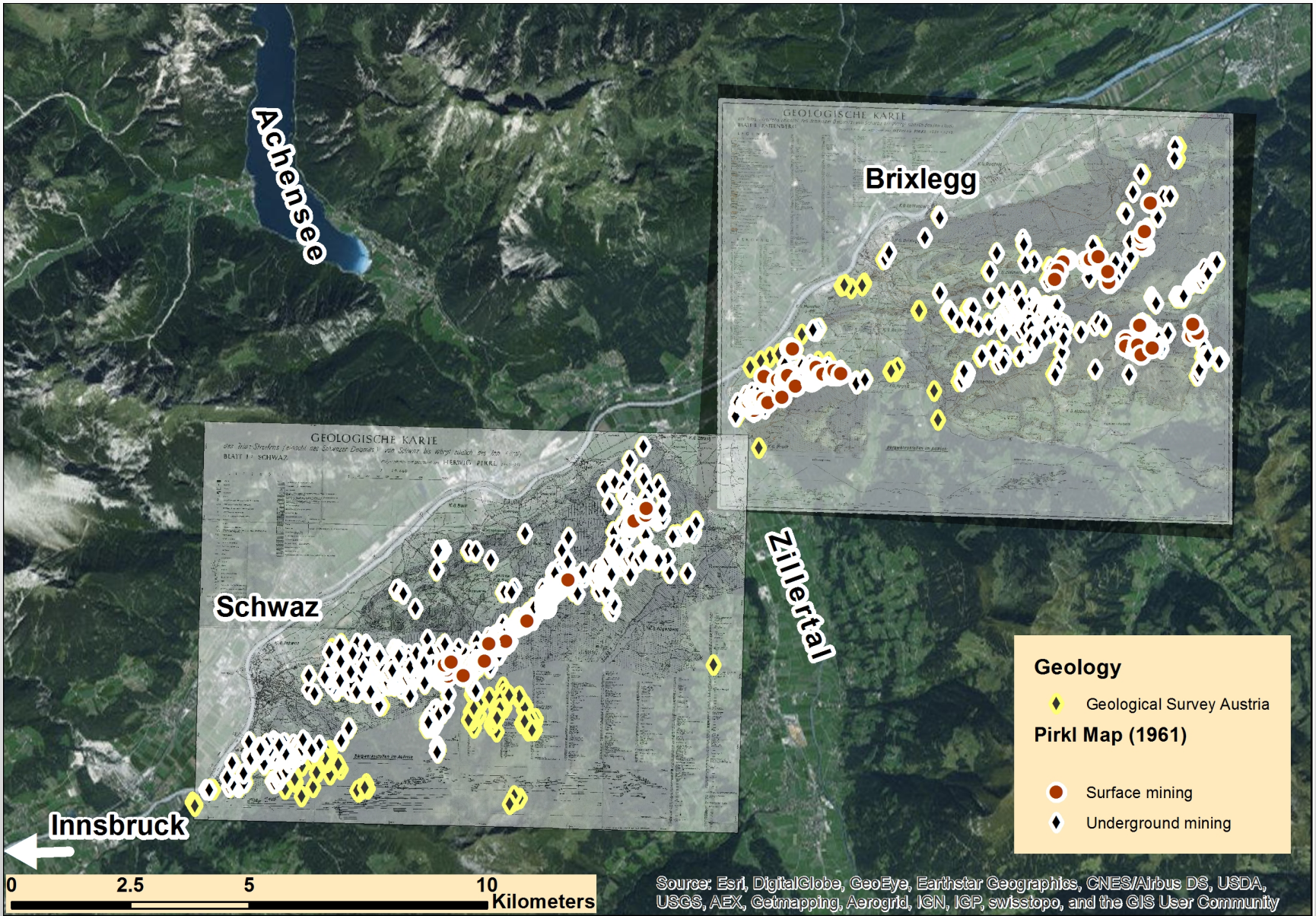
Target two research questions using methodology and data from the ORD Project:

- Data integration of archaeological, geological, surveying and environmental sources for field survey
  - ❖ to identify unknown mining structures like excavation sites or smelting sites (regional level)
- Data integration of research results to answer specific research questions
  - ❖ Spatiotemporal spread of technologies, ore types (trans-regional level)

Goal: provide researchers with a tool to analyse their own and extern research in its semantic and spatial context

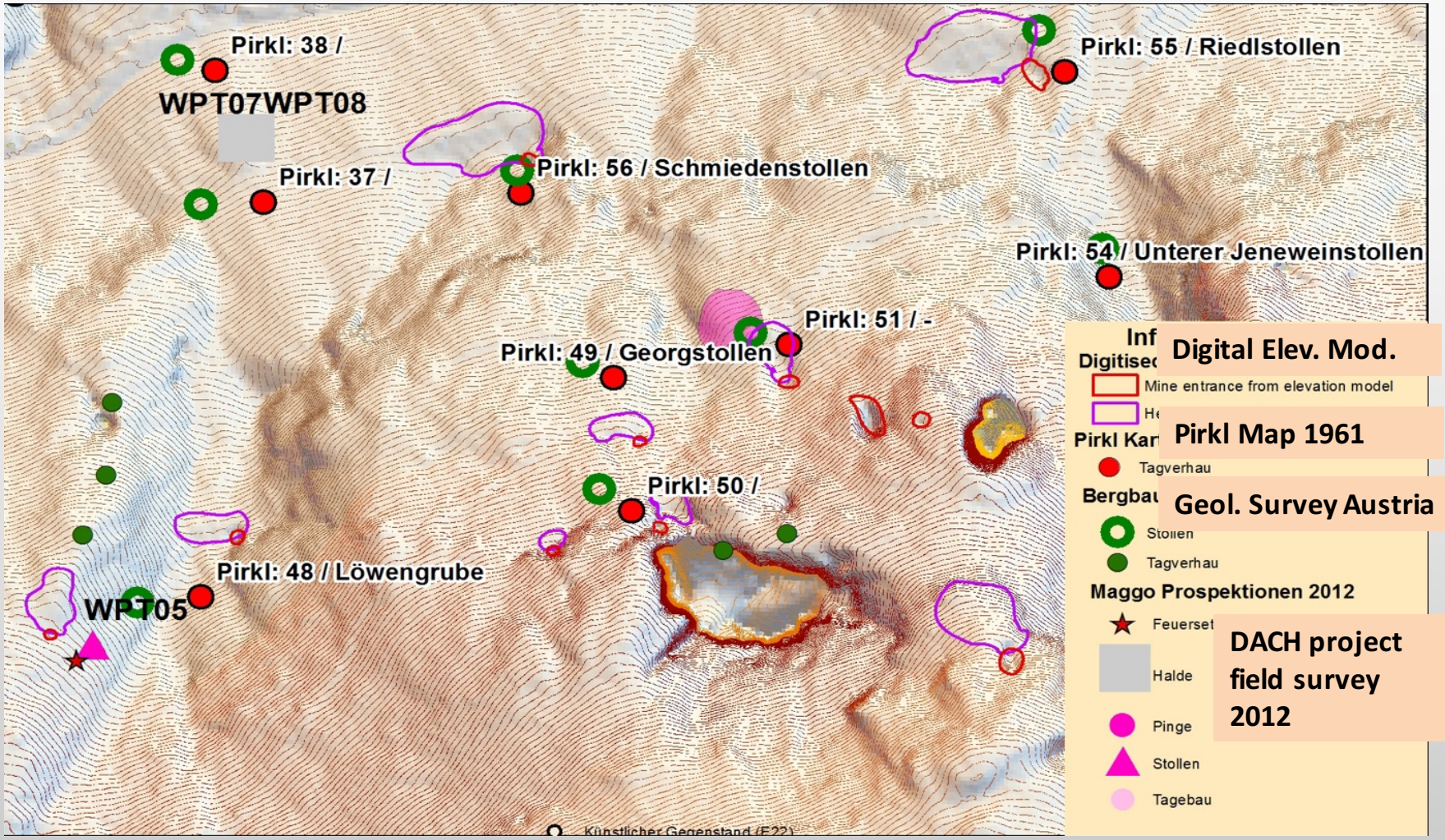
Stand-alone Project at Austrian Science Fund (FWF):
Planned for 4 years: application scheduled for March 2018
Preperatory project funded by the University of Innsbruck

Mining Structures from Geological Maps

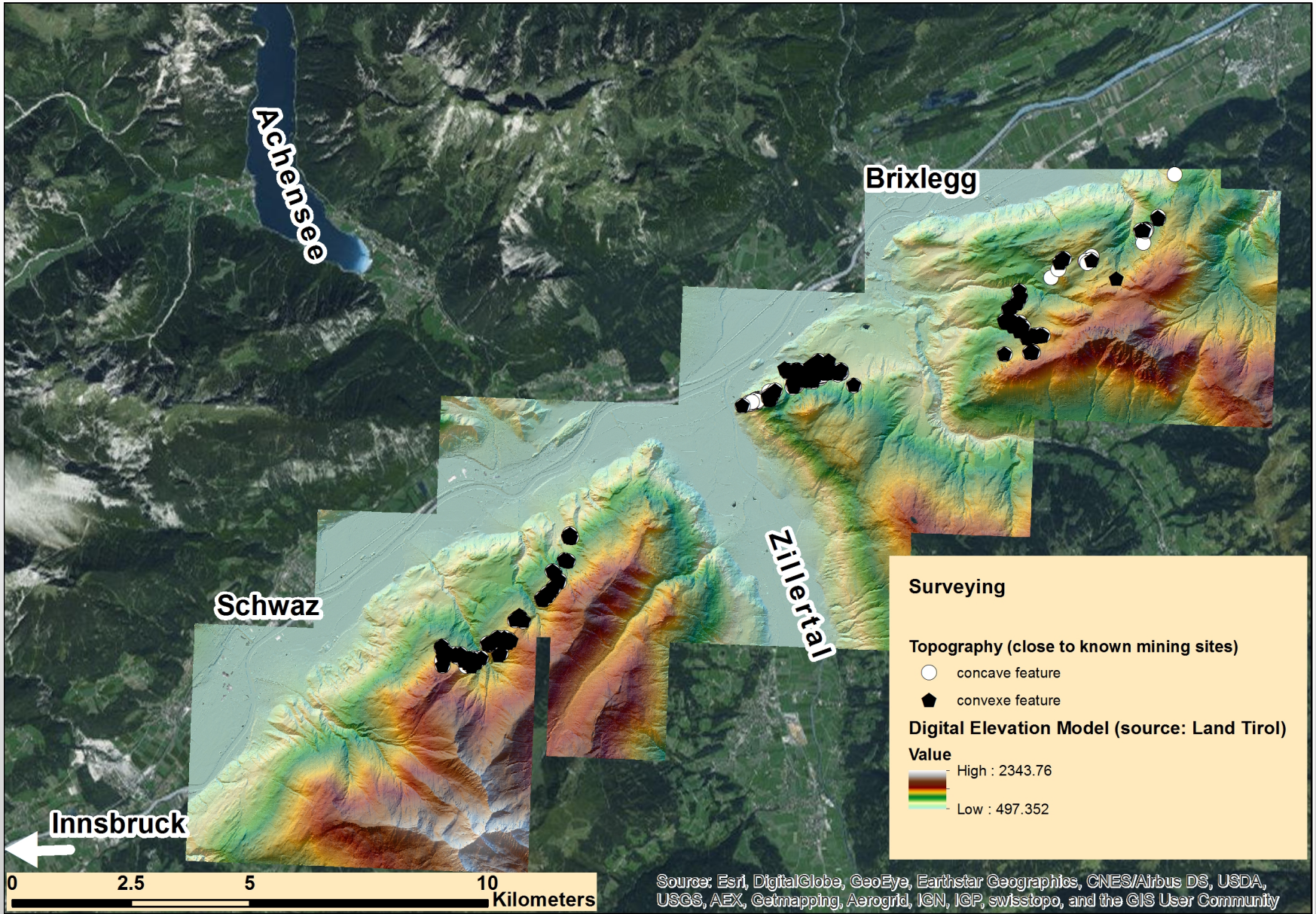


Potential Mining Structures in the Digital Elevation Model

Identification of concave and convex physical features close to mining features from geological and archaeological prospections

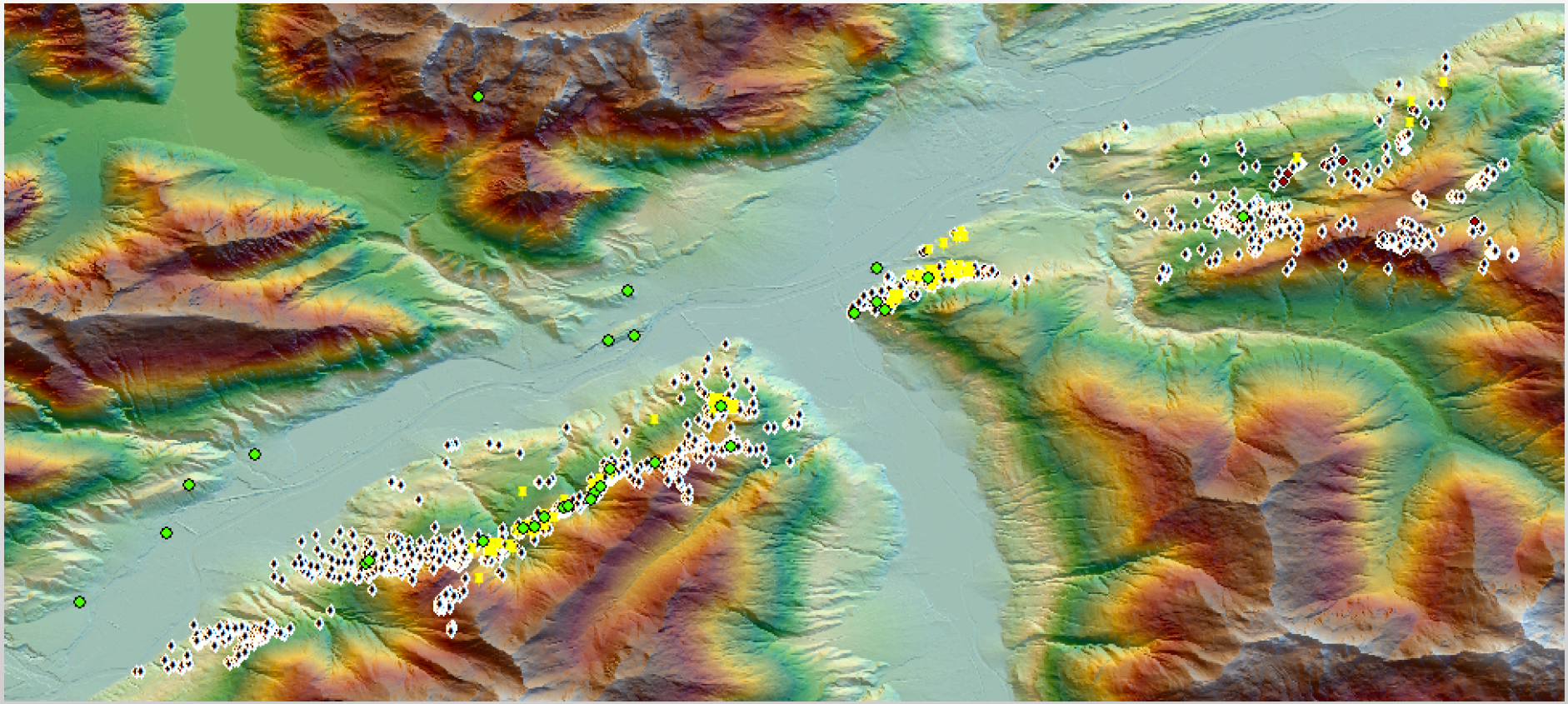


Potential Mining Structures from Surveying

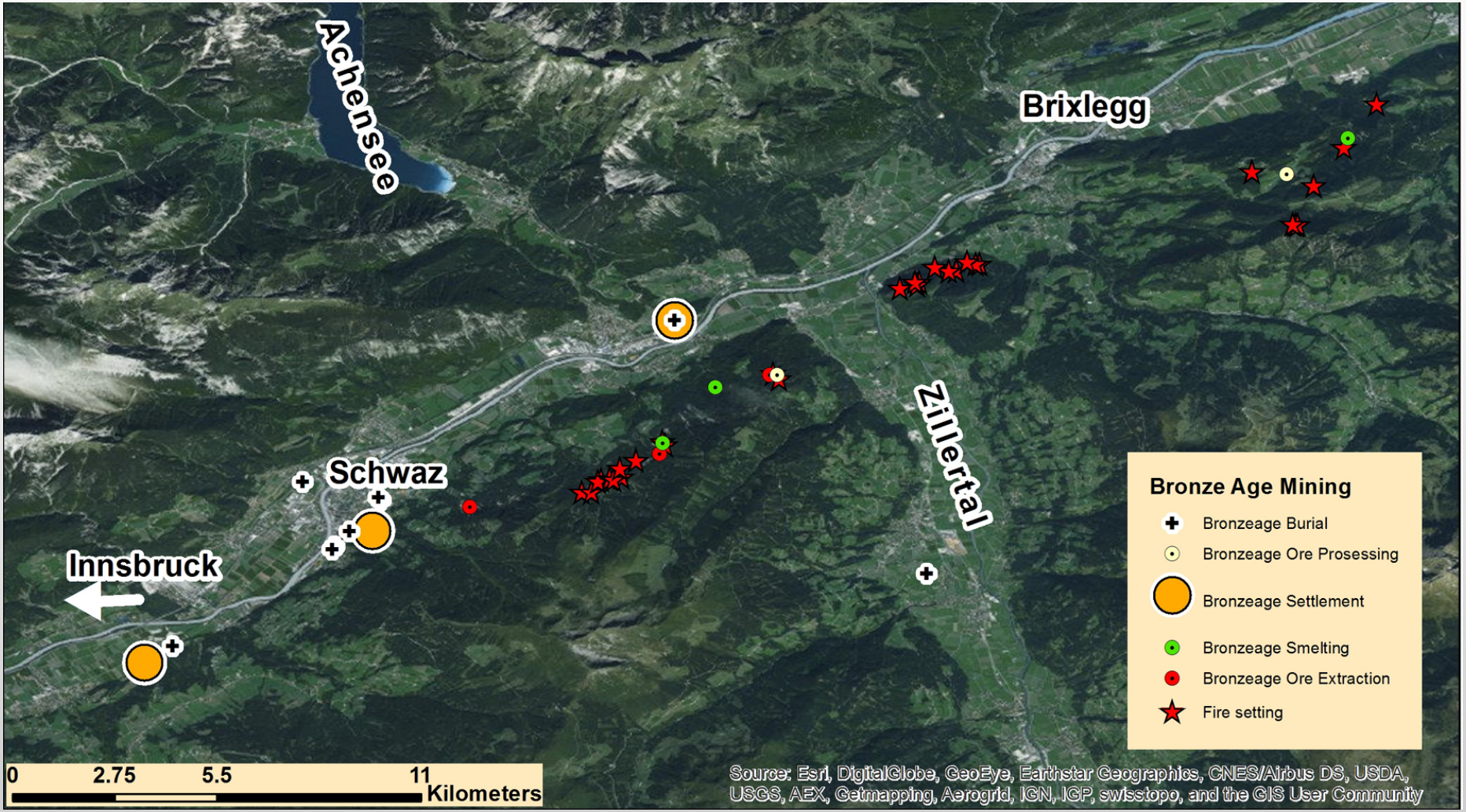


Spatial Integration of data

but no way to ask a question over all datasets because they have different representations



We target: Spatial and semantic integration of data



Summing up

- Create digital data from mining research documentation using Cultural Heritage and Semantic Web Standards
- Provide these data as Open Research Data correspondent with FAIR principles
- Use Open Research Data together with other data for Information Integration
  - to target questions in Prehistoric Mining Archaeology
  - develop new questions based on the visualisations and analysis of integrated data

Dank

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