Advanced Contextualisation Reference Implementation Frameworks in Practice

Coherent Multi-disciplinary Conceptual Knowledge-Spatial Context Discovery Results from the Holocene-prehistoric Volcanological Features and Archaeological Settlement Infrastructure Surveys

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Abstract—**This paper presents the results of the research on coherent multi-disciplinary contextualisation and symbolic representation of worldwide Holocene-prehistoric volcanological features and discovery of archaeological settlement infrastructures, especially for prehistoric contexts. The research targets flexible context representation, processing, and integration, which includes further development of knowledge resources, visualisation, and chorological and chronological views for analysis, interpretation, decision making, and new insight. The presented practical implementation employs the new Conceptual Knowledge Reference Implementation (CKRI) and the Component Reference Implementations (CRI) framework for conceptual knowledge-based context integration, complements knowledge processing, and geoscientific and spatial processing and visualisation. The goal of this research is the creation of practical knowledge-based methods and tool set components, which provide solid, standardised means for sustainable long-term research. Both, methods and components should enable further continuous development and adoption to future research questions and targets. This paper provides the specific context discovery results, references to all component implementations and realisations. Future research will address further, continuous developments of reference implementations and knowledge resources and the application for advanced scenarios in prehistory and archaeology.**

Keywords–Prehistory; Holocene; Archaeological Settlement Infrastructures; Coherent Multi-disciplinary Conceptual Knowledge Contextualisation with CKRI and CRI Framework.

I. INTRODUCTION

This paper presents the results of the research on practical employment of coherent multi-disciplinary contextualisation and symbolic representation of worldwide Holocene-prehistoric volcanological features and archaeological settlement infrastructures. The goal of contextualisation especially targets prehistoric contexts worldwide, identifying and integrating archaeological, prehistoric objects with objects from other scientific disciplines on equal footing, promoting a coherent multi-disciplinary conceptual methodological approach. The methodological goal of this research is the creation of practical and sustainable knowledge-based methods and tool sets, which provide solid means for sustainable long-term research. The methods and sets of tools should provide standardised components, which can be continuously further developed and adopted to future research questions and targets.

The research targets flexible context processing, integration, and representation, which includes further development of knowledge resources, visualisation, and chorological and chronological views for analysis, interpretation, decision making, and new insight. Two major practical reference implementations were deployed for full implementations, realisations, and continuous further developments: The new versions of the prehistory-protohistory and archaeology Conceptual Knowledge Reference Implementation (CKRI) [1] and the Component Reference Implementations (CRI) framework [2] for conceptual knowledge-based context integration, complements processing, and geoscientific visualisation. CKRI provides the knowledge framework, including multi-disciplinary contexts of natural sciences and humanities [3]. CRI provides the required component groups and components for the implementation and realisation of all the procedural modules.

The reference implementations are based on the fundamental methodology of knowledge complements [4], considering that many facets of knowledge, including prehistory, need to be continuously acquired and reviewed [5]. Creating contextualisation requires to coherently integrate multi-disciplinary knowledge and to enable symbolic representations. Realisations need to integrate a wide range of components as required from participating disciplines, e.g., for dynamical processing, geoprocessing, spatial contextualisation.

The rest of this paper is organised as follows. Sections II and III present the implementations of and conceptual knowledge and the respective components with all required references. Section IV provides the results to selected scenarios. Sections V and VI discuss case scenarios and summarise lessons learned, conclusions, and future work.

II. CONCEPTUAL KNOWLEDGE IMPLEMENTATION

Implementations and realisations are based on the CKRI reference implementation [6], and respective contextualisation. References are capable to integrate required context. Besides the core scope of this knowledge-focussed research on prehistoric, archaeological, and geoscientific questions, procedural complements are employed and extended via the CRI frame reference implementations [7]. Both provide sustainable fundaments for highest levels of reproducibility and standardisation.

Many aspects of knowledge [8], including meaning, can be described using knowledge complements supporting a modern definition of knowledge [9] and subsequent component instrumentation, e.g., considering factual, conceptual, procedural, metacognitive, and structural knowledge. Complements are a means of understanding and targeting new insight, e.g., enabling advanced contextualisation, integration, analysis, synthesis, innovation, prospection, and documentation. Regarding knowledge, it should be taken for granted, that scientific members of any disciplines nowerdays continuously practice and train themselves in development and practical employment of methods, algorithms, and components as required by their disciplines and keep track with how to integrate methods.

A. Coherent conceptual knowledge implementation

Universally coherent multi-disciplinary conceptual knowledge is implemented via the CKRI [6], demonstrated with Universal Decimal Classification (UDC) [10] code references, spanning the main tables based on science and knowledge organisation [11], as shown in Table I.

TABLE I. CKRI IMPLEMENTATION OF COHERENT CONCEPTUAL KNOWLEDGE CONTEXTUALISATION; MAIN TABLES (EXCERPT).

Code / Sign Ref.	*Verbal Description (EN)*
UDC:0	Science and Knowledge. Organization. Computer Science. Information. Documentation. Librarianship. Institutions. ...
UDC:1	Philosophy. Psychology
UDC:2	Religion. Theology
UDC:3	Social Sciences
UDC:5	Mathematics. Natural Sciences
UDC:55	Earth Sciences. Geological sciences
UDC:551.21	Vulcanicity. Vulcanism. Volcanoes. Eruptive phenomena. Eruptions
UDC:551.2...	Fumaroles. Solfataras. Geysers. Hot springs. Mofettes. Carbon dioxide vents. Soffioni
UDC:6	Applied Sciences. Medicine, Technology
UDC:692	Structural parts and elements of buildings
UDC:7	The Arts. Entertainment. Sport
UDC:711	Principles and practice of physical planning. Regional, town and country planning
UDC:8	Linguistics. Literature
UDC:9	Geography. Biography. History
UDC:902	Archaeology
UDC:903	Prehistory. Prehistoric remains, artefacts, antiquities
UDC:904	Cultural remains of historical times

The CKRI is provided in development stage editions, prehistory-protohistory and archaeology E.0.4.8, natural sciences E.0.4.0.

B. Implementation of auxiliaries and operations

Tables II and III show CKRI excerpts of auxiliary tables and signs.

TABLE II. CKRI IMPLEMENTATION OF COHERENT CONCEPTUAL KNOWLEDGE CONTEXTUALISATION; AUXILIARY TABLES (EXCERPT).

Code / Sign Ref.	*Verbal Description (EN)*
UDC (1/9)	Common auxiliaries of place
UDC:(23)	Above sea level. Surface relief. Above ground generally. Mountains
UDC:(24)	Below sea level. Underground. Subterranean
UDC:"..."	Common auxiliaries of time.
UDC:"6"	Geological, archaeological and cultural time divisions
UDC:"62"	Cenozoic (Cainozoic). Neozoic (70 MYBP - present)
UDC:"63"	Archaeological, prehistoric, protohistoric periods and ages

TABLE III. CKRI OPERATION SIGNS EXCERPT, INTEGRATING UDC COMMON AUXILIARY SIGNS (ENGLISH COMMENTS VERSION).

Operation	*Symbol*	
Coordination. Addition	+	(plus sign)
Consecutive extension	/	(oblique stroke sign)
Simple relation	:	(colon sign)
Order-fixing	::	(double colon sign)
Subgrouping	[]	(square brackets)
Introduces non-UDC notation	*	(asterisk)
Direct alphabetical specification.	A/Z	(alphabetic characters)
[Reference listing, itemisation]	;	(semicolon)
[Reference listing, sub-itemisation]	,	(comma)

Consistent multi-disciplinary conceptual knowledge is demonstrated via UDC code references spanning auxiliary tables [11]. Standardised operations (Table III) are employed for creation of reference listings and faceted knowledge, integrating UDC auxiliary signs [11]. Conceptual knowledge in focus can be employed to provide references and facets to any universal knowledge context.

III. COMPONENT IMPLEMENTATIONS

A. Resulting methodological component integration

Integration components, reflecting standards and sustainable modules are based on the major groups of the CRI. The CRI framework is provided in development stage edition E.0.3.9. The ten major CRI component groups are:

1) Conceptual knowledge frameworks.
2) Conceptual knowledge base.
3) Integration of scientific reference frameworks.
4) Formalisation.
5) Methodologies and workflows integration.
6) Prehistory Knowledge Resources.
7) Natural Sciences Knowledge Resources.
8) Inherent representation groups.
9) Scientific context parametrisation.
10) Structures and symbolic representation.

All parts were realised based on CRI components, with realisations fully referenced in the following sections.

The conceptual knowledge was realised for all disciplines via the CKRI conceptual knowledge framework [6] and operations (Table III). CKRI is demonstrated with UDC [10] references. For demonstration, CKRI references are illustrated via the multi-lingual UDC summary [10] released by the UDC Consortium, Creative Commons license [12].

Relevant scientific practices, frameworks, and standards from disciplines and contexts are integrated with the Knowledge Resources, e.g., here details regarding volcanological features, chronologies, spatial information, and Volcanic Explosivity Index (VEI) [13]. Corresponding coherent complementary results and details on faceting are available for a whole inventory of volcanological features groups [1].

All integration components, for all disciplines, require an explicit and continuous formalisation [14] process. The formalisation includes computation model support, e.g., parallelisation standards, OpenMP [15], Reg Exp patterns, e.g., Perl Compatible Regular Expressions (PCRE) [16]. Here, common scale of entities for primary objects is 10^3 and for secondary objects 10^4–10^5. Processing operations [17] were parallelised for primary (n_1) features groups with respective instances.

Methodologies for creating and utilising methods include model processing, remote sensing, spatial mapping, high information densities, and visualisation. Respective contextualisation for scenarios in prehistory should be done under conditions especially reflecting state-of-the-art methods, e.g., spatial operations, triangulation, gradient computation, and projection.

The symbolic representation of the contextualisation can be done with a wide range of methods, algorithms, and available components, e.g., implemented here via LX Professional Scientific Content-Context-Suite (LX PSCC Suite) deploying the Generic Mapping Tools (GMT) [17] for visualisation.

Prehistoric objects and contexts are taken from The Prehistory and Archaeology Knowledge Archive (PAKA), which is in continuous development for more than three decades [18], released by DIMF [19].

Several coherent systems of major natural sciences' context object groups from KR realisations have been implemented, especially Knowledge Resources (KR) focussing on volcanological features [13] deployed with in depth contextualisation and with a wide range [10] of contexts [20] and structures [21].

The contextualisation solution can employ state-of-the-art results from many disciplines, e.g., context from the natural sciences resources, integrating their inherent representation and common utilisation, e.g., points, polygons, lines, and spatial techniques and standards. Here, resources are Digital Elevation Models (DEM), High Resolution (HR) (Space) Shuttle Radar Topography Mission (SRTM) [22] data fusion [23], HR Digital Chart of the World (DCW) [24], and Global Self-consistent Hierarchical High-resolution Geography (GSHHG) [25].

Scientific context parametrisation of prehistoric targets can use the overall insight from all disciplines, e.g., parametrising algorithms and creating palaeolandscapes.

Structure is an organisation of interrelated entities in a material or non-material object or system [21]. Here, relevant examples of sustainable implementations are NetCDF [26] based standards, including advanced features, hybrid structure integration, and parallel computing support (PnetCDF).

Overall, all parts of the solution were implemented and realised via these components. Especially, GMT modules were deployed for select procedures together with PCRE and Perl filters. Spatial distance dependencies of objects and conditional decision criteria were realised via GMT geodesic calculation, which is very accurate using the Vincenty algorithm [27].

IV. Scenarios, implementations and results

The results for a multi-disciplinary case scenario from the current research with two primary case instances were choosen, Holocene-prehistoric volcanological features of strato volcanoes and maars (CKRI: UDC:511.2…), with geospherical calculations on a global scale and context discovery with coherently classified archaeological settlement infrastructure instances (CKRI: UDC:711.…,692,903,902,…) in geospherical radii of 300 km spatial distance from primary objects.

A. Methodological approach

The method can be summarised as follows.

- Selection of KR, components, primary and secondary object types, symbolic representation, …
- Conceptual knowledge assignment.
- Selection of chronological properties.
- Selection of primary objects.
- Selection of secondary objects.
- Calculation of secondary objects' geospherical spatial distances.
- Parallelisation of conceptual knowledge processing.
- Parametrisation of symbolic representation.
- Parallelisation of context data processing.
- Visualisation processing.
- (Further development of resources and implementations by the specific disciplines.)

In new applications, all steps and items should be carefully and intentionally addressed for any intelligent employment, depending on the research questions and contexts.

B. Resulting context groups

An excerpt of the two primary context groups and criteria (@ and β) and contextualisation of archaeological settlement infrastructures is shown in (Table IV).

TABLE IV. SCENARIO CONTEXT GROUPS AND CRITERIA: VOLC. FEATURES / ARCH. SETTLEMENT INFRASTRUCTURES (EXCERPT).

Context n_1		*Context n_2*
Geosciences		Archaeology / prehistory
Geoscientific features objects		Prehistoric object groups
Volc. features groups		Settlement infrastructures
• **Strato volcano**	@ ⇒	• **Viereckschanze**
• **Maar**	β ⇒	• **Dwelling**
• Complex volcano		• **Long house**
• Explosion crater		• **Midden context**
• Shield volcano		• **Farm hut**
• Subglacial volcano		• **Enclosure**
• Submarine volcano		• **Roundhouse**
• Volcanic field		• **Siedlungsplatz**
• Fissure vent		• **Homestead**
• Cone		• **Hut circle**
• Dome		• **[individually named]**
• …		• …
[Type Instances …]		[Type instances …]
Decision Criteria (n_1)		*Decision Criteria (n_2)*
Conceptual context (CKRI)		Conceptual context (CKRI)
Feature object type		Prehistoric object type
Chronology conditions		Chronology conditions
Chorology / positional conditions		Chorology / positional conditions
Object attributes		Object attributes
…		Geospherical spatial distance (n_1-instance-conditional)
…		Parametrisation, …,
…		Calculation / analysis

The primary decision criteria include conceptual context, feature object type, chronology, and position. The secondary decision criteria include conceptual context, prehistoric object type, chronology, position, and conditional geospherical spatial distance depending on respective primary objects. Prehistoric object groups include all available language representations, e.g., 'en' and 'de'. Here, the first primary object group defines the spatial projection for consecutive primary groups.

C. Resulting context discovery matrices

Table V shows an excerpt of the result matrix of Holocene-prehistoric volcanological features groups and respective facets, namely conceptual knowledge, chronology, and chorology for the two scenarios (@ and β in Table IV). The result matrix includes conceptual knowledge view groups [10] based on CKRI references [6], factual knowledge from the Knowledge Resources objects, and respective country codes. Context example references for the features groups facets show Prehistoric Volcanic Activity (PVA), Historic Volcanic Activity (HVA), and Continued Volcanic Activity (CVA), e.g., latent volcanic activity. PVA are consequence of the Holocene-prehistoric chronological contextualisation for all objects in the resulting volcanological features groups. Cases for which further facts are holding true can also allow past-prehistoric contextualisation, e.g., with HVA and CVA. Resulting context discovery matrices for both primary case instances of the scenario for multi-disciplinary contextualisation of settlements are given in Tables VI and VII. Instances @ and β refer to Table IV. Figure 1 shows a corresponding visualisation of the calculation results of the context discovery for both instances.

TABLE V. RESULT MATRIX OF HOLOCENE-PREHISTORIC VOLCANOLOGICAL FEATURES GROUPS FACETS (EXCERPT, Ⓐ, Ⓑ). IT INCLUDES CONCEPTUAL KNOWLEDGE VIEW GROUPS [10] (CKRI), VOLCANIC ACTIVITY, CONTEXTS, KNOWLEDGE RESOURCES OBJECTS, AND COUNTRY CODES (EXCERPT).

Multi-disciplinary Conceptual Knowledge Facets	*Chronology Facets*		*Chorology Facets*		
Volcanological Features Conceptual Knowledge View / Facets Group	*Volcanic Activity*	*Context*	*KR Object & Ref.*		*Country Code*
CKRI: UDC:551.21,550.3,(23),STRATO_VOLCANO;“62”…	Holocene	PVA / HVA	Agua de Pau	①	PT
CKRI: UDC:551.21,550.3,(23),STRATO_VOLCANO;“62”…	Holocene	PVA	Alngey	②	RU
CKRI: UDC:551.21,550.3,(23),STRATO_VOLCANO;“62”…	Holocene	PVA / HVA	Azuma	③	JP
CKRI: UDC:551.21,550.3,(23),STRATO_VOLCANO;“62”…	Holocene	PVA / HVA	Hekla	④	IS
CKRI: UDC:551.21,550.3,(23),STRATO_VOLCANO;“62”…	Holocene	PVA	…		…
CKRI: UDC:551.2…,551.21,550.3,(23),…MAARS_FEATURES;“62”…	Holocene	PVA	Cerro Tujle	①	CL
CKRI: UDC:551.2…,551.21,550.3,(23),…MAARS_FEATURES;“62”…	Holocene	PVA / HVA	Suoh	②	ID
CKRI: UDC:551.2…,551.21,550.3,(23),…MAARS_FEATURES;“62”…	Holocene	PVA / HVA	Ukinrek Maars	③	US
CKRI: UDC:551.2…,551.21,550.3,(23),…MAARS_FEATURES;“62”…	Holocene	PVA / (CVA)	West Eifel Volcanic Field	④	DE
CKRI: UDC:551.2…,551.21,550.3,(23),…MAARS_FEATURES;“62”…	Holocene	PVA	…		…
…	…	…	…		…

TABLE VI. RESULTING SETTLEMENT INFRASTRUCTURES FROM CONTEXTUALISATION WITH HOLOCENE-PREHISTORIC STRATO VOLCANO Ⓐ VOLCANOLOGICAL FEATURES GROUP (EXCERPT), INCLUDING CONCEPTUAL KNOWLEDGE VIEW GROUPS [10] (CKRI).

Multi-disciplinary Conceptual Knowledge Facets	*Chronology Facets*		*Chorology Facets*		
Prehistorical Conceptual Knowledge View / Facets Group	*Dependency*	*Context*	*Knowledge Resources Object*	*Count*	*Ref. & Range*
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Grota do Medo	$\sum = 1$	① 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	–	$\sum = 0$	② 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Sakiyama Kaizuka		③ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Togariishi		③ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Yaze		③ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	…	$\sum = 14$	③ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Flókatóftir		④ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Þjóðveldisbærinn		④ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Vogur		④ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Stöðvarfjörður	$\sum = 4$	④ 300 km

TABLE VII. RESULTING SETTLEMENT INFRASTRUCTURES FROM CONTEXTUALISATION WITH HOLOCENE-PREHISTORIC MAARS Ⓑ VOLCANOLOGICAL FEATURES GROUP (EXCERPT), INCLUDING CONCEPTUAL KNOWLEDGE VIEW GROUPS [10] (CKRI).

Multi-disciplinary Conceptual Knowledge Facets	*Chronology Facets*		*Chorology Facets*		
Prehistorical Conceptual Knowledge View / Facets Group	*Dependency*	*Context*	*Knowledge Resources Object*	*Count*	*Ref. & Range*
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Potrero de Payogasta		① 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Pucará de Tilcara		① 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Tulor		① 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	…	$\sum = 8$	① 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Segayun megalithic site	$\sum = 1$	② 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	–	$\sum = 0$	③ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Federlesmahd VS		④ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Gelbrunn Wald VS		④ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	Hardheim VS		④ 300 km
CKRI: UDC:711....,692,903,902,SETTLEMENT_INFRASTRUCTURE;…	Synchronous	MN-LIA	…	$\sum = 180$	④ 300 km

V. DISCUSSION OF CASE SCENARIO RESULTS

Implementation and realisation provide a seamlessly coherent multi-disciplinary conceptual knowledge contextualisation for the case scenario and its instances.

The context discovery result matrices (Tables VI and VII) for the instances Ⓐ and Ⓑ both refer to n_2 in Table IV. Especially, these secondary object groups include objects from Middle Neolithic (MN) to at least Late Iron Age (LIA), including ages in between, e.g., Bronze Age. The objects groups comprise all types of settlement infrastructures, e.g., Celtic ramparts, Viereckschanzen (VS), and middens with settlement contexts. The resulting group of strato volcanoes aligns along 0°/360° longitude (Figure 1). An appropriate Transverse Mercator projection was choosen in order to minimise the distortion along a respective meridian for the generation of the primary results of strato volcanoes and results for other consecutive, secondary, contextualised volcanological features, e.g., maars. The CRI framework components were employed for all steps, including knowledge organisation, conceptual and spatial calculation, and visualisation. Primary objects, strato volcano (medium green volcano symbol) and maars (light green volcano symbol) are marked as well as resulting secondary objects, settlements (blue rectangular symbols), all in their precise georeferenced position. Resulting conceptual knowledge is given for these objects. Resulting sums of secondary discovery objects were calculated. Any case can be dynamically contextualised with coherent multi-disciplinary knowledge, as demonstrated for geosciences, prehistory, and archaeology, e.g., referring to prehistoric object properties and

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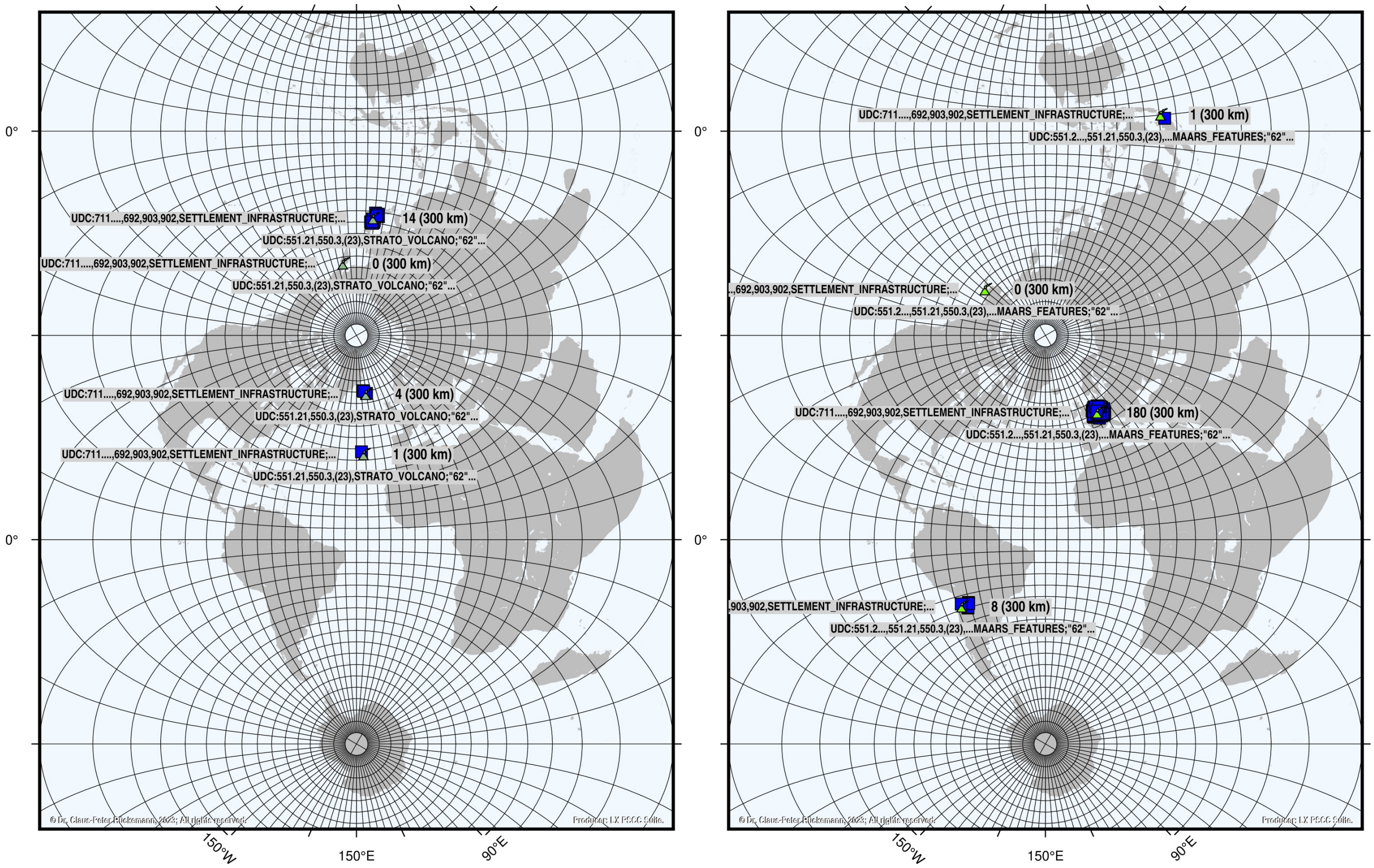

(a) Strato volcano group @: Resulting archaeological settlement infrastructures.

(b) Maars group ⓑ: Resulting archaeological settlement infrastructures.

Figure 1. Contextualisation: Holocene-prehistoric volcanological features groups for the two case scenarios and the resulting settlement infrastructures. Coherent multi-disciplinary context integration and results based on CKRI, chronological, and chorological criteria (excerpts, Transverse Mercator projections).

excavation results and targeting new insight from geoscientific and multi-disciplinary context integration.

Any resulting contextualisation matrices and coherent conceptual and faceted knowledge can further be input to consecutive contextualisation processes. The more, solutions with individual methods and workflows can be created for countless different questions and situations.

VI. CONCLUSION

This research implemented and realised multi-disciplinary contextualisation, based on employing the contextualisation reference implementation frameworks for coherent multi-disciplinary conceptual knowledge-spatial context discovery achieved its goals and proved efficient and sustainable. The case scenarios for context discovery of archaeological settlement infrastructures for Holocene-prehistoric volcanological features resulted in valuable contextualisation potential and possible insight.

The contextualisation integrates conceptual, factual, procedural, structural, and metacognitive knowledge complements. Based on the methodological approach, complements can be identified and assigned during the contextualisation processes. An excerpt of complements relevant for this case scenario are CKRI classification, position data, calculation algorithms, content structures, and parametrisation experiences.

The methods and reference implementations can be efficiently and effectively employed for practical implementations and realisations for multi-disciplinary research, especially in prehistory, archaeology, natural sciences, and humanities. The solutions provide countless facilities and modules for adopting to individual solutions.

Future research will address archaeological settlement infrastructures and further object groups and new models for their coherent multi-disciplinary contextualisation. Prehistoric object groups are matter of future surveys and investigations, e.g., context artefacts and soil characteristics, including further integration and processing of knowledge complements, georeferencing, spatial and satellite data processing.

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