ARCHAEOMETRIC DATABASE OF ARCHAEOLOGICAL STONE TOOLS (A SUGGESTION FOR NEW DATA PROCESSING METHOD)

RÉGÉSZETI KŐESZKÖZÖK ARCHEOMETRIAI ADATBÁZISA (JAVASLAT EGY ÚJ TÍPUSÚ ADATFELDOLGOZÁSRA)

ANNA FARKAS-PETŐ[1], TÜNDE HORVÁTH[2]

[1]Debreceni Egyetem, Ásvány- és Földtani Tanszék. H-4010, Debrecen, Pf. 4., Debrecen, Hungary,

[2]MTA BTK Régészeti Intézete, H-1014 Budapest, Úri u. 49., Hungary, E-mail: horvath.tunde@btk.mta.hu

E-mail: farkasanna74@freemail.hu

Abstract

Interdisciplinary approaches to archaeology allow the application of new scientific methods in the study of archaeological objects, and make it possible to examine a large number of artefacts including stone tools, with petrological-geochemical (archaeometrical) methods. However, as of today, a complex but easy-to-use, simply accessible register of the archaeometrical research results has not been developed yet. The project presented in this paper endeavours to fill this gap for archaeological stone tools.

The experimental work proposed here is based on the comprehensive analysis of 1200 stone tools from the Middle Bronze Age Vatya Culture from sites all over the Central Carpathian Basin. The new type digital database ("Archaeometric Stone Tool Database") has been developed on the basis of the results. This database is aimed to combine the archaeological and geological data of polished and ground stone tools studied by scientists in various archaeometric centres in the Carpathian Basin. The unified database includes data of diverse archaeological and geological analyses performed on polished stone tools.

This integrated system is planned to be accessible via the Internet and hopefully it would facilitate a rapid flow of information, easy and quick data management, allow for new type data selection and statistical analysis, provide options for immediate database queries, groupings and clusterings. Parallelisms would be thus minimalised, while new extensions to the system could be added by professionals with specific access rights granted. For the realization of the defined objectives and the long-term viability of the system, a flexible and effective informatic background with constant updates and safe operation are required. For the operation of the proposed project, the system should gain the full acceptance, consent and approval of the research centres with further clarification of the operating conditions and requirements.

Kivonat

A természettudományok régészeti kutatásokban való megjelenésével nagy számú régészeti tárgy, eszköz, ezen belül kőeszköz került feldolgozásra régészeti, valamint kőzettani-geokémiai (archeometriai) módszerekkel. Ez utóbbiak egységes, jól áttekinthető, könnyen hozzáférhető rendszerezése, nyilvántartása nem történt meg. Jelen tanulmány ennek megoldását kívánja elősegíteni a kőzet anyagú régészeti kőeszközökre vonatkozóan.

E kísérleti munka alapját a Kárpát-medencében központi fekvésű középső bronzkori vatyai kultúra több mit 1200 kőeszközének feldolgozása jelentette. Ennek vizsgálati adatainak alapján szerkesztettük meg azt az új típusú digitális adatbázist („Archeometriai Kőeszköz Adatbázis"), amely a különböző archeometriai műhelyekben feldolgozásra került csiszolt kőeszközök és szerszámkövek régészeti és geológiai szempontú adatait szeretné egységesíteni Kárpát-medencei szinten.

Ez a terveink szerint interneten hozzáférhető rendszer lehetővé tenné az információk gyors áramlását, az adatok könnyű kezelését, statisztikai elemzését, a különféle lekérdezések, csoportosítások lehetőségét. Használatával kiszűrhetők lennének a párhuzamosságok, miközben maga a rendszer meghatározott hozzáférési joggal rendelkező szakemberek számára bővíthető lenne. Mindennek reális megvalósításához egy olyan rugalmas és fejleszthető informatikai alap szükséges, amely nem évül el és biztosítja a fenti célok hosszútávú megvalósíthatóságát. A javasolt rendszer működtetéséhez a szakmai műhelyek egyetértése és megállapodása szükséges, a működtetés feltételeinek és körülményeinek tisztázása mellett.

KEYWORDS: CARPATHIAN BASIN, VATYA CULTURE, ARCHAEOMETRIC DATABASE, POLISHED STONE TOOLS, GROUND STONES

KULCSSZAVAK: KÁRPÁT-MEDENCE, VATYAI KULTÚRA, ARCHEOMETRIAI ADATBÁZIS, CSISZOLT KŐESZKÖZÖK, SZERSZÁMKÖVEK

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Introduction

Adopting the described geological approach to the study of archaeological objects, one can get answer to specific questions that would otherwise remain unarticulated. Results obtained in this way can largely contribute to the interpretation and evaluation of cultural landscapes (including lifestyle, scope of action, level of technical development, etc.) (Pető, 1999; Pető - Kelemen, 2000; Szakmány, 2009).

Bearing this in mind, the Institute of Archaeology, Research Centre for the Humanities, Hungarian Academy of Sciences and the Department of Mineralogy and Geology of the University of Debrecen has initiated a successful inter-institutional cooperation for the joint research of stone artefacts from the Middle Bronze Age Vatya Culture, starting in 1995. The results are plentiful and mutually beneficial (Farkas–Pető, 2008; Horváth, 2004; Horváth et al. 1999; 2000a; 2000b; 2001; Pető et al. 2002).

We focused on the following questions:

– What types of mineral resources and rock materials were used by this centrally located, advanced Bronze Age culture?

– What is the provenance/source of raw materials used for polished stone tools and implements? (collection sites, countertrade)

– Based on the amount and manufacturing of the artefacts, what could be the level of technical development?

– What were the basic economic/subsistence practices of the community and what functional relevance can be assigned to the rock materials applied for these activities?

Several problems arose while analysing the complete stone tool assemblage, probably not unknown for those who deal with similar type of archaeological evidence:

– since stone implements from the Bronze Age are generally considered to be of secondary importance, no standardized, all-encompassing inventory of the objects is available

– the items are distributed among several different museums

– repositories and registers are diverse

– access rights, legal, personal and other terms of use are not clearly defined

– strict limitations are set to the sampling of stone tools (for purposes of raw material tests)

One of the most difficult problems we faced during our research work was the lack of a uniform, easily accessible and standardized register of the objects. The systematic analysis of more than 1200 items made it indispensable to develop a consistent system of records, so as to make the published data transparent and generally available, allowing for multidisciplinary approaches and multifaceted data comparisons (e.g. geological vs. archaeological).

The basis for database development: the stone tool assemblage of the Vatya Culture

Importance of the Vatya Culture

Relics of the Middle Bronze Age Vatya culture are of special importance from several aspects. This prehistoric culture seems to have occupied the Central Danubian Region (**Fig. 1**.), taking control of the main transport routes along the line of the Danube and the related minor river systems. The strategic habitat of the people fit well with their lifestyle and subsistence practices, which were supposedly based on agricultural activities and land cultivation. Site excavations reveal diverse settlement types and traces of a complex, stratified society. In the Hungarian context, we can talk about a well-researched, properly described material culture. Archaeological evidence – including the respective stone tool assemblage – is abundant and homogenous, showing a typical tell culture with identifiable, distinctive characteristics (Bóna, 1992).

While most of the published literature discusses the Bronze Age with prime focus on metallic instruments and elaborate pottery, our research work is novel in the sense that it emphasizes the prolonged importance of stone tools used either as weapons, stabbing and cutting implements (sickle, arrowhead, axe, scraper); or as moulds, corn and paint grinding stones. Several hundreds of the mentioned instruments were identified among the findings of the Vatya Culture – as opposed to the limited set of bronze tools that would rather have functioned as weapons, external ornaments or status symbols. A detailed study of the stone implements allows for a comparative analysis with material evidence from earlier periods.

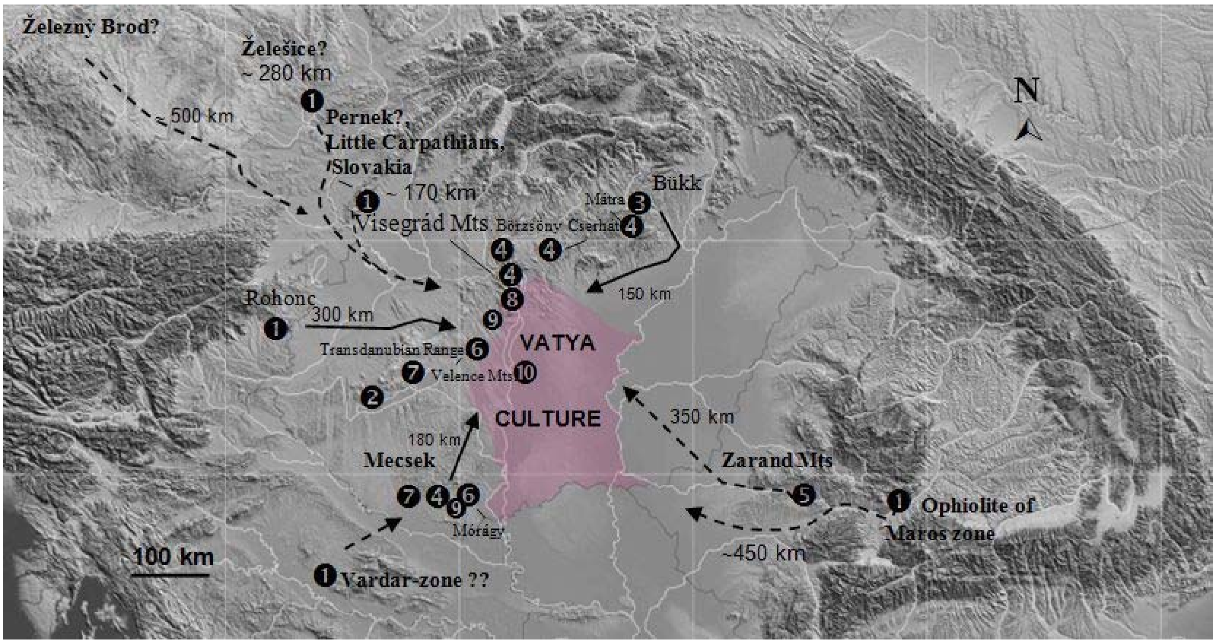

Fig. 1.: Habitation area of the Vatya culture (Middle Bronze Age) in the Carpathian Basin and its presumable lithicl raw-material source areas

1. ábra: A vatyai kultúra (középső bronzkor) elterjedési területe a Kárpát-medencében és kőeszközeinek feltételezhető nyersanyagforrás területei

Key:

❶ **Metabasic/serpentinized ultrabasic-basic rocks:** Rohonc (Rehntitz) Window, Bernstein, Austria; Železný Brod (?) (Bohemia), Želešice(?), Czech Republic; Pernek(?), Little-Carpathians, Slovakia;Ophiolite of Maros zone (??); Vardar-zone (??)

❷ **Basalt:** Balaton Highland

❸ **Dolerite-metadolerite, metadolerite-gabbro:** Bükk Mts. - Szarvaskő; Zarand Mts. (?)

❹ **Andesites:** Mátra Andesite Formation: Visegrád Mts., Börzsöny Mts., Cserhát Mts., Mátra Mts. (?), „Komló andesite": Mecsek Mts.

❺ **Diorite:** Zarand Mts.(?)

❻ **Granite:** Velence Mts.; Mórágy Hills

❼**Red sandstone:** Balaton Highland; Mecsek Mts.

❽**Hárshegy type sandstone:** Buda Mts. (Hárshegy Sandstone Formation)

❾ **Neogene sandstones:** Budafok Formation, Buda Mts., edge of Tétényi Highland, Budafa Formation, southern foreland of Mecsek Mts.

❿ **Metamorphic pebbles** (amphibolite-, mica-schist, gneiss, phyllite, metasediments, quartzites): Pleistocene gravel in the Pest Plain.

Limestone, marl, siliceous rocks : Transanubian Range and its foreland

Jelkulcs:

❶ **Metabázit/szerpentinesedett ultrabázit-bázit:** Rohonci-ablak, Bernstein, Ausztria; Železný Brod (?), Želešice(?), Csehország; Pernek, Kis-Kárpátok , Szlovákia(?); Maros menti ofiolit(??); Vardar-öv (??)

❷ **Bazalt:** Balaton-felvidék

❸ **Dolerit-metadolerit, metadolerit-gabbró:** Bükk hegység, Szarvaskő; Zarándi-hegység (?)

❹ **Andezitek:** Mátrai Andezit Formáció: Visegrádi-hegység, Börzsöny, Cserhát, Mátra(?), „Komlói andezit": Mecsek

❺ **Diorit:** Zarándi-hegység(?)

❻ **Gránit:**Velencei-hegység; Mórágyi-rög

❼**Vörös homokkövek:** Balaton-felvidék; Mecsek

❽**Hárshegyi-típusú homokkövek:** Budai-hegység (Hárshegyi Homokkő Formáció)

❾ **Neogén homokkövek:** Budafoki Formáció, Budai-hg., Tétényi-fennsík pereme, Budafai Formáció, Mecsek D-i előtere

Applied archaeometric methods

Stone artefacts studied in the current work are curated in 12 museums and local historical collections.

In order to identify the potential raw material sources the available literature was analysed, sample collections were studied and geologists were consulted, too. Apart from these we have tried to visit and sample the possible raw material

Table 1. Summary table of the Vatya culture compiled on the distribution of the stone tool according to stone type

1.táblázat: A vatyai kultúra vizsgált kőeszközeinek összesített, régészeti-kőzettani táblázata

VATYA CULTURE	metabasites/serpentinized-basic-ultrabasic rocks	basalts/basaltic andesites	dolerites/meta-dolerites/ metadolerite-gabbros	andesites (pyroxene-, amphibole andesites and tuffs)	diorites	granites	Σ (db/%)	Permian red sandstones	Hárshegy-type sandstones	Neogene sandstones	aleurolites	marls	limestones	siliceous rocks	Σ (db/%)	amphibolite schists	mica-schists	gneiss	phyllite	metapelites, metaaleurolites, lidites	meta-sandstones	quartzites	Σ (db/%)	outher (uncertain, unidentified pieces)	Σ (db)	Σ (%)
stoneaxes/hammers	29	2	5	42	2		78/74	2	2	8	1	1			14/12	2		2		4	2	5	15/14		107	12,6
chisels	2						2/100								-										2	0,2
maces/hatchets	5						5/100								-										5	0,6
whetstones				2			2/22			1		2	1		4/45						2	1	3/33		9	1,0
pounders				1			1/4			1					1/5						4	16	20/91		22	2,5
grinding stones/sheets	1			25		3	28/9	91	161	35	1		4		292/90		1	1			1	1	4/1		324	37,6
handstones			1	9	1		11/18		2	3			3		8/13						8	35	43/69		62	7,2
anvils									1	1					2/100										2	0,2
grindstones				2			2/6		1	21	1		2		25/73					1	5	1	7/21		34	3,9
polishing stones				3			3/6	1	1	5	1				8/17			1	1	2	7	26	37/77		48	5,5
retouchers						1	1/25			2					2/50							1	1/25		4	0,5
amulets				1			1/20	1		1					2/40						1	1	2/40		5	0,6
moulding forms				1			1/25			18					18/90		1						1/5		20	2,3
outher stonetools	1	1		5		2	9/4	1	6	11	1			1	20/9					5	6	23	34/22	158	221	25,6
Σ db	38	3	6	91	3	3		96	174	107	5	3	10	1		2	2	4	1	12	36	110		158	865	100
Σ %	4,4	0,3	0,7	10,5	0,3	0,3		11,1	20, 1	12,4	0,6	0,3	1,2	0,1		0,2	0,2	0,5	0,1	1,4	4,2	12,7		18		100
Σ db/ %	144 pcs/17% MAGMATITE							396 pcs/46% SEDIMENTARY ROCK								167 pcs/19% METAMORPHIC ROCK								158pcs/18% UNCERTAIN	865	100

Table 2.: Appliciation of subjective reliability index relevant for the presumable raw-materials source areas

2. táblázat: Szubjektív megbízhatósági index alkalmazása az egyes nyersanyagtípusok származási helyére vonatkozóan

RAW MATERIAL	PRESUMABLE SOURCE AREA(S)	INDEX
METABASITE/SERPENTINIZED BASIC-ULTRABASIC ROCKS	- Ophiolite sequence of Eastern Alps - Bohemian Massif, Železný Brod - Pernek, South Slovakia - Vardar-zone	2 (in many cases)
	- Ophiolite sequence of Eastern Alps, Rohonc(Rehnitz) Window (Bernstein)	4 (in some cases)
BASALT	- Tapolca Basalt Formation, Balaton Highland and Little Hungarian Plain	3
DOLERITE/META-DOLERITE/ METADOLERITE-GABBRO	- Tardos Gabbro-, Szarvaskő Basalt Formation, Bükk Mts. - Maros-zone - Vardar-zone	2
ANDESITES	- Mátra Andesite Formation: Visegrád Mts., Börzsöny, Cserhát, Mátra Mts.	3
	„Komló andesite", Mecsek Mts.	3
DIORITE	- Zaránd Mts. , Maros zone (South Transilvania)	2
GRANITE	- Velence Granite Formation, Velence Mts.	4
	- Mórágy Granite Formation, Fazekasboda-Mórágy	4
PERMIAN RED SANDSTONE	- Balaton-highland Red Sandstone Formation	4
	- Jakabhegy Sandstone Formation - Kővágószőlős Formation	3
HÁRSHEGY-TYPE SANDSTONE	- Hárshegy Sandstone Formation	3
NEOGENE SANDSTONE	- Budafok Formation, Törökbálint Formation	3
	- Budafa Formation	3
MESOZOIC LIMESTONE	- Transdanubian Range	2
EOCENE LIMESTONE	- Szőc Limestone Formation, Bakony Mts., Gerecse Mts.	3
MIOCENE LIMESTONE	- Rákos Limestone Formation - Pécsszabolcs Formation	3
MARL	- Buda Marl Formation	2
METAMORPHIC GRAVELS (amfibolite-, mica-schist, gneiss, phyllite, metasediments, quartzite)	- Pleistocene gravel in the Pest Plain	4

outcrops in Hungary, in the Carpathian Basin and abroad as well. Regarding serpentinites for example we have taken samples for comparison from the vicinity of Felsőcsatár, Bernstein and Dobšina and from the Mountains in Czech Republic.

In order to characterize the petrography of the stone tools macroscopic and microscopic analyses were performed.

During the detailed macroscopic analysis, similar stone types of almost identical genetic characteristics were identified in the museums. Samples representing the selected groups were further used as etalons and made as many investigations on them as possible. Some of the etalons were reserved for comparison as well. In case the group was not homogeneous the material of several tools were analysed.

In the course of our work a new sampling method was worked out involving drilling with a micro-crown-driller and cutting sheets that although causes destruction on the tool but it can be eliminated and the method yields a sample of representative size for macroscopic and microscopic analyses and also for other instrumental analytical methods. According to our experience, the results of this method can be used for wider interpretation than the results of completely non-destructive surface analyses.

Macroscopic and microscopic analyses of the stone tools were carried out in the laboratory of the Department of Mineralogy and Geology, University of Debrecen.

Mineral composition of crystalline material was measured by X-ray analysis at the X-ray Laboratory of the Geological Institute of Hungary (today, Geological and Geophysical Institute of Hungary).

Major element analysis of the archaeological stone tools was carried out at the Department of Mineralogy and Geology, University of Debrecen while the trace element composition determination was performed at the Department of Inorganic and Analytical Chemistry, University of Debrecen.

As a further development of the methods started by the construction of the Lithotheca by Katalin T. Biró and Viola Dobosi (T. Biró – T. Dobosi, 1991; T. Biró et al. 2000) the tool and material groups were documented in detail and their samples were stored in an etalon collection in the course of several years of a multi-level research. Samples taken for comparison were handled in a similar way.

Stone tools of the Vatya Culture

People using stone tools tried to use the most suitable stone types from the available ones considering the function of the tool to be made. Although they might have tried to make tools of similar function from various rock types slowly he could identify the most suitable raw material for each function. These are presented in the summarizing table compiled based on the distribution of the stone tool according to stone types (**Table 1.**).

This reveals that polished stone tools are made dominantly of harder, more resistant and well polishable igneous and metamorphic rocks while for grinding stones hard, coarse grained quartz containing sedimentary rocks were selected.

Chopping tools used in the process of grinding were made of metamorphic sandstone or quartzite pebbles.

Moulding forms used for bronze moulding were made predominantly of fine grained but porous volcanogenic sandstone as these rocks could be shaped well and enabled the gas release of the moulds excellently.

Regarding the origin of the raw material of the stone tools, the results suggested that people in the Vatya Culture had a very developed stone industry and they could have acquired the stone types appropriate for raw material from nearby sources, mostly within or near the district of their residence area. Only a few rocks of more distant localities were identified. Their place of origin was probably along the trading routes connecting the cultures.

In our opinion the raw material mostly originated from the Vatya culture residential area (with 50 km of transport distance range) while in the case of imported raw material the maximum transport distance could eventually reach 350 km (**Fig. 1.**).

In the case of several potential raw material sources either the accurate and costly analysis of all potential localities has to be carried out or we have to assume that the probability of material acquisition decreases with increasing distance.

Due to the objective difficulties during the identification of raw material source localities and to the limited financial possibilities the overall description and source research of the associations was possible with various efficiencies. Based on these, the probability of the source localities of the given stone groups was characterized by a reliability index for which the following reliability categories were set: 1. unknown source locality; 2. the material originates presumably from one of the given localities; 3. the material originates very likely from one of the given localities, however, the accurate identification of the locality is uncertain (identification is possible at formation level); 4. source locality can be exactly identified with good reliability at locality district level; 5. source locality can be exactly identified. In our case the highest value was 4 and the source of most of the materials was identified at formation level (**Table 2.**).

Archaeological databases

There are several examples for the classification and presentation of archaeological stone tools in the literature providing a good basis for our work.

The Lithotheca Compartment of the Hungarian National Museum (T. Biró & T. Dobosi, 1991; T. Biró et al., 2000) rock types are put on display that were once employed as raw materials for the manufacturing of chipped and (to a lesser extent) polished stone tools deriving from identified and researched Palaeolithic–Neolithic cultures.

Early versions of the Lithotheca information database ran under MS-DOS. With the launch of Visual Basic, the database was moved to Windows, using an MS Access database. Advancements in the digital inventory management and computerized registration system of the Hungarian National Museum made it necessary to convert the complete Lithotheca-database to a Java-based application

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running on Oracle relational database management system, generally used by the Museum Registration System in Hungary (MNYR) (T. Biró, 2005).

As seen from the information recorded on the Lithotheca datasheets (rock type, lithogenetics, geological age, colour, etc.), the database is a useful tool for archaeologists of geological interest. It helps in the visualisation of the most frequent lithic raw materials, based on their textural-structural characteristics. For a subset of samples, complex geochemical profiles are displayed. Abbreviations used on the datasheets are explained in the Key of Symbols.

The *MissMarble Database* published by Judit Zöldföldi contains the analysis results of archaeological and geological marble samples utilizing the advantages of the architecture of the client server (Zöldföldi et al., 2008).

Other findings, e.g. the material of ceramics are also accessible in databases (Zöldföldi et al., 2010).

Archaeometric Stone Tool Database

The taxonomic classification of the exceptionally rich stone tool assemblage attributable to the Vatya Culture made it necessary to compile a new, integrated digital database accessible for both archaeologists and geologists who work in joint research programmes launched on petroarchaeological-archaeological topics. Further project aims included: improved reliability, easy data management and optimized applicability.

These criteria assume a new, integrated digital resource system that contains detailed, accurate and scientifically sound information applicable for multiple-target search and user-defined sample identifications. In an international context, the database should provide options for comparative analysis with assemblages from contemporaneous cultures, and for relative/statistical comparisons with assemblages from earlier and later cultures.

The structure of the database

Our database has to contain the petrogenetically very heterogeneous raw material of every stone tool of a complete culture (Table 1) requiring an approach different from the databases mentioned above.

When a smaller field (stone type, tool type) is included in a database the standardizing of the records is viable and can be very useful as in the case of the MissMarble Database (Zöldföldi et al., 2008). This helps data recording as well as the work of the users when working with the database or search it (e.g. application of keywords). The more heterogeneou the information in the database, however, the more difficult will be the establishment of such standards.

One of the advantages of our database is the diverse complexity of archaeological and geological data; however, it makes the application of simple, uniform descriptions and thus simple searching strategies hard.

In our database each record – for example in the case of the archaeological description of a tool or the petrographical characterization of a raw material – has the possibility to contain a detailed scientific description providing a tinged depiction of the tool more suitable for comparison.

The division of the database according to tool or stone types for simpler handling was rejected because in our opinion the inclusion of all types of data in one database is more valuable and informative for the end-users.

Collation and classification of the data are possible in this system as well for example by stone tool types (e.g. displaying only the datasheets of stone axes) or by raw material types (e.g. pyroxene andesite). Collation can be even finer if performed on the basis of several keywords (e.g. stone axe + pyroxene andesite + Százhalombatta). If the database is extended further – it will contain not only the data of the Bronze Age Vatya Culture – datasheet searches can be refined according to other aspects as well (e.g. culture, archaeological age).

Structure of the database tables

In order to illustrate the structure of the database and the filling of the records (**Fig. 2.**) we are presaenting here one of the completed datasheets.

The database is technically comprising two distinct but complementary parts that can be used jointly or separately. The order of data recording is determined by the softwer setting. In the case of compulsory fields it is not possible to move on until data are entered. In case we have no available data for the field, no data has to be entered or the field has to be lined through to move on to the next field.

The first dataset contains archaeological data for the identification of each item (**Fig. 2.**):

This includes the name of the archaeological site with the county and the country names; the inventory/record number(s); the stone tool type (polished/ground stone/other); function (e.g. stone axe, grinding stone), location of its current storage (museum, private collection) and the name of the archaeological culture. Date of collection or excavation together with the name of the collector/excavation supervisor or the donator can also be given.

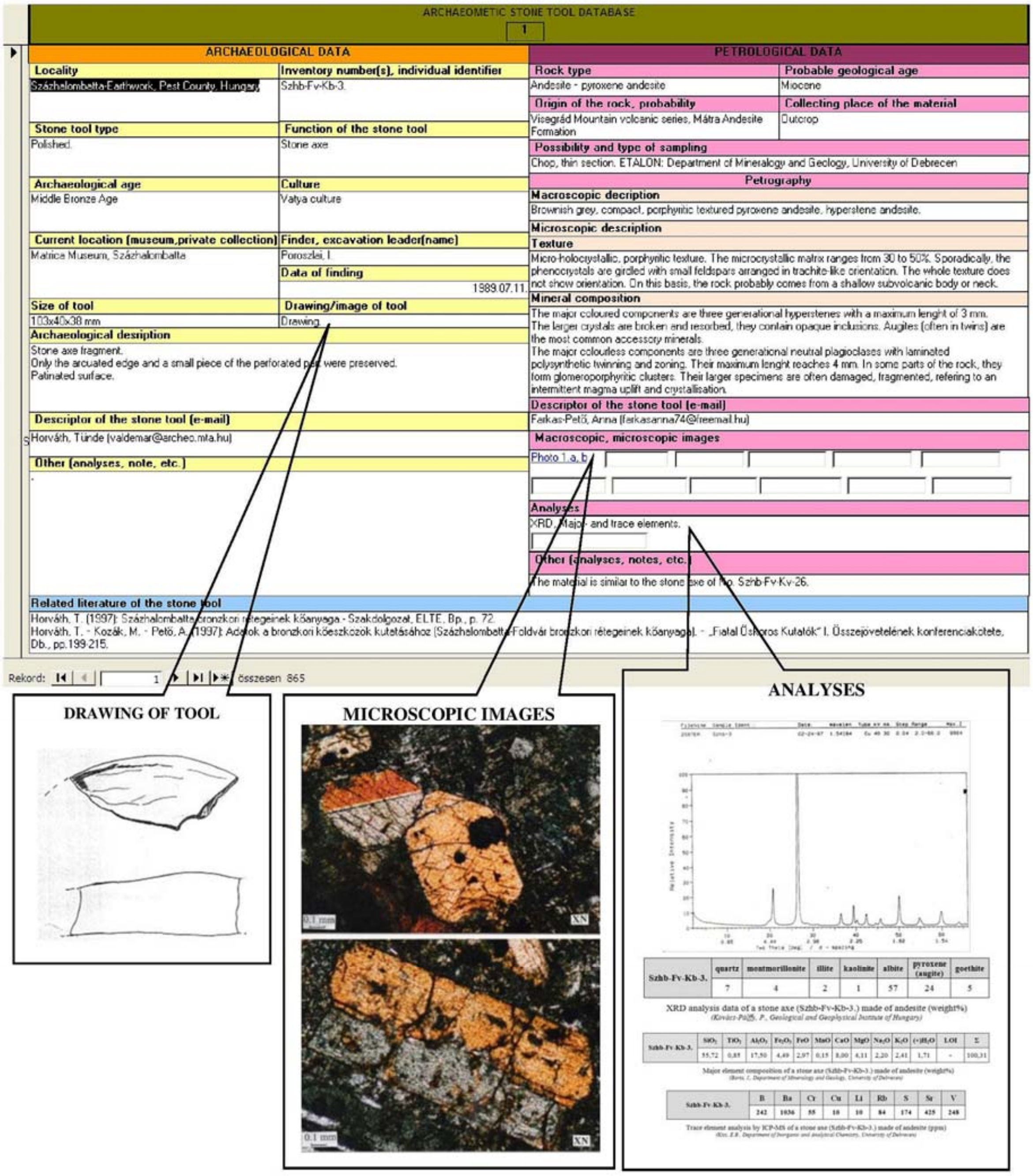

Fig. 2.: Archaeometric Stone Tool Database: sheet of database with the query possibilities

2. ábra: Régészeti kőeszközök összehasonlító kőzetgyűjteménye: adatbázis adatlap a lekérdezhető adatokkal

Archaeological description of the tool is given according to its function as accepted in the archaeological literature.

Dimensions of the tool are contained in a separate field.

The description can be completed by a drawing or macroscopic image of the tool and these have to be indicated by entering the appropriate word (Drawing and/or Image). Photos and drawings can be displayed directly by clicking on the Drawing/Image script on the datasheet.

Another field called other also belongs to the archaeological datasheet. This may contain such information and notes regarding the tool that would not be part of the archaeological description.

The second part of the datasheet is composed of the petrographic and other geological data of the tool containing the following fields:

In the stone tool raw material field the material is identified by the name of the rock. As a rule the name runs from the most general rock name to the more specific ones separated by a hyphen (e.g. andesite – pyroxene andesite) in order to make queries easier.

In the field location of origin of the raw material the potential or most probable locations of origin can be given. Since their identification is difficult in many cases, the probability of the identification (as an estimated percentage) is also given (e.g. Mátra Andesite Formation: from the volcanic formations of the Visegrád Mts.: 80 %).

If the collection location of the raw material can be recognised or supposed with reasonable certitude we can note here whether the material was collected from a rock outcrop, debris or river load.

In the sampling field we can indicate whether sampling from the material of the tool was possible (e.g. chopped fragments, thin-sections) for further analyses/comparisons and the place of its storage can be given as well.

The petrographic description of the raw material is divided into two sub-fields: the first contains the macroscopic and the second contains the microscopic descriptions. The microscopic description is also divided into further two parts: describing the textural characteristics and the mineral composition of the rock. The authors consider the most detailed description as best in order to provide appropriate basis for complex analyses. Standard petrographic description routines are applied; however, there is no standard for rocks of different genetics. When searching, the datasheets can be selected according to rock types based on the rock name field (e.g. selecting the amphibole or pyroxene andesite within the andesites).

Tables belonging to the petrographic part are the following: microscopic images, geochemical data tables. Evaluation diagrams can be indicated on the datasheet and can be accessed directly in the database.

The field called other – similarly to the archaeological part – is used for giving complementary notes for the descriptions (e.g. further analyses required, similarities to other raw material).

The references at the bottom of the datasheet include the archaeometric literature associated with the given stone tool or with the methodology of the analyses.

The Windows/Access based version made by the authors contains the datasheets of 865 polished stone tools and ground tools (Table 1) of the Vatya Culture analysed from the aspect of both archaeology and petrography. The vast amount of data was easier to manage and analyse statistically in this form making the characterization of the stone artefacts of theVatya Culture much easier.

Software background, query options, potentials for database expansion

The intelligent, Windows-based project database provides a flexible framework for the inclusion of additional resources, selective data entries, content upgrades, dynamic queries, multi-target requests, multifunctional applications, statistical data analyses and comparisons. A bilingual (Hungarian-English) version of the database is currently under development.

An open source web application to the database is in scope for the second project phase, to make the system generally accessible for use. With the contribution of entitled researchers inland and abroad, it would function as a "virtual research environment" for professionals. Particular interest of experts from the neighbouring countries (i.e. from the Carpathian Basin and its immediate environs) is expected.

The idea of re-writing the program for a web application ruled out the original concept of developing a CD version of the database system (installable on PCs), considering that a web-based, dynamic and interactive context is more fit for the age and perfectly meets the project aims. This solution implicitly eliminates a number of problems (data redundancies, data expansion, data obsolescence), while includes several extra built-in functions that would otherwise be unavailable. All the more, by adopting the database to a platform-independent medium, it would no longer be of limited use to Windows, but becomes accessible through any operational systems (e.g. Linux, Mac OS-X, BSD etc.) or any devices with internet connection (including mobile tools).

The system is run by Drupal CMS (content management system), using PHP-based programming language and MySql datastore service that allows for safe and sound operation, high-quality performance and unobstructed access.

The user-friendly layout of the system offers easy navigation, flexible data management and effective display of numerous types of content. Using the "Views" toolbars at the top of the page, specific fields (i.e. data elements) and individual items can be selected, database tables can be compiled, queries can be made through filtration against various node attributes, requested information can be tagged – all viewed either on screen or in print version.

Due to constant developments to the core operational system, several customary problems associated with such systems are eliminated, while performance data are registered, system errors are detected and repaired trough dynamic system updates.

Different authority levels – represented by different user roles with defined permissions to the system – can be created. Thus, any user with a special role assignment has access to a specific set of functions. Visitors with no registration to the website ("anonymous users") would have no problems in searching for information or navigating in the database, while any content management or edition function (data addition, data removal, page reorganization, creation of tables etc.) requires proper administrative rights. Thus, "authenticated users" like professionals, experts and researchers can get involved in active database expansion (by adding, processing or revising data) regardless of their actual geographical location.

Converting the database into a web-based, open-access integrated resource system allows for harnessing the community potentials of diffuse and populous user groups. Thus, new features and functions can be added to the system, far beyond the "simple access" to the database. Various user groups can be formed, from special interest groups to communities of professionals, who can actively participate in constant content profiling, updating, and dissemination – for the benefit of the public.

This would open the way for creating an integrated knowledge base, a kind of online lexicon (somewhat like Wikipedia), where the reliability of information would be safeguarded by entries written, edited, revised and updated by researchers or professional experts.

Interactive communication panels are also rendered as notable sources of information. Informal discussion forums, e.g., might function as virtual platforms to debate specific issues, articulate and answer questions, introduce new topics, identify problems, reinterpret and re-evaluate established results.

Research expeditions, even complete archaeological excavation projects can be documented, published and archived through user-customized image galleries, blogs and weblogs that might be of importance in education too.

Summary

During the systemizing of the numerous stone and tool material of the Vatya Culture the idea of a new database was raised that could be useful for both archaeologists and geologists. As a result, the Archaeometric Stone Tool Database was established comprising currently of the 865 polished and ground stone tools of the Vatya Culture studied and analysed from archaeological and petrographic points of view.

The database is suitable for storing archaeological and archaeometric data (e.g. archaeological or petrographic descriptions) in a modern, expandable form that is accessible internationally and can be developed continuously. Various data types can be viewed from the tables of the database (e.g. archaeological drawing, microscopic photos, analytical results). International accessibility presumes bilingual storage of the data; however, the database can operate with even more languages. A further advantage of the system is the reduction of the necessity of destructive analyses.

Due to the lack of development sources, only the downloadable Windows/Access based version of the database can be accessed, however, its operation is good in its present form as well and proved to be a great help regarding data management, queries and statistical evaluation of the high number of stone tool material of the Vatya Culture.

If practice verifies the usefulness of this system then its example can be the basis of other archaeometric databases.

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