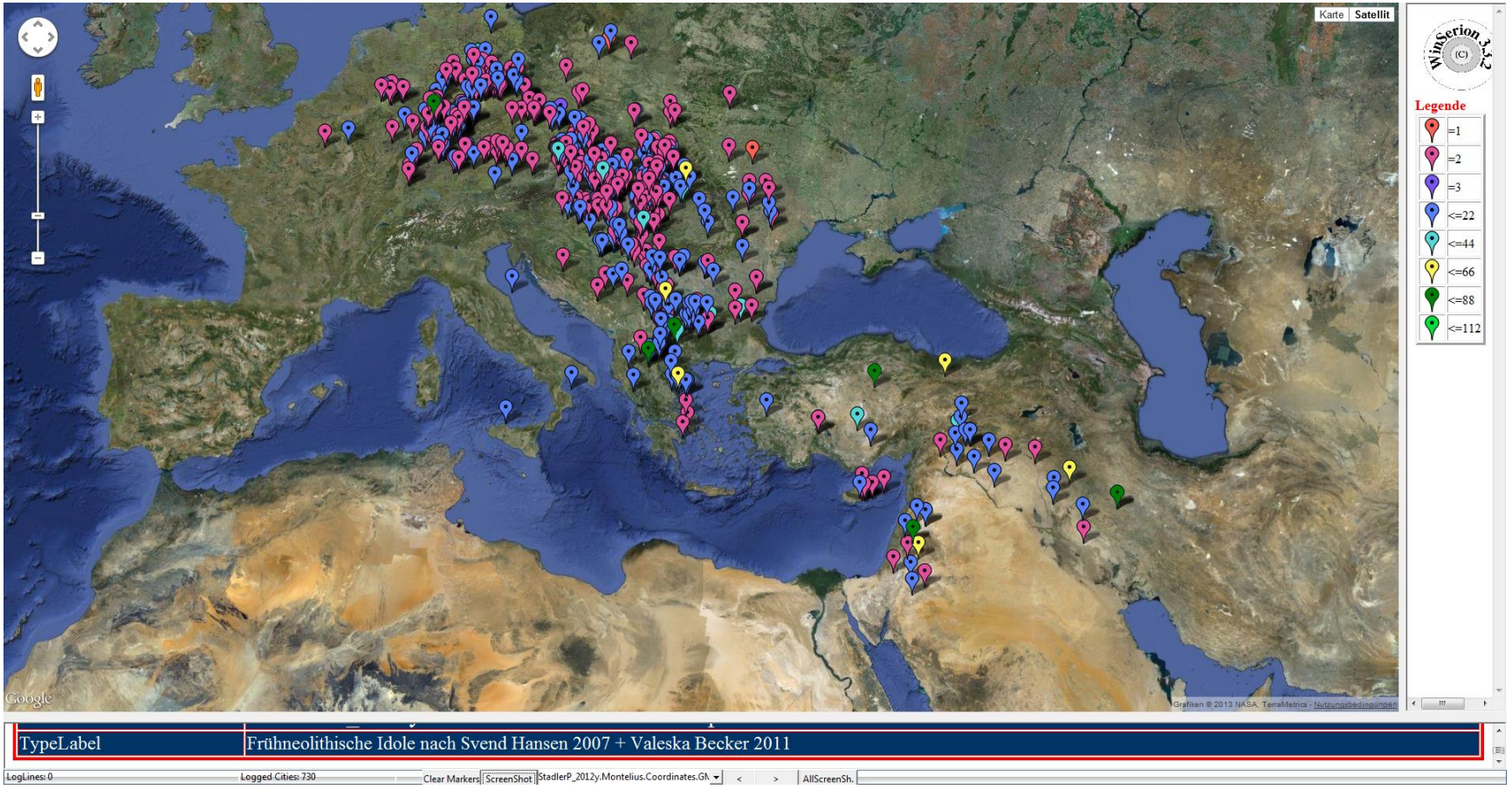
14.06.2015

Quantitative Methods with Image Database Montelius and the Software Package WinSerion for Archaeologists: Examples of Different Analyses.

Peter Stadler, Vienna



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Abstract

Like Sleeping Beauty, archaeological publications sleep deeply within our archive libraries. Due to the abundance of these publications, it is often only possible for the individual archaeologist to have a very limited overview of the archive, and even then things are overlooked again and again. Now this is where our Image Database Montelius comes in, which has taken up the task of collecting all pictures ever publicized from archaeological materials. To date about **960.000** images have been collected, as well as **1.157.358** datasets from all databases.

With our "Know How" and software, for the first time it is possible to evaluate findings and find materials of whole archaeological cultures together. If the image database is ready for a site or a group of sites or a whole culture it is possible to create typology with MonteliusEditor 100 times faster than with conventional methods. If typology has been done you only need to press a button to make evaluations with program package WinSerion. GoogleMapper allows localizing all archaeological sites by their address and making maps of many different subjects.

So far data in the following areas in the field of Prehistory and Protohistory with Montelius were collected: Prehistory and Protohistory, Medieval Archaeology, Classical archeology, Human Biology = Anthropology, Palaeozoology, Palaeobotany, Mineralogy and Geology, etc. More than 100 students and colleagues were involved.

Introduction.

Latest addition: We've now added new databases to Image Database Montelius, which can be used in the same way as before only Montelius: 1) The database of the Department of Prehistory of the Museum of Natural History Vienna with about 100.000 datasets. 2) A database of radiocarbon dates containing currently 21.000 datasets. These databases themselves have no image information, but many images of Montelius can be interlinked with these datasets. All the sites of these databases are joined with all Montelius sites, so everything can be mapped with GoogleMapper.

Like Sleeping Beauty, archaeological publications sleep deeply within our archive libraries. Due to the abundance of these publications, it is often only possible for the individual archaeologist to have a very limited overview of the archive, and even then things are overlooked again and again.

Now this is where our Image Database Montelius comes in, which has taken up the task of collecting all pictures ever publicized in archaeological material. Since this task cannot be completed overnight single-handedly, we have set up "research areas" for ourselves which are determined by our own interests and through cooperation. First, for the "Avar period," we were able to build an image database in which all publications that were available to us were collected using finds from the whole expansion area of the Avar region. In addition, we tried to include continuously appearing publications in this database, so that about **300.000** images of archaeological finds are currently managed in this data collection. More information about the Avar database can be found here (status from 2004):

http://hw.oeaw.ac.at/3508-4

In the meantime, we have expanded this image database to include the early history period (i.e. from the last third of the 4th century to the 12th century AD). This data inventory is not yet complete, but it currently holds **630.000** objects.

The considerably larger data sets shown in the prehistory category is not entirely due to its much longer duration. Thus we were forced here to select sections that are primarily of greater interest to us. Our excavations of the early Neolithic settlement of Brunn Wolfholz, in which a settlement under a strong Starčevo influence developed from 5700 BC to a purely (classic) Linear Pottery (Linearbandkeramik) settlement at about 5400 BC, significantly inspired us to include the Early Neolithic into the Image Database Montelius. Our cooperation with Univ. Doz Dr. Eva Lenneis has also contributed in the analysis of the LBK sites of Strögen, Neckenmarkt, Rosenburg (all three of which have already been published) and Mold (the first volume is already published). For 14 months, a Lise Meitner fellowship from Dr. Nadežda Kotova has not only advanced the study of the pottery from Site 2 of Brunn Wolfholz but also that of our image database. Currently Montelius is promoted by a Marie Curie EU-project for Nadežda Kotova, which started on 1st of May 2014 and will last for two years. Thus, important cultures like Starčevo, Körös-Criş, Linear Pottery and Alföld Linear Pottery are at the center of our attention. Currently **240.000** entries already now exist.

Another research focus lies in the area of the Early Bronze Age, a part project that we have initiated together with Johannes-Wolfgang Neugebauer, due to his highly successful excavations in Traisental which are of enormous importance for Central Europe. In the

meantime, we have made about **40.000** entries for the Unterwölblinger group and the Únětice culture from eastern Austria and neighboring countries.

Due to the cooperation with Univ. Prof. Andreas Lippert in the analysis of the Urn field and Hallstatt period cemetery at Bischofshofen Pestfriedhof (already available as UPA dual volume 165) and of Dr. Michaela Lochner and Dr. Edeltraud Aspöck in the investigation of the Urn field period cemetery at Franzhausen Kokoron, a UK and Hallstatt image database was created which currently holds about **58.000** entries. This was also continued in collaboration with Dr. Bettina Glunz Hüsken for the recording and reconstruction of the original find complexes of the cemetery of Hallstatt. This Hallstatt database serves as the basis for their research project: "Untersuchungen zur religiösen Symbolik in reichen Gräbern der früheisenzeitlichen Nekropole von Hallstatt, Oberösterreich" (Studies on religious symbolism in rich graves of the Early Iron Age necropolis of Hallstatt, Upper Austria). It is supported with the means of the Deutsche Forschungsgemeinschaft (as of 1.10.2010) and is located at the Institute for Archaeological Sciences, Department of Prehistoric Archaeology (Prof. Ch. Huth), Albert-Ludwigs-University of Freiburg.

http://www.winserion.org/Hallstatt-Demo/

The complete literature so far covered, as well as the latest processing status, can be viewed here:

http://www.winserion.org/Literatur.xls

Input with MonteliusEntry.

MonteliusEntry is the input program and image processing program for image separation. In our publications we always have drawn or photographic plates in front of us, which all are collections of figures. For the typological classification of objects, it is necessary that there are images of individual objects in the image database. To follow the way from scanned sheets to the individual images, the images of individual objects are marked and cut with one of our specially developed image-editing programs. A further development is the automatic image separation, but it is still in its infancy. Also very useful will be the automatic image recognition to assign the images of objects to their functional types in the future.

In addition to saving images of individual objects, informations about the depicted objects are also entered, the important information which cannot be already determined from the images. If the site name already is known in Montelius it can simply be selected from a dropdown list. Information about a coarse typology for each object may be selected from a multi-stage thesaurus. The input has been continuously improved since 2000, so that today a trained employee can enter about 100-250 items per hour.

The following figure shows the input mask.

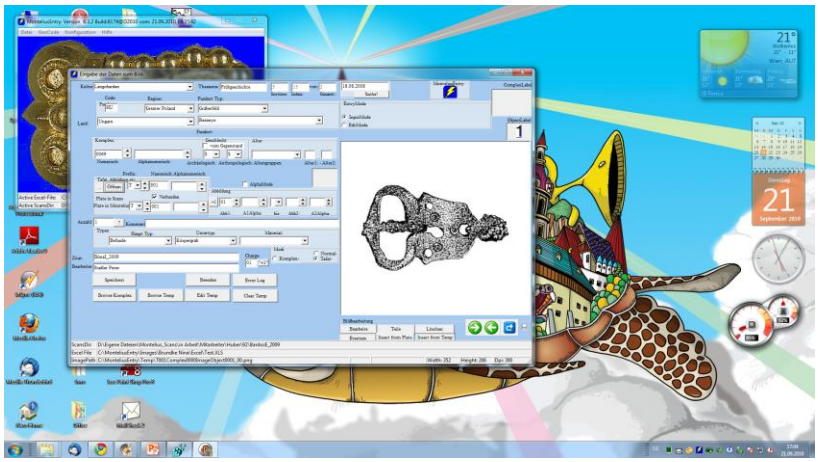


Figure 1: Data entry with MonteliusEntry, Avars.

In the next picture you can see the mask with the information filled in for a Germanic comb from Thuringia.

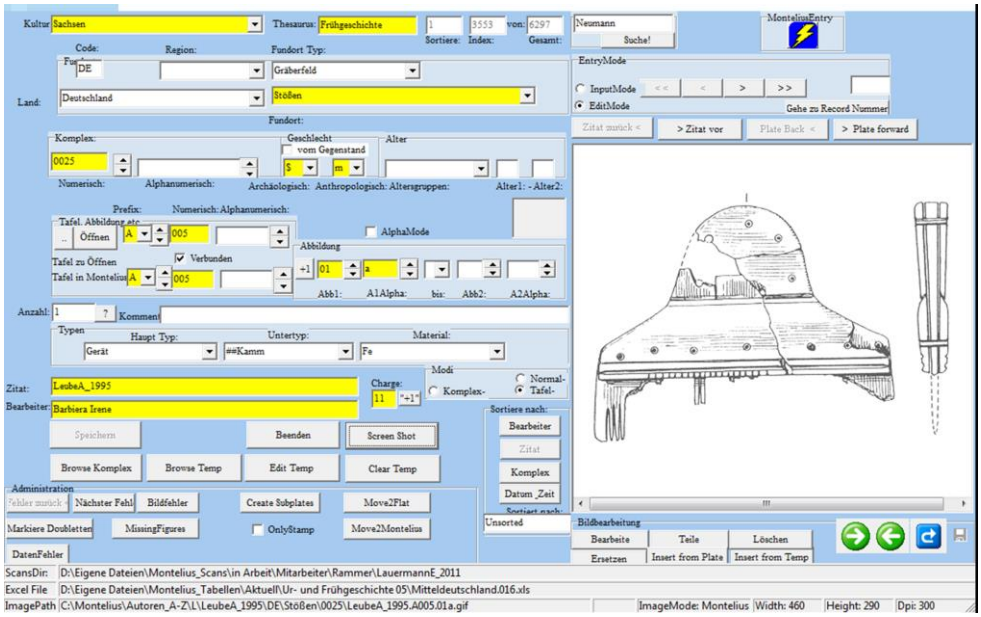


Figure 2: Entries with MonteliusEntry.

A module of MonteliusEntry is MonteliusImageAnalyzer, which should accelerate the entry process in the future. Figure 3 left shows a plate of the Avar period cemetery at Zamárdi, Fig. 3 right shows MonteliusImageAnalyzer with identified individual red marked objects, yellow grave designations and blue object numbering. These texts should be automatically read by an OCR. But this is a future development!

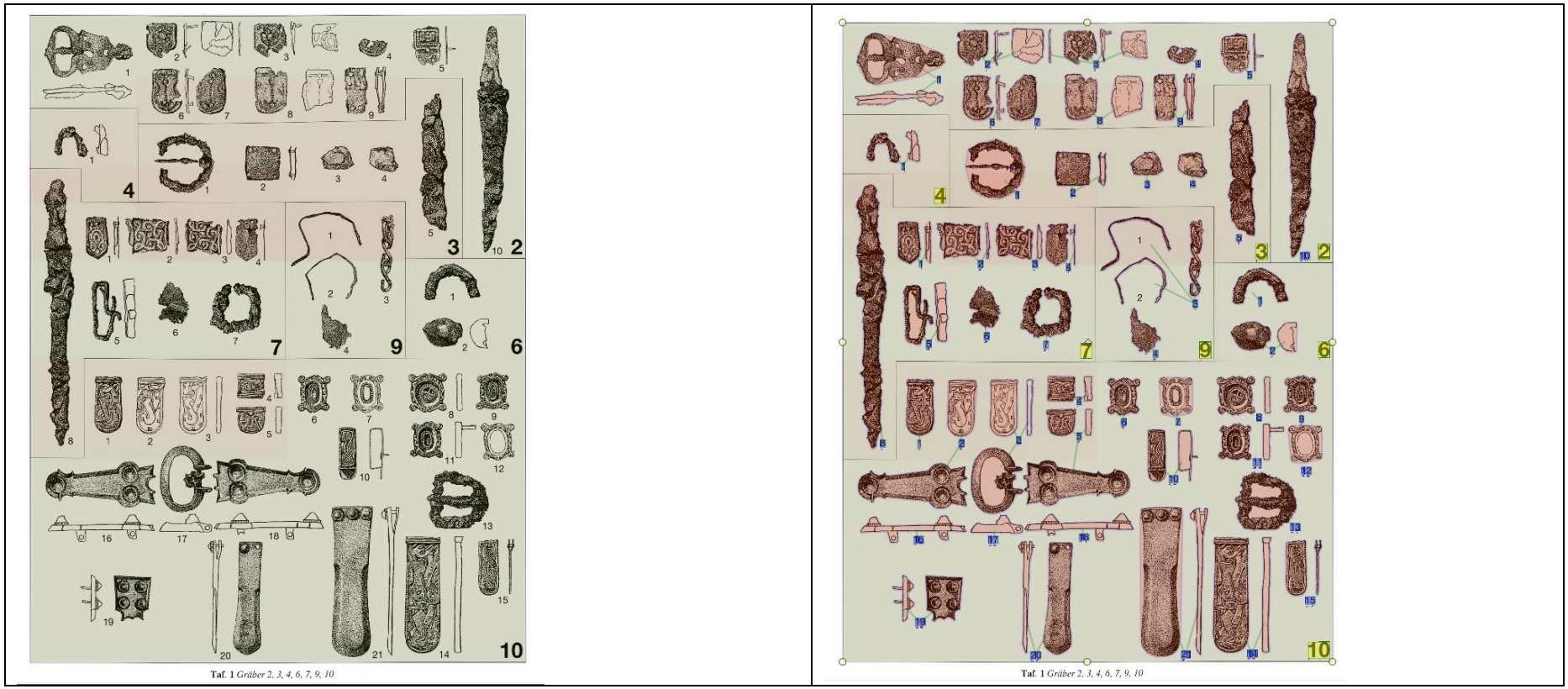


Figure 3: MonteliusImageAnalyzer, plate before and after the analysis.

Concept of the Image Database Montelius.

This database concept is based on the archaeological publications, catalogues and plates of artifact assemblages. These are scanned and broken down into the individual objects by image processing. On this basis, semiautomatic plate types are produced. In the Image Database Montelius, the typology can be created by "drag 'n drop" on the screen. From entries to the typology creation is a laborious process and can involve different people, as is shown in the following figure:

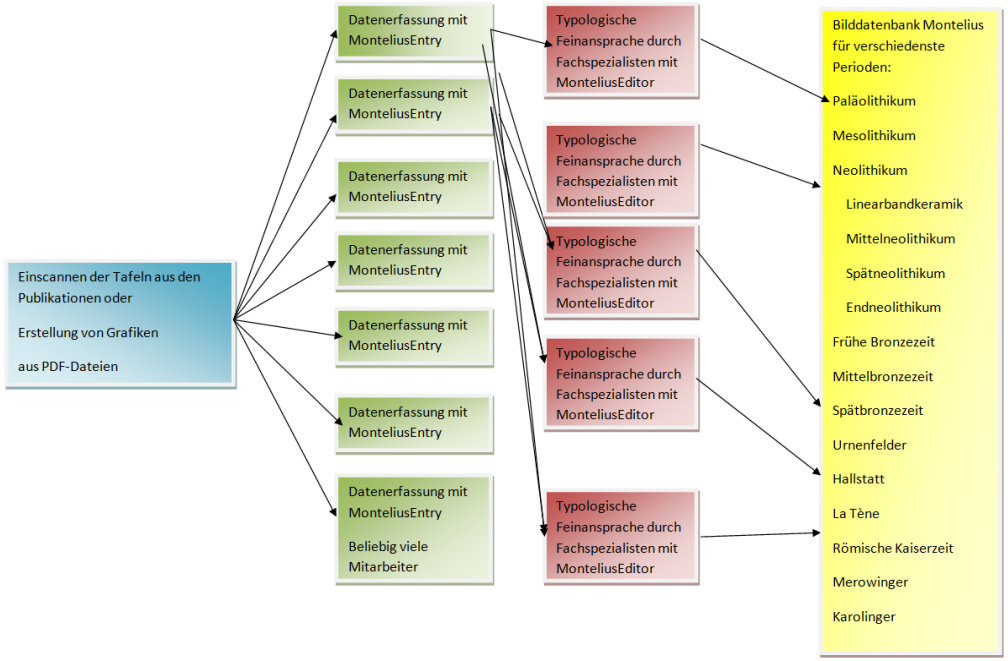


Figure 4: Diagram illustrating the teamwork of various specialists to create an Image Database Montelius.

Montelius" will be explained briefly below. Figures 5 and 6 show in a scheme format, how pictures are entered into Database "Montelius" and how evaluations that take place on this basis can be performed. In Figure 5, one starts from the material publications, either monographs or

articles. The plates which show mostly find complexes are scanned or are already available as pdfs, and then separated by means of image processing to images of individual objects. Each find object is described by filling out the form in the input program MonteliusEntry. Editable thesauri allow doing a standardized input. On the other hand, the publication is also a source of additional information, which can be cataloged, together with the images of the artifacts. Based on the "Montelius"-part of our program package WinSerion, the images can then be shown either in the complex mode or typological mode. In addition, any definable other views are possible.

Figure 6 demonstrates the possibilities of WinSerion after entering the data into the database and after their typological order. WinSerion allows different types of seriations to visualize relationships in the considered archaeological material. Simple seriations as Petrification or Reciprocal averaging up to the Correspondence Analysis, calculate chronologies based on the find complexes and the archaeological chronologically relevant fine typology. In addition, the correspondence analysis based on the functional types is an important tool for the implementation of gender studies. These allow additions to the separation of men and women complexes in the best case, such as the separation of artisan groups or ethnic groups, which will be executed further below. Also the use of local or global base maps gives the opportunity to perform feature mapping by means of an embedded WinSerion geographic information system (GIS), using Google Maps.

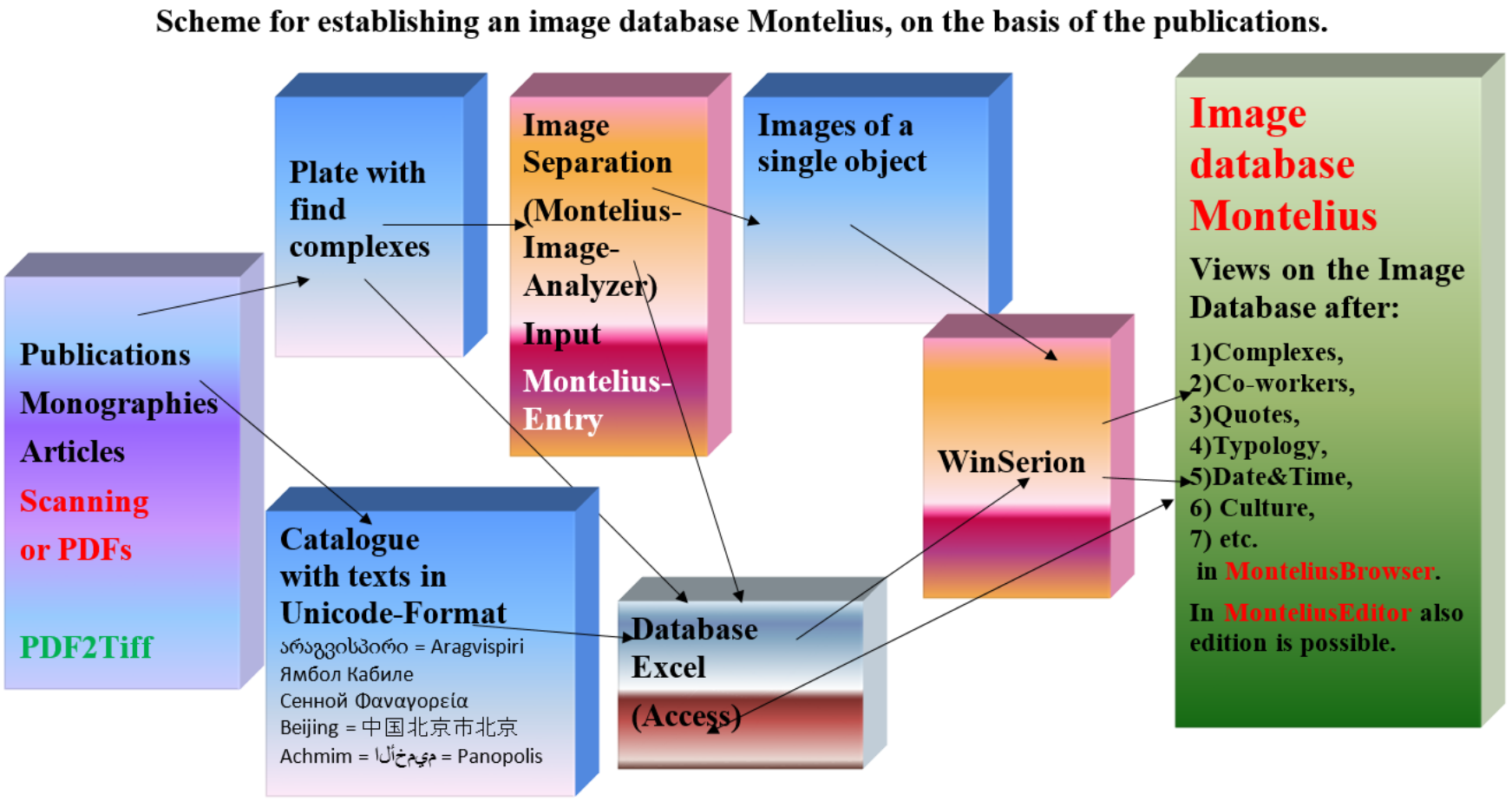


Figure 5: Scheme for creating an Image Database Montelius, starting from the publications.

This typology is available for further analyses, such as seriation or an analysis of the N Nearest Neighbors. The advantage over a conventional typology is that it can be created **about 100 times faster** with Image Database Montelius. The Image Database Montelius is intended for use in scientific work, such as diploma dissertations, master's theses and particularly for doctoral and Habilitation dissertations.

Typological features with image browser and "drag 'n drop".

- The input of an object took an average of 60 seconds. By using new programs (MonteliusImageAnalyzer etc.), this could still be significantly accelerated.
- The search for parallels to an object takes about 30 seconds (compared to weeks of searching in the library).
- The assignment of an image to an existing model requires only a few more seconds.
- A new type is easily created by making a new folder in MonteliusEditor with an appropriate name.
- An existing type can be easily split into two sub-types.
- The main advantage over conventional typology is that the work process is accelerated about 100 times.
- Thus, with 775,000 objects, much of the Protohistory of Central Europe was able to be recorded in the last 12 years.
- A portion of this (about 200,000 items) has already been ordered typologically.

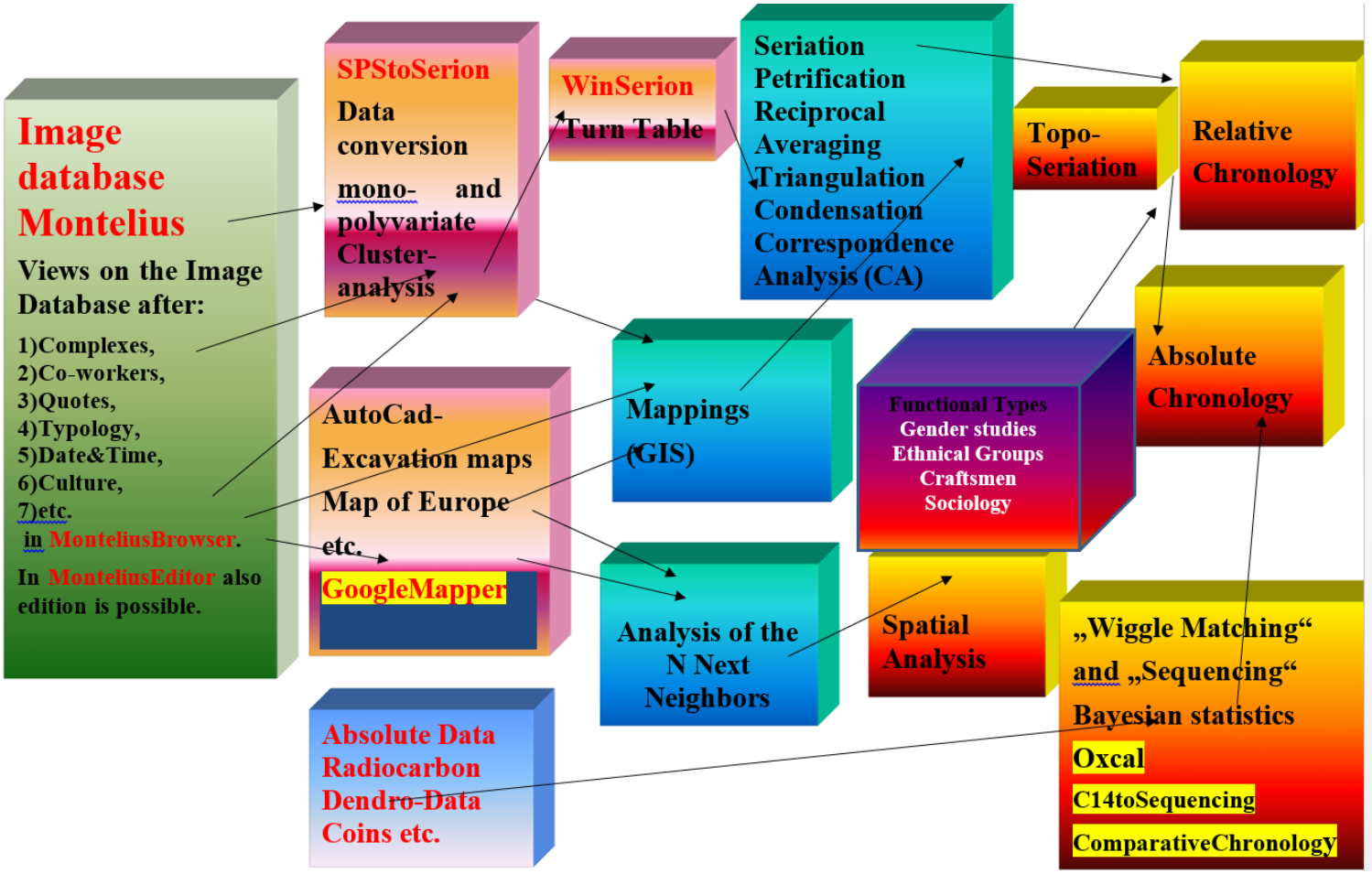


Figure 6: Scheme of the possible analyses based on an Image Database Montelius.

Program PDF2Tiff.

Program PDF2Tiff converts a folder of PDF-Files automatically to Tiff-Pages. The resolution default is 300 dpi, but there are other resolutions possible, between 200 and 600 dpi. These tiff-Files are used as input by MonteliusEntry.

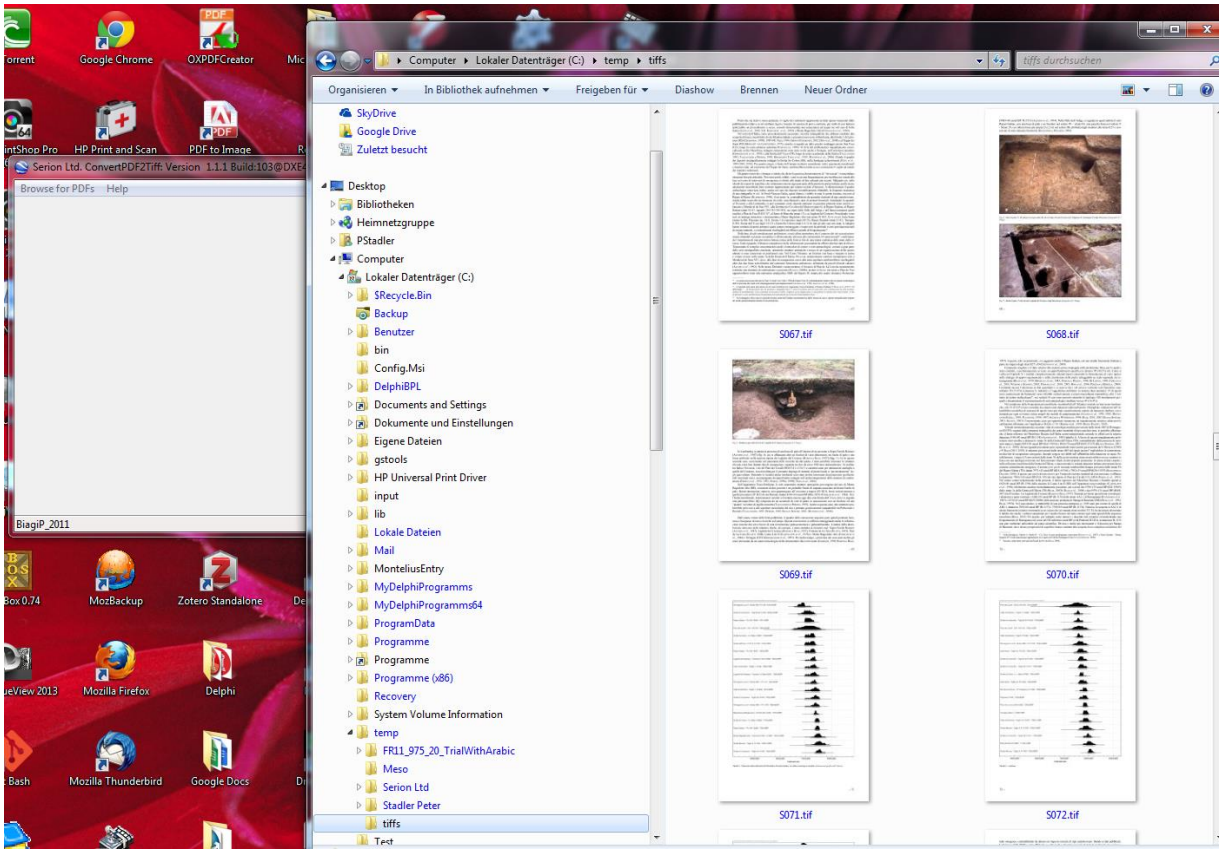


Figure 7: With PDF2Tiff a folder of PDF-Files is automatically converted to Tiff-pages.

MonteliusFunctions.

This is the tool for the database administration.

It allows the following totally different functions:

1) Check that all images are present in the data sets.

2) Check that there are no orphan images.

3) Check that all the images are not corrupted. This is done by loading all the images in an image editor and checking whether this operation was successful.

4) Create various lists, such as supplementing the list of site names by new localities, for which are then automatically provided coordinates by MonteliusEntryGoogleCode.

5) Export of records after filter specifications.

6) Export of images after export records. Exports can be created as a separate image database Montelius on the users' computers.

7) Global corrections for sites and quotes, adjustments in a table are transferred to a list of corrections and automatically applied to the entire database and transmitted synchronously to the image structure.

8) Creation of the current statistics on the individual cultures, users and charge etc.

MonteliusEntryGoogleCode.

This is the tool for the automatic determination of the location coordinates using Google Maps API. In this case, an address is sent to Google Maps, for example:

SI	Krain	Novo Mesto Mirna Peč Hmelčič=Rudolfswerth Hönigstein Hmelčič

In the leftmost field is the Internet code SI for Slovenia, the Krain region and then the location address. Only the current address in the (left of =) Unicode format is searched. The geographical names in the address are arranged from the largest geographical unit on the far left to the smallest unit right hierarchically. First it checks whether the entire string from the Google Maps API is detected. If this is not the case, the right-wing locality names, mostly place names, which Google Maps does not know in general, are eliminated. Then the search is continued with the remaining string. The process is continued until either a localization can be done or the assignment was terminated unsuccessfully.

This is basically the spelling of a locality name in the local language preferable because the transliterations are often ambiguous and are not as well-found by the Google Maps API as the original names. The following place names are for example already in the database:

CN		中国内蒙古自治区鄂尔多斯市=Ordos

The Chinese name is recognized by the Google Maps API better, as opposed to transliteration.

GE		თბილისი=Тбилиси=Tbilissi=Tiflis

The Georgian name in Georgian writing is on the far left in the address field, followed by the Russian transcription, then two transliterations to German.

SY	Homs	Homs=Emesa=حمص

Here is an example from Syria with the right-to-left original letters in Arabic.

Currently in the database there are about 60.000 localities, of which 0.5% could not be located. That of course is not to say that all other localities were arranged properly. A control can be given by GoogleMapper, where, for example, the countries, to which the sites belong, can be checked in the mapping by countries. If there is a locality in the right country that does not automatically mean that it has been properly localized. The better the hierarchical address string is detected, the more likely the correct locality is located. Correct addresses with street and house numbers allow the most accurate localizations, which are only possible in the area of villages or towns. So all the locations have different accuracy, but this is not of great concern for large space mapping.

ExportMaps

Currently this program produces three kinds of maps, which later can be loaded in GoogleMapper:

1) By Culture: For all cultures in Montelius separate maps are produced. If cultural groups are defined in file MonteliusEntry.Culture_Mappings.xls, more maps than that can be produced. They are mapped together with different symbols and with a legend showing all the cultural names.
2) By Quote: For all publications available in Montelius different maps are produced. This is very useful, if the location of sites for newly entered publications need to be checked.
3) By Country: It may also be necessary to check these maps to see if a site was found in the right country.

Acquisition statistics.

	Frühneolithikum			Frühbronzezeit			Eisenzeit	
2	Kultur	Zahl		Kultur	Zahl		Kultur	Zahl
3	Linearbandkeramik	103768		Unterwölbling	8132		Hallstatt	24875
4	Körös	9151		Frühbronzezeit	7854		Urnenfelder	13368
5	Želiezovce	7044		Aunjetitz	7260		Kelten	3603
6	Starčevo	6641		Nitra	2934		Eisenzeit	290
7	Alföld-Linearbandkerami	6383		Straubing	2276		Daker	187
8	Criş	4951		Wietenberg	754		Skythen	164
9	Frühneolithikum	3964		Coţofeni	413		Lausitz	23
10	Impresso	3779		Wieselburg	407			42510
11	Vinča	1993		Otomani-Füzesabony	42			
12	Karanovo	1308			30072			
13	Bug-Dniestr	1110						
14	Criş	789						
15	Zau	659						
16	Karanovo 01	549						
17	Szatmár	391		Urgeschichte	zusammen			
18	Tiszadob	358			227.485			
19	PPN	262						
20	Malo-Korenovo	224						
21	Danilo-Hvar	208						
22	Bükk	196		insgesamt	zusammen			
23	La Hoguette	186			880.000			
24	Kiev-Cherkassy	176						
25	Azov-Dniepr	163						
26	Szakálhát	158						
27	Surskoy	143						
28	Low-Don	129						
29	Butmir	116		Stand vom	04.04.2014			
30	Lepenski-vir	104						
31		154903						

Figure 8: Acquisition status for Prehistory, as of 04.04.2014.

	A	B	C	D	E	F	G	H	I
1	Awaren				Ostgermanen			Merowinger	
2	Kultur	Zahl			Kultur	Zahl		Kultur	Zahl
3	Abasgues	76			Burgunder	528		Alamannen	26295
4	Apsilen	1003			Gepiden	14356		Angelsachsen	671
5	Awaren	171807			Goten	12507		Bajuwaren	40925
6	Bulgaren	1403			Heruler	464		Franken	20335
7	Byzanz	14156			Rugier	101		Hessen	24
8	China	41			Skiren	191		Merowinger	40469
9	Kazaren	76			Vandalen	1280		Sachsen	1041
10	Kopten	28				29427			129760
11	Lomovatovo	1560							
12	Ostgruppe	1470			Nordgermanen			Elbgermanen	
13	Saltovo-Majaki	182			Kultur	Zahl		Kultur	Zahl
14	Sasaniden	1041			Vikinger	2370		Langobarden	38805
15	Sogden	65			Nordgermanen	871		Markomannen	1630
16	Tang	44				3241		Sueben	465
17	Türken	809						Thüringer	12398
18	Slawen	95150							53298
19		288911							
20					Frühgeschichte	zusammen			
21						504.637			
22									
23									
24					Alles	zusammen			
25						880.000			
26									
27					Stand vom	04.04.2014			

Figure 9: Acquisition status for Protohistory, as of 04.04.2014.

So far, a total of 960,000 objects have been registered and controlled.

Typology with MonteliusEditor.

These entries into an Image Database Montelius are essential for a quantitative analysis. In between, there is but a single step, namely the creation of (fine) typology! With our newly developed program MonteliusEditor, it is now possible to create this much more quickly than was previously possible with conventional type tables (on paper). All the participants of our software seminars held by us in Vienna, Budapest, Graz, Munich and Nitra, soon also in Brno and Tübingen, have seen how fast one can create a typology here by simply dragging and dropping (**drag ‘n drop**) images with the mouse into newly created folders with descriptive names. The following are examples of different typologies:

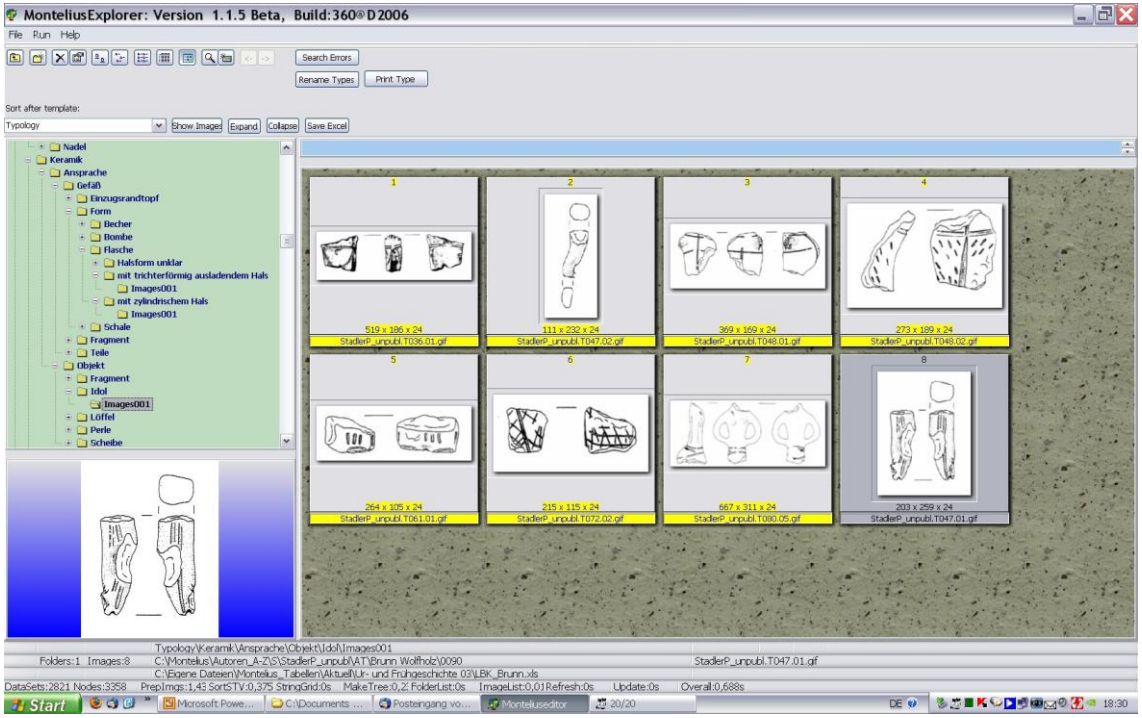


Figure 10: MonteliusEditor with view of the typology. Early Neolithic idols of Brunn am Gebirge Wolfholz site 2.

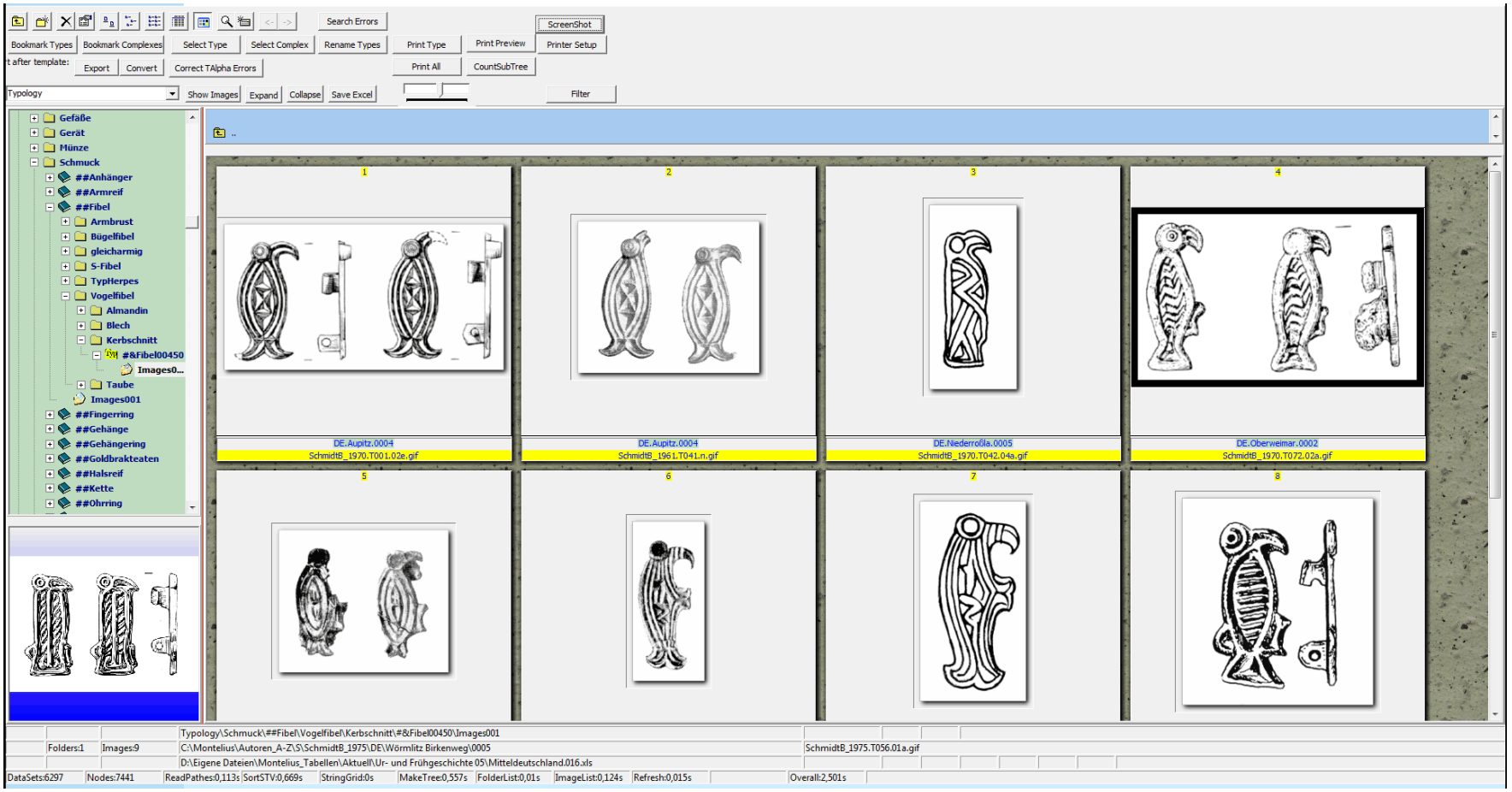


Figure 11: MonteliusEditor with view of the typology. Merovingian period bird brooches.

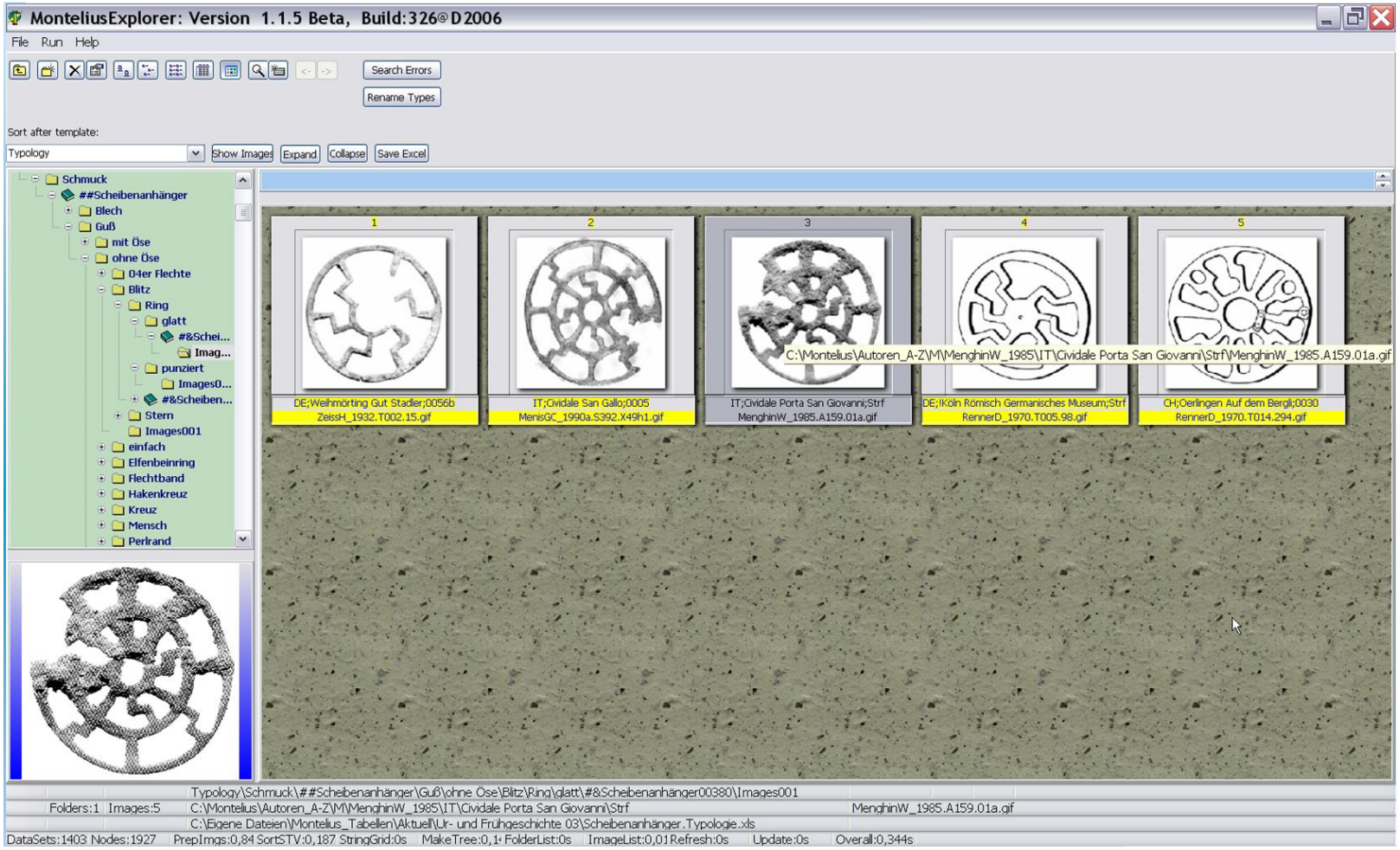


Figure 12: MonteliusEditor with view of the typology. Avar and Merovingian period ornamental discs, lightning-like decorated stars.

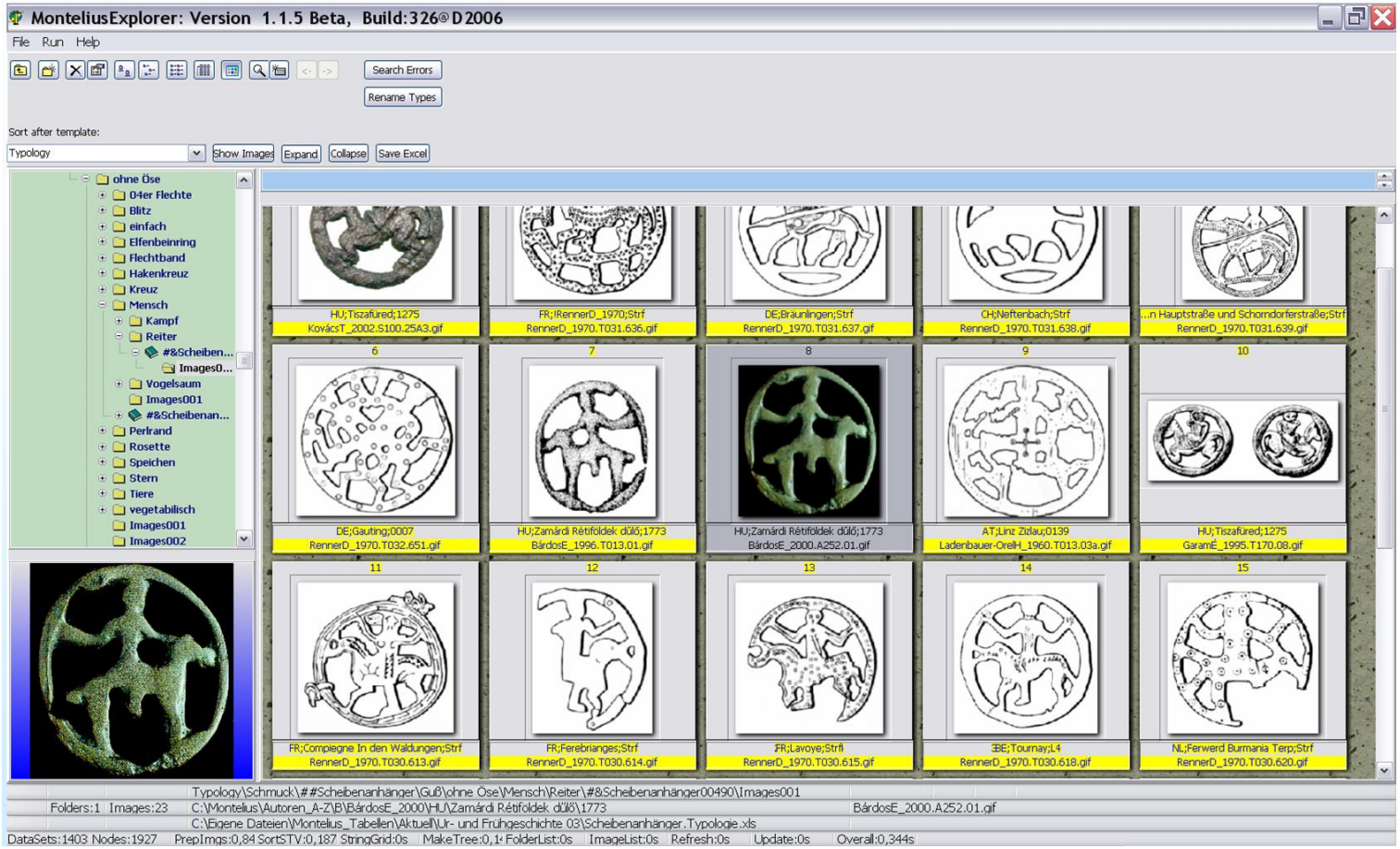


Figure 13: MonteliusEditor with view of the typology. Avar and Merovingian period ornamental discs, depictions of lance rider.

In Figures 9-12, types created with MonteliusEditor are shown. Their arrangement can be achieved using MonteliusEditor and drag 'n drop to place into the correct, previously created folders, which can be given descriptive names.

Results with WinSerion.

As shown in the diagram above, the entries can be used in the image database to create the typology for various analyses. First, we have a collection of seriations:

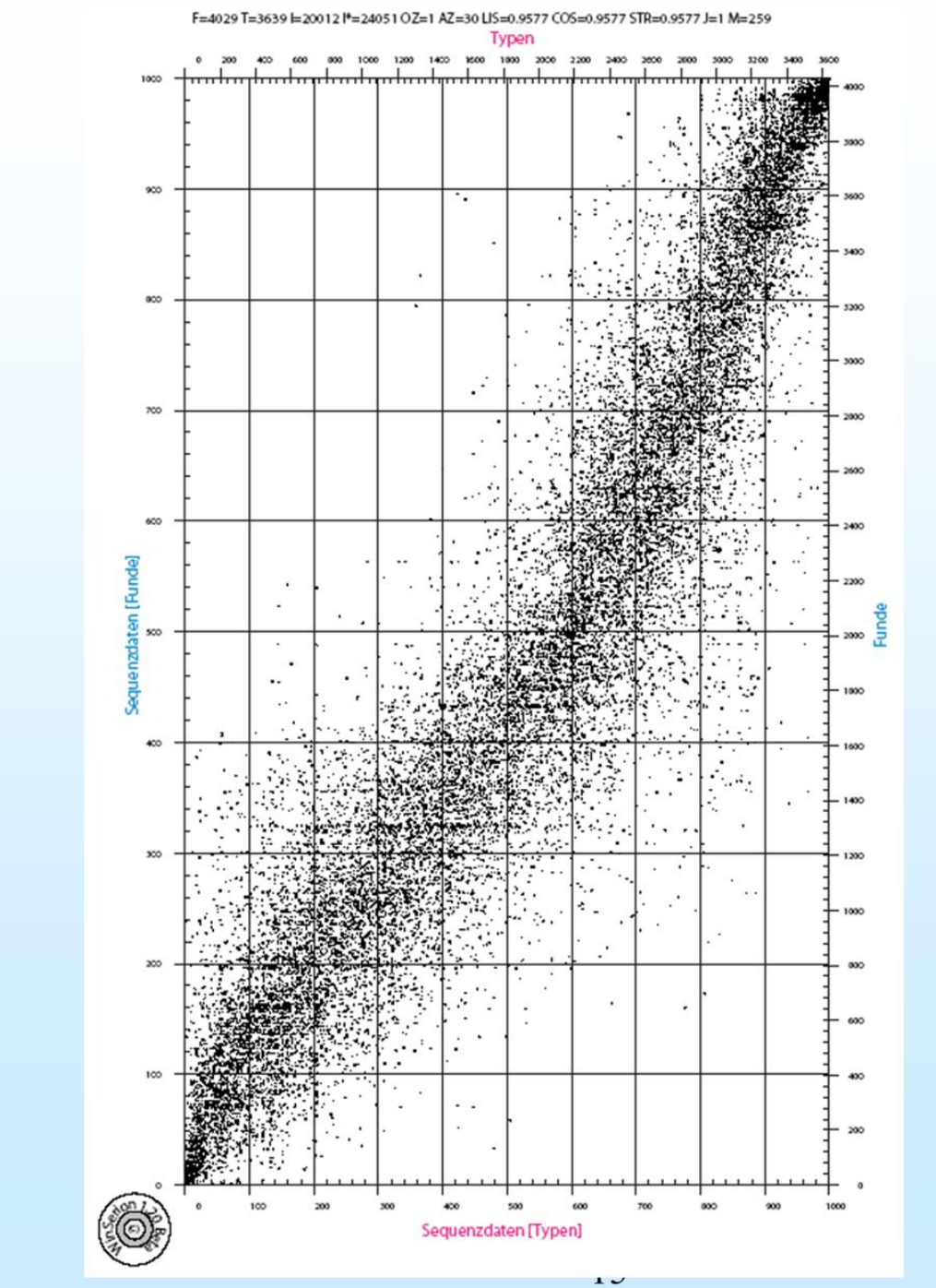


Figure 14: Seriation of Avar period male burials.

Each point corresponds to an object. More than 3600 types are arranged in the columns and more than 4000 find units are arranged in the rows.

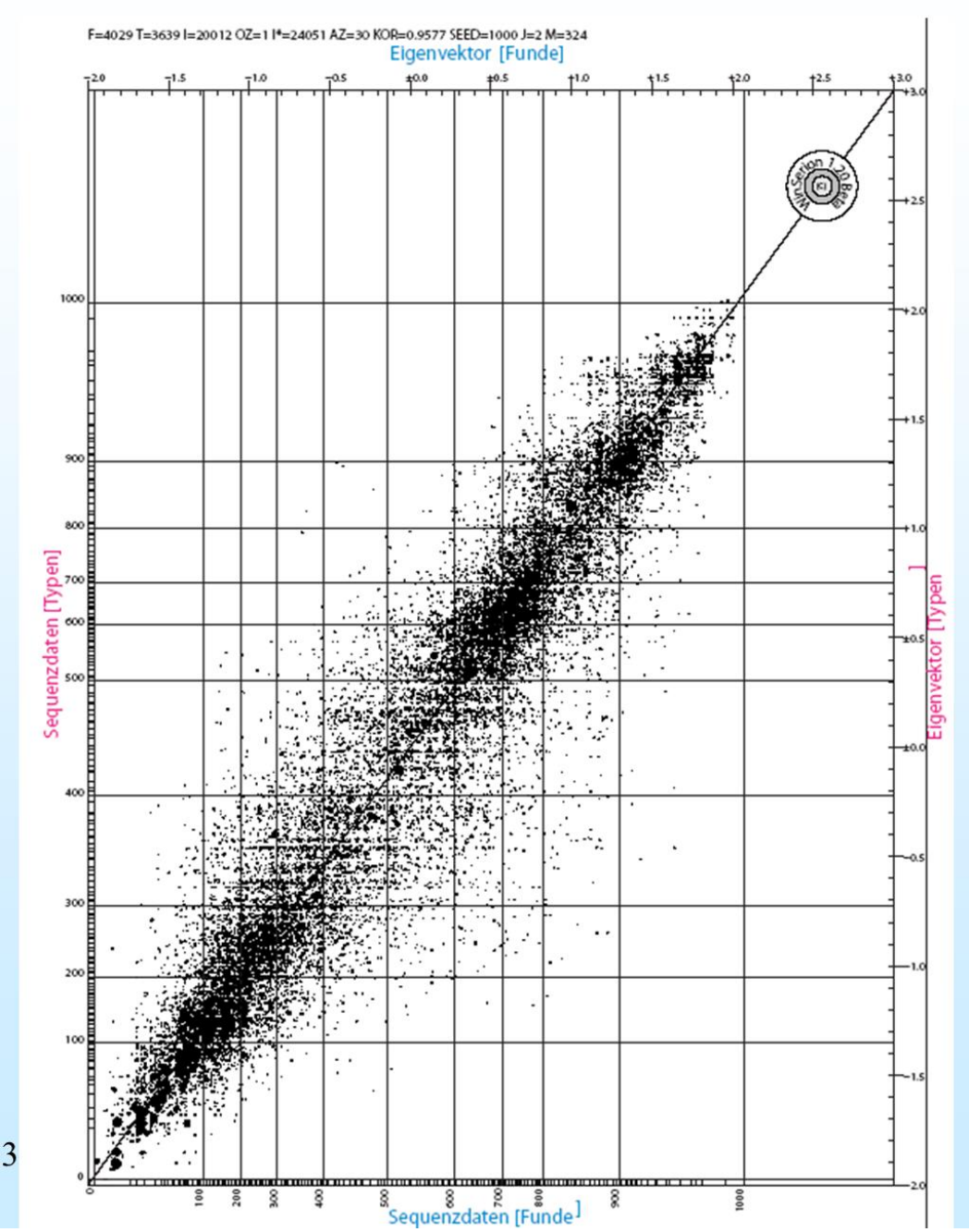


Figure 15: Seriation of Avar period male burials, presented in Eigenvector form.

Thus the find units with the same types are not next to each other as in the previous image, but rather they are superimposed on one another. This leads to stronger clusters in some places.

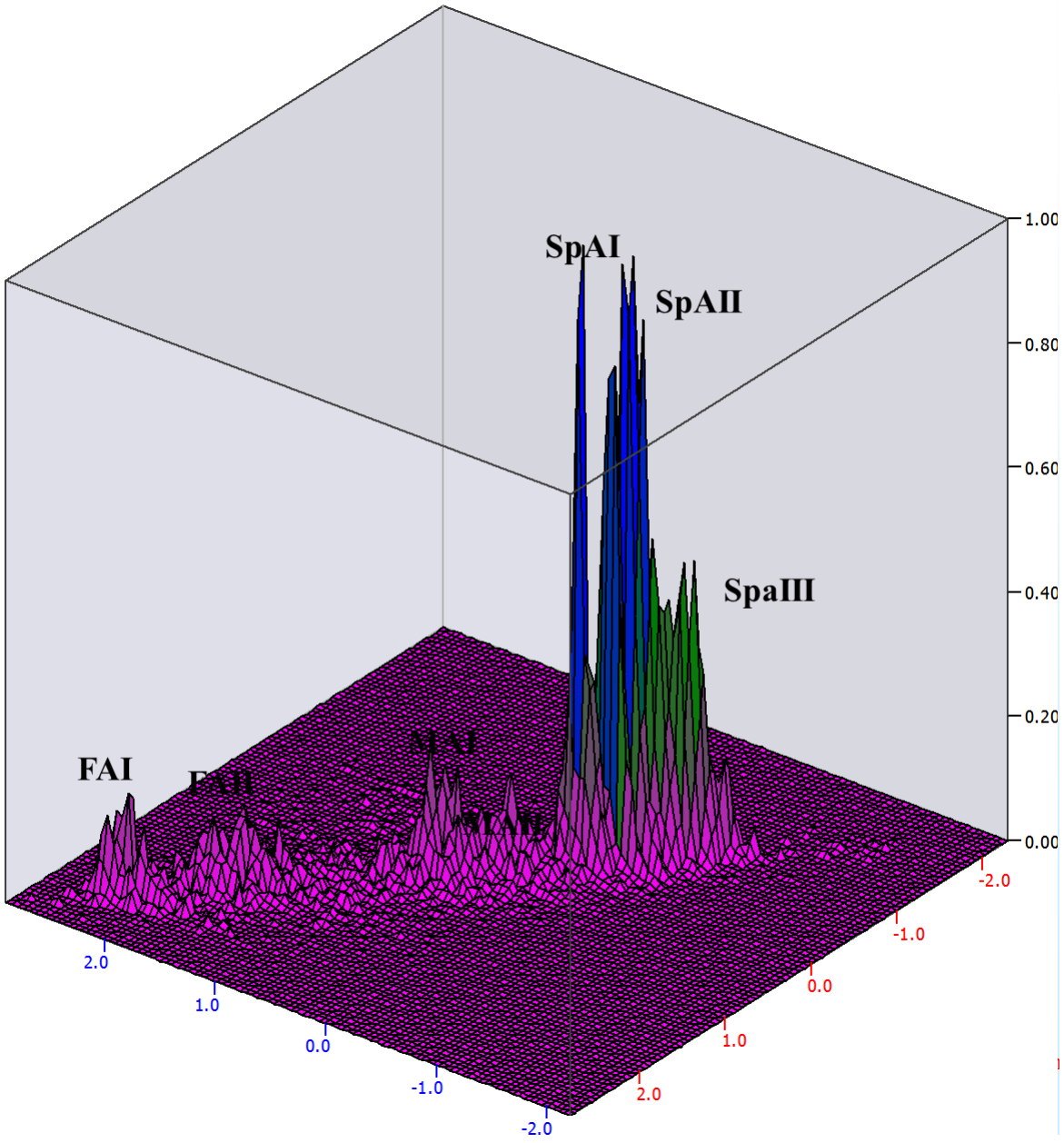


Figure 16: Representation of the eigenvectors of the seriation results of Avar period male burials in 3D.

The resulting peaks were named with the given chronological phases.

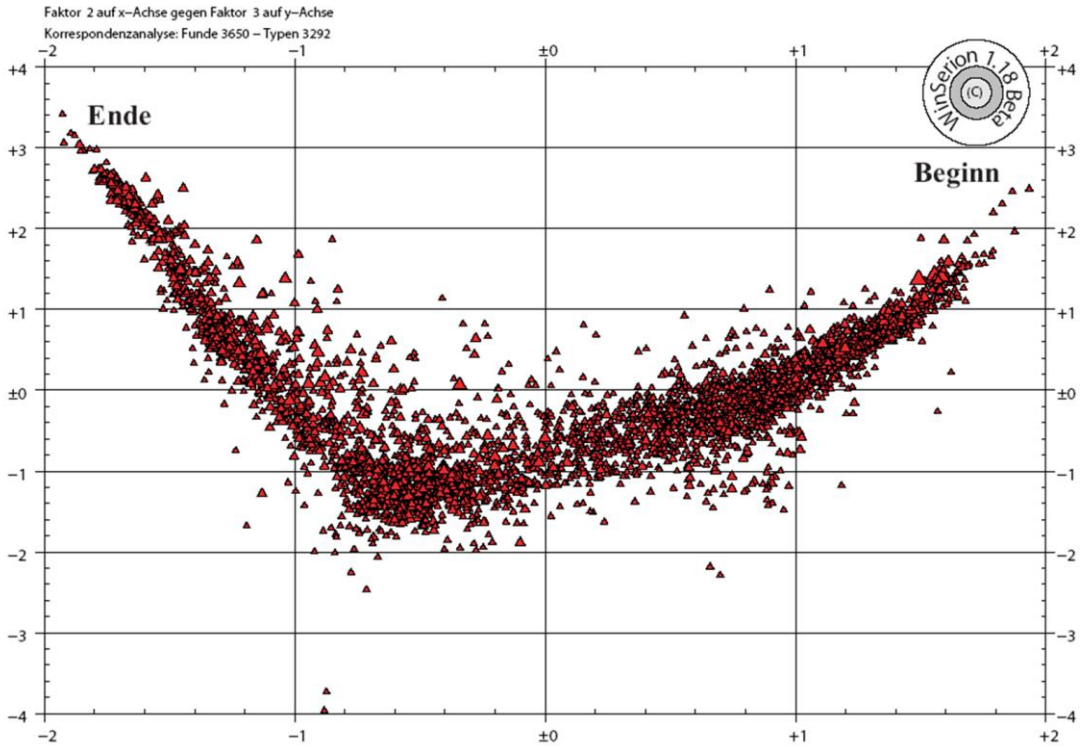


Figure 17: Avar male graves, correspondence analysis with the entire data set, find units.

Each triangle corresponds to an archaeological find unit. The larger the triangle, the more dated find material is included in the assemblage. The arrangement in the shape of a parabola shows the course of time, the beginning is marked as "Beginn", and the end as "Ende". In the top right just after the beginning, there are two particularly large adjacent triangles. These are the Khagan grave of Kunbábony and the princely find of Bócsa. Contrary to former ideas, these two assemblages date to the beginning of the Avar period, probably before 600 AD.

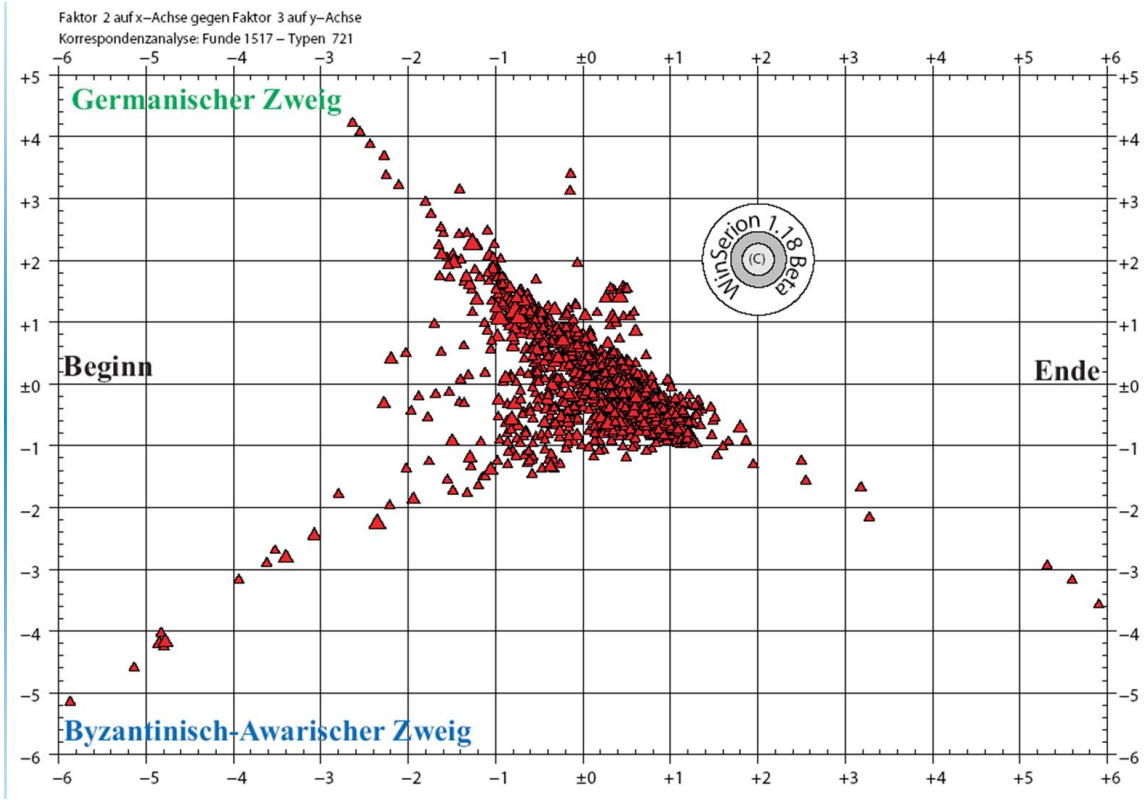


Figure 18: Seriation of Avar female graves, correspondence analysis with the entire data set, find units.

Here, instead of one parabola, there are two. Particularly in the early Avar period shown on the left in the graph, the find material is separated into two very different branches. The upper branch has Merovingian period jewelry, while the lower branch mainly has female jewelry of Byzantine origin. The upper branch can thus be interpreted as Germanic women in the Avar region, and the lower branch as Avar and Slavic women. The branch of both parabolas on the far right shows characteristics of Slavic female burials of the 9th century.

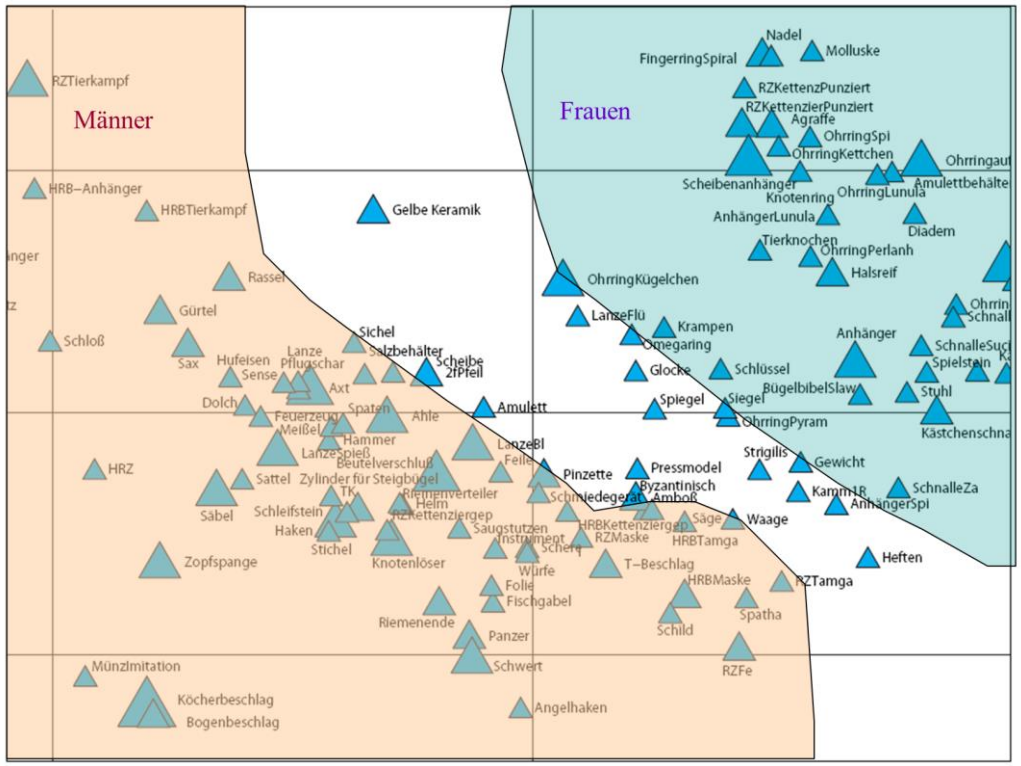


Figure 19: Correspondence analysis of functional types of the Avars. Separation into male and female graves.

Each triangle corresponds here to a functional type, which explains for what it has served. The closer two triangles are to each other here, the more often their corresponding functional types occur together in the same assemblage. The blue marker on the above right shows the features that are found in women's graves. Highlighted in orange on the lower left are objects that occur mainly in men's graves. The white area in between shows objects that can occur in both men's and women's graves.

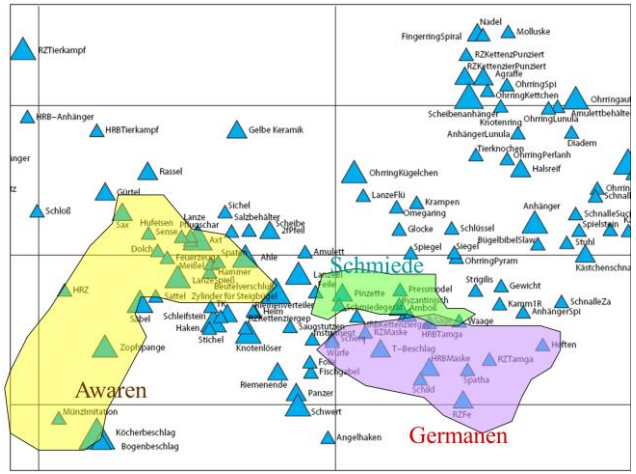


Figure 20: Correspondence analysis of functional types of the Avars. Separation into ethnic groups and goldsmiths.

On the left below you can see two different sized triangles for quiver fittings (small) and bow fittings (large). The two triangles overlapping each other has to do with the fact that whenever a quiver fitting was found, bow fittings were also present, but not vice versa. Of the quivers, parts have only survived if they were carved from bone or decorated with metal fittings. The simple bark quivers leave no trace. The purple group on the bottom right corresponds to functions that occur only in Merovingian cemeteries, such as a spathae, shields or belt strap-ends made of iron. All objects found in this group thus indicate Germanics in the Avar region. Directly above are groups of features that can be placed in connection with goldsmiths, such as the anvil or "Preßmodel". Since this group is close to the Merovingian male features, it can be assumed that they are Germanic goldsmiths. The yellow group to the left now includes the features that can be associated with the Avars, such as bow accessories and plait clasps as well as various riding accessories.

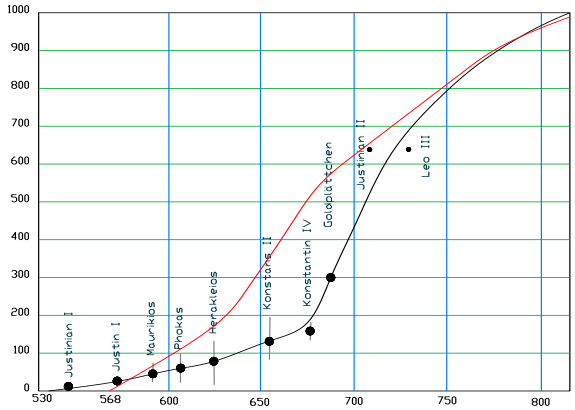


Figure 21: Comparison of two different absolute chronologies for Avar period.

Along the X-axis are the years 530-830 AD. Along the Y-axis are the sequence data, which provide information on the seriation sequence with numbers between 0 and 1000, where 0 marks the beginning of the Avar period, and 1000 marks the end. The black curve shows the position of the coin-dated grave assemblages, with coins of Justinian I, Justin I, Maurikios Tiberios, Phokas, Herakleios, Konstans II, Konstantin IV up to Justinian II and Leo II. The assemblages that contained these mostly uncirculated coins were properly positioned in the seriation in ascending order. There were of course differences, the standard deviation of which is indicated by the vertical lines through the filled circles. After Konstantin IV no more coins reached the Avar region from Byzantium, since from 626 the influx of coins in the form of tribute payments had been discontinued.

The red curve represents ^{14}C-dating of assemblages. Here, human collagen from the bones was extracted and dated. The red curve shows a clear shift in the absolute dating of the same or similar assemblages. What is the reason for this? Human collagen is built up mainly by the age of 25-30 years, with carbon originating externally. In the later years of life, collagen is rebuilt further; however it is done without the absorption of carbon from the outside and with only the rebuilding of old collagen from inside. Thus, with bone collagen dates particularly from young people less than 25 years the time of the death and from older people above 30 years always only the 25-30 age range. This time is also the period in which most grave goods were acquired. Thus, the grave goods of a grave are best determined by ^{14}C. The time of the burial, however, is determined by the other curve, namely through coin dating, as these coins mostly come from the last or the final years of the deceased.

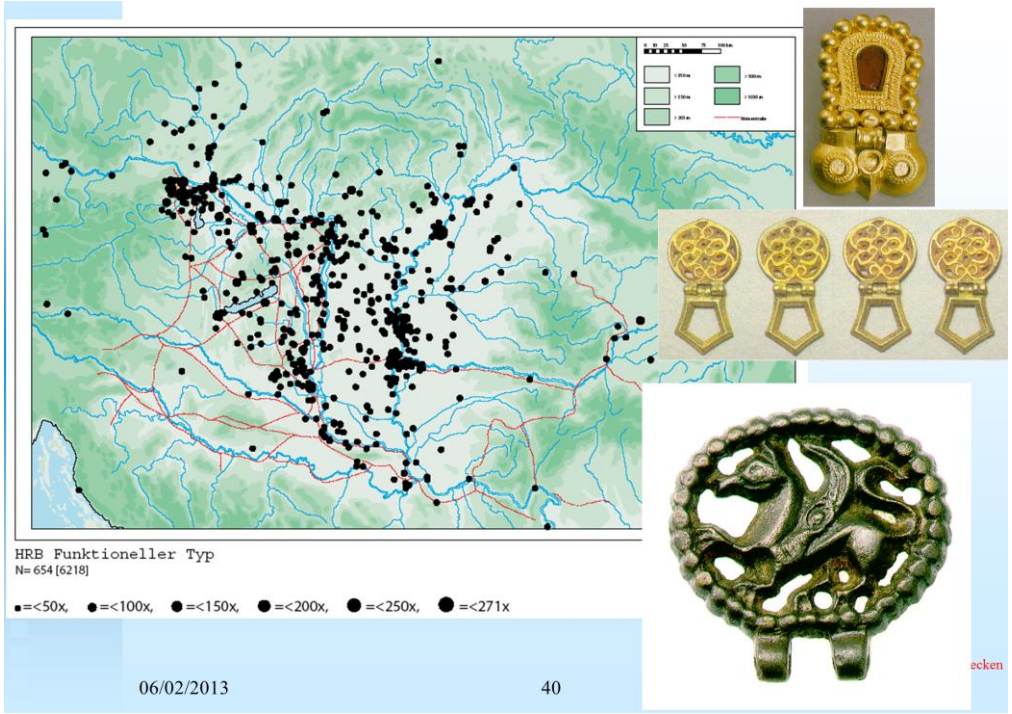


Figure 22: Distribution of Avar period belt fittings.

In the top right is a so-called pseudo buckle that served the early Avar period "Khagan" from Kunbábony as a belt fitting. Underneath are golden belt fittings from the treasure hoard of Erseke that were possibly produced in a Byzantine workshop at the beginning of the late Avar period. Below is shown a heraldic-shaped belt fitting with a griffon with four legs, which is characteristic of the advanced late Avar period. The distribution of the Avar period belt sets shows that these were equally used throughout the range, i.e. by all ethnic groups in the Avar region. Concentrations around Szeged and Szentes indicate the location of the center of Avar Empire; the concentration in the Vienna Basin possibly gives a clue as to the location of the second Avar Khaganate.

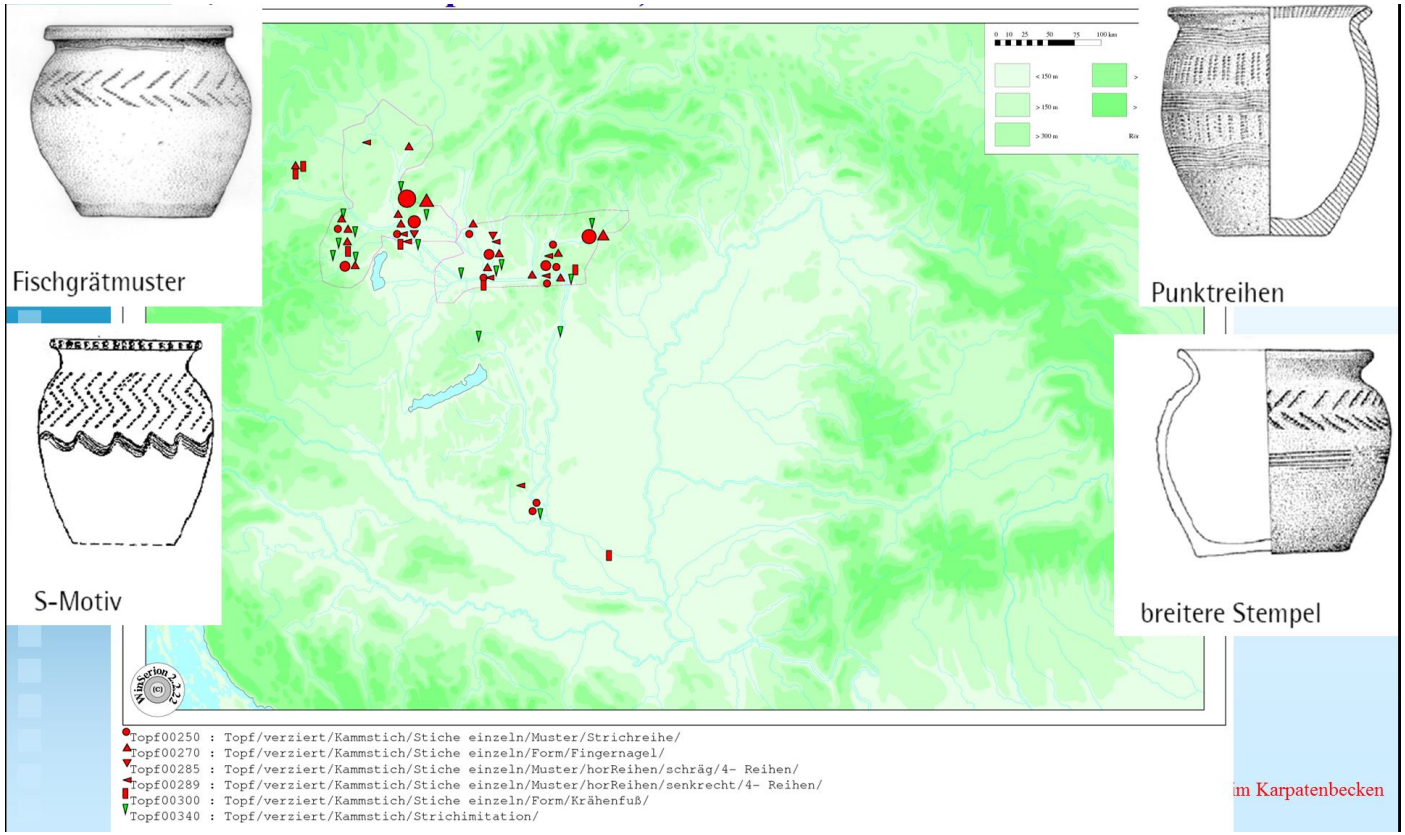


Figure 23: Distribution of comb stamp in the Avar Empire.

Comb stamp is a characteristic decoration of middle to late Avar period vessels. It can occur as herringbone, in an S-shaped arrangement or simply as vertical lines. It is notable for these types dated to the middle Avar period that they are concentrated, with a few exceptions from the area of Pécs, in the Northwest group of the Avar Empire.

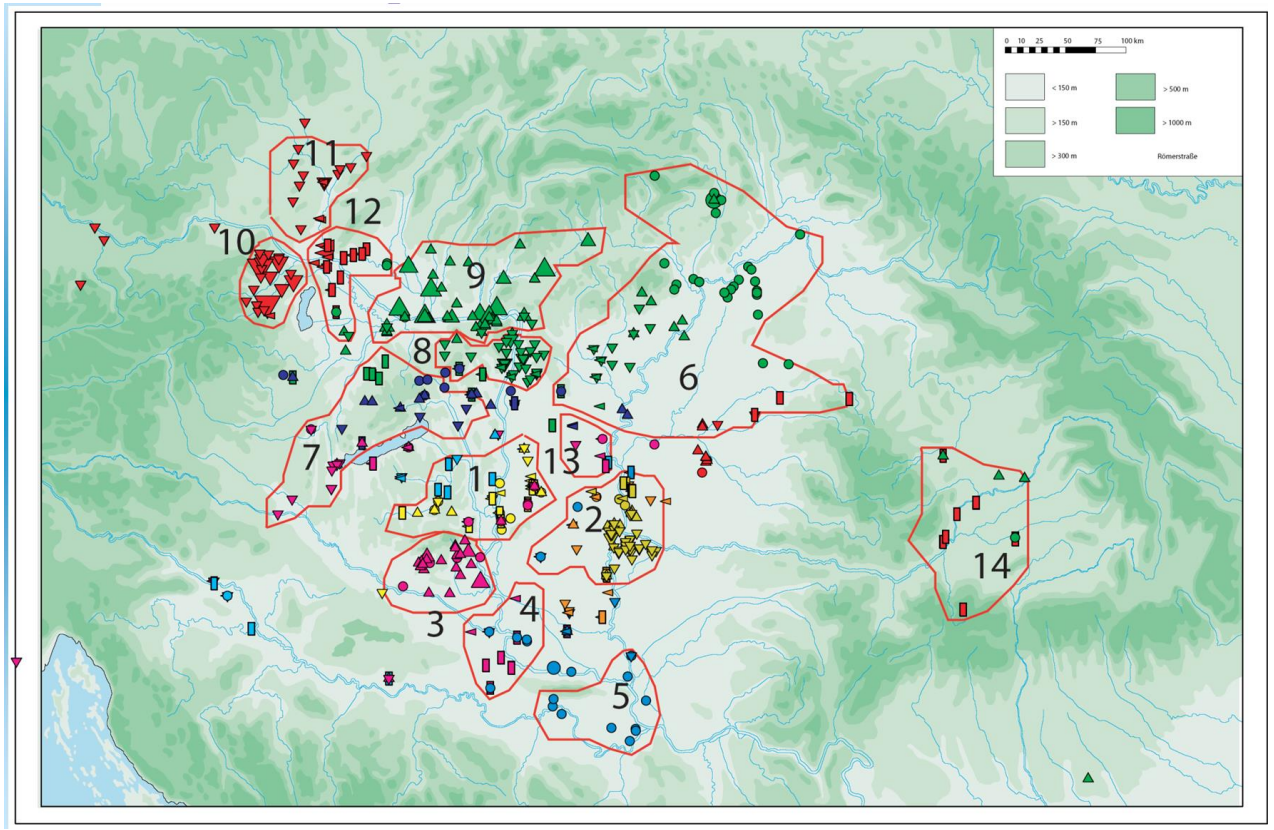


Figure 24: Evaluation of all ceramic characteristics of about 10,000 pots as grave goods in an analysis of the N Nearest Neighbors.

This is a combination map that attempts to summarize similarities between hundreds of ceramic characteristics. The red lines attempt to define 14 characteristic groups. The groups 10, 11 and 12 correspond to the Northwest group of the Avar region. This might have been a part of Samo's Empire.

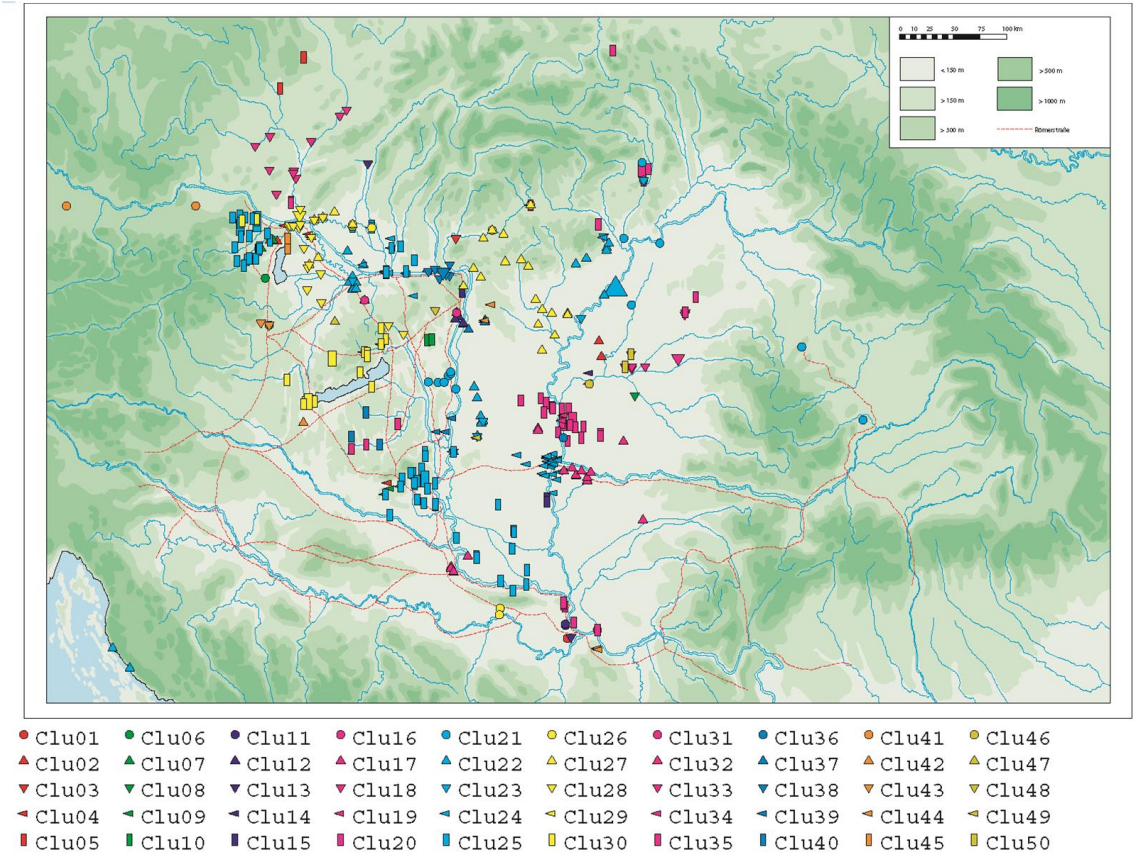


Figure 25: Analysis of the N Nearest Neighbors on the basis of cast belt fittings of late Avar period.

The investigation of all the characteristics of late Avar period cast belt fittings shows a similar result as before, likewise in an analysis of the N Nearest Neighbors. Thus, the 14 groups seem to correspond with different workshops areas in both ceramic and also cast belt fitting production.

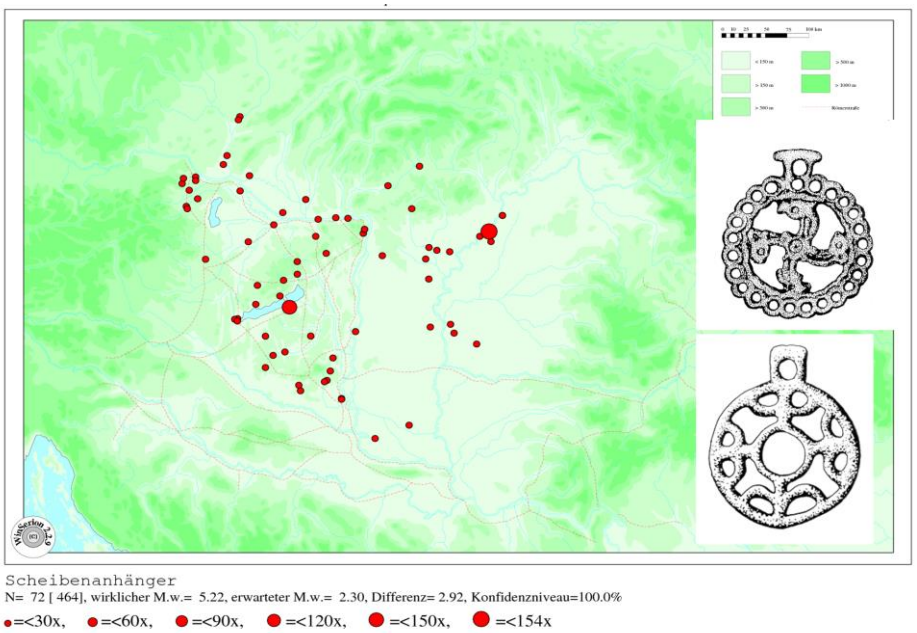


Figure 26: Distribution of the so-called Merovingian ornamental discs in the Avar region.

These ornamental discs were worn by women on "chest hangers". These Germanic women were either probably Suebes or Gepids. The main distribution of the early Avar period is in the area of the former Pannonia, where the cemetery of Zamárdi on the Balaton seems to have been the starting point, with about 140 examples. The individual pieces found in many cemeteries indicate a female exogamy, i.e. the marrying into other communities, in which the wearing of these disks was not common. From the middle Avar period the cemetery of Tiszafüred began, in which even more disks were found, numbering 154. It is therefore likely that a group of Zamárdi people around 630 A.D. emigrated to Tiszafüred.

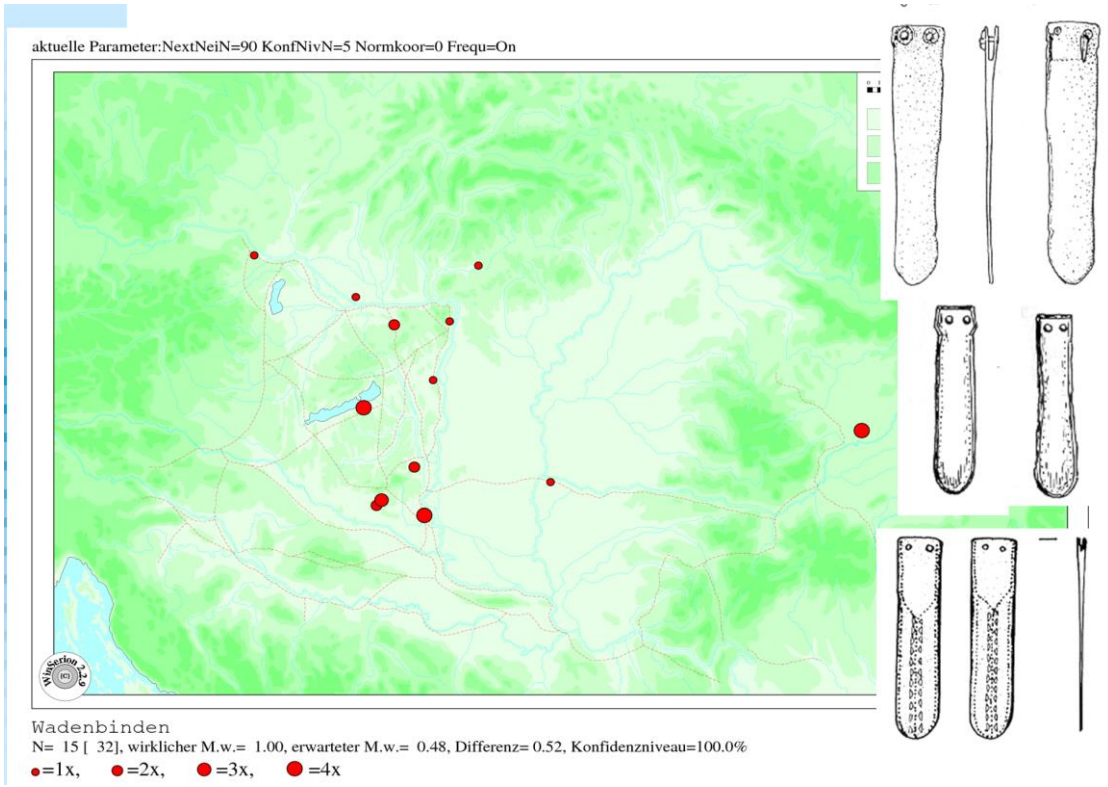


Figure 27: Distribution of early Avar period calf binding strap-ends.

Calf binding strap-ends as shown here belong to respective buckles of the so-called calf binding (Wadenbindengarnituren) or shoe fittings (Schuhgarnituren), which were worn by both men and women. These examples from the Avar region fully correspond to their Merovingian equivalents. The concentration in the former Pannonia indicates that they were used by Germanics in the Avar region.

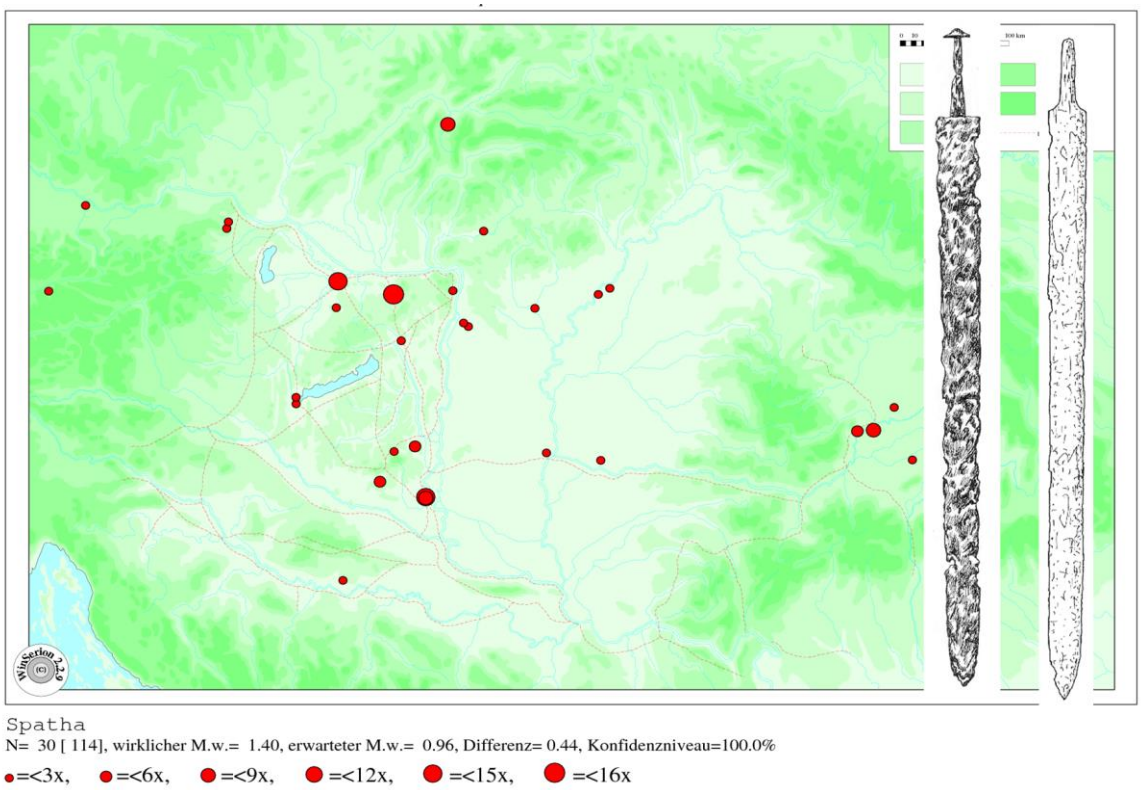


Figure 28: Distribution of early Avar period Spathae.

These "Germanic" long weapons come from cemeteries in the former Pannonia, from the Tisza, the original settlement area of the Gepids and from the second Gepid settlement area in Transylvania.

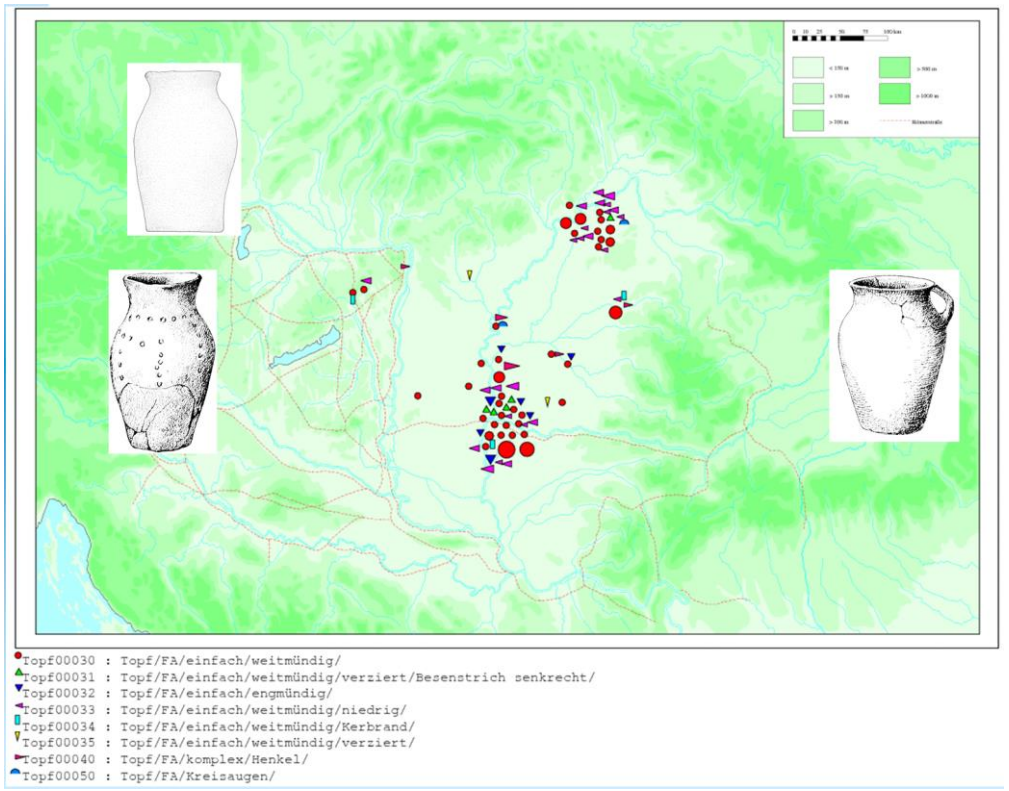


Figure 29: Distribution of funnel rim pots (Trichterrandtöpfe).

The pots can be decorated with circular eyes or equipped with handles. This pottery is closely related to that of the so-called Eastern European pastoral nomads, who besides the making of these individual, hand-made ceramics also had special features in funerary practices, namely niche and tunnel graves. All of these characteristics show a similar distribution in the early Avar period namely a group east of the middle Tisza and a second one east of the upper Tisza.

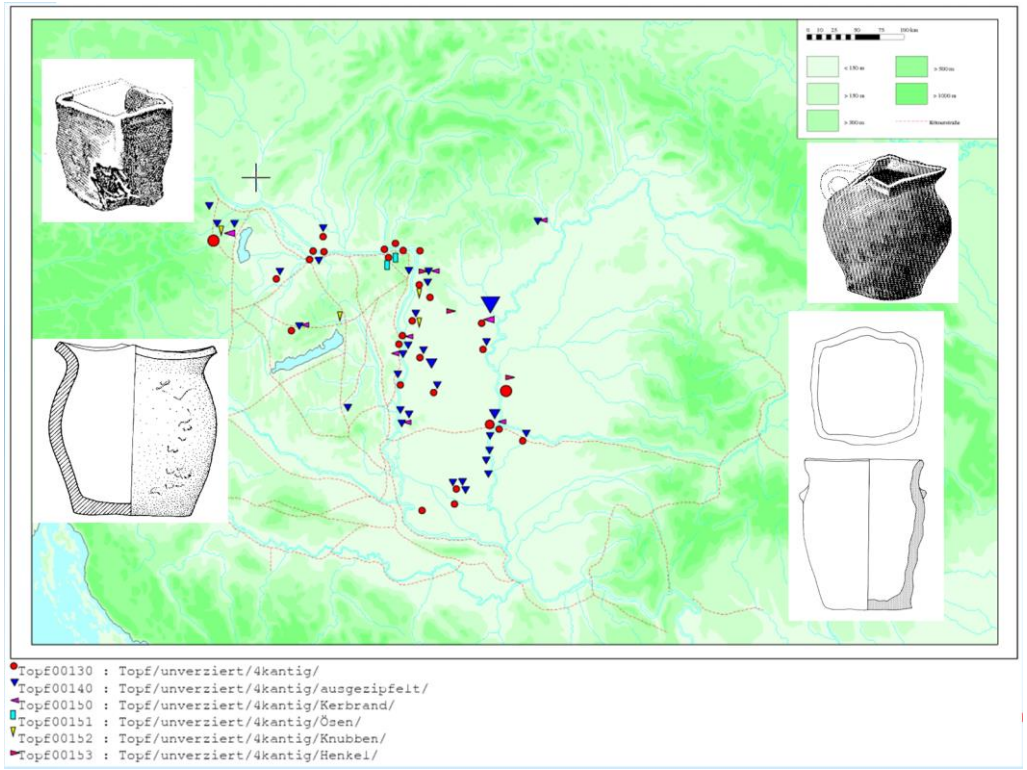


Figure 30: Distribution of four-edged vessels.

This vessel type indicates the origin of the Avars from Central Asia, where such vessels also occur. In the Avar region, they are concentrated in the early Avar period on the Danube-Tisza region, and only from the middle Avar period do they also occur in Pannonia and particularly in the Vienna Basin. Thus, this type shows, among other features, the settlement of the ethnic Avars in the early Avar period between the Danube and Tisza rivers.

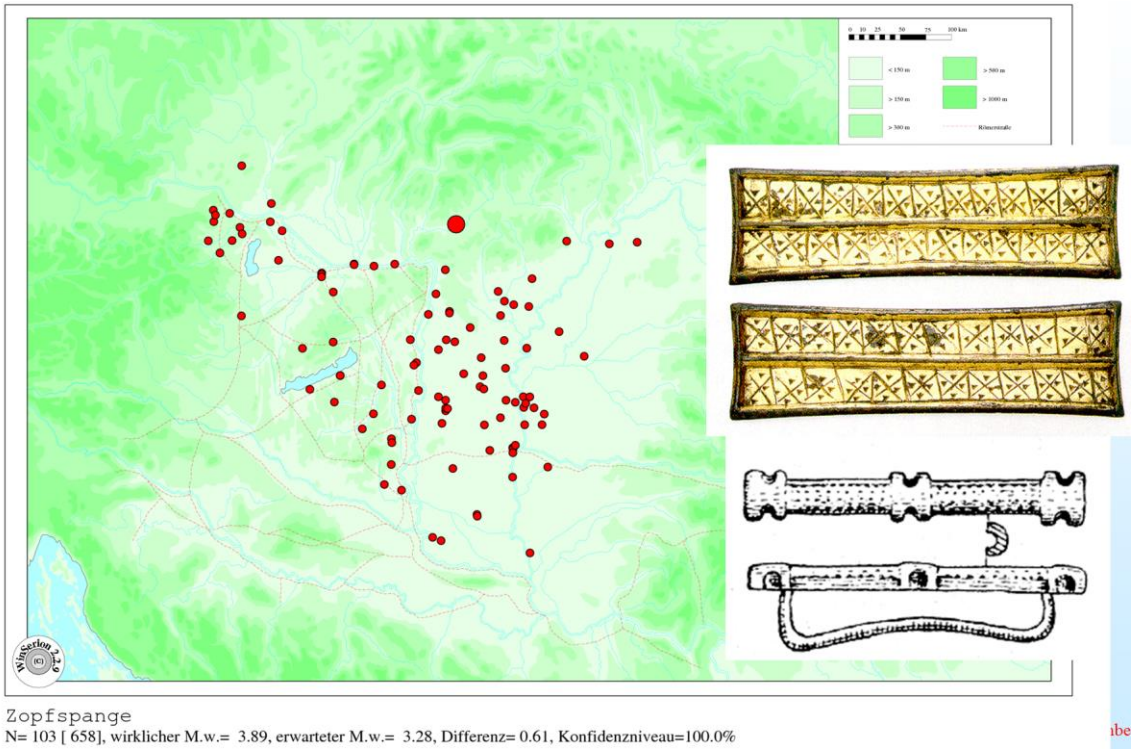


Figure 31: Distribution of plait clasps (Zopfspangen).

On their first visit to Constantinople, the Avars were described as double-plait wearers. These plaits cannot be proved by archaeology as they are gone, but the plaits clasps certainly can. In pairs, i.e., worn on two plaits, the plait clasps can have different shapes. It is quite clear that this is a fashion that only concerned men. In the early Avar period, we only know of plait clasps from the area between the Danube and the Tisza, and only later do they appear particularly in the Vienna Basin. In addition to earrings in men's graves and the four-edged pots, they provide a key feature for recognizing ethnic Avars there.

Global mapping with GoogleMapper.

To date, image data has been collected from about **60,000** archaeological sites in Central Europe. The sites were automatically geocoded with the use of our program **MonteliusEntryGoogleCode** in cooperation with Google Maps giving known address information from this database. Our program **GoogleMapper** allows mapping the collected data onto any portion of Google Maps. Here are just a few examples:

Maps of GoogleMapper with sites of a country.

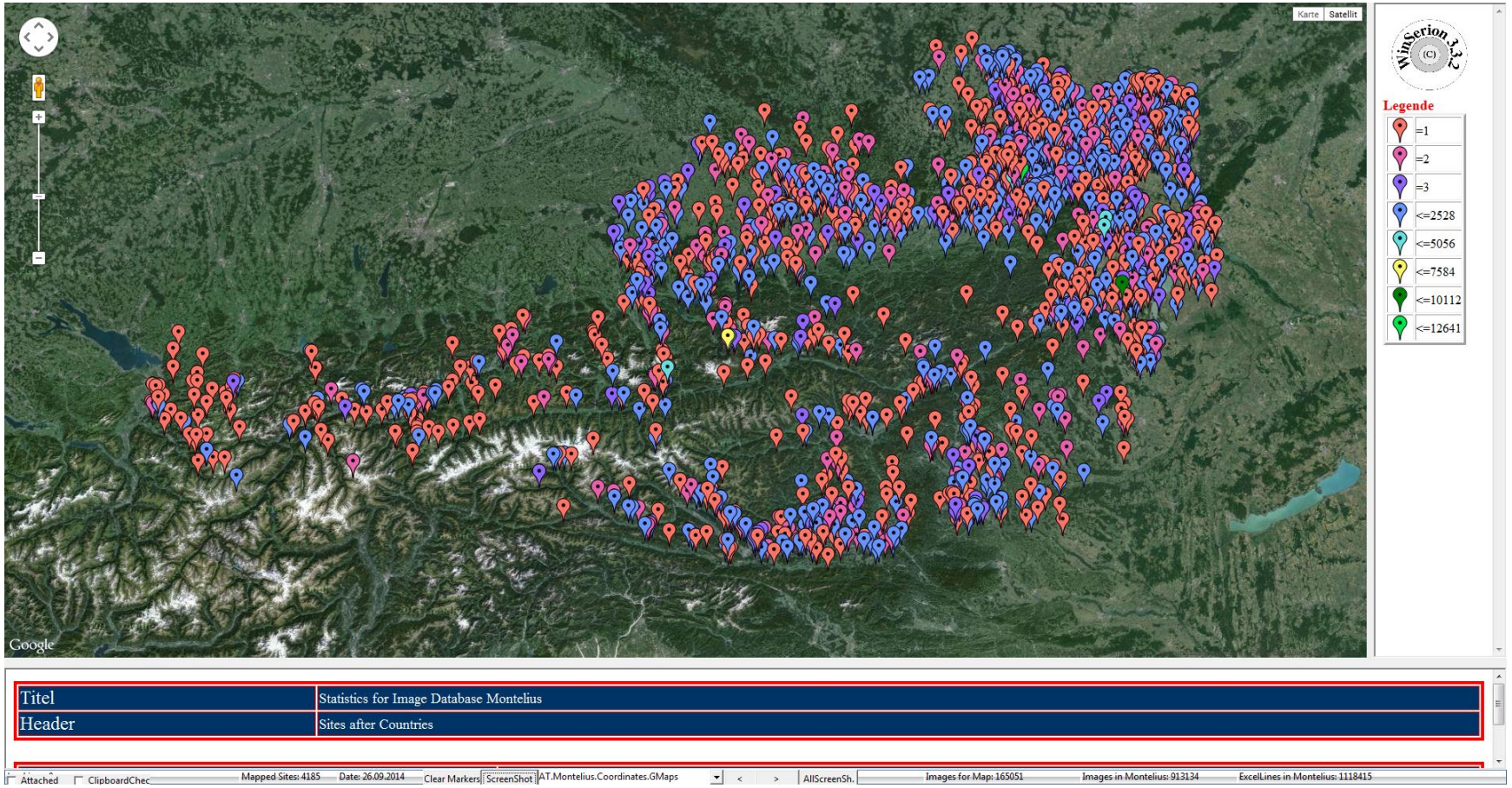


Figure 32: Sites in Image Database Montelius for Austria.

All currently recorded 4.185 sites from Austria reveal which parts of the country were settled. From these sites 165.051 images are in Montelius.

Germany and Hungary, like many other countries in Central Europe, have already been very well recorded:

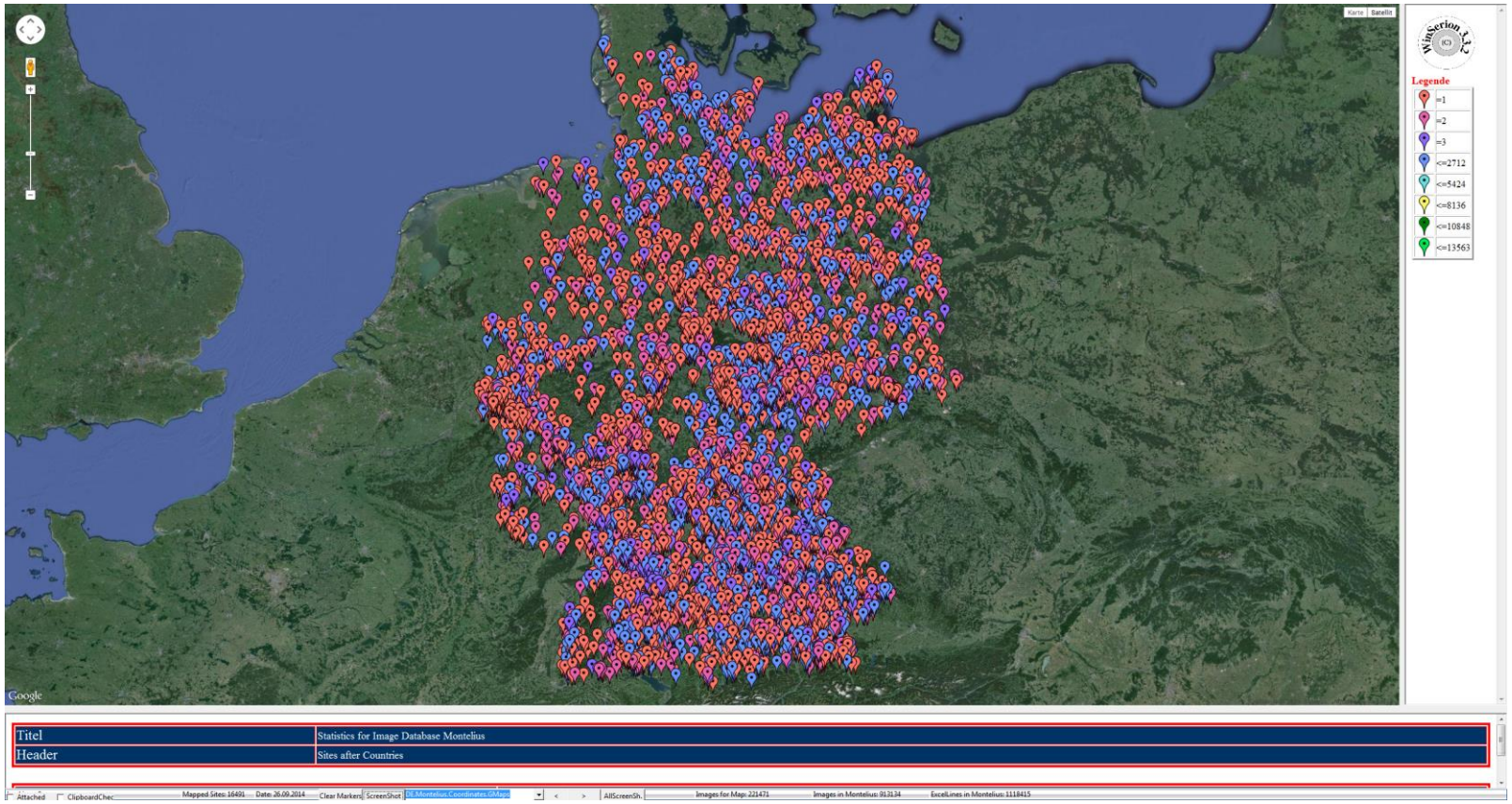


Figure 33: Sites in Image Database Montelius for Germany.

Here is Germany with 16.491 archaeological sites (bottom line left), the number of Images in the German part of Montelius is 221.471, see this information in the line below the graphic. The total number of checked images in Montelius is now 913.134, as shown at the bottom right.

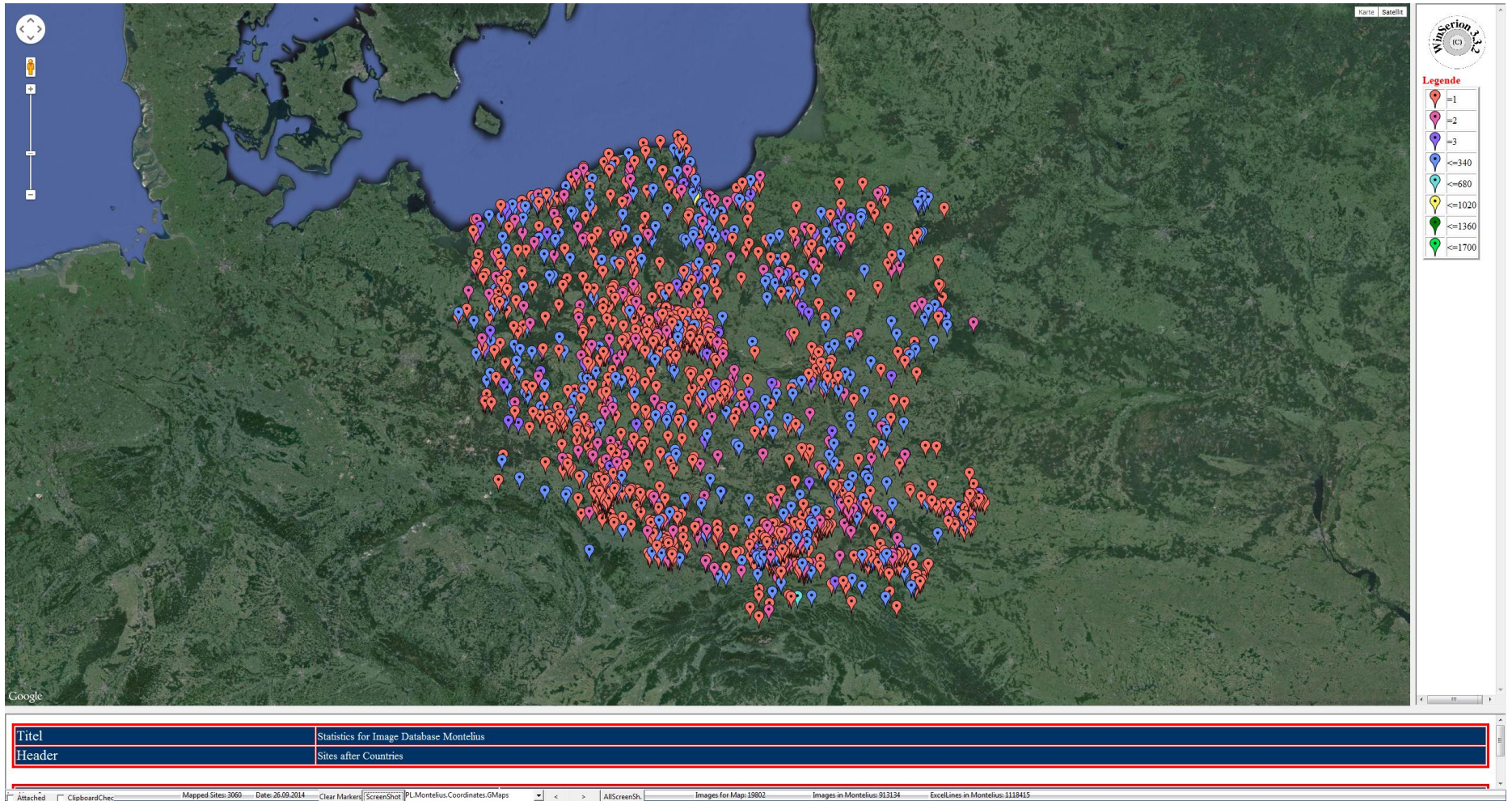


Figure 34: Sites in Image Database Montelius for Poland.

From Poland 3.060 sites are known in Montelius with 19.802 images.

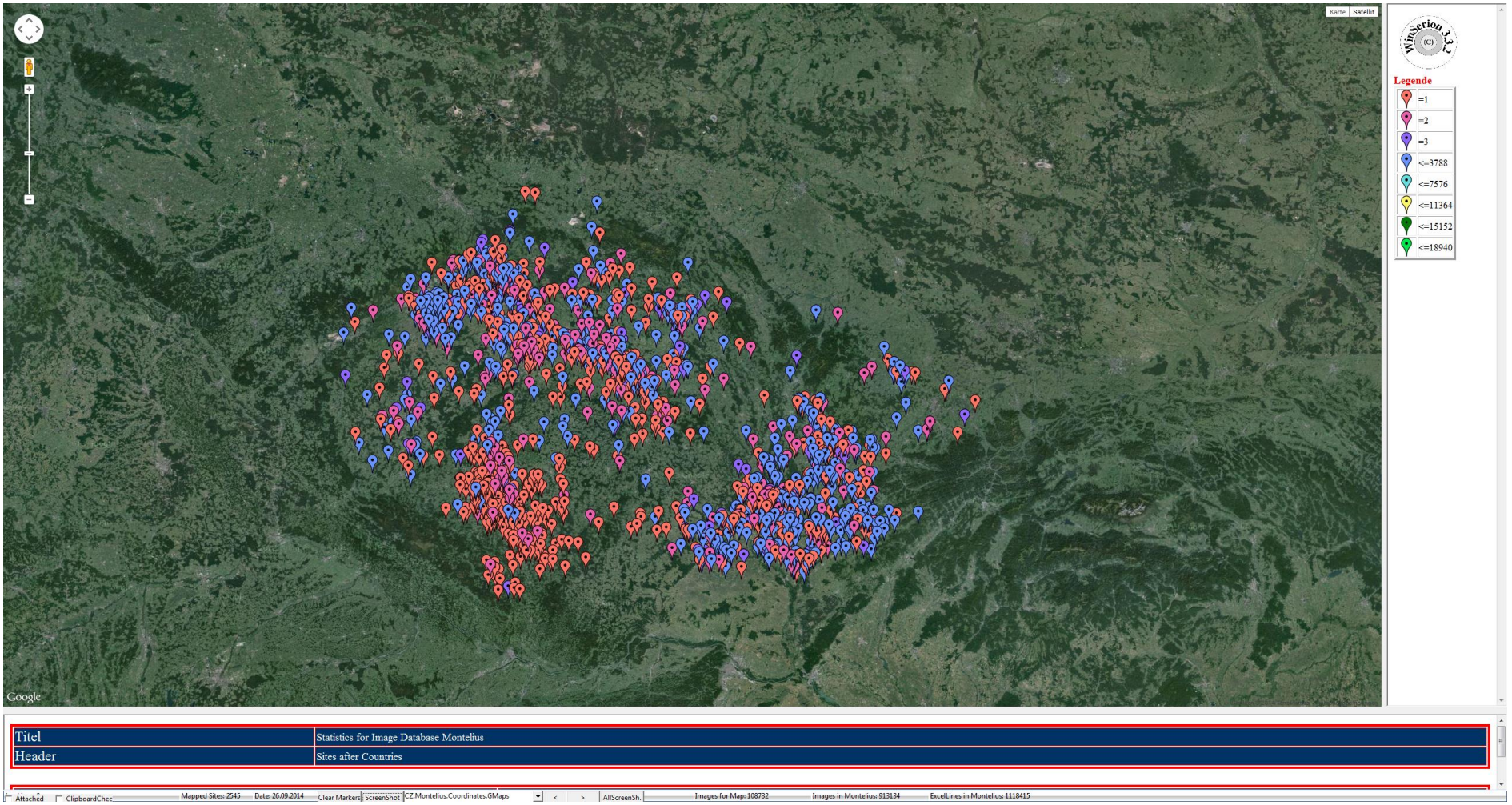


Figure 35, Sites in Image Database Montelius for Czech Republic.

Here Czech Republic with 2.545 sites with 108.732 images.

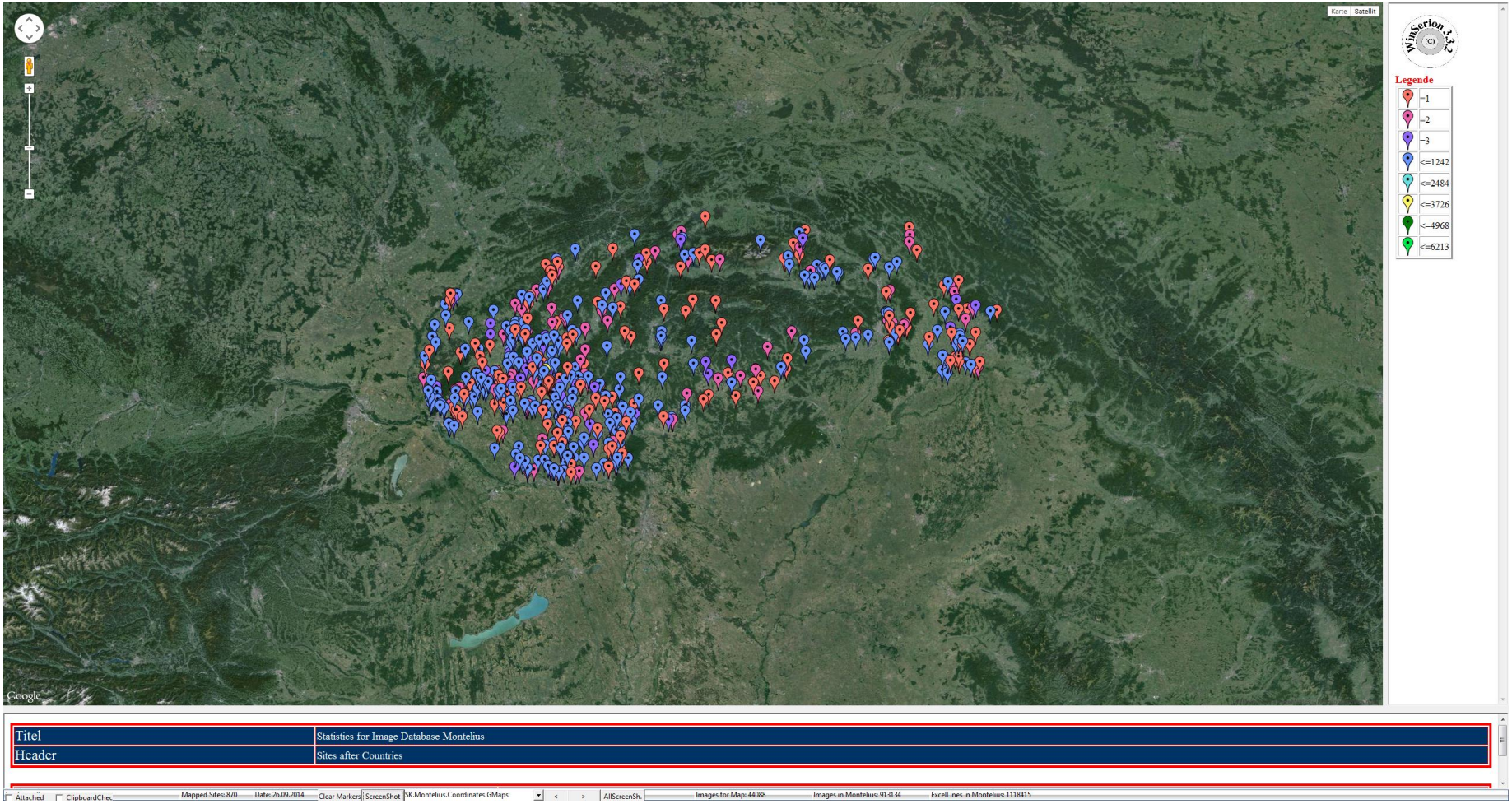


Figure 36: Sites in Image Database Montelius for Slovakia.

Here Slovakia with 870 sites together with 44.088 images.

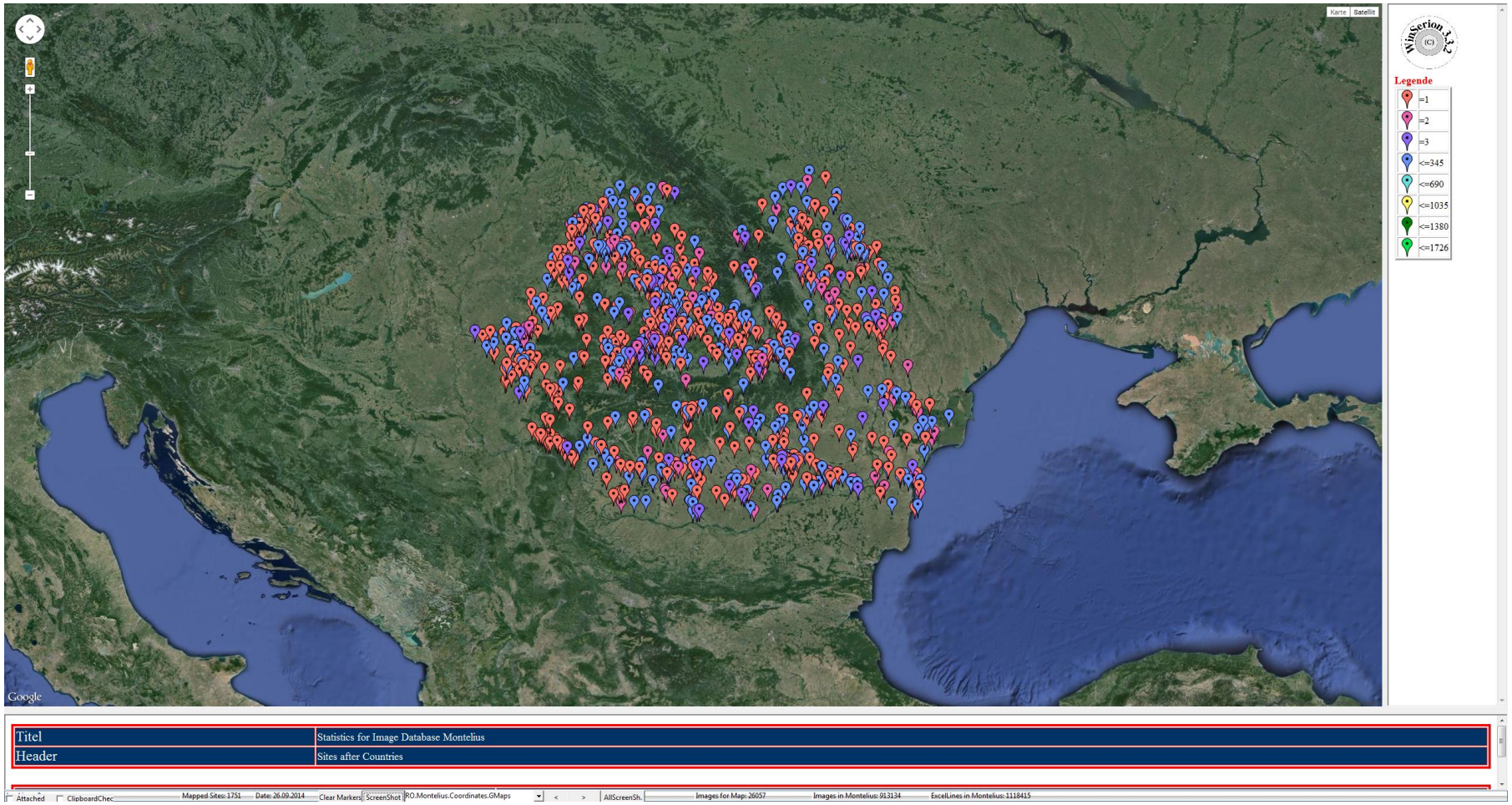


Figure 37: Sites in Image Database Montelius for Romania.

From Romania data from 1.751 sites have been collected together with 26.057 images.

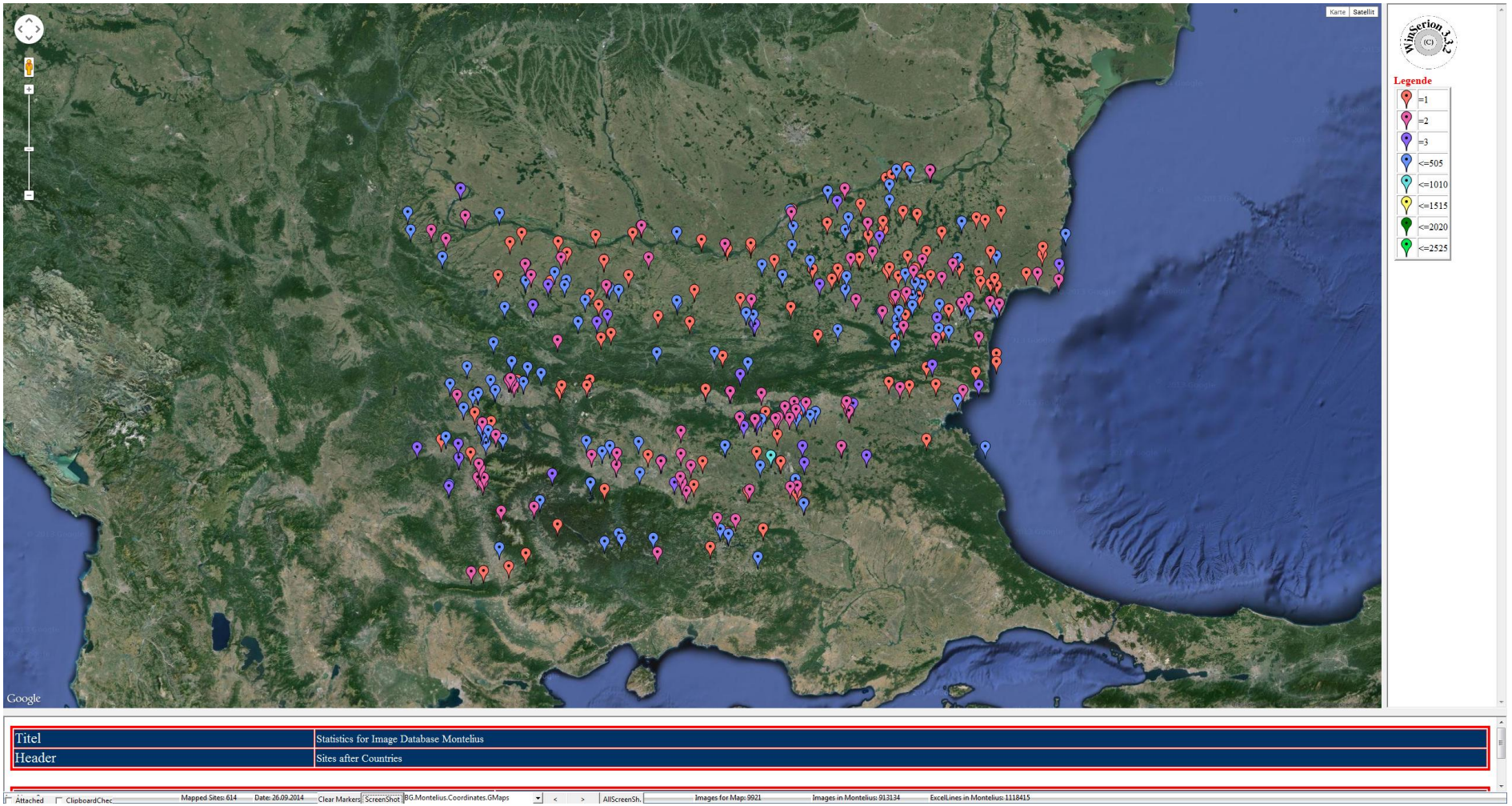


Figure 38: Sites in Image Database Montelius for Bulgaria.

For Bulgaria 614 sites have been entered, from them we have 9.921 images.

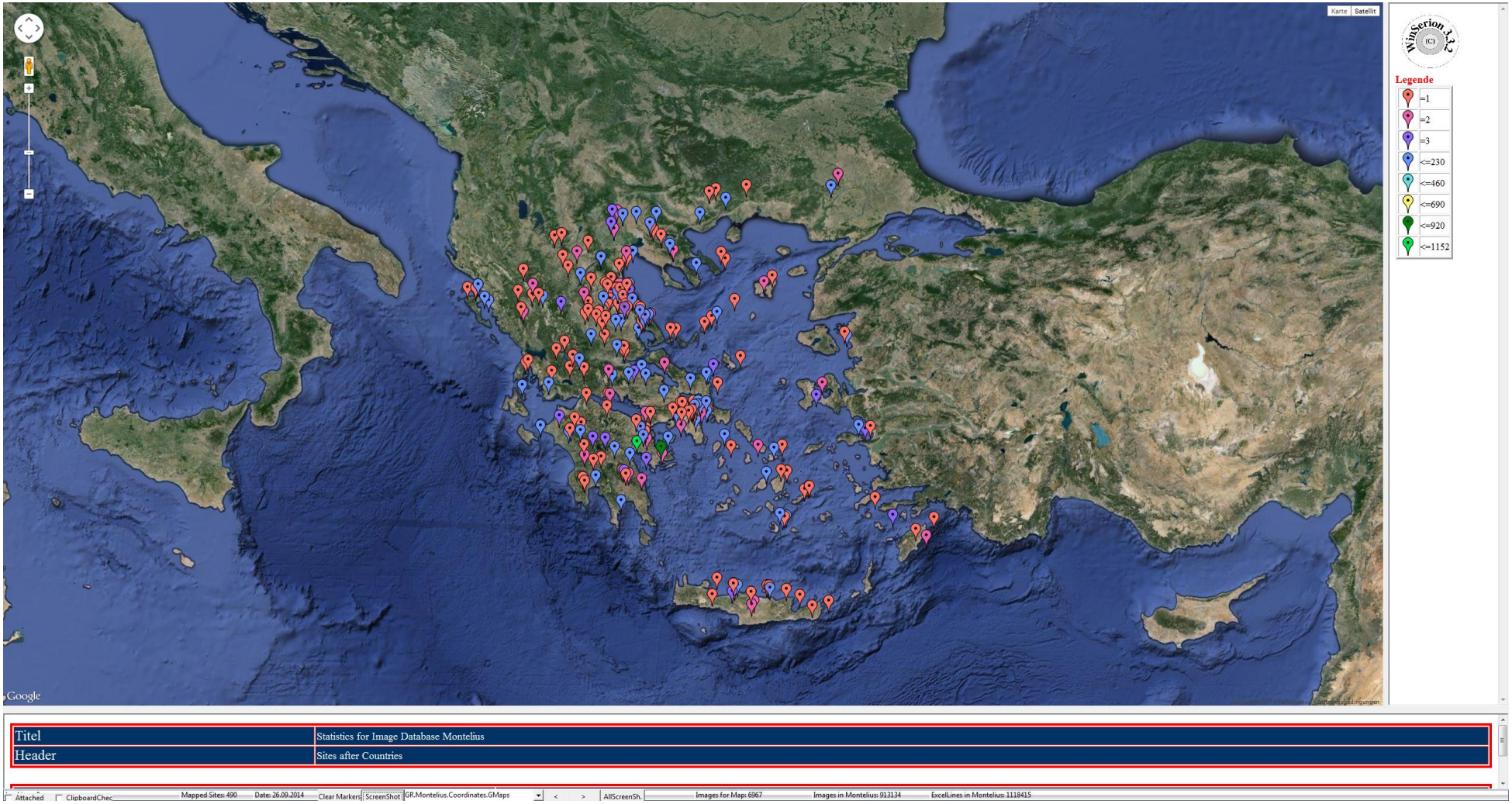


Figure 39: Sites in Image Database Montelius for Greece.

In Greece we know 490 sites with 6.967 images.

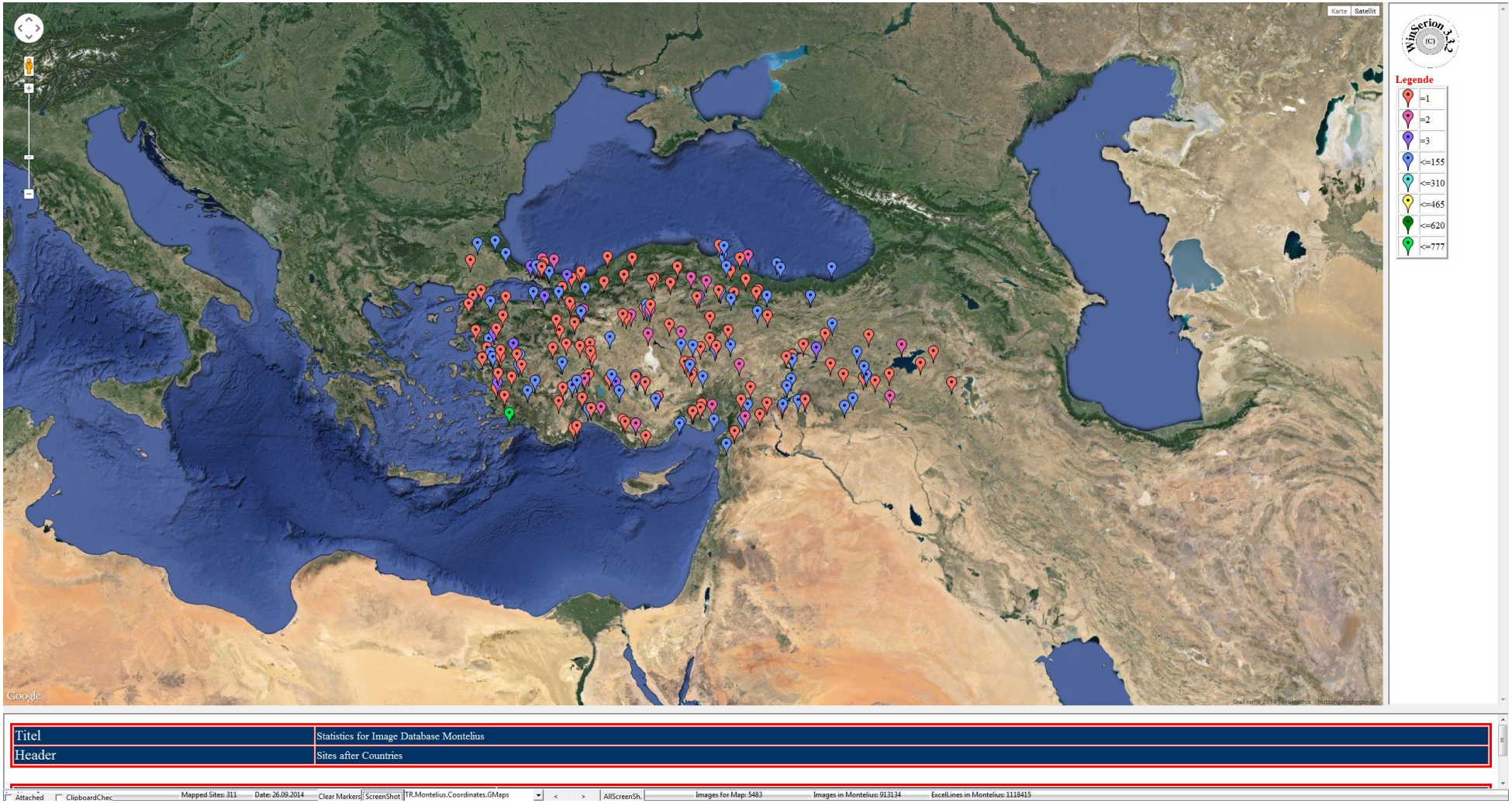


Figure 40: Sites in Image Database Montelius for Turkey.

In Turkey we know 311 sites with 5.483 images.

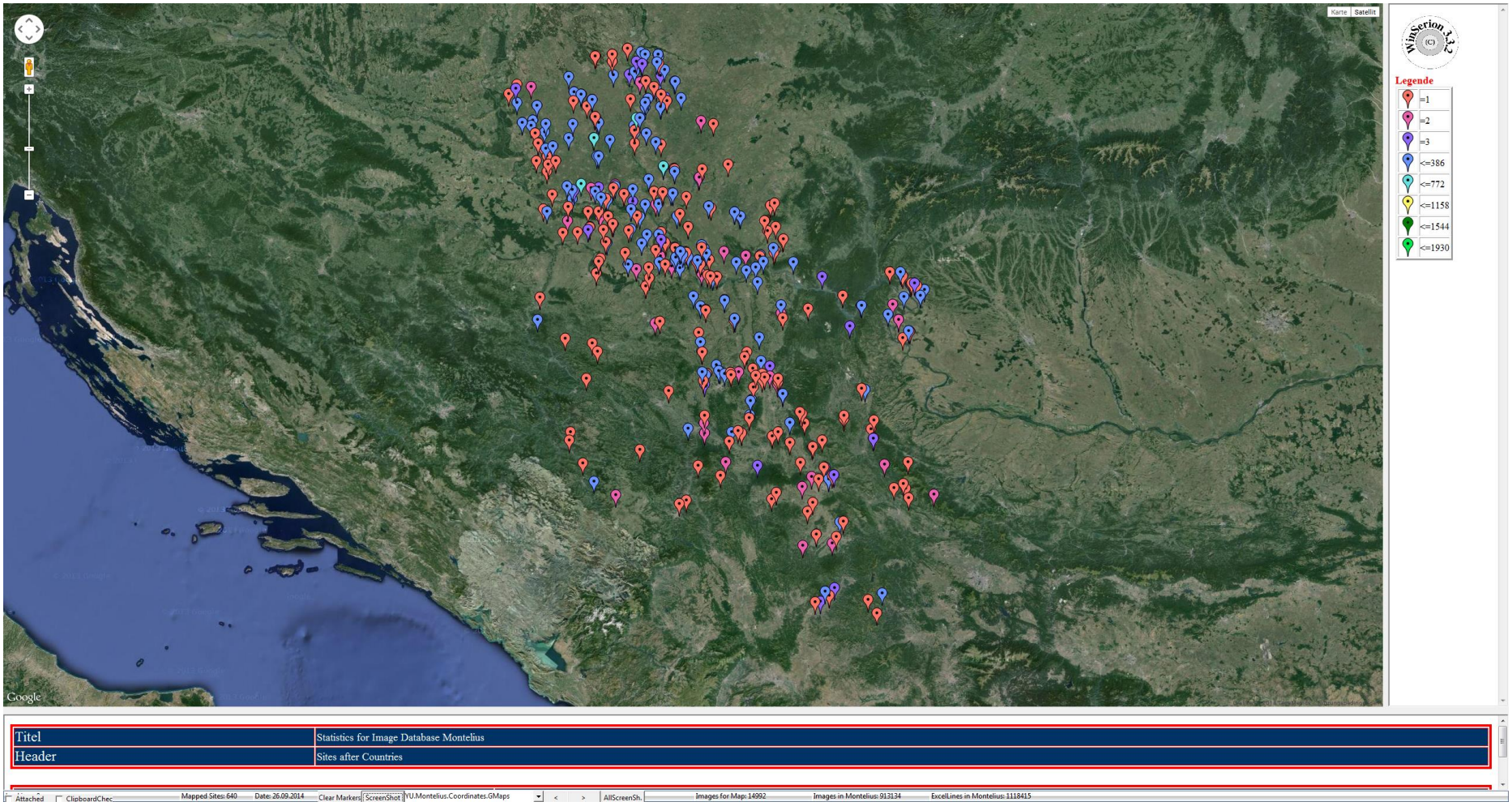


Figure 41: Sites in Image Database Montelius for Serbia.

For Serbia data from 640 sites have been collected together with 14.992 images.

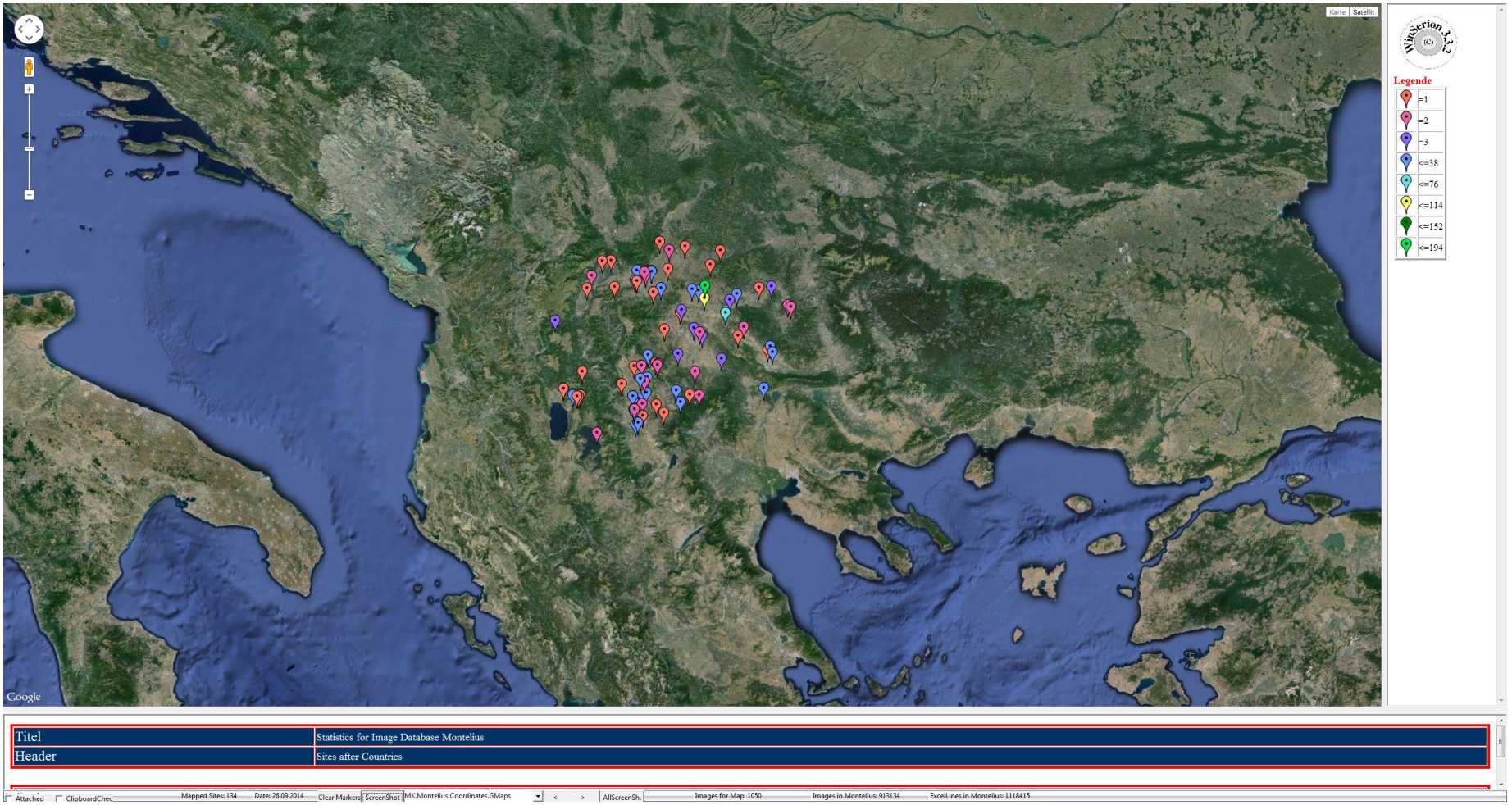


Figure 42: Sites in Image Database Montelius for Macedonia.

For Macedonia data from 134 sites have been collected together with 1.050 images.

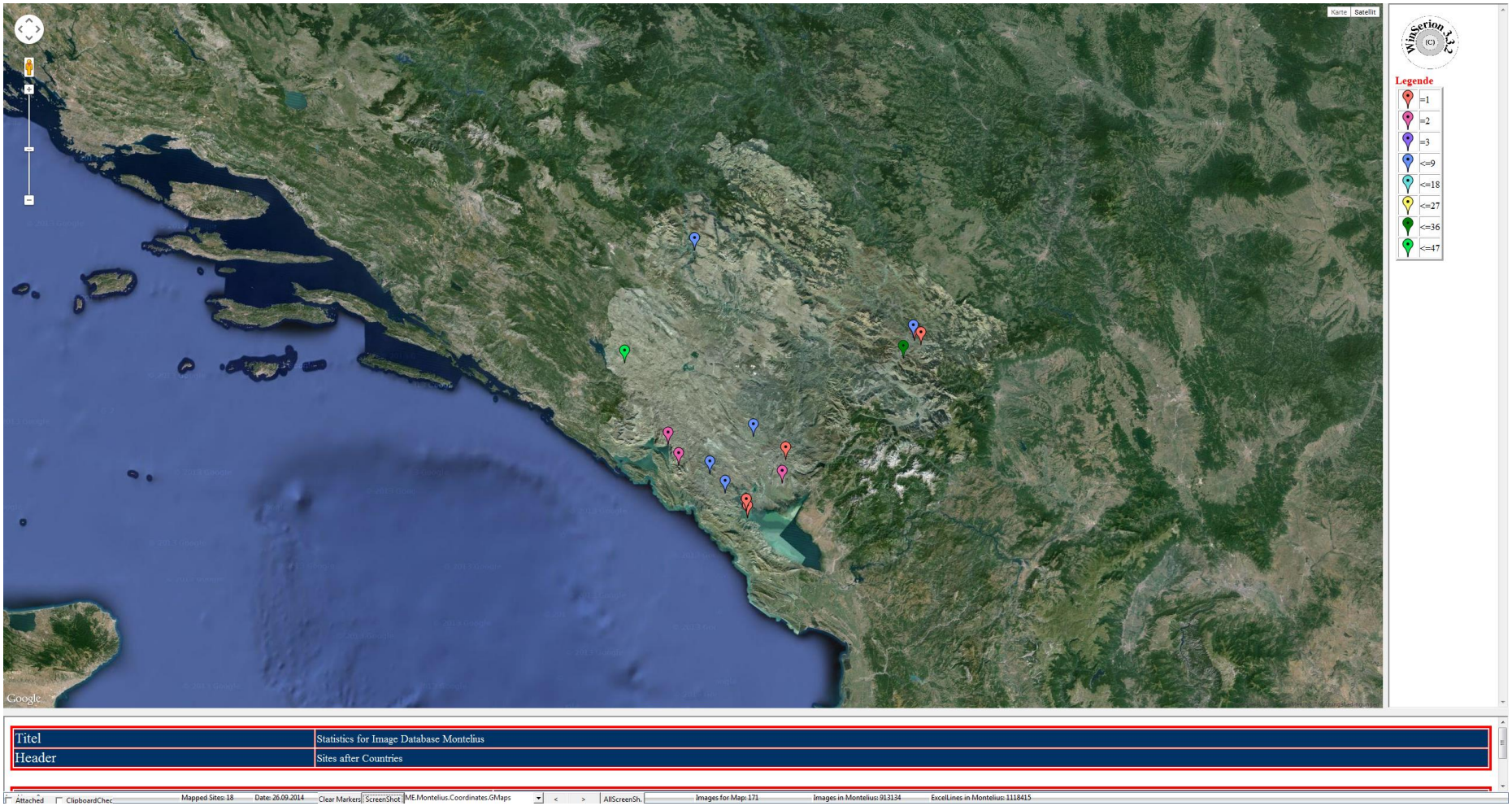


Figure 43: Sites in Image Database Montelius for Montenegro.

For Montenegro data from 18 sites have been collected together with 171 images.

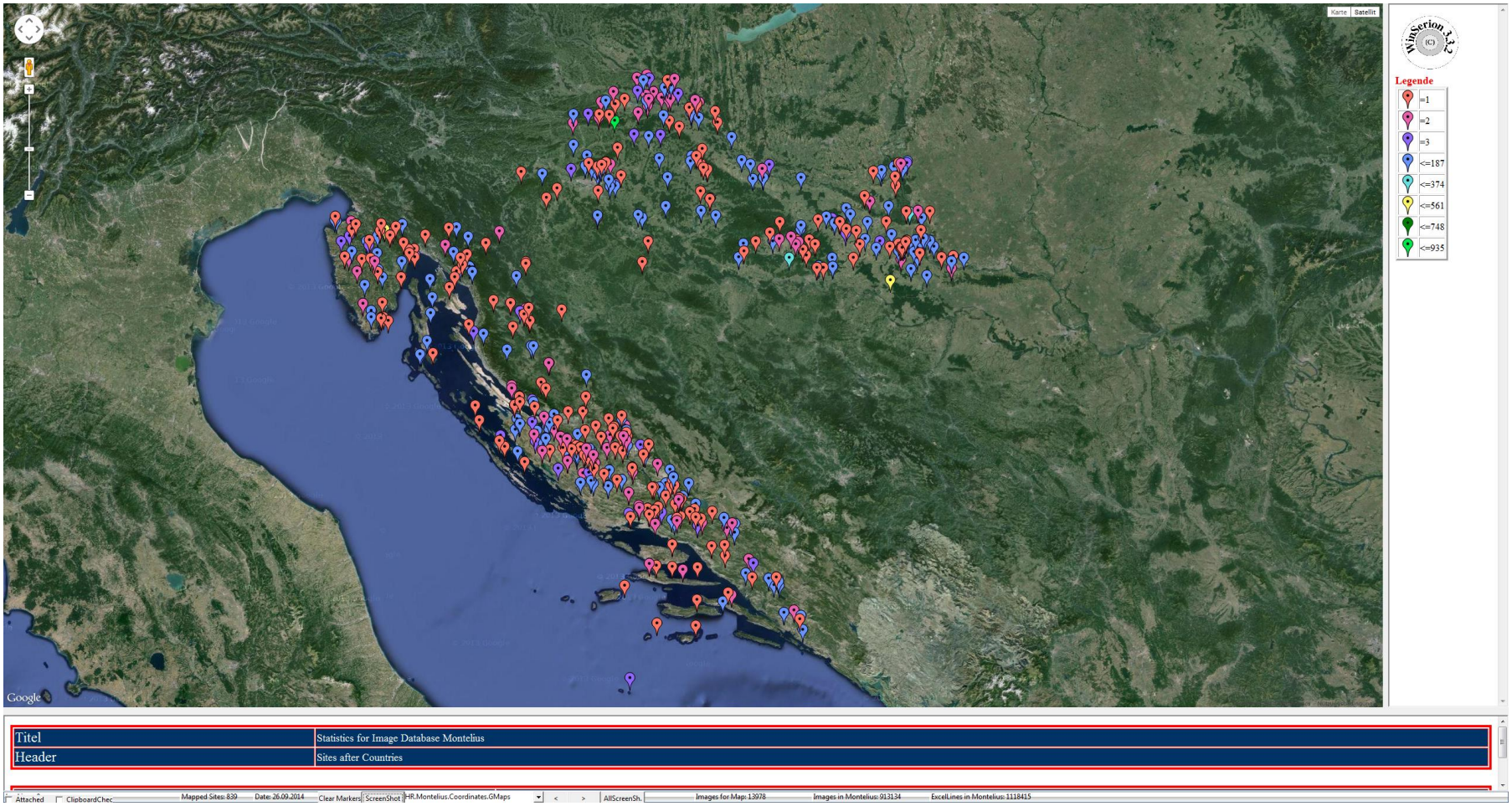


Figure 44: Sites in Image Database Montelius for Croatia.

In Croatia 839 sites have been recorded with 13.987 images.

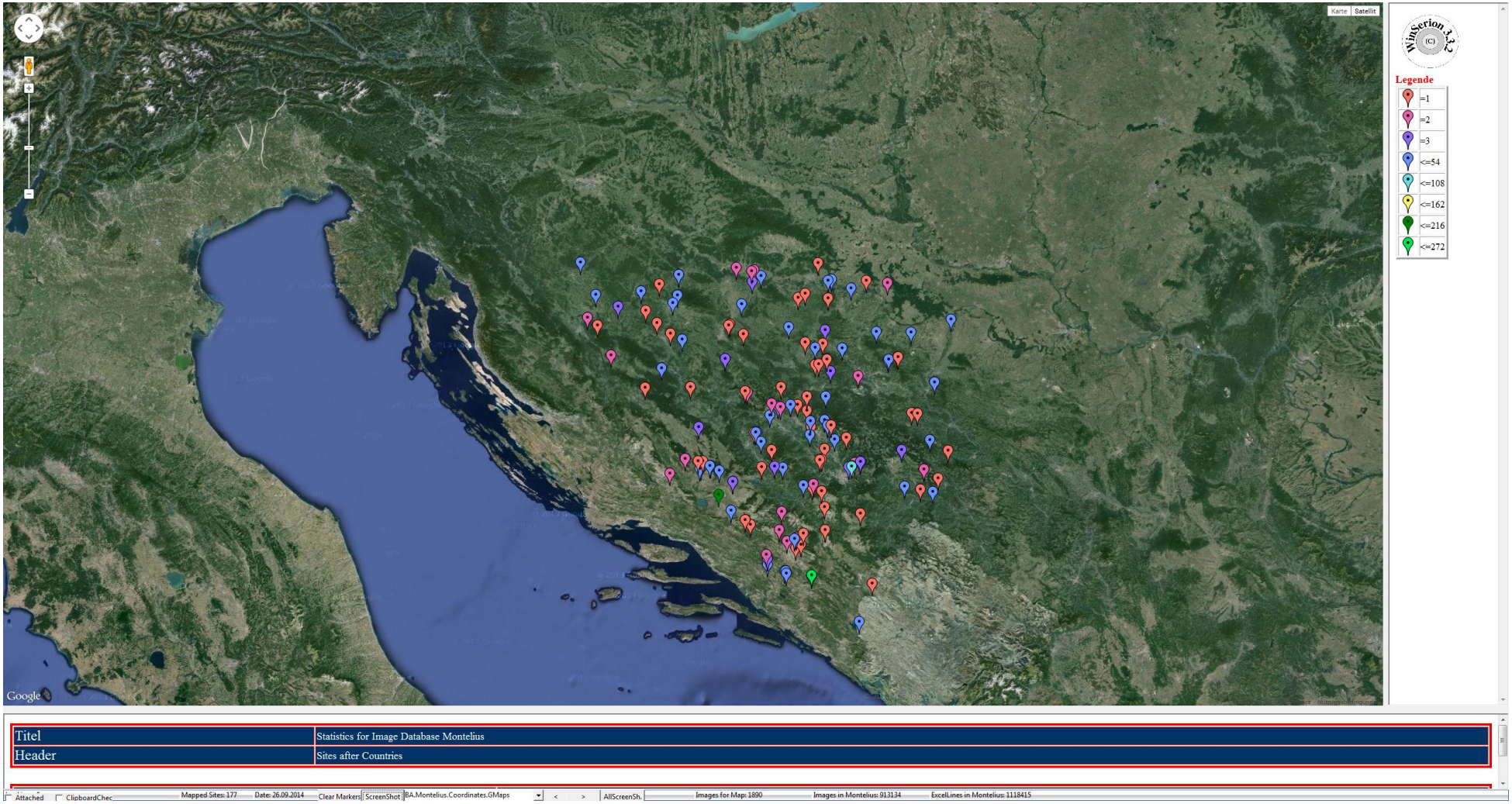


Figure 45: Sites in Image Database Montelius for Bosnia and Herzegovina.

From Bosnia and Herzegovina 177 sites are known with 1.890 images.

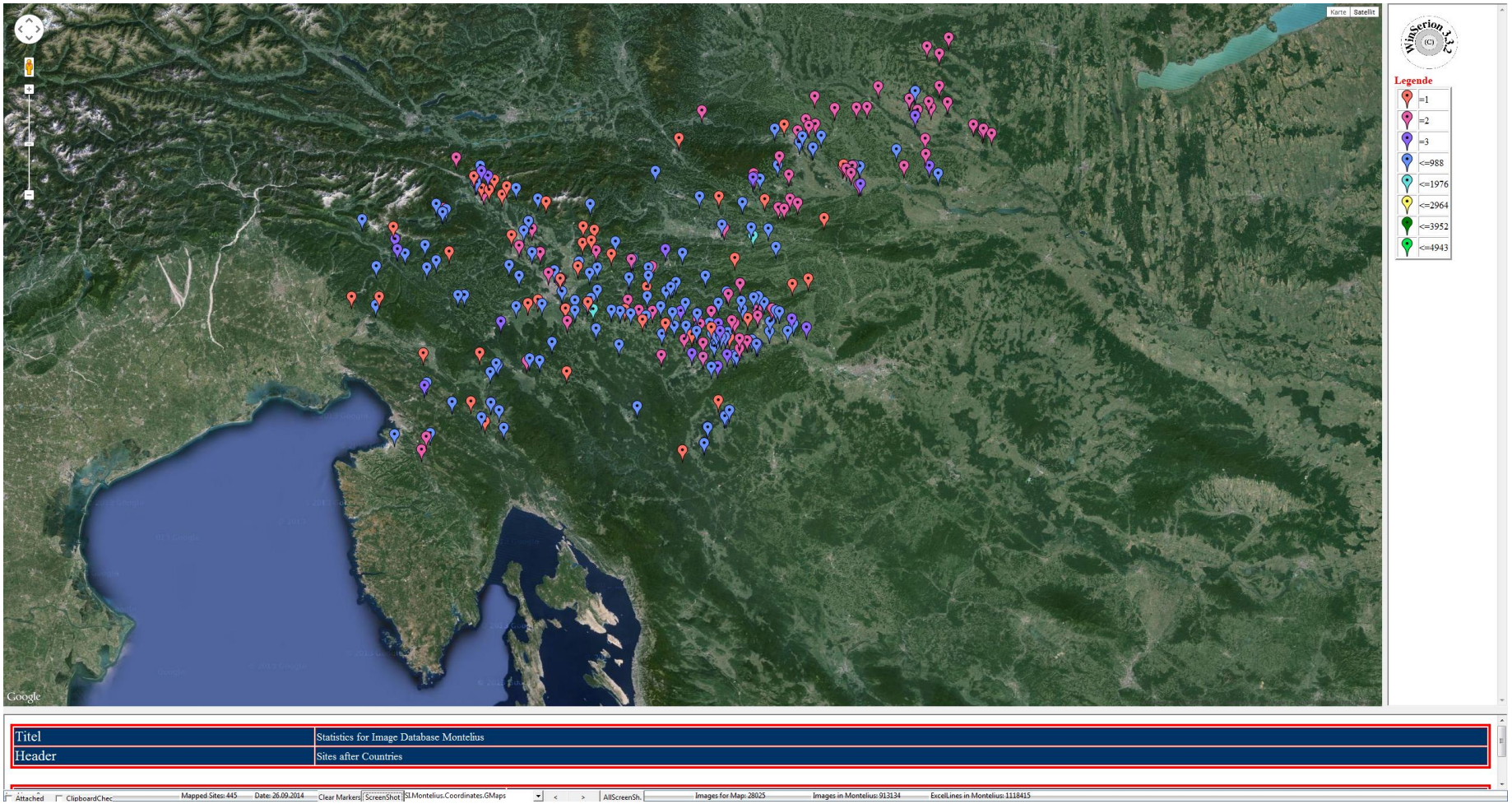


Figure 46: Sites in Image Database Montelius for Slovenia.

For Slovenia 445 sites are known to Montelius with 28.095 images.

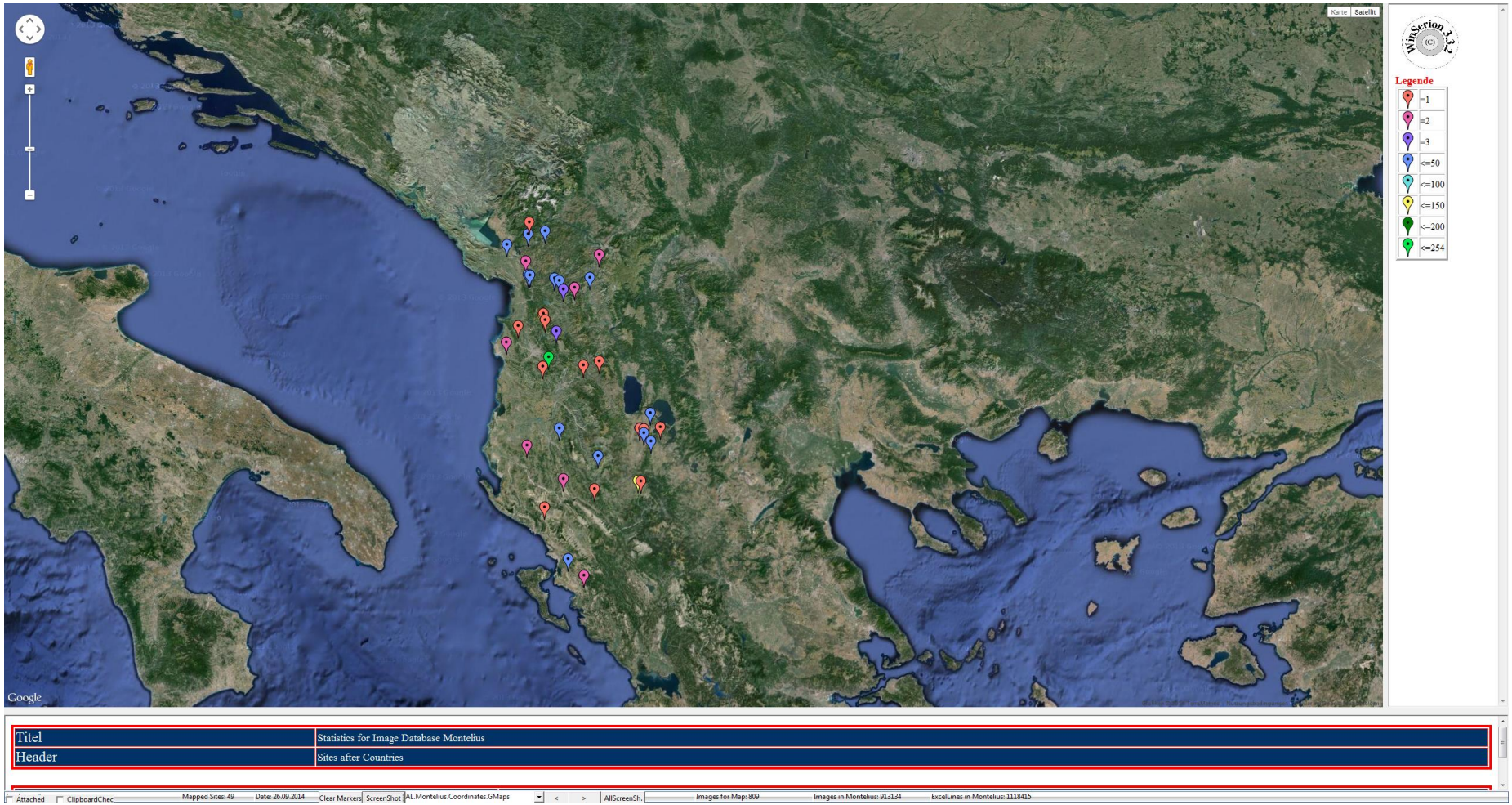


Figure 47: Sites in Image Database Montelius for Albania.

From Albania 49 sites are known with 809 images.

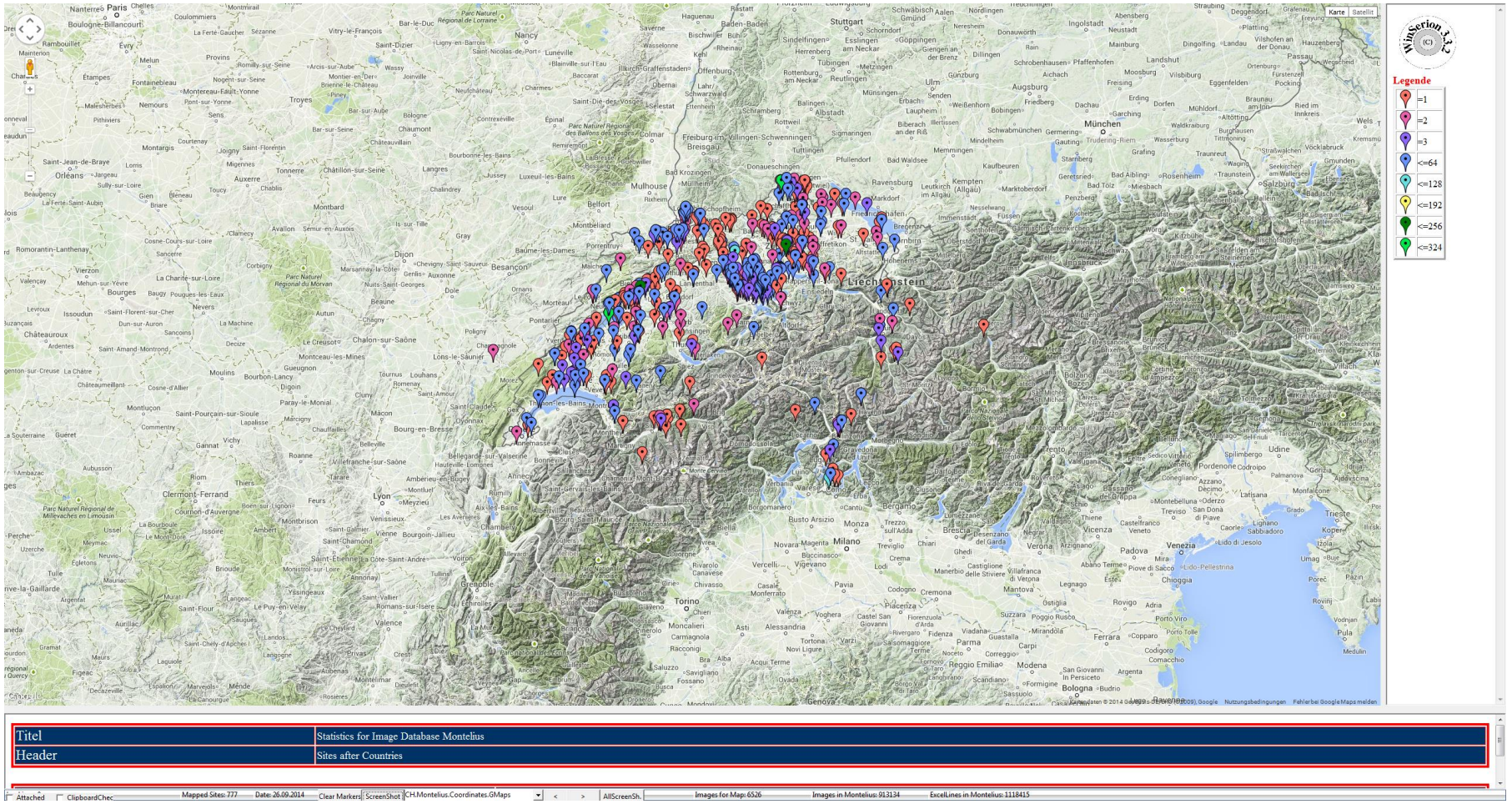


Figure 48: Sites in Image Database Montelius for Switzerland.

In Switzerland we have information of 777 sites with 6.526 images.

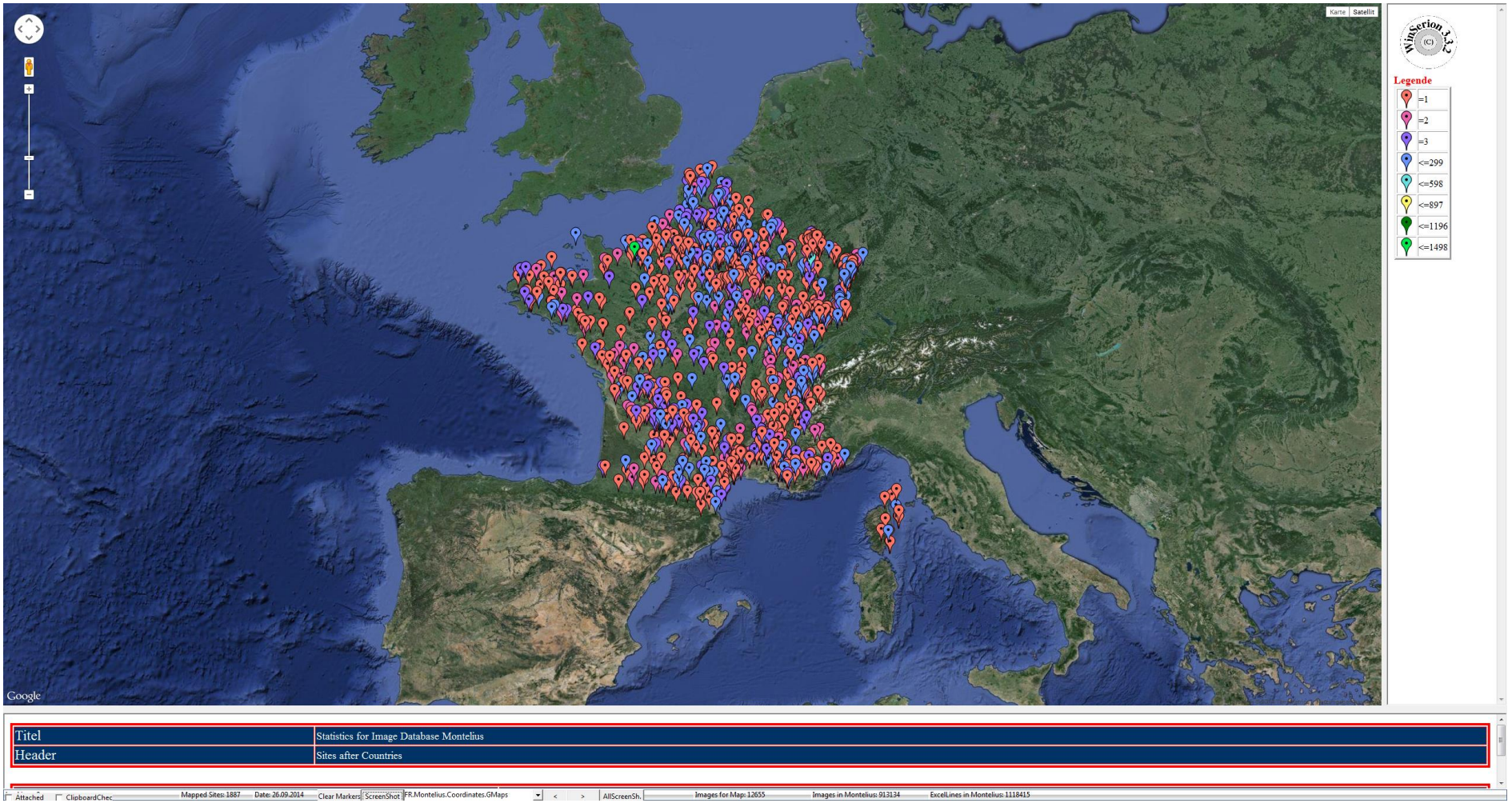


Figure 49: Sites in Image Database Montelius for France.

In France currently 1.887 sites have been collected with 12.655 images.

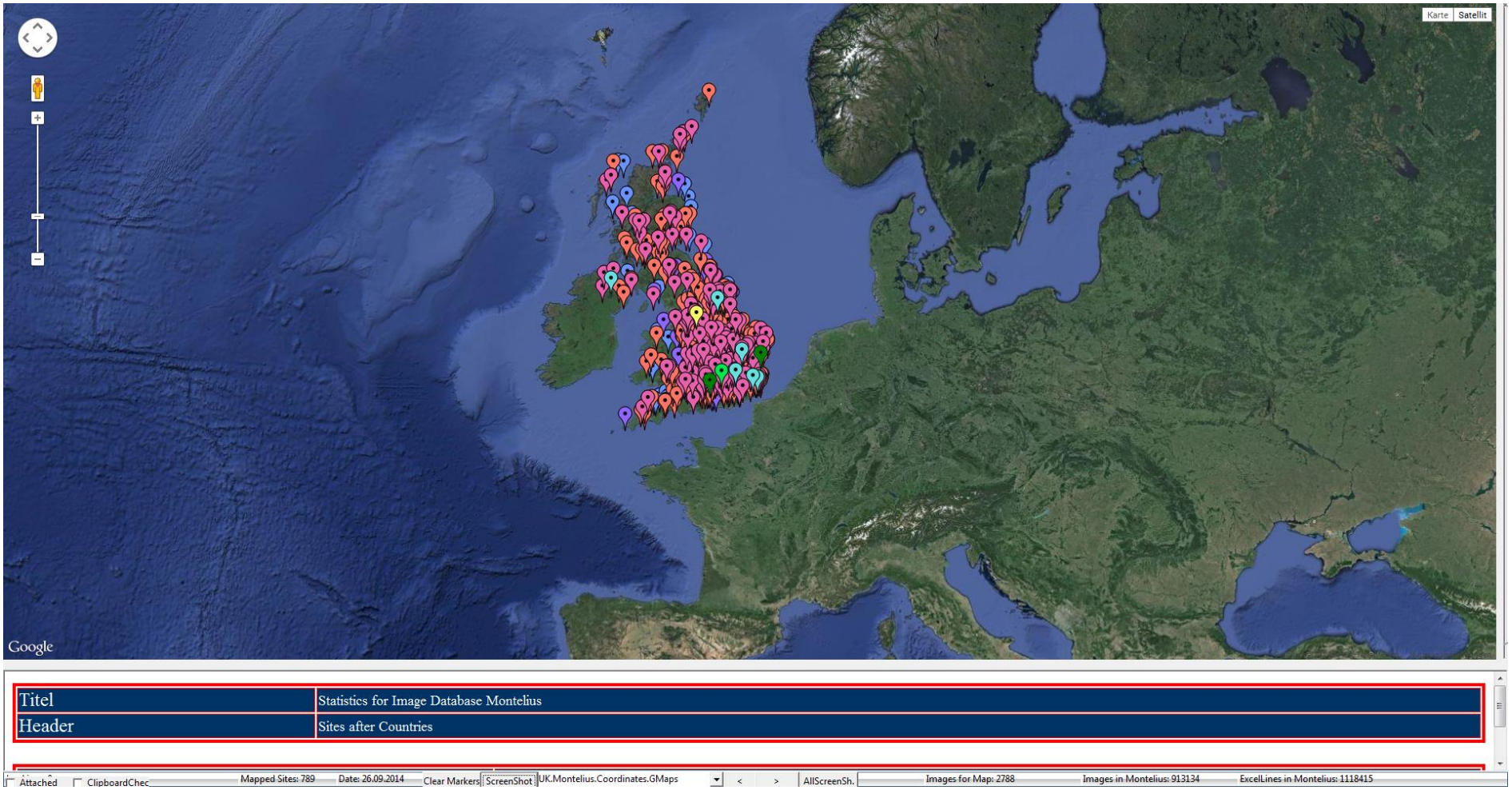


Figure 50: Sites in Image Database Montelius for United Kingdom.

For the United Kingdom we map 789 sites with 2.779 images.

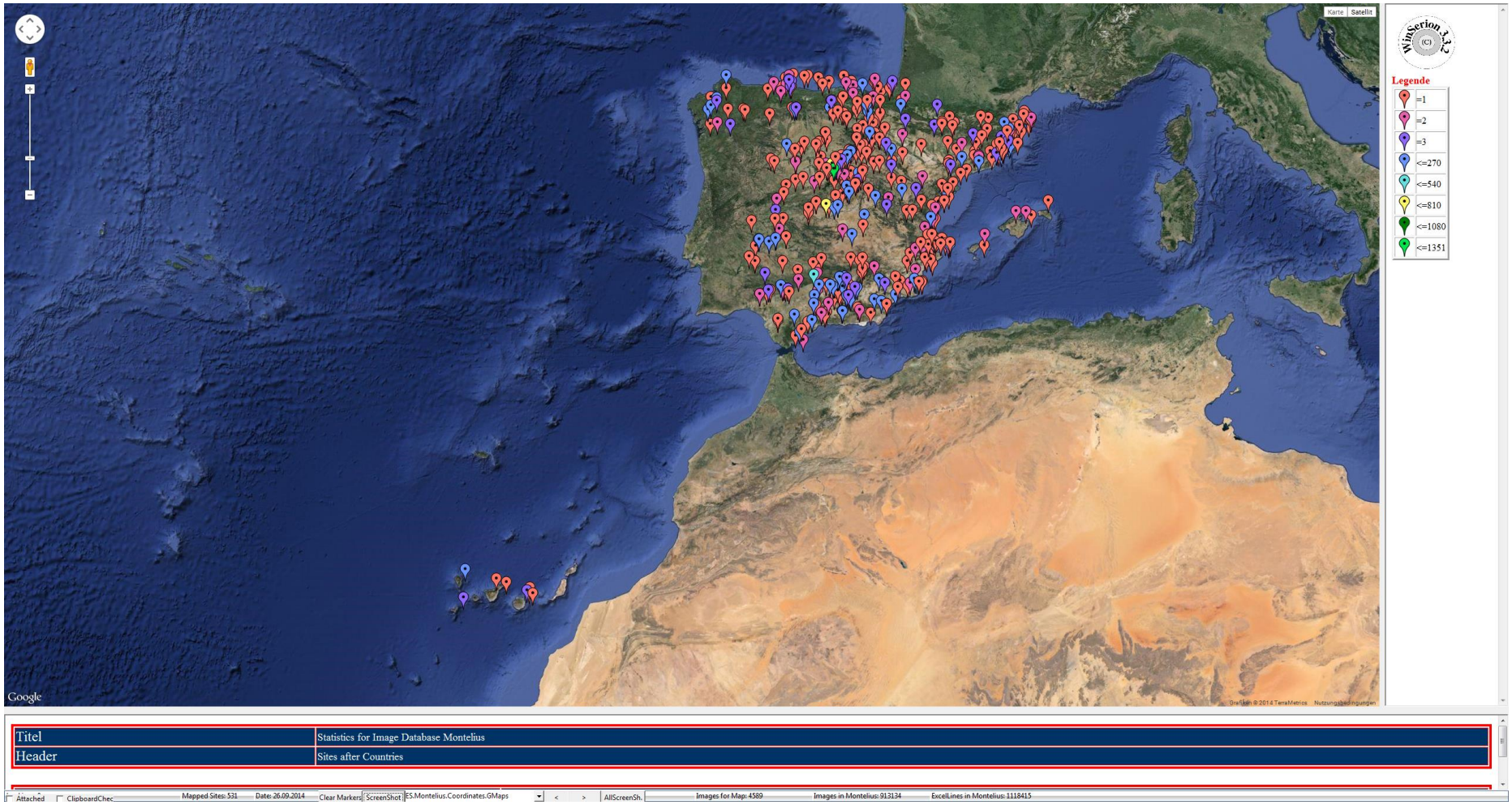


Figure 51: Sites in Image Database Montelius for Spain.

For Spain 531 sites are recorded with 4.589 images.

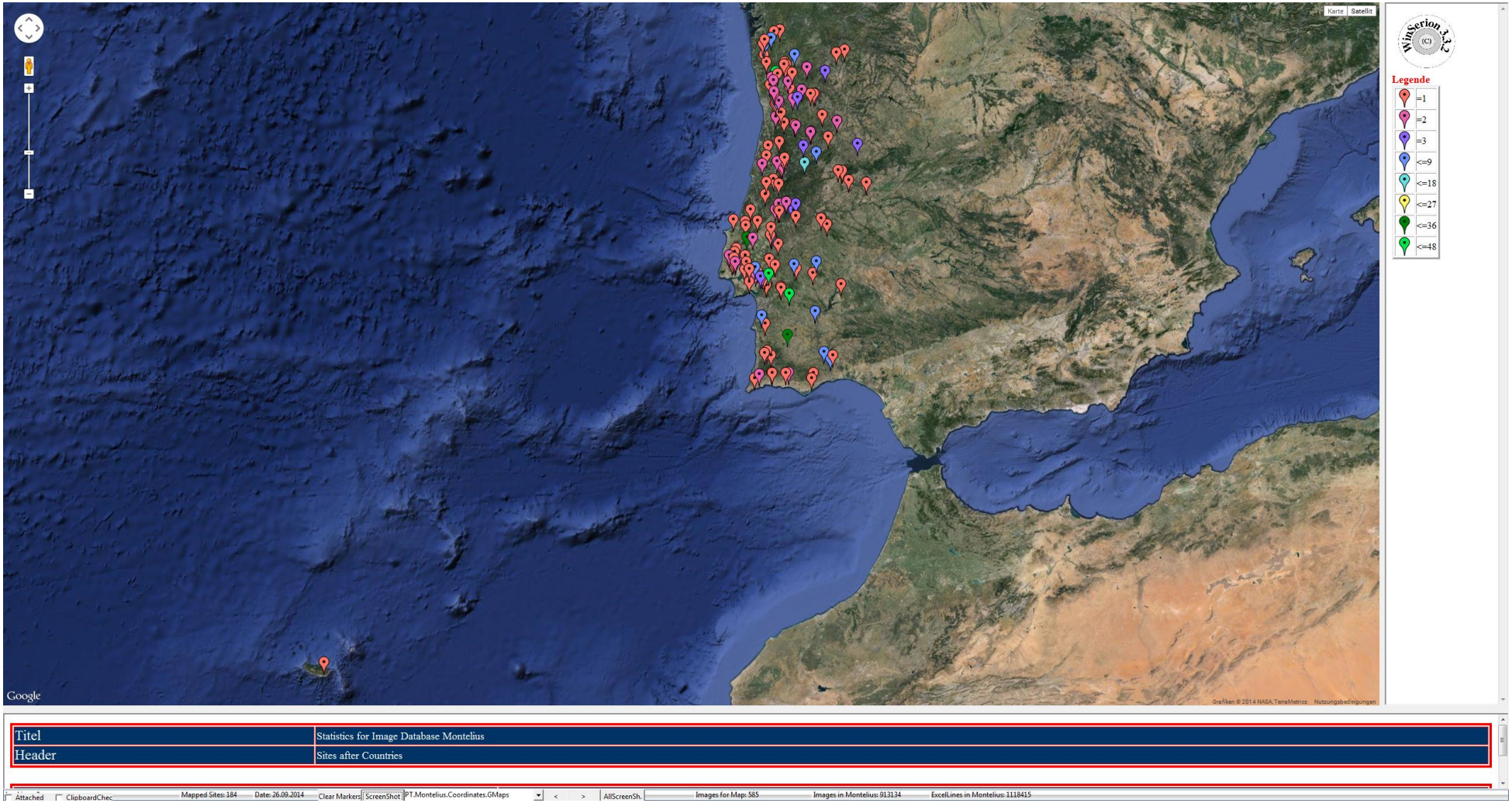


Figure 52: Sites in Image Database Montelius for Portugal.

For Portugal 184 sites have been input with 585 images.

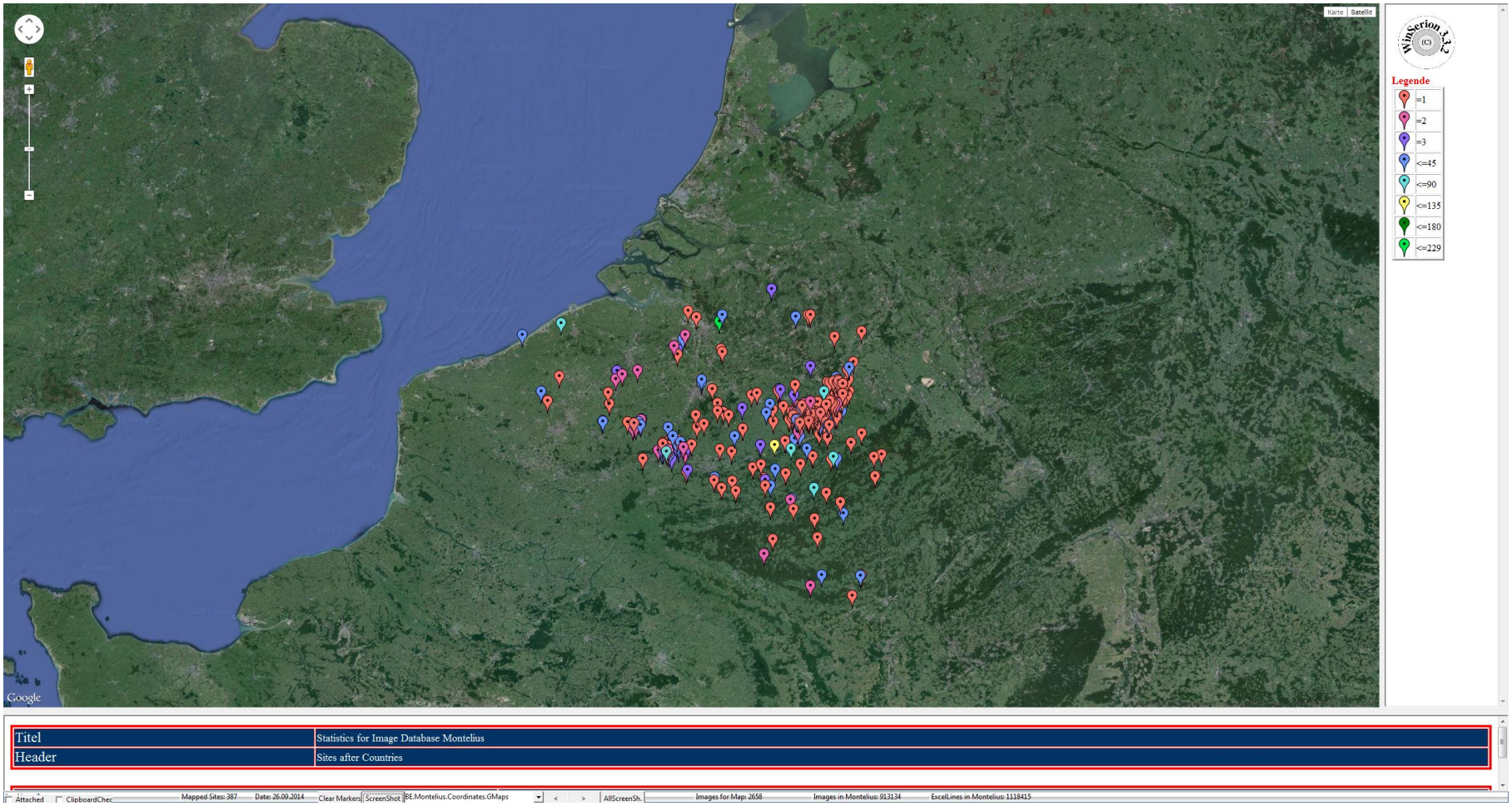


Figure 53: Sites in Image Database Montelius for Belgium.

In Belgium 387 sites are localized, from them 2.658 images are present.

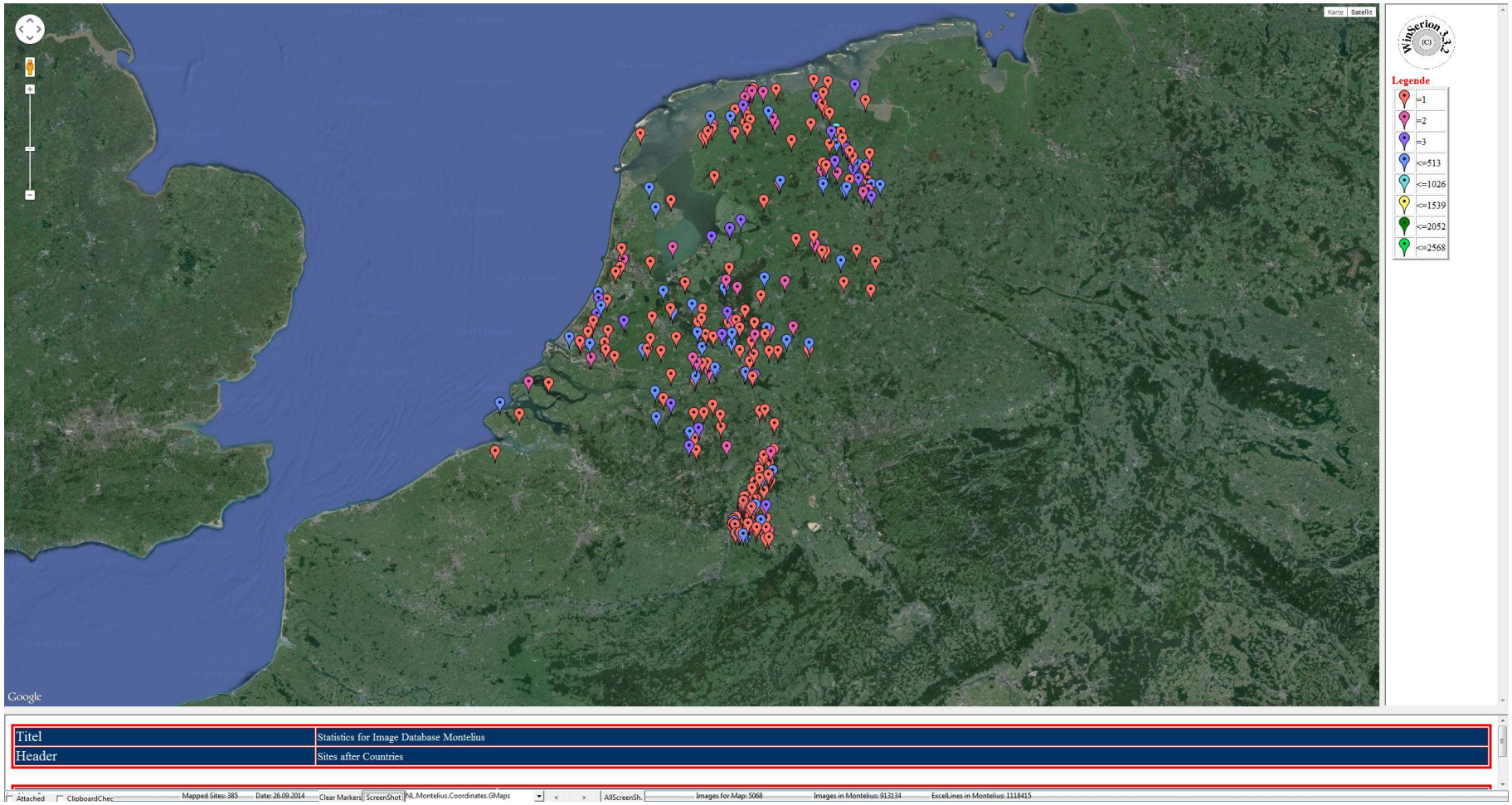


Figure 54: Sites in Image Database Montelius for Netherlands.

For Netherlands 385 sites are mapped with 5.068 images.

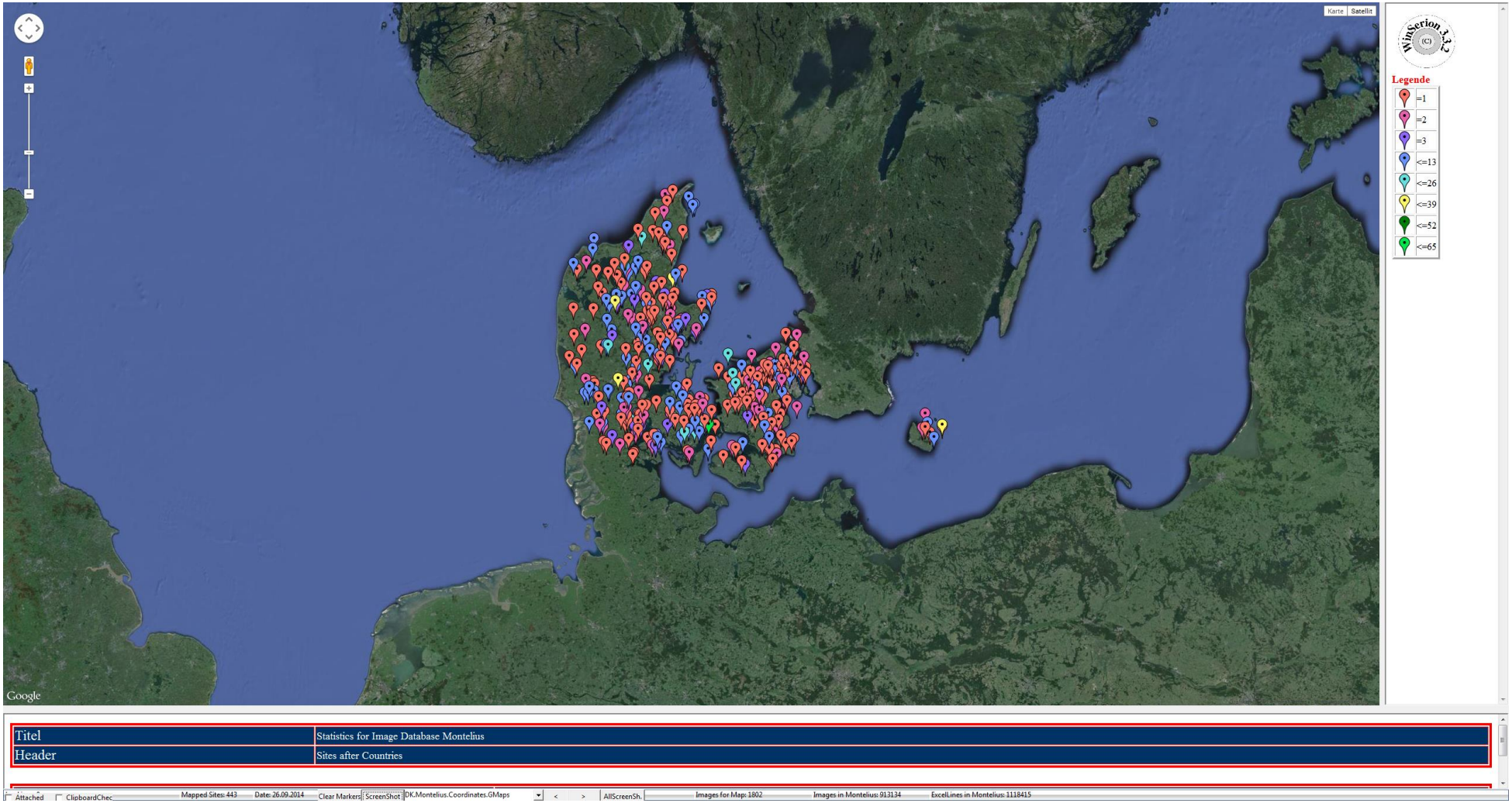


Figure 55: Sites in Image Database Montelius for Denmark.

In Denmark we know 443 sites with 1.802 images.

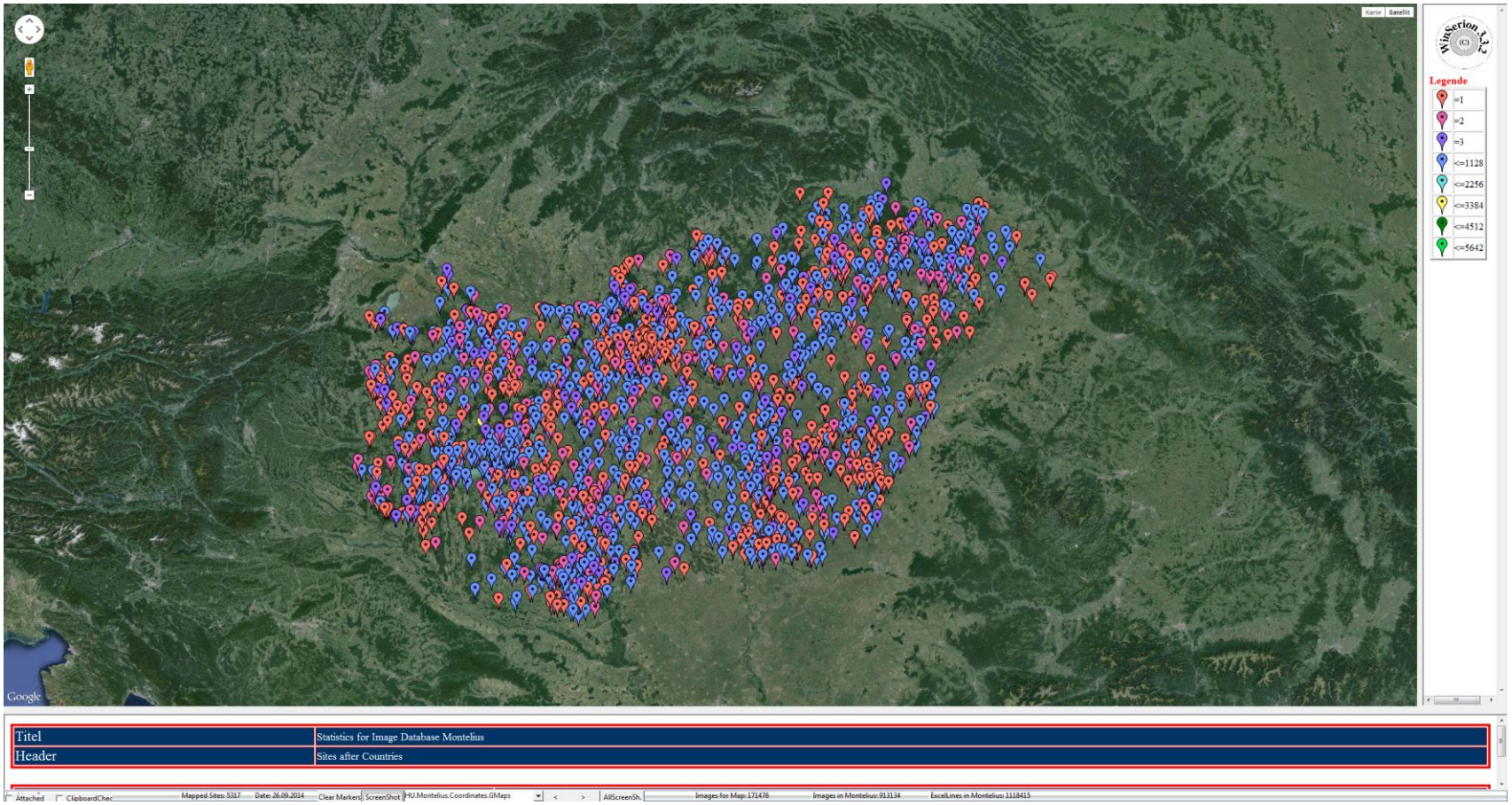


Figure 56: Sites in Image Database Montelius for Hungary based on satellite photos.

Here is Hungary with 5.317 archaeological sites, 171.476 images have been collected.

In addition, it is also possible, as is possible with GoogleMaps, to create maps based not only on satellite photos, but also on a standard map.

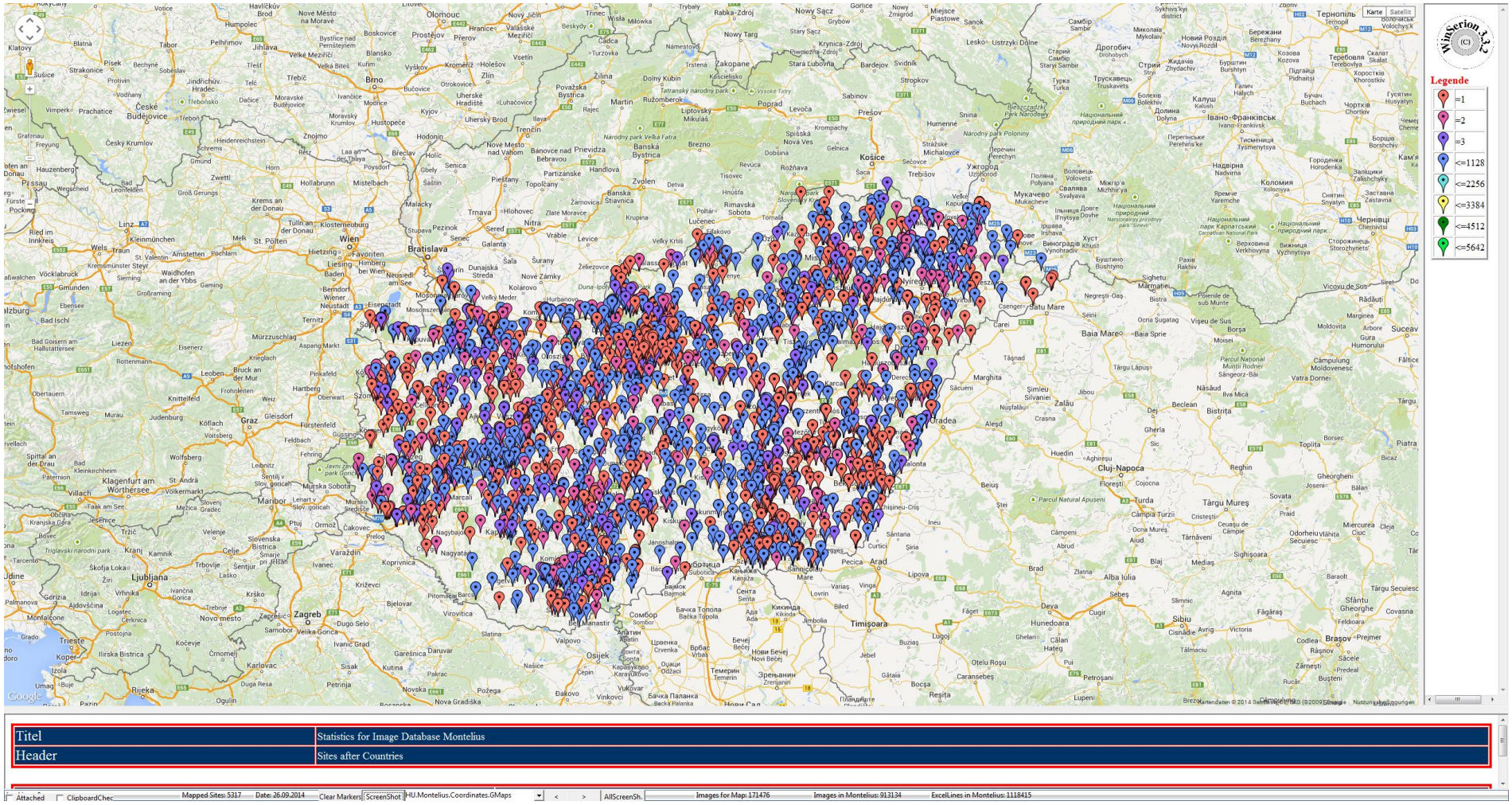


Figure 57: Sites in Image Database Montelius for Hungary on a standard map.

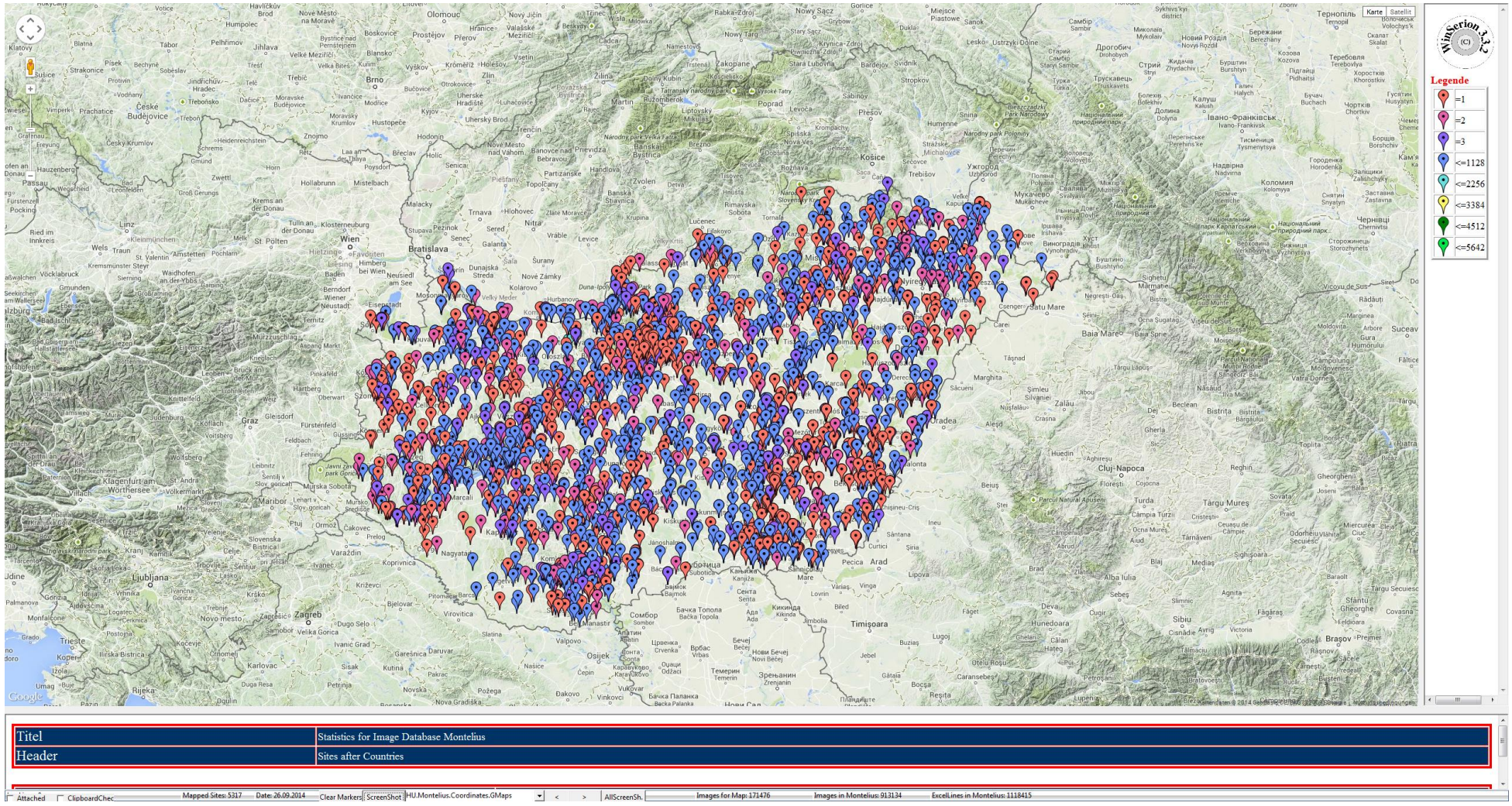


Figure 58: Sites in Image Database Montelius for Hungary on relief map.

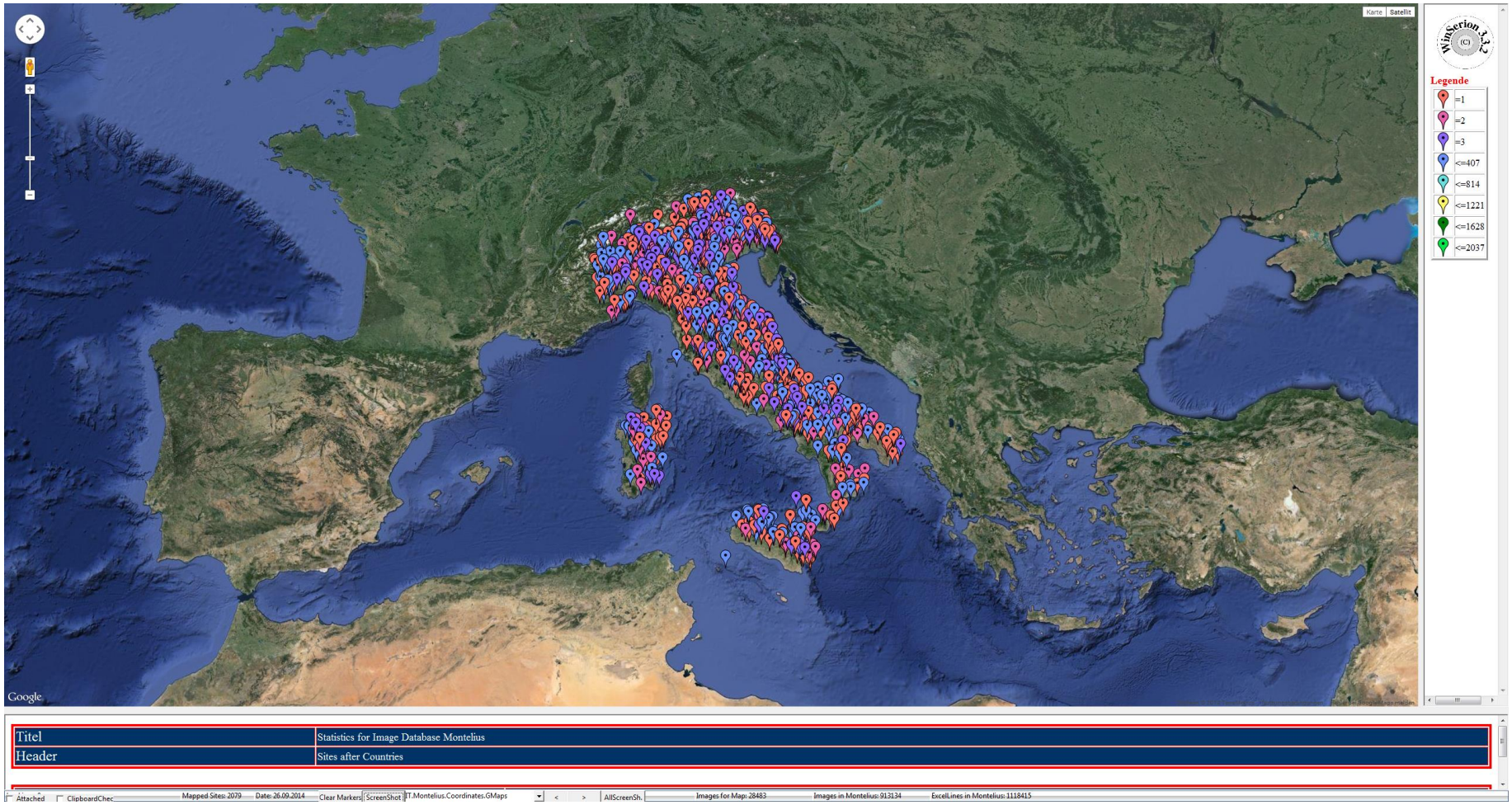


Figure 59: Sites in Image Database Montelius for Italy.

So far, 2.079 sites from Italy have been recorded, with 28.483 images.

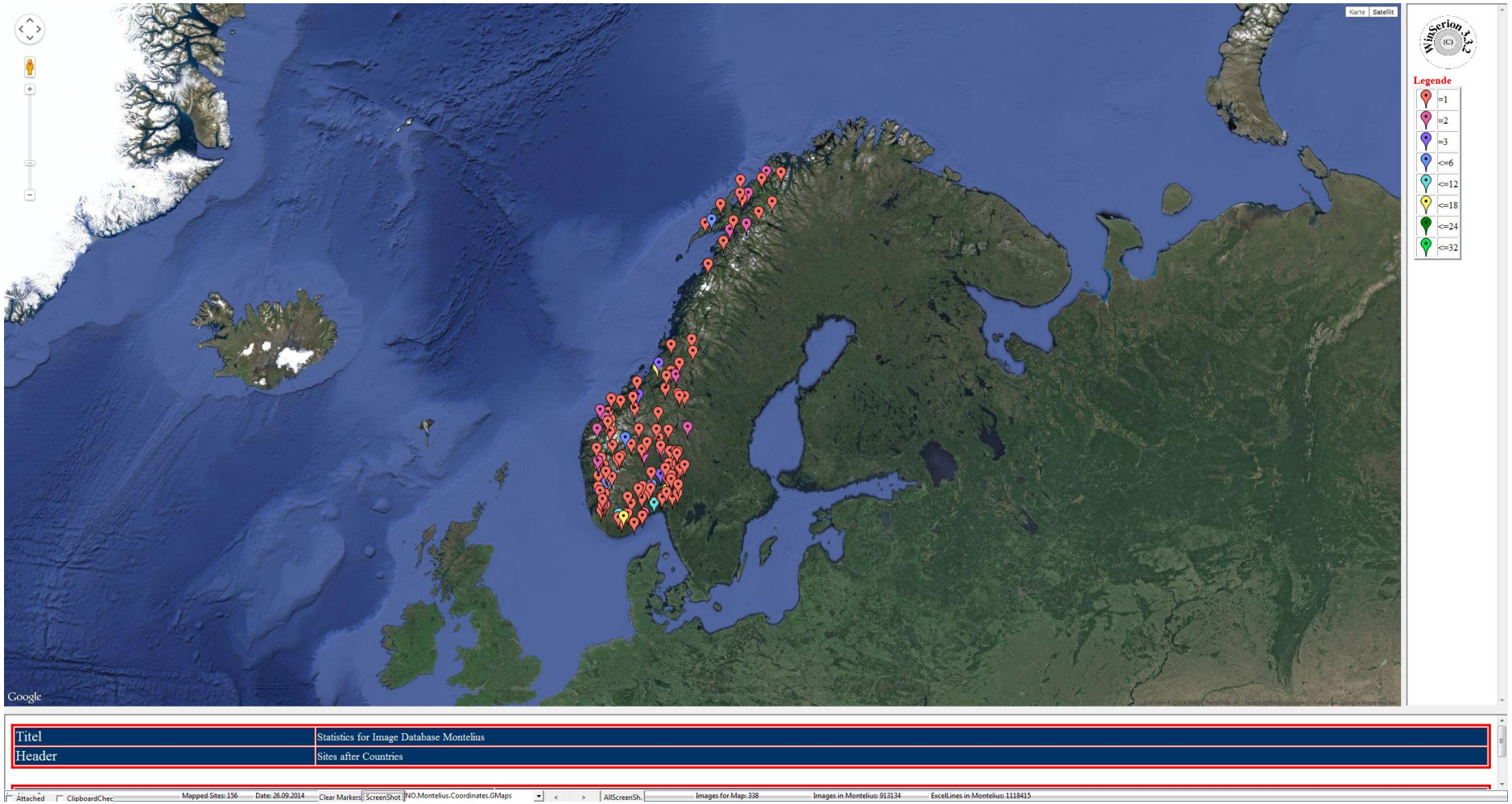


Figure 60: Sites in Image Database Montelius for Norway.

In Norway 156 sites are known in Montelius with 338 images.

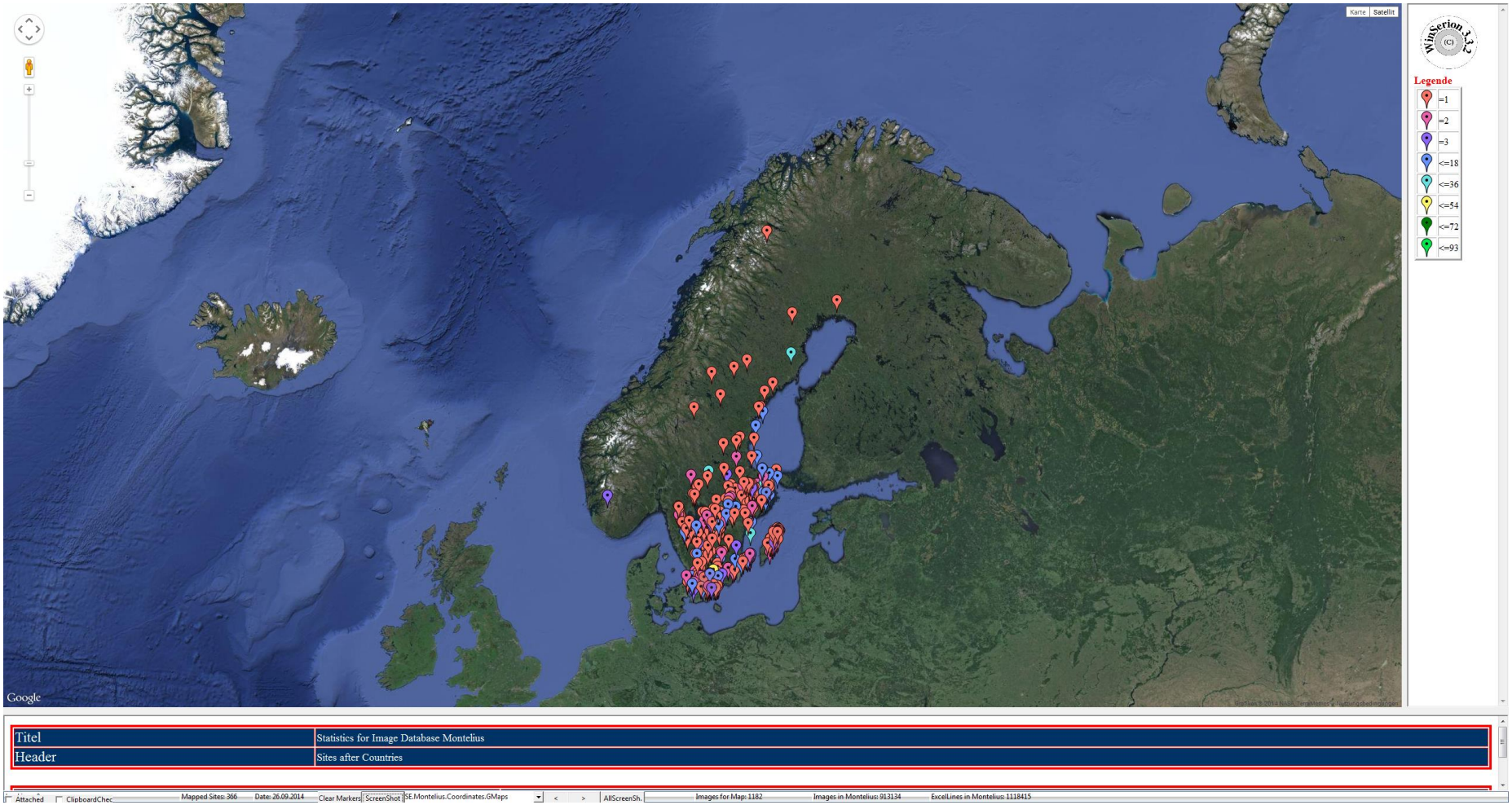


Figure 61: Sites in Image Database Montelius for Sweden.

For Sweden 366 sites are recorded with 1.182 images.

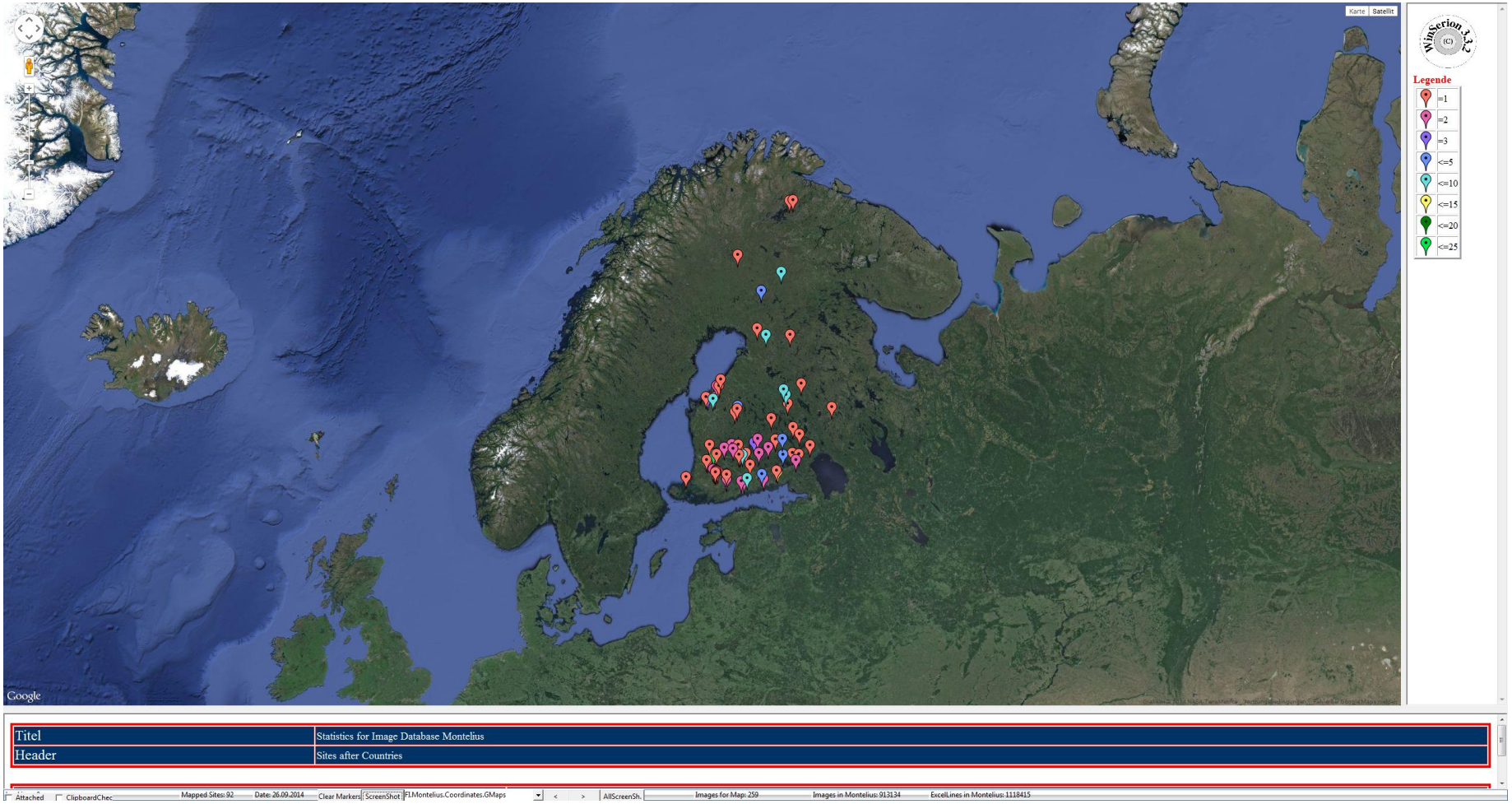


Figure 62: Sites in Image Database Montelius for Finland.

From Finland we have 92 sites and 259 images.

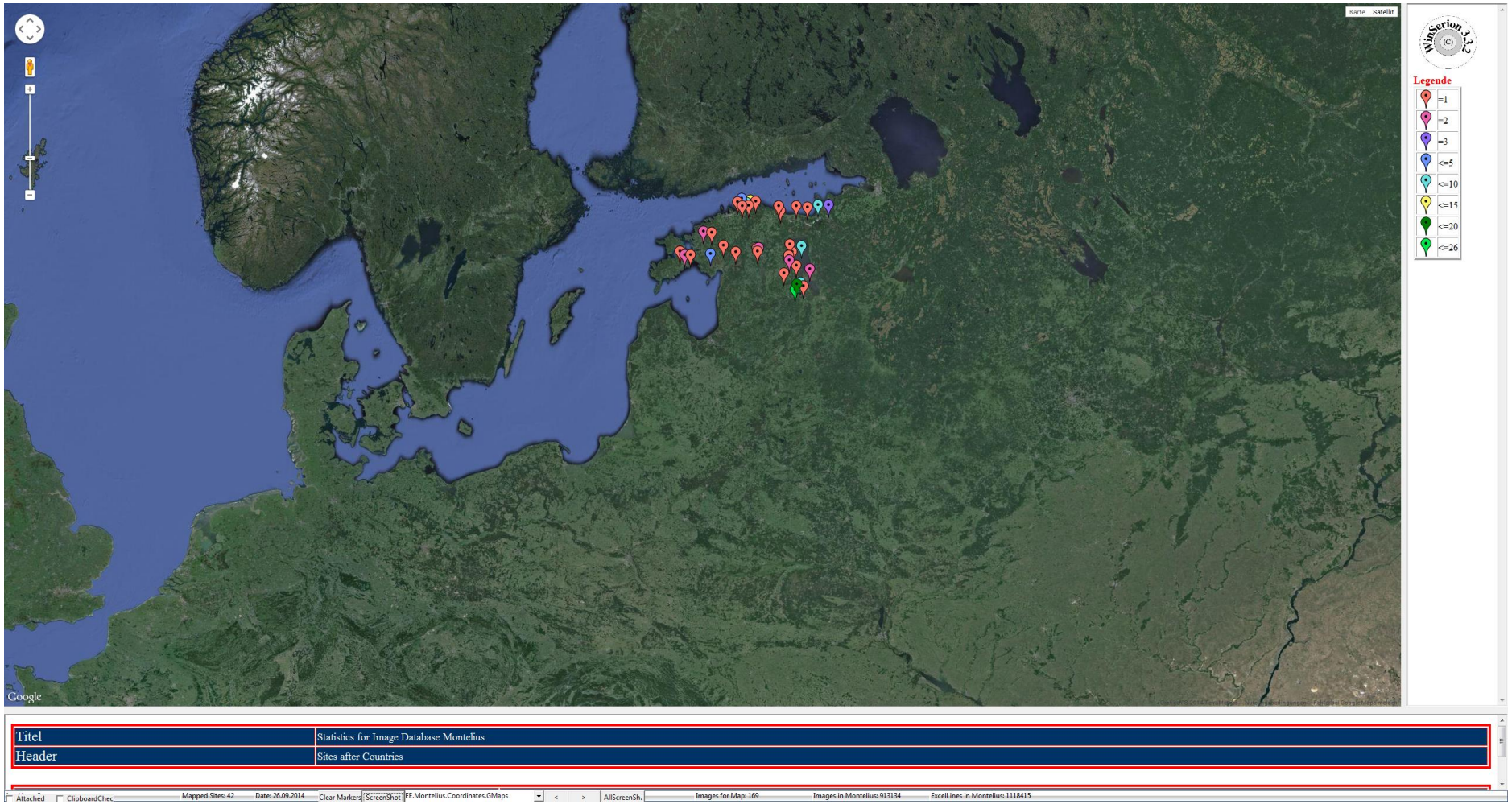


Figure 63: Sites in Image Database Montelius for Estonia.

For Estonia we have 42 sites with 160 images.

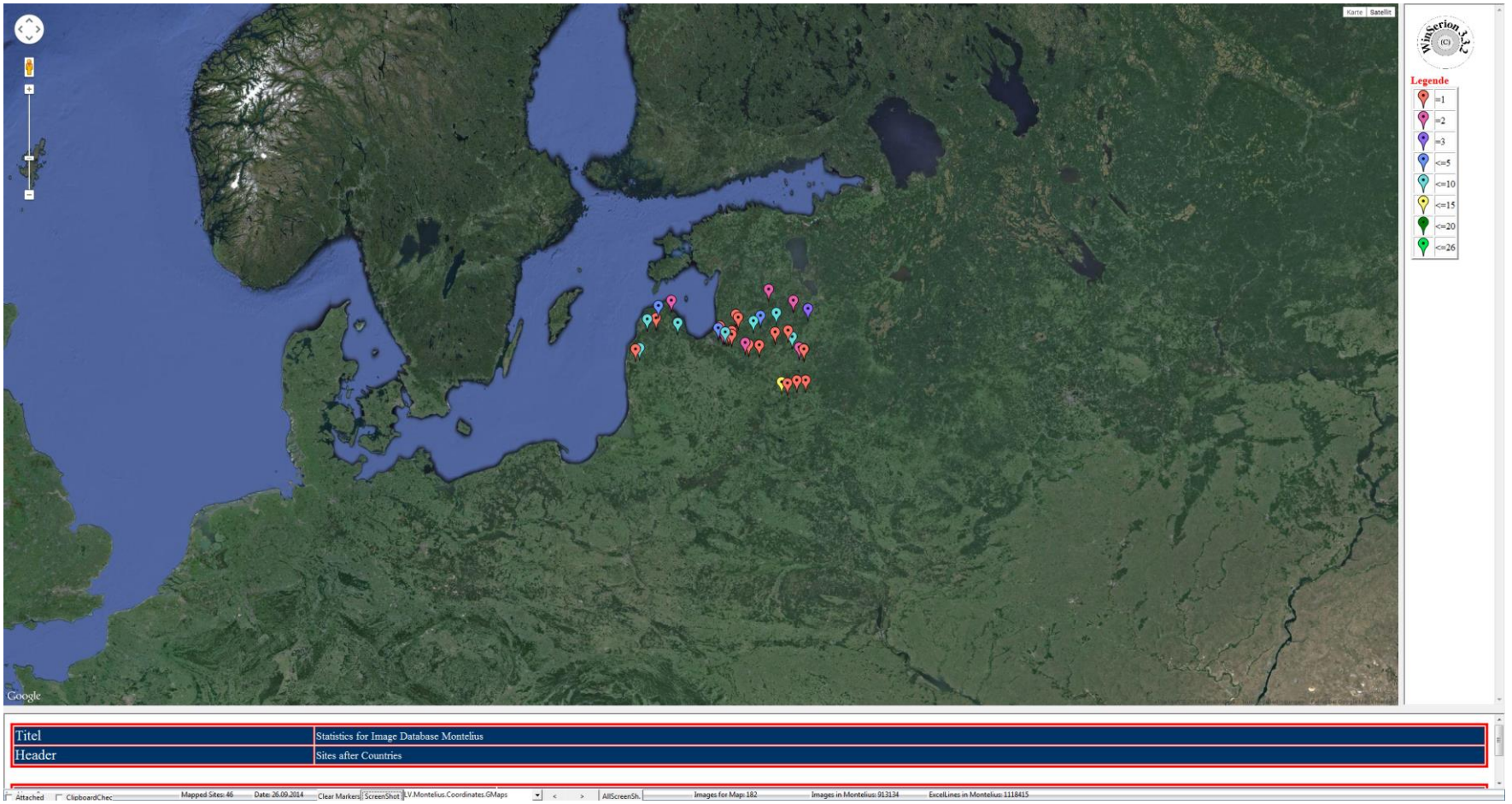


Figure 64: Sites in Image Database Montelius for Latvia.

In Latvia 46 sites and 182 images are recorded.

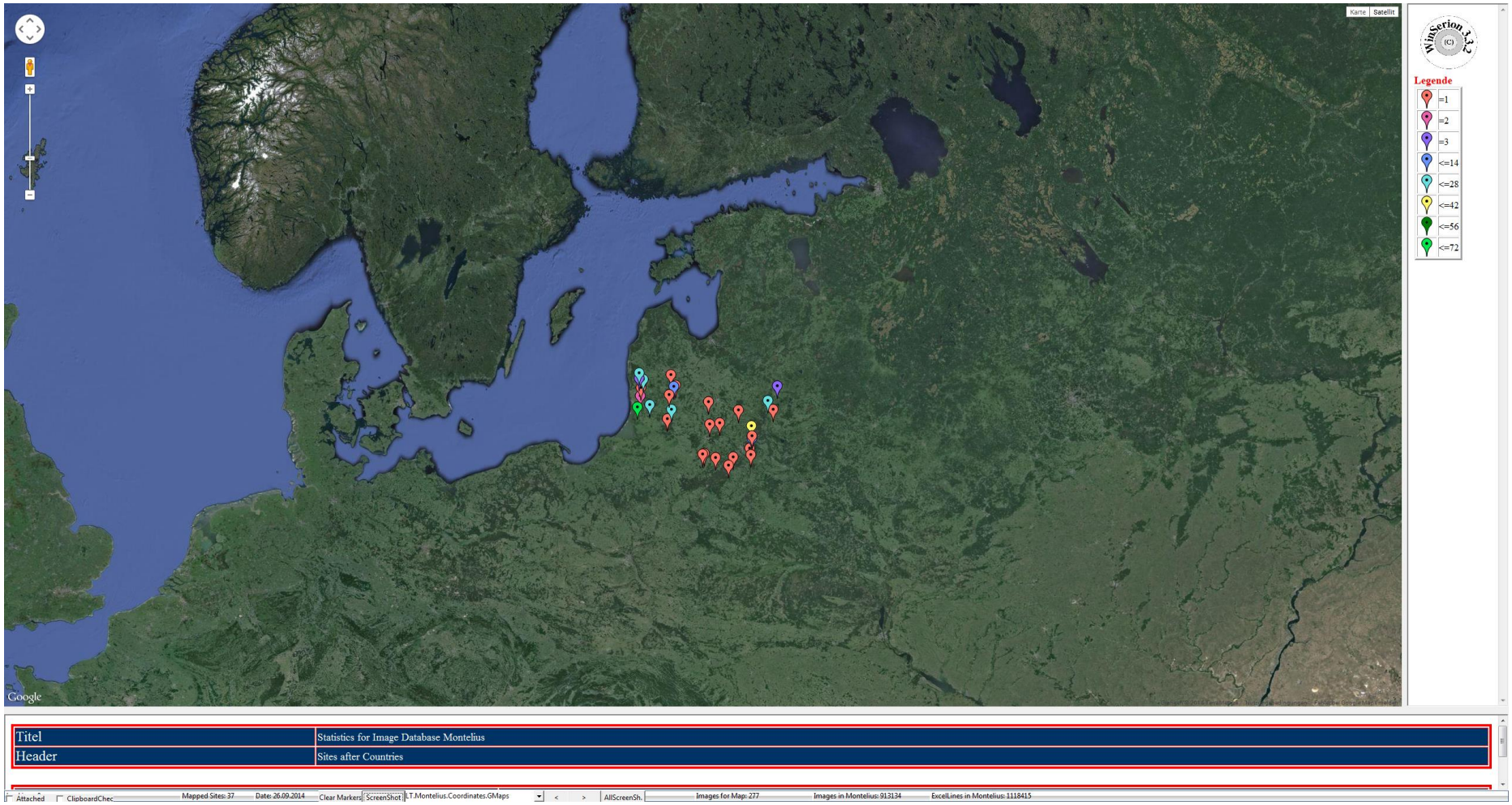


Figure 65: Sites in Image Database Montelius for Lithuania.

In Lithuania 37 sites and 277 images are collected.

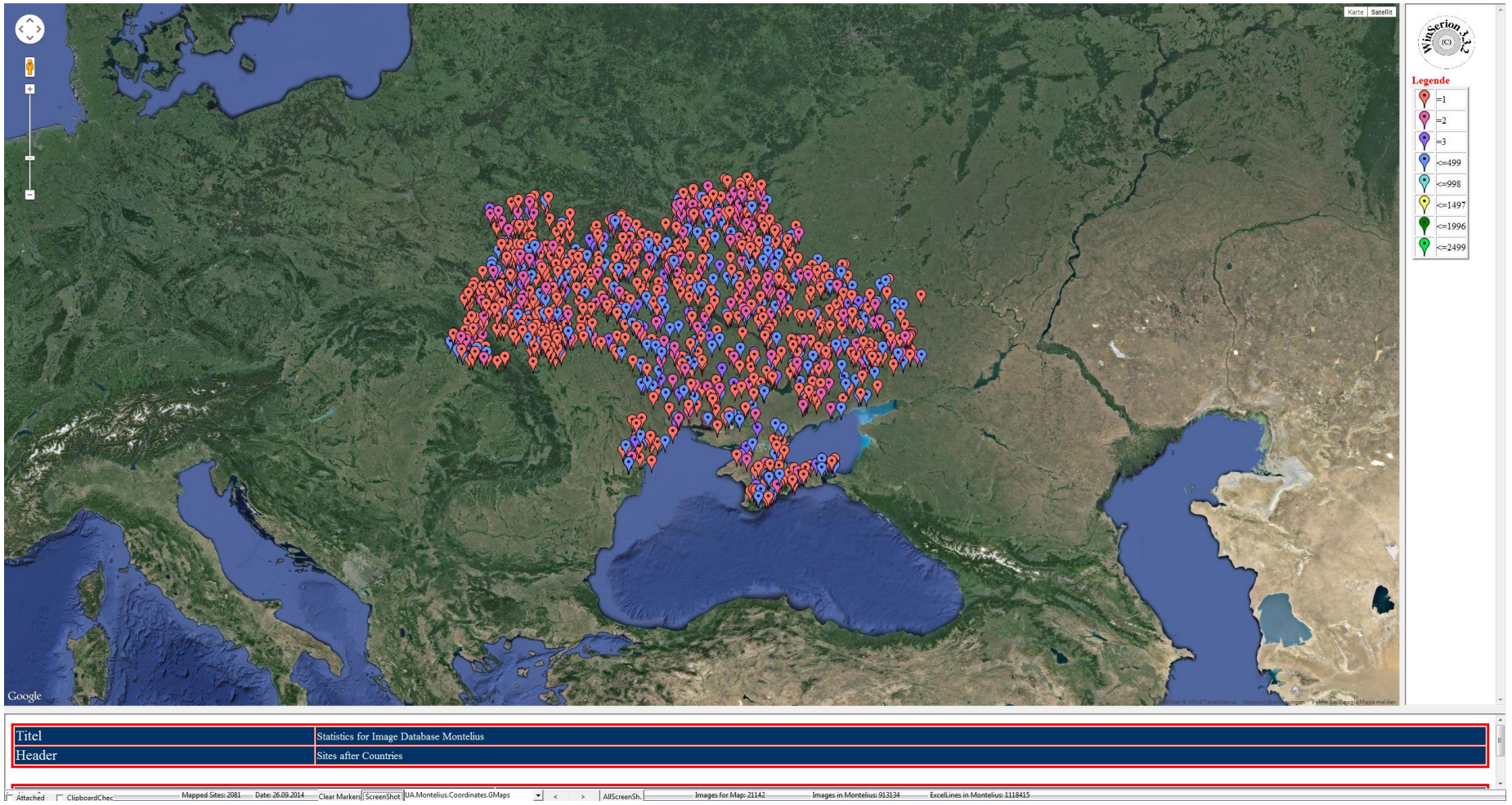


Figure 66: Sites in Image Database Montelius for Ukraine.

For Ukraine we know already 2.081 sites with 21.142 images.

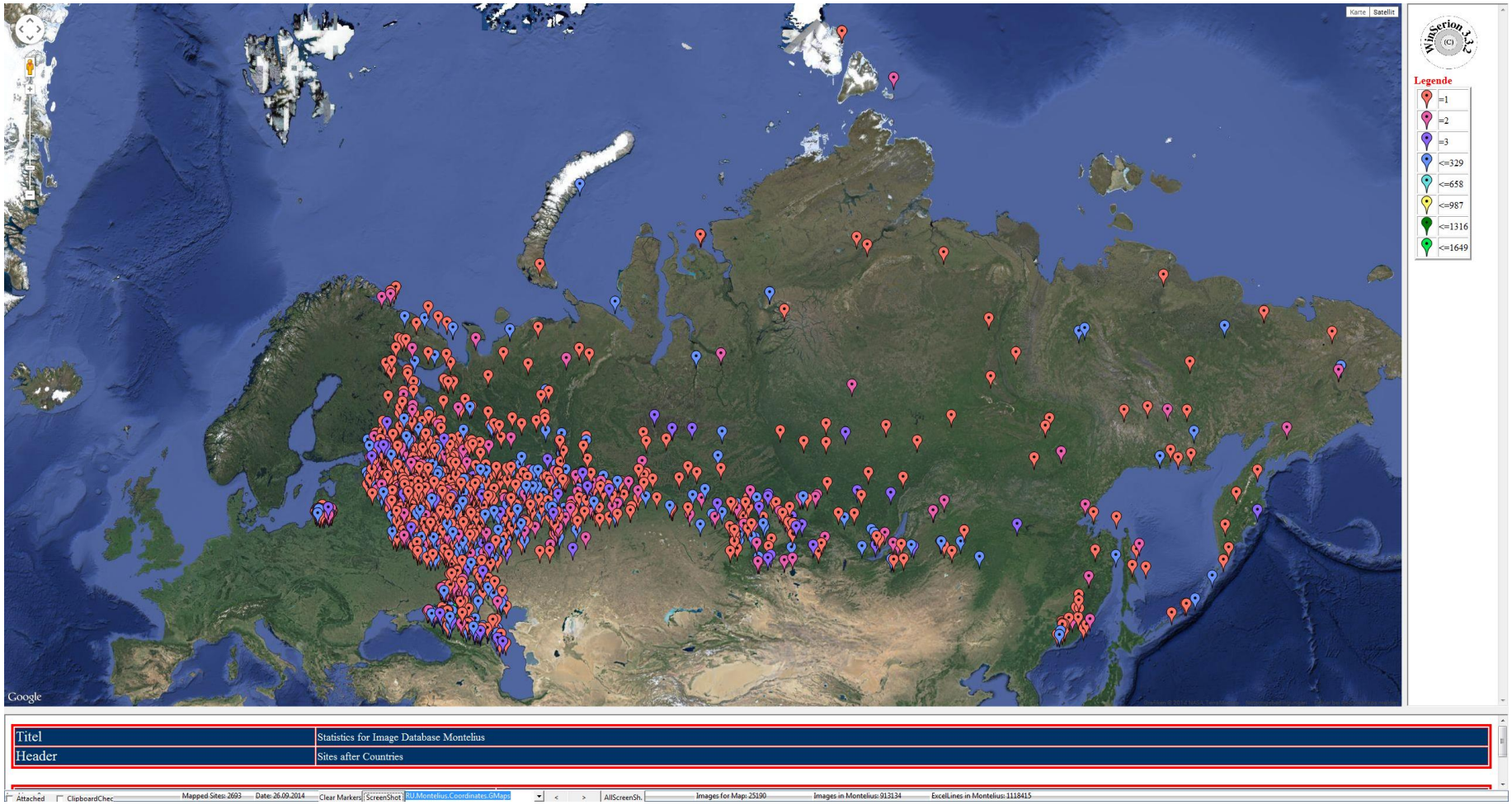


Figure 67: Sites in Image Database Montelius for Russia.

For Russia we have already 2.693 sites with 25.190 images.

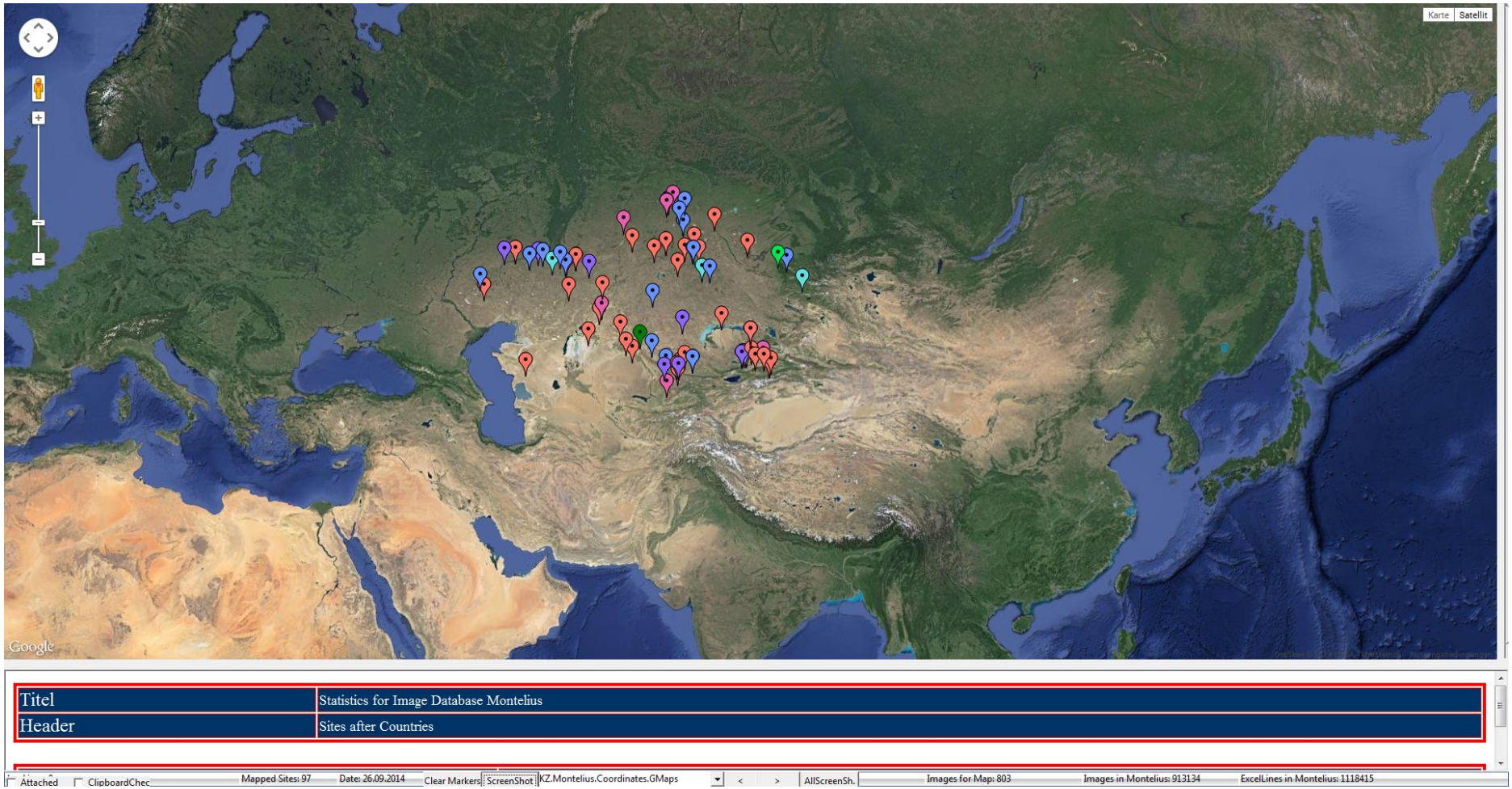


Figure 68: Sites in Image Database Montelius for Kazakhstan.

For Kazakhstan 97 sites are located with 803 images.

Map of GoogleMapper with the collection of the Prehistoric Department, Museum of Natural History, Vienna.

The collection comprises about 150.000 objects, from which are about 92.000 objects in Montelius, but not yet with images and not all sites located. The rest are objects from recent excavations of our Department in Lower and Upper Austria, which will be added in the next time. This map shows that the interest of the collection was focused on Central Europe, but some finds are present from North America and Africa. In these maps are total 84.269 find objects from 1.983 localized sites.

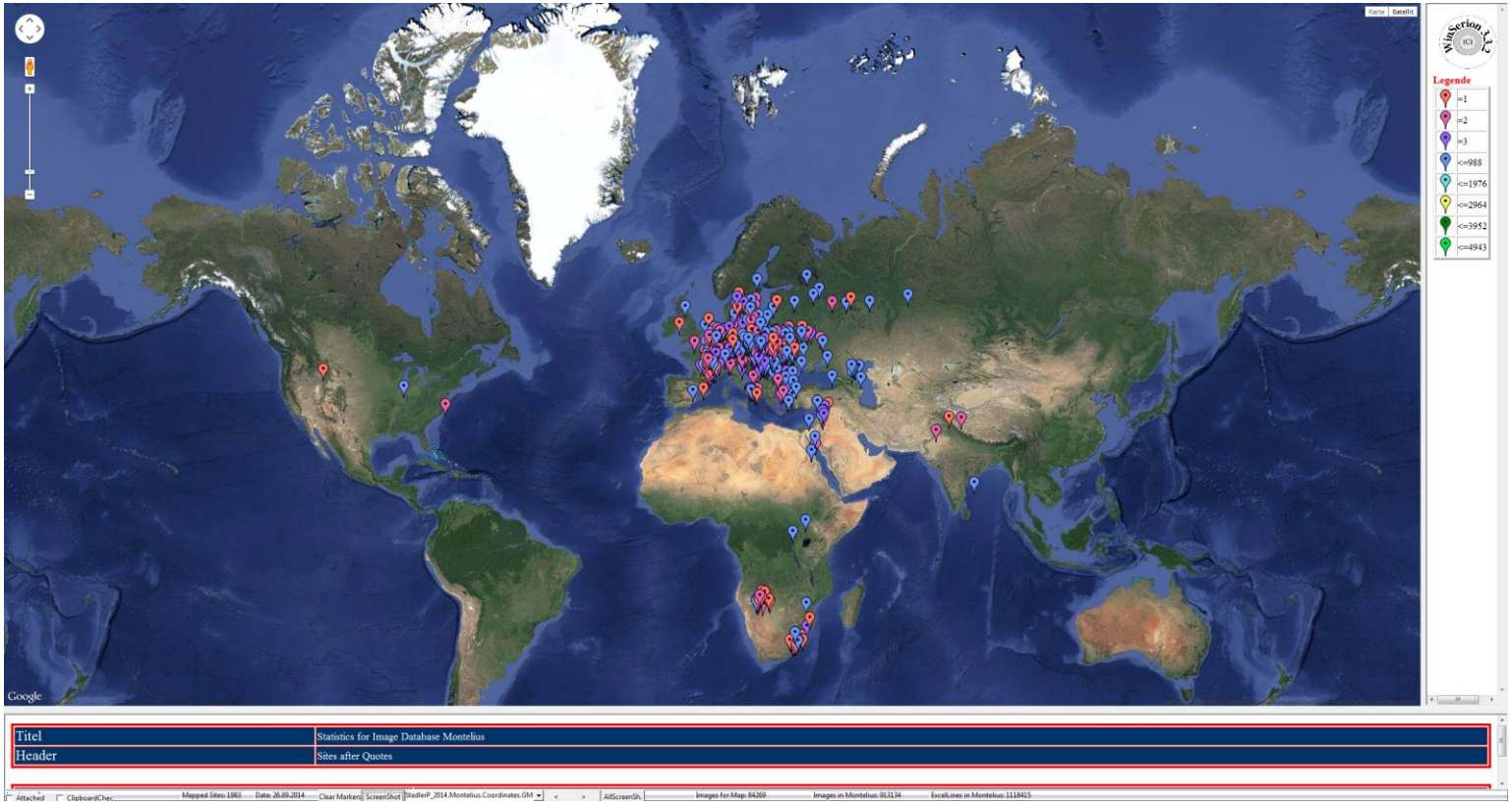


Figure 69: Sites in Image Database Montelius for Collection of Prehistoric Department, Global View.

Some finds are present from Spain, more from France, mainly from the Dordogne, some come from Italy, especially from Sicily, some from Scandinavia and Russia.

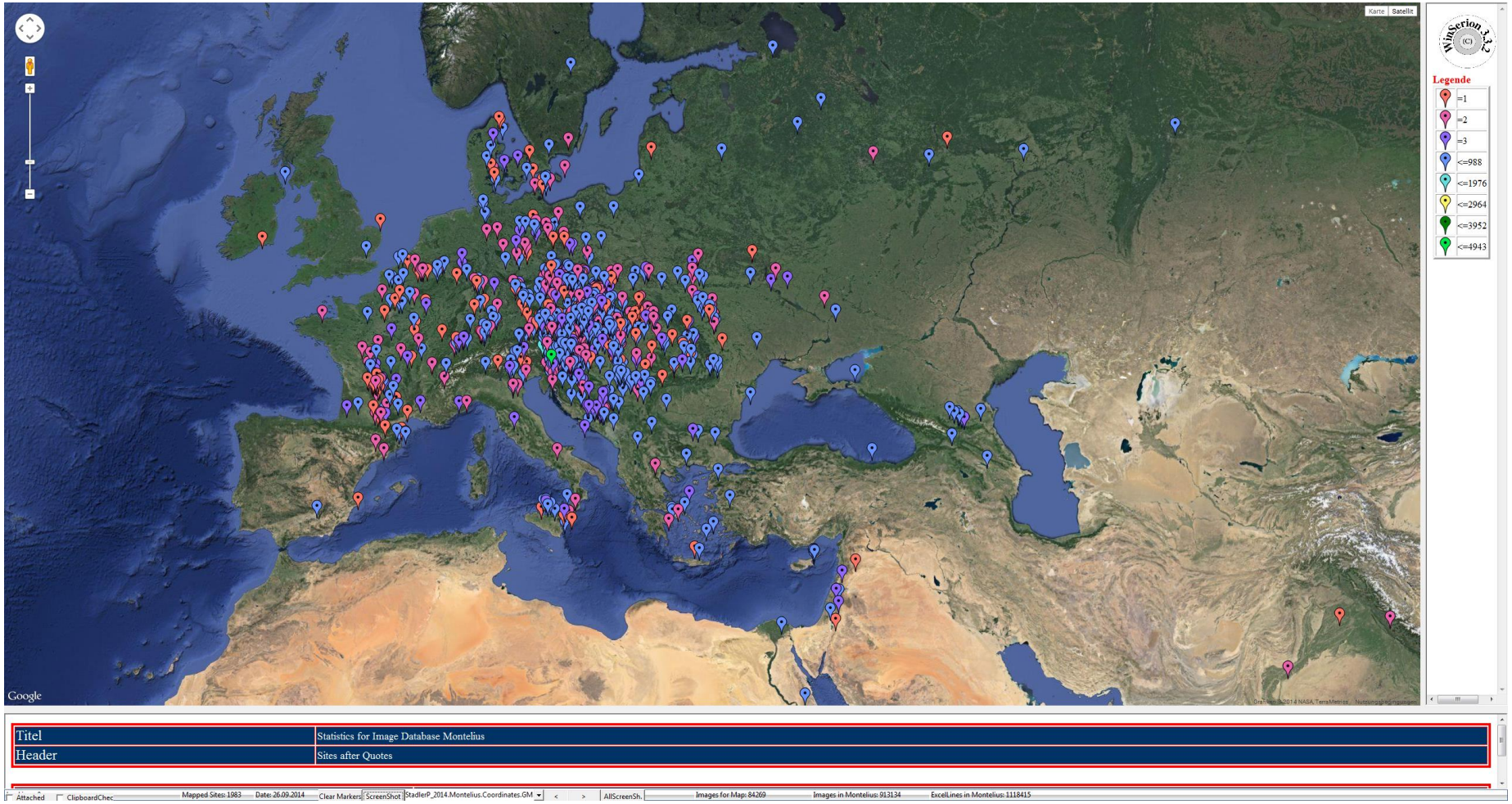


Figure 70: Sites in Image Database Montelius for Collection of the Prehistoric Department, View on Europe.

The main focus of the collection was put on the area of the former Austro-Hungarian Empire. It is interesting, that the collection contains very little material from Hungary and Slovakia, but extremely much material from Czech Republic and Slovenia. There are also materials from Poland and Ukraine, very little also from Russia, not to forget the relatively big Caucasus collection from only some sites.

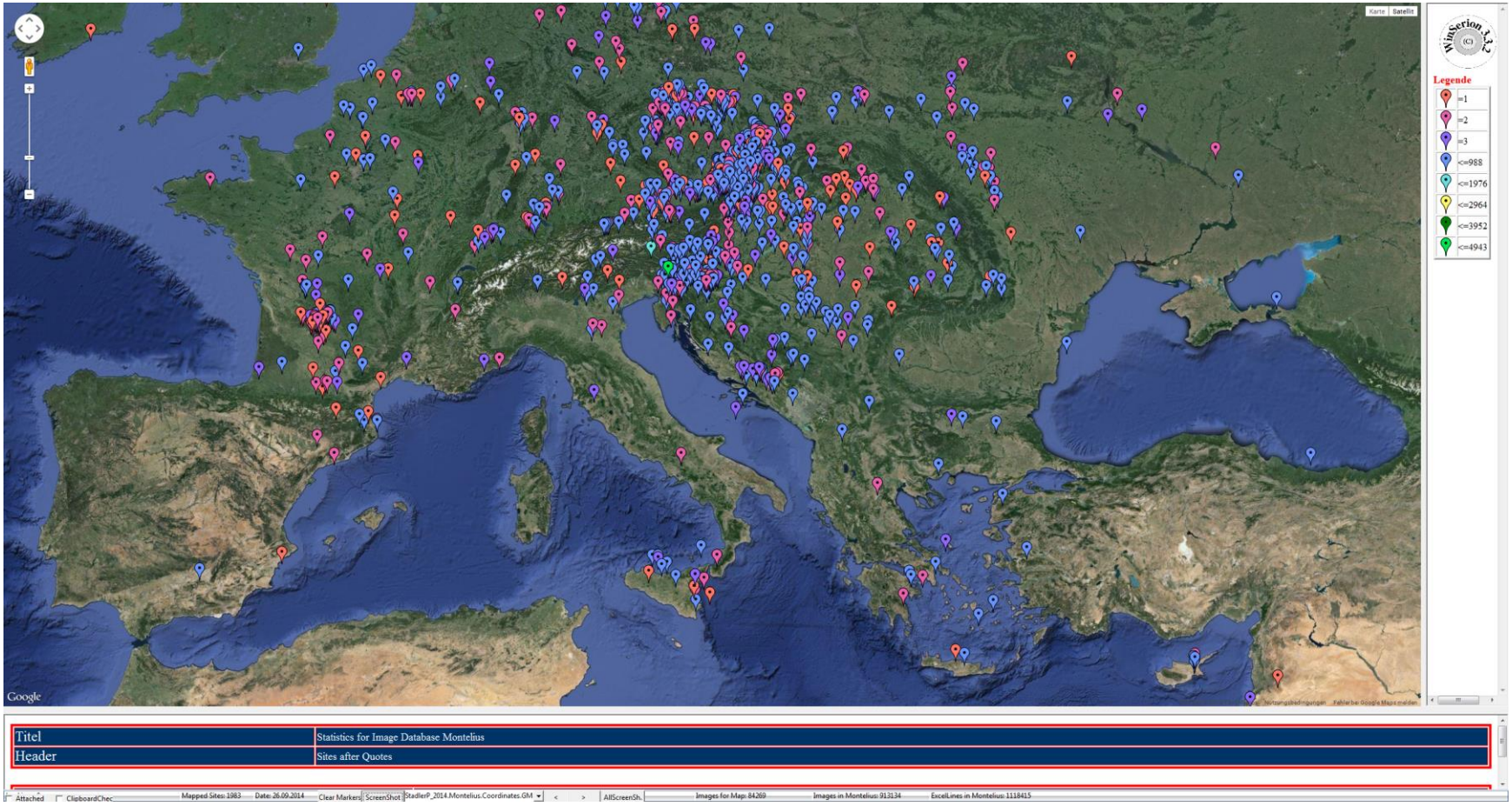


Figure 71: Sites in Image Database Montelius for the Collection of Prehistoric Department, View on Central Europe.

Map of GoogleMapper with the current radiocarbon database connected to Image Database Montelius.

In our radiocarbon project "Absolute Chronology for Early Civilisations in Austria and central Europe using ^{14}C Dating with accelerator mass Spectrometry", which was funded by the Austrian funds FWF under number **P12253-PHY** we collected from publications a lot of radiocarbon dates in the years 1999-2001. Currently about 21.000 dates are available and have been used for creating the following maps. 18.084 Radiocarbon dates are from 3.868 located sites. Many dates are duplicates from different publications and will be removed in the future.

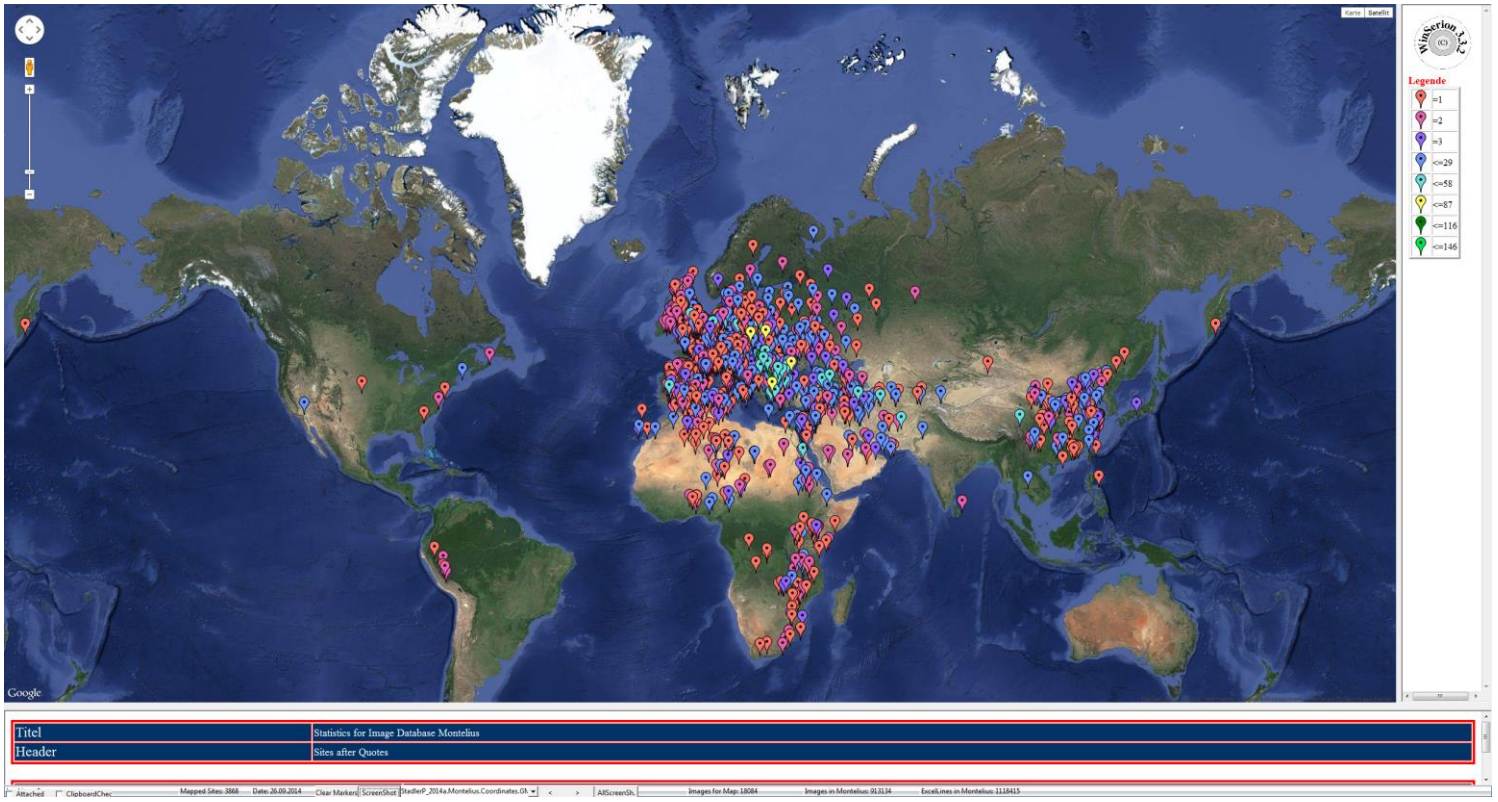


Figure 72: Radiocarbon dates in image database Montelius, worldwide view.

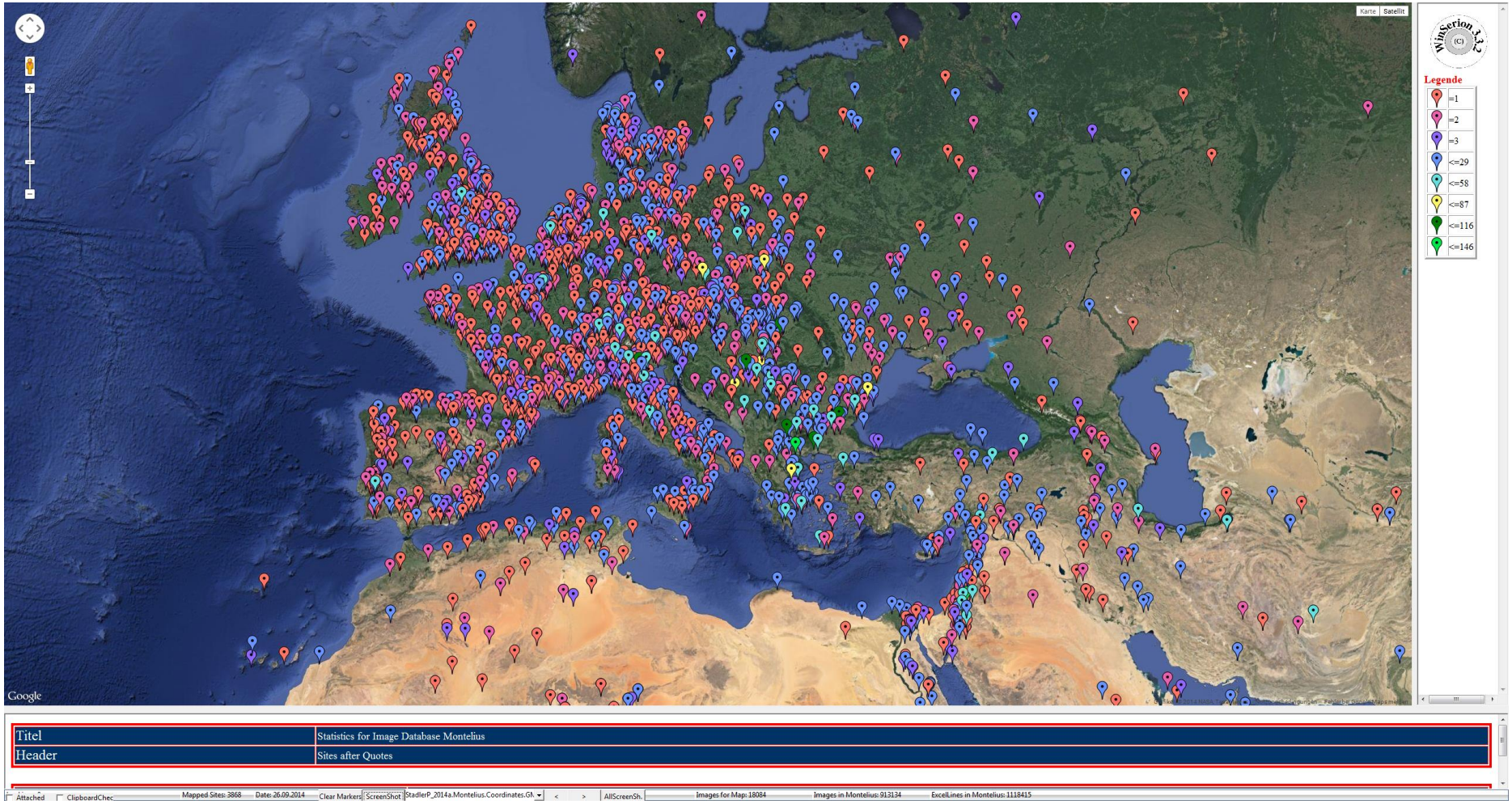


Figure 73: Radiocarbon dates in image database Montelius, view on Europe.

Maps of GoogleMapper with cultures

In addition, cultures can be mapped:

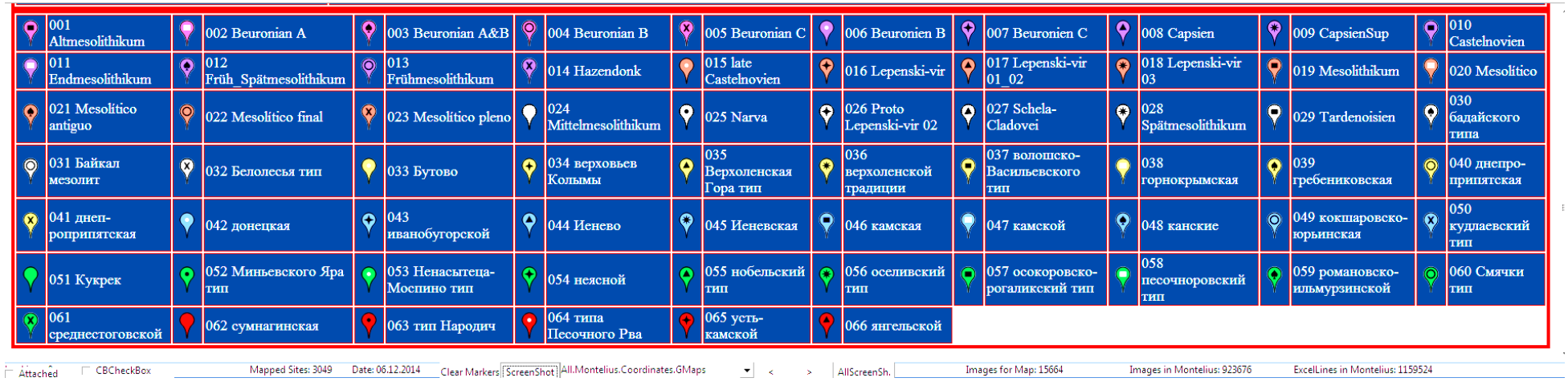


Figure 74: Legend of symbols for 66 Mesolithic cultures from the Fertile Crescent to Europe in image database Montelius, is needed by the next maps.

Here are 66 Mesolithic cultures mapped from 3,049 sites (with 15,664 images).

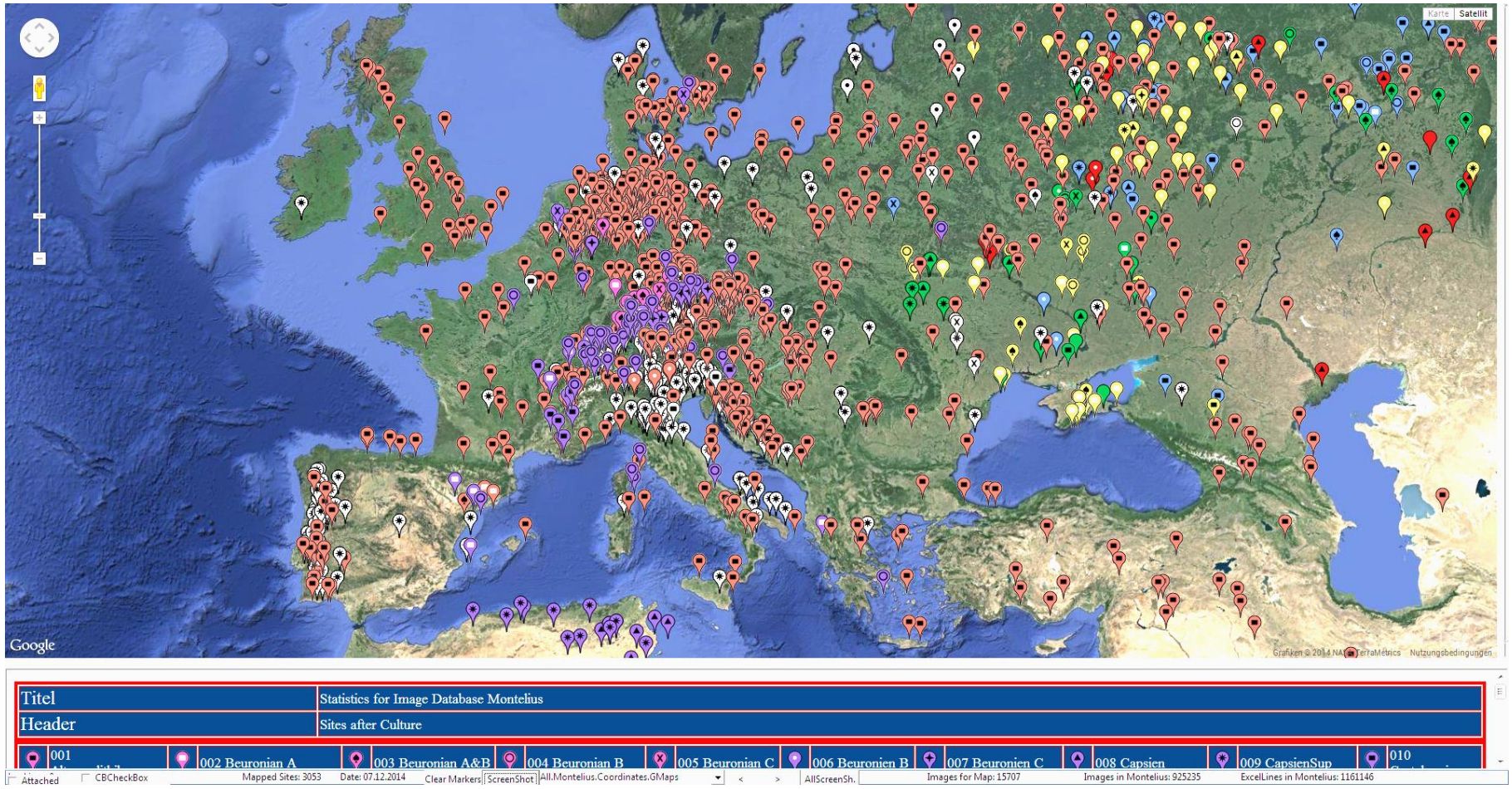


Figure 75: Mesolithic cultures from the Fertile Crescent to Europe in image database Montelius.

In the Alpine region, north and south of the Alps and in northeastern Bavaria and southern Bohemian region are concentrations of Mesolithic settlement. Numerous pollen profiles have delivered cereal pollen (Nielsen E. H. 2009, Gehlen B. 2010) and thus agriculture (?) as early as 7000 B. C. Whether these cultures with a "Prepottery Neolithic" came also from the Fertile Crescent as in the Neolithisation process, is currently only speculation as aDNA evidence is missing.

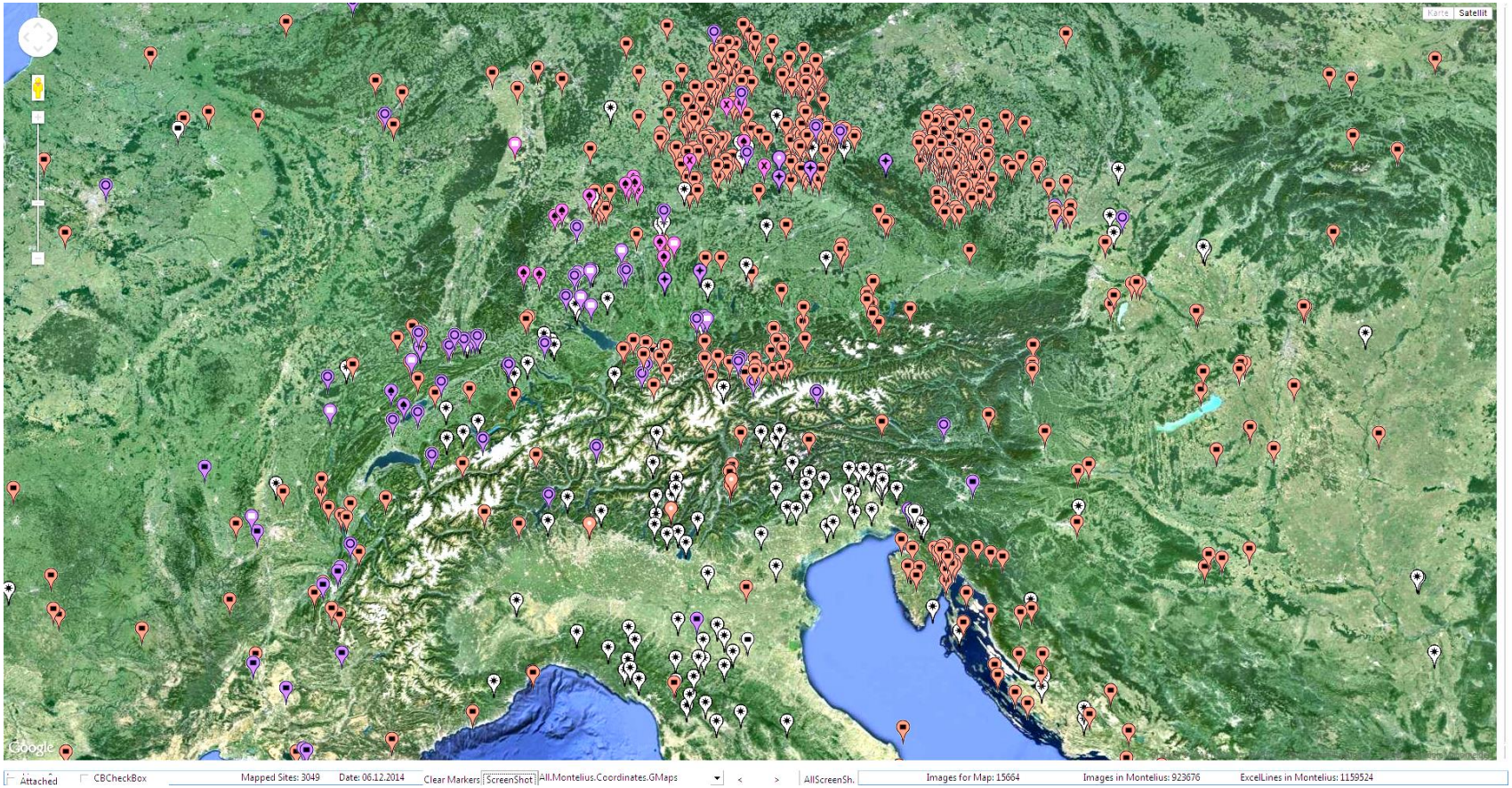


Figure 76: Mesolithic cultures in the alpine area.

In northern Germany, there is a Mesolithic agglomeration, from which then obviously the Limburg culture developed in the process of Neolithisation (?).

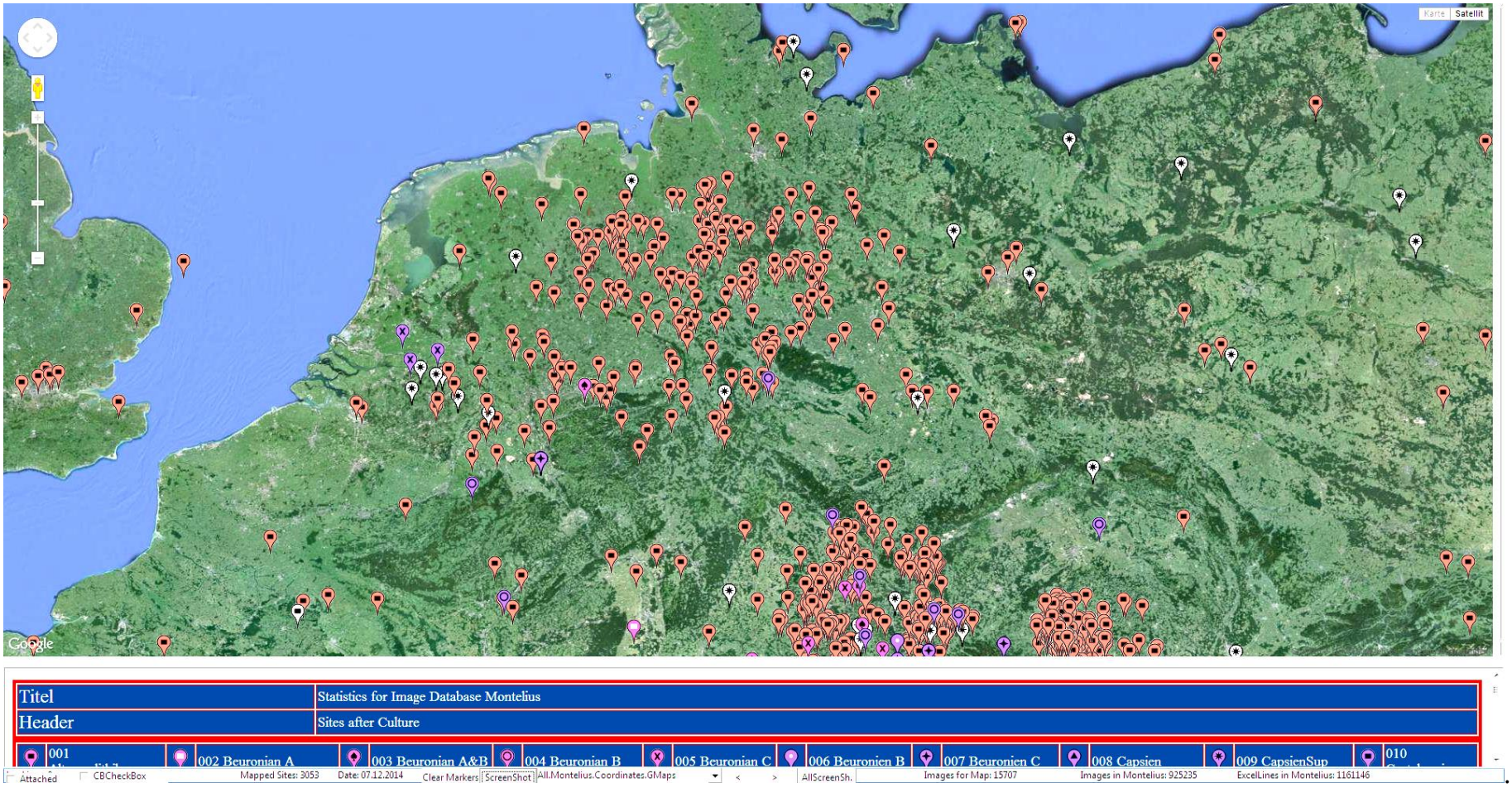
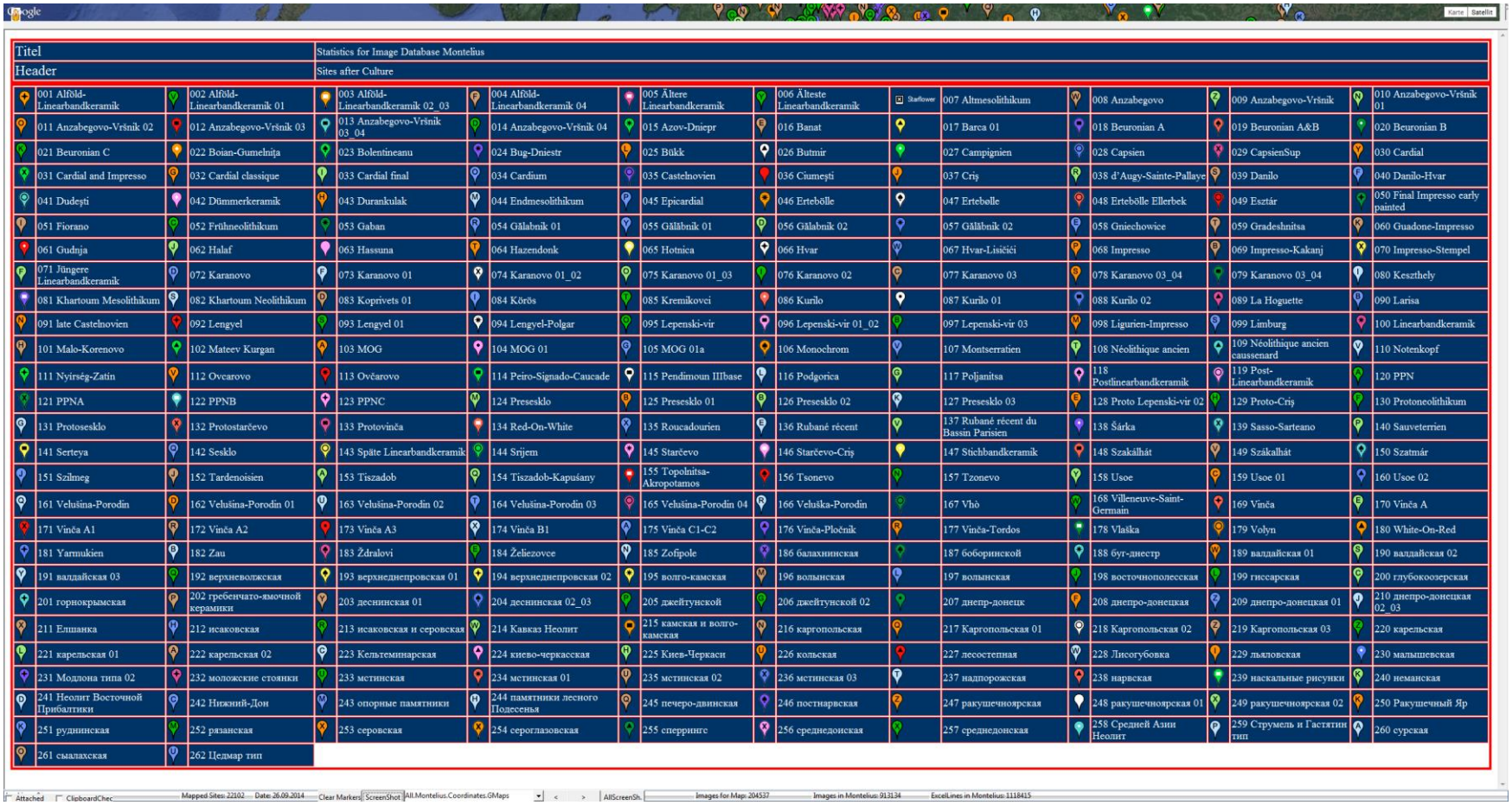


Figure 77: Mesolithic cultures in Northern Germany.

Here comes the legend for Neolithisation:



Titel	Statistics for Image Database Montelius
Header	Sites after Culture

001 Alföld-Linearbandkeramik	002 Alföld-Linearbandkeramik 01	003 Alföld-Linearbandkeramik 02_03	004 Alföld-Linearbandkeramik 04	005 Ältere Linearbandkeramik	006 Älteste Linearbandkeramik	Starflower	007 Altmesolithikum	008 Anzabegovo	009 Anzabegovo-Vršnik	010 Anzabegovo-Vršnik 01
011 Anzabegovo-Vršnik 02	012 Anzabegovo-Vršnik 03	013 Anzabegovo-Vršnik 03_04	014 Anzabegovo-Vršnik 04	015 Azov-Dniepr	016 Banat	017 Barca 01	018 Beuronian A	019 Beuronian A&B	020 Beuronian B
021 Beuronian C	022 Boian-Gumelniţa	023 Bolentineanu	024 Bug-Dniestr	025 Bükk	026 Butmir	027 Campignien	028 Capsien	029 CapsienSup	030 Cardial
031 Cardial and Impresso	032 Cardial classique	033 Cardial final	034 Cardium	035 Castelnovien	036 Ciumeşti	037 Criş	038 d'Augy-Sainte-Pallaye	039 Danilo	040 Danilo-Hvar
041 Dudeşti	042 Dümmerkeramik	043 Durankulak	044 Endmesolithikum	045 Epicardial	046 Ertebölle	047 Ertebølle	048 Ertebölle Ellerbek	049 Esztár	050 Final Impresso early painted
051 Fiorano	052 Frühneolithikum	053 Gaban	054 Gălăbnik 01	055 Gălăbnik 01	056 Gălăbnik 02	057 Gălăbnik 02	058 Gniechowice	059 Gradeshnitsa	060 Guadone-Impresso
061 Gudnja	062 Halaf	063 Hassuna	064 Hazendonk	065 Hotnica	066 Hvar	067 Hvar-Lisičići	068 Impresso	069 Impresso-Kakanj	070 Impresso-Stempel
071 Jüngere Linearbandkeramik	072 Karanovo	073 Karanovo 01	074 Karanovo 01_02	075 Karanovo 01_03	076 Karanovo 02	077 Karanovo 03	078 Karanovo 03_04	079 Karanovo 03_04	080 Keszthely
081 Khartoum Mesolithikum	082 Khartoum Neolithikum	083 Koprivets 01	084 Körös	085 Kremikovci	086 Kurilo	087 Kurilo 01	088 Kurilo 02	089 La Hoguette	090 Larisa
091 late Castelnovien	092 Lengyel	093 Lengyel 01	094 Lengyel-Polgar	095 Lepenski-vir	096 Lepenski-vir 01_02	097 Lepenski-vir 03	098 Ligurien-Impresso	099 Limburg	100 Linearbandkeramik
101 Malo-Korenovo	102 Mateev Kurgan	103 MOG	104 MOG 01	105 MOG 01a	106 Monochrom	107 Montserratien	108 Néolithique ancien	109 Néolithique ancien caussenard	110 Notenkopf
111 Nyírség-Zatin	112 Ovcarovo	113 Ovčarovo	114 Peiro-Signado-Caucade	115 Pendimoun IIIbase	116 Podgorica	117 Poljanitsa	118 Postlinearbandkeramik	119 Post-Linearbandkeramik	120 PPN
121 PPNA	122 PPNB	123 PPNC	124 Preseklo	125 Preseklo 01	126 Preseklo 02	127 Preseklo 03	128 Proto Lepenski-vir 02	129 Proto-Criş	130 Protoneolithikum
131 Protoseklo	132 Protostarčevo	133 Protovinča	134 Red-On-White	135 Roucadourien	136 Rubané récent	137 Rubané récent du Bassin Parisien	138 Šárka	139 Sasso-Sarteano	140 Sauveterrien
141 Serteya	142 Sesklo	143 Späte Linearbandkeramik	144 Srijem	145 Starčevo	146 Starčevo-Criş	147 Stichbandkeramik	148 Szakálhát	149 Szakálhát	150 Szatmár
151 Szilmeg	152 Tardenoisien	153 Tiszadob	154 Tiszadob-Kapušany	155 Topolnitsa-Akropotamos	156 Tsonevo	157 Tzonevo	158 Usoe	159 Usoe 01	160 Usoe 02
161 Velušina-Porodin	162 Velušina-Porodin 01	163 Velušina-Porodin 02	164 Velušina-Porodin 03	165 Velušina-Porodin 04	166 Veluška-Porodin	167 Vhò	168 Villeneuve-Saint-Germain	169 Vinča	170 Vinča A
171 Vinča A1	172 Vinča A2	173 Vinča A3	174 Vinča B1	175 Vinča C1-C2	176 Vinča-Pločnik	177 Vinča-Tordos	178 Vlaška	179 Volyn	180 White-On-Red
181 Yarmukien	182 Zau	183 Ždralovi	184 Železovce	185 Zofipole	186 балахинская	187 бобоpинской	188 буг-днестр	189 валдайская 01	190 валдайская 02
191 валдайская 03	192 верхневолжская	193 верхнеднепровская 01	194 верхнеднепровская 02	195 волго-камская	196 волынская	197 волынская	198 восточнополесская	199 гиссарская	200 глубокоозерская
201 горнокрымская	202 гребенчато-ямочной керамики	203 деснинская 01	204 деснинская 02_03	205 джейтунской	206 джейтунской 02	207 днепр-донецк	208 днепро-донецкая	209 днепро-донецкая 01	210 днепро-донецкая 02_03
211 Елшанка	212 исаковская	213 исаковская и серовская	214 Кавказ Неолит	215 камская и волго-камская	216 каргопольская	217 Каргопольская 01	218 Каргопольская 02	219 Каргопольская 03	220 карельская
221 карельская 01	222 карельская 02	223 Кельтеминарская	224 киево-черкасская	225 Киев-Черкаси	226 кольская	227 лесостепная	228 Лисогубовка	229 льяловская	230 малышевская
231 Модлона типа 02	232 моложские стоянки	233 мстинская	234 мстинская 01	235 мстинская 02	236 мстинская 03	237 надпорожская	238 нарвская	239 наскальные рисунки	240 неманская
241 Неолит Восточной Прибалтики	242 Нижний-Дон	243 опорные памятники	244 памятники лесного Подесенья	245 печеро-двинская	246 постнарвская	247 ракушечноярская	248 ракушечноярская 01	249 ракушечноярская 02	250 Ракушечный Яр
251 руднинская	252 рязанская	253 серовская	254 сероглазовская	255 сперрингс	256 среднедонская	257 среднедонская	258 Средней Азии Неолит	259 Струмель и Гастятин тип	260 сурская
261 сылахская	262 Цедмар тип								

Figure 78: Legend of Symbols for 262 Early Neolithic cultures from Fertile Crescent to Europe in Image Database Montelius, as used by the next maps.

Here are 262 Early Neolithic Cultures from 22.102 sites (with 204.537 images).

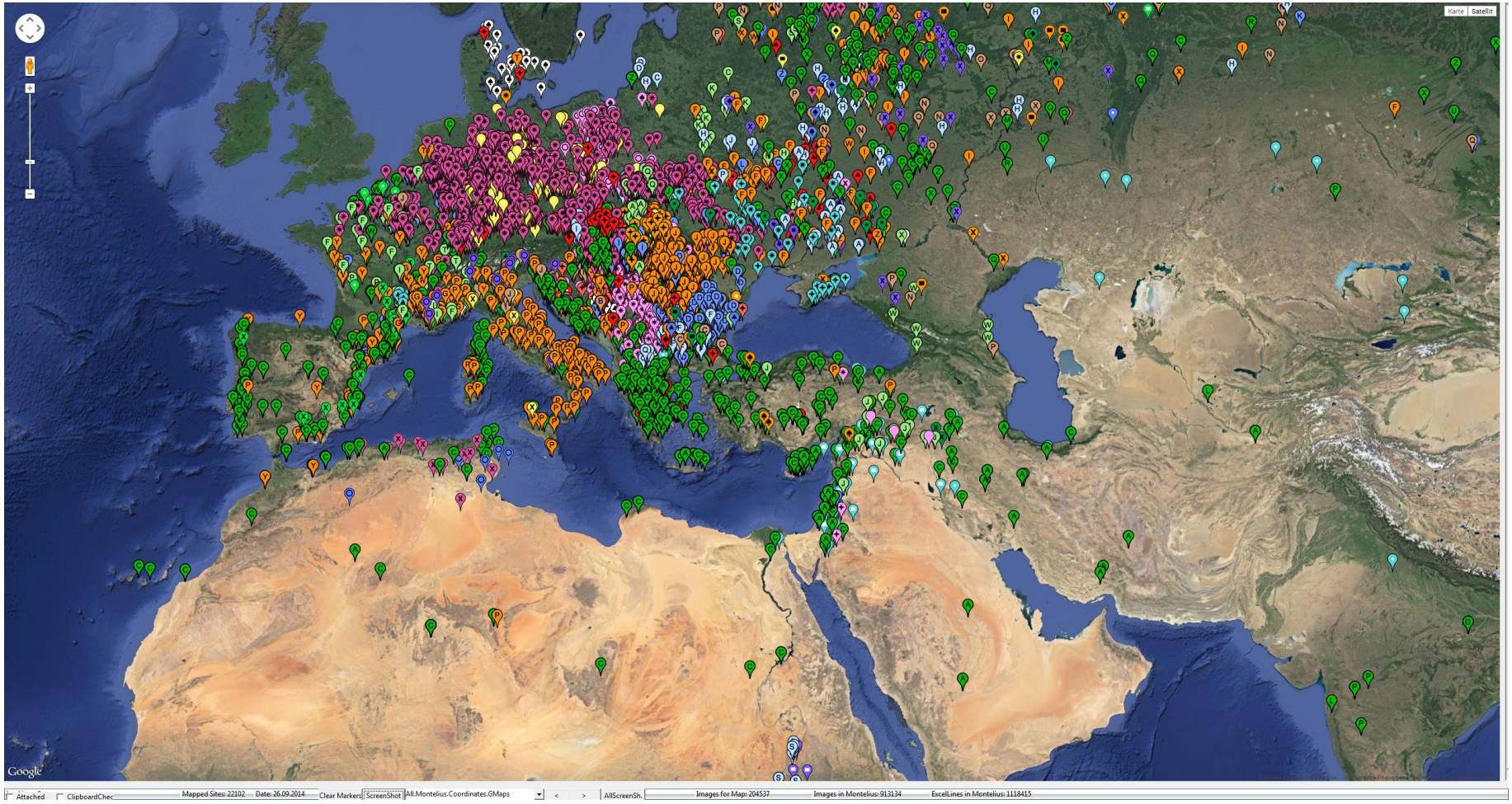


Figure 79: Early Neolithic cultures from Fertile Crescent to Europe in Image Database Montelius.

Here we see Early Neolithics from the Balkans. Brunn Wolfholz is marked with a blue star. Linearband Ceramics is the red symbol filled with a star.

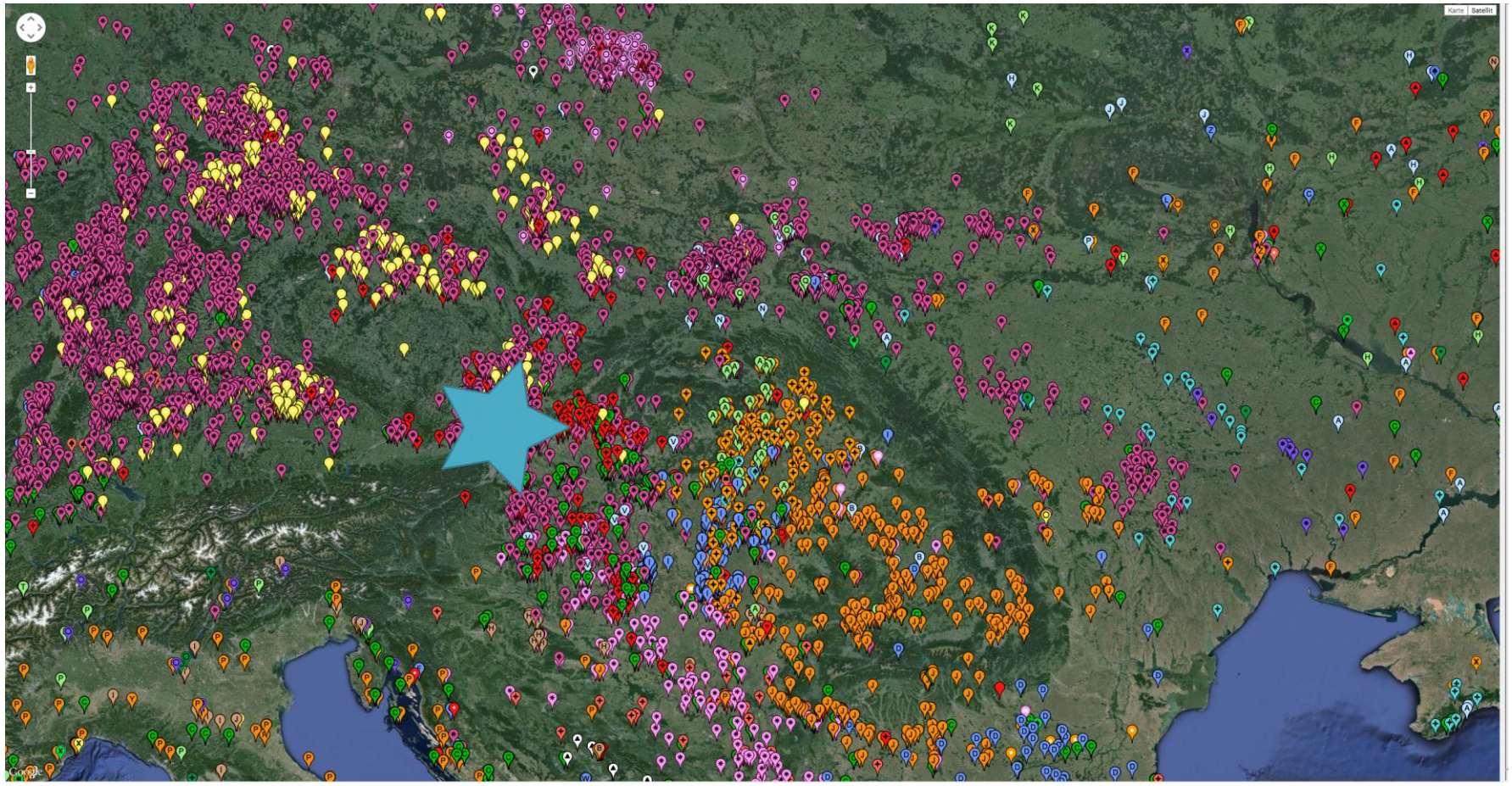


Figure 80: Early Neolithic Cultures in Europe in Image Database Montelius.

This map shows mostly the cultures of Impresso and Cardial Ceramics in Croatia and Italy.

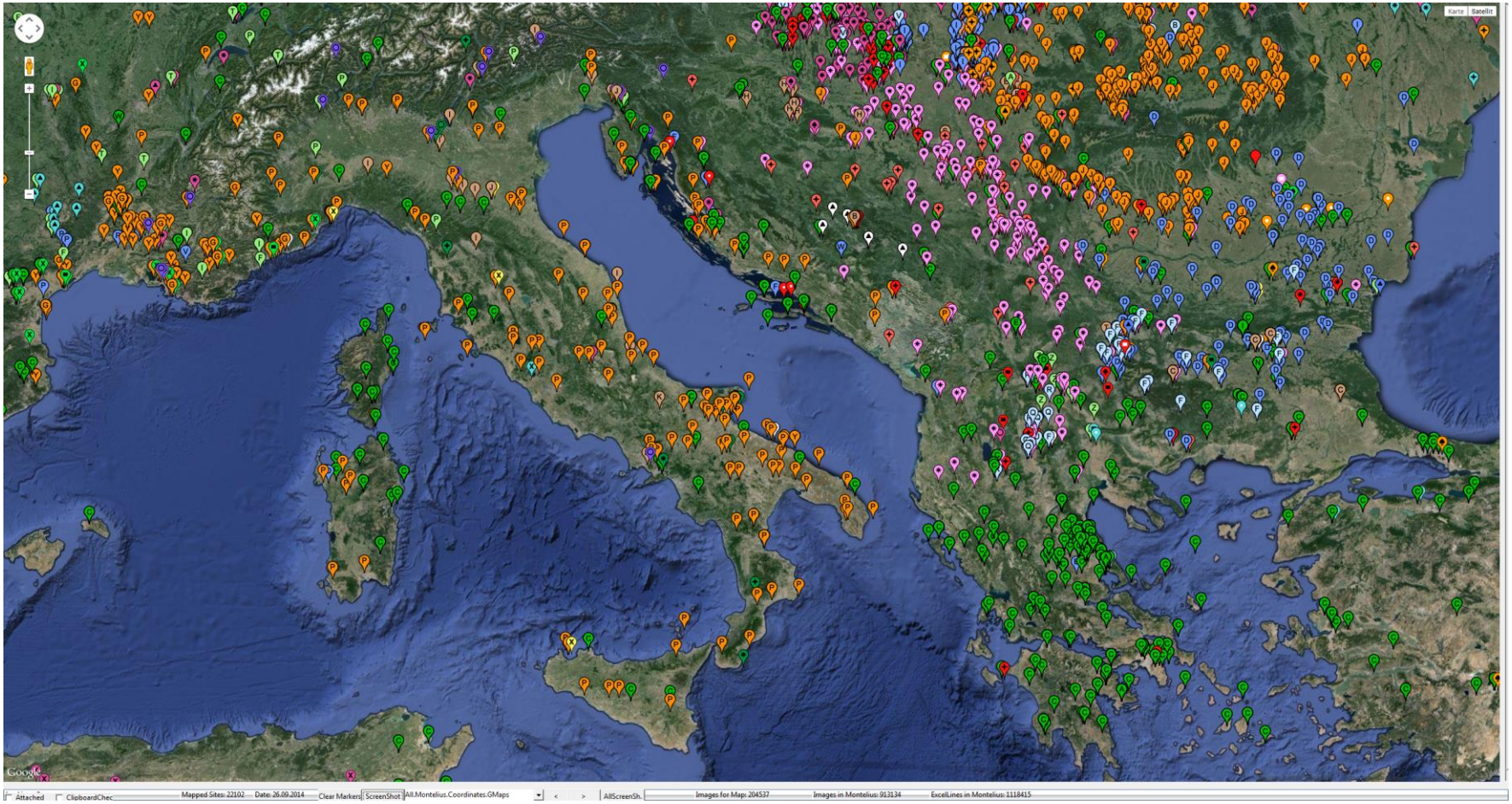


Figure 81: Early Neolithic Cultures around the Adria in Image Database Montelius.

This map shows the heterogeneous cultures in the West of Europe. Data for this part come from Michaela Schauer 2013.

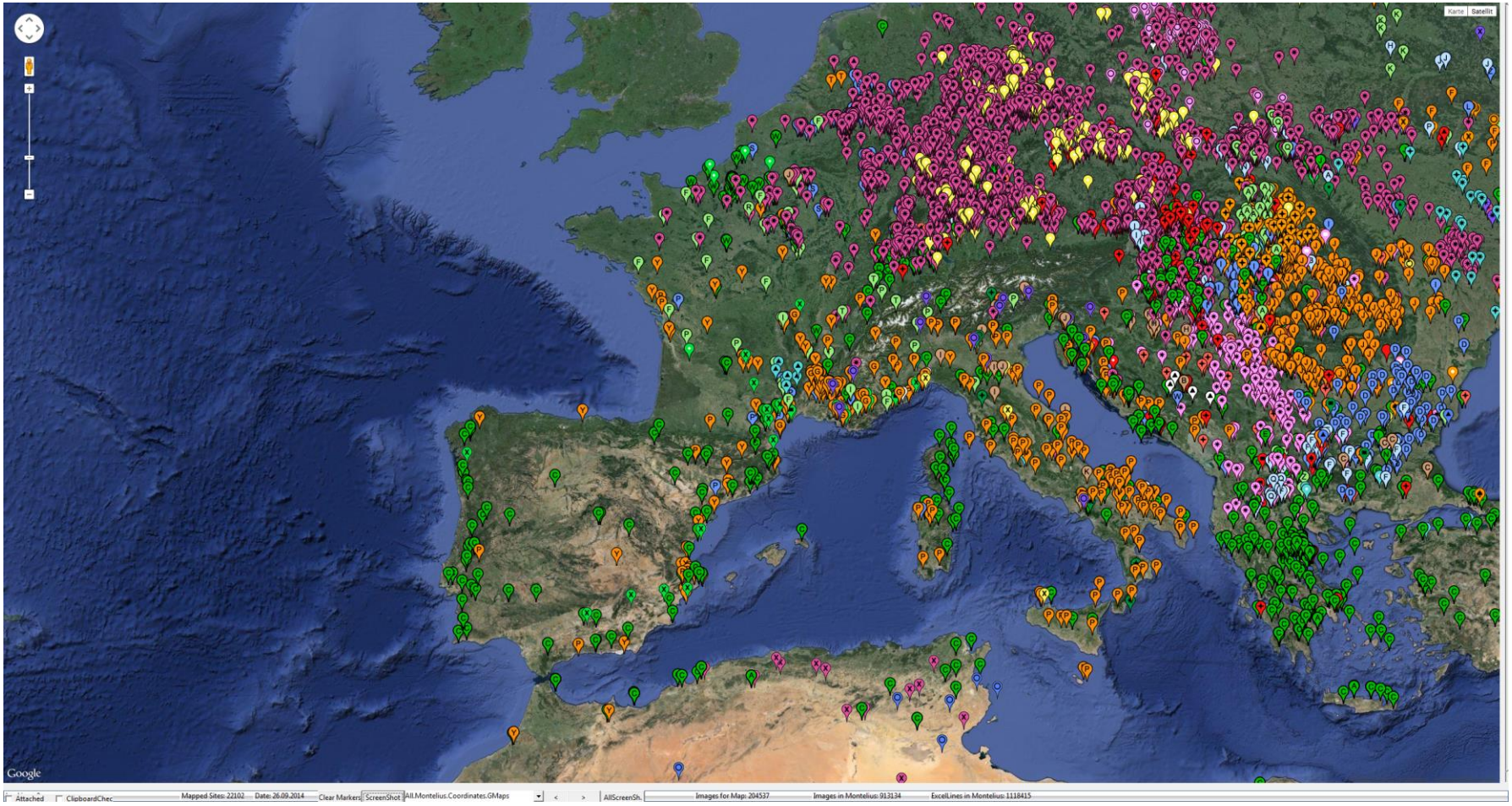


Figure 82: Early Neolithic Cultures in Western Europe in Image Database Montelius.

Here we see which data have been entered for 86 Middle Neolithic Cultures from 5.960 sites with 29.094 images.

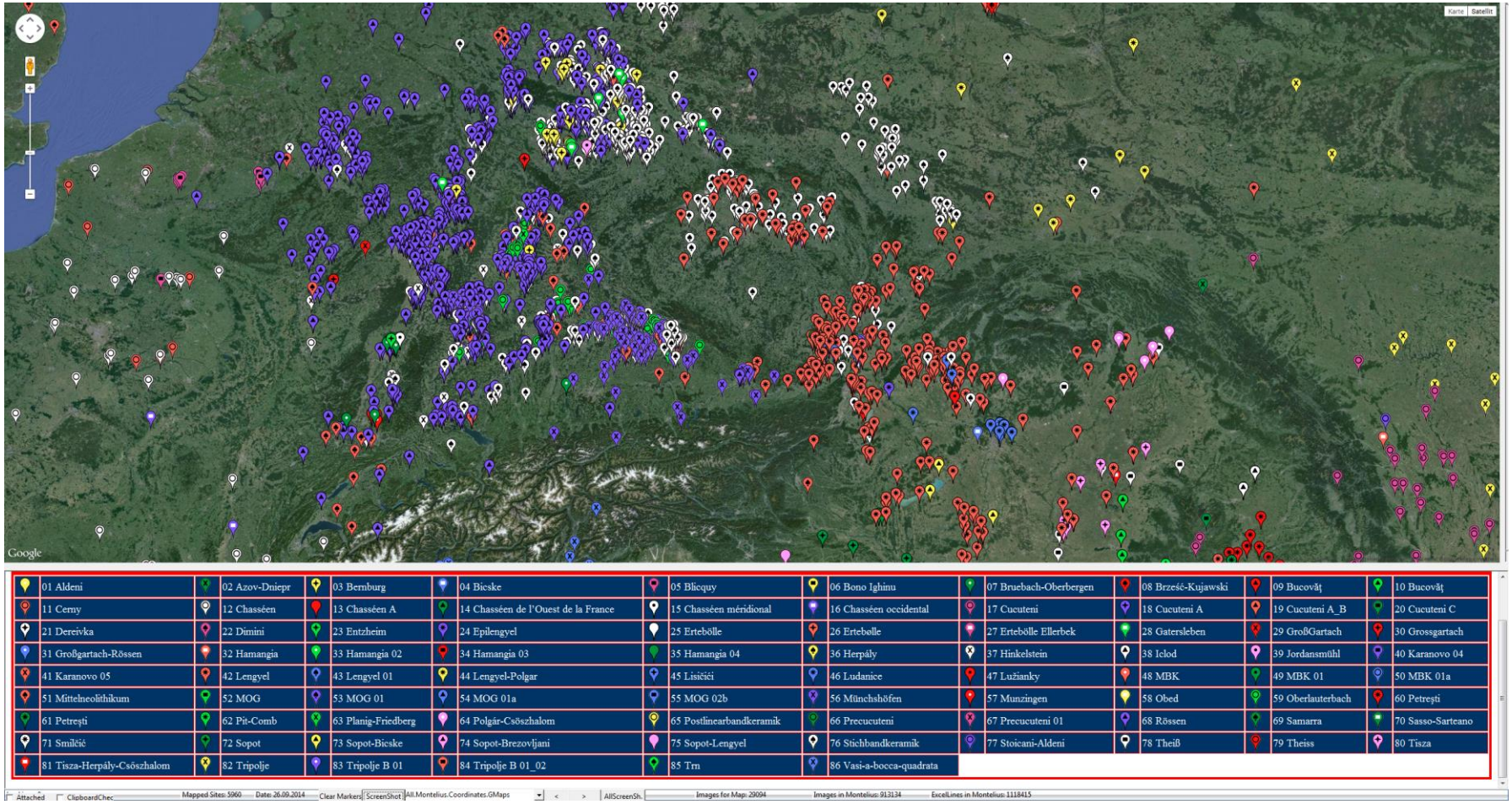
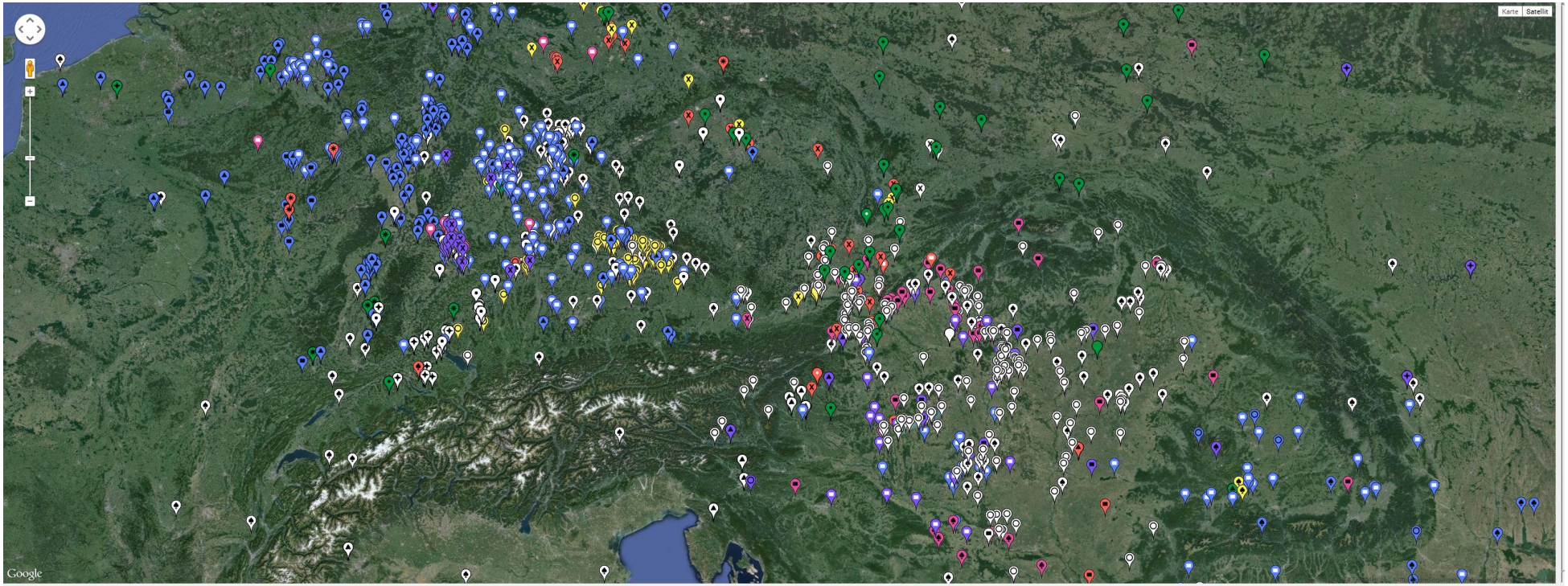


Figure 83: Middle Neolithic Cultures in Europe in Image Database Montelius.

This page is devoted to the input of Young Neolithics in Central Europe from 56 Cultures from 2.038 sites with 10.931 images.



Titel	Statistics for Image Database Montelius
Header	Sites after Culture

01 Aichbühl	02 Altheim	03 Baalberg	04 Baden	05 Baden-Boleráz	06 Baden-Ossarn	07 Bisamberg-Oberpullendorf	08 Bischheim	09 Bischheim-Münchshöfen	10 Boian
11 Boleráz	12 Bošáca	13 Bronocice	14 Cernavoda	15 Epilengyel	16 Epirössen	17 Furchenstich	18 Furchenstich-Bajč-Retz	19 Ganggrab	20 Gorzsa
21 Gumelniţa	22 Hornstaad	23 Hunyadihalom	24 Jungneolithikum	25 Kakanj	26 Kanzianiberg-Lasinja	27 Kostolac	28 Laibach-Vučedol	29 Michelsberg	30 Ossarn
31 Pfyn	32 Pfyn 01	33 Post-Bischheim	34 Poströssen	35 Precucuteni 02	36 Precucuteni 03	37 Proto-Boleráz	38 Rachmani	39 Sălcuţa	40 Salzmünde
41 Šarovce	42 Schussenried	43 Schwieberdingen	44 Seče	45 Spätneolithikum	46 Tiefstich	47 Trichterbecher	48 Trichterbecher-Jevišovice	49 Turdaş	50 Turdaş
51 Vădastra	52 Vajska-Hunyadihalom	53 Varna	54 Wallerfing	55 Walternienburg	56 Wauwil				

Figure 84: Young Neolithic Cultures in Europe in Image Database Montelius.

Here we mapped the dataset entered for 37 End Neolithics Cultures in Central Europe, from 1.846 sites with 16.812 images.

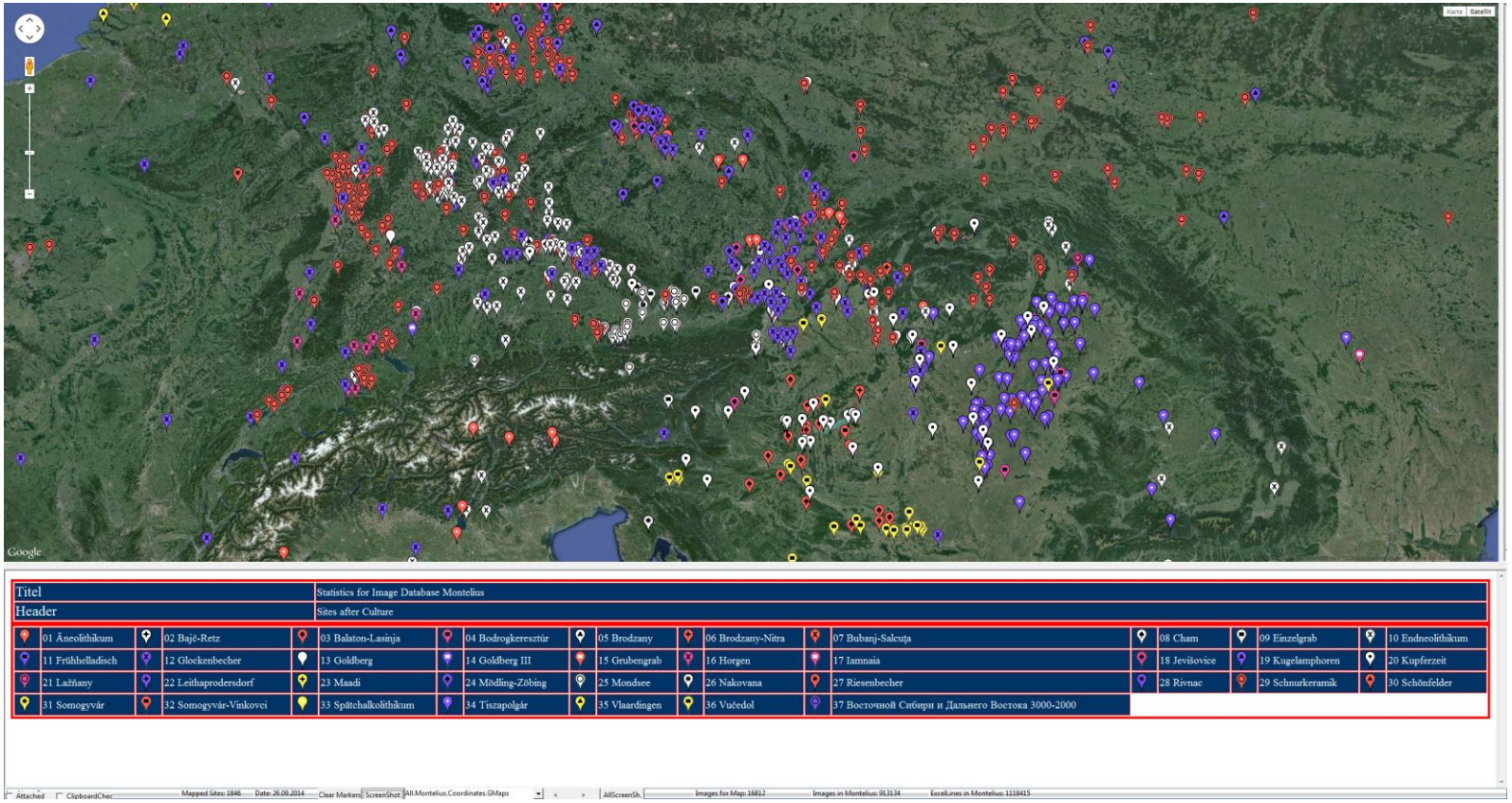


Figure 85: End Neolithic Cultures in Europe in Image Database Montelius.

For Early Bronze Age in Central Europe we have already from 31 cultures and 1.846 sites and with about 37.801 images.

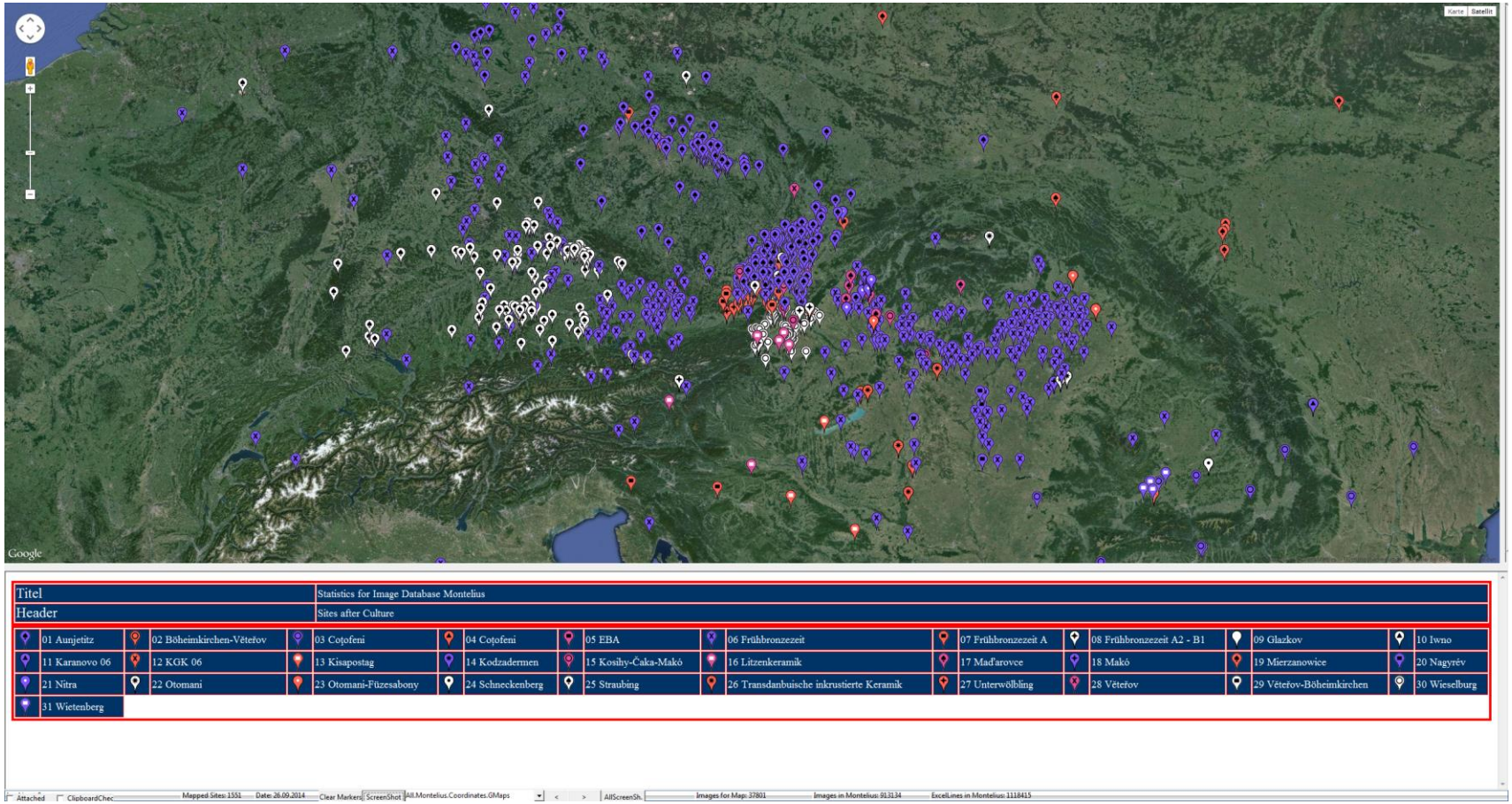


Figure 86: Early Bronze Cultures in Europe in Image Database Montelius.

For Late Bronze Age in Central Europe we have already about 14.127 images from 10 cultures and 978 sites.

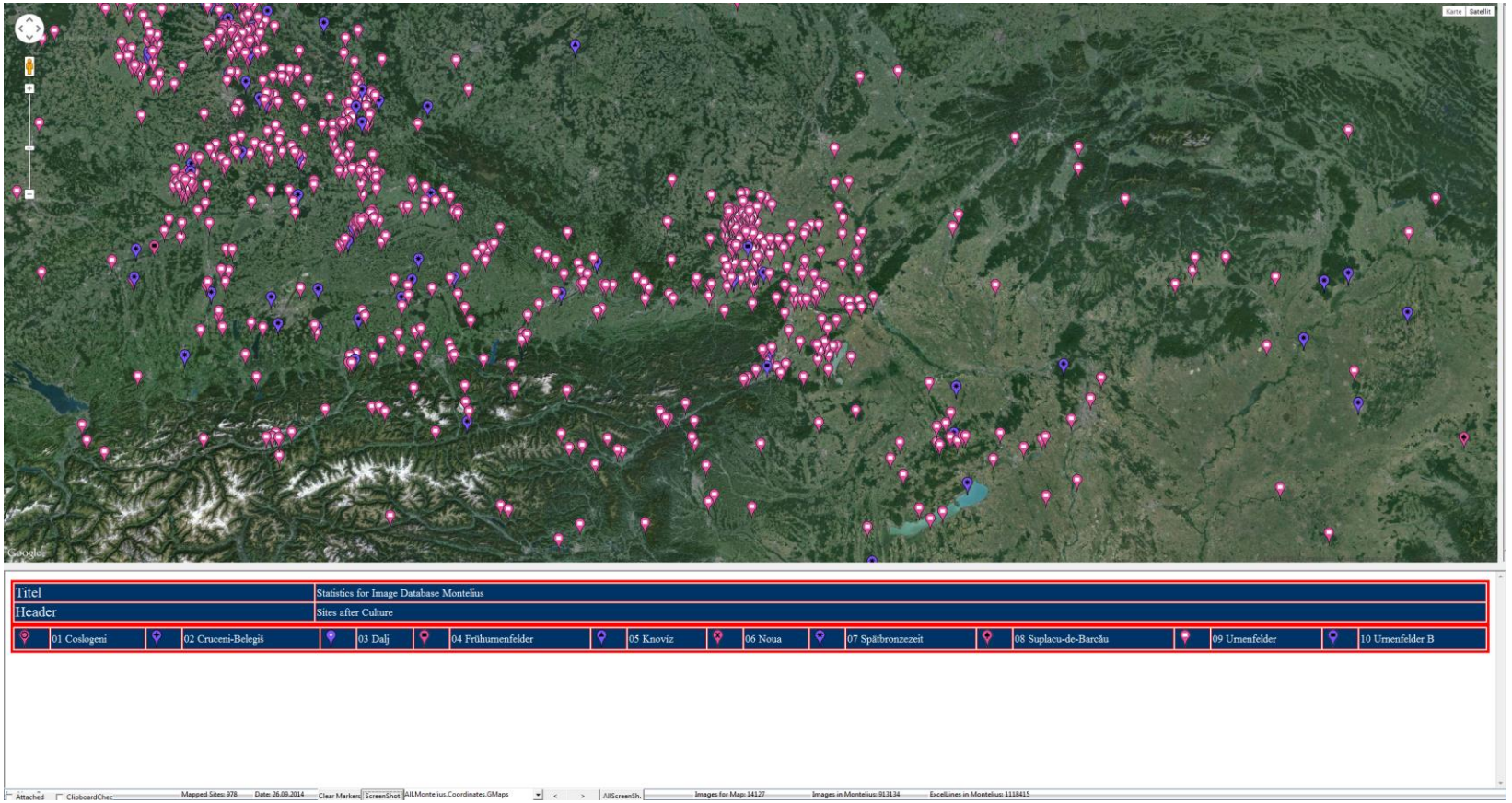


Figure 87: Late Bronze Age Cultures in Central Europe in Image Database Montelius.

For Iron Age in Central Europe we have already from 26 cultures and 2.947 sites with about 51.972 images.

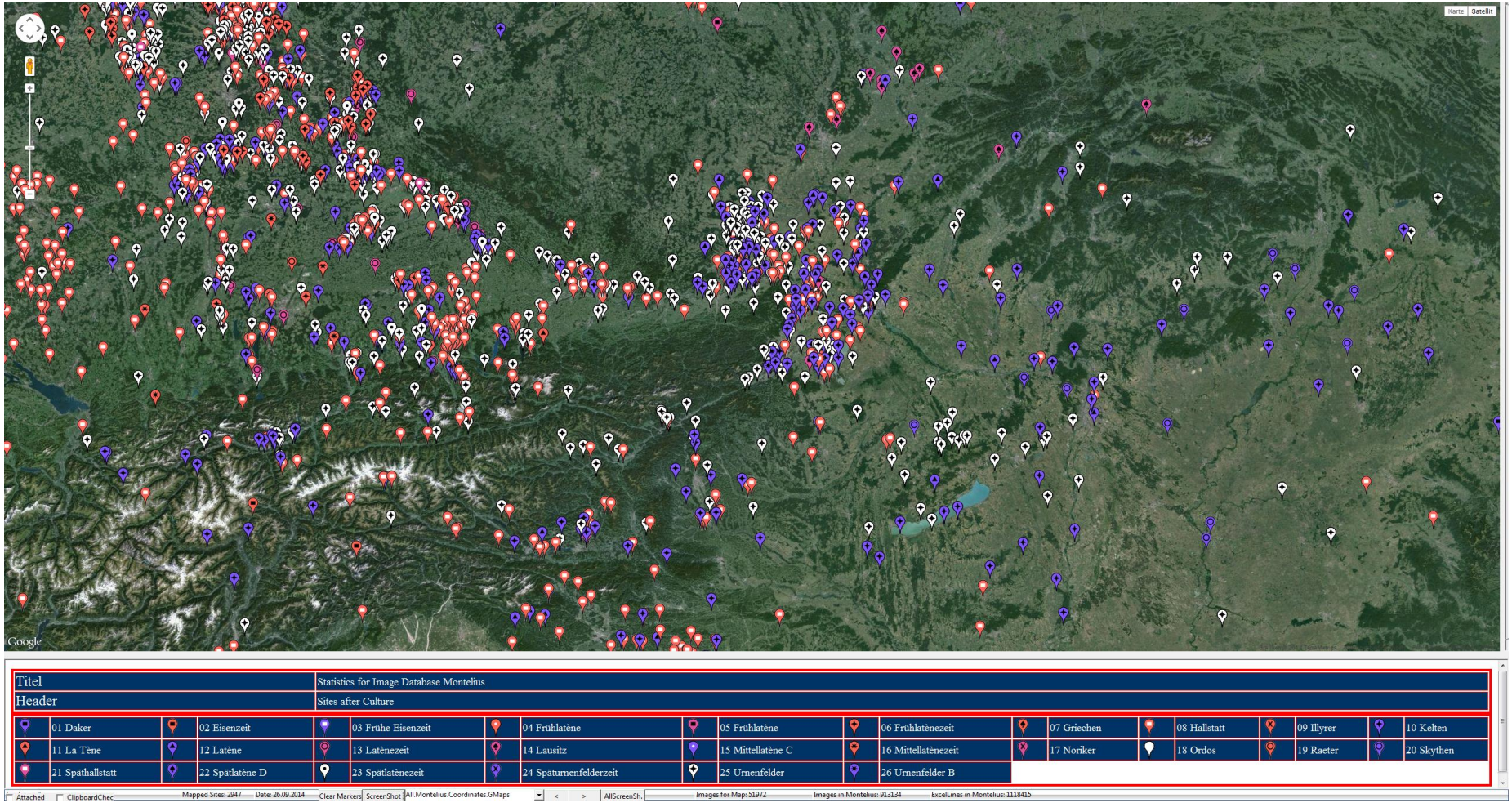


Figure 88: Iron Age Cultures in Central Europe in Image Database Montelius.

Here are the Roman Empire period finds from 3.187 sites with 37.487 images. There are already inputs from the Roman Empire, but these rest only a small percentage of the whole archaeological material, as we had not yet any project or interest in this direction, so in a co-operation with Roman provincial archaeologists there would much to be done. Included are Germanic finds from 1st to 4th century, from Late Antiquity and several explicitly named tribes. A hope in the future would be to identify all the tribes by their archaeological find material, but maybe this never will be possible as the differences may be very small.

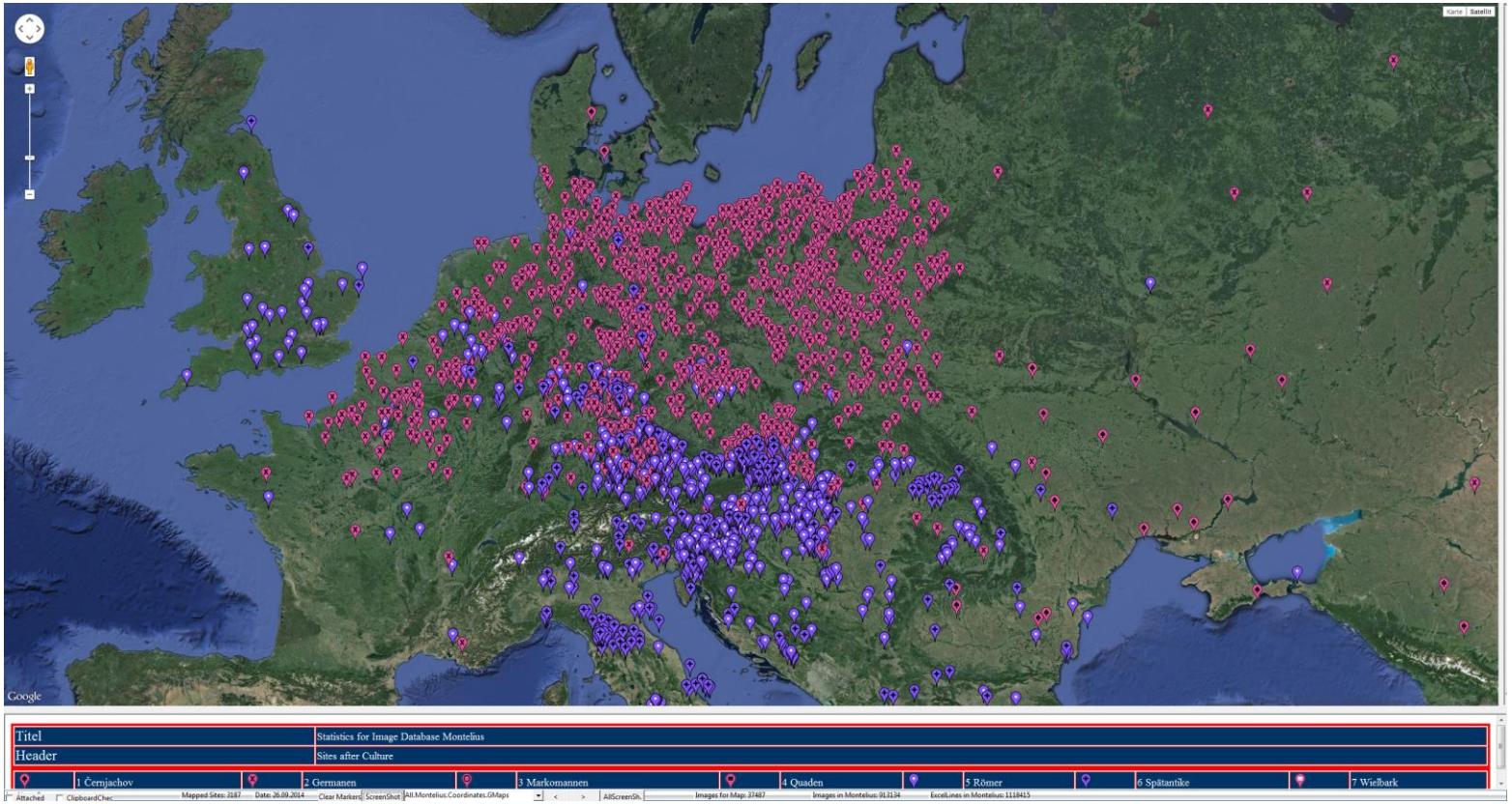


Figure 89: Sites of the time of Roman Empire in Image Database Montelius.

The Hun (or Hun period) finds from 2.087 sites with 23.238 images. Here you can see the geographical relationships reaching far into the East. The wide dispersion must still be archaeologically verified, to eliminate late antiquity and also find material belonging to other ethnic groups and to obtain a clearer picture of the Hun migration.

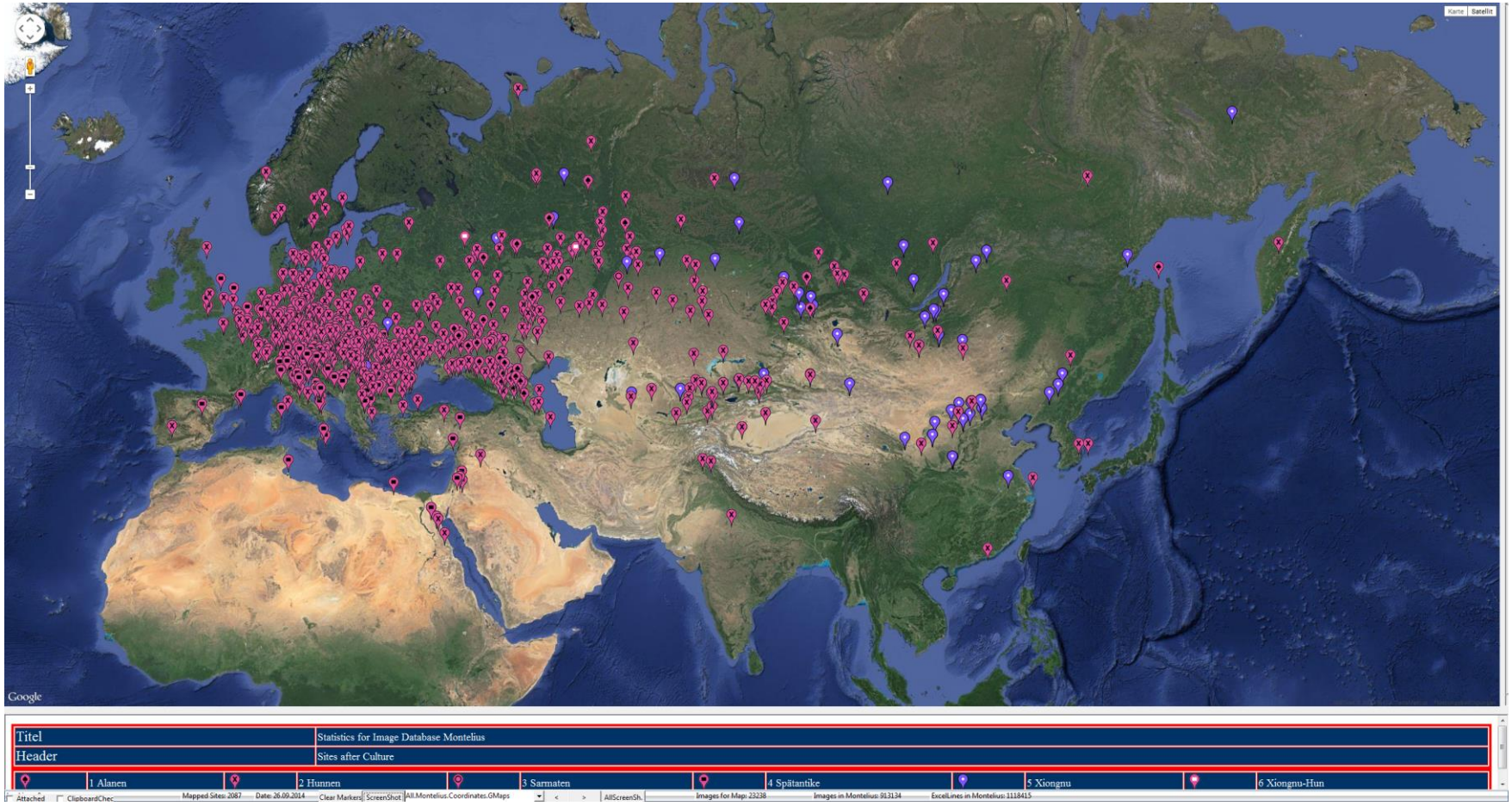


Figure 90: Hun period sites in Image Database Montelius.

In the next Figure we see the main settlement area of the Huns in the Carpathian Basin, as demonstrated by the greatest density of find spots. There is a certain degree of similarity to the later Avar and Magyar colonization of the Carpathian Basin, which can be attributed to the same geographical conditions for nomadic horse riders.

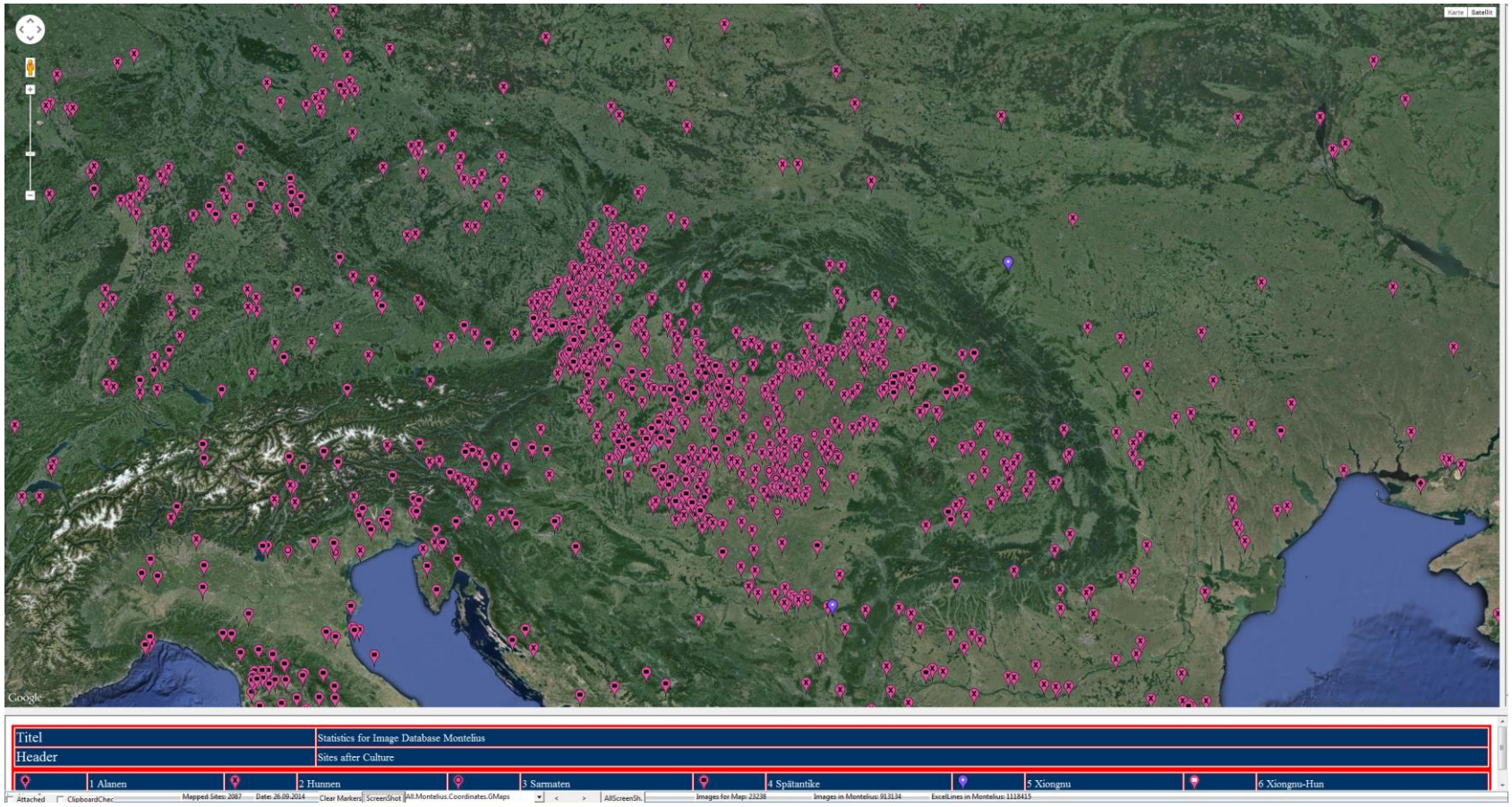


Figure 91: Hun period sites in Europe in the Image Database Montelius.

The migration of the Goths was one of the longest and so it is very difficult to reconstruct with archaeological means. They reached many European territories. Here we present the find complexes which are attributed to the Goths. Further work will help to check every find spot, if it belongs really to Goths (Visigoths and Ostrogoths) or to another ethnic group. One problem is that the Goths' male graves do not contain weapons, so mostly the ethnic attributions must be done via female costume. Currently we have complexes from 1.096 sites with 10.350 images.

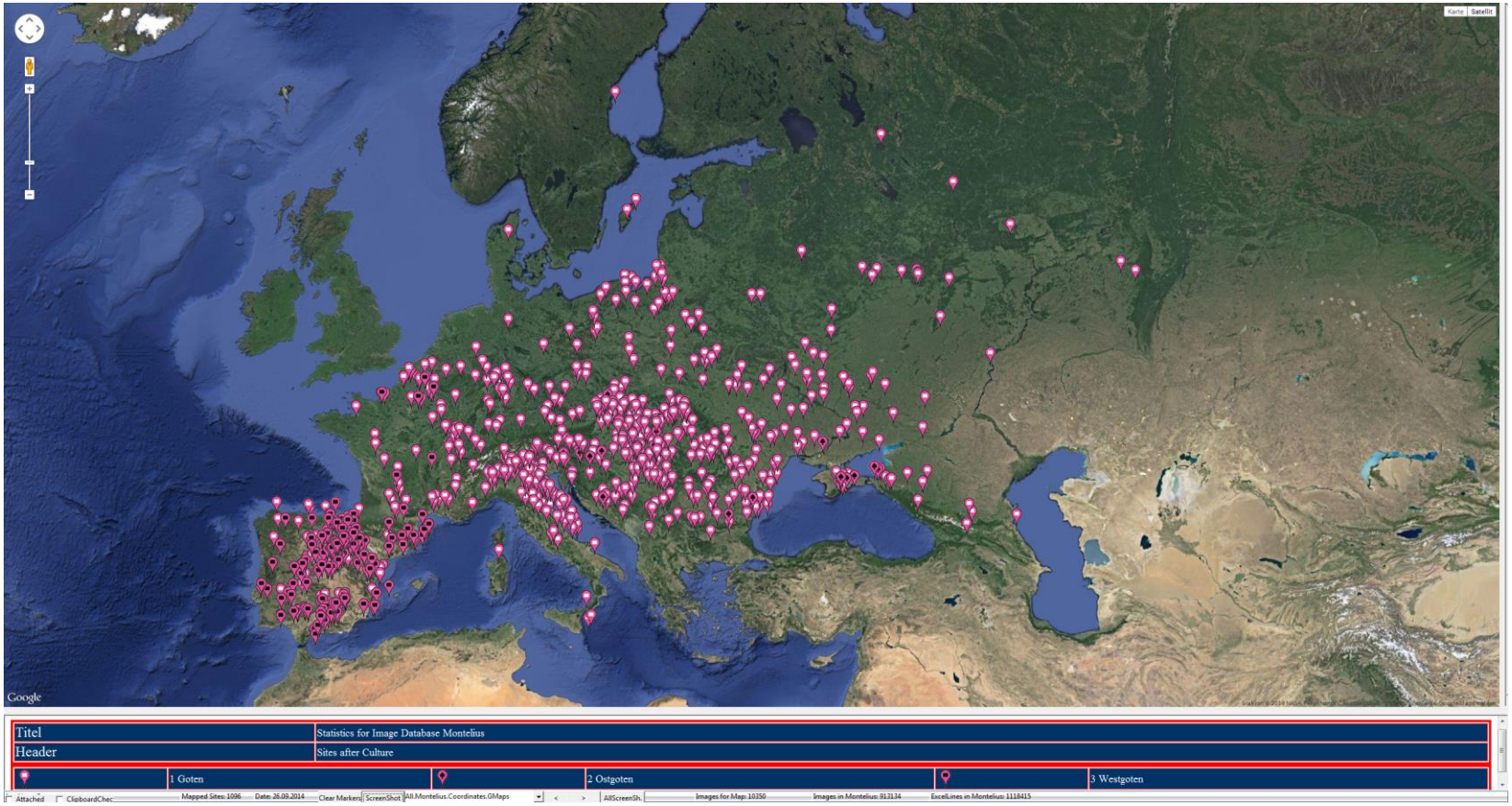


Figure 92: Sites of Goths find materials, of Ostrogoths and Visigoths in the Image Database Montelius.

Here we are showing the cultural maps of East Germanics. We have them from 2.130 sites together with 25.035 images.

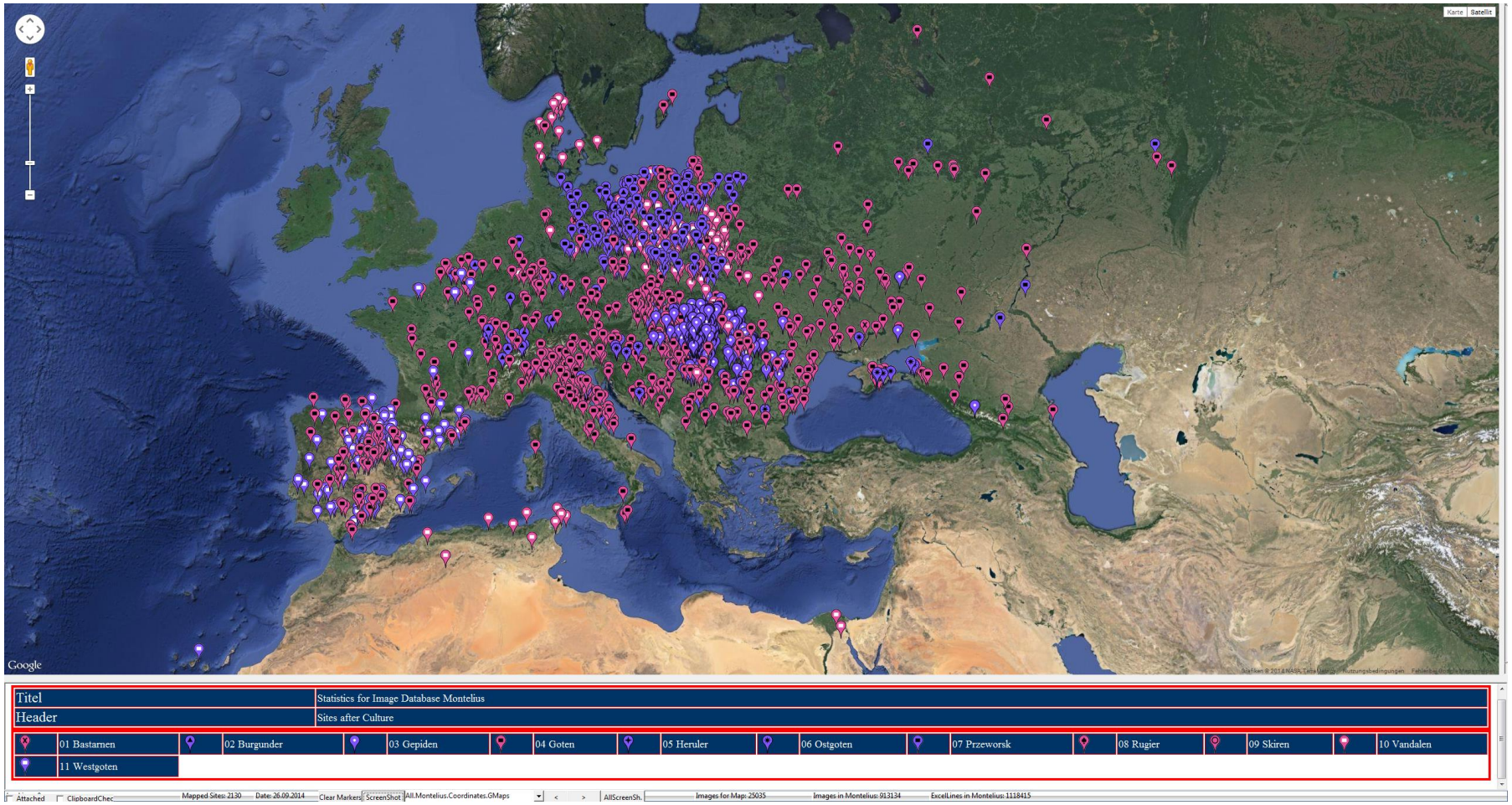


Figure 93: Sites of East Germanic find complexes in the Image Database Montelius.

In this figure the Lombard migration is shown from 1.462 sites, with 28.007 images. Several different phases of movement can be identified. Initially in the north, we have finds from the 1st - 4th century AD. Then a group in Bohemia, two groups in Moravia, and then the Pannonian phase with a settlement group in Croatia and Slovenia. And finally, 568 AD, the colonization of Italy all the way to Southern Italy.

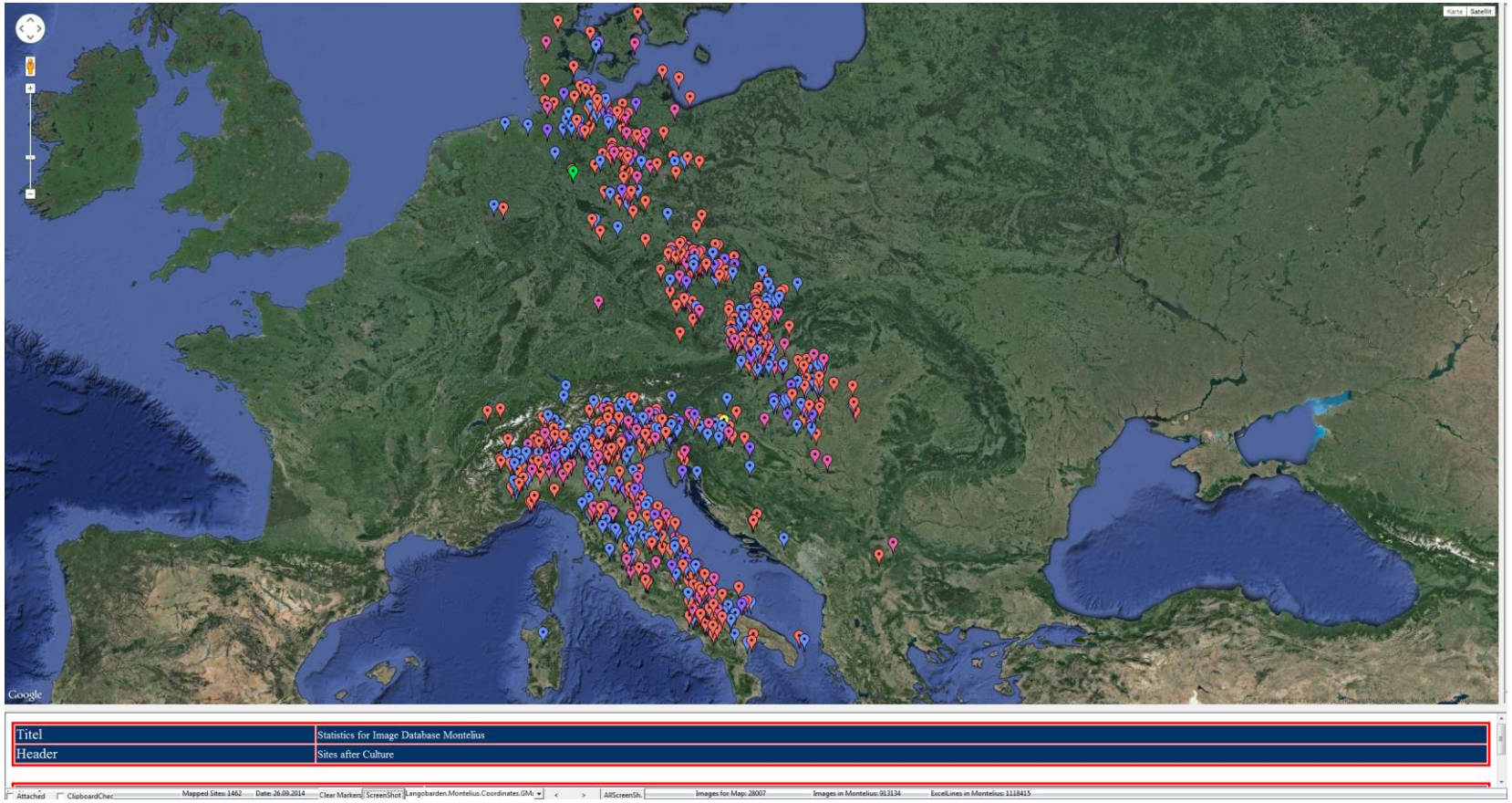


Figure 94: Lombard sites in the Image Database Montelius.

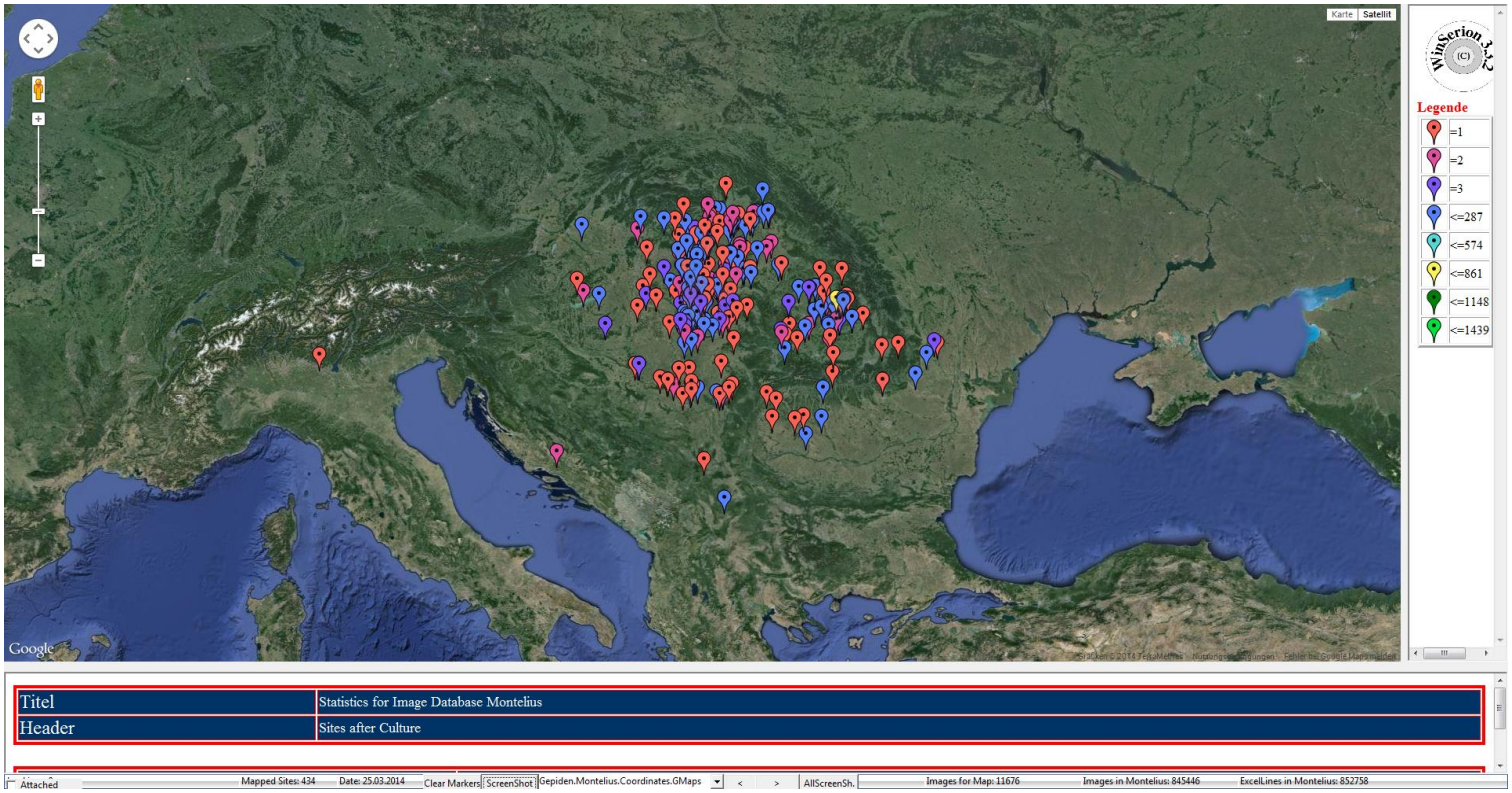


Figure 95: Gepid sites in the Image Database Montelius.

We know 523 Gepid sites with 11.862 images. There are few significant differences in the archaeological material between the Lombards and the Gepids. The amber beads that are among the Gepids occur only rarely with the Lombards. Conversely, the S-brooches come almost exclusively from Lombard graves. The Gepids on the Tisza region and in Transylvania can be geographically differentiated rather well from the Lombards.

In a combination of several maps it is possible to show the co-existence of the Elbe Germanics and the Gepids. It is in question how close Thuringians and Lombards lived together, at least for a part of their history. In total are mapped 8 groups from 2.622 sites with 52.232 images.

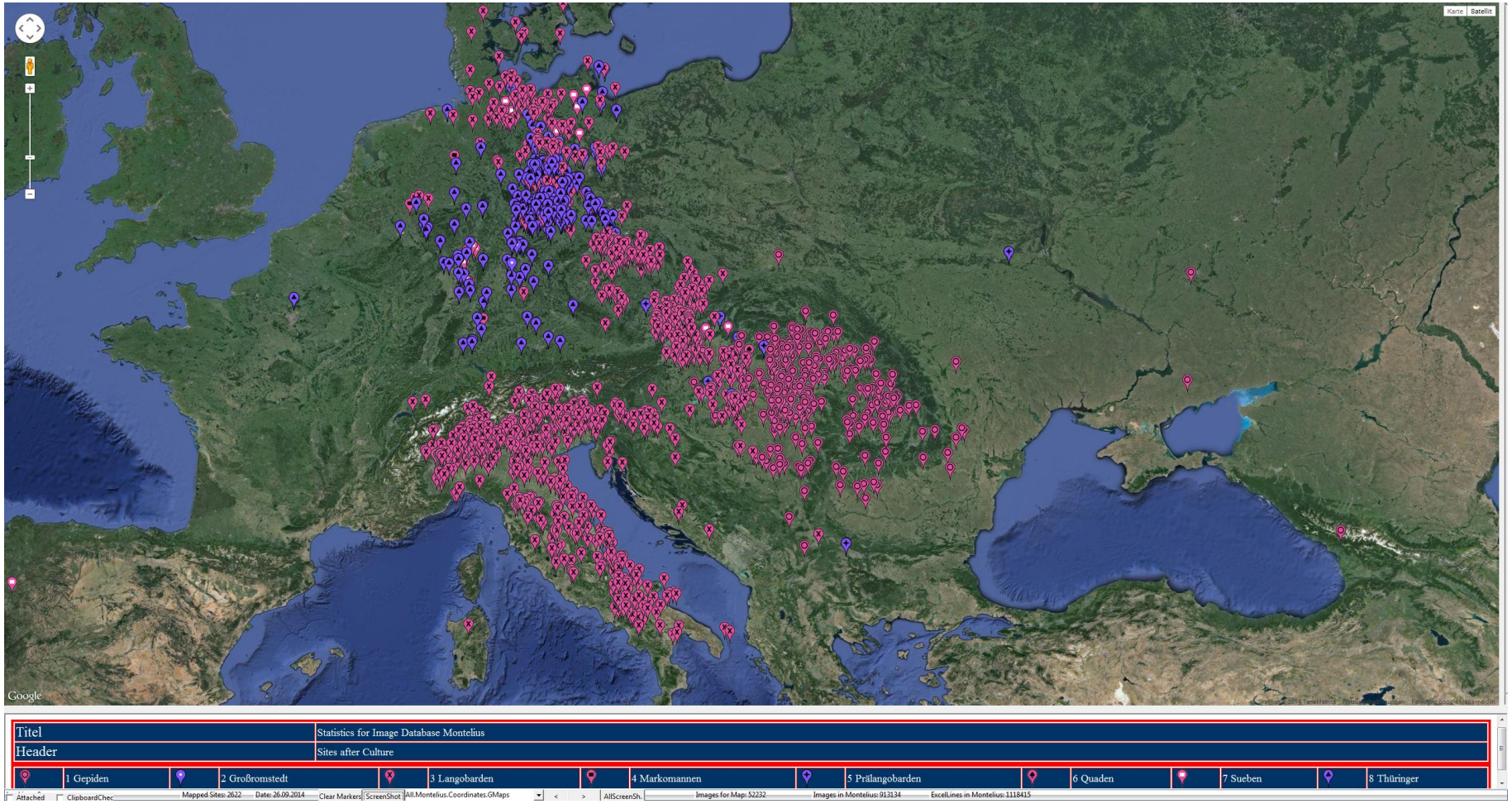


Figure 96: Elb Germanics and Gepid sites in the Image Database Montelius.

A huge data collection exists already for the Merovingians and Anglo-Saxons. 132.511 images from 4.174 sites.

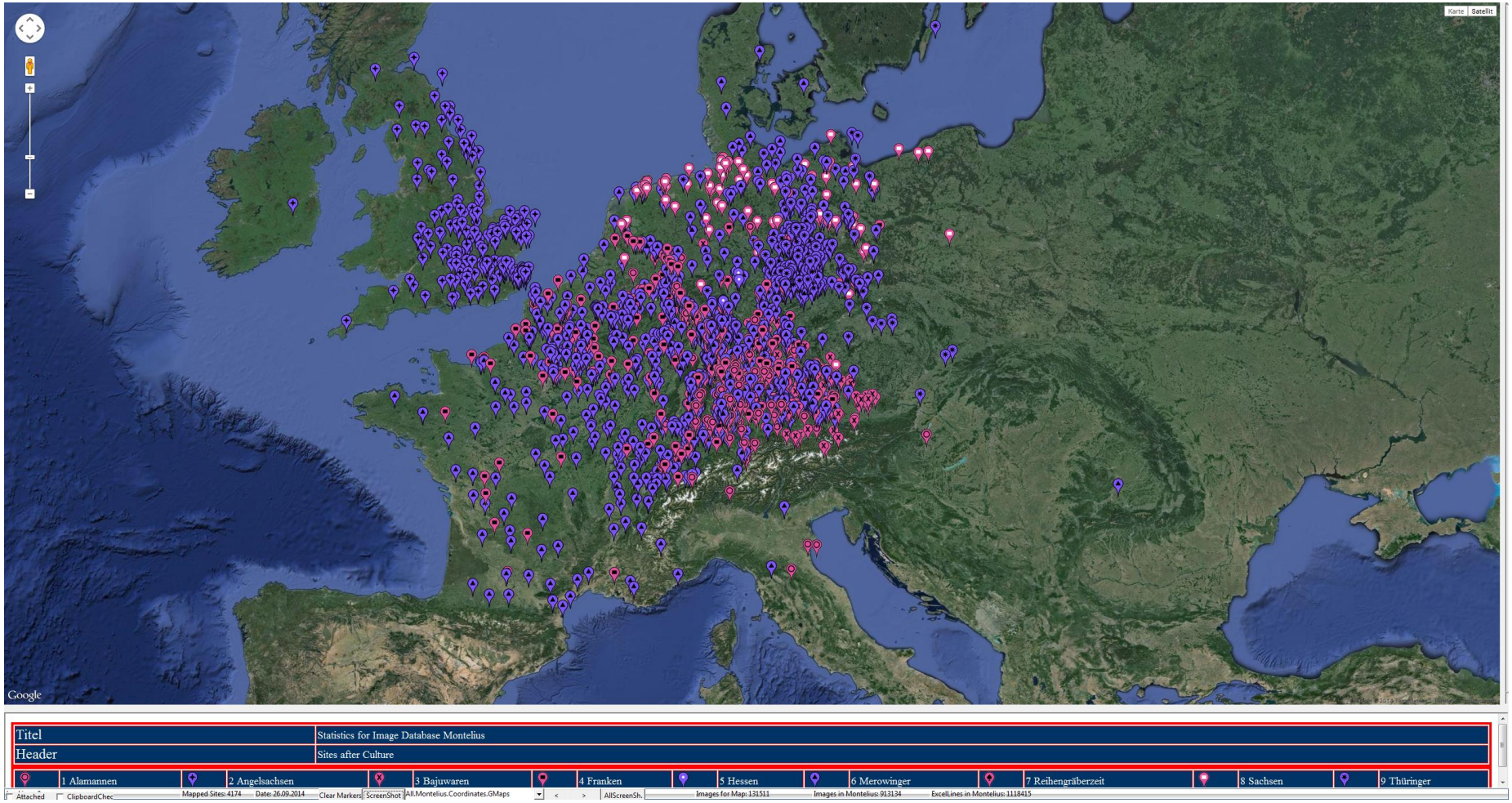


Figure 97: Merovingian and Anglo-Saxon sites in the Image Database Montelius.

Here are 2.468 Avar sites with 149.658 pictures from the Carpathian Basin. You can clearly see where the most important Avar settlement area is because of the dense concentration of archaeological sites. The findings outside the central region thereof are usually parallels to the Avar archaeological material.

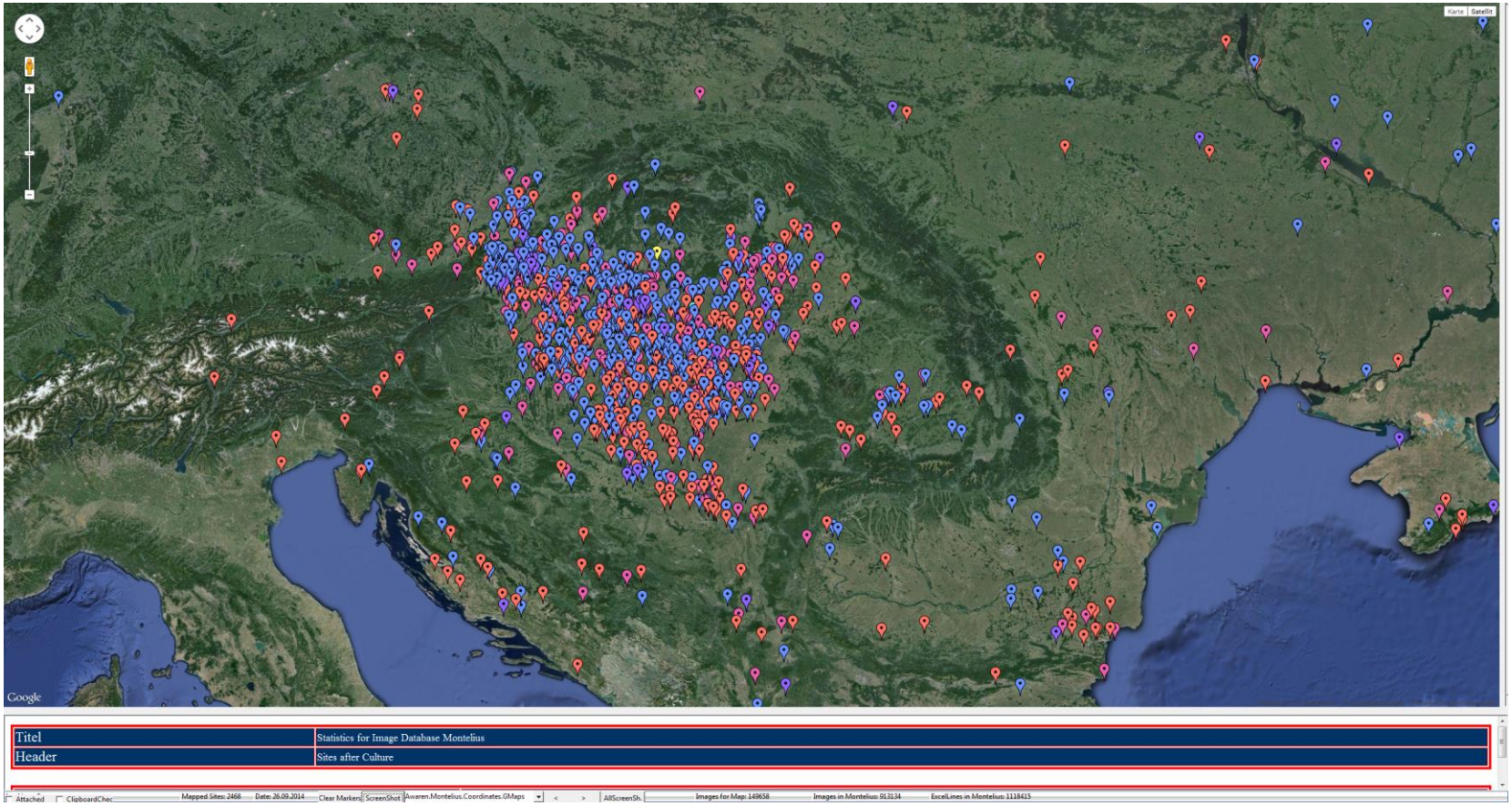


Figure 98: Avar sites in the image database Montelius.

Here are 4.573 Avar period sites from 22 cultural attributions with 166.610 images from Europe. One can clearly see the main Avar settlement area due to the dense concentration of find spots; the finds outside of it are mostly parallels to the Avar find material.

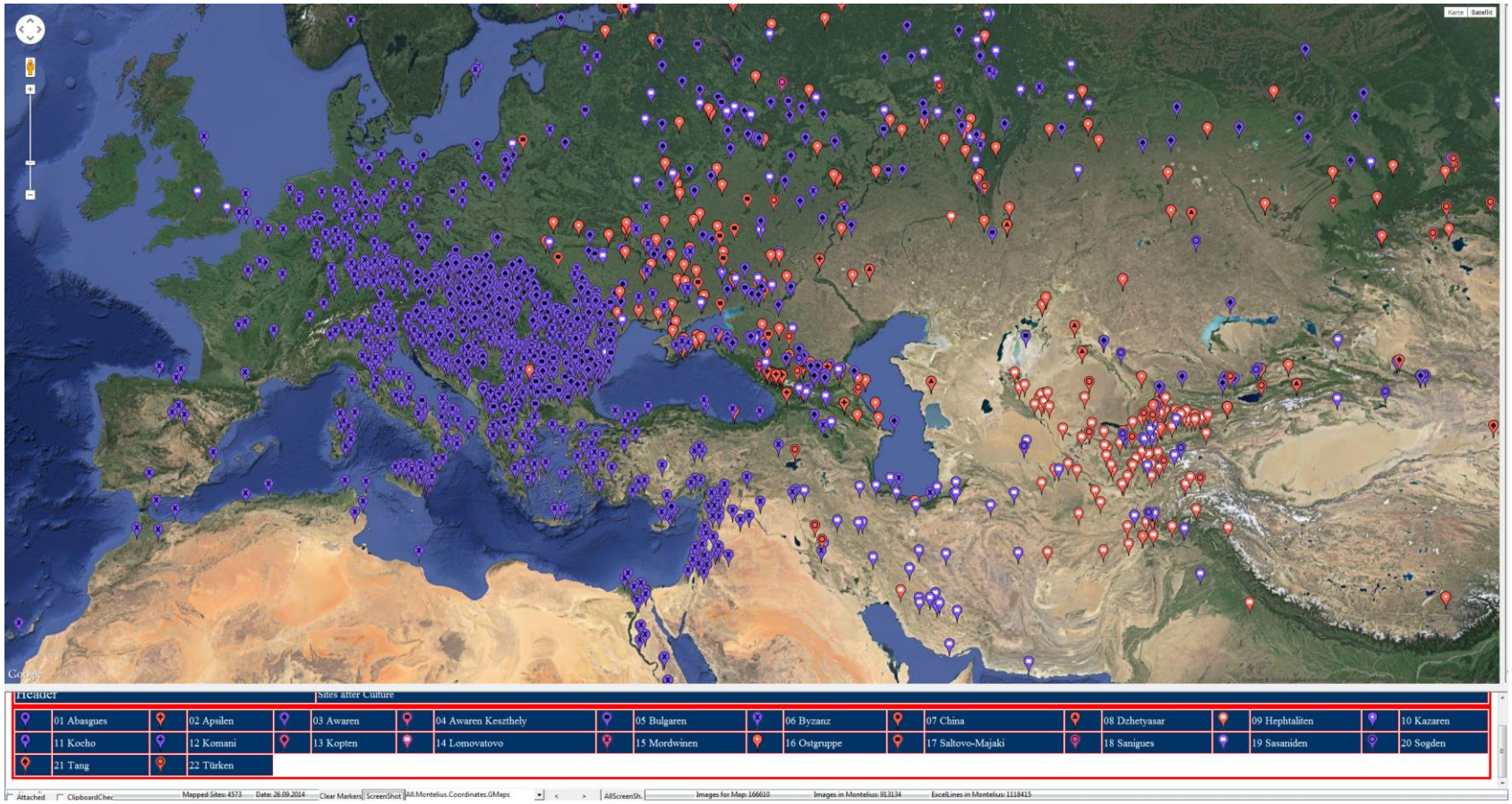


Figure 99: Avar period sites in the Image Database Montelius.

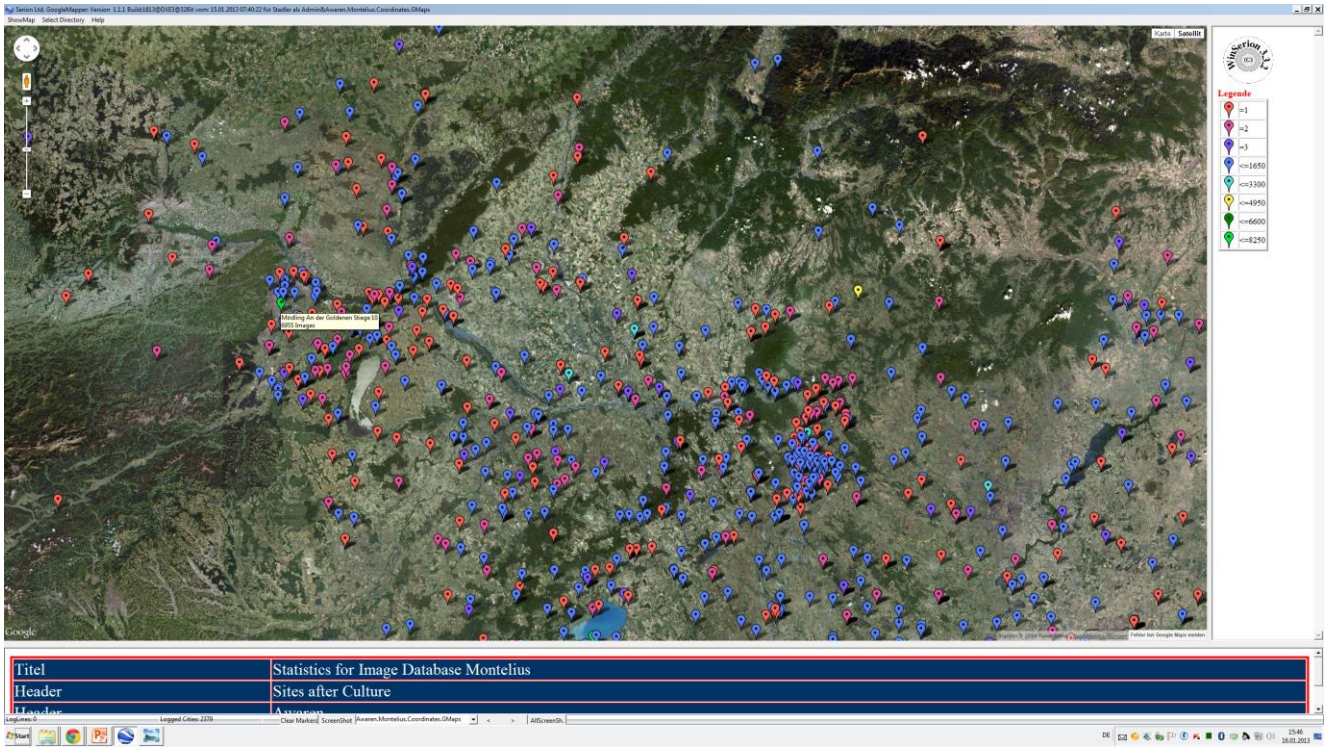


Figure 100: Avar period sites in the Image Database Montelius, Northwest group of the Avar region.

Here we have zoomed in on the previous map, with the Avar period sites cut-out from the North-western part of the Khaganate. The cursor is positioned on the site Mödling, An der Goldenen Stiege, which is why its name is displayed.

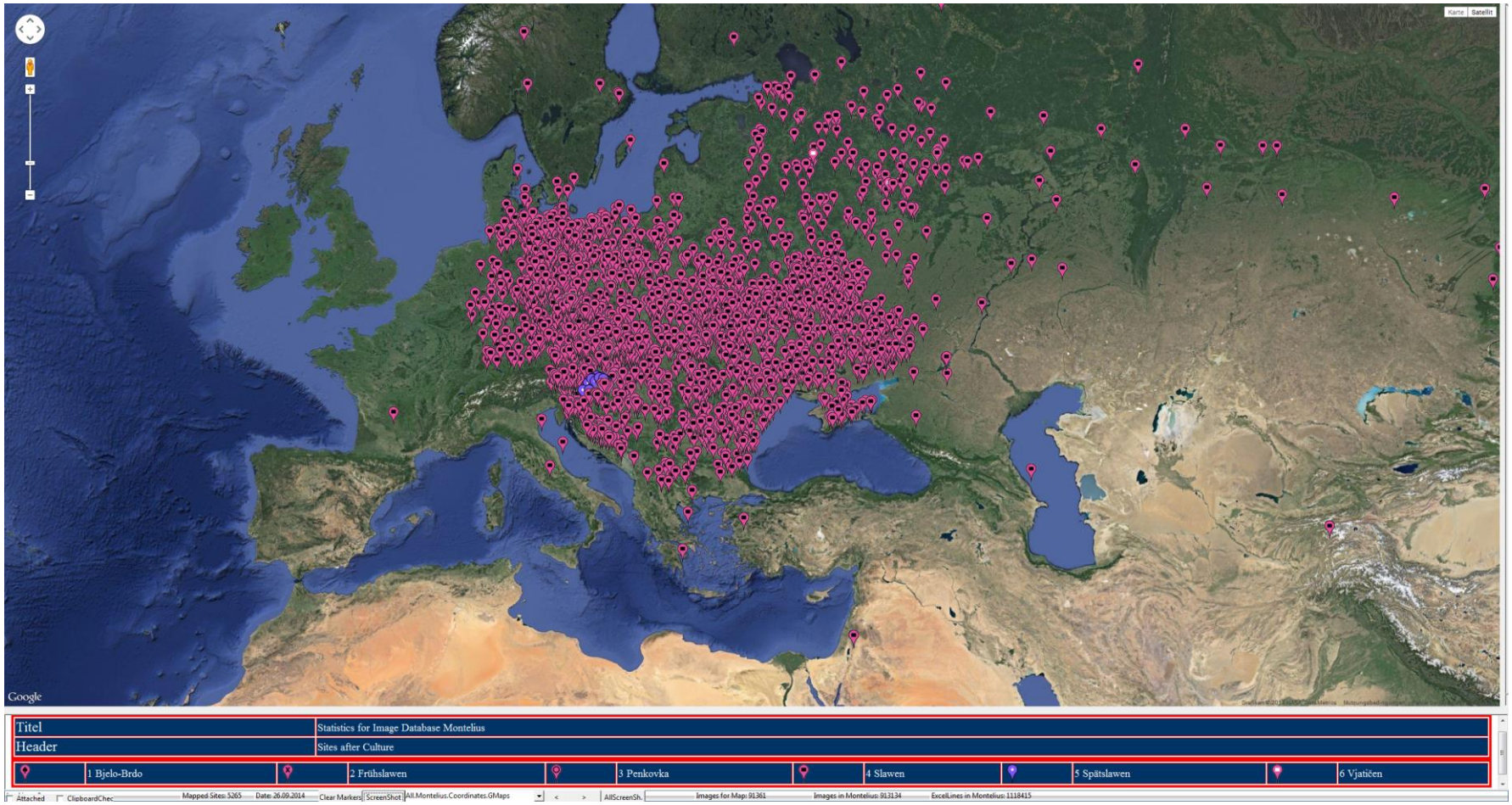


Figure 101: "Slavic" sites in the Image Database Montelius.

Here you see the distribution of 5.265 sites with Slavic finds (91.361 images) from the 6th to 10th century, from the Balkans to northern Germany. Slavic assemblages are mainly tied to ceramics; other find categories are far less represented.

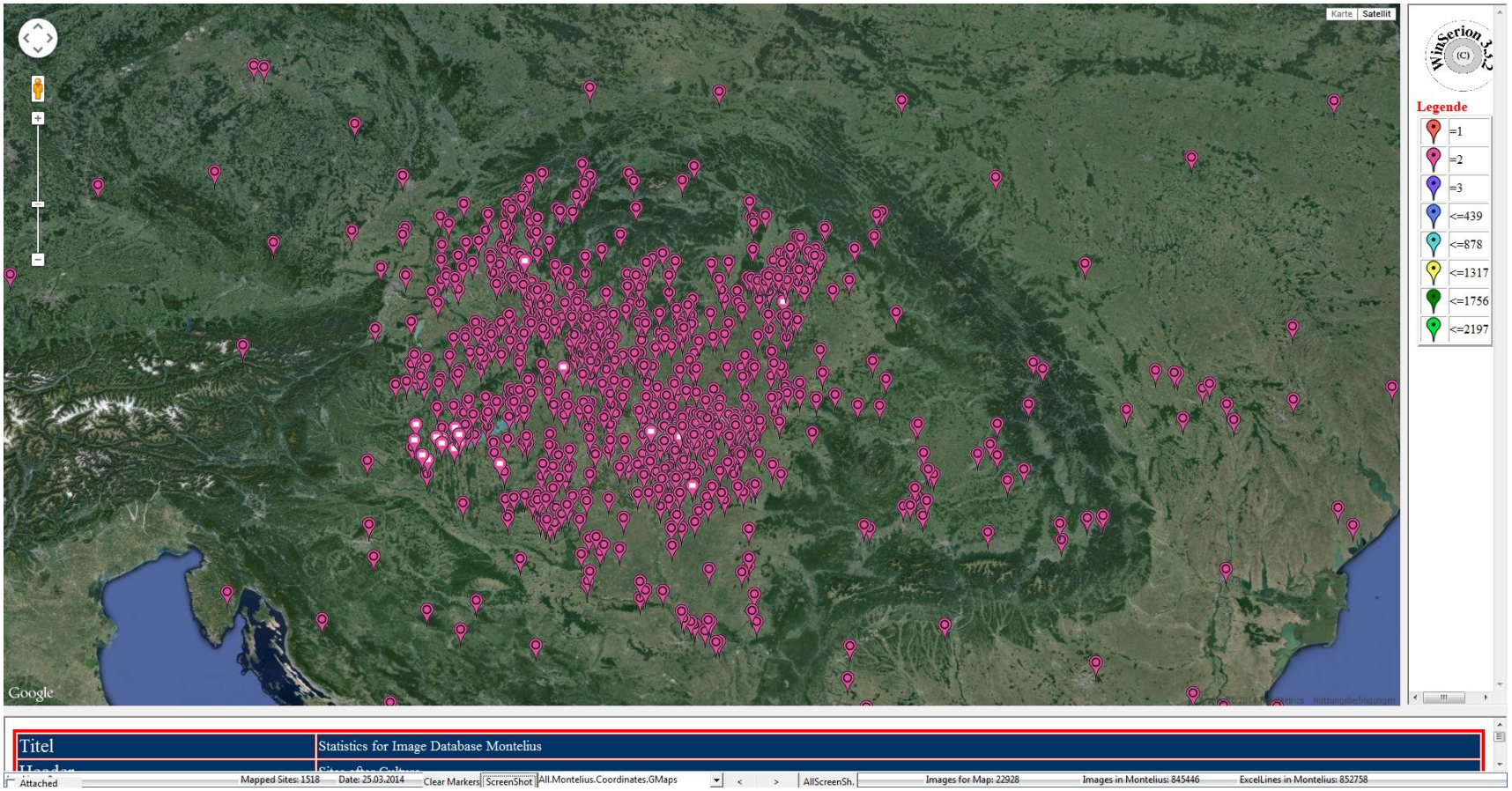


Figure 102: Magyar Sites in Image Database Montelius.

Also here, similar to Huns and Avars, there is a concentration in the Carpathian basin from 1.651 sites with 23.719 images.

Maps of GoogleMapper produced with WebLogAnalyzer from log Files.

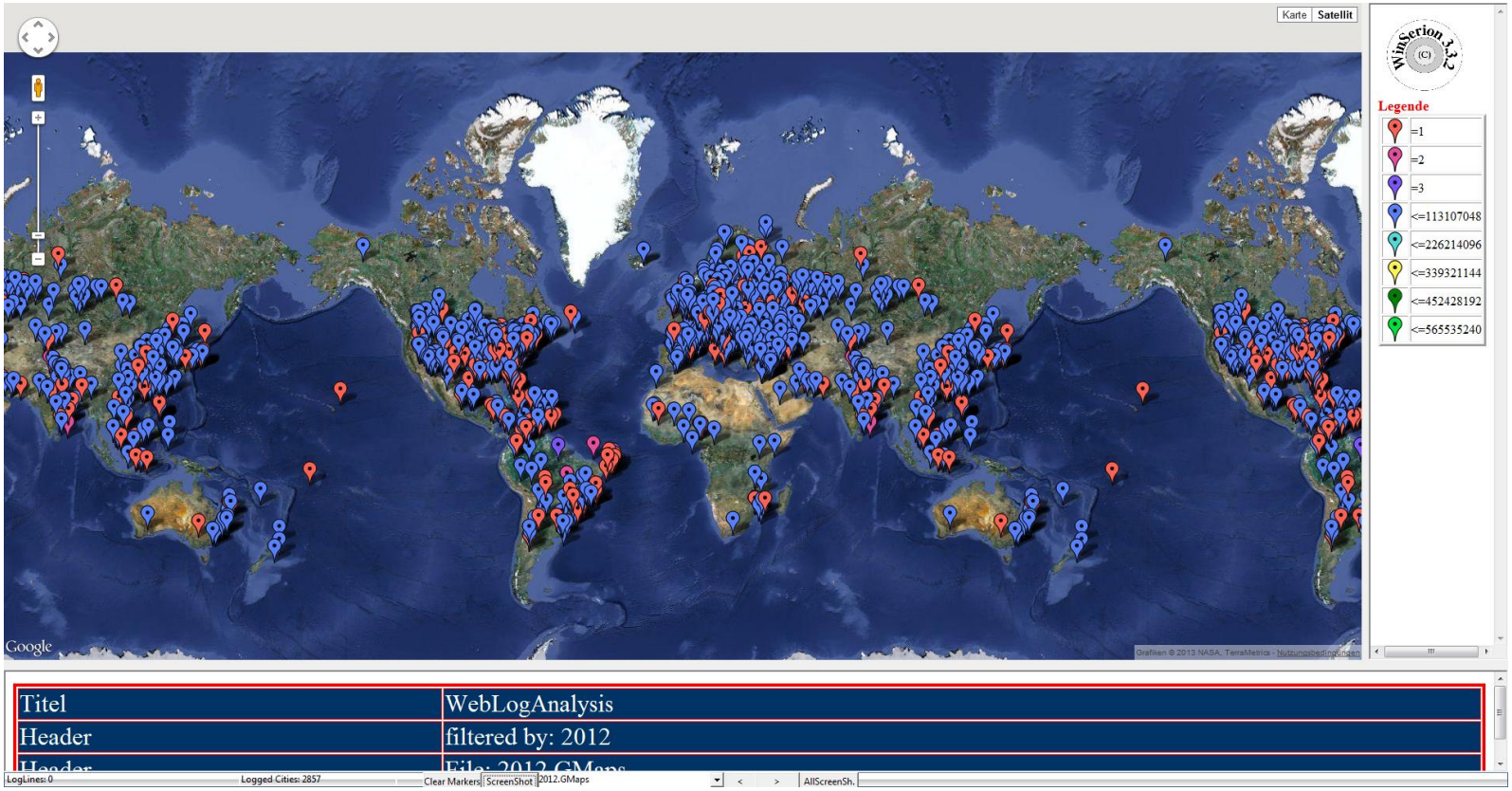


Figure 103: World-wide distribution of visitors on www.winserion.org.

Web visitors in the year 2012 come from 2857 cities from the whole world.

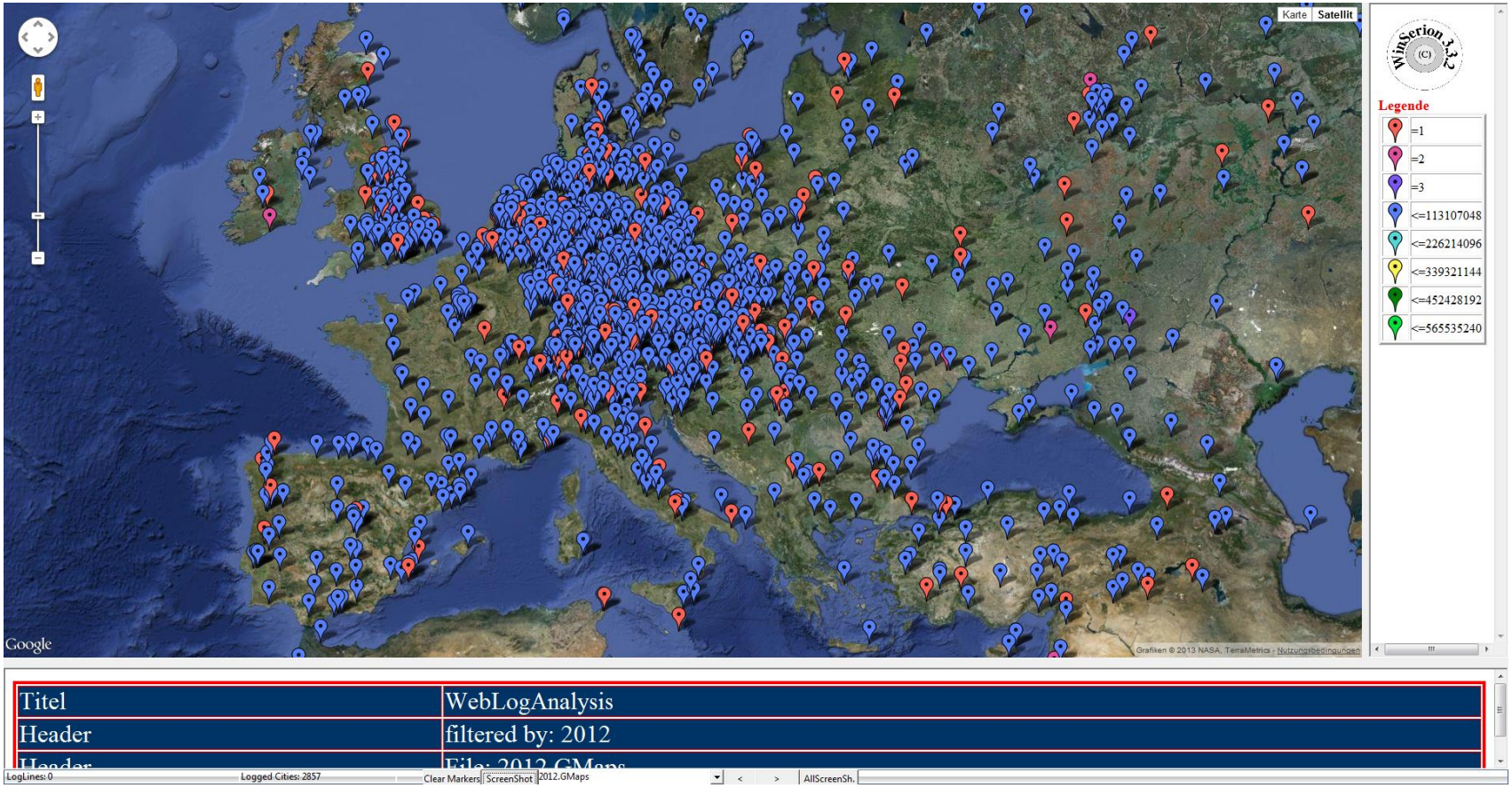


Figure 104: World-wide distribution of visitors on www.winserion.org.

Concentration of Users in Central Europe. Data were extracted from log-Files with program WebLogAnalyzer © Serion Ltd.

Maps of GoogleMapper with Typology.

Svend Hansen has in his 2007 Habilitation collected an incredible wealth of material of the idols of the Paleolithic and Neolithic. This is illustrated in our map here:

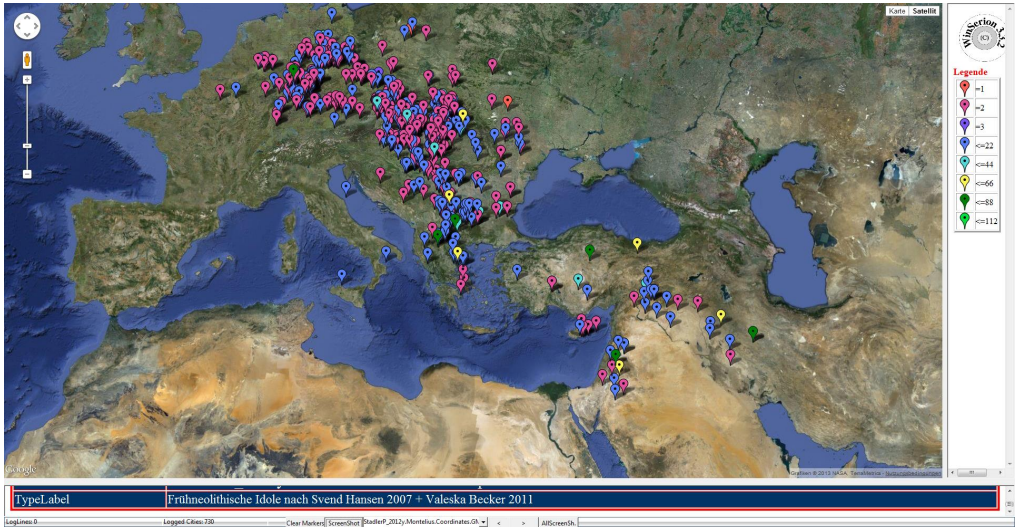


Figure 105: Distribution of more than 3000 early Neolithic pottery figurines, known as idols.

The mapping of these idols from the 10th to the 6th Millennium BC suggests a migration from the Fertile Crescent via Anatolia to Cyprus, Greece, up the Danube from Bulgaria, through Serbia, Croatia, Hungary, Austria and Germany, and then down the Rhine. Mapped with GoogleMaps © Google 2014 with the program GoogleMapper © by P. Stadler 2014. Data from Image Database Montelius © by P. Stadler 2012, mostly by S. Hansen, 2007, V. Becker 2011, as well as others. Stadler et al. 2014 (?), publication in preparation for PNAS. The different colored symbols indicate the different frequencies of the idols from a site; see also the legend on the right side.

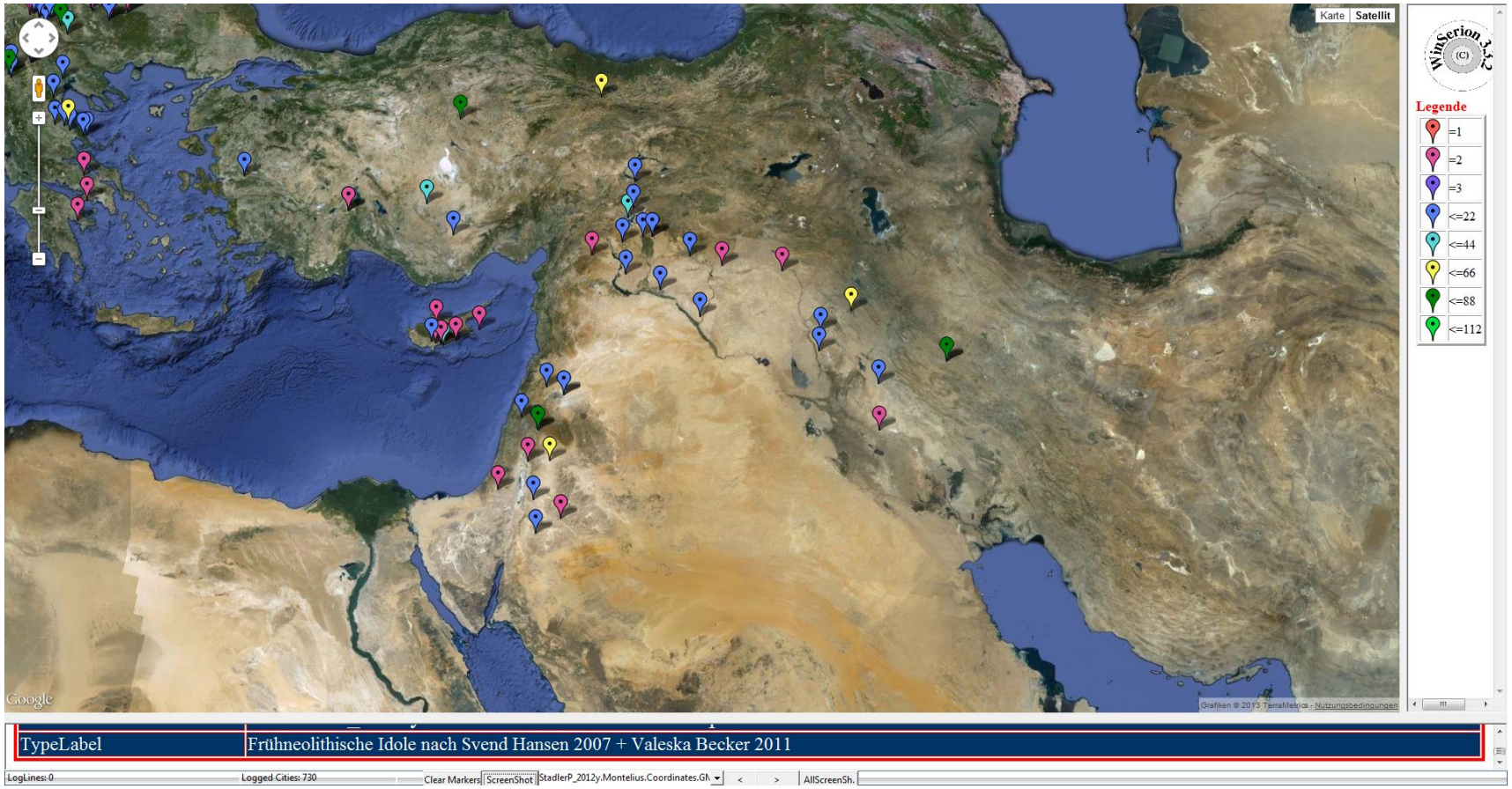


Figure 106: Distribution of early Neolithic idols. Detail of the Fertile Crescent.

Here along the Fertile Crescent the first idols were produced about 10,000 to 8,000 BC.

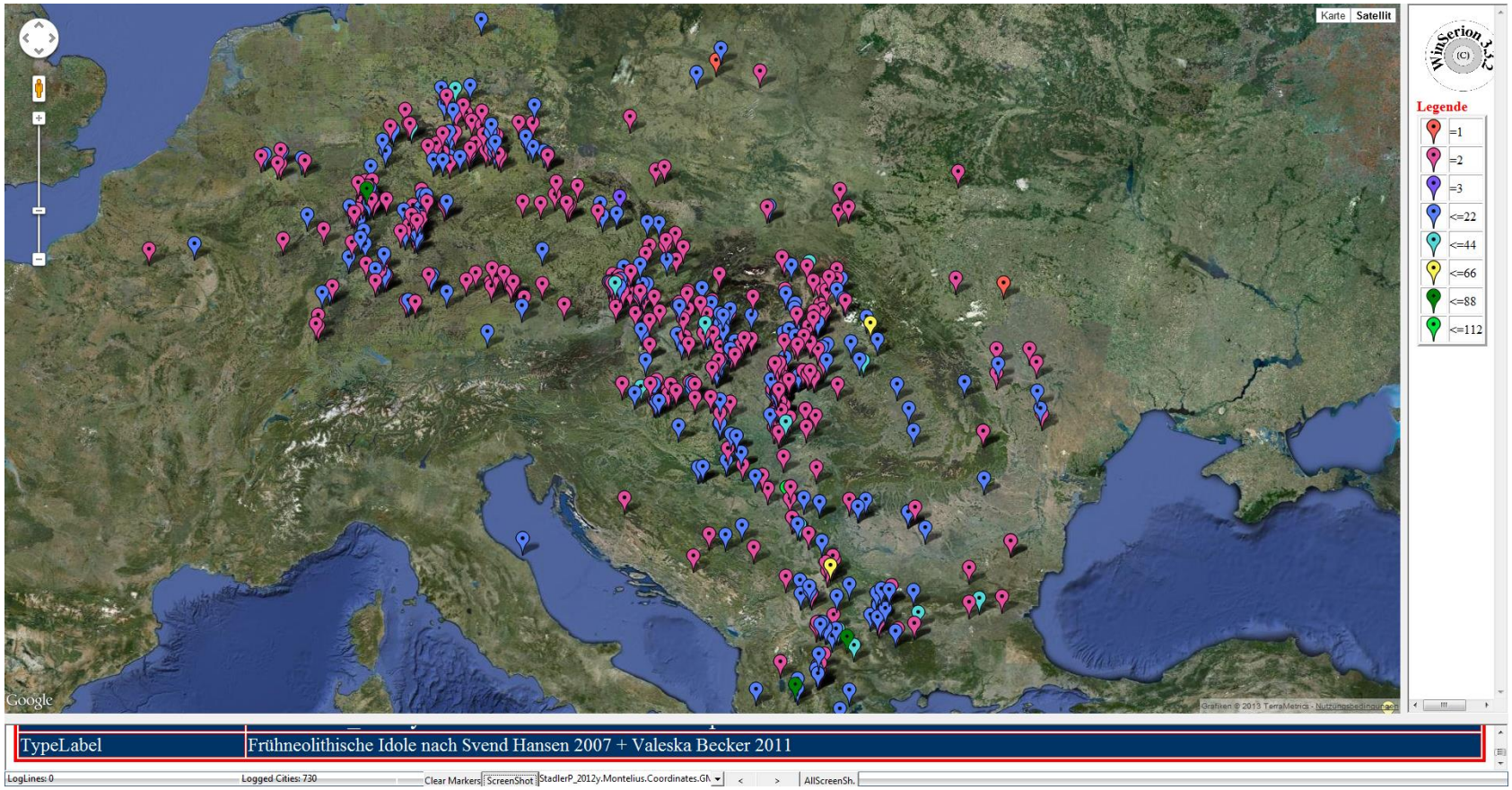


Figure 107: Distribution of early Neolithic idols. Detail of idol distribution in the Balkans.

The settlement of these areas occurred along the Danube. The upward migration of the Tisza occurred around 5800 BC. This group was separated by archaeologists into the Körös culture. Brunn Wolfholz in the Vienna Basin was then reached in 5700 BC.

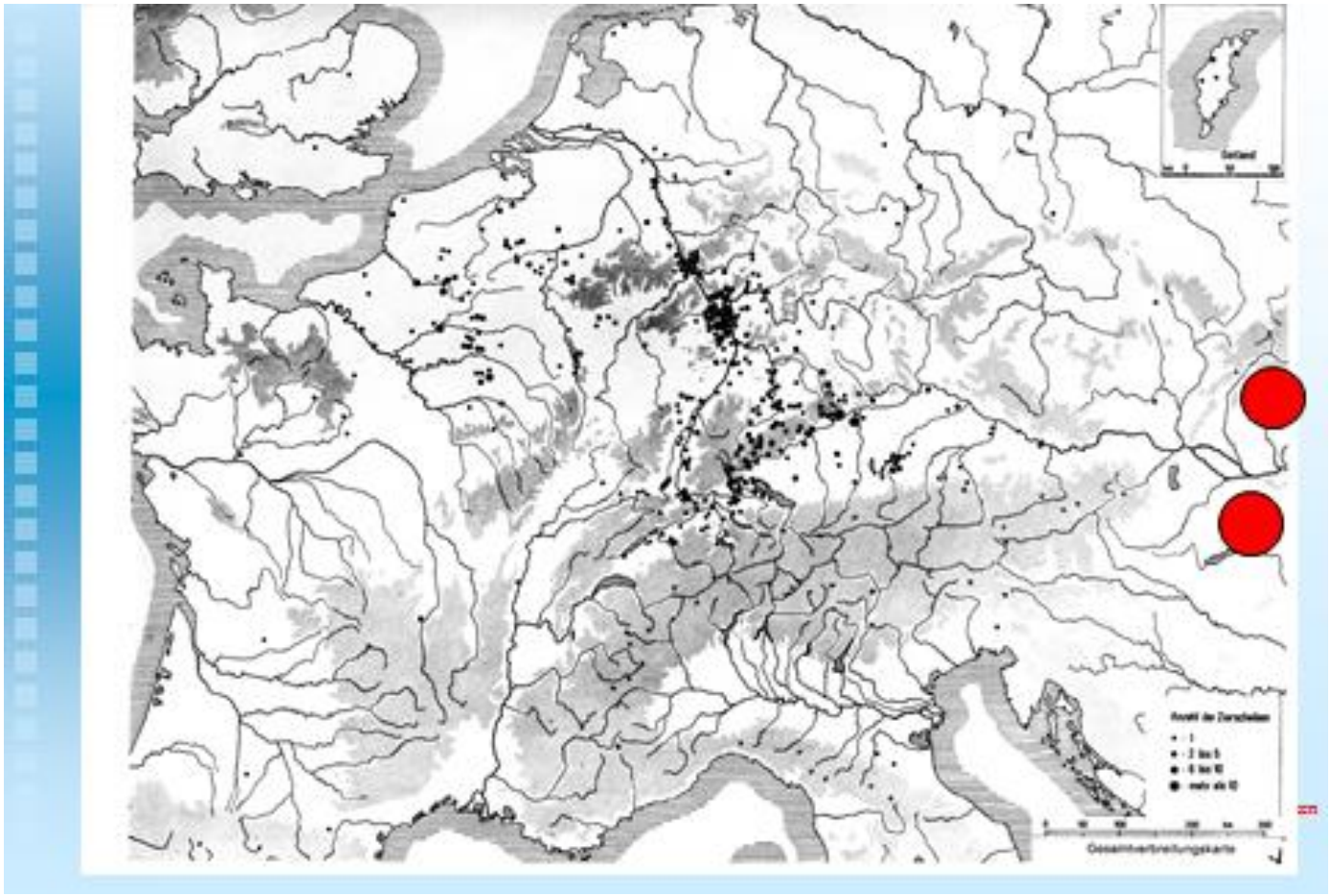


Figure 108: Distribution of Merovingian period ornamental discs after Renner.

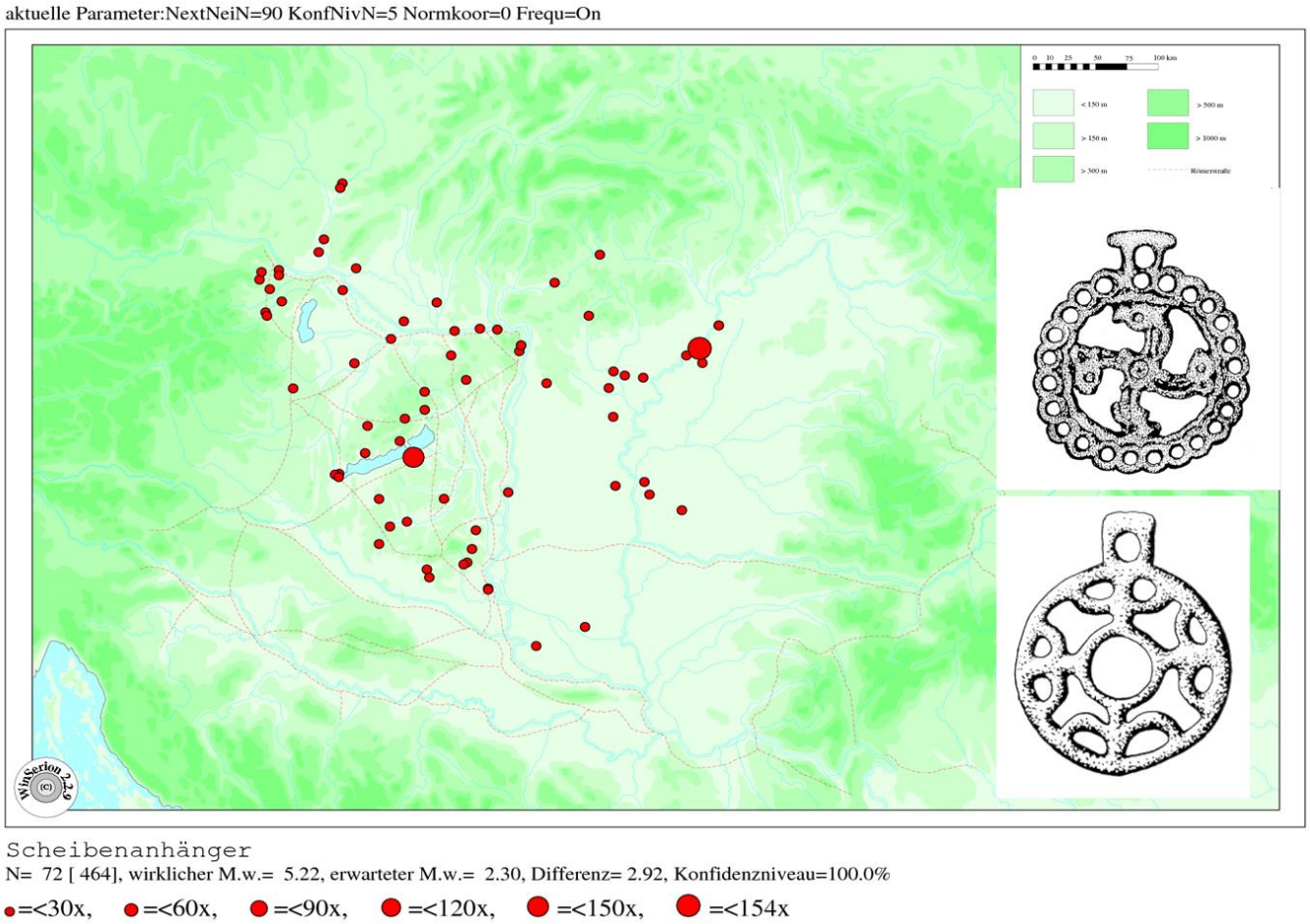


Figure 109: Distribution of Merovingian period ornamental discs in Avar Empire.

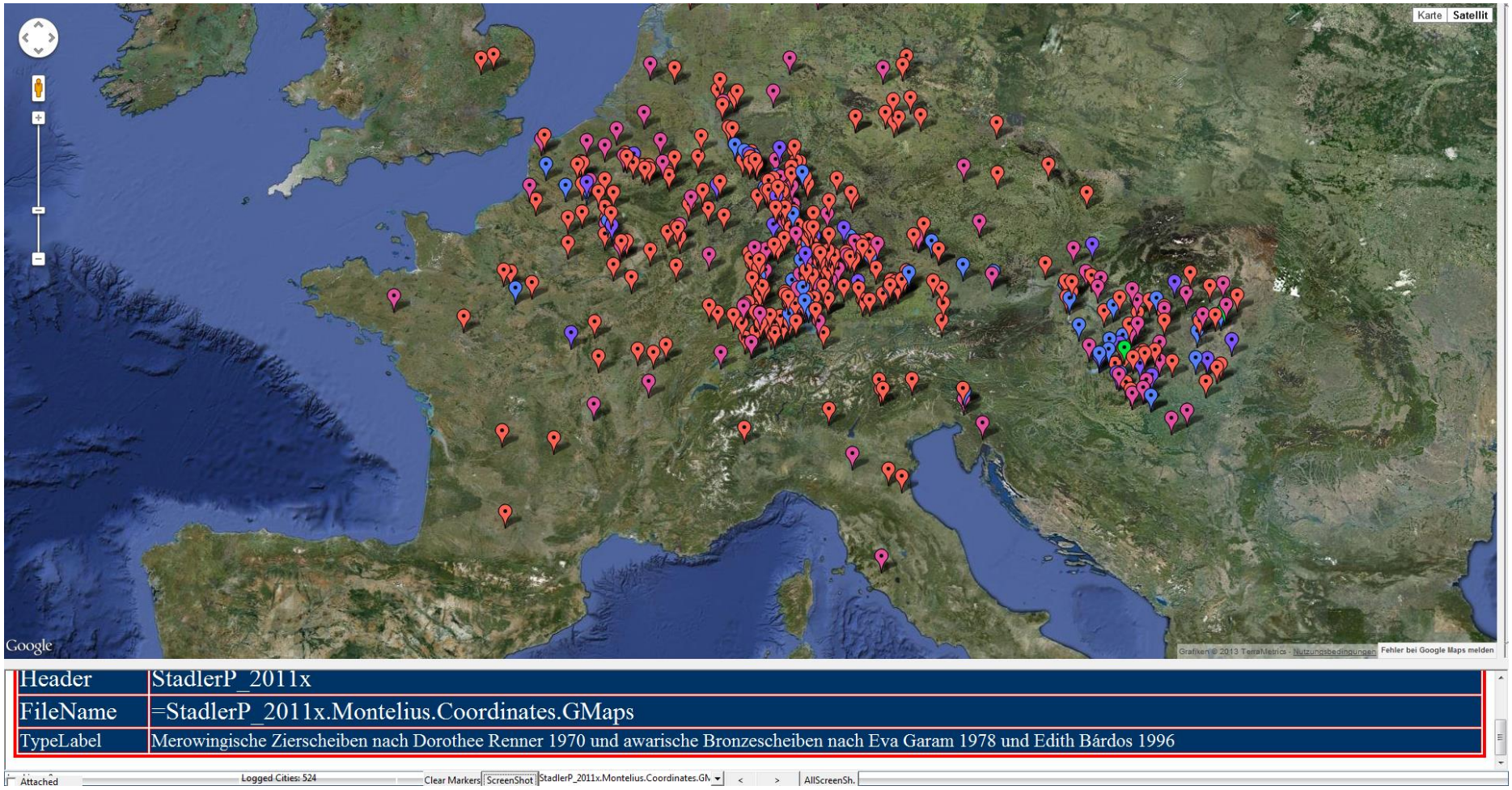


Figure 110: Distribution of Merovingian period ornamental discs among Merovingian's and Avars.

Figure 111: Distribution of early medieval saddles. Global view.

Here saddles from 147 sites with 760 images are mapped. The most saddles were found in the Carpathian basin.

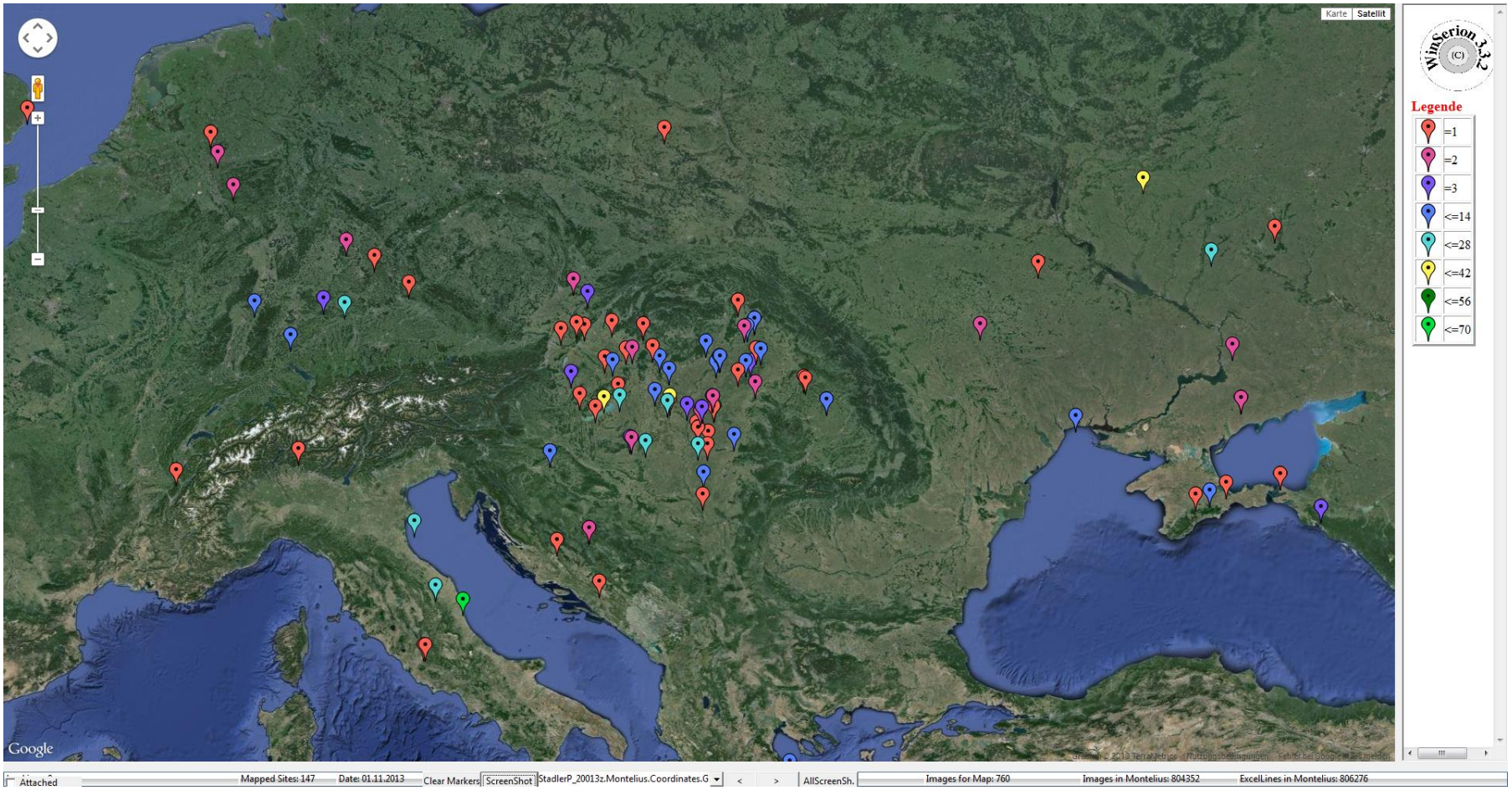


Figure 112: Distribution of early medieval saddles. View of Central Europe.

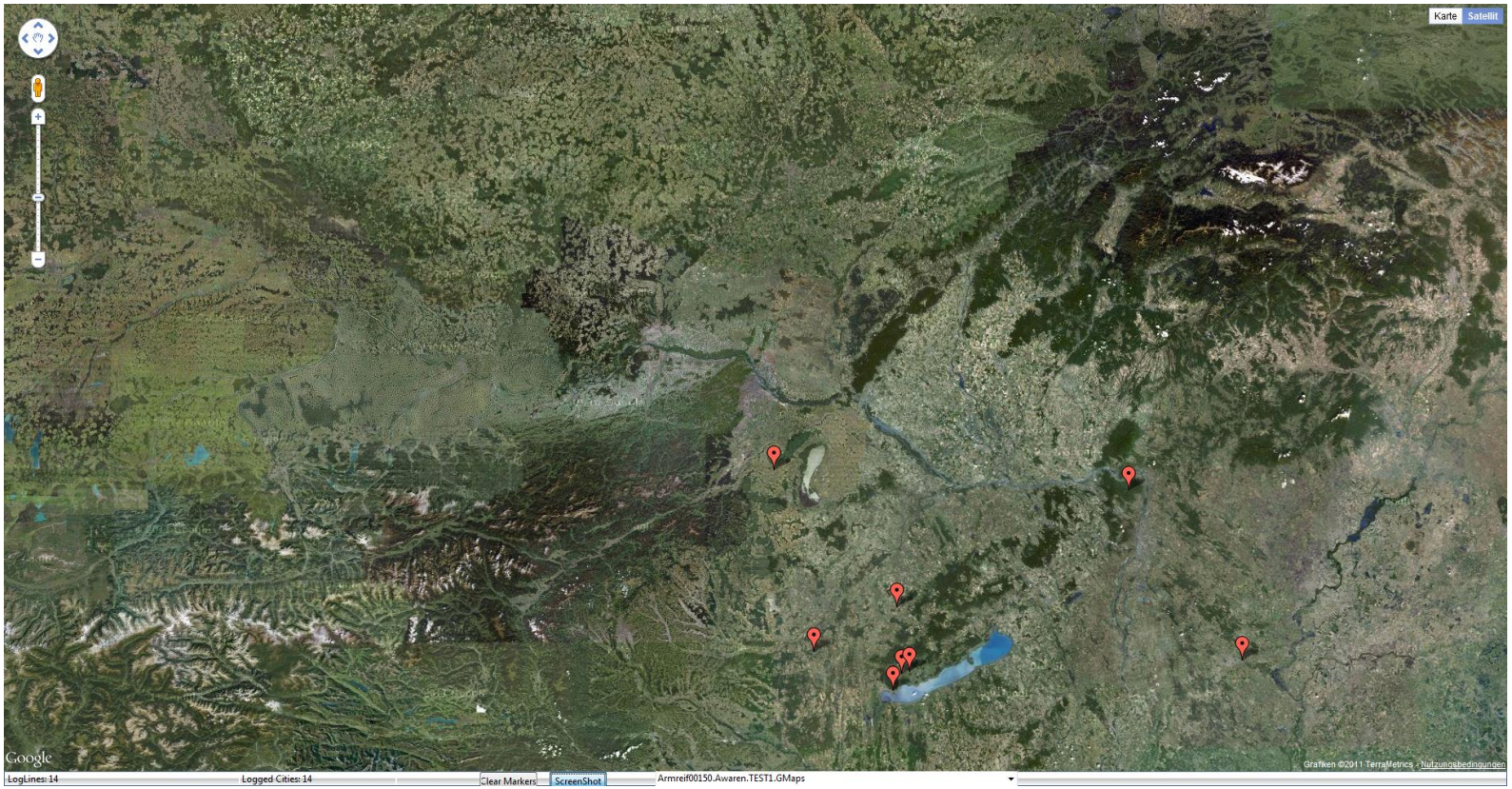
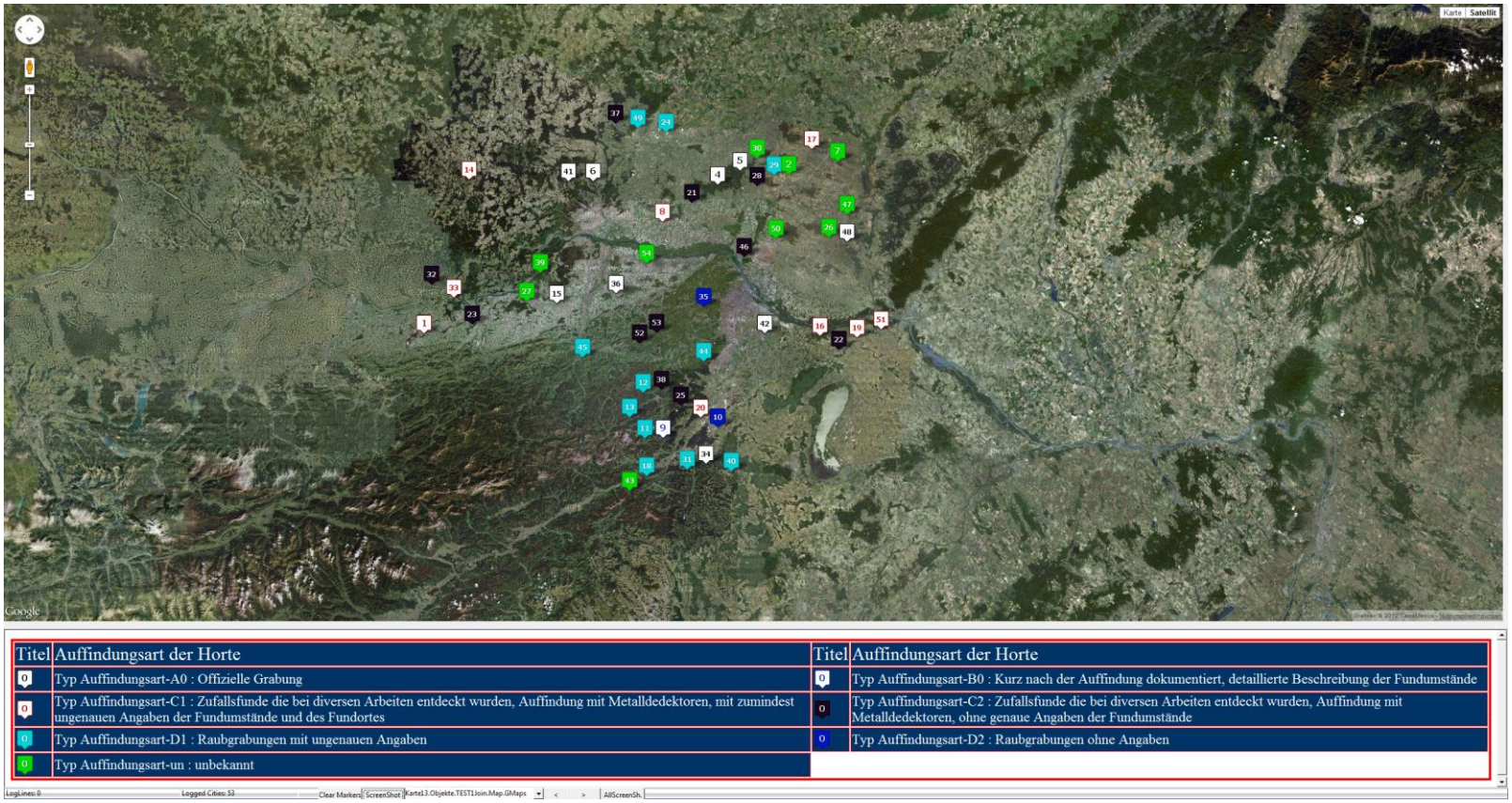


Figure 113: Example mapping of archaeological types.

Of course it is possible to map all previously compiled types with MonteliusEditor; here is an example of the Avars: Armreif00150 is a bangle with animal head ends from the Keszthely group in the Avar region (currently there are about 6,000 such mappings).

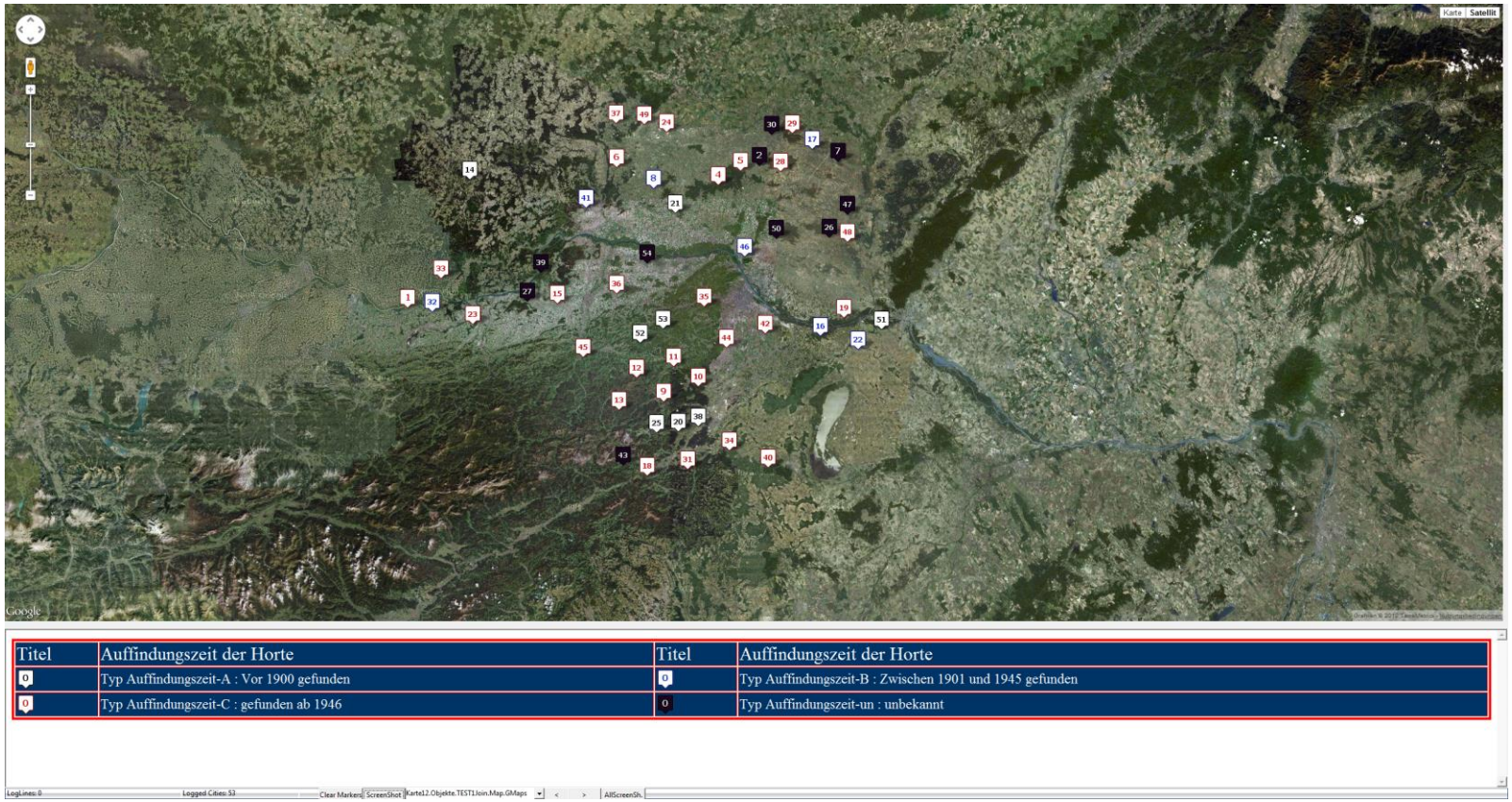
Here is a map from a recently published book by Ernst Lauermann and Elizabeth Rammer on the kind of documentation of Urn field period hoards of Lower Austria:



Titel	Auffindungsart der Horte	Titel	Auffindungsart der Horte
0	Typ Auffindungsart-A0 : Offizielle Grabung	0	Typ Auffindungsart-B0 : Kurz nach der Auffindung dokumentiert, detaillierte Beschreibung der Fundumstände
0	Typ Auffindungsart-C1 : Zufallsfunde die bei diversen Arbeiten entdeckt wurden, Auffindung mit Metalldedektoren, mit zumindest ungenauen Angaben der Fundumstände und des Fundortes	0	Typ Auffindungsart-C2 : Zufallsfunde die bei diversen Arbeiten entdeckt wurden, Auffindung mit Metalldedektoren, ohne genaue Angaben der Fundumstände
0	Typ Auffindungsart-D1 : Raubgrabungen mit ungenauen Angaben	0	Typ Auffindungsart-D2 : Raubgrabungen ohne Angaben
0	Typ Auffindungsart-un : unbekannt		

Figure 114: Kind of documentation of Urn field period hoards in Lower Austria.

Here is another map from the same book about the Time of documentation of Urn field period hoards of Lower Austria:



Titel	Auffindungszeit der Horte	Titel	Auffindungszeit der Horte
0	Typ Auffindungszeit-A : Vor 1900 gefunden	0	Typ Auffindungszeit-B : Zwischen 1901 und 1945 gefunden
0	Typ Auffindungszeit-C : gefunden ab 1946	0	Typ Auffindungszeit-un : unbekannt

Figure 115: Time of documentation of Urn field period hoards in Lower Austria.

Maps of GoogleMapper with Link to Image Database Montelius.

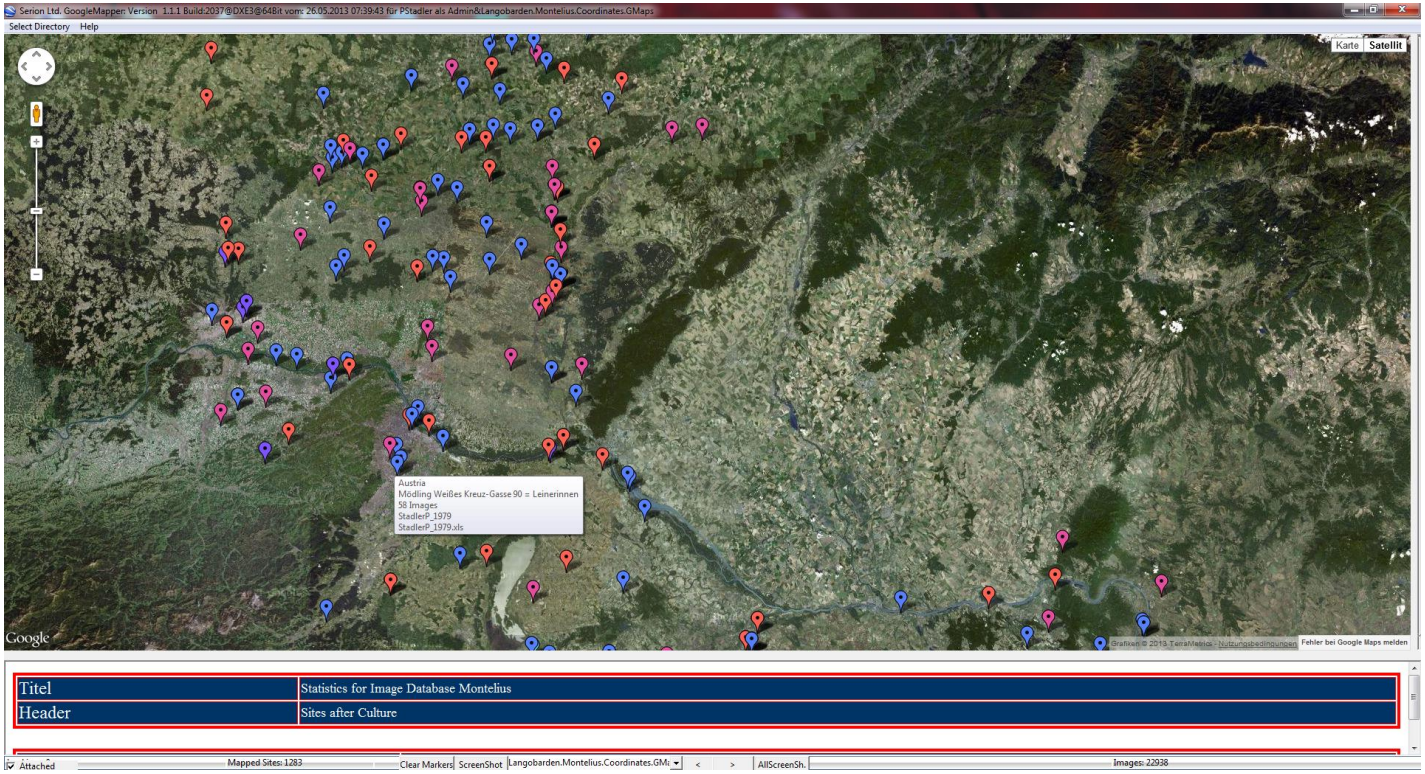


Figure 116: Map of Longobards with selection of the site Mödling Leinerinnen.

In the figure below left “Attached” is checked. This means if you click at the symbol for Mödling Weißes Kreuz Gasse 90, then the map will be connected to Image Database Montelius as can be seen in the two next figures.

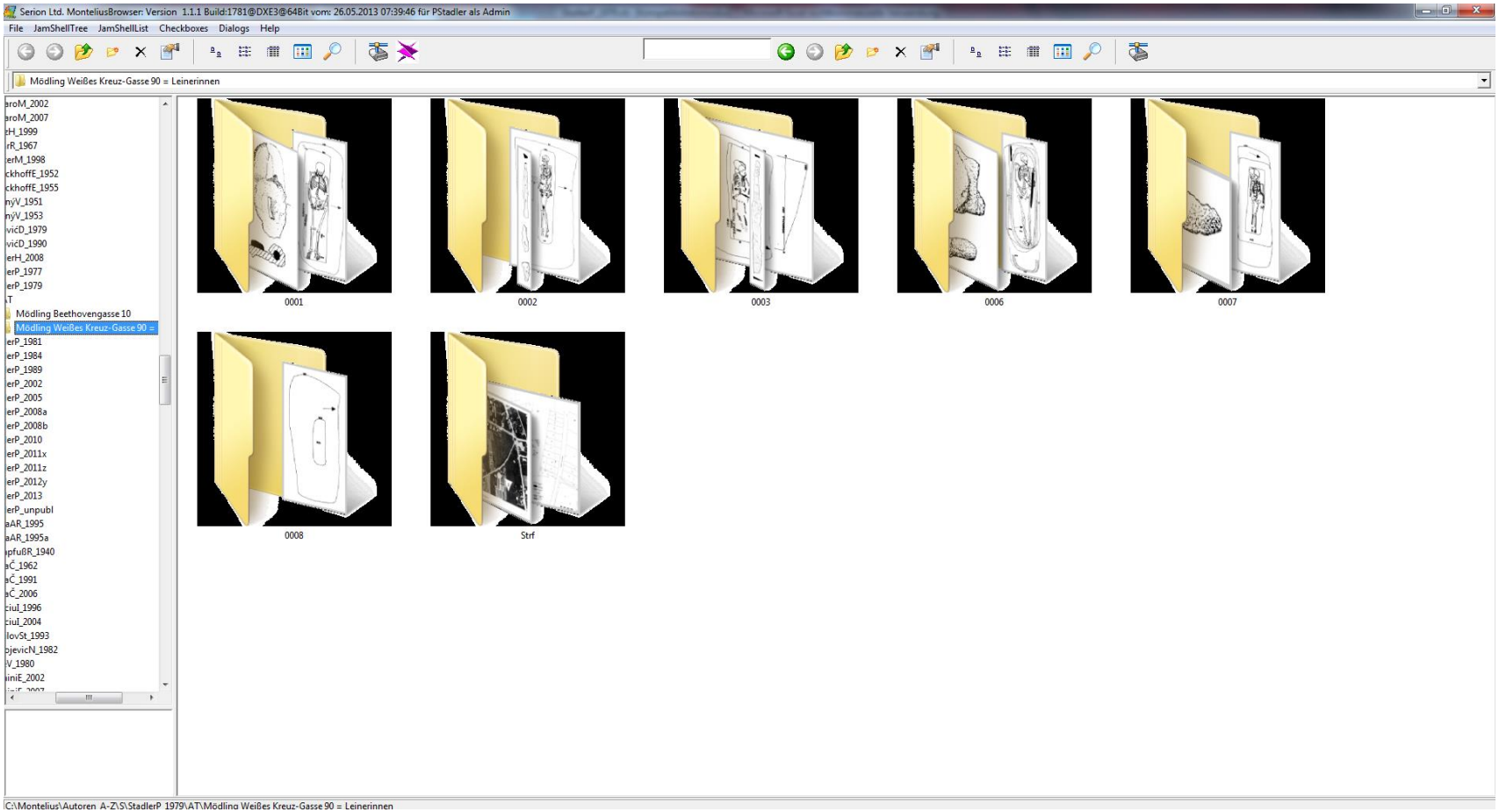


Figure 117: Longobard cemetery, Mödling Weißes Kreuzgasse 90 as seen in MonteliusBrowser opened from map of Longobards.

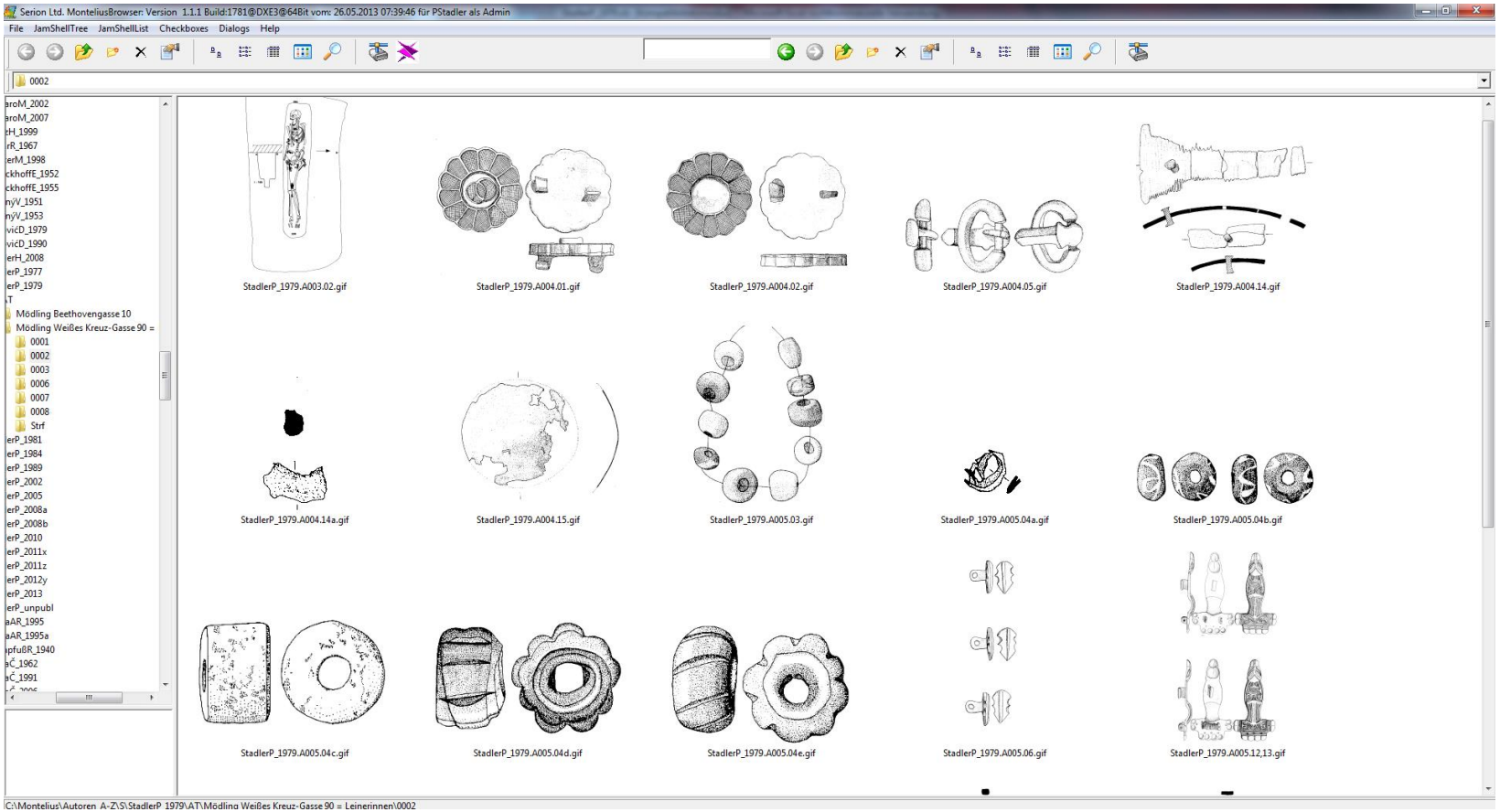


Figure 118: Grave 2, Mödling Weißes Kreuzgasse 90 as seen in MonteliusBrowser opened from map of Longobards.

Maps of GoogleMapper with Layers.

It is possible to open a Layers window, showing all available cultures or type labels and then to select or unselect some of them. After pressing the remap button the new map is shown with a modified legend too, see next page.

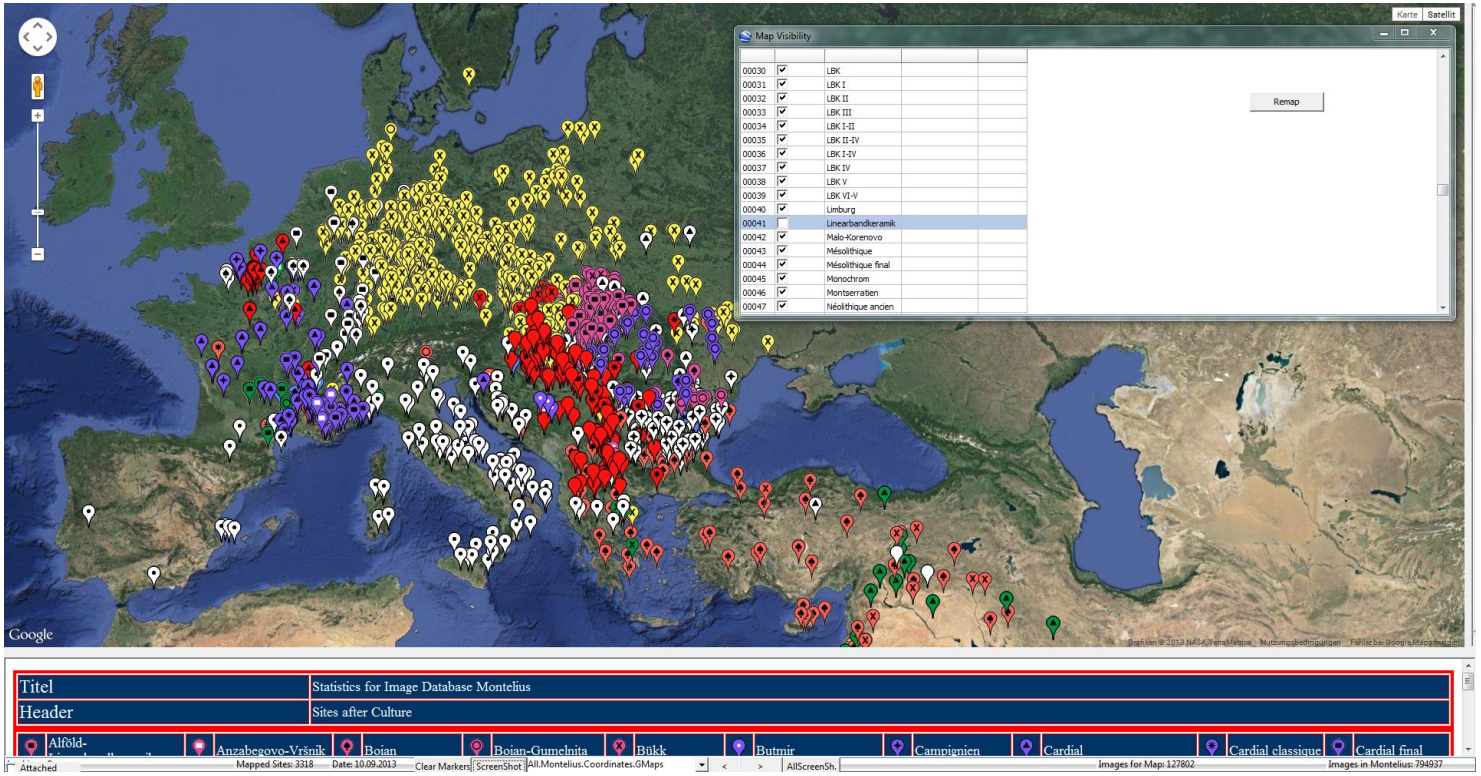


Figure 119: Selection of Layers on a GoogleMap, pressing Remap paints a new map and legend, see below.

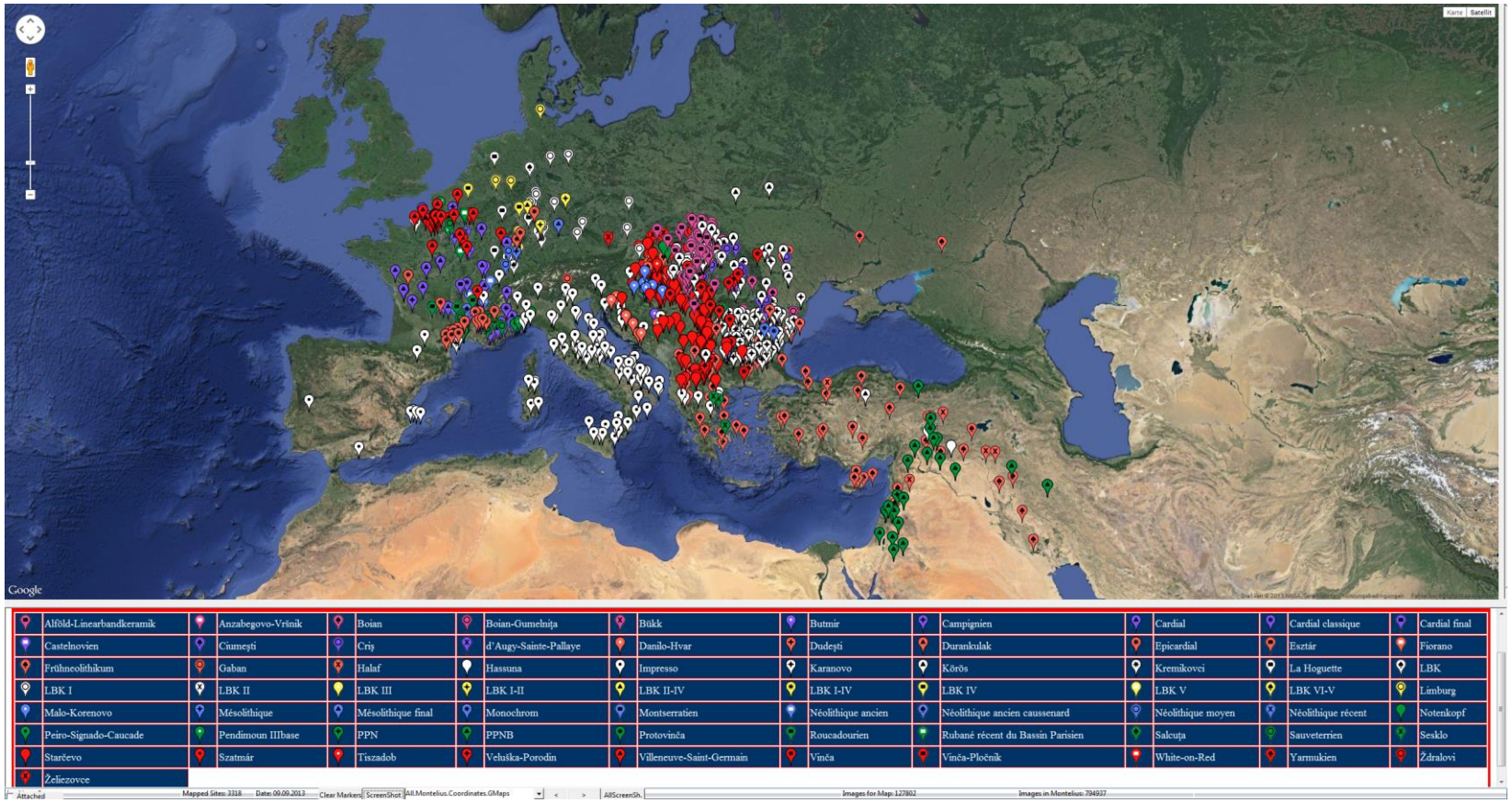


Figure 120: Selection of Layers on a GoogleMap, the culture Linearbandkeramik has been unselected on the map of Early Neolithic cultures.

Global reconstruction Maps.

Here, we now have global mapping with the overall results from the early Neolithic, the Lombard and the Avar periods.

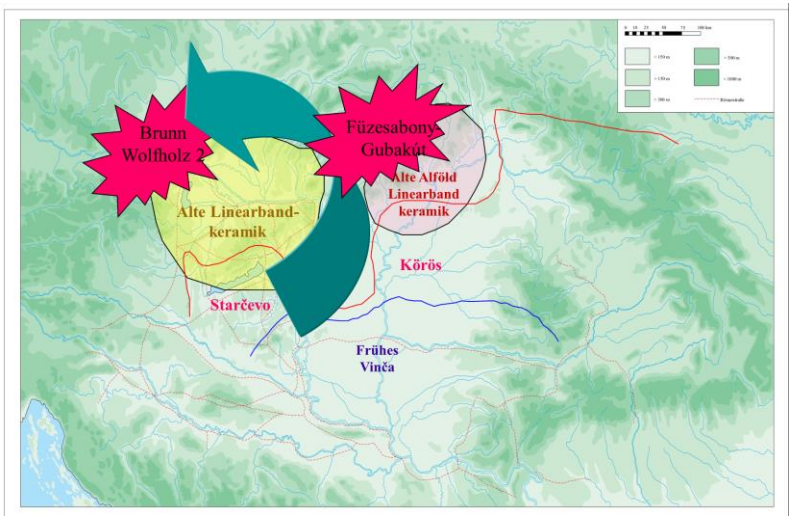


Figure 121: Development of Linear Pottery from Starčevo und Körös.

Ca. 5700 BC, there was a migration from the area of modern day Croatia into the Vienna Basin and it was the foundation of the settlement of Brunn Wolfholz, Site 2. Brunn Wolfholz is located in the northwest corner of the (later) settlement area of the Old Linear Pottery culture. At the same time or a little later, a settlement took place in Füzesabony Gubakút, located in the northwest of the area of the Alföld Linear Pottery. The Old Linear Pottery culture developed here from Starčevo and the Old Alföld Linear Pottery culture from the Körös. However, the distinction between Starčevo and Körös is not necessarily easy since Körös first emerged from Starčevo around 5800 BC. Thus, Körös is comparable to late Starčevo and the origin of the Alföld Linear Pottery relies ultimately on Starčevo too.

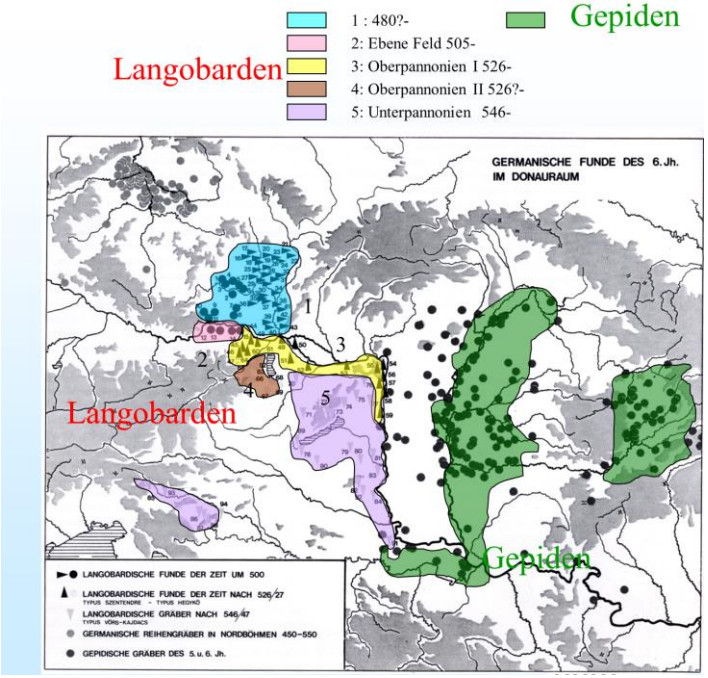


Figure 122: Lombard settlement from Moravia to Lower Pannonia.

The immigration of the Lombards in the former settlement area of the Rugii takes place initially at about 480 AD. They were originally under the rule of the Heruli, from whom they relatively quickly freed themselves. The blue area shows this first phase of settlement. According to the ideas of Horst Adler, the "Ebene Feld" was then settled in the year 505 AD (pink area). Adler equates this with the Tullnerfeld, and so do we here, where a greater number of Lombard cemeteries were in fact discovered. Then the next expansion affected Upper Pannonia (yellow area), mainly a thin strip south or west of the Danube. The brown area corresponds to the Hegykő group identified by István Bóna, which should also include local populations. By far the largest area of expansion occurred in 546 AD with the occupation of Lower Pannonia. This can only be understood if the areas north of the Danube were abandoned at the same time. Then, from about 550 AD, this northern area was open to Slavic migration.

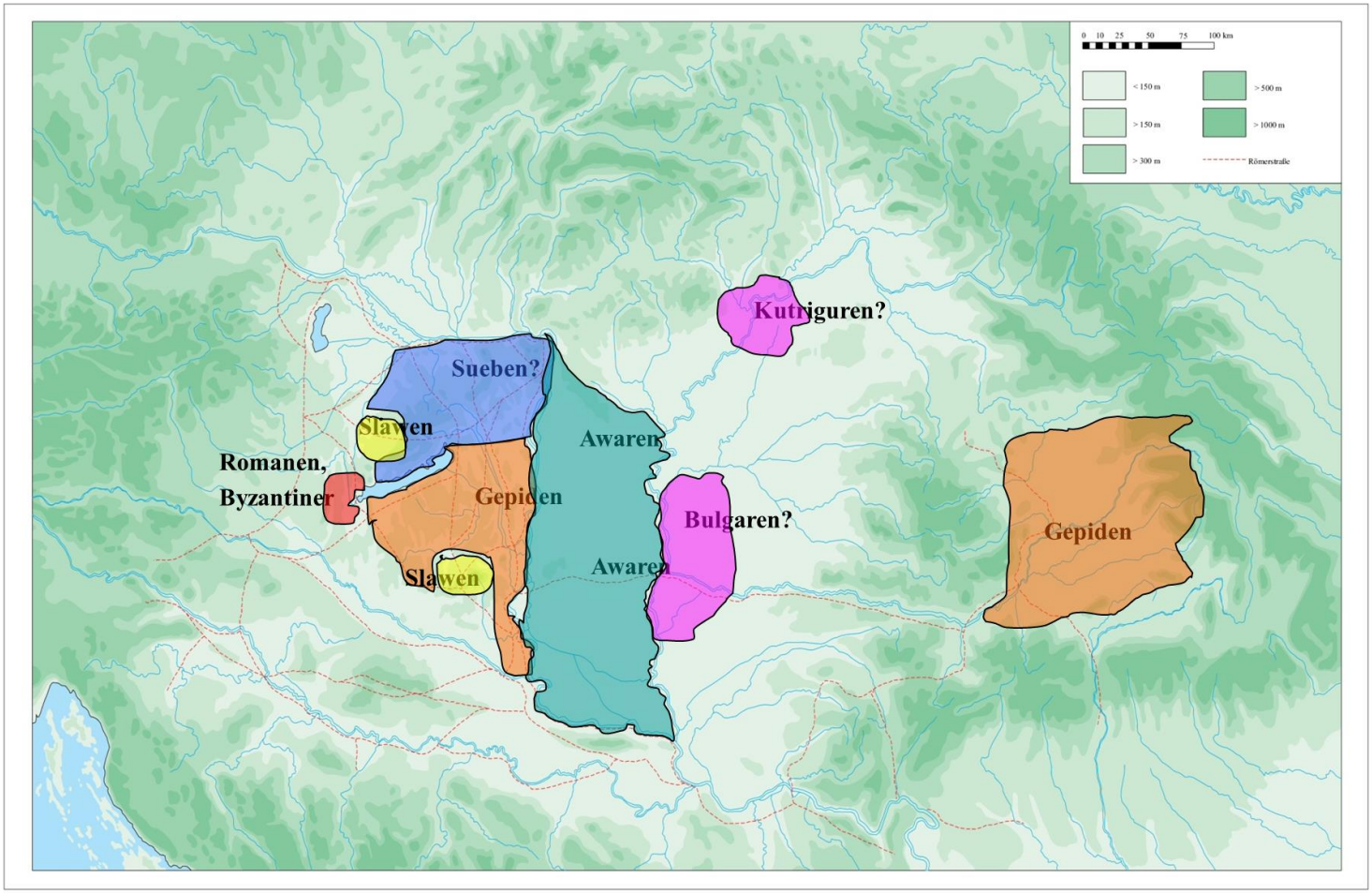


Figure 123: Division of the Carpathian Basin into different ethnic groups during the period of 568-630 AD.

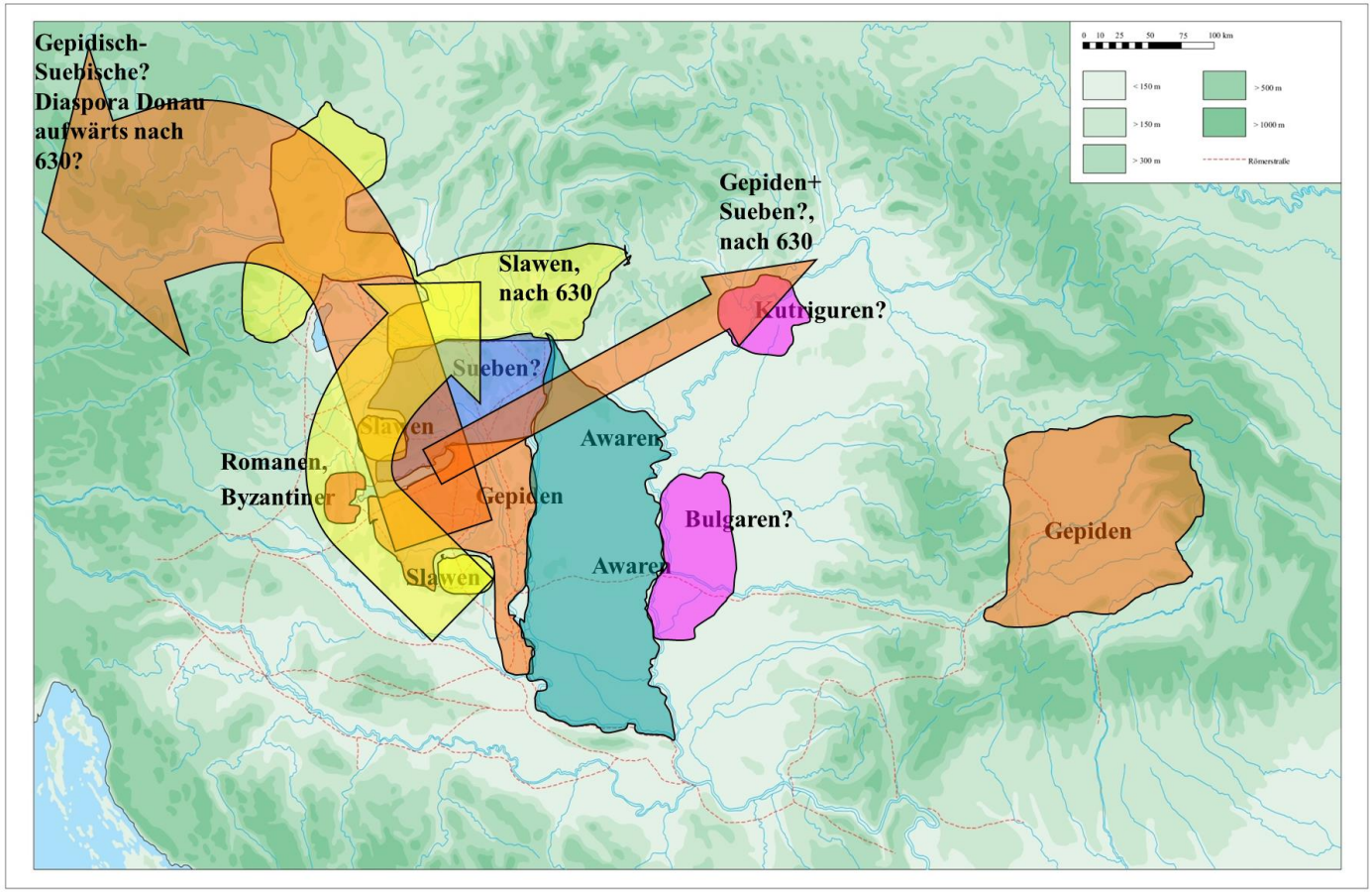


Figure 124: Division of the Carpathian Basin into different ethnic groups during the period of 568-630 AD, including relocations and migrations after 630 AD.

Local Mapping.

In addition to the mapping on a global base map, the mapping of cemetery or settlement plans is also possible.

For analysis of the early Neolithic settlement of Brunn Wolfholz, Site 2, this analysis of the N Nearest Neighbors shows the relationships between neighboring house plans (= rectangles):

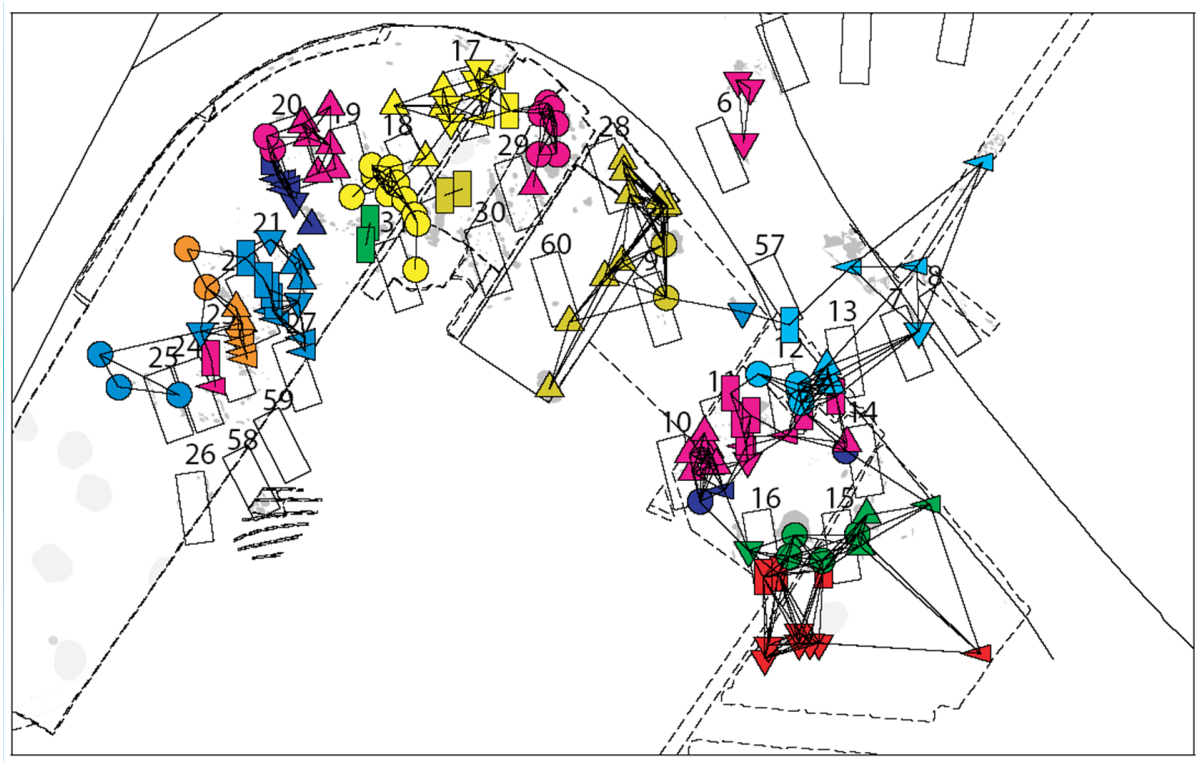


Figure 125: Early Neolithic settlement of Brunn Wolfholz, Site 2; analysis of the N Nearest Neighbors.

Figure 126: Avar period cemetery from Mödling, An der Goldenen Stiege, distribution of earrings in female graves.

Earrings were common for women of all origins in the Avar period. Altogether, 405 earrings are spread over 193 graves. At least two earrings were generally found per grave; with some graves including more than 2 earrings, such as grave 144. In addition, there were about 37 women among the 460 burials which had no earrings. It now remains to be analyzed, whether they were simply too 'poor' for earrings, or they for other reasons did not want earrings.

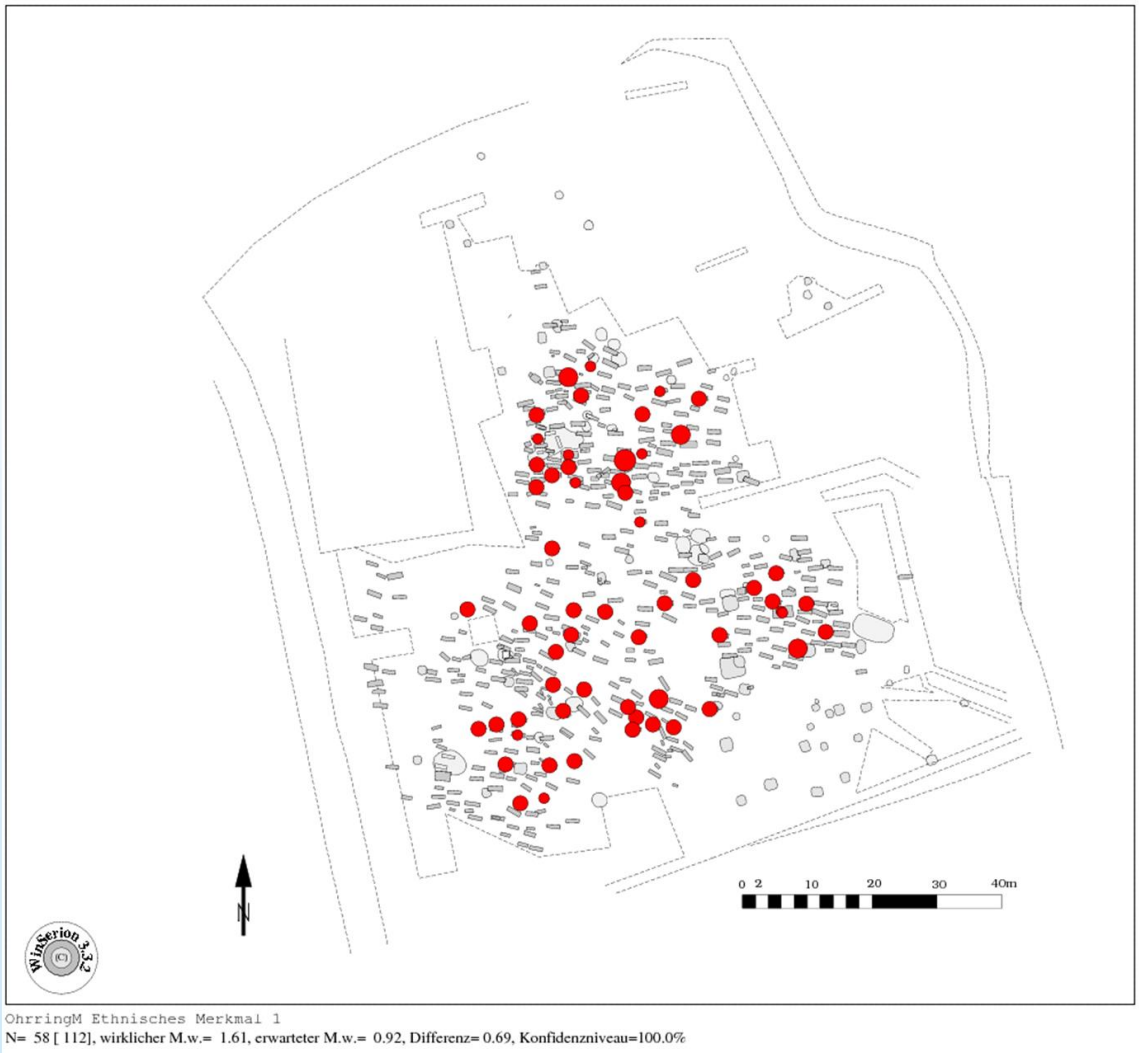


Figure 127: Avar period cemetery from Mödling, An der Goldenen Stiege, distribution of earrings in male graves.

Earrings occur in men's graves much less frequently than in female graves. The earrings are also smaller and simpler than in female graves. Earrings were only common among the ethnic Avars; thus it is possible to set up a calculation here of the ethnic distribution. It can be concluded that about 25% of men in about 460 Avar period burials saw themselves as Avars. The reverse would have to be that 75% of Slavic men renounced earrings. The portion of the Merovingian period "Germanics" in the middle and late Avar period is generally negligible and they have either emigrated after 630 AD or have adapted to the Avar mixed culture.

You can see a concentration in specific neighboring groups in the earring distribution, which could be explained as follows: in addition to the development of the burial fields, family groups were often buried next to each other, which explains why Avars that were buried next to each other were related. An objective verification could be carried out by ancient DNA analyses.

Figure 128: Avar period cemetery from Mödling, An der Goldenen Stiege. Distribution of the grave good pots.

Of the 460 burials, only 56% had grave good pots. The characteristic pots were probably intended for the Slavs, though it is still unclear whether any of the "pot-less' burials conceal Avars or are simply poorer graves.

Figure 129: Avar period cemetery from Mödling, An der Goldenen Stiege. Distribution of the offering vessels with potters' marks.

Outside of the Avar region, pottery with comb stamp and potters' marks were characteristic for the Slavs from ca. 630 to the 10th century. Slavic graves could thus also be identified in the cemetery of Mödling Goldene Stiege.

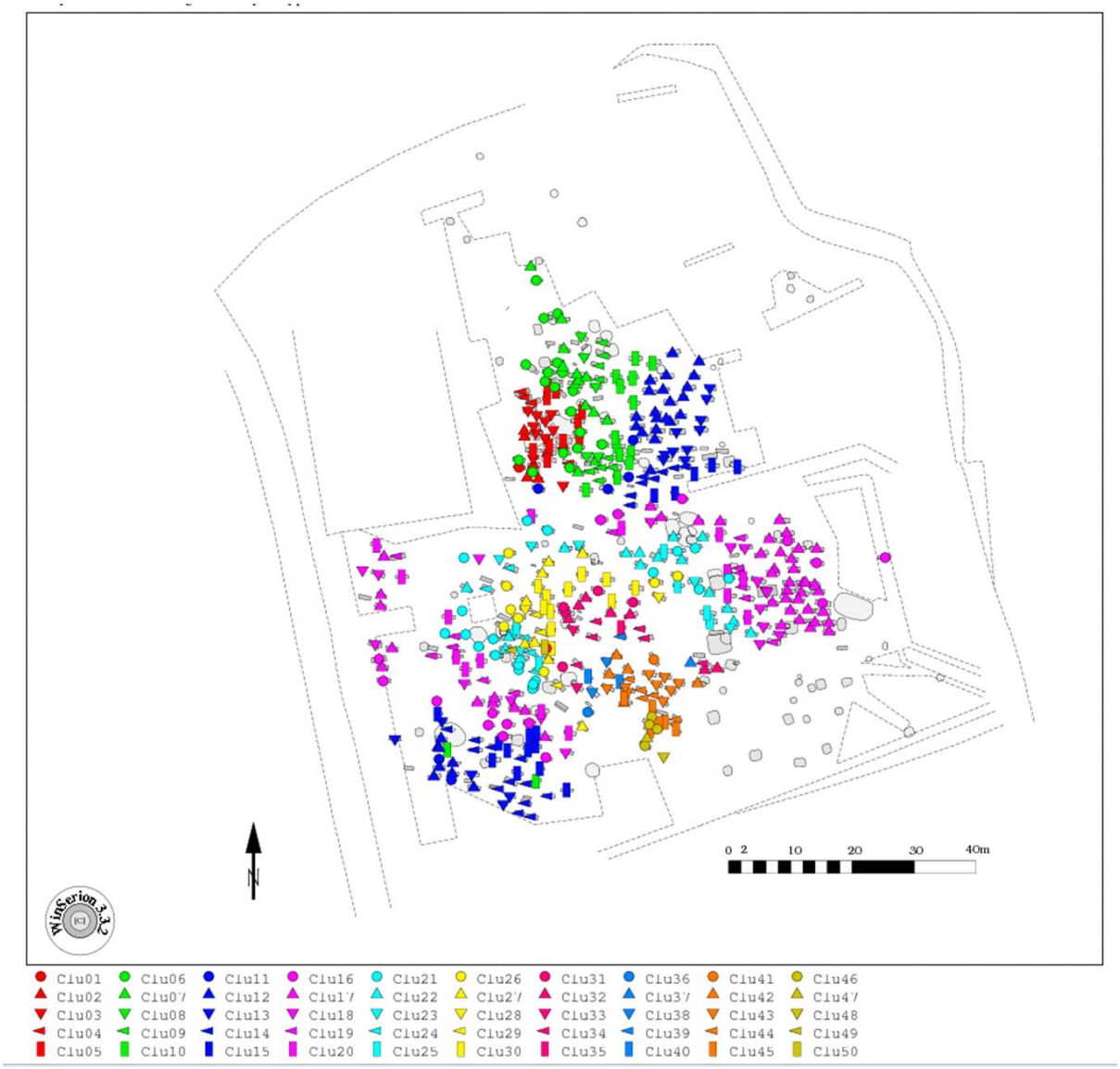


Figure 130: Avar period cemetery in Mödling, An der Goldenen Stiege, analysis of the N Nearest Neighbors.

This analysis of the N Nearest Neighbors in regards to type compares all of the individual mappings and converts the maps with the same tendencies into a single combined map. The same colors and the same symbols show the most similar graves, while the same colors with different symbols indicate graves that are less related to each other. And lastly, graves with different colors are the least related.

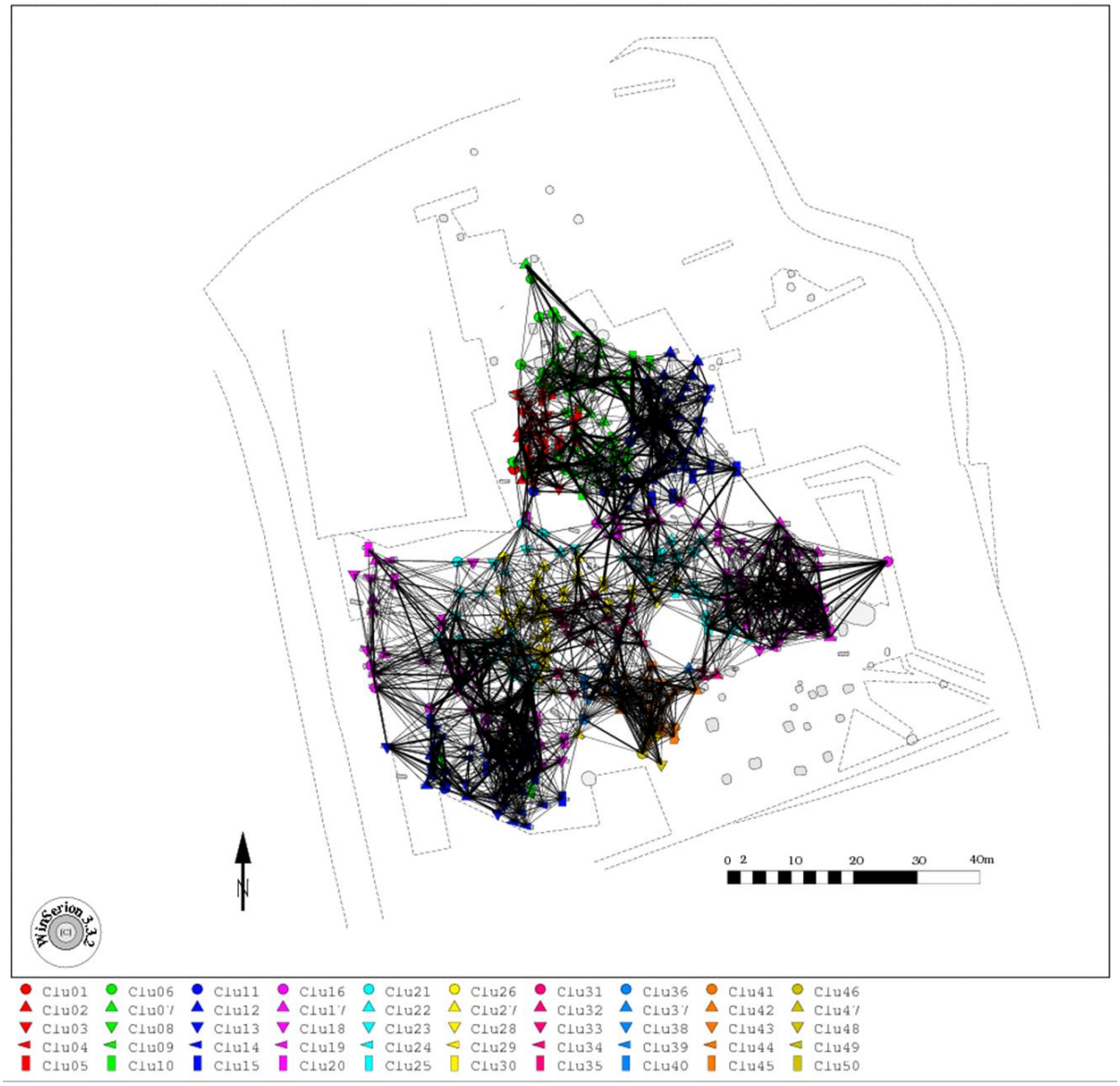


Figure 131: Avar period cemetery in Mödling, "An der Goldenen Stiege", analysis of the N Nearest Neighbors, network representation.

This analysis of the N Nearest Neighbors shows, in addition to colors and symbols, the relationships between neighboring graves. The thicker the lines, the stronger are the relationship between the graves. The spider web shows clear relationship concentrations.

Program ^{14}C2Sequencing.

This program reads data from a radiocarbon database and converts this data according to a project file into an Oxcal-Jobfile. With this Job file Sequencing of different phases of a culture or several cultures in a sequence is possible.

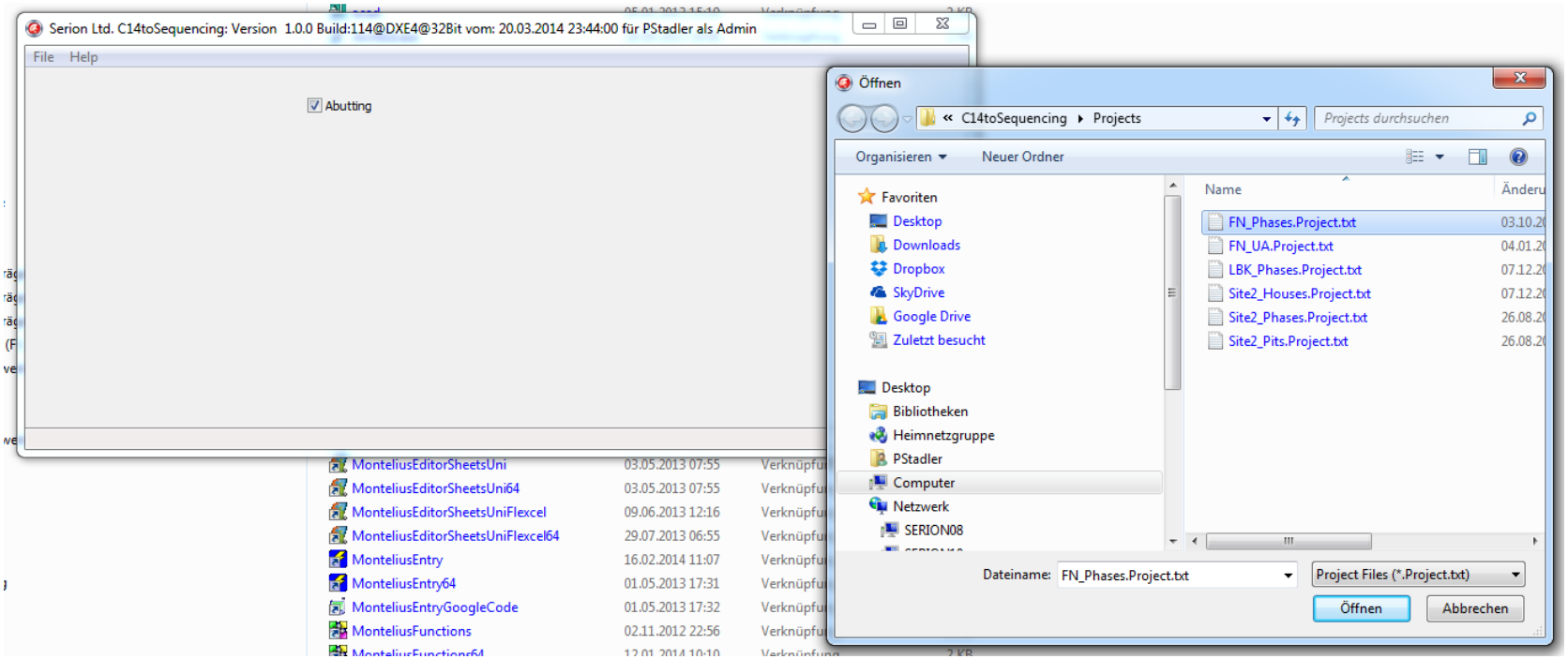
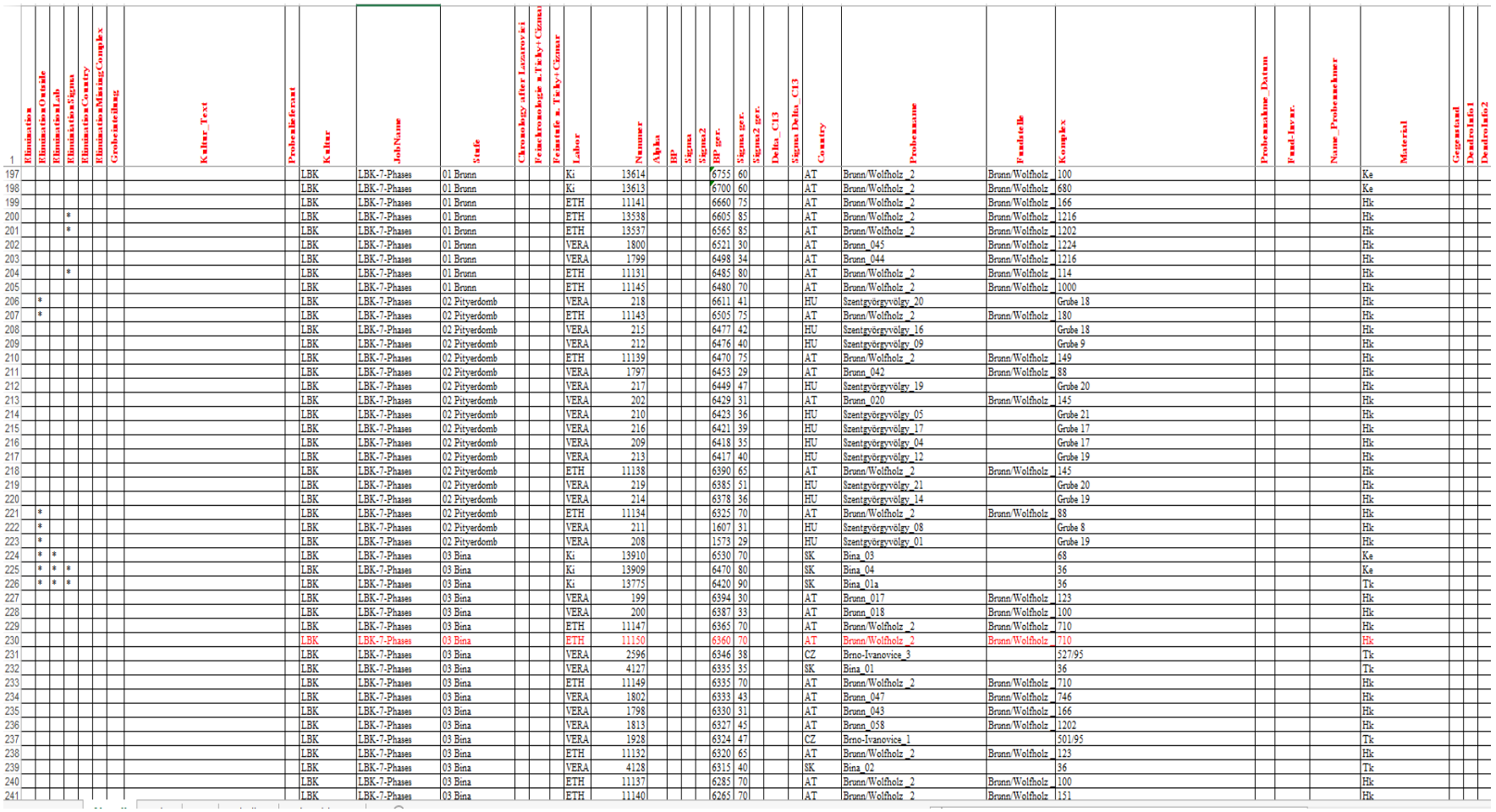


Figure 132: ^{14}C2Sequencing is started with selection of a Project-File.



1	Elimination	EliminationOutside	EliminationLab	EliminationSigma	EliminationCountry	EliminationMissingComplex	Grobeinteilung	Kultur_Text	Probenlieferant	Kultur	JobName	Stufe	Chronologie after Lazarovici	Feinchronologie n.Tichy+Cizmar	Feinstufe n. Tichy+Cizmar	Labor	Nummer	Alpha	BP	Sigma	Sigma2	BP ger.	Sigma ger.	Sigma2 ger.	Delta_C13	Sigma Delta_C13	Country	Probenname	Fundstelle	Komplex	Probenahme_Datum	Fund-Jahr ar.	Name_Probenehmer	Material	Gegenstand	Deadolalo1	Deadolalo2
197										LBK	LBK-7-Phases	01 Brunn				Ki	13614					6755	60			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	100				Ke			
198										LBK	LBK-7-Phases	01 Brunn				Ki	13613					6700	60			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	680				Ke			
199										LBK	LBK-7-Phases	01 Brunn				ETH	11141					6660	75			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	166				Hk			
200				*						LBK	LBK-7-Phases	01 Brunn				ETH	13538					6605	85			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	1216				Hk			
201				*						LBK	LBK-7-Phases	01 Brunn				ETH	13537					6565	85			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	1202				Hk			
202										LBK	LBK-7-Phases	01 Brunn				VERA	1800					6521	30			AT	Brunn_045	Brunn/Wolfholz_	1224				Hk			
203										LBK	LBK-7-Phases	01 Brunn				VERA	1799					6498	34			AT	Brunn_044	Brunn/Wolfholz_	1216				Hk			
204				*						LBK	LBK-7-Phases	01 Brunn				ETH	11131					6485	80			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	114				Hk			
205										LBK	LBK-7-Phases	01 Brunn				ETH	11145					6480	70			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	1000				Hk			
206		*								LBK	LBK-7-Phases	02 Pityerdomb				VERA	218					6611	41			HU	Szentgyörgyvölgy_20		Grube 18				Hk			
207		*								LBK	LBK-7-Phases	02 Pityerdomb				ETH	11143					6505	75			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	180				Hk			
208										LBK	LBK-7-Phases	02 Pityerdomb				VERA	215					6477	42			HU	Szentgyörgyvölgy_16		Grube 18				Hk			
209										LBK	LBK-7-Phases	02 Pityerdomb				VERA	212					6476	40			HU	Szentgyörgyvölgy_09		Grube 9				Hk			
210										LBK	LBK-7-Phases	02 Pityerdomb				ETH	11139					6470	75			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	149				Hk			
211										LBK	LBK-7-Phases	02 Pityerdomb				VERA	1797					6453	29			AT	Brunn_042	Brunn/Wolfholz_	88				Hk			
212										LBK	LBK-7-Phases	02 Pityerdomb				VERA	217					6449	47			HU	Szentgyörgyvölgy_19		Grube 20				Hk			
213										LBK	LBK-7-Phases	02 Pityerdomb				VERA	202					6429	31			AT	Brunn_020	Brunn/Wolfholz_	145				Hk			
214										LBK	LBK-7-Phases	02 Pityerdomb				VERA	210					6423	36			HU	Szentgyörgyvölgy_05		Grube 21				Hk			
215										LBK	LBK-7-Phases	02 Pityerdomb				VERA	216					6421	39			HU	Szentgyörgyvölgy_17		Grube 17				Hk			
216										LBK	LBK-7-Phases	02 Pityerdomb				VERA	209					6418	35			HU	Szentgyörgyvölgy_04		Grube 17				Hk			
217										LBK	LBK-7-Phases	02 Pityerdomb				VERA	213					6417	40			HU	Szentgyörgyvölgy_12		Grube 19				Hk			
218										LBK	LBK-7-Phases	02 Pityerdomb				ETH	11138					6390	65			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	145				Hk			
219										LBK	LBK-7-Phases	02 Pityerdomb				VERA	219					6385	51			HU	Szentgyörgyvölgy_21		Grube 20				Hk			
220										LBK	LBK-7-Phases	02 Pityerdomb				VERA	214					6378	36			HU	Szentgyörgyvölgy_14		Grube 19				Hk			
221		*								LBK	LBK-7-Phases	02 Pityerdomb				ETH	11134					6325	70			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	88				Hk			
222		*								LBK	LBK-7-Phases	02 Pityerdomb				VERA	211					1607	31			HU	Szentgyörgyvölgy_08		Grube 8				Hk			
223		*								LBK	LBK-7-Phases	02 Pityerdomb				VERA	208					1573	29			HU	Szentgyörgyvölgy_01		Grube 19				Hk			
224		*	*							LBK	LBK-7-Phases	03 Bina				Ki	13910					6530	70			SK	Bina_03		68				Ke			
225		*	*	*						LBK	LBK-7-Phases	03 Bina				Ki	13909					6470	80			SK	Bina_04		36				Ke			
226		*	*	*						LBK	LBK-7-Phases	03 Bina				Ki	13775					6420	90			SK	Bina_01a		36				Tk			
227										LBK	LBK-7-Phases	03 Bina				VERA	199					6394	30			AT	Brunn_017	Brunn/Wolfholz_	123				Hk			
228										LBK	LBK-7-Phases	03 Bina				VERA	200					6387	33			AT	Brunn_018	Brunn/Wolfholz_	100				Hk			
229										LBK	LBK-7-Phases	03 Bina				ETH	11147					6365	70			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	710				Hk			
230										LBK	LBK-7-Phases	03 Bina				ETH	11150					6360	70			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	710				Hk			
231										LBK	LBK-7-Phases	03 Bina				VERA	2596					6346	38			CZ	Brno-Ivanovice_3		527/95				Tk			
232										LBK	LBK-7-Phases	03 Bina				VERA	4127					6335	35			SK	Bina_01		36				Tk			
233										LBK	LBK-7-Phases	03 Bina				ETH	11149					6335	70			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	710				Hk			
234										LBK	LBK-7-Phases	03 Bina				VERA	1802					6333	43			AT	Brunn_047	Brunn/Wolfholz_	746				Hk			
235										LBK	LBK-7-Phases	03 Bina				VERA	1798					6330	31			AT	Brunn_043	Brunn/Wolfholz_	166				Hk			
236										LBK	LBK-7-Phases	03 Bina				VERA	1813					6327	45			AT	Brunn_058	Brunn/Wolfholz_	1202				Hk			
237										LBK	LBK-7-Phases	03 Bina				VERA	1928					6324	47			CZ	Brno-Ivanovice_1		501/95				Tk			
238										LBK	LBK-7-Phases	03 Bina				ETH	11132					6320	65			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	123				Hk			
239										LBK	LBK-7-Phases	03 Bina				VERA	4128					6315	40			SK	Bina_02		36				Tk			
240										LBK	LBK-7-Phases	03 Bina				ETH	11137					6285	70			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	100				Hk			
241										LBK	LBK-7-Phases	03 Bina				ETH	11140					6265	70			AT	Brunn/Wolfholz_2	Brunn/Wolfholz_	151				Hk			

Figure 133: Radiocarbon Database is used by ^{14}C2Sequencing. From the database the Oxcal Sequencing Job-File is created.

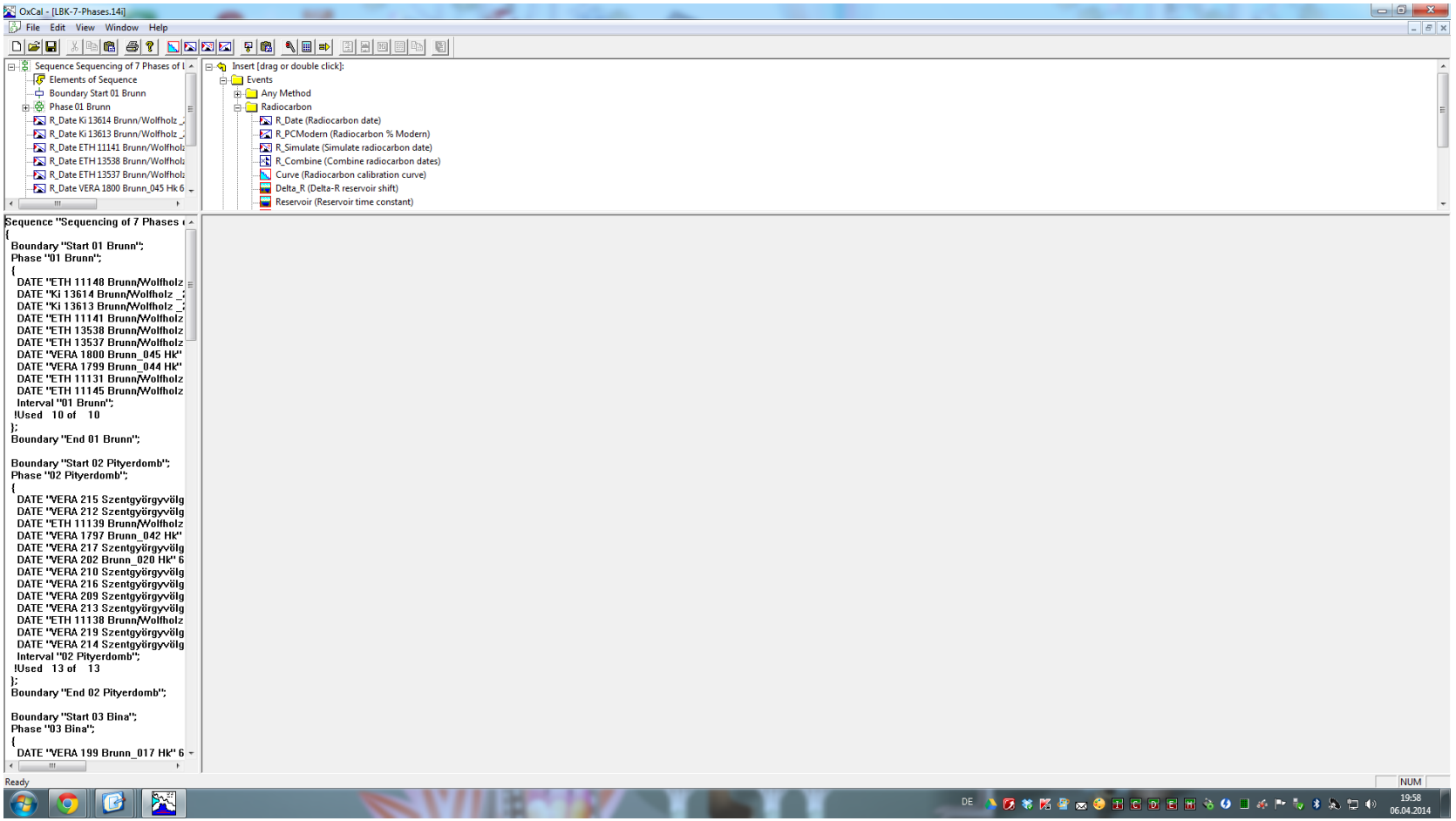


Figure 134: Produced Oxcal Job-File for Sequencing is run with Oxcal.

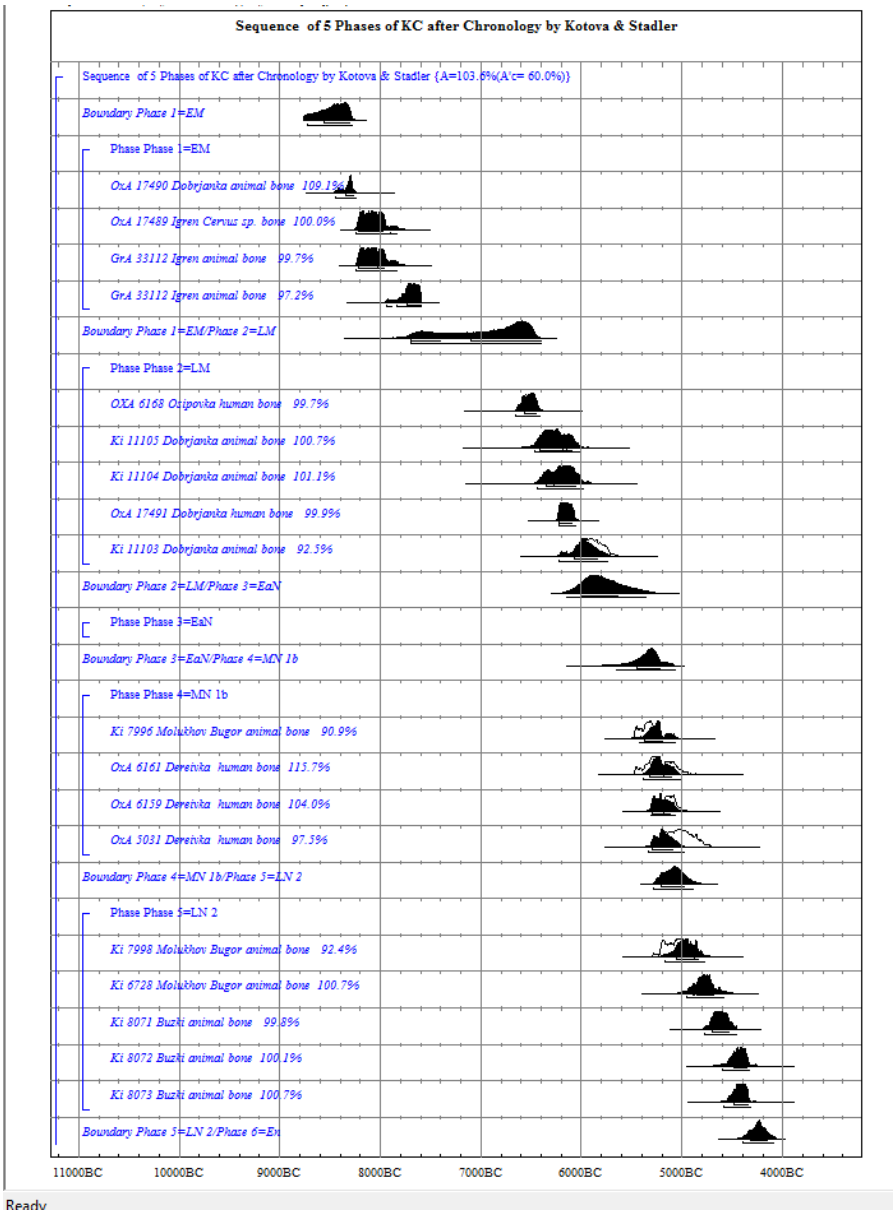


Figure 135: Here you see a result for the Sequencing Job-File for Early Neolithics Cultures in Ukraine.

Program ComparativeChronology.

In this program, the results of different sequencings with Oxcal are compared with each other graphically, so that one can compare these chronologies well together.

Example of the comparison of Absolut Chronologies for Early Neolithics Cultures Starčevo, Körös and Linearbandkeramik.

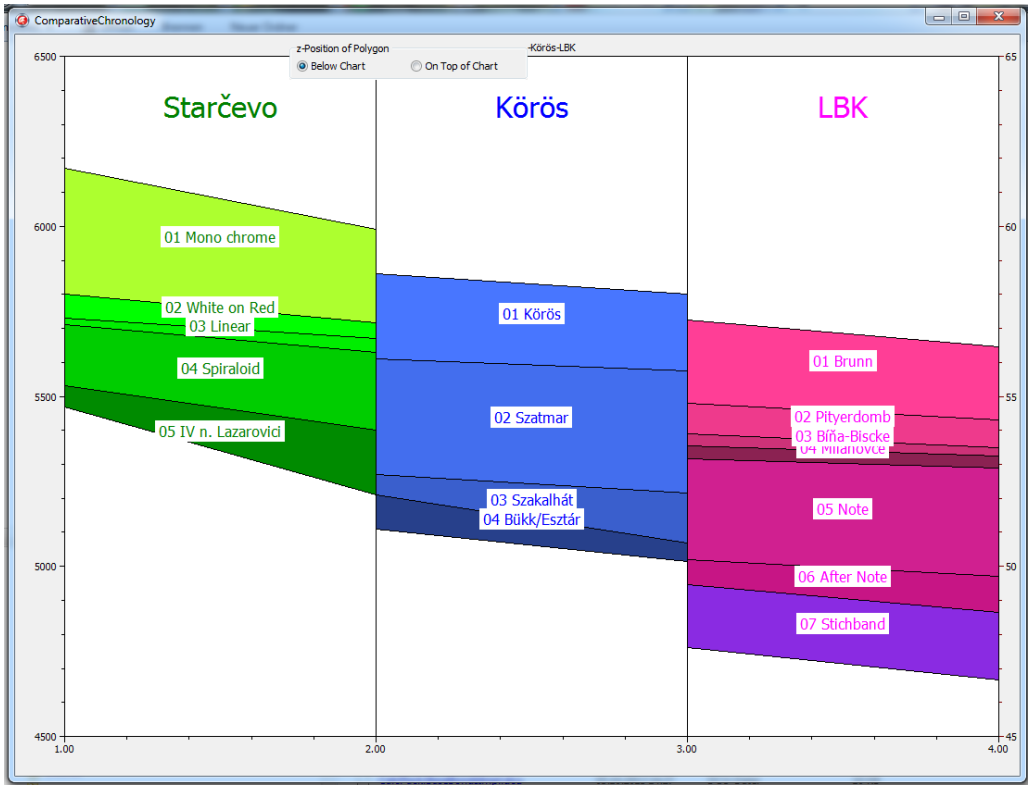


Figure 136: Program Comparative Chronology produces these graphs from Oxcal Results in wmf Vector format.

Work Shops and Lectures.

Currently we are doing Work Shops to teach students the usage of our software at the following universities: Vienna, Munich, Tübingen and Brno. In seminaries lasting 26-32 hours it is possible to learn the usage of almost all our programs.

We already have done Work Shops at the following universities: Graz and Budapest.

We are also doing Work Shops at my place of work, at the museum of Natural History for students, who want to use the software for their Master degree or PhD thesis, if they are unable to participate in seminars.

Very useful are Work Shops for university teachers (lecturers and professors), who afterwards can teach their own students. We started such a cooperation with the Sibiu University in Romania.

Donations and Sponsorship.

Developing software in this dimension is a time-consuming venture. But the work on such a huge image database, which in the near future shall contain every find piece ever published in archaeology (of Europe), is a more tedious project. There are two possibilities on how you can join:

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Intended purpose: Project Image Database Montelius (Doz. DDr. Peter Stadler) and inform me by an email to Peter.Stadler@univie.ac.at

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BLZ 11000;
Account name: Dipl.Ing. Dr. Peter Stadler, project account.
Account number with the Bank Austria-Unicredit: 10605715105
IBAN: AT93 1100 0106 0571 5100
BIC: BKAUATWW

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The money will be used for paying students doing input in our Image Database Montelius.

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b) If you want to cooperate with us, the usage of image database Montelius and our Software will be free, if you do one or several of the tasks listed below:

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2) You provide PDFs of publications, which are not freely available on the internet and we have not yet scanned them.

3) If you want to work in an area where image database Montelius is not yet active, you can scan and input cultures and also evaluate them with our software. You deliver all your inputs and get our software for quantitative evaluation together with our support.

4) You are a specialist for a culture and want to input several publications we have not yet done and deliver these inputs to us.

5) You are specialist for a culture and you could make typological work for yourself and provide this typology for us.

6) Under any condition, if from your work using Image Database Montelius articles will be published, you have to quote the cooperation with us and the usage of our software and Image Database Montelius.

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For a possible co-operation you can contact me anytime by email: Peter.Stadler@univie.ac.at

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List of Figures: