GIS and the University Museum of Cultural Heritage Oslo, Norway.

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Abstract

The University Museum of Cultural Heritage, Oslo, Norway (UKM) has integrated GIS as a central element in its excavation and post excavation strategies. Over the past decade routines have been developed that underpin all archaeological field work in Eastern Norway. UKM is responsible for archaeological management in Eastern Norway, promoting research and presenting archaeology to the public. GIS offers UKM clear advantages in presentation, managing databases and analyzing settlement patterns.

UKM has developed routines to project data into shape file format. Our data is typically total station generated data, though data generated by GPS units, photogrammetry or more traditional plan drawings is used. Compatibility issues exist in using total stations and laptops where polygons are created directly in the field. UKM's excavations generate roughly 20,000 spatially projected objects yearly. In addition UKM manages a large database that is in the process of being integrated with full GIS functionality.

The University of Oslo Museum of Cultural Heritage, Oslo Norway - UKM is responsibility for managing the archaeological record for South Eastern Norway. This area comprises of 10 counties representing roughly 40% of Norway. All major landscape types are represented from coastline, to agriculture, mountain and forest areas. As a consequence UKM has varied tasks and solutions within its management policy. Typically 200 archaeologists and students are employed during the course of the year.

UKM requires that all archaeological excavations be excavated digitally; all site archives must be deposited into the Museums central database, with corresponding shape files projected onto vectorised 1:5000 maps.

Database recording functions on two levels:

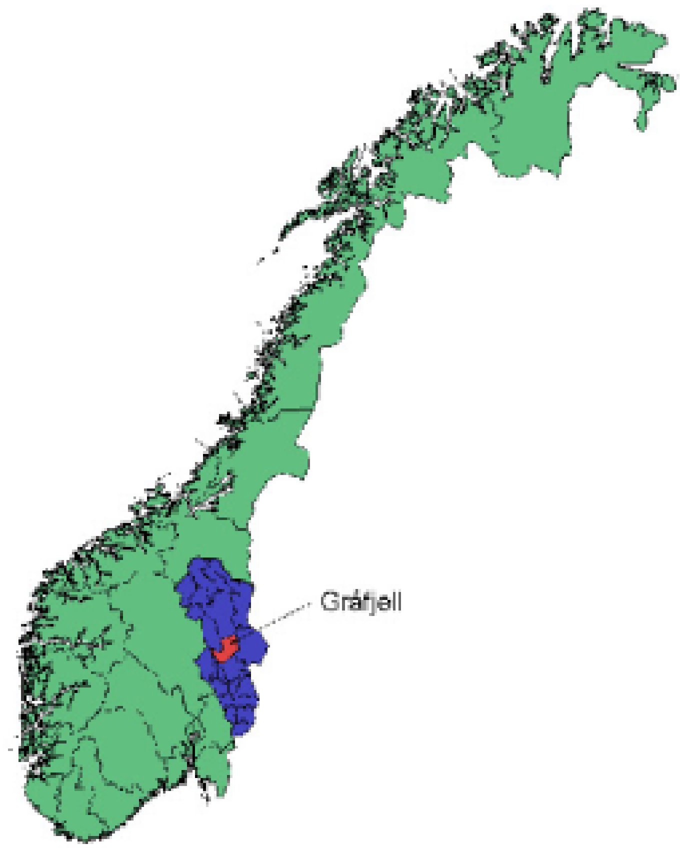
- A sites and monuments record – includes stray finds, objects and geographically related documentary references
- Intrasite GIS for excavation – full recording of layers, structures, finds and samples

The database is made available to archaeologists, students, planners etc via the internet. UKM collaborates with the four other Norwegian regional museums to maintain a national database where not only archaeology, but also natural history and geology are represented.

Case Study: The Gråfjell Project.

There are currently 4 large scale excavation projects being undertaken by UKM, in addition there are a large number of smaller projects such as single site and one season projects. Each excavation is assigned a GIS and digital recording manager. Each excavation regardless size or budget uses the same core system for data collection and the spatial projecting of data. However it must be emphasized that our routines are flexible - the only absolute requirement is that each project must deliver a digital archive in a format that can be uploaded into our central museum's oracle database and corresponding shape files. What happens in between is up to each project to decide dependant on the archaeology and its logistic framework.

The Gråfjell project is a 5 year excavation project investigating a 200 square kilometer area 3 hours north and east of Oslo. The study area is a typical outland area - forest, mountains, bogs and narrow valleys with few roads. The Norwegian military who fund the project are constructing a training area for tanks and artillery. Under the Norwegian Antiquities Act field survey was carried out over 3 seasons and 2191 protected sites were surveyed. Dispensation from the act was granted to the Military to use the area on condition that 1381 sites be included within an investigation strategy.



Map of Norway showing with The Gråfjell Area marked

All periods from the Mesolithic to the present day are represented, but by far the largest group of sites is related to iron production in the Viking and Medieval periods. Gråfjell represents a marginal resource area where cultivation was not possible, but where bog ore and wood for charcoal burning was plentiful. In addition the demographic and technological advances in Eastern Norway from the Viking period to The Black Death created a huge demand for Iron. Since the area has not been cultivated the stratigraphy remains intact.
In addition this Gråfjell can be described as an enclosed landscape in that it is bordered by mountains to the North and rivers to the East, West and South. The systematic field survey work means that a complete picture of human activity is available. There are topographic vectorised maps down to 1:1000 and a complete series of aerial and satellite photos. Gråfjell presents therefore all the main ingredients for applying GIS within archaeology.

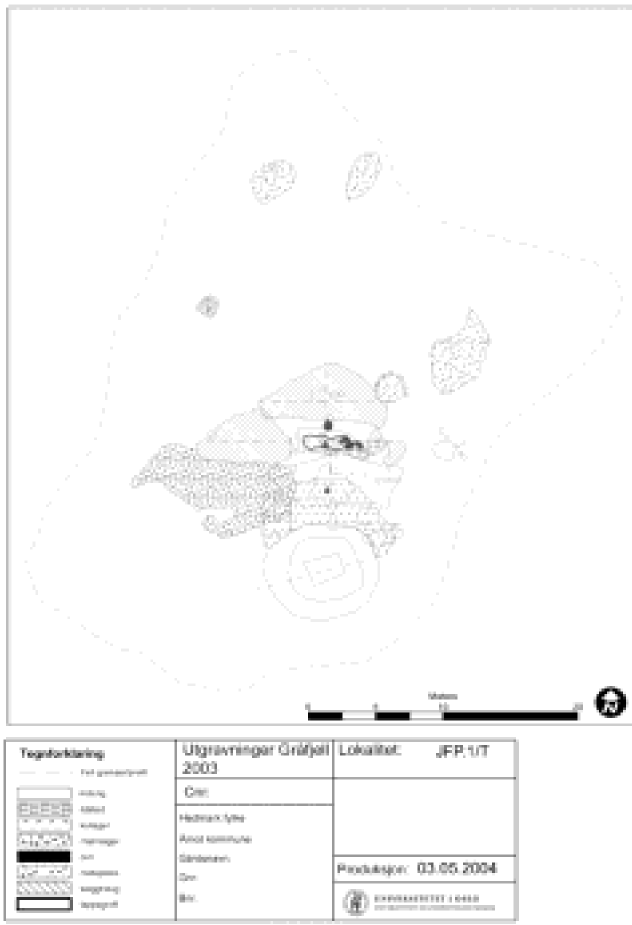
Photograph showing part of the Gråfjell Area

Running a digital excavation

Though Gråfjell presents good opportunities for using GIS the landscape and terrain present us with a set of challenges. In the case of the Gråfjell project we have a large area with few roads, 6 parallel excavations and 2 total stations which have to be moved several times each day between sites. The limiting factor is what can be carried in a rucksack. In the course of the excavation season roughly 25 complex sites will be excavated and perhaps 100 single structure sites such as charcoal pits, pit fall traps, cook pits etc. In order to meet the documentation requirements Gråfjell has had to streamline its hardware use in order to be more mobile.

We survey in the traditional way where data is taken in as points and stored on a pc card The editing therefore takes longer where points are uploaded into Leica's Field link program each evening and manually be edited into line, point, or polygon themes in a shape file. What time we save in the field is offset by editing back at the project office in the evening.

In the planning stage we looked at a Leica GPS system as the main surveying tool, but the further north you go GPS satellites are much lower in the sky and signal obstruction from mountains and trees becomes more marked, and the time slots through the day when enough satellites are available to achieve the high accuracy levels that surveying in plan requires become even shorter. In addition to this z values are less stable that x and y and deviation can be as high as 8 cm. A GPS system costs roughly double that of the most advanced total stations and our budget could only stretch to one GPS or two total stations. The greater mobility afforded by a GPS system was a very attractive factor but would have inhibited us in more in other ways, so instead we survey with Leica TPS1105 one man operated total stations.



Simplified plan drawing of an Iron bloomery site from the early medieval period

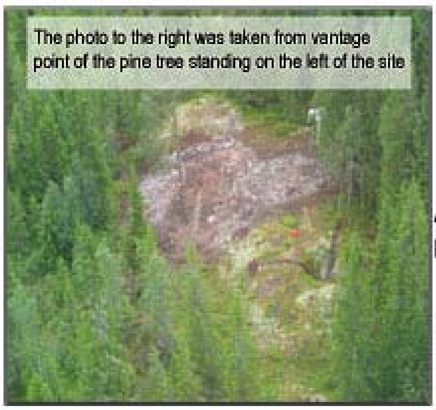
Another UKM project –The E18 project (European Highway 18) that started at the same time employs quite a different surveying solution. The total station is connected to a laptop and steered via Leica's Field link program. Data collection occurs in directly into GIS and shape files created immediately. In this way the plan drawing is built up directly in 'real time' offering the advantages of on site control and editing. However without mains power or an external power source this is not a viable solution for all situations. However the archaeologist is no longer so mobile; setting up takes longer, a laptop must be carried; two surveyors instead of one are needed, a table or stand is needed for the laptop and as we have found a sun shield of some kind so that the screen can be read in sunlight.

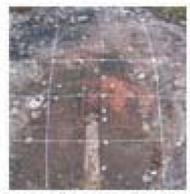
Organizing data collection

In order for GIS to run smoothly we build up only one database for finds, samples, layers, contexts, sites etc Each excavation team is assigned 100,000 context numbers, team one starts at 100,000, team two from 200,000 team three 300.000 and so forth to team six from 600,000. This ensures that only unique numbers are assigned and that we are able as well to recognize to which team and site a context number relates. When each site archive is edited and completed the 6 databases are then put together as one, and when the fifth excavation season is over the databases from each season are in turn put together. The fields within our database correspond to those in UKM's central database where are archive with be deposited.

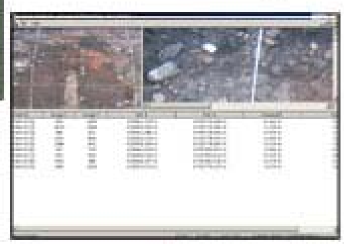
Image referencing as a tool in creating plan drawings

By necessity we have been inventive in projecting excavated data. We wish to reduce the amount of time each total station needs to spend at a site so that it can be used elsewhere with the project. We have used image referencing to reasonable affect. For example plotting large numbers of stones that the excavation leader wishes to have in a site drawing would take a lot of time, conversely it requires much less time to take a photograph that can be rectified and used as a graphic to draw around the stones later on back at the office. However the requirements for site planning are strict and in order to create an accurate site plan we have found that only photos taken in certain ways can be used. Another problem is that stones drawn in later will not have z values attached, stones therefore that are part of a construction need to be surveyed with a total station in order that the archive fulfill archive requirements. Information however that is not of stratigraphic importance but of value to site interpretation is created in this way.

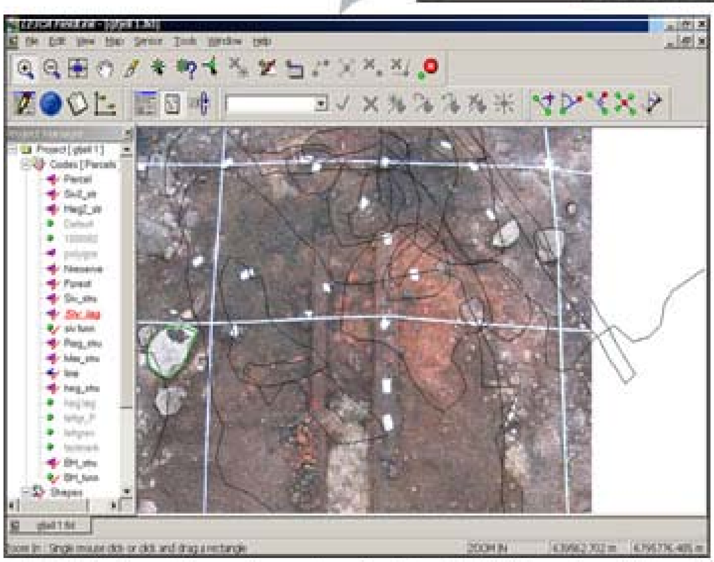




A visible grid was laid out and the cross points surveyed by total station



The photo was the image referenced in Leica's Field link program



And finally the photograph was imported into Field Link and used to build up the plan drawing in scale. We observed high levels of accuracy.

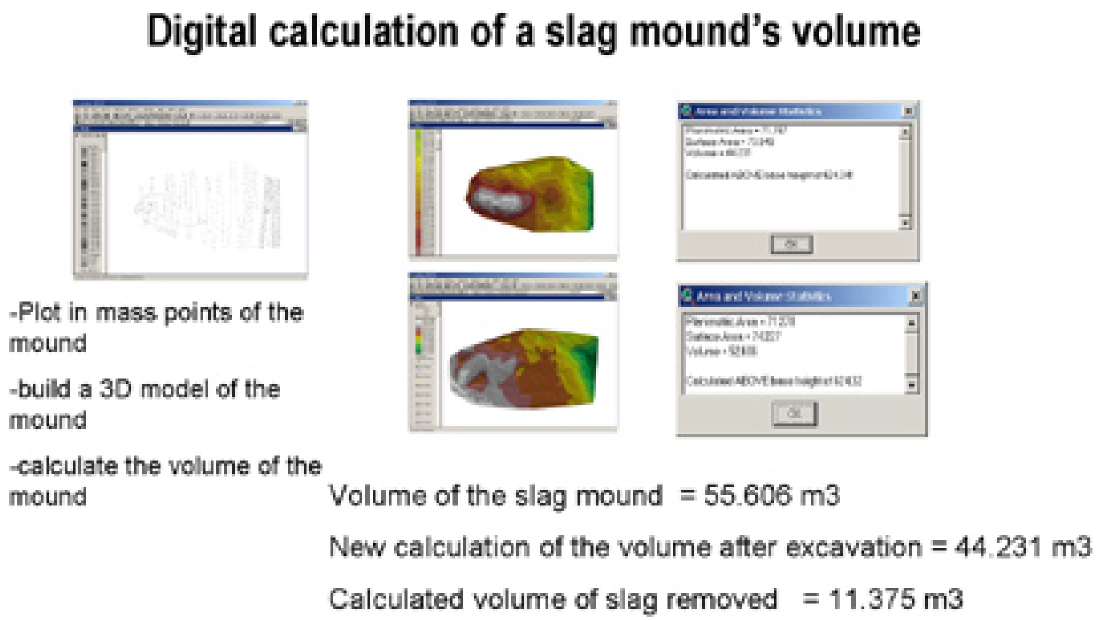
3D modeling
The goal of being able to excavate a site in single context, surveying a site via a scanner as each layer is removed, and being able to build up a 3D virtual site, and take out slices at will for interpretation processes is the utopia archaeologists are moving towards.

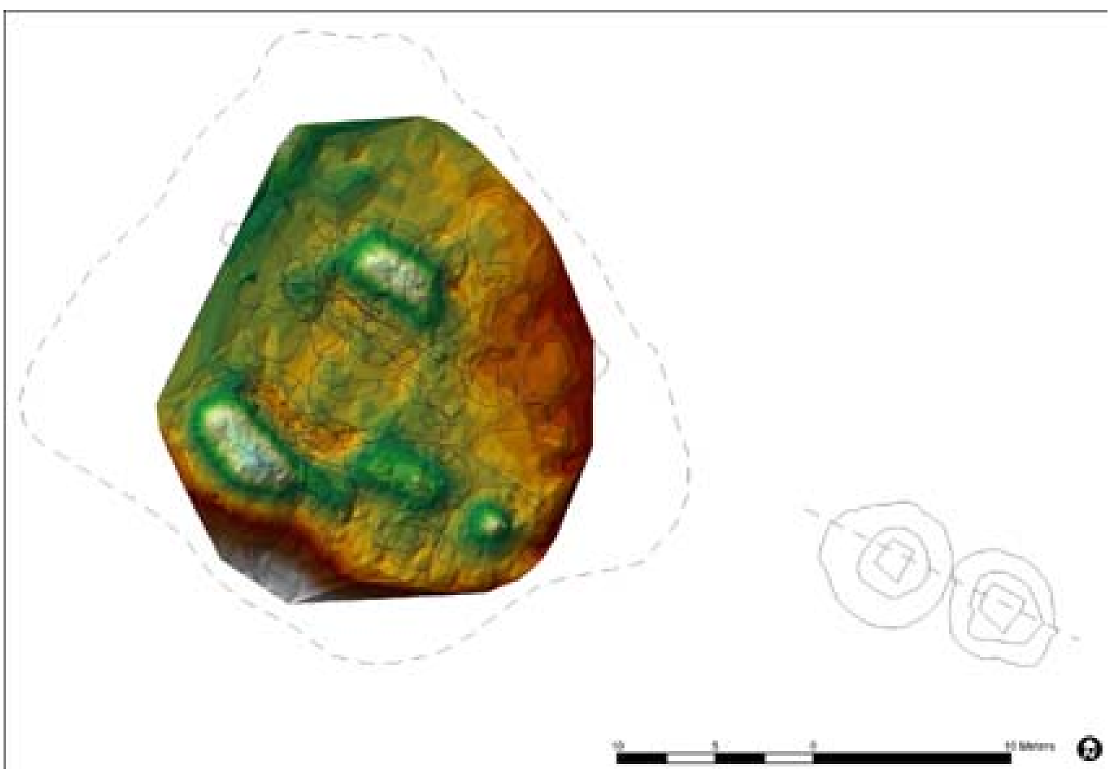
That is where we want to be and probably will be in 10 years. Already in 1990 UKM employed a program called PenMap, created by British based Strata Software, it is still around today and allows simplified 3D mapping directly into a total station on site. Its drawback is that there is no GIS aspect to the plots. The result is a 3D plan drawing but not a relational database.

It must be said however that the seemingly high value of a 3D database might not be worth the resources needed to create it, and it needs to be said that 2D GIS works fine. Urban excavations where several thousand years of occupation is represented and where complex problems of interpretation arise would clearly benefit from 3D GIS.

The Gråfjell project does use 3Dmodels as standard on sites where verticality is relevant, such as bloomery sites where the constellation of slag heaps, charcoal pits, tapping ditches, and furnaces is important to interpretation.

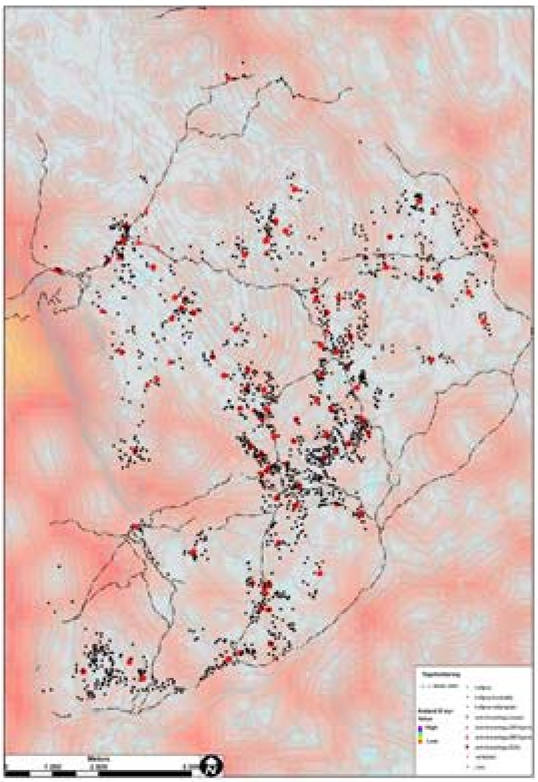
3D models are also used to generate site area and structure volume statistics. In the case of bloomery sites the models to accurately calculate the volume of slag heaps and which in turn is used to calculate the amount of iron that was produced at the site. A model of a slag heap before excavation is created, and another after excavation, volume data is generated and the difference is what has been removed. Chemical analysis of iron slag and ore is standard for such excavations and from this an Iron/slag ratio is arrived at. We weigh one cubic meter of slag and arrive at a total slag weight for the whole site. From this we can calculate the amount of Iron that a bloomery site would have produced. In Gråfjell where we will excavate 40 sites the comparative data on slag volume and iron produced will be central in interpretation as several different bloomery technologies have been developed and employed through time.

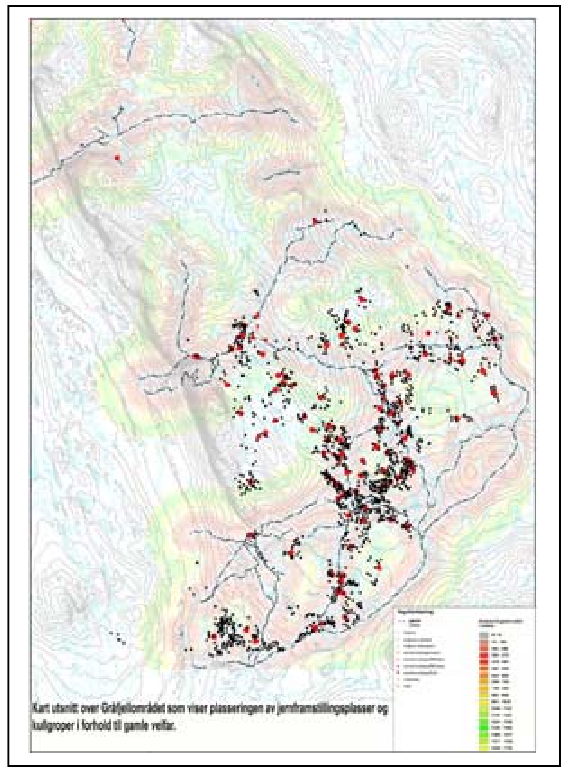




In addition we can use the 3D models as a background to our projected data which is invaluable for interpretation purposes. The 3D model above is from an iron bloomery site showing slag heaps, and slag tapping ditches, with structure data overlaid.

Spatial analyst
As the project continues to generate more and more data spatial analyst will start to play an important role in searching for patterns. The archaeology of Gråfjell is greatly influenced by topographic and natural factors. The two illustrations below show the location of 1. iron production sites in relation to bogs – the main sources for iron ore., and 2. their location to communication routes, for transporting raw iron out to the valley bottom.





Examples of two plots from spatial analyst. The one two the left shows the location of iron bloomery sites in relation to bogs marked as grey.

The plot to the left shows the location of the same bloomery sites in relation to surveyed track ways.

Conclusion
Our experience has shown that when up to 200 archaeologists with varying technical awareness become spread around a varied landscape with varied archaeology a system is required to control the data that comes in. However a system of hard and software solutions must also be flexible enough to allow for differences in archaeology and local conditions. The product must be fixed but the method and the toolbox to create it should be flexible enough to allow for individual creativity. The archaeologist must understand that digital tools are no more than that and that they can be wielded in many different ways.

References

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