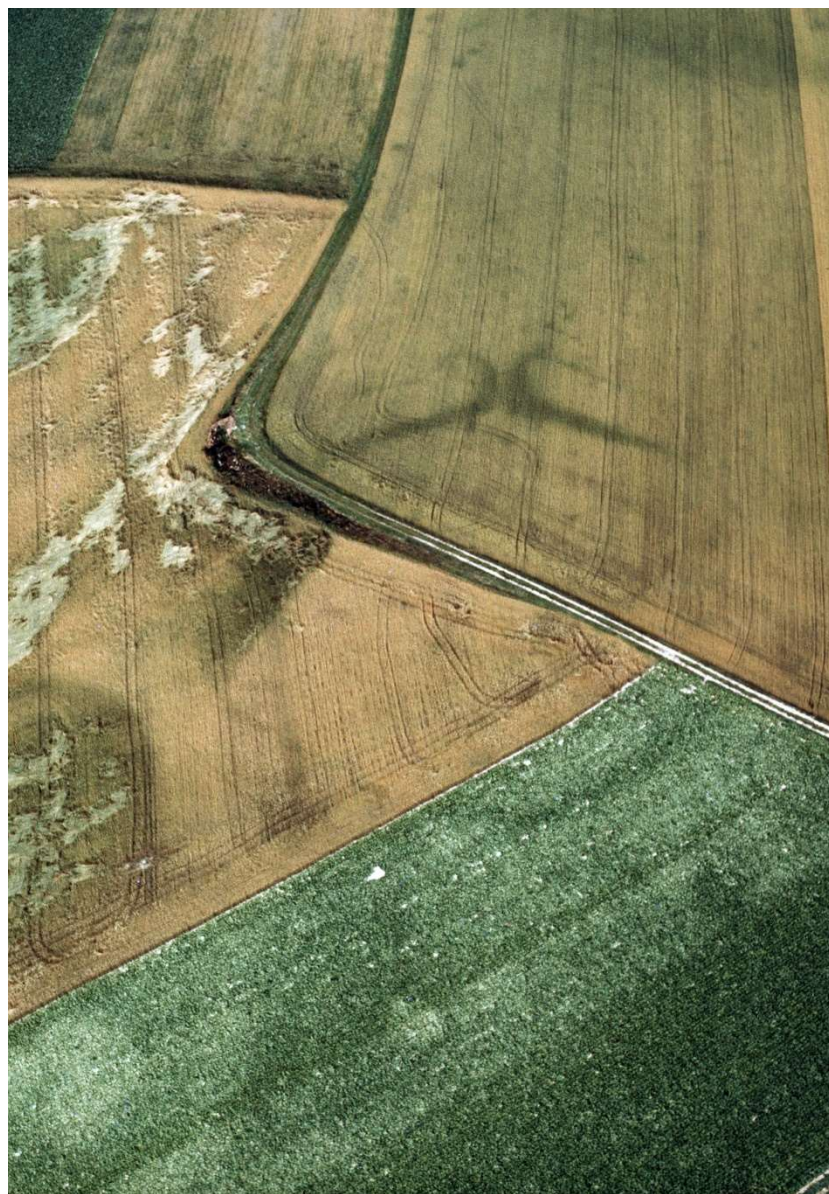


# AARGnews

Number 63: October 2021

The newsletter of the Aerial Archaeology Research Group

Edited by Rog Palmer



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(cover picture: Neolithic ring ditch monument of Künzing-Unternberg that was detected by Otto Braasch during his flights for the BLfD. This was among his first discoveries ever. BLfD Aerial Archaeology Archive, Photographer: Otto Braasch, Date: 12/07/1977, Archive-Nr. 7344/007 Image-Nr. 0000-01.)

## Editorial <sup>1</sup>

### Climate change and crop markings?

Should those of us from temperate lands whose main source of archaeological information comes from differential crop growth worry about the effects of changing climate on the visibility of our data? As I have previously noted, we've had a fortunate 100 years during which increased areas of arable cultivation have corresponded with the invention of flying and orbiting machines along with the development of sensing techniques that have enabled us to record buried archaeological features.

I don't think any aerial people have thought much about what effects, if any, climate change may have on our data source. Perhaps it is too much of a secondary topic to survival, or not, of species? Weather and climate? Neither are our speciality, but the relevant equation seems to be that global heating increases evaporation which forms more clouds which provide increased, and heavier, rainfall. To some extent, or to my limited understanding, this is shown by the interactive time-series graphs that the UK Met Office have published (2021) that, over time, show a steady increase in temperature, rainfall and sunshine with – depending on how you look at the data – a more severe increase since c.1980. Figures from worldwide data show similar trends that are likely to affect how and when crops grow – a small side effect from destroying our world. We know that there are more variables involved in the formation of crop markings than just those, and our collections of photographs show that these include geology, soils, crop types and their sowing dates. Because of those factors, there has never been a time of year when 'all' fields are responsive, and our aerial surveys try to take account of that. Whether you fly over them in a Cessna and ignore them or document their locations on area surveys, we usually have more fields of 'nothing' than of archaeological information. But later in the year, or next year, we may record different information in different fields.

One effect of climate change may be that it shifts the date of the 'crop mark season' – and here I refer to the UK – where it has traditionally has been from middish June to middish July. Are we able, I wondered, to compare the late 1970s with the late 2010s? Sources for such a comparison would be *Information sheets* written, collated and posted by Jim Pickering of which I have copies from 1975 to 1980 and Damian Grady's emailed *Crop condition bulletin* from 2016 to 2021 (that are easily accessible on this computer). However, a quick look through both shows perhaps too much generality of location although description of crop growth is similar. There are also similarities in dates, crop colour and the appearance of colour contrasts in crops that suggest that the busy time in both 5-year periods was mid-June to mid-July – with outliers, of course. So – that's the end of that theory without spending a lot of time unpicking the relevant facts.

Without facts, all we are left with are a few thoughts. How will crops, cereal crops, respond to the climate change? Will plant scientists be able to work quickly enough to produce strains that are able to grow and ripen under new conditions? May we, in temperate regions, find ourselves monitoring two or more cycles of growth a year? Are farmers, traditional or technological, able to respond to the demands brought about by these 'natural' changes? Will governments and energy industrials ever throw aside their delusional dreams of monetary

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profit and cause things to change? Among which, does the effect of all that on the ability of crops to reflect sub-surface archaeological features really matter all that much?

Met Office 2021. <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-temperature-rainfall-and-sunshine-time-series>

### Otto Braasch

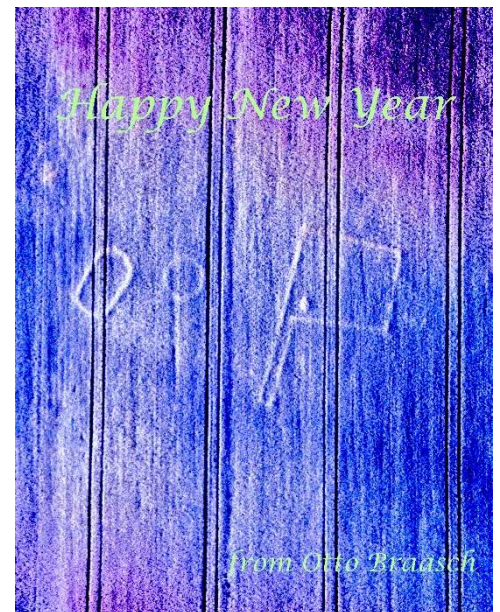
Otto Braasch died on 5 August 2021 after a few weeks' illness. His major contribution was to encourage aerial activities in many parts of continental Europe, especially those parts recently released from Soviet influence in the early 1990s. The schools that were run from 1996, with their contingent of AARG-member teachers, grew from that encouragement and the present-day network of aerial people across Europe is very much part of Otto's legacy.

Photographs Otto published were all targeted obliques, sometimes just of an archaeological site, sometimes artistically atmospheric. His evening slide shows became a frequent part of our annual meetings when, usually with two projectors and screens, we were treated to a mixture of aerial artistry whose explanation was preceded by, "On the port we have... and on the starboard...".

Otto became AARG's 'continental correspondent' and fulfilled that role with reports and presentations until there was a fallout over politics. Otto asked AARG to become an official voice to support his attempts to open the skies in countries which would not allow him to operate in the way he believed he should (Greece comes to mind and I think Romania wanted to charge him excessive amounts). Our then Chairman (Toby Driver, I think) told him that AARG does not do politics after which Otto had less involvement with us and later refused the offer of Honorary Membership.

I liked Otto and admired the way he had expanded aerial knowledge and practitioners in Europe. We argued at times about the role of aerial photographs in archaeology and what comprised a 'useful photograph'. For him, photographs were the end product of his work, whereas they are the beginning of mine and we saw them as very different resources. It was a healthy argument and, while Otto was still flying, we maintained a correspondence that was much concerned with how to promote aerial photographs and their uses in archaeology. He was never a believer in mapping, beyond a dot on a distribution map, and the necessity to include control points in photographs to enable this. Somewhere, I have an email in which he wrote that '...I do not like my beautiful photographs spoiled by your control points.' And several years later, after he had a forced landing on a country road, another email included '...things went well until my wingtip hit one of your control points.' (a roadside sign post). It was good to know that he had survived the emergency landing and I could so easily imagine him climbing down from his Cessna and cursing me for leaving a control point in such a silly place.

Elsewhere in this issue is an assortment of memories of Otto by people who flew with him or have collections of his photographs. Books featuring his aerial photographs include:



Otto-art, possibly 2009.

Christlein, R. and Braasch, O., 1982. *Das unterirdische Bayern: 7000 Jahre Geschichte und Archäologie im Luftbild*. Theiss: Stuttgart.

Planck, D., Braasch, O., Oexle, J. and Schlichtherle, H., 1994. *Unterirdisches Baden-Württemberg: 250,000 Jahre Geschichte und Archäologie im Luftbild*. Theiss, Stuttgart.

### Romas Jarockis

It took the best part of a year for news to filter through to AARG of the death of Romas Jarockis last November. Romas was one of the ‘students’ at the first training week in Kiliti, Hungary, in 1996 after which he joined AARG and was involved in a number of projects including participating in Culture 2000, a forerunner of Arcland. As part of Culture 2000, he organised an aerial archaeology seminar where he was teaching at the university of Klaipėda, Lithuania, in November 2005 (Jarockis, *et al*, 2007). Klaipėda was on the edge of nowhere for most of us travelling there and the way I remember his story about it was that he had been sent to this ‘outpost’ from Vilnius where his teaching was considered too radical to fit in. He had been banished to Klaipėda where he could teach in the manner he wanted without upsetting the staid members of the teaching staff.

Lithuania did not have a crop-marked past landscape but it did have hillforts and other cultural heritage sites, and Romas used aerial photographs to record these, their context and state of preservation. The (then) unusual aerial view also helped raise interest among school children and the general public.

We met several times after the 1996 school but it was the 2005 seminar that those present may remember best. A friendly mix of participants, cold walks ‘home’ from what I remember as a different jazz pub each evening, and a field trip to Curonian Spit after an overnight snowfall that had effectively masked the upstanding features we had gone to see. So we threw snowballs instead. Romas was always eager to do more and to publicise aerial work in his Baltic region and had, in the months before the pandemic, offered to host a future AARG meeting which now is unlikely to take place.

Jarockis, R., Kraujalis, R. and Musson, C., 2007. *Past from the Air: aerial archaeology and landscape studies in Northern Europe: papers of the international seminar held at Klaipėda University: 16-20 November 2005*. Versus Aureus: Vilnius.

### AARG 2021

I thought the two September zoom meetings were a good mix of papers, the sessions short enough to maintain interest, but would have liked more elastic discussion times. There was an added bonus to holding AARG remotely: “It’s the first time I’ve been to AARG and not had a hangover”. (Chris Cox, 19 September 2021.)

Lucy Killoran, a research student at Glasgow, ran a workshop for the final AARG 2021 session. Its purpose was ‘... to engage people involved in archaeological survey projects in



Romas and Darja Grosman at the Kiliti school, June 1996.  
Photo, Michael Doneus.

defining some software functionalities and outputs relating to ML automation that would be a valuable integration into their workflows.’ Participants engaged in this by adding sticky note comments to answer Lucy’s research questions – comments intended to help her project’s aims. I was in the first of two groups for this and sometimes felt a bit out of my depth regarding the technicalities but more so because the term ‘archaeological survey’ covers a wide range of aims and levels of results and it was not further defined. My view is that at present ML/AI is quite good at finding simple kinds of sites but way off beginning to help us understand their role in the wider landscape. However, we need to keep in touch with what these magicians are doing with our data.

### **Is AI taking us back to the 17<sup>th</sup> century?**

A thought arising from a mix of Lucy Kiloran’s workshop, exchanges with Iris Kramer and the recent publications about AI finding 10,000 burial mounds in Iberia (see *Books and papers of interest?*) made me wonder in which direction this is taking us. Yes, we all agree that AI can find a very restricted range of features on (usually) ALS data, but may this be reminiscent of blokes on horses – John Aubrey (1626-1697) perhaps – finding and recording lumps in the countryside? Or, to bring it into the aerial world, of St Joseph’s series of *Air reconnaissance: recent results* in the journal *Antiquity* (1964 to 1980). Both of those methods of research and publication tended to focus on single features in the same way that AI does and this may be good for beginning an inventory or showing the distribution of elementary ‘types of site’ but it doesn’t help us understand them or even to consider them in an archaeological way other than by totalling the number found. I appreciate that AI (probably) has a place in image analysis but don’t think that the current way of measuring success as ‘I found more than you did’ is doing it justice. Give us a landscape of AI-discovered things, let human interpreters fill in the rest of that landscape from the other necessary sources and then throw some archaeological questions at it to see how AI has added (or not) to the content and understanding of that landscape’s past. As yet, no one has gone beyond using it to identify and count lumps.

### **This issue**

I was more than happy to receive a contribution from Martin Fowler after a several year absence from AARG during which he was distracted by searches for exoplanets. Those of you old enough to remember his many contributions to *AARGnews* know that he has been documenting the history and development of image capture from satellites and has a particular interest in the archaeological potential of declassified of US (and other) satellite photographs. In this issue he writes about the changing access to HEXAGON photographs and demonstrates their capabilities through examination of sites in Southern England. Following receipt of Martin’s paper I searched the USGS website for HEXAGON data for various places (Armenia, S. Africa, Australia, Europe) and have found only a few gaps in its cover (mainly those dark places north of Hadrian’s Wall). The website is easy to use and the thumbnail images are of adequate quality to let users decide if purchase may help their study of an area. That these are useful and should be added to photographs examined was demonstrated by his comparison of the mapping in the newly-released Historic England website (see *Cropmarks* this issue) and a HEXAGON image that includes a field or two of lynchets that apparently were not recorded on photographs examined in preparation of HE’s map that includes Worthy Down in Hampshire.

There are a couple of reports from AARG's Sentinel 2 Working Group, notably a piece by Mathias Broch about the progress he has made analysing non-visual wavelengths to chart changes in moisture index (NDMI) and vegetation index (NDVI) and relate them to dates of aerial photography. There will be more to follow on this aspect as other members of the group will (hopefully) apply it to their study areas.

Regarding AARG WGs, but not elsewhere in the contents of this issue, I mention here that the monthly photo reading evenings have been enjoyable opportunities to learn new things and sometimes to revise old things. Recently we have broadened our territory to the landscapes of stone-built iron age structures in South Africa thanks to the input of new AARG member, Erica Winter. While not necessarily wanting to enlarge the group membership (although enquiries will be welcomed) this sort of thing mixes fun and learning and is something that any members who work with all kinds of aerial images may enjoy. If you're shy, why not share a photo with a friend and chat for an hour or so about everything that can be seen in that image.

Contributions in this issue are closed with a collection of memories of recently deceased AARG members: Romas Jarockis and Otto Braasch. Romas's activities are summarised by Dariusz Krasnodębski and Włodzimierz Rączkowski who collaborated with him on various Baltic ventures. Otto Braasch is remembered by a handful of the many AARG members who flew and taught with him. These range from the formal to the personal and show the mixture of friendship and respect that can be formed after being flung around in the cockpit of his Cessna.

Plus a few pages of *Cropmarks* and notice of more published papers than anyone with any sense would need to read.

## **AARG notices**

### ***AARG fund***

AARG will allocate funds each year to support projects that demonstrably advance knowledge and understanding within the field of aerial archaeology. Guidelines were circulated with the 2021 AGM report and should be available shortly on AARG's web site.

### ***AARG's news and information in other formats***

**Twitter account:** @AerialArchRG

**Facebook page:** <https://www.facebook.com/aerialarchaeologyresearchgroup/>

**AARG's Google Group** is here: <https://groups.google.com/forum/#!forum/aarg-group>. This is for AARG members only and all requests to join will be approved (or not) by the administrator of the Google Group. After having joined the group, you are free to start new topics about anything you want to ask or discuss with AARG members.

### ***The Derrick Riley Bursary***

The Derrick Riley Bursary still exists. It is £500 a year, usually a single award, but sometimes is split and given to two people.

There is an application form at the link below on the Sheffield Archaeology Department website and a Riley Bursary page on the Sheffield website where potential applicants will be able to find information and download the application form.

<https://www.sheffield.ac.uk/archaeology/derrick-riley-fund>

### ***ISAP Fund***

ISAP have a fund to provide support of up to £1000 to assist with members' projects [membership costs less per year than AARG does] that 'further the objectives of the Society'.

Guidelines and application form from the ISAP web site:

<http://www.archprospection.org/isap-fund>

### ***Information for AARGnews contributors***

*AARGnews* is published at six-monthly intervals. Copy for *AARGnews* 64 (April 2022) needs to be with me no later than **April 1, 2022**. Editorial policy (for want of a better word) tends to be that if I am sent interesting contributions they go in unless there's a danger of an issue overflowing. Instructions for contributors are no longer on the AARG website, but this issue may serve as a guide or more information can be sent on request.

Please do not use any 'clever' formatting, avoid footnotes, and include jpg illustrations as separate files.

Address for contributions: [rog.palmer@ntlworld.com](mailto:rog.palmer@ntlworld.com)

## AARG's Sentinel 2 working group – second report

Rog Palmer<sup>1</sup>

Our first report described the aims and the first three months work of the Sentinel 2 (S2) working group members (*AARGnews* 62, 9-10). Since then we have lost members through default (Belgium, England, Ireland and Scotland) and are now a group of seven active members plus two (or three) advisors. We have met via Zoom on 14 dates following our first meeting in December 2020. We increased the frequency of meetings to fortnightly during what we hoped would be the flying season in anticipation of having more to report at that time and have now returned to monthly slots. AARG generously contributed towards flying costs for Mathias Broch to observe his S2 area in Denmark.

In advance of what was hoped to be the 'crop mark season' during summer 2021, most of us kept track visually of how the S2 images were showing changes in crop growth and colour. However, any chances of compiling a regular local pattern of such changes were thwarted by cloud cover which allowed most WG members only infrequent views of the ground between mid-April and the end of July in 2021.

While cloud obscured the satellites' view of the ground, archaeological observations could be made below and Andreas Ziegler continued his frequent and year-round flights in parts of Austria, Rog Palmer flew his Cambridgeshire area at weekly intervals from mid-May and Mathias Broch overflew his Jutland test area on two dates. Simon Seyfried undertook multi-spectral drone flights at his selected fields near Muschenheim and has also written a program in R to successfully automate analysis of S2 layers. Crop conditions were such that neither Carmen Miu or Lidka Žuk flew in their chosen areas while Darja Grosman has been chasing a range of aerial sources while waiting for her March(+/-) flying season in Serbia. A general observation from those of us who did fly was that crop development was 2-3 weeks late in 2021 as, for example, is shown by the early-September cereal harvest in Cambridgeshire.

The discontinuity caused by cloud cover caused us to ask if it is possible or worthwhile to make any sequences of observation (but see Mathias Broch's following paper) as a prelude to flying or whether we could base our use of S2 on occasional looks at the ground. As Lidka Žuk asked, "How many days in advance do you need to know that conditions are suitable to plan your flight?". A fair point, and one that may be answered by a single clear day followed by a phone call to book a flight – which may be a week later.

Visually, we can see major changes on S2 images that indicate when green-on-ripening crop marks may be seen but are unable to identify the earlier green-on-green phase nor any changes once crops are ripe. Mathias's retrospective work using NDVI and NVMI shows promise (see following contribution) but may need a sequence of observations in order to predict when crop growth is significant. As a postscript, written while waiting hopefully for the Chairpiece to arrive and complete this issue, we have begun to produce similar retrospective curves for parts of Austria and England with results that seem to follow the trends identified by Mathias although it's early days to assess whether these may have predictive value.

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## Working with Normalised Difference Vegetation and Moisture Indexes in AARG's Sentinel 2 working group – the idea, the method and the next step

Mathias Christiansen Broch<sup>1</sup>

Using the frequent capture data from the Sentinel-2 satellite array has its merits for aerial archaeological purposes. It is possible in the preprocessed RGB-formats to deduce when crops ripen or are stress at a basic level. Archaeological crop marks do not necessarily show, but the crop colour changes indicate when it's time to go flying, at least when the fields are not obscured due to cloudiness. However, the usefulness is not without some issues. First, this approach requires a keen and experienced eye as the colour changes can appear minuscule and highly reliant on crop types, local geology, or agricultural tradition. Second, it is challenging to quantify the crop colour change, i.e. it is difficult to formulate criteria for what colour change is enough to merit surveys. An issue the working group has had throughout the work we've been undertaking. In addition, the idea to predict when it is time to go flying becomes difficult, as the criteria for such predictions are qualitative and observer beholden rather than quantifiable.

The idea to work with the Sentinel-2 data as indexes rather than RGB images was a product of these issues. The hope was that band-data would quantify the relevant changes in crop vegetation and thus make our collaborative Sentinel-2 effort comparable throughout the working group. Two promising indexes were chosen for this experiment; the Normalised Difference Vegetation Index (NDVI) and the Normalised Difference Moisture Index (NDMI). Where the NDVI estimates a given vegetation's health and indicates a level of stress that could result in crop marks, the NDMI calculates variance in a given vegetation's moisture levels. As such, the two indexes are temporally separated in terms of crop mark formation. For example, a prolonged water deficiency can result in crop mark formation (NDMI). Following this, the crop marks may appear due to moisture deficiency-induced stress (NDVI). This difference provides a chance to monitor water levels and how they influence crop health on a field-by-field or regional scale. The NDVI indicates healthy crops in the interval [0,7-0,9], and NDMI shows healthy moisture levels in [0,4-0,9]. Index values below show respectively vegetation stress or moisture deficiency.

It was necessary to compare these indexes with actual crop mark photography to test this hypothesis. In essence, a comparison between archaeologically recorded crop marks and the Sentinel-2 data. In 2018, we did several good surveys, and these photos were further supplemented by Google Earth orthophoto imagery. The test was done with Sentinel 2 data from 1<sup>st</sup> May to 31<sup>st</sup> August 2018, as this is the usual "survey season" in Denmark. As a result, 25 known crop mark sites (discovered between 2008-2018) were selected in a ca. 8x17km area of central Jutland. Each site was marked by a polygon, within which 25 random points were appointed. The L2a corrected sentinel-2 band-data tiles (band 4, 8, and 11) were downloaded using the Qgis-plugin "Semi-Automatic Classification Tool", and data was harvested from each of the three bands for each capture date during the period using the Qgis-plugin "Point Sampling Tool". The dataset was then exported to Microsoft Excel. The process is not too tricky nor very time-consuming. In this retrospective study, all the data was gathered in one go, but doing this ad hoc during a "survey season" would make the process even less laborious.

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With the band data at hand, it is easy to calculate the indexes.  $NDVI=(B8-B4)/(B8+B4)$  and  $NDMI=(B8-B11)/(B8+B11)$ . It was beneficial to calculate averages per site to get an idea of the index values for given fields, rather than having the variance of 25 values per respective date. The underpinning data works well as statistical value ranges that can give an idea of data collection accuracy. The compiled data from all the 25 sites can easily be merged into one area average to give a more broad idea of the vegetation development in near real-time.

The date-specific NDVI & NDMI averages are best displayed in a simple scatterplot with a temporal progression along x. Compared to the imagery data from oblique photos and vertical orthophotos, the values corresponding to crop mark formation worked out well. Before crop marks form at the chosen sites, a period of 1 to 1,5 weeks of moisture deficiency occurs in a given field (NDMI values ranging from 0,4 to -0,2 followed by varying declines in NDVI). The trend is disrupted when clouds cover the selected areas, and the NDVI and NDMI inverse shows such a situation making disruption easily recognisable. As such, the idea seems to be a success at least for the given case (cf. figure 1 & table 1).

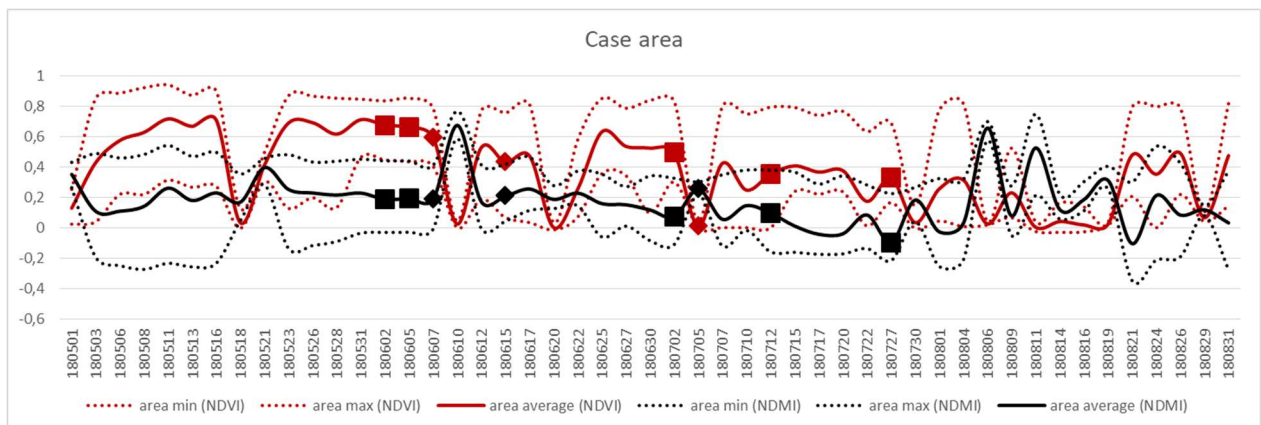


Figure 1: The NDVI and NDMI averages compiled for the study area in central Jutland, Denmark. Min/max ranges are displayed as dotted lines. Inversion of NDVI/MI indicates heavy cloud cover. NDMI ranges  $<0,4$  indicates moisture deficiency in vegetation canopies. Imagery capture dates marked with squares. Large squares indicate GE-imagery skewed squares indicate ODS. Cross reference with Table 1 for the difference in crop mark visibility.

From visually monitoring the RGB imagery from Sentinel 2, it is possible to see crop colour changes that indicate crop mark formation in colour ranges between green on yellow. However, green on green crop marks have proven more challenging to identify. Likewise, issues appear when attempting to distinguish yellow on yellow crop marks. The NDVI/MI approach in this preliminary study seems to show when such crop marks would occur and if the crop marks with any likelihood linger through the maturation cycle. As such, this approach not only determines the best retrospective opportunity to survey for the green on yellow crop marks but can possibly be used to determine the entire temporal window, for when surveys in a given area can be considered worthwhile. At least in conventional grain crop fields.

The next step for the Sentinel 2 working group is to conduct similar studies from our respective survey areas and compare the data. Gathering a larger comparable dataset (different years, soils, crops, and temperatures) will hopefully help us determine a qualifying trend for when the crop marks appear. The preliminary studies show that the NDVI/MI trends are visible regardless of archaeological features present in the given field. The hope is that this will allow us to predict crop mark formation better using satellite data irrespective of how well explored the given area is. However, we have yet to determine a minimum of sample points needed to obtain a reliable area-

NDVI/MI sample before this can be attempted with any degree of reliability. The hope of the Sentinel 2 Working Group is still that this collaborative effort will make surveying more efficient and lower the risk of less productive surveys.

| Site                    | Discovered | 1-6<br>(GE) | 1-6<br>(GE) | 3-6<br>(GE) | 5-6<br>(GE) | 6-6<br>(ODS) | 15-6<br>(ODS) | 2-7<br>(GE) | 5-7<br>(ODS) | 13-7<br>(GE) | 26-7<br>(GE) |
|-------------------------|------------|-------------|-------------|-------------|-------------|--------------|---------------|-------------|--------------|--------------|--------------|
| Sahl Kirke Ø            | 2008       |             |             | 0           | 0           |              |               | 0           |              |              | 0            |
| Bærsholm                | 2008       |             |             | 1           | 1           |              |               | 0           |              | 0            | 0            |
| Tradum N                | 2008       |             |             | 1           | 1           |              |               |             |              | 0            | 0            |
| Tradum S                | 2008       |             |             | 1           | 1           |              |               |             |              | 0            | 0            |
| Bjerregård,<br>Vridsted | 2008       |             |             | 1           | 1           | 1            |               |             |              | 1*           | 1*           |
| Sahl Kirke              | 2008       |             |             | 0           | 0           |              |               | 1           |              |              | 1            |
| Sahl Kirke V            | 2008       |             |             | 0           | 0           |              |               | 1           |              |              | 1            |
| Trevad                  | 2009       |             |             | 1           | 1           |              |               |             |              | 0            | 0            |
| Mølgård,<br>Jattrup     | 2009       |             |             | 1           | 1           | 1            |               |             |              |              | 1*           |
| Hvejnkjær               | 2009       |             |             | 1           | 1           |              |               |             |              |              | 1            |
| Stubberkloster          | 2009       |             |             | 1           | 1           |              |               |             |              |              | 1            |
| Sandhøj, Sahl           | 2010       |             |             | 1           | 1           |              |               | 0           |              |              | 0            |
| Agerbækgård             | 2010       |             |             | 1           | 1           |              |               | 0           |              |              | 1*           |
| Grønkær                 | 2010       |             | 1           | 1           |             |              | 1             | 1           |              | 1            | 0            |
| Stoholm<br>Vandværk     | 2010       | 1           | 1           | 1           |             | 1            |               |             |              | 1*           | 1*           |
| Hedegård,<br>Lånrum     | 2010       |             | 1           | 1           |             |              | 1             |             |              | 1*           | 0            |
| Fly Høje                | 2014       |             |             | 1           |             | 1            |               |             |              | 1*           | 0            |
| Nørregård,<br>Vridsted  | 2014       |             |             | 1           | 1           |              |               |             |              | 0            | 0            |
| Nørgård                 | 2017       | 1           |             | 1           | 1           | 1            |               | 1*          |              | 1*           | 1*           |
| Ørbækgård               | 2018       |             |             | 1           | 1           |              |               |             |              | 1*           | 1*           |
| Dåsbjerggård            | 2018       |             |             | 1           | 1           | 1            |               |             |              | 1*           | 1*           |
| Fly Vest                | 2018       | 1           |             | 1           | 1           |              |               | 1           |              | 0            | 0            |
| Hvidemose               | 2018       |             |             | 0           | 0           | 0            | 0             | 0           | 0            |              | 0            |
| Bavnehøje, Fly          | 2018       | 0           |             | 1           |             |              |               | 1*          |              | 1*           | 1*           |
| Nørre Sahl              | 2018       |             |             | 1           | 1           |              |               | 1           |              |              | 1            |

Table 1: Cropmark (1) or no cropmark (0) identified on vertical imagery from Google Earth (GE), and oblique observer directed surveys (ODS) during the period 1<sup>st</sup> May to 31<sup>st</sup> August 2018. In case of no data from the given fields are left blank. (1\*) symbolises yellow-on-yellow crop marks in fully matured crops.

Finally, I would like to thank AARG for funding two reconnaissance surveys this 2021-season as part of the Sentinel 2 Working Group. Both surveys were focused on collecting photos to compare with NDVI/MI trends from the 2018 studies. The hope is that this addition will strengthen our ability to interpret the index values to benefit our aerial archaeology community.

## The archaeological potential of KH-9 HEXAGON satellite photographs: examples from Southern England

Martin J. F. Fowler<sup>1</sup>

### Introduction

Five years ago, I described the archaeological potential of declassified high-resolution panoramic photographs acquired by KH-9 HEXAGON photoreconnaissance satellites (Fowler 2016). With a global coverage like that of CORONA, but with a higher spatial resolution, declassified HEXAGON photographs were seen to have a clear archaeological potential. However, at the time of writing in 2016, access to HEXAGON photographs was the limiting factor. Whilst coverage of the United States was available from the US Geological Survey (USGS) EarthExplorer website (<https://earthexplorer.usgs.gov/>), the process of seeing photographs of other areas was torturous and required a physical visit to the US National Archives and Records Administration in Maryland. Thus, until the access was improved, the HEXAGON photographs represented a latent resource for archaeological studies.

Since writing the article, my remote sensing interests have turned skywards to study transiting exoplanets using a robotic telescope, but that's a different story (e.g., Zellem *et al.*, 2020). However, over the past 5 years I have periodically checked the EarthExplorer website to see if there had been any changes to HEXAGON availability. On checking the site in March of this year, I was pleasantly surprised to find that worldwide photographs are now available online, either as downloads of existing scans or as new scans at a cost of US \$30 per frame, and at the time of writing ~6,900 photographs were available for download. In this article I provide examples of HEXAGON images of archaeological features from Southern England to illustrate the quality and potential of the photographs for archaeology.

### Coverage

The British Isles were photographed on 5 satellite passes between 1973 and 1976 (Figure 1A). The images are largely cloud-free, which is in marked contrast to earlier coverage by the CORONA satellites. Differences in swath width represent differences in the scan widths of the panoramic cameras, which can range from 30 to 120 degrees depending on the original mission requirements. Although the EarthExplorer website provides an indication of the coverage for each photograph frame as a ground footprint, this does not reflect the distortion because of the panoramic camera. This is illustrated in Figure 1B where the actual footprint of frame F015 taken by the forward-looking camera of Mission 1206-3 is compared with the EarthExplorer footprint and can be seen to have the characteristic 'bow tie' shape of a panoramic camera photograph. Whilst the EarthExplorer footprints provide a rough indication of coverage, the quality of the browse images of each frame available on the website are sufficiently good that they can confirm whether the frame includes the target area of interest.

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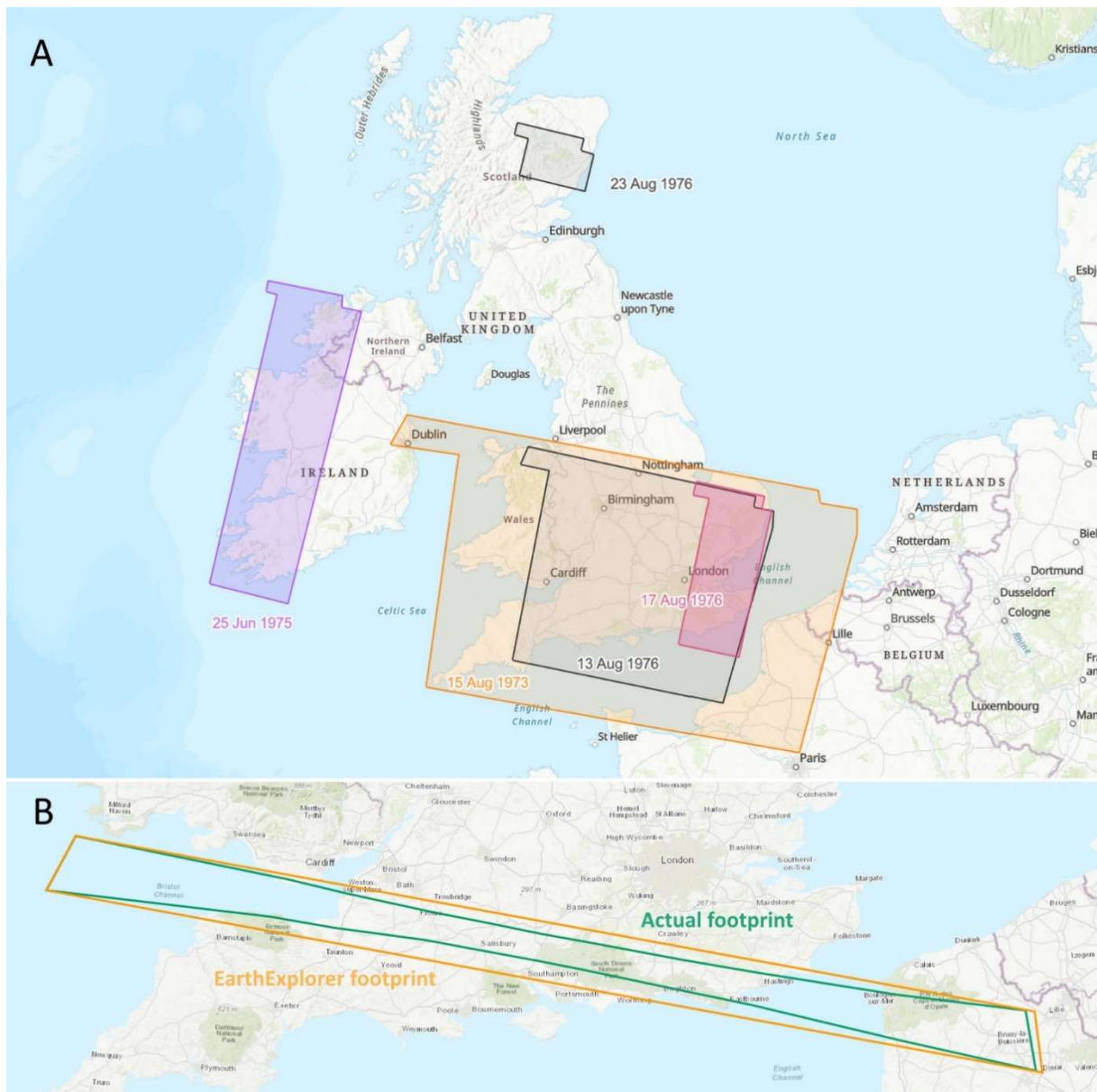
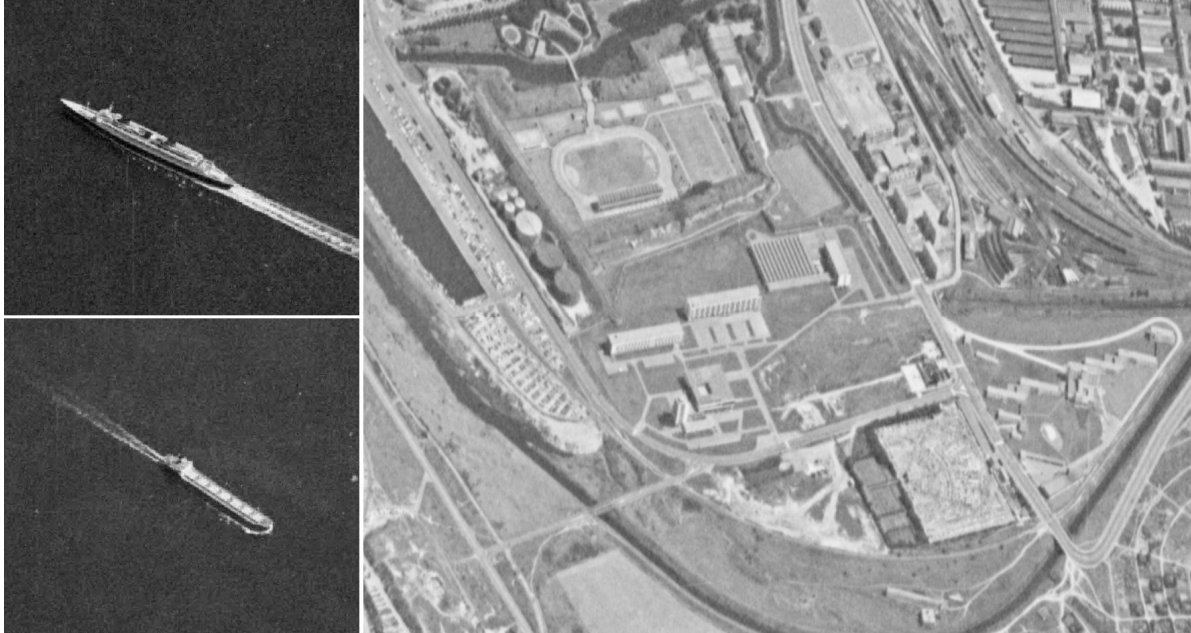


Figure 1. KH-9 HEXAGON ground coverage. A. Coverage of the British Isles. B. Comparison of the EarthExplorer footprint of frame F015 acquired by the forward-looking panoramic camera of Mission 1206-3 with the actual footprint derived from georeferencing snippets of the photograph using ArcGIS Earth. *ESRI Topographic base map: Esri, USGS | Esri UK, Esri, HERE, Garmin, FAO, NOAA, USGS.*

## Evaluation

Scans of four HEXAGON frames covering Southern England were purchased from the USGS to evaluate the archaeological potential of the panoramic camera photographs. The photographs had been taken by the forward-looking camera on Mission 1206-3 at 12:37 UTC on Wednesday 15 August 1973 and were provided as digital images scanned at a resolution of 7 microns (3,600 dpi). Each frame covers an area of approximately 13,400 km<sup>2</sup> and whilst the middle two-thirds of the frame are comparable to vertical aerial photographs, towards the ends of each frame, they are more akin to oblique photographs. This can be seen by the

oblique images of a passenger liner and bulk carrier transiting the Dover Strait, and buildings and storage tanks to the west of the port of Calais (Figure 2).



*Figure 2.* Extract from KH-9 HEXAGON panoramic camera photograph showing a passenger liner and freighter transiting the Dover Strait, and buildings and storage tanks to the west of the port of Calais, France. *Image courtesy of the US Geological Survey. Entity ID: entity ID: D3C1206-300341F013.*

In the following, four extracts from the HEXAGON photographs of Southern England are shown to illustrate the ability of the HEXAGON product to show both upstanding and plough-levelled archaeological features. The extracts have been chosen because they are within my local area and no attempt has been made so far to review systematically the complete photographs.

**Worthy Down.** Literally on my doorstep, Figure 3 shows plough-levelled archaeological features near the former airfield at Worthy Down near Winchester, Hampshire. I first observed the oval enclosure, which measures some 110 by 85m, on a Russian KVR-1000 satellite photograph over 20 years ago (Fowler 1999). Unfortunately, the digital KVR-1000 image has since been lost and so a direct comparison with the KH-9 photograph is no longer possible. Other plough-levelled features can be seen in the fields surrounding the village of South Wonston, just to the north of the airfield.

**Portchester Castle.** The upstanding remains of the Roman fort and later Norman castle at Portchester, Hampshire, present the opportunity to compare directly the appearance of the site on both CORONA and HEXAGON satellite photographs (Figure 4). The site was photographed by KH-4B CORONA mission 1104-2 on 17 August 1968 through a fortuitous break in the clouds and shows the upstanding walls of the Roman fort and the keep of the Norman castle. In comparison, the HEXAGON photograph is less grainy, has a higher spatial resolution, and shows the wall and bastions of the Roman fort more clearly, as well as the church of St Mary, in the south-eastern quadrant of the fort, which is difficult to interpret on the CORONA photograph.



Figure 3. Extract from KH-9 HEXAGON panoramic camera photograph covering Worthy Down, Hampshire. An oval enclosure can be seen in the centre of the image and other plough-leveled features can be seen in the surrounding fields. Image courtesy of the US Geological Survey. Entity ID: D3C1206-300341F015.



*Figure 4. Comparison of KH-4B CORONA and KH-9 HEXAGON panoramic camera photographs of Portchester Castle, Hampshire. Images courtesy of the US Geological Survey, entity IDs: DS1104-2156DA020 and D3C1206-300341F015.*

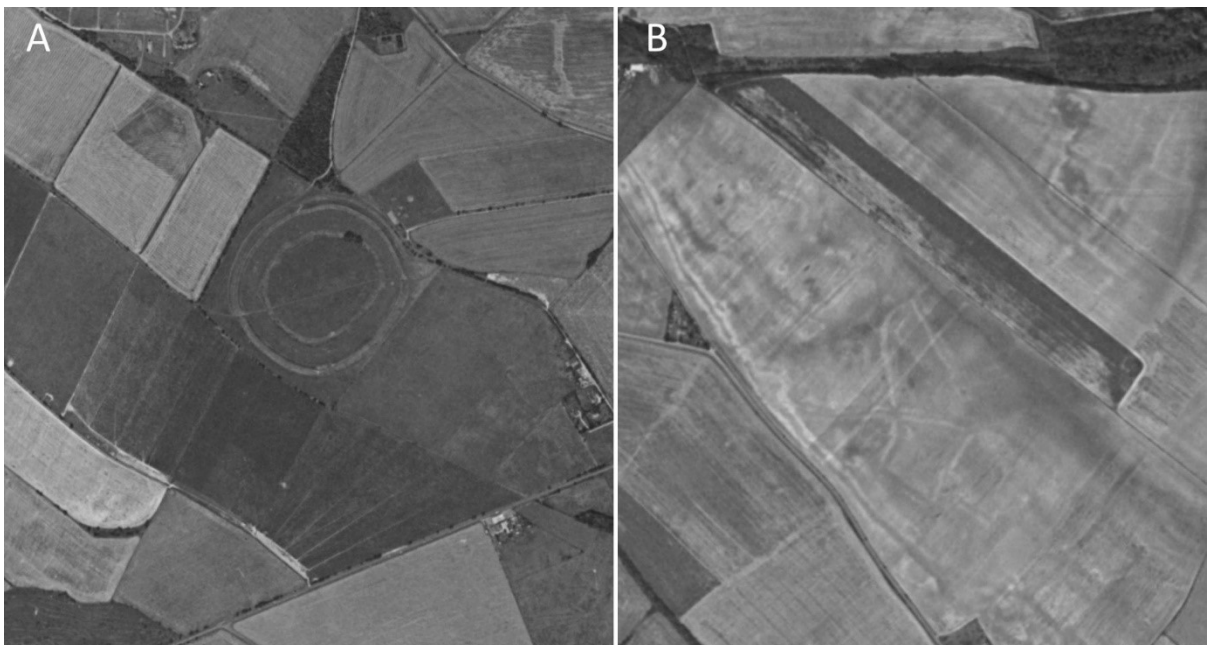
**Old Sarum and Figsbury Ring.** Figure 5 shows an extract from HEXAGON frame F016 covering the area to the west of Salisbury, Wiltshire. At Old Sarum the earthworks of the Iron Age hillfort and the later Norman motte-and-bailey castle can be seen in relief, as well as the high-contrast markings of the foundations of the cathedral on the grass of the outer bailey. Leading away from Old Sarum to the east, the course of the former Roman road to Winchester (RR45a) is clear as a linear feature that has become fossilized in the landscape as field boundaries and modern roads. At the eastern edge of the extract, and in the enlargement shown in Figure 6A, the slight univallate hillfort at Figsbury Ring and its inner Neolithic henge can be seen in relief. These are comparable to the appearance of the features on a KVR-1000 satellite photograph dating from June 1993 (Fowler 2002). In Figure 6B, the linear ditch running approximately north-south to the south of Figsbury Ring that was mapped by Rog Palmer from aerial photographs (Palmer 1984) can be seen together with other plough-levelled features. It is of note that the whole of the Rog's Danebury study area is covered by 4 HEXAGON frames (two forward-looking and two aft-looking) from Mission 1206-3 compared with the many hundreds of conventional aerial photographs that he used. Of course, the HEXAGON photographs cover only a single moment in time and thus are subject to the temporal variation of crop marked features with only a subset of the totality Rog observed being apparent.

**Fovant Badges.** Finally, Figure 7 shows the Fovant Badges, a set of regimental badges cut into the chalk hillside at Fovant Down, Wiltshire. The HEXAGON image has been draped over a digital elevation model using ArcGIS Earth and is viewed obliquely from the north. On the top of the hill, the sub-circular univallate Chiselbury Camp hillfort can be seen. The regimental badges were cut into the hillside by soldiers garrisoned nearby while waiting to go to France during the First World War and can be clearly seen as the white chalk gives a notable contrast to the grass of the hillside. This is quite a remarkable achievement, given that the photograph was taken by the camera on the satellite some 168 km away!





*Figure 5.* Extract from HEXAGON photograph covering the area to the west of Salisbury, Wiltshire. The earthworks of the Iron Age hillfort and the later Norman motte-and-bailey castle at Old Sarum and the hillfort and inner Neolithic henge at Figsbury Ring can be seen in relief on the left- and right-hand sides of the image, respectively. *Image courtesy of the US Geological Survey. Entity ID: entity ID: D3C1206-300341F016.*



*Figure 6.* The Iron Age hillfort and henge at Figsbury Ring (left) and the linear ditch and other plough-levelled features to the south of the hillfort (right). *Image courtesy of the US Geological Survey. Entity ID: entity ID: D3C1206-300341F016.*



Figure 7. Extract from a KH-9 HEXAGON panoramic camera photograph the Fovant Badges, Wiltshire, georeferenced and draped over a digital elevation model using ArcGIS Earth. Image courtesy of the US Geological Survey. Entity ID: entity ID: D3C1206-300341F016.

## Conclusions

From this brief study of HEXAGON photographs of Southern England, it is apparent that the satellite photographs have the potential to show both upstanding and plough-levelled archaeological features in the landscape. Compared with earlier CORONA photographs of the British Isles, which suffer from significant cloud cover, the HEXAGON products are mainly cloud free and provide snapshots of most of England and Wales, the west of Ireland and part of Scotland from over 40 years ago. Since their declassification in 1995, photographs taken by the CORONA photoreconnaissance programme have revolutionised the application of satellite remote sensing to archaeology (Casana 2020; Fowler 2013; Lasaponara *et al.* 2018). With a world-wide HEXAGON archive of over 2 million photographs, compared with approximately 800,000 photographs for CORONA, and a higher spatial resolution and greater proportion of cloud-free images, HEXAGON panoramic camera photographs have an archaeological potential that could surpass that of the photographs from the CORONA programme.

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## **Romas Jarockis – putting Polish-Lithuanian archaeological cooperation into international level**

Dariusz Krasnodębski<sup>1</sup> and Włodzimierz Rączkowski<sup>2</sup>

Writing research reports, creating monographs or theoretical considerations related to archaeology is our bread and butter, but sometimes we write about matters that go beyond our standard duties. And it's not easy. Almost exactly a year ago, on November 20th, 2020, Romas Jarockis, a Lithuanian archaeologist who was involved in the activities of AARG, as well as the history of cooperation between Lithuanian and Polish archaeologists, passed away.



Romas Jarockis (30.04.1963–20.11.2020). Photo: Pete Horne

Poland and Lithuania share a long common history. As far back as in the Middle Ages, both states created a political structure that built a commonwealth of interests and also gradually led to social integration. The collapse of Poland and Lithuania as a unified state at the end of the 18<sup>th</sup> century also initiated the process of social disintegration; later on, in the 19<sup>th</sup> century, it fuelled national disintegration as well. There were integrating elements in these processes (history, tradition, religion), but also disintegrating ones (like political interests). It was the politicians who often used ethnic tensions in building the national identities of Lithuanians and Poles. The peak of the conflict situation came at the end of World War I, when the great European powers fell and multiple nation-states emerged. Poland and Lithuania were reborn as independent states, but there was no longer any trace of the former cultural unity. Much animosity and bad emotions fuelled by politicians played an important factor in Polish-Lithuanian relations; it happened again after Lithuania regained independence as a result of the USSR's collapse. Fortunately, the actions of politicians do not

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always translate to the views of ordinary people who, regardless of the circumstances, were and still are able to build friendly and fruitful relationships.

It was in this context that Romas appeared in the orbit of our aerial-archaeology-related activities. Political changes in Central Europe opened many countries to initiatives emerging in Western Europe. One of them was promoting the development of aerial archaeology undertaken by AARG, and by Otto Braasch in particular. Lithuanian representatives probably did not attend the conference in Kleinmachnow in 1994, but they took part in the first aerial archaeology training project in Siófok-Kiliti/Ságvár (Hungary) in 1996. Romas Jarockis and Rimantas Žvirblis travelled from Lithuania via Poland and Slovakia to Hungary by train (!). How had the information about the training reached them? Perhaps via contact with Jan Norrman from Sweden, where Romas had studied for some time (Stockholm - 1994/1995). For many of us, their arrival at Siófok-Kiliti was a big surprise. Who among us back then knew anything about archaeologists from Lithuania? My [WR] closer relationship with Romas and Rimantas emerged... due to a need to give them a lift to the train station. Few people can imagine a well-built person such as Romas travelling in a Polish Fiat 126p!



Aerial Archaeology Training in Siófok-Kiliti (Hungary) in 1996. Romas – the tallest guy in third row

From 1996, aerial archaeology was constantly present in his scientific and organizational activities, although it was not their main theme. He used aerial photos in studies of settlement patterns and urbanization processes of the Iron Age and the Middle Ages periods in the southeast Baltic Sea region.

He undertook various initiatives to promote aerial photography in Lithuanian archaeology. Due to the cultural specificity of Lithuania's past and different soil and geomorphological conditions, British or German patterns were not directly transferable to

effective reconnaissance possibilities. Of course, the Scandinavian (Jan Norrman) and Polish experiences were important to him. The first step in this direction was a seminar he organized in Vilnius in April of 2001. It was combined with a flight... an unforgettable reconnaissance flight in a doorless Wilga, in which I [WR] took part with Chris Musson. It was hard to concentrate on the relics of the past! Previously, he took part in *NATO Advanced Research Workshop: Aerial Archaeology – developing future practice* in Leszno (November 15<sup>th</sup>-17<sup>th</sup>, 2000).

The contacts he established allowed him to join European projects (*European Landscapes: Past, Present & Future* in 2004-2007 and *ArchaeoLandscapes Europe* in 2010-2015). He was an active partner of them. As part of the *European Landscapes* project, he organized the *Aerial Photography & Coastal Cultural Heritage* conference in Klaipėda (November 17<sup>th</sup>-19<sup>th</sup>, 2005), which resulted in a publication titled *Past from the Air. Aerial archaeology and Landscape Studies in Northern Europe* (2007). On the other hand, as part of *ArcLand* and in cooperation with the German Archaeological Institute, he organized a Summer School called *Methods of non-invasive archaeology* (August 27<sup>th</sup>-31<sup>st</sup>, 2012) in Rambynas. Starting from 2017, we discussed organizing the AARG's Annual Conference in Lithuania.



Summer School *Methods of non-invasive archaeology* in Rambynas (2012).

Romas – sitting on the right in the first row

Aside from his many other things he did, he was also a specialist in medieval fortified settlements and castles on the border of the Kingdom of Poland and the Grand Duchy of Lithuania. As chance would have it, in 2013, at the Institute of Archaeology and Ethnology of the Polish Academy of Sciences, an idea was born to implement a research project related to recognizing the border between the Kingdom of Poland and the Grand Duchy of Lithuania at the turn of the 15<sup>th</sup> and 16<sup>th</sup> centuries. Romas was the person to whom I [DK] obviously

turned with a cooperation proposal. Later, we met in beautiful Druskininkai and decided on the scope of activities. However, it just so happened that the beginning of the grant coincided with major changes in Romas' professional life. In the same 2013, he became the deputy minister of culture in the Lithuanian government. Despite completely new obligations, the main assumptions of the joint project were achieved. On the Polish side, the stronghold in Suraz and the remains of the oldest brick church in north-eastern Poland were researched, while in Lithuania, investigations were carried out in the stronghold in Liškiava. A joint trip to the Kernave Cultural Reserve and a visit to Vilnius were undoubtedly unforgettable experiences. We were also planning a visit to the Curonian Spit, which we postponed until the next meeting in Lithuania...

It is a truism to say that face-to-face contact would make the world more beautiful and friendlier. We often forget about this simple truth and allow ourselves to be manipulated and driven into stereotypes and prejudices. As scientists, we have more opportunities to discuss with people of different views, and in fact, this is in line with our work. In our disputes as well as exchanges of thoughts and experiences, things like language, religion, race, or place of residence do not matter; scientific reliability and the knowledge we want to develop are the only really important aspects. It can be said that modern Europe, which grew out of the tradition of Greek and Roman philosophies, should fully support and understand such actions. We all want to be Europeans, and whether we are successful is a matter of debate. Romas, however, was definitely a true European and created friendly conditions for cooperation.

He had a unique ability to organize meetings combining the conditions of scientific discussion and... relaxing atmosphere. Certainly, the participants of the Klaipeda conference will not forget visits to the jazz club or trips to the snow-covered Curonian Spit (with an extraordinary view of Rog ... in his shoes!). During the Summer School in Rambynas there was also time for rest and informal discussions. We [DK, WR] believe that Pete Horne expressed it perfectly in his e-mail: [...] *[he] provided the perfect combination of relaxed enjoyment in great company whilst feeling you might be doing something useful.* We are so sorry we won't be seeing him again.



Time for work, time for rest and.... we know the direction. Romas during the Summer School *Methods of non-invasive archaeology* in Rambynas (2012)



Field trip to Curonian Spit, November 2005. L-R: Romas Jarockis, Rog Palmer (with shoes), Rimantas Žvirblis, Juris Urtans. Unknown photographer.



## Memories of Otto Braasch

*AARGnews asked for memories of Otto from those who had worked and flown with him. Two of these included formal and repetitive obituaries from which have been extracted the personal elements. A more formal offering closes this section and has been written by (geophysical) colleagues from Bavaria, the State in which he began his aerial photography.*

### **Martin Gojda (Czechia)**

During the 1990s I was in repeated personal contact with Otto who in 1992-93 arrived three (or four?) times to Czechia – once including J. K. St. Joseph on board of his Cessna (see the image taken at the airfield in Brno, Moravia - eastern half of the Czech Republic). During almost entire weekends which we spent in the small and noisy cockpit of the aircraft (each flight took no less than 3 hours, usually 4-5, which for me was then very tiring – especially during Otto’s frequently practiced sharp turns) I step by step absorbed principles on which a variety of activities during flight were based in those times (such as communication between pilot and archaeologist, detection, identification, photographic documentation, immediate hand-made mapping, writing important notes to a paper form, etc.). For me, his prospection ability was inscribed to my memory via an experience during one of our flights over an early spring Bohemian landscape. He recognized a cluster of several ploughed-out soil-marked prehistoric sunken features (in fact patches of irregular rather than rectangular plan) and interpreted them as pits datable to the early Neolithic period. He commented his exact dating by statement that the colour of the dark infill, relatively well visible on the background of the light coloured field surface when illuminated by sun during flying in a circle over the site - is apparently “metal bluish”, typical for that period. Well, next week I attended the field, localized the features and – to my surprise - collected large freshly ploughed-out Neolithic (and a few from later prehistory) pottery fragments.



Martin Gojda, Otto Brasch, J.K.St Joseph and 'Bravo Charlie' at the airfield in Brno, Moravia, in 1992 or 1993.

What I will never forget is a flight, which Otto kindly organized just for me in summer 1993, namely a two-day flight over Germany. We started from Karlovy Vary (Karlsbad) in western Bohemia and flew across Bavaria, Saxony, Brandenburg, Mecklenburg to the Baltic Sea island Rujana. The route was focused both on well visible crop sites (evidenced in previous weeks by Otto during his contract prospection flights) and on a variety of standing monuments (such as Slavic strongholds), historical towns, monasteries, archaeological open-air museums, etc. A collection of colour slides (recently scanned and transformed to digital format) has been deposited in the archive and repository of the Inst. of Archaeology, Czech Academy of Sciences and are occasionally displayed in exhibitions and used as illustrations in my publications.

**Visy Zsolt (Hungary)**

After 1989, Otto Braasch initiated flights and research in the former GDR and then in the countries of the former Eastern Bloc. This is how he got to our country. From 1994, he established a lasting relationship with the archeological unit of the University of Pécs, which can be said to have become perhaps the most significant in addition to his work in Germany. In 2002, the University of Pécs awarded him the title of Honorary Doctorate for his selfless support to the Department of Aeronautical Archeology in Hungary.

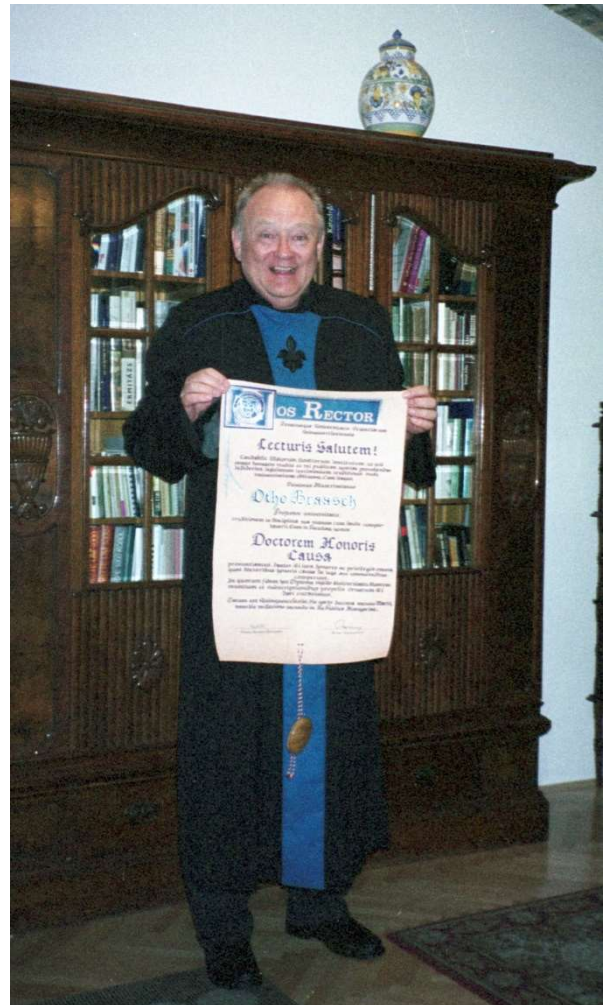
Otto Braasch made the entire material of his aerial photographs in Hungary for a decade and a half available to the aerial photography archive established at the Department of Ancient History and Archeology of the University of Pécs thanks to his close working relationship with the Department of Ancient History and Archeology of the University of Pécs. He made about 18,000 slides and handed them over to the Pécs Aerial Archeology Department. In Hungary, since 1994, he has performed 5-7 days of flights and photography several times a year. In doing so, he used his own aircraft, partly financing all the costs of the flights in Hungary, including the development of the slides. He mainly carried out a thorough mapping of the lines of Transdanubia, South-Eastern Hungary and the Danube and Tisza.

One of the organizers and instructors was Balaton-Kiliti in on June 15-22, 1996. The 1st Summer School of Aerial Photography was held in 2006, where 24 researchers from 10 countries were able to learn the basics of aerial photography.

In 1997-1998, he participated in the aeronautical research and conference program supported by the Raphael program, which was implemented with the participation of five countries, including Hungary (PTE Department of Ancient History and Archeology).

Between 2004 and 2006, he also participated in the international research supported by the Culture 2000 program, one of the partners of which was Hungary (Museums of Baranya County), and its external sponsor was the Pete Aerological Archeology Institute of PTE.

The cooperation did not stop after that. Based on the contractual cooperation with the Department of Aeronautical Archeology of the University of Pécs, it made thousands of recordings of the archaeological sites of Hungary for several weeks a year, and these recordings enriched the PLT collection in each case. PLT wanted to take part in the Transylvanian aerial archeological research (Dacia eastern limese) started in 2008, but this could not take place due to the complexity of the licensing in Romania.



Otto Braasch and his Honorary doctorate in 2002

***Anthony Crawshaw (England)***

I was saddened to hear of the death of my friend Otto Braasch.

I first met Otto at the 1984 Cambridge meeting, one of a series that preceded AARG. At these, and subsequent AARG meetings, Otto's presentations were the "stand-out" items and one of the main reasons for attending AARG. Otto's photography was outstanding and usually the 'best-in-show'. People may say that, given Otto's flying time, a high standard was to be expected but a photographer's eye was needed and Otto had that to a high degree.

I understand that Otto gained early flying experience with the fledgling post-WWII Luftwaffe, flying Lockheed Starfighters, a machine with handling qualities such that it earned the nickname "the widowmaker". Having survived service flying, and in civilian life, Otto's 172 was fitted with every available safety and navigation aid, which he used to good effect. Otto's airborne survey technique was a series of successive banks to left and right, which enabled him to look at the otherwise invisible area directly underneath the aircraft. Although this technique was efficient it necessitated an abundant supply of sickbags for passengers!

Despite Otto's thoroughly professional approach he was always prepared to share his expertise, as demonstrated by his many practical appearances at AARG training schools throughout Europe, which he helped organise. Unfortunately there seems to have been a disagreement between Otto and AARG, leading to his disappearance from AARG activities. To me this meant that we lost one of the great mentors of aerial archaeology, thus depriving subsequent generations of the inspiration and knowledge that I had benefited from. Is any squabble worth that?

Otto seemed happy to stretch rules that he felt to be detrimental to aerial archaeology; I understand that this may have occurred during his early trips to Italy with Derrick Riley. Such certainly happened during the Hungarian training school at Balaton where the authorities insisted in removing the student's films for processing and clearance by security personnel, before returning them for use in the school. Clearly the authorities did not envisage that the pilots would also be taking photographs, as they never asked for their films!

Otto was a big man, in every sense of the word. Otto himself must have had a big tank, as he fitted his aircraft with long-range fuel tanks, giving it a seven hour endurance. Apart from any considerations about the limits on pilot's hours, lesser men, such as myself, would have been sitting there cross-legged by then – Otto clearly wasn't, as a cross-legged pilot might have had difficulty flying the aircraft! Otto had a sense of humour and I well remember him telling me with glee that, when flying his aircraft to an AARG meeting in Britain, he had detoured to photograph the Cerne Abbas Giant. We will not see Otto's like again and, by his loss, we are diminished.

***Francesca Radcliffe (England and Italy)***

Read with great sadness the news of Otto's death.

I will always remember his great knowledge and kindness, and the unforgettable 'lunchtime flight' over Puglia in his magnificent flying machine. Bob Bewley was there too and I rashly declined his offer of the front seat near Otto. So after a while of bouncing cheerfully in the back seats I realised my mistake. But Otto seemed to have eyes at the back of his head and

immediately advised to look into the pocket in front of me and pick up the health restoring chewing gum.

Will always remember Otto and his great contribution to aerial archaeology.

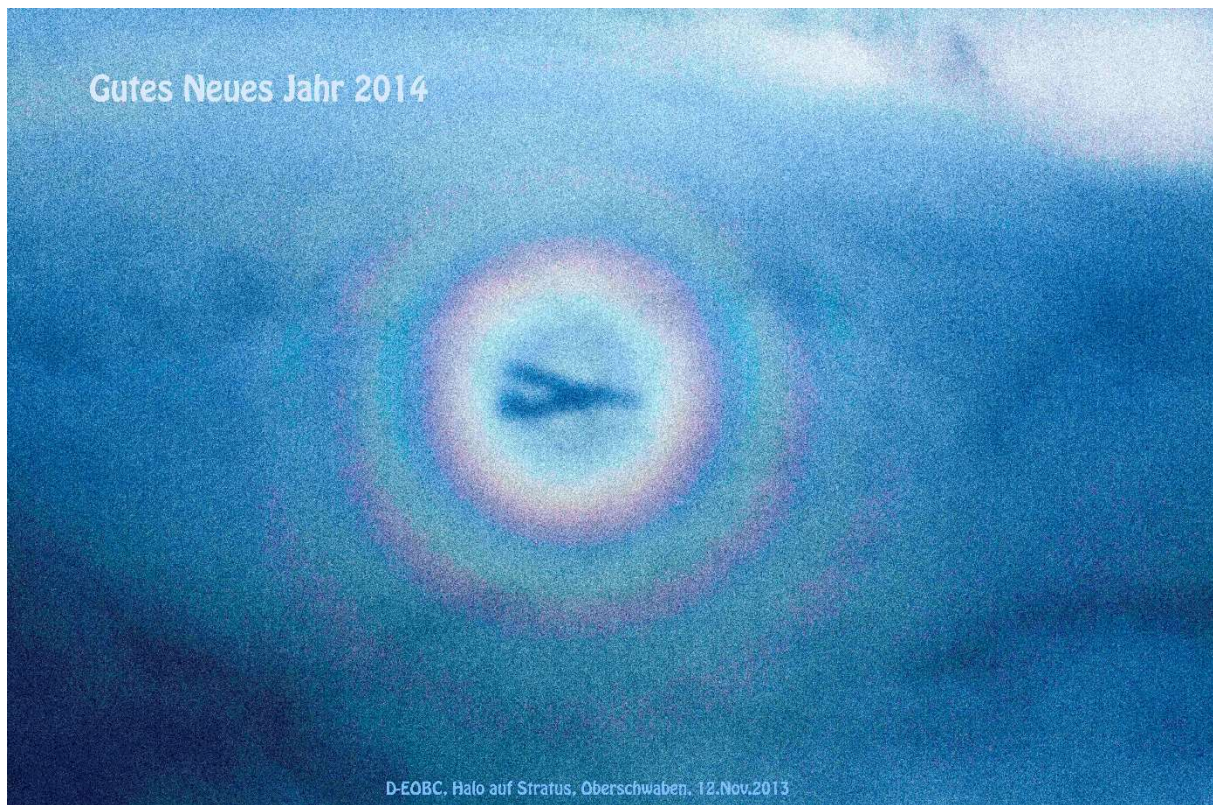
***Ioana Oltean (England and Romania)***

So sorry to hear about Otto! I remember him well of course from my very first aerial archaeology meetings in Pecs and Leszno. One of a kind.

***Carmen Bem (Romania)***

He was a legend for me ... I met him in 2005 first time. After that, in 2007 I flew with him and Darja in Italy. It was a wonderful flight in an Italian afternoon. He left the 'stick' and took many photos with his camera. It was a little scary for me, but Darja's laughter made me calm down.

R. I. P Otto...



## **Otto Braasch's first aerial archaeology mission in Hungary (1992): A belated thank you**

Zoltán Czajlik<sup>1</sup>

### **The background**

From the 1980s, when Hungary was behind the Iron Curtain, several research programmes involving aerial photography were carried out but their results and publications were largely unknown. While Zsolt Visy's *limes* researches (VISY, 1978, 1988) were familiar, we had less information about the Roman roads research programme of Endre Tóth and Vajk Cserményi (CSERMÉNYI – TÓTH 1984), István Zalai-Gaál's researches of the Neolithic rondels (ZALAI-GAÁL 1990), Zsuzsa Miklós's aerial archaeological investigations of the hillforts from 1990 (MIKLÓS 2007, 22), and György Csáky's aerial photos of Békés County (CUCARZI 1992, 20-23). With the exception of one or two images, György Csáky's results in the areas of Öcsöd – Kováshalom and Nagyrév, achieved in cooperation with Pál Raczky and József Laszlovszky from the Department of Archaeology at the Eötvös Loránd University, are rather overlooked. Not only the technological developments (photo technique, first GIS applications), but also the gradual easing of restrictions on aerial photography were in the background of the process. As far as we know from 1992 (until 2000) only obtaining permission subsequently from the military remained a task, providing a much better opportunity for the aerial photography for archaeological (and other civilian) purposes. The changing conditions paved the way for the researchers at the Department of Archaeology of Eötvös Loránd University (József Laszlovszky, Miklós Szabó and Pál Raczky) to start intensive aerial archaeology investigations. At the same time, it was clear that the professional competence, the technological and the financial background necessary for long-term projects were not available yet. The growing interest among Western European specialists in Central Europe became apparent as well. This way Miklós Szabó contacted René Goguey, and József Laszlovszky – with the help of Robert Bewley – Otto Braasch. Two missions in Hungary were organized by 1992, involving Pál Raczky and the author of this article, and ultimately the researches of Otto Braasch were carried out.

### **The mission**

Otto Braasch's first aerial archaeology campaign in Hungary took place between June 27 and 1 July, 1992, and its main airfield was in Budaörs, the former civil airport of Budapest. The Department of Archaeology at the Faculty of Arts of Eötvös Loránd University, that is the later Institute of Archaeological Sciences, organized the project and acquired the permits necessary. The flights departed from Budaörs with a radius of about 100-150 km, based on the capabilities of the Cessna aircraft. The main goal of Otto Braasch was to assess the country's physical characteristics, primarily in terms of cropmarks. He chose this time window to help the assessment, and based on our experiences of the last 30 years, it was highly successful choice. The photographs were taken with a Contax film camera, and the individual GPS waypoints (coordinates) were also documented in the researched area. The Institute of Archaeological Sciences received a copy(?) of all the black and white photographs on Kodak Technical Pan(?) films, the contact prints, the list of coordinates and 13x18 cm high resolution photos of particularly interesting archaeological sites.

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As the monoculture crop production needed for cropmark research is not typical to the north of Budapest, there were no flights in that area. Based on the data available, it is obvious that Otto

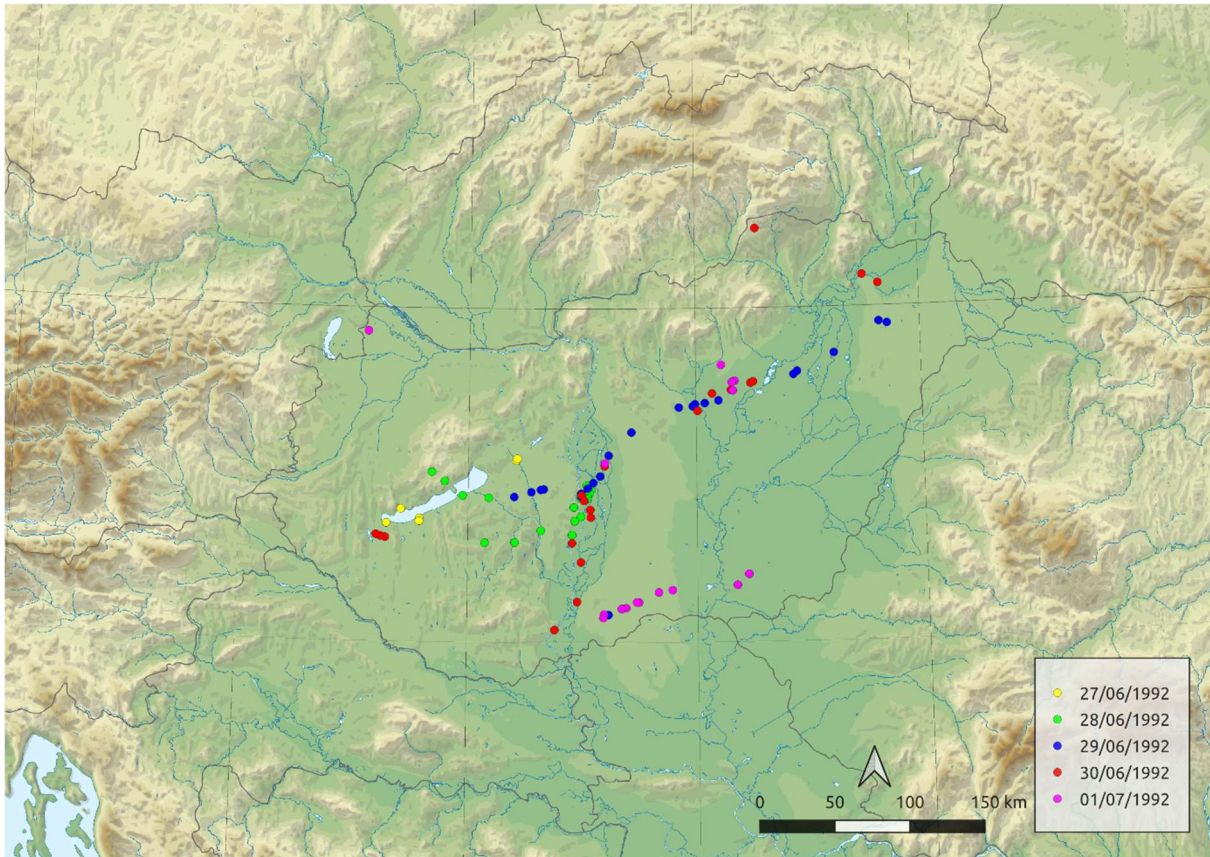


Fig. 1. The areas examined during Otto Braasch's first mission in Hungary, based on the data available (June 27 – July 1, 1992; Zoltán Czajlik – Ádám Marton, background map: © [Creative Commons Attribution-Share Alike 4.0 International](#))

Braasch conducted his research in three main directions; first at Lake Balaton, then along the Danube, and finally the region of Northeast Hungary (Fig. 1). He took two significantly different routes from these severally examined zones, as there are photographs of the eastern part of Southern Transdanubia and the southern part of the Danube-Tisza Interfluve too. It is likely that the year 1992 was average in terms of the amount of cropmark areas. However, in the areas to the south of Budapest along the Danube and to the south of the Mátra Mountains in Heves County (along the track of the later M3-motorway) more archaeological sites were identified, as shown by the multiple flights. The region had a large number of cropmarks, moreover they were proven to be of excellent quality. For example, numerous photographs were taken of the Sarmatian circular ditches with burials at Pély and Jászkisér. The one of Jászkisér was included in a later publication by Otto Braasch as well (BRAASCH 2003, 57). The impressive images showed incredible details and soon became famous. Thanks to this, the bird's eye view photograph of the Jászkisér cemetery was included in the cover of Valéria Kulcsár's monograph, published in 1998 (KULCSÁR 1998). The wide circular enclosure at Boconád (Fig. 2) was previously unknown, however, the field researches later on proved it to be a Bronze Age fortified settlement (NOVÁKI – BARÁZ 2000, 6). In the 2010s, a comprehensive research programme led by Csilla Farkas was launched at the archaeological site, and it included geophysical researches, excavation and environmental reconstruction (FARKAS et al. 2020, HARKÁNYINÉ SZÉKELY 2019). The latter in particular is a good

example on how important identifying sites with the help of aerial photography is, as it can set complex archaeological research programmes in motion.



Fig. 2. The Bronze Age fortified settlement at Boconád – Alatka-puszta (aerial photograph by Otto Braasch, July 1, 1992)

### **Conclusion**

We are certain that Otto Braasch deemed his 1992 mission successful, and, encouraged by it, he helped in organizing further regular campaigns. In 1993, he completed aerial archaeology flights organized by the Institute of Archaeology at the Faculty of Arts of Eötvös Loránd University, and from 1995, he continued his research in cooperation with the University of Pécs. Although, as mentioned in the introduction, Hungarian archaeologists already had significant practical experience and remarkable achievements, Otto Braasch's and, from 1993 onwards, René Goguéy's missions were extremely important for two reasons:

- we got to know the technology used in aerial archaeology, and the equipment that can be used to practice oblique aerial photography effectively for non-cartographic purposes;
- in addition, thanks to Otto Braasch from 1992 and, from 1993, to René Goguéy, the cropmark based investigations started in Hungary, where the focus was not on well-known sites or intensively examined micro-regions, but on large areas and their aerial archaeological reconnaissance.

Dear Otto, this belated short article honours the beginning of your missions. Besides your research for Eötvös Loránd University, we would like to thank you for your reliable publications, your helpful advice shared during conference breaks and your support for Hungarian archaeology! May your memory be a blessing!

### Acknowledgement

We would like to thank professors József Laszlovszky and Pál Raczky for their help and Rog Palmer for his important suggestions in writing this short study. The National Research, Development and Innovation Office's research programme Nr. 134635 supported the elaboration of the data.

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## A cautionary tale of a herring salad

Lidka Żuk<sup>1</sup>

My memories of Otto will weave through three short stories related to my first, middle and last flight with him. But they will not be presented strictly in a chronological order. More important here is what I have learnt from Otto and how I remember him. And the *crème de la crème* (literally) of this story is connected with the middle flight.

Like most aerial archaeologists, I met Otto during one of aerial workshops which were so enthusiastically organized across Europe at the turn of the millennium. In my case this was the Leszno workshop (1998) organized by Włodek Rączkowski to persuade local heritage officers about usefulness of aerial archaeology. With a group of students I was a ‘busy helper’, delivering films for development, cataloguing photos, etc. For our good behaviour we were offered a treat, a one-hour reconnaissance. This was my first flight ever. As it happened, I took it with Otto, unaware of what was waiting for me with his unique flying style. Others will probably remember the famous Hungarian (1996) ‘competition’ between pilots to make sick as many students as possible. Fortunately, during my first flight I was too excited to even consider being sick, despite Otto’s sharp turns and banks which were relocating my stomach much higher than it ought to be (fig. 1).



Fig. 1. Back on the solid ground after my first flight with Otto, white-greenish but apparently happy. Leszno, 7 July 1998 (photo: D. Krasnodębski).

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The last flight (2007) was the longest. Seven hours with a refuelling stop (and a nice lunch at a local airfield) took us as far as the largest open coal mine in Bełchatów (central Poland) and back to Poznań. Otto visited us for no other reason than to fly once again over his old haunts and to meet friends. I joined him and Włodek after a night-long wedding party and a few badly slept hours in a train. With demands of Otto's flying I ought to have dropped dead. Yet this was the most gentle flight I have ever had, sleeping like a baby on a front seat through its second half and not even once shaken by a sudden turn. Or was it because there was nothing to be seen and all we could do was to enjoy ourselves in the setting sun?

And that unforgettable flight in Barth. For three years (2005-2007) I was attending workshops *Bringing Air and Water Together* which were organized within the framework of the *European Landscapes: Past, Present and Future* project. Susanne Gerhard was the local organizer, Otto was in charge of the flying school while Dave MacLeod and myself shared responsibility for the ground school. One sunny day, while students were up flying, we decided to try a local speciality, a salted herring in a sour cream. After an enjoyable meal Susanne came and quite unexpectedly announced that Otto was waiting at the airfield to give tutors a three-hour-flight along the Baltic coast. He was enthusiastic and impatient to show us shipwrecks, the ruined pre-war Nazi summer resort of a truly totalitarian construction known as Prora and other wonders on the island of Rügen. All I could do in a hot and turbulent aircraft was to concentrate with all my might to keep the herring in its current location despite its desperate attempts to get back to the Baltic by the shortest route. How I wished then that I had a rice pudding instead! But I can proudly say that even in that moment of the worst trial, I survived and never used Otto's sick bags. I hope that those who flew with him can truly appreciate this achievement.

Otto taught me a passion for aerial archaeology that made me overcome my weaknesses. I will remember his keenness to demonstrate the power of aerial photography to newcomers and attempts to reveal a site at its best. All those tight circles with wings banked nearly vertically to catch the best view and Otto's broad smile when we were pointing at something on the ground, excited about 'discovering' a site. It was a passion and enthusiasm which I will always associate with flying. And a memorable lesson to never eat a herring salad if there is Otto-like enthusiast nearby to offer you the best treat sh/e can think of – a flight into the sun.

## Otto Braasch, an aerial archaeology pioneer

Roland Linck<sup>1</sup>, Jörg W.E. Fassbinder

Sad news for the AARG community: in the night to the 5th August 2021 Otto Braasch, one of the aerial archaeology pioneers in Germany, passed away at the age of 84 years in Lahr (Black Forest, Germany). Otto Braasch was born in 1936 in Kutenholz near Hamburg and has grown up in Cloppenburg (Lower Saxony, Germany). Since his early years, he was interested in historical remains, as he often told.

Already in 1956, when he was 20 years old, he acquired his glider pilot license and joined the newly founded German Air force two years later. During his officer's career, he was qualified as a tactical aircraft pilot on Starfighters and Phantoms. Some years later, in 1974, his second career as aerial archaeologist began, as he got interested in the historical remains in Southern Germany that he detected during his flights with small propeller machines at the weekends. His archaeological interest was further stimulated by his contact to Irwin Scollar, one of the pioneers in Archaeological Prospection in Germany.

In 1980, he left the air force as a Lieutenant Colonel to concentrate solely on aerial archaeology. Otto Braasch was an autodidact in the archaeological sciences; nevertheless, he managed to stand his ground in this topic. Between 1975 and 1989, Otto Braasch was aerial archaeologist for the Bavarian State Department of Monuments and Sites (BLfD). His work in cooperation with Rainer Christlein, the first field executive of the Landshut BLfD department, was the base for the BLfD's aerial archive, with nowadays more than 800,000 images one of the biggest archives of this kind worldwide. His new discoveries of aerial pictures formed not only the basis but was also the most important starting point for geophysical prospecting in Bavaria. Until the late years of his life, he provided the archaeological prospecting group of the BLfD with latest discoveries that he made during occasional flights to Landshut. Many of these pictures were the basis of the exhibitions *Blick unter die Erde* at the "Museum Reich der Kristalle" (Munich) in 2013 and *Unter Wiesen und Wadis - Archäologische Geophysik im Ries und anderswo* at the Ries-Krater Museum in Noerdlingen in 2014-2015.

After his work for the BLfD, he flew in different other German Federal Lands like Baden-Wuerttemberg and Saxony as well as many other countries mainly in the former Eastern Bloc. Among his most famous discoveries were the Roman fortress of Marktbreit (Bavaria), the Neolithic ring ditch of Goseck (Saxony-Anhalt) or the monumental Celtic burial mound at the Ipf (Baden-Wuerttemberg).

During his entire career as aerial archaeologist, he was in contact with scientist all over the world, especially in France and U.K. One of his most important concerns always was the training of junior scientists, like e.g. Klaus Leidorf, his successor at the BLfD, and Baoquan Song. Therefore, Otto Braasch circulated his enormous knowledge in aerial archaeology as a lecturer at the Ludwig-Maximilians-University Munich and the Humboldt-University Berlin and in a multitude of scientific publications and conferences. During his career, he published more than 100 articles in several scientific journals and books. Among these are his monographs, *Das unterirdische Bayern* (1982) and *Das unterirdische Baden-Württemberg* (1994). Even decades after his retirement, he published his work until the early 2000s. All of

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his published work proved that Otto Braasch was an excellent photographer and provided funded interpretations of the visible archaeological features. One of the most important facts he told all his students was that also the work at the ground in the office is important in aerial archaeological research: each flight hour needs eight hours for image processing. Due to his merits for the archaeological research, he was awarded with the honorary doctorate of the Freie Universität Berlin in 1999.

As long as possible, Otto Braasch was in the air for the search of new archaeological sites. After his pilot license was no longer extended due to health reasons, he still made aerial archaeological images as a passenger. Therefore, his interest in the aerial archaeology never disappeared. Otto Braasch's merits in the aerial archaeology in Germany and worldwide, especially his pioneering work, never will be forgotten.



Otto Braasch at the Conference “Pioneering in Archaeological Prospection” in Laa a.d. Taya (Austria) in October 2011 (© Photo by Roland Linck, BLfD).

*(The authors provided the cover photograph for this issue which, while not a ‘best’ or artistic image, was one of his earliest taken for the BLfD Aerial Archaeology Archive in July 1977.)*

## Cropmarks

Harvested by Rog Palmer<sup>1</sup>

*(web links were accessed on various dates between May 2021 and mid-October 2021)*

### **Aerial Archaeology Mapping Explorer (England)**

*From the press release:* ... Historic England has made the results of over 30 years' of aerial photograph mapping projects freely available online. The mapping allows all these features to be seen not just as individual sites, but as part of complex, multi-period landscapes. The map brings together the results of numerous projects undertaken ... since the late 1980s ...[and is based on] aerial photographs, ranging in date from the 1920s to the present [and] airborne laser scanning and web-based sources, such as Google Earth... Every site mapped has a simple description (FISH compliant) with links to the full Historic Environment records held online; for most of the areas mapped there is also a free report detailing the highlights and new discoveries encountered in each project.

This makes it sound quite boring but the web site is a tremendous resource on which the AP mapping can be seen against a range of backgrounds, an assortment of OS maps, a multitude of layers under the heading of 'world imagery' at various resolutions, the best of which seems to be 30cm. There is also 'high resolution aerial imagery' but that didn't show anything when I tried it and ALS background derived from 1m Environment Agency data. These give a useful range of backgrounds on which to visualise the mapped information and the links available by clicking the mapping make available data held by county HERs and also let you download the official HE reports. The website's map of project areas mixes the early ones that were drawn by hand with the more recent digital maps and (so far?) detailed mapping is available only for the digital projects. We can hope that, by showing the hand-drawn areas, there is the intention to digitise and add them to the website at a future date.

One thing that should be pointed out is that most of this mapping is quite old and may need updating if new sources have been acquired since its completion. The completion date, or the date span of the project, is the last entry in the Heritage Gateway record for each object and will give a date after which new material may have been acquired but was not consulted for mapping. This is of relevance to anyone thinking of using HE's mapping as showing the complete state of knowledge prior to development. This may not be so for any work older than 12 months, for which a search should be made to update (as necessary) from more recent images or those more recently made accessible (such as HEXAGON – see Martin Fowler, this issue).

<https://historicengland.org.uk/research/results/aerial-archaeology-mapping-explorer/>

### **ALS in Northumberland**

Northumberland is an upland part of England that has good potential for ALS and the National Trust recently announced using it to identify 120 archaeological sites on their Wallington Estate property from the 57 sq km ALS survey <sup>(1)</sup>. The note does not say whether

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the eastate is included in the scattered areas mapped by Historic England<sup>(2)</sup> so we can assume (perhaps) that these are new discoveries.

- (1) <https://www.nationaltrust.org.uk/press-release/national-trust-shines-a-light-on-the-cultural-landscape-to-get-the-right-trees-in-the-right-places>
- (2) <https://historicengland.org.uk/research/current/discover-and-understand/landscapes/south-east-northumberland-project/>

### **CropRadar**

Another website that offers to help precision farmers, identify crops and so on. It may be worth asking nicely if they'll help archaeologists identify crops.

<https://cropradar.digital/technology/>

### **Google Earth clearance?**

The release below suggests that GE may be in the process of deleting old layers. It's not clear whether these include timeline layers but these may seem outdated to Mr Google – so it may be useful to copy any old stuff that may be relevant to any projects you are working on.

(Google release dated 21 July 2021)

<https://support.google.com/earth/thread/117930184/new-layers-set-in-google-earth-pro>

### **Use of AI and satellite SAR to find stuff in UAE**

The 'stuff' seeming to be buried, or part buried – something that SAR can document. The source gives no clues how the AI comes into it. (From a press release.)

<https://www.ku.ac.ae/researchers-at-khalifa-universitys-engeos-lab-use-remote-sensing-and-machine-learning-to-find-potential-unexplored-archeological-sites-in-uae>

### **AI finds burial mounds in Galicia**

A claim that use of AI has identified some 9000 burial mounds in Galicia. Fieldwork to check some of them is planned for summer 2021. See *Books and papers of interest?*

[http://giap.icac.cat/2021/07/23/almost-9000-burial-mounds-detected-in-galicia-by-artificial-intelligence/?fbclid=IwAR2TD6xH-rvgct5IVAR5GIZYxScnxoU1JurfpIdd59zo-MrP06\\_0yS0dC9M](http://giap.icac.cat/2021/07/23/almost-9000-burial-mounds-detected-in-galicia-by-artificial-intelligence/?fbclid=IwAR2TD6xH-rvgct5IVAR5GIZYxScnxoU1JurfpIdd59zo-MrP06_0yS0dC9M)

### **Droning in Germany**

A website showcasing the work of Stefan Kluthe in the Munich area who seems to have been recording sites there since 2018.

(thanks to Simon Seyfried)

<http://www.bewuchsmerkmale.de/index.html>

### **Fire patterns from the air**

A long piece from ABC that includes use of vertical survey pics taken c1947 to show patterns of controlled hand burning of bush made by Karajarri people who left the desert area a few years later. The APs preserve evidence of fire management that probably has a very long history.

[https://www.abc.net.au/news/2021-05-11/historic-photos-guide-indigenous-burning-great-sandy-desert/100083720?utm\\_medium=social&utm\\_content=sf245753807&utm\\_campaign=fb\\_abc\\_news&utm\\_source=m.facebook.com&sf245753807=1&fbclid=IwAR0\\_WizmdKhPjobrLrvyotSMDpV2\\_2oVnUp5jdT68DOM1nt5IB188IncNG4](https://www.abc.net.au/news/2021-05-11/historic-photos-guide-indigenous-burning-great-sandy-desert/100083720?utm_medium=social&utm_content=sf245753807&utm_campaign=fb_abc_news&utm_source=m.facebook.com&sf245753807=1&fbclid=IwAR0_WizmdKhPjobrLrvyotSMDpV2_2oVnUp5jdT68DOM1nt5IB188IncNG4)

### **Check your crop marks**

Deepfake satellite images were recently noted by geographers. Someone had put structures from one country into another. It's relatively easy to do and I guess it's even easier to move crop-marked sites from one field to another if you want to upset developers or get an unloved colleague to excavate in the wrong place.

<https://www.theverge.com/2021/4/27/22403741/deepfake-geography-satellite-imagery-ai-generated-fakes-threat>

### **US drone + archaeology site**

Maybe of interest to droners among the AARG community although the links didn't go anywhere when I tried (October 2021).

<https://dronearchaeology.com/>

## Books and papers of interest?

Rog Palmer<sup>1</sup>

*There is so much relevant or vaguely-relevant stuff being churned out now that the following are usually little more than titles, links, and bits of the published abstracts. They're in approximate chronological order of publication.*

Golden, C.; Scherer, A.K., Schroder, W., Murtha, T., Morell-Hart, S., et al., 2021. Airborne Lidar Survey, Density-Based Clustering, and Ancient Maya Settlement in the Upper Usumacinta River Region of Mexico and Guatemala. *Remote Sens.* 2021, 13, 4109. <https://doi.org/10.3390/rs13204109>

*Abstract:* We present results from the archaeological analysis of 331 km<sup>2</sup> of high-resolution airborne lidar data collected in the Upper Usumacinta River basin of Mexico and Guatemala. Multiple visualizations of the DEM and multi-spectral data from four lidar transects crossing the Classic period (AD 350–900) Maya kingdoms centered on the sites of Piedras Negras, La Mar, and Lacanja Tzeltal permitted the identification of ancient settlement and associated features of agricultural infrastructure. HDBSCAN (hierarchical density-based clustering of applications with noise) cluster analysis was applied to the distribution of ancient structures to define urban, peri-urban, sub-urban, and rural settlement zones. Interpretations of these remotely sensed data are informed by decades of ground-based archaeological survey and excavations, as well as a rich historical record drawn from inscribed stone monuments. Our results demonstrate that these neighboring kingdoms in three adjacent valleys exhibit divergent patterns of structure clustering and low-density urbanism, distributions of agricultural infrastructure, and economic practices during the Classic period. Beyond meeting basic subsistence needs, agricultural production in multiple areas permitted surpluses likely for the purposes of tribute, taxation, and marketing. More broadly, this research highlights the strengths of HDBSCAN to the archaeological study of settlement distributions when compared to more commonly applied methods of density-based cluster analysis.

Berganzo-Besga, I., Orengo, H.A., Lumbreras, F., Carerro-Pazos, M., Fonte, J. and Vilas-Estévez, B., 2021. Hybrid MSRM-Based Deep Learning and Multitemporal Sentinel 2-Based Machine Learning Algorithm Detects Near 10k Archaeological Tumuli in North-Western Iberia. *Remote Sens.* 2021, 13, 4181. <https://doi.org/10.3390/rs13204181>

Further proof that AI can detect round mounds. With all these dead people under their mounds, an important research question is to find where their occupants previously lived and what they did.

*From the abstract:* This paper presents an algorithm for large-scale automatic detection of burial mounds, one of the most common types of archaeological sites globally, using LiDAR and multispectral satellite data. ... Our proposed approach combines random forest for soil classification using multitemporal multispectral Sentinel-2 data and a deep learning model using YOLOv3 on LiDAR data previously pre-processed using a multi-scale relief model. The resulting algorithm significantly improves previous attempts with a detection rate of 89.5%, an average precision of 66.75%, a recall

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value of 0.64 and a precision of 0.97, which allowed, with a small set of training data, the detection of 10,527 burial mounds over an area of near 30,000 km<sup>2</sup>, the largest in which such an approach has ever been applied. The open code and platforms employed to develop the algorithm allow this method to be applied anywhere LiDAR data or high-resolution digital terrain models are available.

Vasily Novikov, 2021. Experience of UAV-based aerial laser scanning in the forest and forest-steppe zones of the European part of Russia. Preliminary results of the work. *Archaeology and Geoinformatics* Volume 10.

Those of you who want to follow up Vasily's talk for AARG this year may be able to track down this paper (I couldn't) which summarises work and results between 2018 and 2020 at 20 area sites in Smolensk, Tver, Moscow, Penza, Vladimir, Tula regions and Krasnodar Krai.

Parcero-Oubiña, C. and Nión-Álvarez, S., 2021. Forms of settlement inequality over space. A GIS-based method for measuring differences among settlements. *Journal of Archaeological Science: Reports* 35: 102739. DOI: [10.1016/j.jasrep.2020.102739](https://doi.org/10.1016/j.jasrep.2020.102739)

Aerial photographs and ALS provided settlement samples for this project.

*From the abstract:* ... The case study deals with settlements in the NW Iberian Peninsula dating from the Iron Age, towards the end of which different economies of power existed, implying different forms of social complexity and different uses of material culture and architecture to create and express them. We describe a method to measure the relative importance of two alternative forms of building and expressing settlement inequality: one based on population size and the other based on the display of elaborate complexes of defensive earthworks. By quantifying and comparing three variables (extension of settlement areas, percentage of total area occupied by defensive earthworks and effort invested in their construction), some basic statistical indicators were obtained, suggesting a systematic pattern for our study area: size-based differences in some sectors, and differences expressed mostly through defensive monumentality in others.

Grzegorz Kiarszys, 2021. A Nuclear Generator of Clouds: Accidents and Radioactive Contamination Identified on Declassified Satellite Photographs in the Mayak Chemical Combine, Southern Urals. *Cambridge Archaeological Journal*. doi:[10.1017/S0959774321000494](https://doi.org/10.1017/S0959774321000494)

A tale of detection that shows where analysis of images can lead you – and it even got picked up by *Nature*: <https://www.nature.com/articles/d41586-021-02756-4>

*From the abstract:* ... This paper aims to present the research potential of declassified Cold War intelligence records for archaeological landscape studies of off-limits military sites. To outline a somewhat broader perspective, I will combine those sources with contemporary historical knowledge and modern remote sensing data. The analysis will be focused on the Central Intelligence Agency [CIA] satellite imagery (CORONA and GAMBIT) from the 1960s to the beginning of the 1970s. The discussed sources recorded outcomes of nuclear disasters, hundreds of square kilometres of uninhabited wasteland, abandoned villages, disappearing lakes, dying forests, diverted rivers, and other features related to this clandestine plutonium facility.

Fonte, J.; Meunier, E.; Gonçalves, J.A.; Dias, F.; Lima, A.; Gonçalves-Seco, L. and Figueiredo, E., 2021. An Integrated Remote-Sensing and GIS Approach for Mapping Past Tin Mining Landscapes in Northwest Iberia. *Remote Sens.* 2021, 13, 3434. <https://doi.org/10.3390/rs13173434>

Use of ALS and historic aerial photographs to identify and map ancient tin mining remains in the Tinto valley, Portugal.

João Fonte, Jose Manuel Costa-García & Manuel Gago, 2021. O Penedo dos Lobos: Roman military activity in the uplands of the Galician Massif (Northwest Iberia), *Journal of Conflict Archaeology*, <https://doi.org/10.1080/15740773.2021.1980757>

Roman camp initially identified on ALS from the Instituto Geográfico Nacional and processed using endless visualisations. Follow-up fieldwork provided a late 1<sup>st</sup> century BC date.

Lancaster, J., 2021. Testing a Low-Cost Application of Thermal Remote Sensing. *Academia Letters*, Article 340. <https://doi.org/10.20935/AL340>

A poorly-conceived experiment to test thermal imaging from a drone. Needs doing properly. Štular, B., Eichert, S., Lozić, E., 2021. Airborne LiDAR Point Cloud Processing for Archaeology. Pipeline and QGIS Toolbox. *Remote Sens.* 13, 3225. <https://doi.org/10.3390/rs13163225>

*Abstract:* The use of topographic airborne LiDAR data has become an essential part of archaeological prospection. However, as a step towards theoretically aware, impactful, and reproducible research, a more rigorous and transparent method of data processing is required. To this end, we set out to create a processing pipeline for archaeology-specific point cloud processing and derivation of products that are optimized for general-purpose data. The proposed pipeline improves on ground and building point cloud classification. The main area of innovation in the proposed pipeline is raster grid interpolation. We have improved the state-of-the-art by introducing a hybrid interpolation technique that combines inverse distance weighting with a triangulated irregular network with linear interpolation. State-of-the-art solutions for enhanced visualizations are included and essential metadata and paradata are also generated. In addition, we have introduced a QGIS plug-in that implements the pipeline as a one-step process. It reduces the manual workload by 75 to 90 percent and requires no special skills other than a general familiarity with the QGIS environment. It is intended that the pipeline and tool will contribute to the white-boxing of archaeology-specific airborne LiDAR data processing. In discussion, the role of data processing in the knowledge production process is explored.

Tapete, D.; Traviglia, A.; Delpozzo, E. and Cigna, F., 2021. Regional-Scale Systematic Mapping of Archaeological Mounds and Detection of Looting Using COSMO-SkyMed High Resolution DEM and Satellite Imagery. *Remote Sens.* 2021, 13, 3106. <https://doi.org/10.3390/rs13163106>

*From the abstract:* ... the 3 m resolution imaging capability allowed by the Italian Space Agency's COSMO-SkyMed Synthetic Aperture Radar (SAR) constellation in StripMap HIMAGE mode was used in this study to generate DEM products of enhanced resolution to undertake, for the first time, a

systematic mapping of tells and archaeological deposits... in the Governorate of Wasit in central Iraq ... the COSMO-SkyMed DEM proves capable to detect both well preserved and levelled or disturbed tells, standing out for more than 4 m from the surrounding landscape. ... integration with CORONA KH-4B tiles, 1950s Soviet maps and recent Sentinel-2 multispectral images ... led to localization of tens of sites that were not previously mapped, alongside the computation of a figure as up-to-date as February 2019 of the survived tells, with those affected by looting. ... The change detection tests undertaken on selected clusters of disturbed tells prove how a dedicated monitoring activity may allow a regular observation of the impacts due to anthropogenic disturbance (e.g., road and canal constructions or ploughing).

Roland Linck and Tatjana Gericke, 2021. Everything Archeology?, *ArcheoSciences*, 45-1, 295-299. <https://doi.org/10.4000/archeosciences.10220> This will become open access in January 2023.

A short note giving three case studies of photo reading to show that not all things on aerial photographs are archaeological. The note shows the hazards of making decisions based on a single image, or images of only one date and shows the value of looking at all available images and chatting to the farmer. We must all expect to make mistakes of interpretation, sometimes never corrected, and these case studies give useful examples.

[Thanks to Darja Grosman for buying and sharing this note in advance of its freedom.]

Anna I. Zalewska and Grzegorz Kiarszys, 2021. The forgotten Eastern Front: dealing with the social and archaeological legacies of the Battle of the Rawka and Bzura Rivers (1914–1915), central Poland. *Antiquity* 2021, Research Article. <https://doi.org/10.15184/aqy.2021.134>

Resulting from the 2020-2021 project, *Archaeology of the Eastern Front of the Great War and the Legacy of Armed Conflicts as a Cognitive, Social and Curatorial Challenge*, this is perhaps of more interest for military historians than aerial people but is noted here because of the use of ALS and aerial photographs to identify and map components of the Eastern Front in a case study area that remains rich in upstanding remains as well as decaying equipment and personal possessions.

Justin St P. Walsh<sup>1</sup> & Alice C. Gorman, 2021. A method for space archaeology research: the International Space Station Archaeological Project. *Antiquity* 2021, Method Article. <https://doi.org/10.15184/aqy.2021.114>

Included in *AARGnews* for the definition: Space archaeology is defined as the study of ‘the material culture relevant to space exploration that is found on Earth and in outer space (i.e. exoatmospheric material) and that is clearly the result of human behavior’ (Gorman, A.C. and B.L. O’Leary. 2013. The archaeology of space exploration, in P. Graves-Brown, R. Harrison & A. Piccini (ed.) *The Oxford handbook of the archaeology of the contemporary world*: 409–24. Oxford: Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199602001.013.040>)

Jan M. Waga & Maria Fajer, 2021. The heritage of the Second World War: bombing in the forests and wetlands of the Koźle Basin. *Antiquity* 2021 Vol. 95 (380): 417–434. <https://doi.org/10.15184/aqy.2020.154>

During WW2, the USAF targeted fuel plants in the Koźle Basin in S Poland with a variety of ordnance. Mapping bomb craters from ALS data led to classification via crater size of bomb weight and type. The area is suggested to be worthy of official protection.

Verschoof-van der Vaart, W. B., & Lambers, K., 2021. Applying automated object detection in archaeological practice: A case study from the southern Netherlands. *Archaeological Prospection*, 1–17. <https://doi.org/10.1002/arp.1833>

*Based on the abstract:* Use of an automated detection tool, WODAN, to detect barrows and Celtic fields in LiDAR data from the Dutch Midden-Limburg area.

Titolo, A., 2021. Use of Time-Series NDWI to Monitor Emerging Archaeological Sites: Case Studies from Iraqi Artificial Reservoirs. *Remote Sens.* 2021, 13, 786. <https://doi.org/10.3390/rs13040786>

Use of NDWI from lowish resolution satellites (Landsat 2-8 and Sentinel 2) to examine whether, and when, known sites are submerged or not.

Abate, N.; Frisetti, A.; Marazzi, F.; Masini, N. and Lasaponara, R., 2021. Multitemporal–Multispectral UAS Surveys for Archaeological Research: The Case Study of San Vincenzo Al Volturno (Molise, Italy). *Remote Sens.* 2021, 13, 2719. <https://doi.org/10.3390/rs13142719>

*From the abstract:* ... This work shows data acquired by multitemporal and multispectral aerial surveys in the archaeological site of San Vincenzo al Volturno (Molise, Italy)... one of the most important medieval archaeological sites in the world... an area not accessible to archaeological excavation has been investigated... a method based on spectral and radiometric enhancement techniques combined with a selective principal component analysis was used for the identification of useful information.

Hugh Thomas, Melissa A. Kennedy, Matthew Dalton, Jane McMahon, David Boyer & Rebecca Repper, 2021. The mustatils: cult and monumentality in Neolithic north-western Arabia. *Antiquity* 2021 Vol. 95 (381): 605–626. <https://doi.org/10.15184/aqy.2021.51>

Some results from the Aerial Archaeology in the Kingdom of Saudi Arabia AIUla project, commissioned by the Royal Commission for AIUla. The project utilises publicly-available satellite imagery (Google Earth/Bing Maps) to perform systematic surveys of AIUla and Khaybar, an area covering 40,000 sq.km., followed by selective helicopter and ground surveys to photograph and investigate the identified structures. Mustatils are one of the range of stone monuments in Arabia and recent fieldwork allows them to be interpreted as ritual installations dating back to the late sixth millennium BC, with recent excavations revealing the earliest evidence for a cattle cult. Examination of satellite sources has identified 641 mustatils of which over 350 have been photographed from the air.

Carlo Oetheimer and Yohann Oetheimer, 2021. New enigmatic geoglyphs in the Indian Thar Desert: The largest graphic realizations of mankind? *Archaeological Research in Asia* 27 (2021), 1-11. <https://doi.org/10.1016/j.ara.2021.100290>

*From the abstract:* A meticulous survey of the Indian Thar Desert with Google Earth led us to identify eight sites in the Jaisalmer District, with clear geometrical lines that may resemble geoglyphs. The data collected in the field, together with images taken by a drone, revealed the exceptional character of the graphic patterns near the village of Boha. ... these lines may be at least 150 years old and possibly linked to the Hindu memorial stones surrounding them.

Marlize Lombard<sup>1</sup> & Matt G. Lotter<sup>1</sup> & Jaco van der Walt<sup>1</sup> & Matthew V. Caruana, 2021. The Keimoes kite landscape of the trans-Gariep, South Africa. *Archaeological and Anthropological Sciences* (2021) 13:90. <https://doi.org/10.1007/s12520-021-01328-x>

Recently discovered desert kites in South Africa are examined in terms of landscape-based data derived from ALS which enabled comparison of the morphometric and topographic characteristics of the individual kite funnels.

Geert Verhoeven, Dave Cowley and Arianna Traviglia (eds), 2021. Archaeological Remote Sensing in the 21st Century: (Re)Defining Practice and Theory. *Remote Sens Special issue*. [https://www.mdpi.com/journal/remotesensing/special\\_issues/21archaeological\\_rs](https://www.mdpi.com/journal/remotesensing/special_issues/21archaeological_rs)

A collection of papers that ‘...aims to contribute to the exploration of developing practice and theory in remote sensing archaeology for the 21st century.’. Most were previously published individually and noted in recent issues of *AARGnews*. You can also buy it as a printed book for £56.09.

Fiz, I.; Cuesta, R.; Subias, E. and Martin, P.M., 2021. Tests with SAR Images of the PAZ Platform Applied to the Archaeological Site of Clunia (Burgos, Spain). *Remote Sens*. 2021, 13, 2344. <https://doi.org/10.3390/rs13122344>

The authors conclude that current SAR images must be used with other sources (MS optical and/or thermal) to be of any use.

Filzwieser, R.; Ivanišević, V.; Verhoeven, G.J.; Gugl, C.; Löcker, K.; Bugarski, I.; Schiel, H.; Wallner, M.; Trinks, I.; Trausmuth, T.; et al. 2021. Integrating Geophysical and Photographic Data to Visualize the Quarried Structures of the Roman Town of *Bassianae*. *Remote Sens*. 2021, 13, 2384. <https://doi.org/10.3390/rs13122384>

*From the abstract:* Large parts of the urban layout of the abandoned Roman town of *Bassianae* (in present day Serbia) are still discernible on the surface today due to the deliberate and targeted quarrying of the Roman foundations. In 2014, all of the town's intramural (and some extramural) areas were surveyed using aerial photography, ground-penetrating radar, and magnetometry to analyze the site's topography and to map remaining buried structures. The surveys showed a strong

agreement between the digital surface model derived from the aerial photographs and the geophysical prospection data.

Bollas, N., Kokinou, E. and Polychronos, V., 2021. Comparison of Sentinel-2 and UAV Multispectral Data for Use in Precision Agriculture: An Application from Northern Greece. *Drones* 2021, 5, 35. <https://doi.org/10.3390/drones5020035>

Nothing to do with archaeology but perhaps of interest to those hoping to use free image sources or UAV surveys to predict good times to flying or obtaining high resolution images. Both gave comparable results so if you have a drone you may not need a satellite and *vice versa*.

Lombard, M., Lotter, M.G., van der Walt, J. *et al.*, 2021. The Keimoes kite landscape of the trans-Gariep, South Africa. *Archaeol Anthropol Sci* 13, 90 (2021). <https://doi.org/10.1007/s12520-021-01328-x>

This is a Springer publication and requires money to access the full article.

*From the abstract:* ... recently discovered desert kites of South Africa ... derived from LiDAR scanning ... enable us to compare the morphometric and topographic characteristics of the individual kite funnels. ... least-cost-path analysis, and use both older and younger ethno-historical and ethno-archaeological observations ... help understand possible animal and human interaction with the Keimoes kite landscape. Our results highlight the hunters' understanding of animal behaviours and migration patterns, and the minimum requirements for funnel construction. We show that all the sites were constructed within 2 km of seasonal water pans, and that elevation relative to the surrounding landscape was key to the placement of the kites. We further found that the Keimoes kite landscape was probably one of complex inter-connectedness, with dynamic human land-use patterns interlaced with concepts of inheritable custodianship across generations. The Keimoes kite funnels are most similar to those of the Negev Desert in the Levant, and demonstrate ... that southern African hunter-gatherers in arid regions intentionally modified their landscape to optimise the harvesting of ungulates such as migrating gazelle—in this case the local, desert-adapted Springbok. Our landscape approach provides a nuanced understanding of these features within the southern African context.

Davis, D. 2021. Theoretical Repositioning of Automated Remote Sensing Archaeology: Shifting from Features to Ephemeral Landscapes. *Journal of Computer Applications in Archaeology*, 4(1), 94–109. DOI: <https://doi.org/10.5334/jcaa.72>

A year or two ago, this bloke was using AI to find circles which he continues to do in the next paper. Here he reviews its potential to find our landscapes.

*From the abstract:* Automated remote sensing has made substantial breakthroughs for archaeological investigation. Over the past 20 years, the reliability of these methods has vastly improved, and the total number of practitioners has been increasing. Nonetheless, much of the work conducted, to date, focuses almost exclusively on specific topographic features and monumental architecture, ignoring the potential of automation to readily assess more ephemeral components of

the archaeological record. Likewise, the emphasis on specific feature types overlooks broader landscape patterns, thus delegating automated remote sensing analysis as a method in and of itself, mostly disconnected from larger archaeological and anthropological investigations. Here, I review recent attempts to rectify this shortcoming by using automated analysis methods to record and explain ephemeral archaeological material distributions. While such research is limited, I argue that the successes achieved in these recent studies offer a pathway forward for automated remote sensing to become more fully integrated with archaeological work beyond the detection of specific topographically distinct features.

Dylan S. Davis, Gino Caspari, Carl P. Lipo and Matthew C. Sanger, 2021. Deep learning reveals extent of Archaic Native American shell-ring building practices. *Journal of Archaeological Science* 132. <https://doi.org/10.1016/j.jas.2021.105433>

*From the abstract:*

In the mid-Holocene (5000 - 3000 cal B.P.), Native American groups constructed shell rings, a type of circular midden, in coastal areas of the American Southeast. ... only about 50 such rings have been documented to date. Recent work using automated LiDAR analysis demonstrates that many more shell rings likely exist than are currently recorded in state archaeological databases. Here, we use deep learning ... to detect shell ring deposits and identify their geographic range in LiDAR data from South Carolina. We corroborate our results using synthetic aperture radar (SAR), multispectral data, and a random forest analysis. We conclude that a greater number of shell rings exist and that their distribution expanded further north than currently documented.

Štular, B., Lozić, E. and Eichert, S., 2021. Airborne LiDAR-Derived Digital Elevation Model for Archaeology. *Remote Sens.* **2021**, *13*, 1855. <https://doi.org/10.3390/rs13091855>

This seems to be recommending use of an archaeology-specific DFM (digital feature model) to give confidence when using ALS in archaeological surveys, especially of building remains.

*From the abstract:* ... little attention has been paid to the key element of processing: an archaeology-specific DEM. Accordingly, the aim of this paper is to describe an archaeology-specific DEM in detail, provide a tool for its automatic precision assessment, and determine the appropriate grid resolution. ... We introduce a confidence map (QGIS plug-in) that assigns a confidence level to each grid cell. ... which is useful for detecting data bias in archaeological interpretation. Confidence mapping is also an effective tool for identifying the optimal grid resolution for specific datasets. Beyond archaeological applications, the confidence map provides clear criteria for segmentation, which is one of the unsolved problems of DEM interpolation. All of these are important steps towards the general methodological maturity of airborne LiDAR in archaeology....

Ringle WM, Gallareta Negrón T, May Ciau R, Seligson KE, Fernandez-Diaz JC and Ortegón Zapata D, 2021. Lidar survey of ancient Maya settlement in the Puuc region of Yucatan, Mexico. *PLoS ONE* 16(4): e0249314. <https://doi.org/10.1371/journal.pone.0249314>

A survey in which ALS has been used to answer archaeological questions rather than just to find stuff.

*From the abstract:* ... This contribution presents a substantial lidar dataset from the Puuc region of Yucatan, Mexico, a cultural subregion of the ancient Maya and a distinct physiographic zone within the Yucatan peninsula. Despite the high density of known sites ... little is known about intersite demography. Lidar technology allows determination of settlement distribution for the first time, showing that population was elevated but nucleated, although without any evidence of defensive features. Population estimates suggest a region among the most densely settled within the Maya lowlands, though hinterland levels are modest. Lacking natural bodies of surface water, the ancient Puuc inhabitants relied upon various storage technologies, primarily *chultuns* (cisterns) and *aguadas* (natural or modified reservoirs for potable water). Both are visible in the lidar imagery, allowing calculation of *aguada* capacities .... The imagery also demonstrates an intensive and widespread stone working industry. Ovens visible in the imagery were probably used for the production of lime, used for construction purposes and perhaps also as a softening agent for maize. Quarries can also be discerned, including in some cases substantial portions of entire hills. With respect to agriculture, terrain classification permits identification of patches of prime cultivable land and calculation of their extents. Lidar imagery also provides the first unequivocal evidence for terracing in the Puuc, indeed in all northern Yucatan. Finally, several types of civic architecture and architectural complexes are visible, including four large acropolises probably dating to the Middle Formative period (700–450 B. C.). Later instances of civic architecture include numerous Early Puuc Civic Complexes, suggesting a common form of civic organization at the beginning of the Late Classic demographic surge, (A.D. 600–750).

Oula Seitsonen and Janne Ikäheimo, 2021. Detecting Archaeological Features with Airborne Laser Scanning in the Alpine Tundra of Sápmi, Northern Finland. *Remote Sens.* 2021, 13, 1599. <https://doi.org/10.3390/rs13081599>

*From the abstract:* ... we present the first results of applying this newly available ALS material [5 points/m<sup>2</sup>] for archaeological studies. Finnish LIDARK consortium has initiated the development of semi-automated approaches for visualizing, detecting, and analyzing archaeological features with this new dataset. Our first case studies are situated in the Alpine tundra environment of Sápmi in northern Finland, and the assessed archaeological features range from prehistoric sites to indigenous Sámi reindeer herding features and Second World War-era German military structures. Already the initial analyses of the new ALS-5p data show their huge potential for locating, mapping, and assessing archaeological material.

Nabil Bachagha, Lei Luo, Xinyuan Wang, Nicola Masini, Tababi Moussa, Houcine Khatteli and Rosa Lasaponara, 2020. Mapping the Roman Water Supply System of the Wadi el Melah Valley in Gafsa, Tunisia, Using Remote Sensing. *Sustainability* 12, 567; [doi:10.3390/su12020567](https://doi.org/10.3390/su12020567)

*From the abstract:* ... investigations conducted using multi-spectral satellite remote-sensing data of the ancient canal systems of the Wadi el Melah Valley (WMV) in southern Tunisia. ... describes the use of GeoEye-1 and Ziyuan-3 satellite remote-sensing data to reveal ancient Roman canals, which were part of an advanced hydraulic system devised to capture runoff water and cope with the lack of water in the area.

Cohen, A, et al. 2020. Ethics in Archaeological Lidar. *Journal of Computer Applications in Archaeology*, 3(1), pp. 76–91. DOI: <https://doi.org/10.5334/jcaa.48>

I'm not really sure what this article is trying to say unless it is 'share your data'. The abstract offers a small clue: We draw on our collective experiences to propose a range of improvements in



how we collect, use, and share lidar data, and we argue that as lidar acquisitions mature we are well positioned to produce ethical, impactful, and reproducible research using the technique.

Diofantos G. Hadjimitsis, Kyriacos Themistocleous, Branka Cuca, Athos Agapiou, Vasiliki Lysandrou, Rosa Lasaponara, Nicola Masini and Gunter Schreier (ed), 2020. *Remote Sensing for Archaeology and Cultural Landscapes: Best Practices and Perspectives Across Europe and the Middle East*. Springer. ISBN 978-3-030-10978-3. ISBN 978-3-030-10979-0 (eBook). <https://doi.org/10.1007/978-3-030-10979-0>

Full of theories, equations and image manipulation with little useful archaeological outcome.

*From the Preface:* This book aims to investigate the potential value that satellite technologies and remote sensing could provide for a more sustainable mapping, monitoring, and management of heritage sites, be it for purposes of regular maintenance or for risk mitigation in case of natural or man-caused hazards.

Michael Kempf, 2019. The application of GIS and satellite imagery in archaeological land-use reconstruction: A predictive model? *Journal of Archaeological Science: Reports* 25 (2019) 116–128 <https://doi.org/10.1016/j.jasrep.2019.03.035>

This seems to be working from the theory that absence of evidence really does mean evidence of absence to some heritage organisations. Use of various satellite image types aims to counter this absence but without telling us what is meant by an archaeological site.

*From the abstract:* Landscape reconstructions are subject to multiple filters [but] are the basis for scientific interpretations of the archaeological record. The resulting distribution maps in turn serve to create archaeological maps for the prediction of areas with a high archaeological vulnerability potential. This predictive modelling also leads to the classification of archaeological-free areas. However, the fact that this spatial classification was created on the basis of an archaeological database, which in turn is strongly biased by find densities in modern agglomerations, leads to the potential destruction of archaeological monuments that are located in the invulnerable periphery. Such potential maps can only be sharpened by integrating a large number of different methodical concepts. This article presents the comprehensive combination of satellite remote sensing data, GIS-based landscape analyses and environmental data sets for the construction of a potentially *holistic* landscape scenario. Only with the highest possible information density of a large-scale study area can interactions in the geographical control factors be identified and conclusions be drawn on archaeological land-use and settlement concepts.

Nadia Khalaf & Timothy Insoll (2019). Monitoring Islamic Archaeological Landscapes in Ethiopia Using Open Source Satellite Imagery, *Journal of Field Archaeology*, DOI: [10.1080/00934690.2019.1629256](https://doi.org/10.1080/00934690.2019.1629256)

*From the abstract:* ... This paper explores how satellite imagery, in particular open source imagery (Google Earth, multispectral satellite imagery from Landsat and Sentinel-2), can be utilized to monitor and protect sites that are already known with particular reference to Islamic archaeological

sites in Ethiopia. The four sites used are in different geographic and geomorphological areas: three on the Somali Plateau (Harlaa, Harar, and Sheikh Hussein), and one on the edge of the Afar Depression (Nora), and have varied histories. The results indicate that open source satellite imagery offers a mechanism for evaluating site status and conservation over time at a large scale, and can be used on data from other areas of Africa by heritage professionals in the African continent at no cost.

Michele M, Alessio C, Gabriele F, Andrea G, Giuseppe M., 2019. Multispectral satellite imagery processing to recognize the archaeological features: The NW part of Mount Etna (Sicily, Italy). *Math Meth Appl Sci.* 2019;1–7. <https://doi.org/10.1002/mma.5990>

*From the abstract:* ... a new GIS-based procedure to retrieve archaeological elements using satellite remote sensing. The processing of multispectral satellite images consists in a pre-processing phase using the pan-sharpening technique to improve the spatial quality and in the exploitation of linear equations of the initial spectral bands with the aim of generating accurate and precise raster data that can be used as input for an object classification. The proposed methodology has been tested in an archaeological area located on the north-west flank of Etna volcano (Sicily, Italy).

Rosa Cuesta, Ignacio Fiz, Eva Subias, Francesc Tuset and Miguel Ángel de la Iglesia, 2019. Hydraulic and urban management during Roman times based on GIS and remote sensing analysis (Clunia, Spain). *Revista d'Arqueologia de Ponent* 29, 123-146. DOI. [10.21001/rap.2019.29.4](https://doi.org/10.21001/rap.2019.29.4)

*From the abstract:* ... The suitability of the city's location is evident by the fact it was built on a plateau concealing an underground karst cave that provided direct access to water without requiring major engineering works. This study provides an overview of the modern drainage systems in order to study more profoundly the forms of urban organization, on which we have only partial knowledge currently, given the breadth of the field. We believe that some of these drains are actually tracks of ancient streets that have been fossilized in orography. To reach these conclusions, we analysed several IR photographs, and applied hydrological GIS functions to observe the path of these tracks and their relationship to what is currently known of the city's urban layout. This analysis of the surface was completed by relating it to the karst topography by conducting geophysical surveys in areas where wells giving access to the cave were detected using radiolocation. Finally, we applied a range of hydrological GIS functions and indexes on a high-resolution DEM, obtained from LIDAR technology (5 m/pixel), to confirm how the drainage worked.

## The Aerial Archaeology Research Group

AARG sees the aerial perspective as integral to the pursuit of key questions in archaeology and heritage, including landscape character, long term landscape change, human ecodynamics, and the experience of place. We are a community of heritage professionals, researchers, students and independent scholars dedicated to education, research and outreach initiatives involving the acquisition and application of data from airborne platforms. AARG provides opportunities for networking, mentorship, and exchanges of ideas on theories, methods and technologies related to aerial archaeology. The organization supports an annual conference, workshops, training schools, and publications.

Membership is open to all who have an interest or practical involvement in aerial archaeology, remote sensing and landscape studies.

AARG is a registered charity: number SC 023162.

**AARG homepage.** <https://a-a-r-g.eu/>

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**Student scholarships.** AARG has a limited number of student scholarships for attendance at its annual meeting. These are aimed at supporting bona fide students and young researchers who are interested in aerial topics and may wish to attend.

Anyone wishing to apply should write to AARG's Chairman ([aargchair@gmail.com](mailto:aargchair@gmail.com)) with information about their interests in archaeology and aerial archaeology, as well as their place of study. The annual closing date for applications to the annual AARG conference is mid-May. Other meetings for which scholarships may be available will be advertised on an ad hoc basis. Support for conference attendance may also come from the Riley Fund (see elsewhere, this issue).