In memory of Prof. Arnold Aspinall

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ISAP NEWS

The newsletter of the International Society for Archaeological Prospection

Contents

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Editor's Note – Robert Fry

It is extremely sad news to report another loss to the ISAP community since the last newsletter. Prof. Arnold Aspinall was instrumental in the development of archaeological geophysics as a discipline in England, and his legacy within the subject has influenced the profession on a worldwide scale.

Speaking as a past student from the Bradford MSc. in Archaeological Prospection, I especially remember visiting Arnold's garden on our first fieldwork trip. I wonder how many past students, now in professional geophysics all over the world, have surveyed that land, and gained valuable insights from his wise words.

It is perhaps a tribute to Arnold that once again, the newsletter is packed with enthusiastic articles, demonstrating that the discipline is thriving. News of our 500th ISAP member back in March; is testament to this. This issue of ISAP News is dedicated to the memory of Arnold, who will undoubtedly be missed by all who knew, and were inspired by him.

*A huge thank you to all who have found the time to contribute to the newsletter, it is always fascinating to hear about the work you are involved with. Please send any contributions or queries for the next newsletter (ISAP News 36) to r.j.fry@student.bradford.ac.uk by the **31st July 2013**. All entries are gratefully received; I will always try to respond to emails in the same day if possible.*

Important Notices

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Obituary for Arnold Aspinall

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Prefaced by Chris Gaffney

For the second Newsletter running I have to preface an obituary for one of our Honorary Members. Arnold Aspinall was a friend and inspirational figure to many and whose death was a sadness for all who had met him. I was interviewed by Arnold in 1979 for a place on his undergraduate Archaeological Science course. When I arrived in his office I found a clean and tidy chap in a suit and tie - a million miles away from the field archaeologists that I had met on summer excavations. Strangely it was those 'diggers' who pointed me towards Bradford; on first sight it was not clear why. Quickly it became apparent that beneath that formal façade was a kind man who cared about his (potential) students. Like many others I came away from the 'interview' feeling that he had persuaded me to come to Bradford and not that I had to convince him to take me. The decision to come to Bradford was not one that many were to regret. If you read the tributes to Arnold on the ISAP webpage you will find that he treated everyone with courtesy; the description of '…old world charm, dry wit and strong intellect…' is one comment. The words below from Armin Schmidt perfectly capture a man who was at ease with himself and easy with other people.

Arnold Aspinall: educator, inspirer and friend.

Dr Chris Gaffney, Chairman ISAP

Prof. Arnold Aspinall, who has died aged 86, will be missed for many things. But having inspired a generation of archaeologists to take up archaeological geophysics and other archaeological sciences will be his most lasting legacy. All students of archaeology in the UK are nowadays exposed to a good measure of archaeological sciences and probably even some hands-on geophysical field practice. That these topics have become part of the archaeological 'mainstream' in the UK is in large parts due to Arnold's foresight. Being a scientist himself with a deep interest (and understanding) of archaeology he knew that the gap between archaeology and the sciences has to be bridged and so he introduced the intriguingly named 'Master of Arts in Scientific Methods of Archaeology' at the University of Bradford in 1973. His students developed the most widely used archaeological geophysical instruments (Roger Walker with Geoscan Research) and set up the first archaeological geophysical survey company (John Gater and Chris Gaffney with GSB Prospection) that led to TV stardom in the form of Time Team.

Arnold studied physics at University College, London and undertook his postgraduate research at Manchester University's Jodrell Bank Radio Telescope with Professor Sir Bernard Lovell. He then became Lecturer in Applied Physics at Bradford Technical College (later to become the University of Bradford) where Prof. Gordon Brown's nuclear physics group started applying neutron activation analysis (NAA) to archaeological samples. Arnold and Gordon Brown established an archaeometry research group in 1962 and were joined by Stanley Warren, characterising and provenancing archaeological samples. Arnold soon realised that the entrenched divide between 'white-coat scientists' and 'woolly-jumper archaeologists' was a considerable hindrance to achieving outcomes and therefore established the MA in Scientific Methods of Archaeology to teach archaeologists about the potential and limitations of scientific techniques. This was followed in

1974 by the first BSc in Archaeological Sciences, leading to the transformation of the physics department into the Department of Archaeological Sciences, with Arnold as its first Head. Since then many other universities have followed suite and now include some scientific investigations as part of their archaeology degrees.

Arnold's own research interests gradually shifted away from neutron activation analysis towards archaeological geophysics. By influencing the design of the early fluxgate gradiometers built by Plessy, Littlemoor and Philpot, the ground that he could cover with magnetometer surveys increased. This led to challenges with the display of resulting data and the superintendent technician, Jim Pocock, commented that he was actually meant to do other things than spending hours creating dot density plots by hand. Nevertheless, he produced beautiful plots, including one of the hillfort at Thwing (a collaboration project with Terry Manby), which adorned the first few volumes of the journal *Archaeological Prospection* and the original of which I passed on to current research students, reminding them of how much easier data presentation now is. Arnold experimented with displaying single grids on oscilloscopes (he was a physicist, after all) from which he took Polaroid shots that could then be assembled to represent the whole survey area on a wall. But the breakthrough came with the Epson HX-20 portable computer that allowed data logging in the field, computerised processing of single grids and printing the results on dot-matrix printers (Kelly *et al.* 1984). Arnold's foresight of having added computer sciences to the Department proved again extremely advantageous for this research (in 1983 John Haigh organised the CAA conference in Bradford).

Investigating a new ERI system at Fountains Abbey

In 1970 Arnold published a paper with John Lynam, one of his research students, which introduced the 'twin-probe' earth resistance array to the archaeological geophysics community (Aspinall & Lynam 1970). Lynam's theoretical analysis showed the suitability of this configuration for shallow archaeological investigations, and its lightweight operation (having to move only two electrodes) made it very popular for fieldwork. The instrument was initially designed for Induced Polarisation measurements with non-polarising electrodes made of Tufnol and conducting gel. Although very clear IP results were collected with this system, the hollow electrodes broke too often to be suitable for larger surveys and were therefore replaced with steel electrodes for earth resistance measurements. For the rapid recording of these readings the Bradphys resistance meter was developed in the University's electronics workshop in 1970 and delivered to archaeologists as far afield as Mexico and Canada. Even in 1999 I received an enquiry from a company in Vancouver that wanted to interface their old Bradphys to a digital data logger. Arnold restarted research on IP measurements with his research students Susan Ovenden and Colin Heathcote, while Chris Gaffney evaluated the use of other electrode configurations for archaeological prospection.

In addition to magnetic and electrical methods, Arnold also investigated the potential of electromagnetic methods for archaeology. His research students Roger Walker and David Skinner were tasked with building field-ready instruments for frequency-domain and time-domain investigations, respectively. When Arnold, after his retirement, discovered a commercial metal detector that resembled the same 'banjo design' that these earlier instruments had used he restarted his research and evaluation, applying it to the Towton Battlefield with Tim Sutherland. Arnold also influenced the early developments of GPR in archaeology, especially through his links with York. Peter Addyman recalls how disappointed he was when Arnold dampened his initial excitement about the potential of GPR in urban archaeology (Stove & Addyman 1989). Needless to say that Arnold was right and that far more development work was needed to achieve the GPR results that we are now used to.

Despite all these technical improvements in archaeological geophysics Arnold always maintained that these techniques had to be *useful* for archaeological research, demonstrating that he had become a real 'archaeological scientist'. He had a keen interest in history from the start, but was a Lancastrian. And that was (is...) a problem in Yorkshire. So he attended archaeology evening classes in Leeds and built excellent links with local history groups, the York Archaeological Trust and the Yorkshire Archaeological Society. While his geophysical contributions to international archaeological projects were essential for popularising the benefits of geophysical methods, it was the fruitful collaboration with local groups that allowed him to 'embed' these techniques into everyday archaeological practice. Not only were new instruments tested and adapted, but he also found ways of communicating geophysical results to archaeologists. His departmental archaeological colleagues Rick Jones and John Hunter, amongst others, were a great help in overcoming the still existing 'language barriers'. For field-testing Arnold also made his garden at Manor Vale available, and the cesspit under his main lawn has been surveyed with virtually every geophysical technique; not to mention the various pigs that were buried in his back garden to provide forensic examples.

Arnold knew about the importance of engaging with archaeologists, partly from serving on the funding board of the Science-based Archaeology Committee but also out of his own firm belief in the benefits of interdisciplinary work. In the early 1990s he launched four important initiatives. He developed, together with Cathy Batt, a specialised MSc in Archaeological Prospection (first intake of students in 1994); a new journal, *Archaeological Prospection*, with Arnold and Mark Pollard as editors (the first issue in 1994); a new dedicated research and lecturing post in archaeological geophysics at the Department of Archaeological Sciences (my appointment in 1994); and a series of International Conferences on Archaeological Prospection (first conference in 1995 in Bradford). It was an amazing time to join the Department.

When Arnold retired from the University his work was continued by students and friends, guided by his principles of interdisciplinary inquiry, respect for other people's views and advancement of archaeological geophysics. Whether this was for Geoscan Research to develop new instruments specifically tailored to archaeological geophysics; for GSB Prospection to undertake high-quality geophysical surveys and popularise archaeological geophysics by developing a particular Time Team approach to TV presentation; or for the Department of Archaeological Sciences to undertake research and teaching in archaeological geophysics. Not to mention the many students who became 'better archaeologists' having been encouraged and inspired throughout their studies in Bradford by Arnold. For his many contributions to archaeological sciences he was awarded an Honorary DSc by the University of Sheffield in 1994 and an Honorary Professorship by the University of Bradford in 2006. He became one of the first five Honorary Members of ISAP in 2004. After his retirement, Arnold maintained close links with the University of Bradford and continued his research, for example with earth resistance experiments in the laboratory's deep water tank (Aspinall & Crummett 1997; Aspinall & Saunders 2005). His insistence on the correct usage of important terminology also informed his last book, on magnetometer techniques (Aspinall *et al.* 2008), for example through the clear distinction between dipolar and bipolar magnetic anomalies, a useful concept that continues to make data interpretation easier to understand.

Over the years, working with local groups and community archaeologists, Arnold had become increasingly interested in dowsing. Does it work and if so why and for what? As a physicist he applied trial and error methods himself and always had some dowsing rods in his car using them occasionally whilst students undertook the magnetometer surveys. We had interesting discussions about experiments that compared the flipped periodicity of dowsing amplitudes between England and New Zealand and Arnold was even asked to continue that research in his own garden, but declined. He solicited Martijn Van Leusen's paper on dowsing in archaeology for *Archaeological Prospection* (1998) and showed a keen interest in the editorial process. It certainly was a topic that kept him bemused and he used it, to great effect, in his lecture on 1st of

April 2000 during the Bradford reunion conference.

As much as Arnold's scientific approach to archaeology was admired it was his quiet authority, depth of knowledge, genuine kindness and wry humour that made him such a special person. Many people were touched by his friendship and insightful personal comments; he was a true gentleman. Never one to interfere in other people's business, it was clear that on those rare occasions when he offered advice one better take notice. Several former students reported how they found their ways after 'a quiet word' from Arnold.

In his garden at Manor Vale

And his wonderful garden. Arnold was passionate about gardening and had an amazing insight into plants and how to get the best out of them. He could visit garden centres for hours and spending time in (and with) his garden was a wonderful balance that he had found to the otherwise sometimes dry scientific enquiries. He enjoyed talking about gardening, for example with my wife; but when I once started a conversation about his amazing Rhododendron plants he just gave me that wry Arnold look, patted me on the back and said "it's no good talking to *you* about gardening".

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A page on the ISAP website has been set up to the memory of Arnold Aspinall, with contributions from colleagues, friends and family.

The page can be accessed here: http://www.archprospection.org/arnold-aspinall

Current research at San Salvatore Telesino, Campania (Italy)

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A joint team from the British School at Rome (BSR) and the Archaeological Prospection Service of Southampton (APSS) recently completed work at a medieval abbey complex at San Salvatore Telesino, Benevento (Campania, Italy).

Figure 1: The Abbey at San Salvatore Telesino. A, the church facing north; B, the church facing south; C, fresco of Anslemo d'Aosta located inside the church; and D the crypt underneath the church.

During the medieval period San Salvatore Telesino developed as an important cultural centre (Balasco, 2006: 260). The Abbey of San Salvatore Telesino has Norman foundations (Cielo, 1995: 7), although its exact foundation date is unknown (Cofrancesco et al, 2007: 13), but it is likely the Norman Counts of Caiazzo founded the abbey before 1075 (Loud, 2007: 127) and an earthquake in 1094 caused the abbey to be rebuilt and extended towards the end 11th century. The extant church building is constructed of tufa blocks robbed from the Roman town of *Telesia* (Cofrancesco et al, 2007: 14) a few kilometres from the medieval centre. The church is composed of three aisles with adjoining apses (Balasco, 2006: 260), a private chapel situated towards the front of the church (Balasco, 2006: 261), as well as a crypt and frescos representing scholastic saints (Figure 1). In the 19th century the abbey was deconsecrated and used for agricultural purposes. Part of the abbey complex was restored in 1994, including areas in the apse, presbytery and transept (Cofrancesco et al, 2007: 14).

Geophysical survey was used to identify and map the remains of the abbey cloister and any associated buildings. Ground-penetrating radar (GPR) and resistance survey were selected as the most appropriate geophysical survey techniques given the nature of the monument and modern urban surroundings. A GSSI SIR-3000 with a 400 MHz antenna mounted on a cart system was employed for the GPR survey, whereas the resistance survey used a twin probe array and readings were recorded using a Geoscan RM15 (Figure 2). To increase the efficiency of the resistance survey data collection, a twin parallel frame with a multiplexer was used so that every sample took two readings simultaneously at a 0.5m separation. Data was collected for both survey techniques in a zigzag pattern in a north-south direction. Both GPR and resistance surveys were carried out with a resolution of 0.5m traverse separation and a 0.5 sample interval.

Figure 2: Data collection during the: A, resistance survey; and B, GPR survey

The geophysical surveys recorded a previously unknown courtyard complex to the south of the Norman church, which is composed of a central cloister surrounded by a series of contiguous rooms and a possible infirmary to the east. In particular, the GPR results revealed a very detailed plan of the remains (Figure 3), whilst the results from the resistance survey were less conclusive, with much of the interpretation being aided through comparisons with the GPR data sets. It is unlikely that seasonality issues, such as soil moisture content, affected the results of the resistance survey. Instead, it is likely that the archaeological remains exist at a depth greater than the resistance survey was able to detect. Therefore buried features have largely been identified as a consequence of the greater depth penetration offered by the GPR survey. This is reflected in the GPR survey results with structural remains occurring between 11 to 69ns (depth of approximately 0.55m to 4.53m); anomalies have the clearest signature between 33-54ns (depth of approximately 2.12m to 3.57m). Through superimposing the GPR interpretations at different depths, it is possible to suggest an overall plan of the layout and extent of the abbey complex (Figure 4).

The survey was carried out on behalf of the Comune di San Salvatore Telesino and in collaboration with the Università degli Studi Suor Orsola Benincasa di Napoli and completed at the request of Dr.Federico Marazzi. The geophysical survey was undertaken by a joint team from the APSS (Archaeological Prospection Services of Southampton) and the British School at Rome (Sophie Hay, Alice James, Stephen Kay and Elizabeth Richley).

For further information about BSR geophysical survey services contact s.hay@bsrome.it

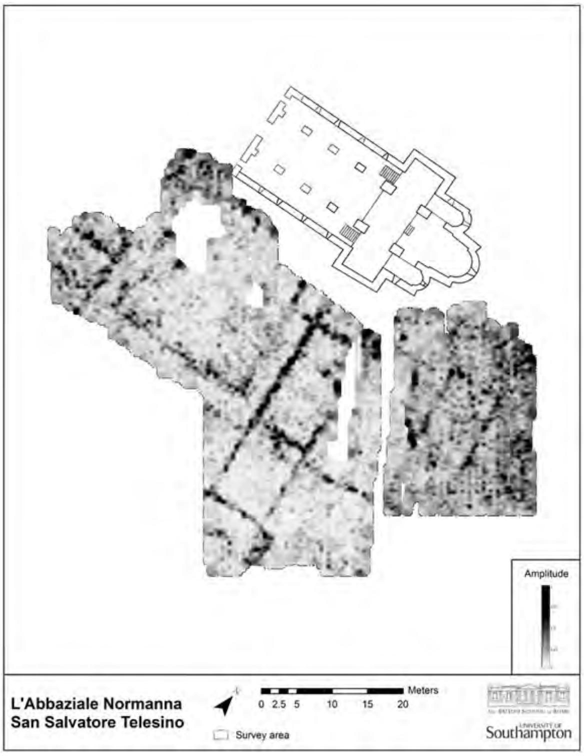

Figure 3: GPR survey results
(depth approximation 3840ns: 2.49m-2.61m).

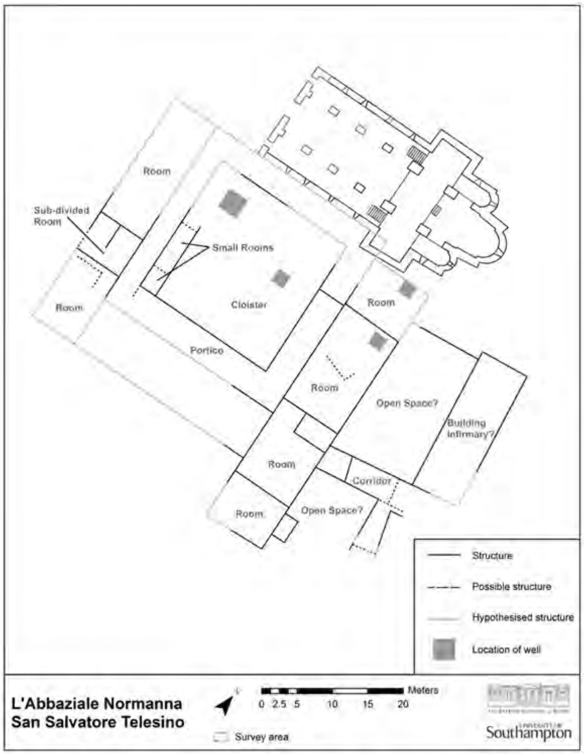

Figure 4: Suggested plan of the layout of the abbey complex

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Analysis of Umayyad desert fortresses in the Near East by Declassified CORONA satellite images

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The so called CORONA missions were operated between 1959 and 1980 for U.S. reconnaissance purposes. Originally they were designed to survey the territory of the Soviet Union while the Cold War. To be able to resolve even small military installations, the corresponding satellites had a very high resolution of up to 60 cm. In the 21 years of operation around 990,000 photos from all over the world had been acquired. After the end of the cold war the U.S. government decided in 1995 and 2002 to declassify the CORONA images and make them available for the public through the National Archives and Records Administration (NARA) and the U.S. Geological Survey (USGS). As they are a unique collection of satellite images of the second half of the 20th century, they can be used to record changes in land use since this time (USGS, 2008). As a result of their high resolution the CORONA photographs are also a very suitable tool to survey archaeological sites in areas like the Near East where other free satellite image sources like GoogleEarth provide only low resolution images or where the intensive building and agricultural activity of the last decades destroyed many monuments. A lot of work in this field has been done by Jesse Casana of the University of Arkansas (e.g. Casana, 2013). The aim of our project was to study the famous Umayyad desert fortresses in Jordan and Syria from space.

Historical background

In the first half of the 8th century AD the Umayyad caliphs erected several so called "desert castles" all over their dominion, especially in Syria and Jordan. The function of these constructions was mainly political: The caliph stayed there temporarily to receive the legates of the local people and therefore control these Arab desert tribes (Ruprechtsberger, 1993; Sack & Becker, 1998).

The "desert castles" were built in the tradition of the Late-Roman "castrum", i.e. a central court that is surrounded by several rooms and a fortification wall with towers. The reason therefore was that the Umayyad caliphs used Byzantine builders and considered themselves as the successors of the Byzantine emperors (Procházka; 1993, Sack, 1998).

Results

In the following section four examples will be presented (Fig. 1) to demonstrate the potential of declassified CORONA images in archaeological prospection.

One of the most famous sites is situated in Resafa (Syria) where the caliph Hisham I. erected a huge palatial town of 3 km² size near the well-known Byzantine fortified pilgrimage centre. The town consisted of six palaces with a huge amount of minor buildings in the environment. The CORONA image (Fig. 2a) shows in detail the remains of the densely settled palatial town. Nowadays they are only visible as small sandy hills as the buildings themselves have been destroyed in the late Middle Ages. Only the fortified Byzantine town in the north has survived over the centuries.

Similar palaces can be found e.g. in Qasr al-Hayr al-Sharqi, Qasr al-Hayr al-Gharbi and Djebel-Usais in Syria. The first one, which is still preserved today, can be seen as a model for Resafa (Konrad, 2006). The complex in Qasr al-Hayr al-Sharqi

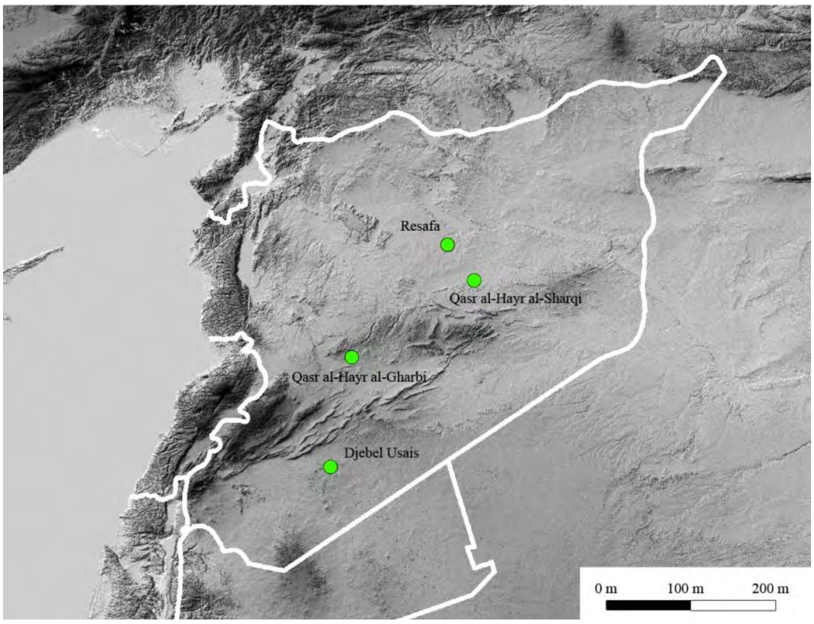

Fig. 1: Map of the presented "desert castles" in Resafa, Qasr al-Hayr al-Sharqi, Qasr al-Hayr al-Gharbi and Djebel-Usais in Syria (© Digital Elevation Model: USGS, 2013).

consisted of two palaces. The smaller one covered an area of ca. 70 x 70 m. Because of the internal division, it was probably used as a caravanserai. The palace itself has a size of 160 m and is hence bigger than most of the other "desert castles". The CORONA image (Fig. 2b) shows clearly the two buildings and their well preserved external walls with the corresponding towers. The results show furthermore that the internal constructions are already destroyed. In the circumference of the palace several, probably until now unknown buildings buried beneath the surface can be identified.

The palace of Qasr al-Hayr al-Gharbi has a size of ca. 70 x 70 m, too. The CORONA image reveals that it is mainly destroyed nowadays (Fig. 2c). Also the caravanserai and the bath that belong to the site are not very well preserved. But the analysis reveals that north of the known palace another rectangular structure is buried in the sand. It has a similar layout than the "desert castles". Hence it is very likely that this newly discovered feature belongs to the Umayyad complex of Qasr al-Hayr al-Gharbi. At both sides a linear structure is visible. Eventually it can be interpreted as a wall or a part of a water supply.

The palace of Djebel-Usais lies at the foot of the volcano Sais and has a size of ca. 67 x 67 m. It belongs to a group of ruins together with a mosque, a bath, a caravanserai and several other buildings. The basements of the monuments can be clearly identified in the CORONA image (Fig. 2d). The satellite data show in detail the layout of the palace with the central court and the distinct surrounding rooms, the fortification wall and even the towers. Also the other mentioned ruins can be mapped in the photograph.

The presented results demonstrate impressively the huge possibilities for archaeological prospection by declassified CORONA satellite images, especially in regions that are not accessible for ground surveys and where the modern free satellite images of e.g. GoogleEarth have no high enough resolution.

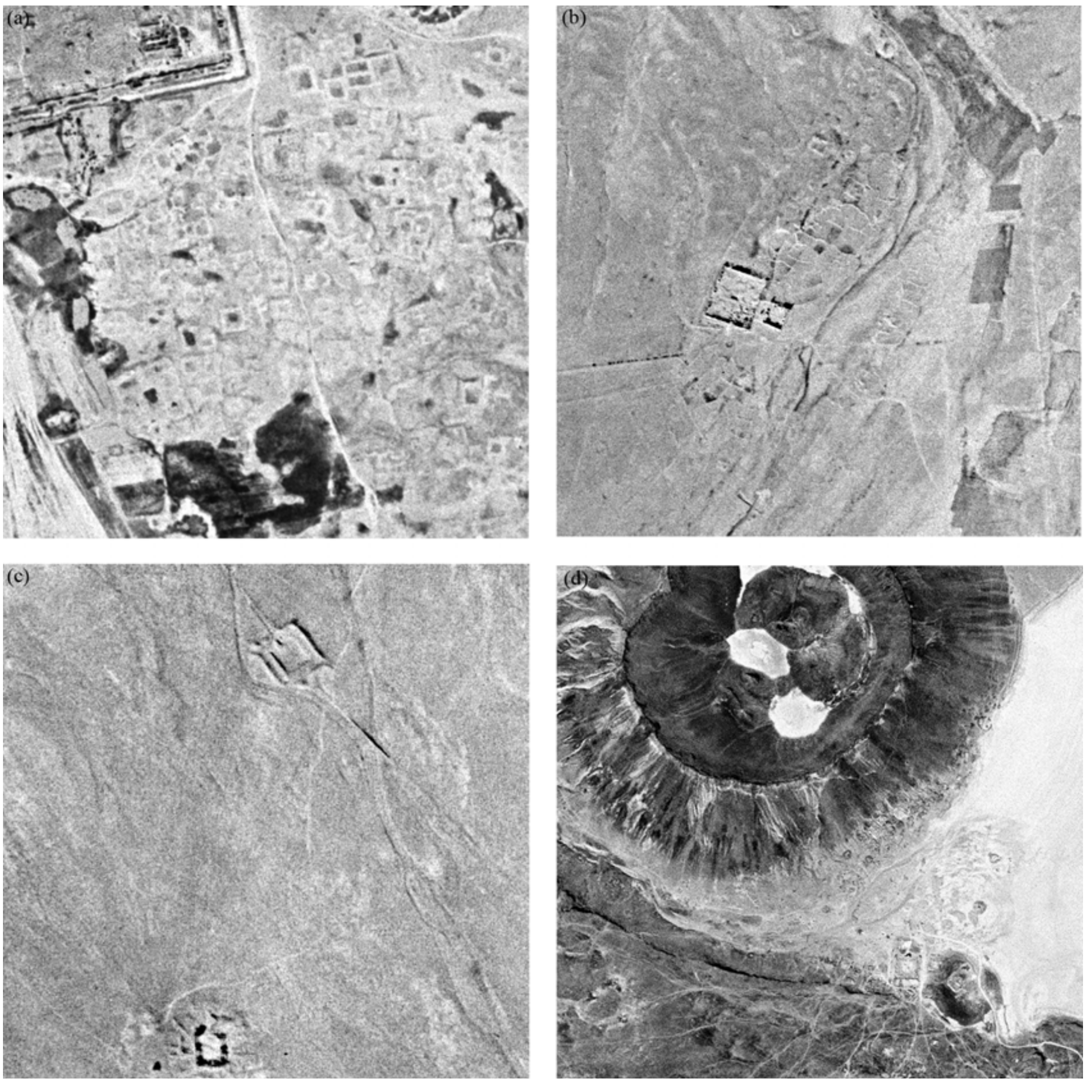

Fig. 2: Declassified CORONA satellite images of the four "desert castles". All data was taken by the KH-4B mission with a resolution of 1,8 m. (a) Resafa (data take: 26/05/1972); (b) Qasr al-Hayr al-Sharqi (data take: 4/11/1968); (c) Qasr al-Hayr al Gharbi (data take: 04/11/1968); (d) Djebel-Usais (data take: 12/11/1968) (© USGS, 2013).

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Archaeological Geophysical Surveys reveal the Basketmaker III Population at Dillard Site

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In the southwestern region of Colorado the 7th century AD was a period of transformation, migration, and advancing technologies. This is a period when the bow and arrow replaced the atlatl, where beans and true cooking pottery were introduced, public architecture in the form of great kivas were invented, and communities were beginning to form as a result of the transition from gathering to farming. Time Team America joined the Crow Canyon Archaeological Center (CCAC) in June 2013 to investigate the Dillard site (Figure 1), a community center during the Basketmaker III (BM III) period, A.D. 500-725. The Time Team America challenge at the Dillard site was to (1) try to determine the site population, (2) to better understand why a Great Kiva was built here (the only one within 100 miles), (3) and to gain insight into the organization of the site, (5) its context to the broader landscape, and (6) what this meant for the development of community.

Figure 1 Dillard site, Basketmaker III, Crow Canyon Archaeological Center, Cortez, CO.

BM III settlements cannot be identified or analyzed from the ground surface, they simply are not visible. Over the past three years CCAC investigations have identified eight pit structures to the south of the Great Kiva through systematic auguring, excavation, and a small amount of resistivity. In the three days of geophysical surveys (Figure 2) conducted by Time Team America, an additional eight to nine pit structures were identified through a combination of magnetic, resistivity, and EM surveys (Figure 3). Through ground-truthing (excavation and auguring) geophysical anomalies, recovery of a variety of artifacts, and two C_{14} samples, the site is firmly dated to A. D. 610 to 670.

One pit structure identified in all of the geophysical survey methods was sampled as part of the Time Team America Program (Figure 3 A). A formalized suite of ritual features was revealed on the floor of the structure. The features include a sipapu, a formal hearth, and an ash pit, aligned North –South (Figure 4), in contrast to the northwest to south east orientation of floor features in other pit structures at the site. All three features were ritually closed prior to abandonment of the structure. Though these features are often found in BM III pithouses, the orientation and formality of the construction and closing of the features may be a result of their close proximity and the structures relationship to the great kiva.

The identification of pit structures though the geophysical surveys begins to give us an idea of the distribution of structures and an estimate of the population of the site. We went a step further to begin to try to better understand the use of space between structures by employing the coring method used by Kvamme (2003) at Huff Village.

Figure 2 Bartington 601 magnetometer, Geoscan RM15 resistivity meter(survey collaboration with Mona Charles, Fort Lewis College), Geonics EM38B conductivity meter.

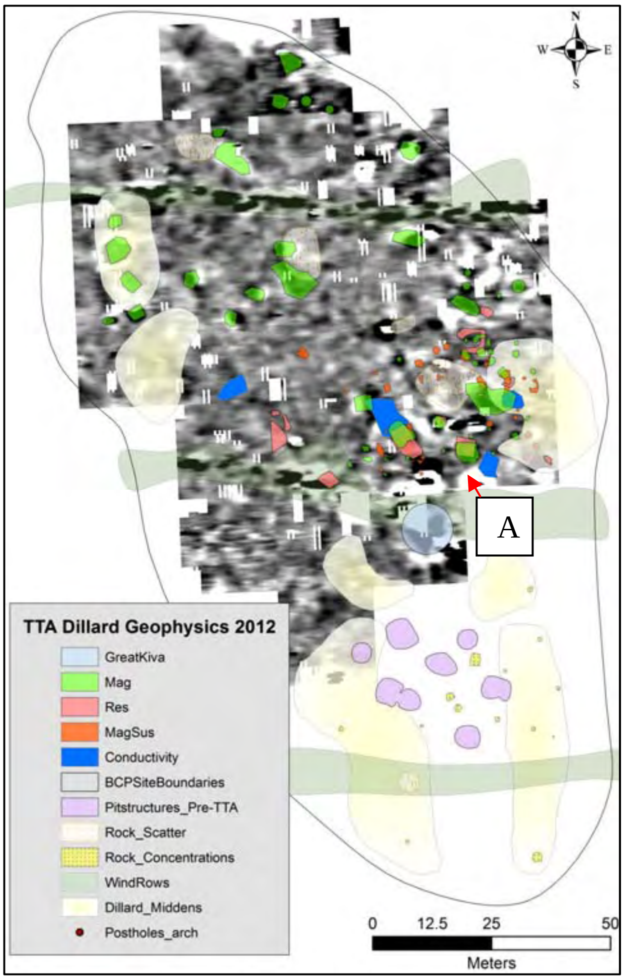


Figure 3 Magnetic survey results with overlain interpretations (from all geophysical survey methods) and Dillard site features. A is the location of the excavation of a pithouse with ritual features.

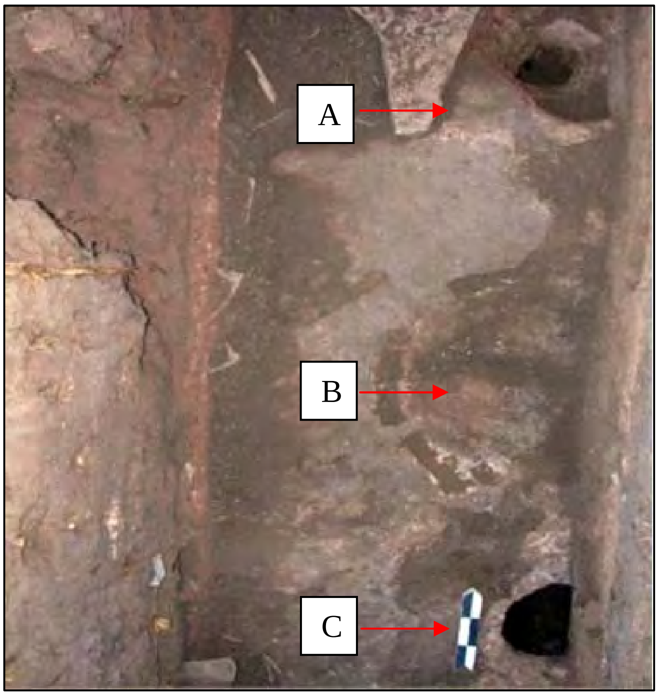


Figure 4 Floor of the ritual structure with the Sipapu (a), hearth (b), and ash pit (C). Photo provided by CCAC.

As part of the auguring, we focused on what appeared as a double 'ring' of magnetic point anomalies encircling several pit structures to the north of the Great Kiva (Figure 5). Preliminary results identify four of these point anomalies as pits and thus, suggest an alignment of postholes that would have been associated with a fence This reveals not only information on the organization of space but also begins to provide insight to social and community organization.

Viewing the site and interpreted features draped on a LiDAR DEM shows its location within the broader natural and cultural landscape. The site's orientation to local landmarks such as the San Juan Mountains to the east, the Mesa Verde questa to the south, and lone Ute Mountain to the west confirm the site's expansive view shed of the prehistoric Mesa Verde Region. Despite this emphasis on view shed, the LiDAR DEM demonstrates that the site sits on one of many low lying ridges, making it easily accessible to the 107 known BMIII habitation sites in the surrounding settlement providing insight on its role in the larger community.

CCAC will continue to investigate every anomaly that was identified in the geophysical surveys in future seasons. They have purchased their own resistivity meter and will incorporate it into all of their field public education programs as well as continue to engage magnetic gradient surveys as part of their ongoing investigations of the BM III and the archaeological landscape(Diederichs and Copeland 2012).

The material in this report is based upon the work supported by the National Science Foundation under Grant number 1114113. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

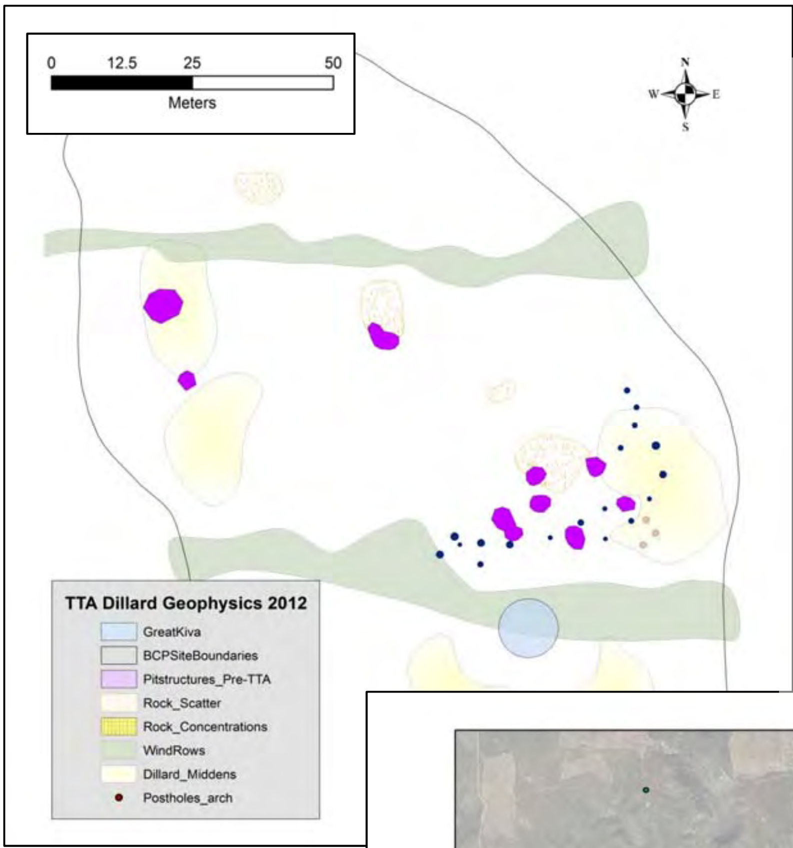
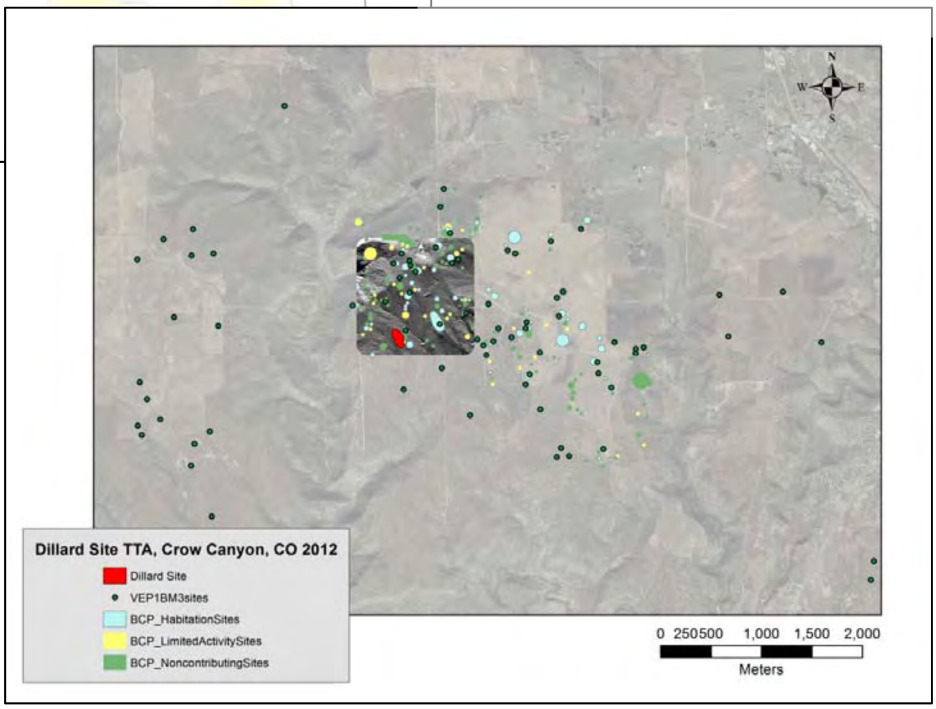


Figure 5 (left) The navy blue points identify a double 'ring' of what are thought to be pits associated with a fence that bounds the cluster of structures to the north of the Great Kiva.

Figure 6 (below). LiDAR DEM and the broader landscape with BM III site distribution in reference to the Dillard site (red)



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Quadrature-Phase Susceptibility Anomalies Detected with the Geonics EM 38B

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It has been noticed in many archaeological surveys that Geonics EM 38B susceptibility (inphase) anomalies also showed a coincident, paired (but normally of different amplitude) negative anomaly in the conductivity (quadrature phase) data. Similarity in shape of these paired anomalies showed that a common phenomenon was causing both responses and that the coincident quadrature phase anomalies were not caused by changes in terrain conductivity.

A sample of such anomalies are illustrated in the figures below (Fig 1), which show survey profiles and contours from the Thibodeau Village site in Nova Scotia. Survey area is 50 X 50 m in size. Magnetic susceptibility and electrical conductivity were measured simultaneously along fifty-one north/south lines (vertical direction) spaced 1 m apart. Data were taken automatically at about 25 cm intervals.

For nearly three-quarters of the survey area the susceptibility values are very low, in the range of 100 ppm, and line-to-line correlation is good. Responses in the north-eastern part of the survey area are, however, of very high value with some over 1000 ppm (greater than 200 ppm is considered anomalous), and change abruptly over small lateral distances.

Detailed features are illustrated in the survey profiles for lines 5, 15, 30, and 48. The scale for quadrature phase/conductivity (red profile) is on the left and inphase/ susceptibility (blue profile) on the right. Profile susceptibility scale is in ppt (0.5 ppt=500 ppm). Conductivity profile 'zero level' is at the bottom of the chart whereas the susceptibility profile zero is offset upwards by 0.5 ppt to facilitate comparison of the two types of response. Conductivity data range (0 to 40 mS/m) has been chosen so that both scales are roughly equivalent in ppt of primary magnetic field.

Profile for line 5 is typical of many survey areas; susceptibility anomalies are usually few. When they occur, anomalous susceptibility values are normally of the order of 0.2/0.3 ppt.
Lines 15, 30 and 48 are very anomalous, with several different types of anomaly response. Line 15, for example, shows a large, continuous

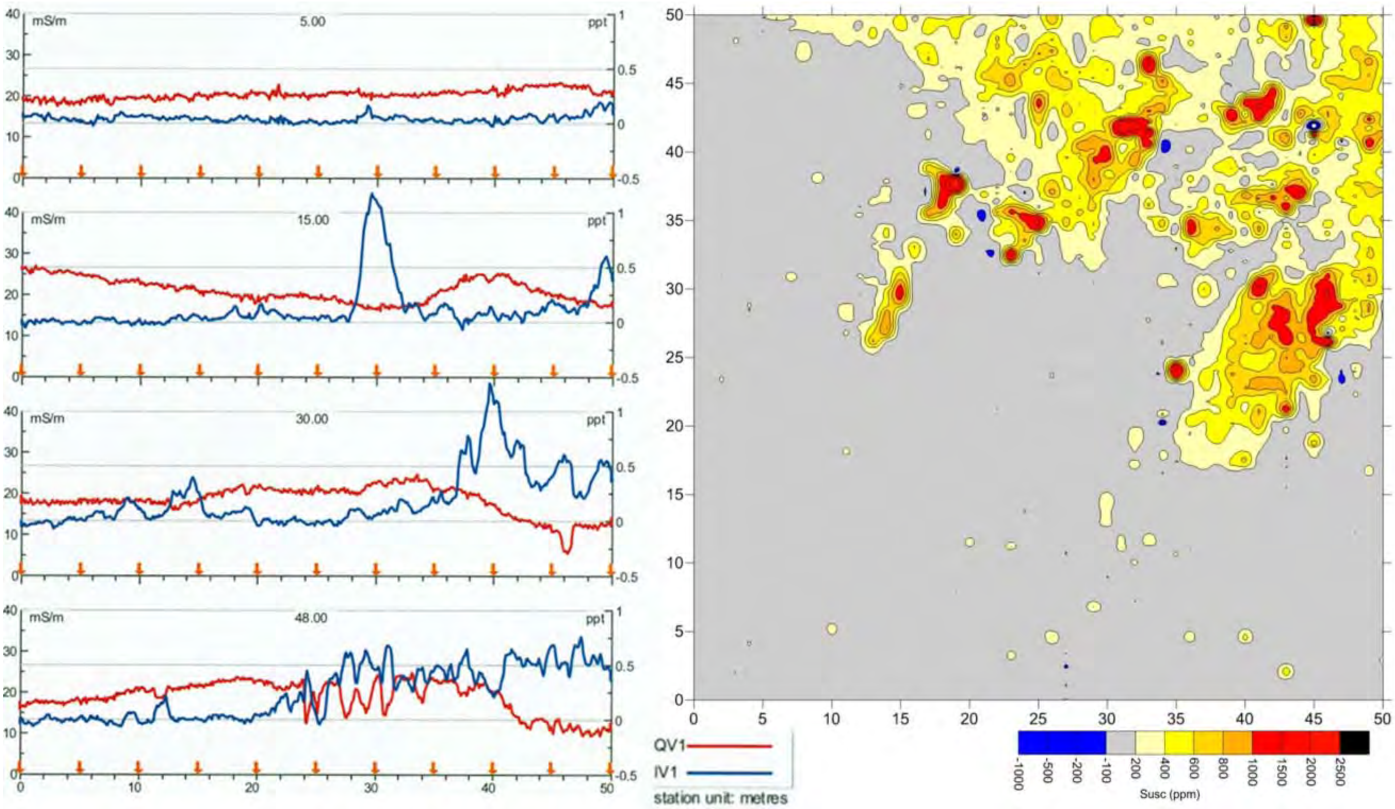

Figure 1. EM 38B Magnetic Susceptibility and Conductivity Survey Profiles (left) EM 38B Magnetic Susceptibility Contours (ppm) (right)

inphase anomaly at station 30 and several smaller inphase anomalies, none with indication of any accompanying quadrature phase anomalies. Similarly for line 30, except that the susceptibility anomaly at station 46 shows a small negative conductivity (quadrature phase) anomaly. There is also a broad decrease in the conductivity channel which may be associated with the large susceptibility anomaly.

Line 48 shows a small susceptibility anomaly at station 12 with an accompanying negative conductivity anomaly, but also a series of susceptibility anomalies from stations 24 to 34 with associated negative conductivity anomalies. The first of these, sharply defined, is probably a response to metal, but not the others. The ratio of quadrature phase to inphase ratio is about one.

Such variable, localized, quadrature phase susceptibility anomalies are not permitted by the Néel (1949) theory of magnetic susceptibility which calculates the response from a series of uniform amplitude Debye-type relaxation components of varying time-constants, the whole extending over an infinite frequency range.

In an attempt at explanation we have studied possible responses from variants of a finite series of such time-constant components, each of uniform amplitude but extending over a limited frequency range as shown below.

Two possible sources of anomalous quadrature phase response (removal of the longer time-constant (low frequency) components) and/or addition of a frequency-independent inphase component) were discarded as inconsistent with measured data. The next possible source, addition of a localized susceptibility anomaly of arbitrary quadrature to inphase ratio at a frequency near 15 kHz, while not impossible, would be inconsistent with Néel theory and the many studies that have vindicated this theory.

The last source, which we favour, is due to removal of the short time-constant (high-frequency) components of the distribution. This behaviour can cause anomalies of the type and amplitude seen in survey data and is felt to be more consistent with Néel theory. We also show that data on mineral grain size emerges from this model.

An expanded version of this study along with many more archaeological case histories of susceptibility mapping with the EM 38B are available as recently issued Technical Notes TN34 to TN37 at www.geonics.com .

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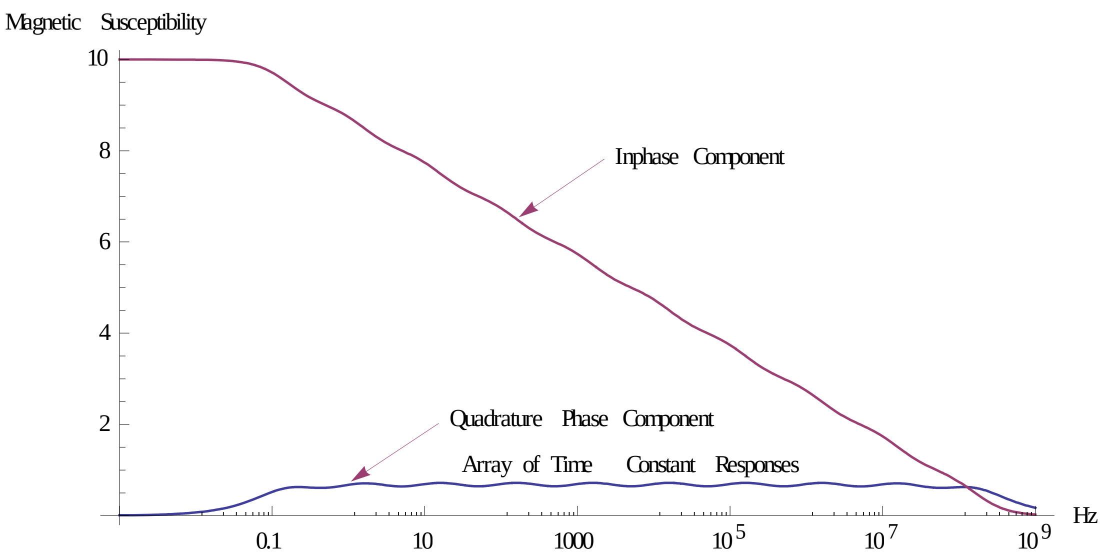

Archaeological and Maritime Surveys on the Island of Ghagha, Al Gharbia, Abu Dhabi, United Arab Emirates

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Beech, M
Blue, L.
Sheehan, P.

In November 2012 a geophysical survey was conducted by the Archaeological Prospection Services of the University of Southampton (APSS) and the Maritime Archaeology Stewardship Trust (MAST) with Dr Mark Beech and Peter Sheehan of Abu Dhabi Tourism and Culture Authority (TCA Abu Dhabi), on the island of Ghagha, lying some 3km off the coastline of the Al Gharbia (Western Region) in Abu Dhabi emirate, within the United Arab Emirates. The aim of the survey was to locate and map archaeological remains from a number of key sites on the island, spanning the main periods of habitation. An extensive archaeological reconnaissance was also conducted, utilising both hand-held and differential GPS, to assess the archaeological potential of the island, and to compare the current preservation of archaeological sites with the results of the Abu Dhabi Islands Archaeological Survey (ADIAS) conducted in the early 1990s.

The archaeology of the islands of Abu Dhabi covers the majority of the chronological range of the region, from the Neolithic period (mid 6th millennium BC) to 20th century settlement, with the coast of Al Gharbia giving evidence of Middle Palaeolithic material. Ghagha island is the westernmost of the Abu Dhabi islands which stretch along the southern coast of the Arabian Gulf, and include the islands of Abu Al-Abyadh, Marawah, Sir Bani Yas and Delma. The western islands comprise Ghagha, al-Ufzayyag and the Yasats, all situated off the Sila peninsula close to the border with Saudi Arabia. Evidence of earliest settlement on the islands of Abu Dhabi take the form of middens running along the coastline of many of the islands, hearths and other associated posthole or pit features, and artefact scatters. Surveys forming part of the work undertaken by ADIAS have located such evidence on islands including Abu Al-Abyadh and Ghagha. A number of fish traps are also visible on the island, similar to those found elsewhere on islands along the Abu Dhabi coastline including Qamein, Yasat and Delma (as mentioned in ISAP News Issue 30). While difficult to date, some of these traps may have some antiquity judging from their relative submerged position in relation to present day sea level.

On Ghagha (Fig. 1) previous survey in the 1990s located a number of midden sites along the coast of the island. Some of these sites appear to be associated with the pre-oil era villages, although earlier deposits of material are also present. The earliest site mapped (J), dating from the 5th millennium BC onward, is located on a promontory on the northern part of the island, and comprises a series of stone mounds. A later artefact scatter (K) dating to the 3rd-2nd millennium BC was also located on the south-west portion of the island. A number of possible Bronze Age sites are located on Ghagha, principally taking the form of cairns of beach stone, similar to cairn sites found elsewhere in the region. The current survey mapped a collection of cairns in the north-western zone of the island, potentially dating to this period.

Figure 1. Satellite image of Ghagha Island with principal sites marked.

The ADIAS survey located a scatter of material dating to the 3rd-4th century AD, Late Pre-Islamic period, in the centre of the island. This site had surface pottery which has parallels with ceramic types found at Ed-Dur, Mleiha and Ra's Bilyaryar. A series of three platforms were noted in the vicinity during the current survey, suggesting settlement of this period on Ghagha.

Three pre-oil era settlement sites, abandoned in about 1960, are also visible on the island, comprising a north village, south village and a single building associated with a palm plantation in the centre of the island. In addition to the sites noted above, the island is covered with other ephemeral settlement remains, including middens (Fig. 2), cairns, cemeteries, 'outline mosques' stone structures and other features, including fish traps (Fig. 3). The precise nature of these features and their broad chronology is difficult to ascertain. Some features, including a small mound in the vicinity of the southern village, and some of the possible mounds or cairns, are difficult to identify and date in terms of their form. However the wealth of archaeological sites on the island is undisputed. Comparison of the reconnaissance survey of the island in the 2012 season with the ADIAS survey shows that many of the more ephemeral sites have been greatly eroded, either through natural deflation of the soil, or through modern human activity. The widely distributed and ephemeral nature of the monuments on the island, and the limited understanding of some of the forms of features, required a new strategy that combined new reconnaissance survey and more intensive topographic and geophysical survey of target sites.

Figure 2. Midden material eroding from the modern ground surface at one of the sites.

The aim of the archaeological survey at Ghagha was to conduct a broad reconnaissance survey for comparison with the results of the ADIAS survey in the 1990s, to assess the current state of preservation of archaeological sites on the main west island, and to map any sites present on the less accessible east island. More intensive topographic and geophysical survey was also applied to map the nature and extent of particular archaeological sites from different periods of the island's habitation. Ground Penetrating Radar (GPR) and magnetometry were applied to map archaeological deposits at one of the ore-oil era settlement sites, the Late Pre-Islamic settlement and the Bronze Age cairn site in the north-west portion of the island. In addition the field season was used to assess the island in the context of a dynamic maritime cultural landscape. This very much drew on previous surveys of the island, particularly the ADIAS survey of the 1990's, and aimed to map the changing use of the island over time. It also sought to highlight the critical role of the sea in this respect regarding fishing, pearling, trading and the importance of the island within the broader maritime landscape.

Both magnetometry and Ground Penetrating Radar (GPR) were applied for the surveys. Results of these techniques are extremely dependent on the geology of the particular area, and whether the archaeological remains are derived from the same materials. The presence of a variety of archaeological features of different periods, including cairns, house platforms and beach stone houses and courtyards, some comprising possible burnt layers in the archaeological record, provided adequate conditions for the use of magnetometry at the different sites. The ground conditions and nature of materials indicated that a GPR survey of targeted areas would be productive. The beach stone and coral construction of many of the structures, in contrast to the surrounding sandy beach deposits, provided good conditions for the GPR. In addition to the geophysical survey methods, a topographic survey was conducted in different areas using a differential GPS, taking accurate measurements on archaeological features. Elevation points taken over different areas provided data on the form and extent of different visible deposits and structures across the island.

The results of the topographic and geophysical surveys on Ghagha Island, together with the broader field reconnaissance, give a comprehensive cross-section of the type and nature of the archaeology of the island. The general distribution of middens, cairns, fish traps and material scatters from the prehistoric phases of occupation of the island indicate the presence of a population on the island gathering and utilising the marine resources of this part of the Arabian Gulf. The biggest challenge that a number of these sites face, however, derives from modern disturbance of the sometimes ephemeral archaeological deposits, and the eroded and deflating nature of the deposits and soils on the island.

Figure 3. Fish trap at high tide in the inlet on the western part of the island.

The coastal field walking survey used handheld GPS to note the location of over forty new sites of varying date and archaeological signature. These sites offer huge potential to further appreciate the maritime nature of the island over time, suggesting extensive fishing, shell processing and pearling, together with stone structures representing potential domestic, industrial and religious practise. Of particular note in this respect is the mapping of the substantial fish trap noted in the western bay. Within living memory fish traps have been used along much of the southern coast of the Arabian Gulf, although precise dating of their construction is problematic without comparative typological examples. However, it is believed that existing traps are likely to have been in use, and subject to continuous repair, over an extended period of time until their recent abandonment and subsequent decline.

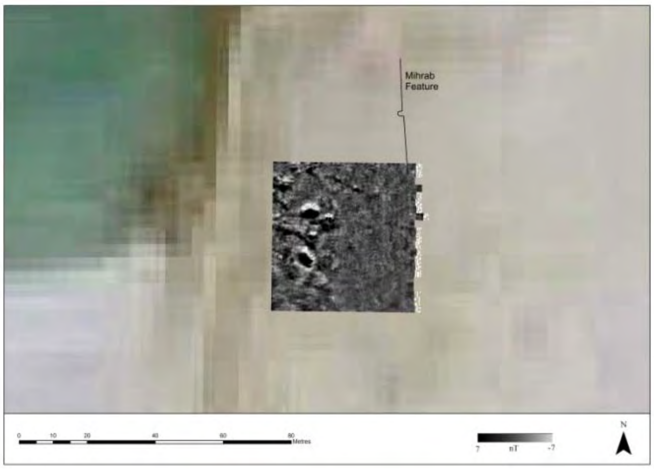

Figure 4. Magnetometer survey results of the cairnfield or hut circle features.

The survey of the prehistoric site on the north-west part of the island (Fig. 4) shows the presence of what appears to be either a small cairnfield or series of hut circles overlooking a small bay. Anomalies in the magnetometry show deposits within some of the features, suggesting possible burnt deposits associated with burials or settlement structures. Furthermore, the results of both magnetometry and GPR indicate far more cairns or hut circles than are visible on the surface. What is also apparent in the results is the effective erosion of features in the extreme south and east of the survey areas, closest to possible drainage features on the surface of the area. The site overlooks a bay to the west, and is located on one of the highest and most exposed areas of the island, similar to a much more eroded prehistoric concentration of material located on the northernmost promontory of the island (Site J) that has been almost completely lost due to erosion and extensive land use. The exact nature of the features will require further investigation, possibly excavation, in future seasons of work.

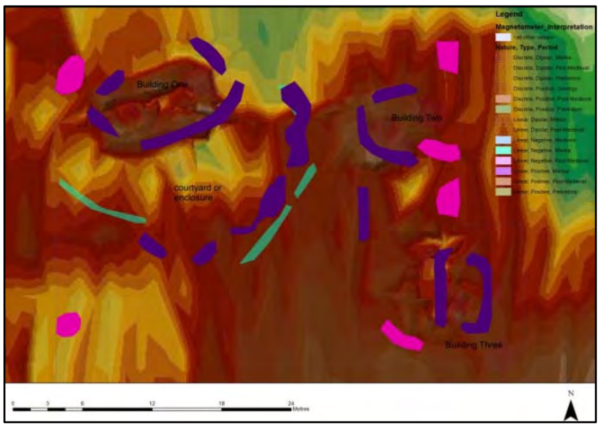

Figure 5. Interpretation plot superimposed on the digital elevation model of the late pre-islamic settlement.

The Late Pre-Islamic period site in the north-central part of the island (Fig. 5) also marks one of the more ephemeral areas of archaeological importance on Ghagha Island. The site comprises three small building platforms, each c. 7m across, with the presence of an enclosure to the south of the largest structure. The topographic variation of these features, as with the cairnfield, is small, suggesting a heavily eroded site, although 0.3-0.5m of deposits may be present at the site. It suggests rectangular features possibly with internal units similar to Late Pre-Islamic buildings known at Mleiha probably part of a small farm or habitation, overlooking the central part of the island.

Survey of the southern village on the island (Fig. 6) revealed that, in addition to the extant building remains, several potential structures lie buried at the village, with two possible courtyards also present. In addition a feature that seems to relate to the earlier settlement of the island, potentially similar to the Late Pre-Islamic period site situated further north, is located on the edge of the modern village, together with a series of small buried stone or pit features to the south-west of the village, marking a possible cemetery or series of markers. Finally the survey of the buildings and the geophysical survey in the south village shed light on the extent of the pre-oil era settlement in this part of the island, including the extant remains of buildings and courtyards, and their buried counterparts. Several potential buried structures were noted in the magnetometry survey, and both magnetometry and GPR located a further structure, marked by a rise in the topography, suggesting an earlier settlement in the area, possibly of Late Pre-Islamic date.

Figure 6. Results of the magnetometer survey at the southern village.

Irish Archaeological Geophysical Survey Database launched online

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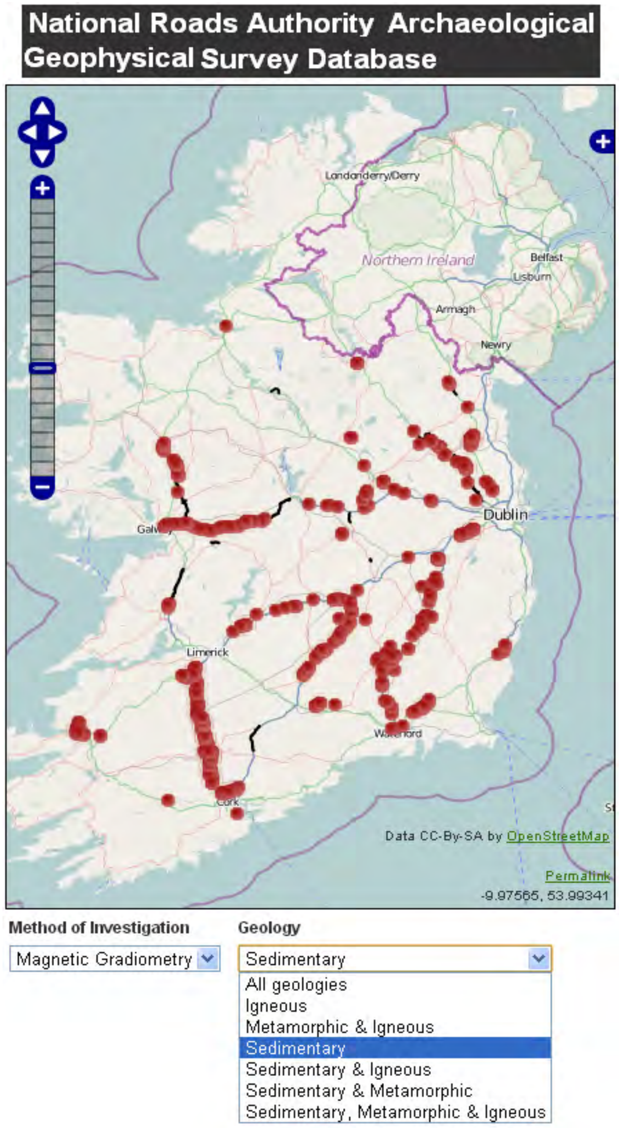
A new online database of geophysical surveys on Irish national road corridors has recently been launched. The *NRA Archaeological Geophysical Survey Database* contains an archive of each archaeological geophysical survey report carried out for the National Roads Authority (NRA) in advance of new road schemes in the Republic of Ireland between 2001-2010. The *NRA Archaeological Geophysical Survey Database* complements the existing *NRA Archaeological Database* which currently holds metadata on more than 800 excavations, that will itself shortly be supported by downloadable pdf reports.

James Bonsall, Dr. Chris Gaffney and Prof. Ian Armit at the University of Bradford were commissioned to review archaeological geophysical surveys on NRA road schemes from 2001 to 2010 as part of an NRA Fellowship Programme. One of the key deliverables of the research Fellowship was an on-line database from which the geophysical reports could be viewed. The *NRA Archaeological Geophysical Survey Database* has been designed by James Bonsall and Thomas Sparrow to meet this need and can be currently accessed at http://www.field2archive.org/nra/ .

The background to the database is that geophysical surveys have been used by the NRA over the past decade to prospect for previously unknown archaeological sites and/or to investigate known or suspected archaeological sites on 70 new roads across Ireland covering more than 1,700 hectares of survey. The geophysical surveys were carried out by a number of consultancies from Ireland, the UK and Germany, resulting in more than 170 individual reports.

The database can be queried to identify survey reports that used a specific geophysical technique and/or upon a specific geology; the results are presented in an OpenLayers viewer (with data supplied from OpenStreetMap) as a clickable point source (for isolated surveys) or a polygon (for entire road schemes). When clicked, each result will return some basic metadata for the survey report including land use, geology, contractor, survey techniques used, area coverage, spatial resolution, a report summary and a link to the full report.



The NRA have assembled a vast quantity of archaeological information from its road building activity and a key objective of their work is to ensure that the knowledge generated feeds back not only into the decision making and project planning process, but also that this knowledge is disseminated and is transparently accountable to the Irish general public, who fund much of the work. Information on all of the reports has been made available by the NRA, some of these are restrictive and others are available as a pdf document that may be downloaded freely by the public for personal use or for educational purposes. The database will make a valuable contribution to promoting a greater awareness of the past among local communities through which national road schemes pass. The cumulative effect of the professional geophysical survey work ensures that the NRA not only fulfils its statutory obligations (as set down in legislation and national policy), but also demonstrates a commitment to meaningful compliance. These efforts also serve to place the NRA at the cutting edge of the development and application of new archaeological geophysical investigation technologies and techniques, with direct benefits for the efficiency of its work on road schemes.

The database is a testament to the quality of work and the dedication of the geophysical surveyors; without their initial hard work on the road schemes – and the collection of some truly outstanding geophysical data - this project would not have been possible. The NRA and the University of Bradford would like to thank all the geophysical consultants that worked on Irish road schemes between 2001-2010, culminating in this archive.

The *NRA Archaeological Geophysical Survey Database* was formally launched at the Institute of Archaeologists of Ireland spring conference “The Legacy of Development-led Archaeology” on 6th April 2013.

10th International Conference on Archaeological Prospection

May 29th-June 2nd, 2013 Vienna

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Journal Notification

Archaeological Prospection

Archaeological Prospection – 20(2)

The next issue of the journal Archaeological prospection has Guest Editors Rosa Lasaponara and Nicola Masini. The subject is 'Satellite Radar in Archaeology and Cultural landscape'. For many of our regular readers this is a relatively new topic and the Special Issue is an excellent way to understand some of the current themes in this area. The papers include:

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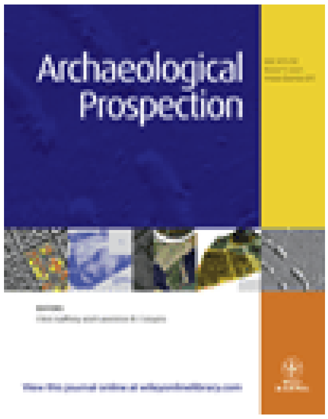

Morrison - Mapping Subsurface Archaeology with SAR

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Cover image: Magnetometer survey on the West Bank of Thebes, Egypt (photo: Angus Graham)