UKRAINE – Mass Grave Research
Lviv Oblast Region

REPORT ON GEOPHYSICAL SURVEYS, NOVEMBER 2014
ACKNOWLEDGEMENTS

The survey team would like to thank Mr Meylakh Sheykhet of the Union of Councils for Soviet Jews (UCSJ) not only for facilitating our involvement in such a prestigious project but also for his support during the field operations and being a very supportive host during our deployment to Ukraine. We are also grateful to the UCSJ for provided background information on the survey sites, including the maps, photographs and testimony that they provided. Producing many of the images in this document would have been much harder without this collaboration. We are also grateful to Dr Karl Harrison of Alecto Forensic Services (UK) for his initial involvement in the planning phase and for useful discussion on the results and recommendations.

CONTRIBUTORS

Project planning was carried out by Charlie Enright. The geophysical field work was carried out by Tim Fletcher and Charlie Enright. Post processing, mapping and CAD drawings were completed by Tim Fletcher and this report was co-authored by both of the above.

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DISCLAIMER

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This document was originally written in English. The authors cannot accept any responsibility for the content if translated into any other language.
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INTRODUCTION

Background Synopsis
At the request of Meylakh Sheykhet, Director for Ukraine department of the Union Council of Soviet Jews (UCSJ), a team of forensic archaeologists deployed to Ukraine in November 2014. The purpose of this visit was to provide specialist search advice and use technical survey skills in support of the ongoing development of a strategy for a large-scale project investigating possible mass grave sites in Ukraine.

Tertiary evidence in the form of witness testimonies and aerial photographs were provided by the UCSJ office in L'viv and all technical equipment and skills were provided by the UK based forensic archaeologists. Over the course of five days the forensic archaeologists applied geophysical survey techniques (Electrical Resistivity (ER) and Ground Penetrating Radar (GPR)) at a number of sites in the Lviv Oblast region of Western Ukraine.

It was hoped that the results of the survey would support the basic concept that geophysical survey methods could and should be used in the future to support existing evidence in identifying the location of known or suspected mass grave sites.

The fieldwork took place between the 17th November and 21st November 2014. Post-processing and interpretation was completed by the end of 2014 and the report submitted to the UCSJ early 2015.

Historical Context
There is significant variation in the total estimates of individuals killed in Ukraine between 1941 and 1945. One source claims that total civilian losses during the war and German occupation in Ukraine is in the region of four million, including up to a million Jews who were murdered by the Einsatzgruppen and local Nazi collaborators.

According to a senior Einsatzgruppen commander at his trial:

"...the mission was to protect the rear of the troops by killing the Jews, Romani, Communist functionaries, Communists, uncooperative slavs, and all persons who would endanger security."

In practice, their victims were nearly all Jewish civilians.

These already overwhelming numbers do not include the deaths of Soviet soldiers executed in the field or held captive in Prisoner-of-War camps in the region. Again, estimates vary widely, but one source claims 3.3 million Soviet POWs died in Nazi custody, out of 5.7 million. Nazi mistreatment of Soviet prisoners is hard to refute. The total percentage of Soviet POW fatalities whilst in secure facilities is 57%, contrasted with only 8,300 out of 231,000 British and U.S. prisoners (3.6%).

In the decades following WW2 large amounts of research has been undertaken by various organisations with an interest in recording, preserving and commemorating the sites attributed to these atrocities. With the end of Soviet dominance in the region this has accelerated, but current evidence often isn’t enough to confirm suspected sites to Authorities who ultimately could, and should ensure they are offered the respect and preservation the sites deserve.

Report Structure
The first part of this report provides the reader with an overview of the entire pilot project, including background information, methodology and summary of the results. It concludes with recommendations from the authors on the best way to plan for the next phase of the investigation, including how to incorporate geophysical survey techniques into the longer term strategy.

A significant part of the recommendations includes the detailed evaluation and research for prospective sites before further geophysical work is attempted.

The second part (Annex A to E) of this report contains detailed reports for each of the four sites surveyed, including larger scale drawings and useful reference information for further research. The intention of this section is to provide investigators with ‘stand-alone’ documents that can then be included within pre-established or case files, or alternatively become the first element of a newly created case file.

Survey Aims
The aims of the field element of the work were as follows:

- To conduct a reconnaissance survey of a representation of sites suspected of containing unmarked human burials.
- Conduct geophysical surveys of one known mass grave site/cemetery previously surveyed by Kyiv University in order to compare the strategies and methodology.
- Conduct a detailed geophysical survey of at least one mass grave/cemetery site selected from the reconnaissance survey.
- Provide forensic archaeological advice for the needed obligatory list of steps to search and locate human burials.
• Establish the needs and expectations of further investigative work supporting the study and investigation of human burial sites.

• Assess the feasibility of future investigative work on the unknown sites in a manner that meets the Government of Ukraine’s approval.

Survey Schedule and Site Overview

Table 1 – Deployment Itinerary

<table>
<thead>
<tr>
<th>DAY 1</th>
<th>Bryukhivochi</th>
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<tbody>
<tr>
<td>This is a rural site approximately 8km NW of Lviv on the outskirts of the Bryukhivochi. Covering a wide area this site sits in a large depression on the inside of an arcing curve on the railway. There is significant evidence of anthropological ground disturbance laid out in what appears to be a methodical way. A long linear ditch runs in NW-SE alignment following the ‘bottom of slope’ of an escarpment. Radiating from this linear feature appears to be a series of 30+ depressions with proportionate ridges to the sides, creating an almost large scale ridge and furrow appearance. To the Northern and Southern sides of the site the area plateaus away from the escarpment. A sample survey from each of these areas was undertaken.</td>
<td></td>
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<tr>
<td>AOI 1 – Area to the W of the site situated at the corner of a road junction, behind what was the main barrack block. On the slightly raised ground from the road the area selected for ER survey is adjacent to a vehicle ramp that can be identified on the 1944 aerial image, and partially covers a significant area of disturbed ground.</td>
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<tr>
<th>DAY 2</th>
<th>St Marta’s Church Grounds</th>
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<tr>
<td>This urban site is situated in the NE area of Lviv on Zhovkivska Street. Reputedly this building was used as a clothes factory by the German Authorities who made use of forced local labour. Executions and burials are suspected to have taken place in the church grounds. Today, the external area to the front of the main church building is block paved. An area of this ground was selected for survey using RADAR.</td>
<td></td>
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<tr>
<td>• Electrical Resistance</td>
<td></td>
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<tr>
<td>• Ground Penetrating RADAR</td>
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<tr>
<td>AOI 2 &amp; 3 – Both AOIs are within the confines of a post war tennis court (date of construction unknown) that is situated to the north of the main barrack block and near two smaller barrack buildings. This area was selected for survey based on evidence of disturbed earth on the 1944 aerial imagery and testimony obtained at the time the tennis courts were constructed.</td>
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<tr>
<th>DAY 3</th>
<th>Citadel – STULAG 328 POW Camp</th>
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<tr>
<td>The area locally known as the Citadel is situated almost in the centre of Lviv. An apparent mid-19th century defensive fortification consisting of four large bastion towers and earth ramparts constructed on the natural high ground that overlooks the city. Many original features of the fortification remain, with some now developed and used as offices and warehouses with one of the larger bastions also having been converted into a hotel. Between 1941 and 1944 the Germans turned the fort into a POW camp (STULAG 328), mainly housing Soviet combatant prisoners. From testimony it is known that vast numbers (estimates of 140,000) died whilst in captivity here, either from disease, maltreatment or by execution. Disturbed areas of ground are clearly visible on aerial imagery from 1944. Three Areas of Interest (AOIs) were selected for surveying over two days.</td>
<td></td>
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<tr>
<td>• Electrical Resistance</td>
<td></td>
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<tr>
<td>• Ground Penetrating RADAR</td>
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<tr>
<td>AOI 3 surveyed – The second tennis court that was considered to be an area of interest.</td>
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<tr>
<th>DAY 4</th>
<th>Citadel – STULAG 328 POW Camp</th>
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<tr>
<td>Surveys continued from previous day on AOI 2.</td>
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<th>DAY 5</th>
<th>Biligorshcha</th>
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<tr>
<td>This is a remote rural site approximately 8km from the city centre and adjacent to the Lviv-Kosice railway. Reputedly there are a number of possible grave sites in this vicinity. The area surveyed was open grassland near to what appeared to be a natural drainage channel. The ground was much waterlogged in parts and was selected because of the noticeable changes in vegetation growth compared with its surroundings.</td>
<td></td>
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<tr>
<td>• Electrical Resistance</td>
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<tr>
<td>• Ground Penetrating RADAR</td>
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METHODOLOGY

Geophysical Survey Techniques

A geophysical survey uses techniques that take physical measurements at the surface of the Earth to investigate shallow depths. Shallow prospective techniques such as these are often successfully used in the search land location of clandestine human burials in many parts of the world in different climates and conditions.

The survey methods employed during the November 2014 deployment was electrical resistance and ground penetrating RADAR (GPR). Both techniques are termed ‘active’ as they measure an induced phenomenon as opposed to alternative methods which attempt to measure existing conditions and are termed ‘passive’

Introduction to Earth Resistance

The basis for this method is that electric currents are fed into the ground and the resistance to the flow of these currents is measured. Where they ‘interact’ with buried objects, for example, wall foundations, high resistance readings are recorded, while if a backfilled excavation or mass grave (which would normally be wetter than the surroundings) are encountered then low resistance readings can be
expected. By mapping zones of high and low resistance it is possible to identify, for example, the layout of buildings or the size and orientation of ditches.

The resistance in the ground can be established by measuring the current flowing through it and monitoring the change in voltage across the same material. If the current is kept constant then the resistance is calculated by monitoring the change in voltage.

Limitations of Earth Resistance
Earth resistance relies on electrical current being able to pass through the soil. The amount of interstitial water and various salts within the soil will affect the ability of the soil to conduct electricity. The current flowing through the ground will always be in proportion to the potential difference, or voltage that is used. As with many other geophysical techniques the results require post processing and interpretation, and on a complex site it can often be difficult to differentiate between features.

Earth Resistance Methodology
The equipment used was a Geoscan RM85. The array was twin-probe using mobile probes at a constant separation of 0.5m and remote probes set at least 15m away from any survey point. A survey approach using 10m or 20m square grids with a traverse separation of 0.5m was used throughout. To reduce the number of post processing errors, where possible the method of traverse was zig-zag, but occasionally physical constraints on the ground forced the need for parallel traverses. Collected data was processed using a combination of ‘Sniffer’ and ‘Archaeo Surveyor’ software.

Using a ‘step by step’ approach, areas of high and medium resistance were identified and plotted onto individual site plans. The same approach was then used for areas of low resistance. Using a combination of visible cues and data interpretation areas of insignificance were identified and removed from the plots.

Introduction to Ground Penetrating RADAR
Ground Penetrating Radar (GPR) equipment pulses VHF radio waves directly into the ground from a transmitting antenna. When these electro-magnetic waves meet discontinuities in the ground, or solid surfaces, some of this energy will be reflected back to a receiving antenna, whilst some will penetrate further and possibly be reflected back from a deeper discontinuity. This process will continue until such time that the energy of the transmitted wave has been depleted to a level that prevents further penetration. By measuring the time for the reflections to return, it is possible to estimate the depth of targets along a vertical section. Multiple sections can then be processed in such a way as to provide a plan of the surveyed area at the desired depth.

Limitations of Ground Penetrating RADAR
The ability of the earth to propagate radio waves depends upon several factors, including soil conductivity, water content, soil density, porosity, temperature, the physical structure of the soil, the frequency used and the amount of salt in the ground solution. The most important factor is the electrical conductivity of the soil which determines the speed of wave propagation and the depth of penetration. Soils with high conductivity will result in a loss of signal. On the whole, the ground and soil conditions in the Lviv Oblast region are suitable for GPR surveys.

RADAR Methodology
RADAR surveys were carried out at various sites using a GROUNDVUE 3_1 system manufactured by Utsi Electronics. Survey grids varied in size depending on the nature of each site, but all surveys were carried out using a 400 MHz antenna and a 0.015m read distance. Dielectric properties were estimated separately for each site. For further details see the site results contained within the Annexes to this report.

RESULTS
Four separate sites were visited and surveyed over the course of the five day deployment with multiple Areas of Interest (AOIs) surveyed at the larger Citadel site.

Not one site was the same, and the diversity of each presented both opportunities and challenges from a geophysical survey perspective. This diversity was much welcome as it provided the opportunity to demonstrate the capabilities and limitations of the geophysical methods employed with real time examples of one method succeeding where the other failed simply because of the site conditions, or examples where the results from multiple techniques mutually supported each other. As always the basic premise to avoid over reliance on one method was reinforced.

The second part of this report contains detailed analysis, imagery and interpretation of the geophysical data. Raw data has been subjected to detailed processing, including adjustments relief and obstacles. Propriety software and experience based interpretation was used to generate imagery that best communicates the results without overloading the reader with technical jargon. The detailed results from each survey can be found in a ‘stand-alone document as Annexes to this report.
Table 2 provides summary information on the results on a site by site basis:

<table>
<thead>
<tr>
<th>Annex A</th>
<th>Bryukhovychi</th>
</tr>
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<tbody>
<tr>
<td>AOI 1  – Was surveyed using ER equipment. Areas of low resistance consistent with the visible topographic features on the ground were identified. The results from the ER survey added little to the existing knowledge of the site, and offered no information that couldn’t be obtained just by visual reconnaissance and ground interpretation.</td>
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<tr>
<td>AOI 2 - This area was surveyed using GPR equipment and was considered to be a little more successful than the ER survey, despite the ground conditions being far from perfect which limited the interpretation potential of the results. The survey took place inside a large depression with associated high banking. At approximately 0.5m depth a rectilinear feature, likely to be an historic excavation, can be seen on the scan images. The result of the survey alone cannot be used to define this anomaly as a mass grave site, but with other evidence it undoubtedly increases the likelihood.</td>
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<tr>
<th>Annex B</th>
<th>St Marta’s Church Grounds</th>
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<tr>
<td>A selected area of this urban site was surveyed using GPR equipment. A number of utility services were identified in the search grid at different depths. Some associated with obvious ground markers, i.e. manhole covers, but others appear to be independent of the drains and may well be other services, perhaps power or gas. An anomaly approximately 5m x 2m was identified running alongside a main drain run in an area congested with services. This anomaly is most likely a previous excavation, but the close proximity and possible association with the utility services cannot be ignored, and therefore, it would be unwise to assume that this may be a mass grave site.</td>
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<tr>
<td>No sub-surface anomalies were identified in the areas previously identified by others as mass graves sites, although some of these areas were outside of the GPR search grid and were not part of the survey.</td>
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<tr>
<td>Further survey work at this site is recommended.</td>
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<tr>
<th>Annex C and Annex D</th>
<th>Citadel – STULAG 328 POW Camp</th>
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<tr>
<td>AOI 1  – Was surveyed using ER equipment. A semi-rectilinear low resistance anomaly was identified. This large feature is at least 3m wide with approximately 10m of length contained within the search boundaries, but as it clearly extends beyond these boundaries it is not possible to give an accurate description of the dimensions. The ground conditions prevented the ER survey from being extended in this direction. The anomaly is consistent with ground disturbance seen in a 1944 aerial image of the site.</td>
<td></td>
</tr>
<tr>
<td>Further survey work at this site is recommended.</td>
<td></td>
</tr>
<tr>
<td>AOI 2 &amp; 3 – These adjacent areas were surveyed using both ER and GPR equipment. A large rectilinear feature approximately 2.5m wide and at least 20m in length was identified primarily in AOI 1, although the end of this suspected historic excavation was also identified in AOI 2. This anomaly appears to be consistent with the dimensions of previously identified mass graves and can be associated with an area of ground disturbance visible on the 1944 aerial image of the site. Other anomalies were identified in AOI 3, one with the potential to be a second excavation with a similar width dimension, but it was not possible to determine the exact length. The southern area of AOI 3 displays distinctly different sub-surface properties, consistent with structures visible on the 1944 aerial image and not historic excavations.</td>
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<tr>
<td>Anomalies were identified with both geophysical methods and whilst further geophysical survey of the same areas is probably not necessary, further survey work of the surrounding area is recommended.</td>
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Annex E

**Biligorschcha**

A selected area of this rural site was surveyed using ER equipment and a smaller targeted area was surveyed using GPR equipment. The survey area was selected because of a noticeable change in the vegetation. The ground in this area was very wet, even saturated in some parts. This naturally gave rise to low resistance readings across the survey area, but a ridge of high resistance surrounded the visible vegetation change, and the suspected area generally showed higher resistance properties. Normally the loose fill of historic excavations would allow for increased water retention and generate a low resistance result. However, the natural drainage properties of the soil in this area is very poor, so in this case the expected results seem to have been reversed and the act of excavation and backfilling as actually improved the drainage over the area of the anomaly. The unevenness of the ground made ground coupling with the GPR antenna very difficult and the results from the GPR survey added nothing of any real value.

The UCSJ are in possession of wartime aerial imagery for this site but the resolution is poor and there is no discernable sign of ground disturbance in these images. The dimensions of the anomaly appear to be similar to other confirmed mass grave sites, but even with the surface signs being supported by the geophysical evidence further investigative work is recommended.

**DISCUSSION & RECOMMENDATIONS**

On the whole, the November 2014 deployment to undertake geophysical investigations at potential mass grave sites was considered to be a success. The variety of sites presented to the surveyors allowed for the demonstration of two complimentary geophysical methods that of Electrical Resistance and Ground Penetrating RADAR.

Not all of the locations produced results that added to the already known site information, but this is to be expected, and the investigator should never rely on only one method when establishing the facts, and more often than not, being able to rule out a site is often as important as confirming one. That said, good results were obtained for at least three out of the five areas surveyed.

The authors are convinced that further geophysical surveys undertaken as part of a structured investigative research project would and should play a significant part in any future research. However, as with most work of this nature it can be an expensive process in time and money. Of course time and money are often intrinsically linked, but proper project planning that includes historic research, collation of evidence and the pre-evaluation of sites would reduce this burden. Provided this planning was carried out in a structured and efficient manner, utilising the right expertise in the right circumstances, then many of the sites which currently have the potential for being lost or destroyed could be protected and saved.
The authors have produced a separate document to this report that offers much more detail on the recommendations for taking the project forward, not just from a geophysical survey perspective, but also from an archaeological and project management point of view. The intention of that document is not to provide a bespoke project plan, but to provide a framework for the development of standardised procedures and protocols. The document was written in January 2015 and is titled:

"INVESTIGATING MASS GRAVES IN UKRAINE: FURTHER RECOMMENDATIONS"

It was submitted to the UCSJ at the same time of this document.

ANNEXES

A - Bryukhovychi

B - St Marta’s Church Grounds

C - STULAG 328 POW Camp AOI 1

D - STULAG 328 POW Camp AOI 1 and AOI 3

E - Biligorshcha

APPENDICES

1. About the authors

2. Associated Drawings

ASSOCIATED DRAWINGS

Selected drawings from site report are available in a larger scale and improved resolution. They were issued to the UCSJ as separate documents.

UCSJ_11-2014_010
Biligorshcha Site Map

UCSJ_11-2014_011
Biligorshcha Electrical Resistance Survey
APPENDIX 1

About the authors

Tim Fletcher MSc
Is a leading consultant for Forensic Topographical and Geophysical Survey at Alecto Forensics Ltd (UK) and also operates as a freelance archaeological geophysics surveyor.

He has accumulated many years of experience in survey and search operations, gained primarily with the British Army whilst serving as a Military Diver in the Royal Engineers. With operations completed both at home and abroad, often in hostile environments, he has extensive experience of sub-surface search techniques including the use of side scanning SONAR, Ground Penetrating RADAR, electrical resistance and other electromagnetic search equipment.

With a Master’s Degree in Forensic Archaeology and Anthropology Tim has used geophysical survey techniques to successfully assist with the search and recovery of human remains in a number of Police investigations both in the UK and overseas. He has guest lectured on this subject at Cranfield University (UK).

Charles Enright MSc, PIFA
Is a Field Archaeologist at the Dyfed Archaeological Trust in South Wales, he has extensive experience in geophysical surveys and excavations, and supervised many archaeological projects.

He graduated from Bournemouth University in 2008 with a BSc in Archaeological and Forensic Sciences and in 2010 completed an MSc in Forensic Archaeology and Anthropology from Cranfield University. His final research project utilised a range of geophysical survey techniques to locate mass graves on historic battlefields in the England. Charles also holds a Level three NVQ in Archaeological Practice.

Previously Charles worked as a geophysical surveyor at the Cranfield Forensic Institute undertaking a range of commercial and research projects across Europe. During this time he managed many of his own projects and spent a great deal of time using geophysics to survey WWI defences on the Western Frontline.

Latterly he worked for the National Trust as a community archaeologist where he helped to establish many successful community projects. In addition to this Charles has assisted Alecto Forensics in their forensic casework.

Since 2012 Charles has been a Practitioner of the Institute for Archaeologists (IFA) and is a committee member for the IFA Forensic Archaeology Special Interest Group.

Charles was a member of the original team to deploy to Ukraine in 2012 to test the feasibility of using geophysics to locate mass graves. He then mobilised the second team to deploy in 2014 to conduct a more detailed survey.
APPENDIX 2

Associated Drawings
Selected drawings from site report are available in a larger scale and improved resolution. They were issued to the UCSJ as separate documents:

UCSJ_11-2014_001
Bryukhovychi

UCSJ_11-2014_002
St Marta’s Church Grounds

UCSJ_11-2014_003
Citadel Stalug 328 1944 Aerial image with marked AOIs

UCSJ_11-2014_004
Citadel Stalug 328 2014 Map overlay with marked AOIs

UCSJ_11-2014_005
Citadel Stalug 328 AOI 1 Electrical Resistance results

UCSJ_11-2014_003
Citadel Stalug 328 1944 Aerial image with marked AOIs

UCSJ_11-2014_004
Citadel Stalug 328 2014 Map overlay with marked AOIs

UCSJ_11-2014_006
Citadel Stalug 328 AOI 2 and AOI 3 Combined GPR results

UCSJ_11-2014_007
Citadel Stalug 328 AOI 2 GPR time slices – C scans

UCSJ_11-2014_008
Citadel Stalug 328 AOI 3 GPR time slices – C scans

UCSJ_11-2014_009
Citadel Stalug 328 AOI 2 and AOI 3 Interpretation and combine ER-GPR results

UCSJ_11-2014_010
Biligorshcha Site Map

UCSJ_11-2014_011
Biligorshcha Electrical Resistance Survey