UXO Location using Total Field Magnetics in SE Asia

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SUMMARY

Unexploded Ordnance (UXO) is a major problem in a large number of areas throughout the world and SE Asia is no exception. As most of the older ordnance is of ferrous composition, total field magnetics is an eminently suitable tool for its location.

During the past few years work has been carried out on two major infrastructure development projects in SE Asia, one being in Hong Kong and the other in Taiwan. The projects have involved the use of tightly spaced total field magnetic traverses to locate buried UXO. The located items were then removed to allow for safe operations on the sites.

Both sites were intended for public access and thus required a high level of confidence that no UXO remained buried on site.

Both clients have adopted the results of the survey as an approved methodology for the location and removal of buried UXO.

Key words: Unexploded Ordnance, UXO, Total Field Magnetics, SE Asia.

INTRODUCTION

In SE Asia, like many other parts of the world, land has been contaminated with unexploded ordnance (UXO) through many activities including wars, military training and in some cased, the dredging of sea dumped ordnance.

These UXO items need to be located and removed to make way for infrastructure developments or recreational areas so as to render the area safe for development and the use of future generations.

Work has been carried out in a number of SE Asian countries by the authors over the last three years with total field magnetics and electro-magnetics to locate UXO items for excavation and disposal thus rendering the ground safe for development or habitation.

The two sites that are being discussed include a site infrastructure development site in Hong Kong and a recreational site in Taiwan.

The Hong Kong project was over land reclaimed with sand from the offshore seabed. The area from where the sand was dredged was contaminated with UXO originating from WWII. Ordnance ranged in size from hand grenades to 150mm projectiles. The borrow area had previously been used for sea dumping ordnance. This sand was used to reclaim an area for further development. Geophysics was used to locate ordnance and provide an auditable result of the clearance of the site. As the site was a heavily trafficked area, and disruption to the construction schedule was to be minimised, non-standard techniques had to be used in the data processing to ensure all ferrous objects were located.

The site in Taiwan was a more standard application of total field magnetics; it comprised a beachfront 3.0 kilometres in length and covering an area of 75 hectares. During the project over 4,000 mines (including anti-personnel and anti-tank mines) and 45 bombs were located, a large percentage by total field magnetics.

METHOD

A Caesium Vapour Total Field Magnetometer, the AGS-1 System, was used for these projects. The unit consists of two (or more) Geometrics G-822L magnetometer sensors and pre-amps, connected to a proprietary acquisition system and hand held data logger.

Photograph 1 – AGS-1 in the field, note the sensor separation on this photo is 0.5 metres.

The line spacing on the surveys undertaken in SE Asia was 1.0 metres and a sampling interval along line of 0.1 metres.

For the surveys undertaken in SE Asia a cotton thread odometer was used to provide positioning control down the survey line and local grids was used. In the case of Hong Kong the grids were later positioned with DGPS.

The data processing software package AGSProc, which was developed by Stephen Lee of AGS, was used for all the ordnance related surveys and it is specifically designed for the location of ordnance type items in the near surface.

The AGSProc can model the magnetic dipoles in 2D or 3D and for most of the work undertaken in SE Asia the 3D modelling has been used. A point dipole model is used and the depth, mass and inclination is used to generate a model which best fits the original magnetics anomaly.

The AGSProc software package produces an Interpretation and Excavation Report in a MS Word or MS Excel file format for further input of the 'Source Confirmed' details and is included in the Final Report for the survey. See Figure 1 for an example of an Interpretation and Excavation Report.

The mass on the report is a theoretical mass and can vary depending on the aspect ratio of the buried ferrous body. However in general the calculated depth is usually within 10% of the actual depth of the item.

AGS-1 MAGNETIC ORDNANCE DETECTION SURVEY
INTERPRETATION AND EXCAVATION REPORT
BACTEC SE Asia Pty. Ltd.

Interpreter:	Timothy Pippett	**Project:**	Demonstration
Date:	15 April 2003	**Project-Id:**	AG-062
Sensor-Elevation:	0.50m	**Noise Threshold:**	2.00nT
Depth is:	Below Ground	**Line-Spacing:**	1.00m
Page:	1 of 1	**Area:**	Demonstration

No.	COORDINATES UTM E(m)	N(m)	Theor. MASS kg	DEPTH m	SOURCE CONFIRMED OBJECT	DEPTH m	INTERPRETATION COMMENTS
1	822180.9	861346.5	16.7	0.3	Scrap	0.3	
2	822186.5	861346.6	47.6	0.4	Brick infill (Crater ?)	0.6	
3	822156.0	861346.8	12.1	0.2	Scrap	0.1	
4	822152.1	861346.8	10.2	0.2	Scrap	0.1	
5	822188.8	861346.8	9.6	0.2	Scrap	0.2	
6	822174.7	861346.9	231.6	4.4	**German 250 kg Bomb**	4.5	
7	822170.1	861347.0	28.7	0.3	Scrap	0.3	
8	822192.2	861347.0	24.2	0.5	Brick infill (Crater ?)	0.7	
9	822155.--	861348.0	412.5	4.5	**WWII Pipemine**	8.5	
10	822171.2	861348.2	36.6	0.7	Brick infill (Crater ?)	0.8	
11	822176.1	861348.3	1.4	0.2	**Practice Bomb**	0.2	
12	822164.6	861348.4	6.7	1.3	Scrap	1.4	
13	822165.7	861349.0	1.4	0.3	**Practice Bomb**	0.3	
14	822187.0	861349.1	1.7	0.3	**Practice Bomb**	0.3	
15	822180.3	861349.2	3.9	0.3	Scrap	0.3	
16	822172.8	861349.2	0.1	0.1	**Tail Fin**	0.1	
17	822162.3	861349.2	0.7	0.7	**Practice Bomb**	0.6	
18	822174.6	861349.2	0.2	0.1	Wire	0.1	
19	822195.8	861349.4	5.9	0.7	Scrap	0.8	
20	822157.8	861350.5	5.5	0.7	Scrap	0.6	
21	822152.0	861351.0	5.6	1.0	Scrap	1.1	
22	822178.2	861351.0	1.4	0.0	**Practice Bomb**	0.0	
23	822198.4	861352.0	2.5	0.6	**Practice Bomb**	0.5	
24	822192.6	861352.7	1015.6	3.8	Foundation Base	3.9	
25	822155.5	861352.7	2.8	0.6	Barbed Wire	0.4	
26	822171.1	861352.8	2.7	1.0	Steel Post	1.1	
27	822165.0	861353.6	0.5	0.3	Scrap	0.3	
28	822160.5	861354.0	1.2	0.1	**Practice Bomb**	0.1	
29	822180.6	861354.4	4.9	0.6	Scrap	0.5	
30	822151.7	861354.7	0.1	0.0	**Anti-aircraft Shell**	0.0	
31	822173.8	861354.8	0.5	0.1	**Anti-aircraft Shell**	0.1	
32	822175.2	861354.9	1.2	0.3	**Practice Bomb**	0.2	
33	822168.7	861355.0	1.1	0.1	**Practice Bomb**	0.2	
34	822179.2	861355.2	0.1	0.0	Steel Peg	0.0	
35	822193.4	861355.8	779.5	1.8	Buried Water Tank	1.7	
36	822165.7	861356.3	1.2	0.5	**Practice Bomb**	0.6	
37	822156.1	861356.3	2.0	0.6	**Practice Bomb**	0.6	

Figure 1 – Example of an Interpretation and Excavation Report with the Sources Confirmed

RESULTS

Hong Kong

Due to the Hong Kong site being a construction site during the entire period of the survey, there was a large quantity of construction waste lying around on the site. This waste included nuts and bolts of equivalent size and shape of the smaller ordnance items (hand grenades, CS gas canisters etc) being located. Therefore there were significant false alarms in the interpretations however upward of 180 ordnance items were located in the areas surveyed. It should be noted that in most cases the areas were searched and cleaned with conventional methods before the AGS-1 surveys were conducted.

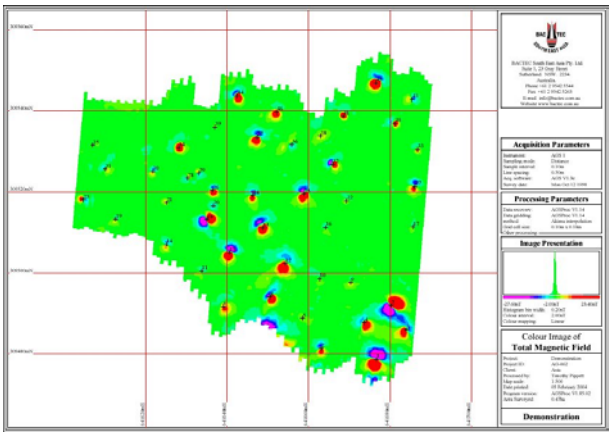

Figure 2 – Example of a Total Field Image

Taiwan

The Taiwan survey was undertaken over a known UXO contaminated site which included six anti-personnel minefields (previously cleared to a depth of 300 mm.) with a large number of other ordnance items from projectiles to 250 lb. bombs.

The site was surveyed and all interpretations which were possibly ordnance character were excavated and disposed of, either on site if they were to dangerous to move or moved to a demolition area for disposal.

A number of passes were made over the sensitive areas such as the minefields to confirm the removal of all items. A number of the sites were heavily contaminated with ordnance and rubbish at various depths and therefore clearance took place as a staged approach.

CONCLUSION

The clients on both these sites recognised the importance of the geophysical surveys in reaching their objectives of making the areas safe for the General Public.

On the Hong Kong site, it would have been impossible to locate the ordnance items without the use of the geophysical survey and its ability to interpret items buried at 3 metres. The geophysics also provided an audit trail of which areas had been surveyed and which had not. This was combined with the drawing files of the site to provide a complete picture of the survey.

On the Taiwan site, the minefields and any other visual surface item was removed before the geophysical survey was undertaken. The geophysical survey was able to locate a large number of deeper buried mines and other ordnance items. Again the survey provided a clear audit trail of the work and what was located by the geophysics.

On both sites, the clients considered the surveys to be successful and would be using the geophysical technique in future on other projects.