

Unexploded Ordnance (UXO) Detection in Marawi City, Lanao del Sur Using Ground Penetrating Radar and Magnetometer

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The Manila Hotel

Contents



01 Introduction

Project Overview | Objectives | Scope & Limitation | Location

02 Methodology

Data Acquisition | Equipment | Processing & Analysis

03 Results & Interpretation

GPR | Magnetometry | Extraction & Detonation

04 Way Forward

Conclusion | Recommendation | Other Applications

A black and white photograph of a drone flying over a city. In the background, a large, ornate dome is visible, surrounded by residential buildings. In the foreground, there is a large area of destruction, with rubble and damaged structures. The drone is a quadcopter with a camera mounted on the front. The image is overlaid with a dark grey semi-transparent box containing text. There are orange and blue geometric shapes on the left and right sides of the image.

Introduction

Project Overview | Objective | Scope & Limitation |
Location

Ground Zero – Most Affected Area
Rehabilitation of 230ha commercial and residential land

01

Task Force Bangon Marawi
Headed by National Housing Authority
Public and private groups

02

03

Debris Management
UXO clearing
Demolition of structures

04

UXO Clearing
Armed Forces of the Philippines
Explosive Ordnance Disposal team
Improvised equipment devices (IEDs) and general purpose bombs

Project Overview

“To detect and identify buried unexploded ordnance through airborne GPR and magnetometry

“To assess the applicability of geophysical techniques to military purposes

Objective



```
graph TD; A[70 AFP coordinates] --> C((Ground Zero)); B[95 EOD visuals] --> C; D[50m x 50m tiling] --> C;
```

70 AFP
coordinates

95 EOD
visuals

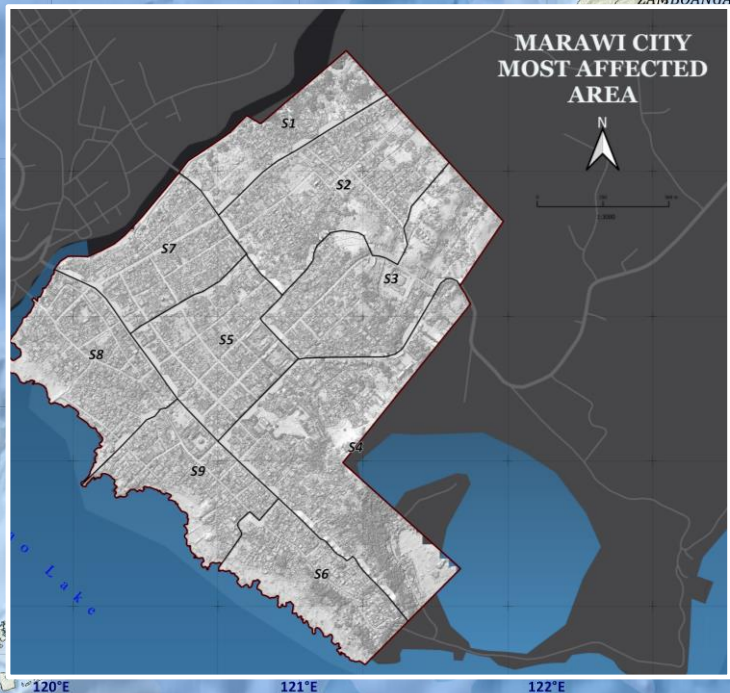
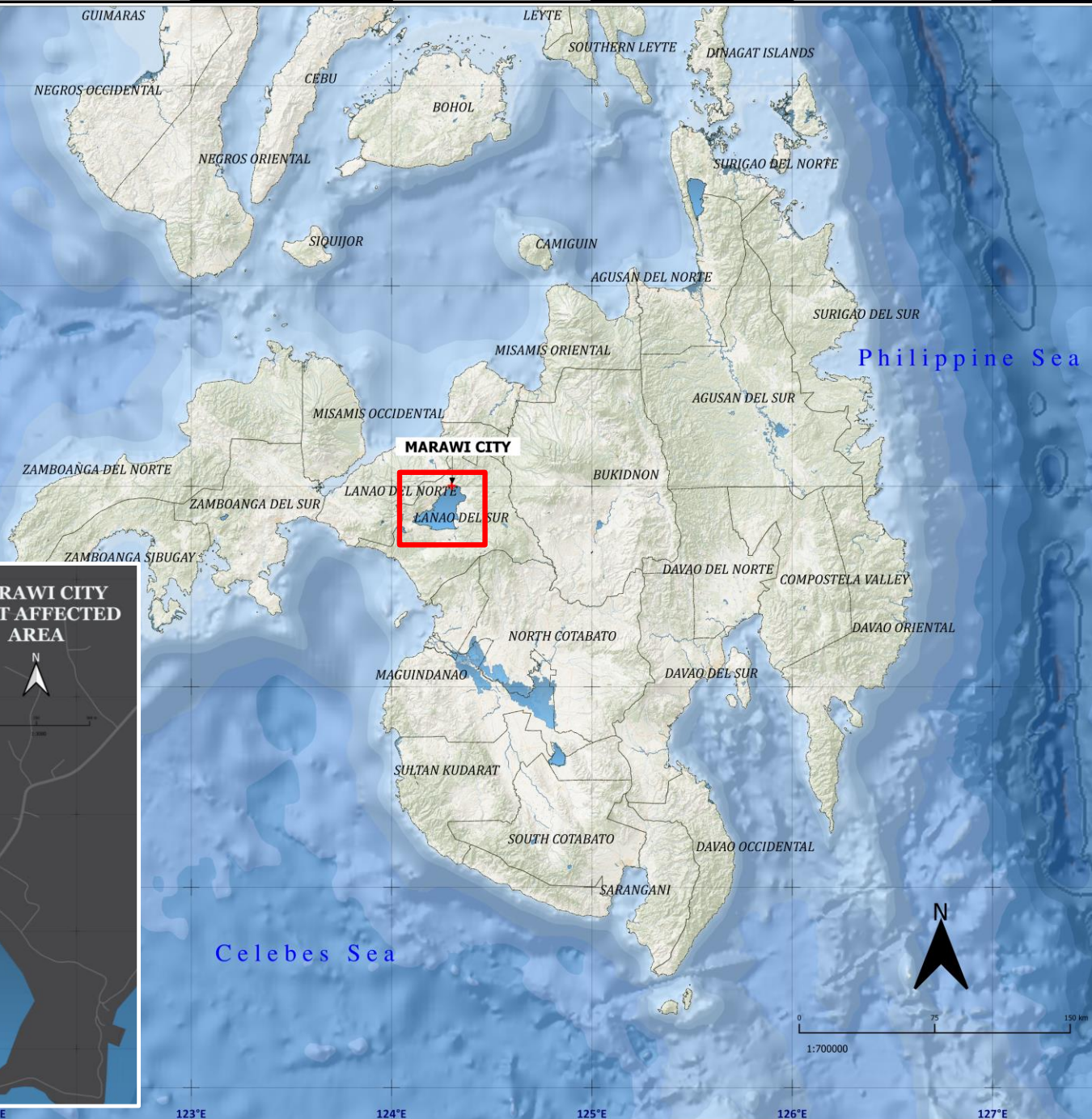
50m x 50m
tiling

Ground
Zero

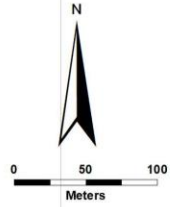
Scope & Limitation



Location



Ground Zero



884,500
884,000
883,500
841,200
842,100
843,000
843,900



Methodology

Data Acquisition | Equipment | Processing & Analysis

LiDAR Mapping

Accuracy (cm):
10.00
Frequency (khz):
400 - 820
Flight altitude (m):
150.00
Min overlap:
40%
Total area (m2):
2,305,100

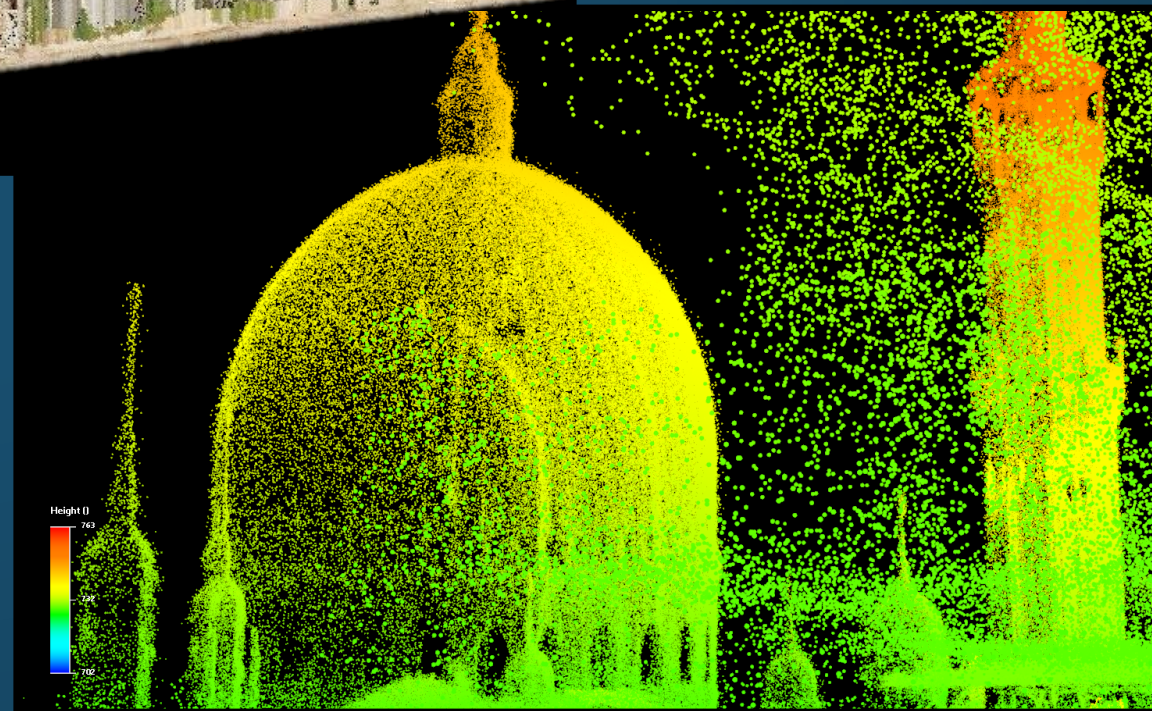
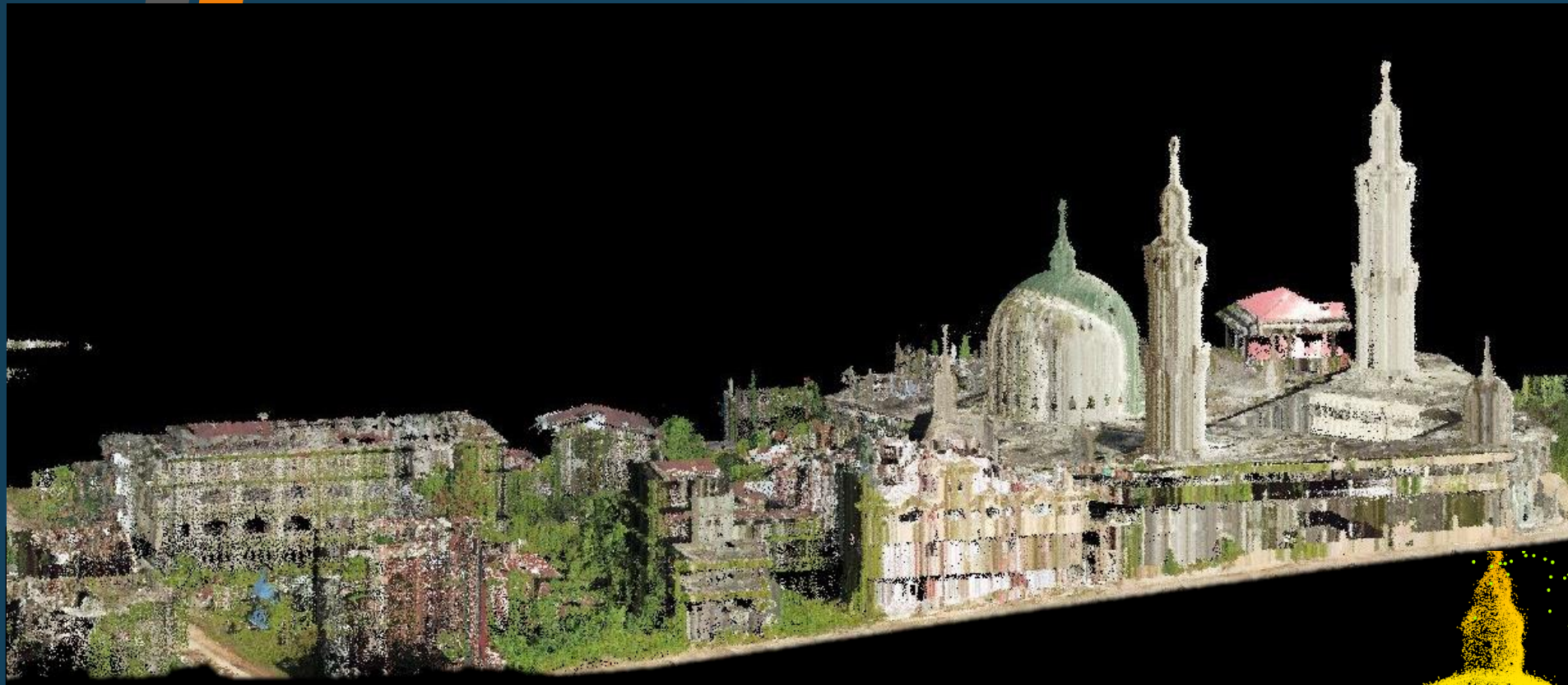
GPR Scanning

Accuracy (cm):
10.00
Frequency (mhz):
70 - 800
Time window (ns):
400 - 1600
Grid spacing (m):
0.07
Flight altitude (m):
15.00 - 20.00
Tile area (m2):
2500

Magnetometry

Accuracy (cm):
10.00
Visible range (nT):
±30,000
Resolution (nT):
0.20
Line spacing (m):
0.20
Tile area (m2):
16.00

Data Acquisition

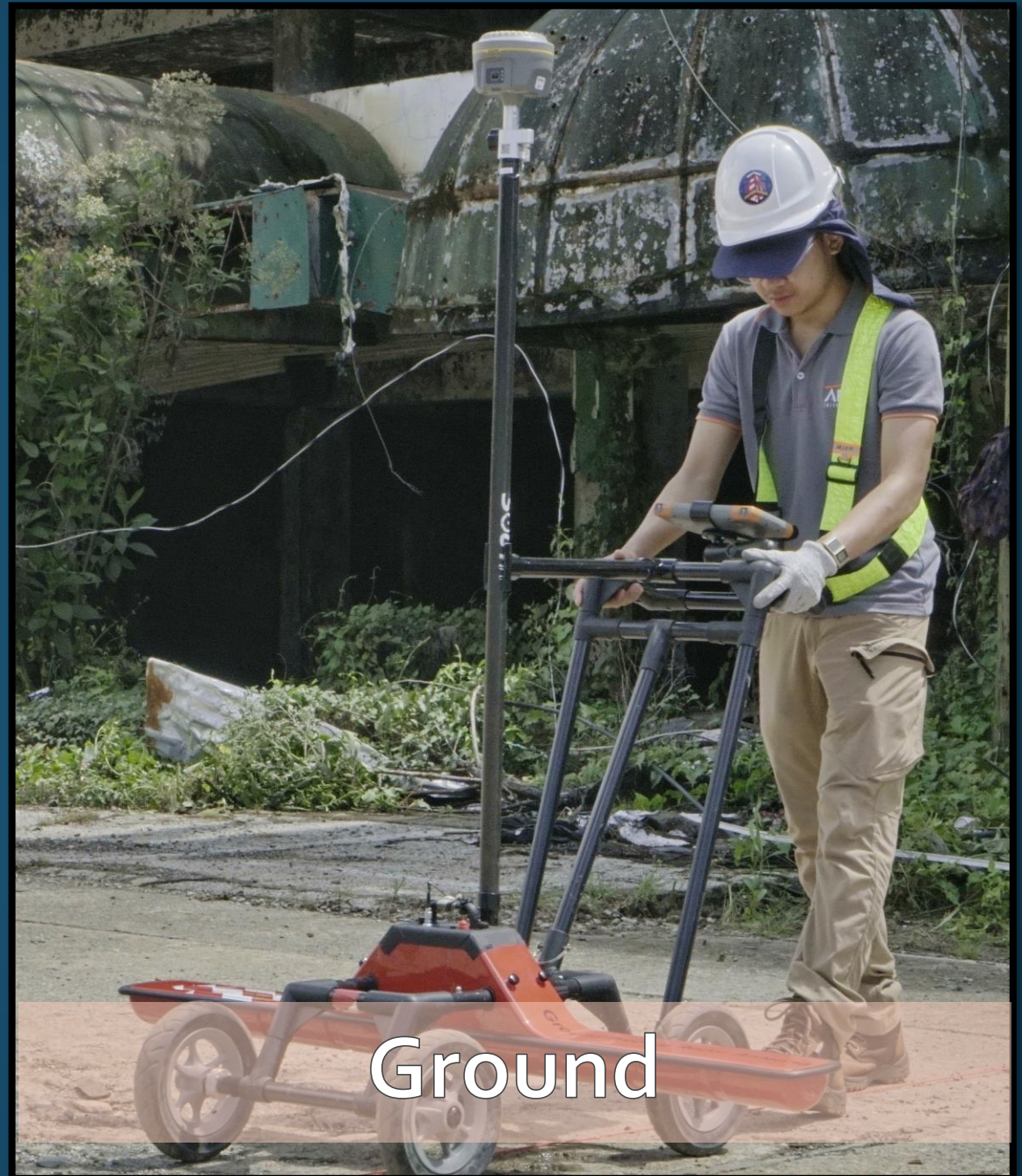


LiDAR mapping



Aerial

GPR scanning



Ground



Magnetometry



RTK-GPS



UAV-based LiDAR & GPR

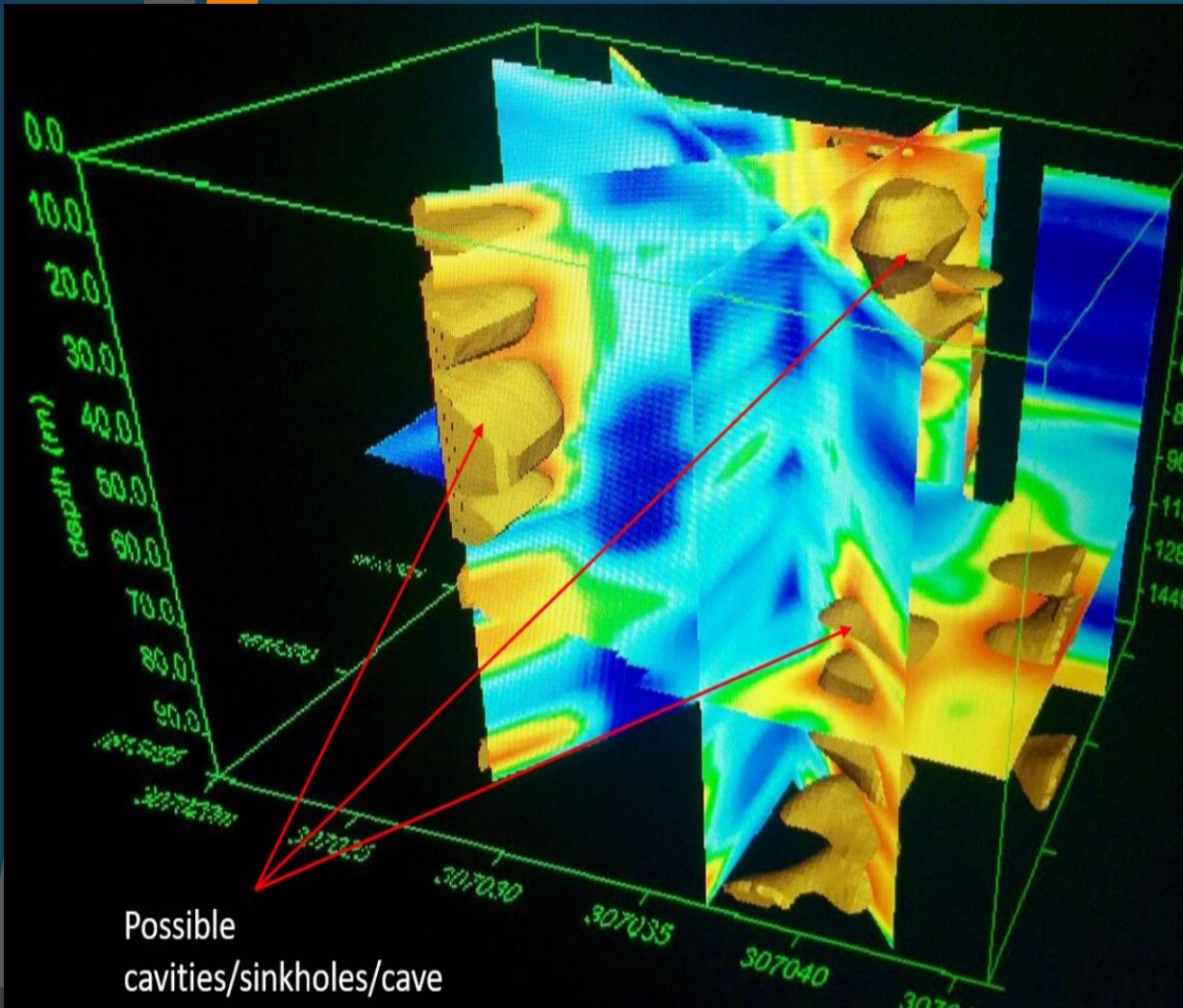


Heavy Machinery



Magnetometer

Equipment



Processing and Analysis

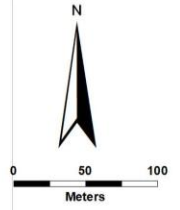


Extraction



Results & Interpretation

GPR | Magnetometry | Extraction & Detonation

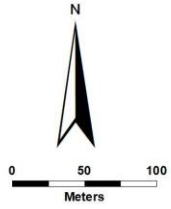


AFP DROP POINT


-  110LB UXO
-  260LB UXO
-  500LB UXO



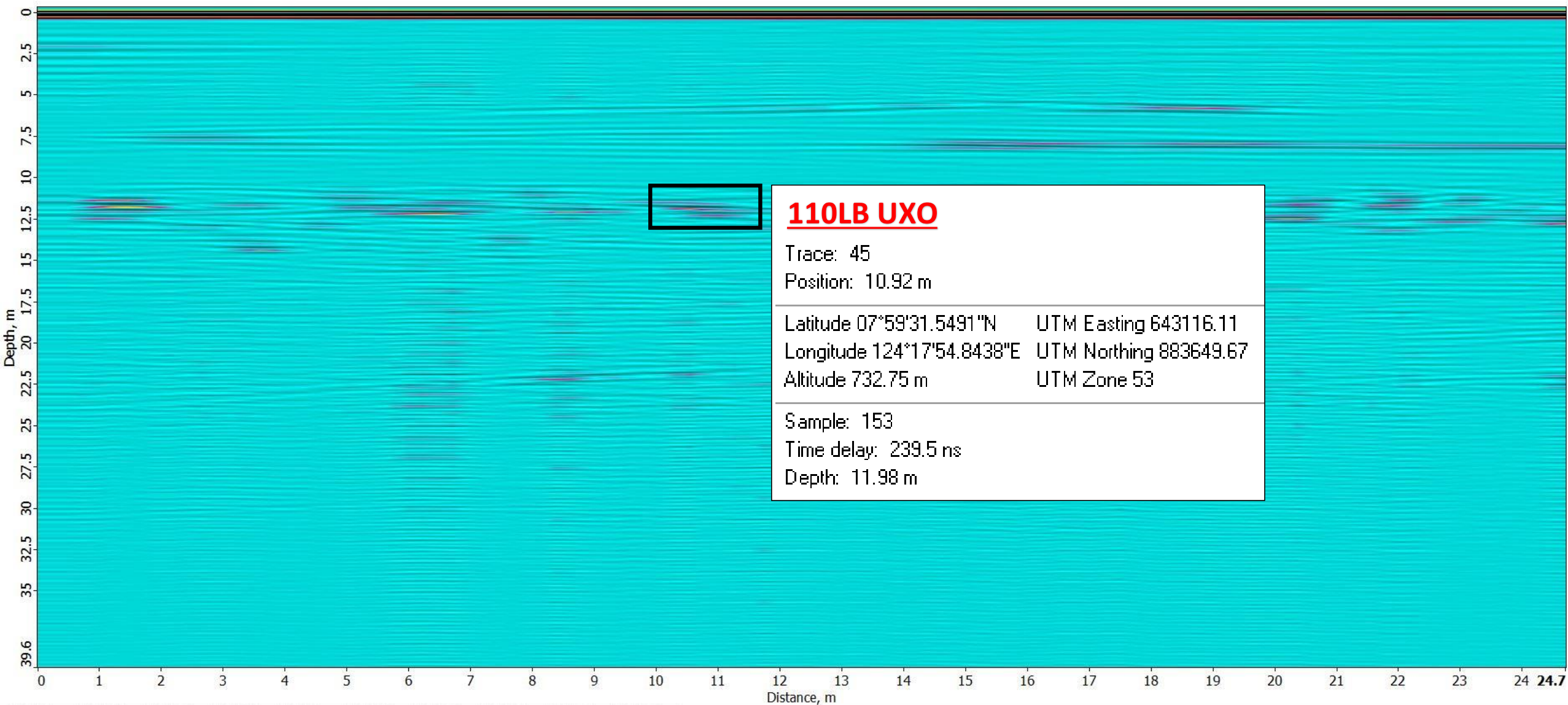
884,500 885,000 885,500

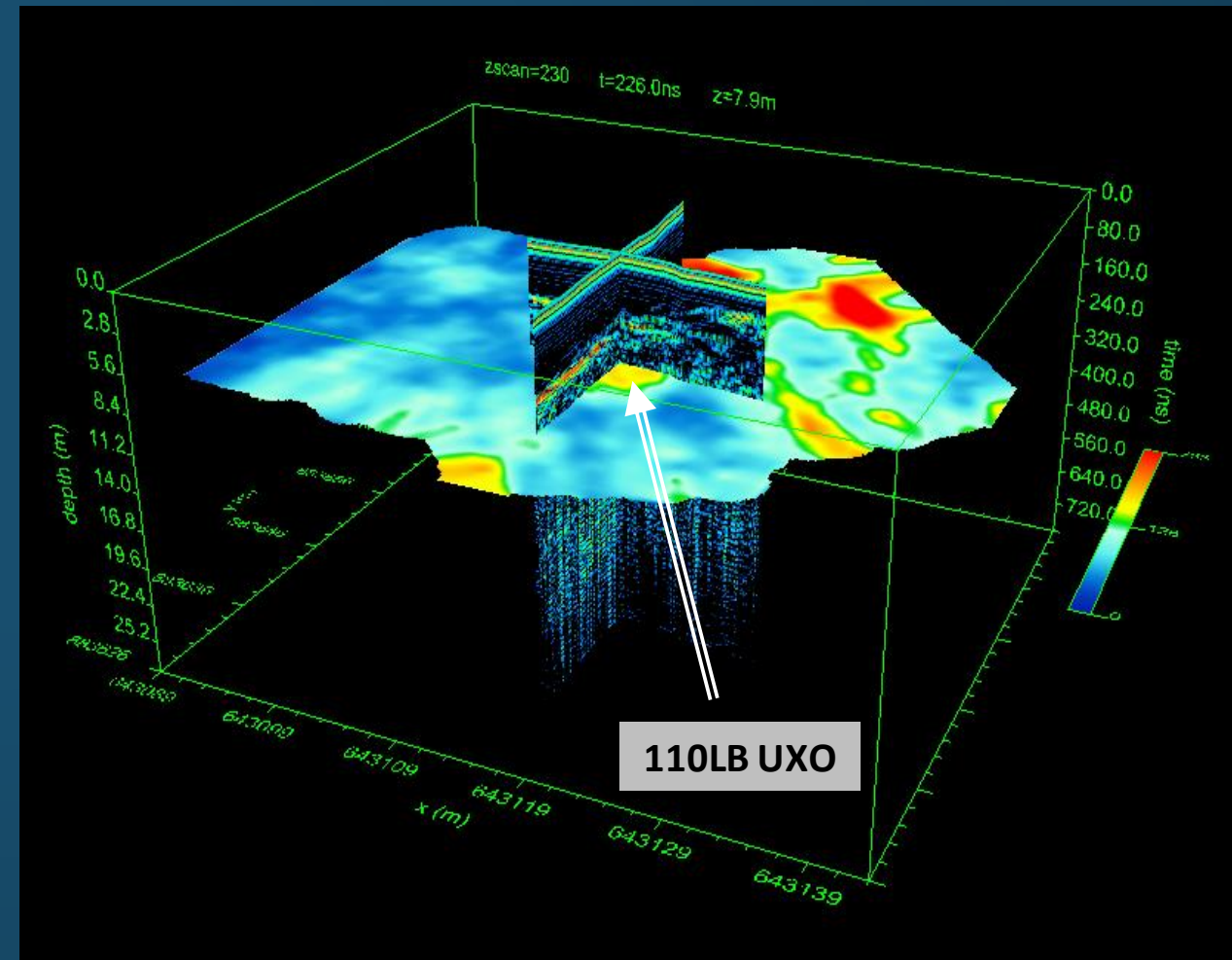
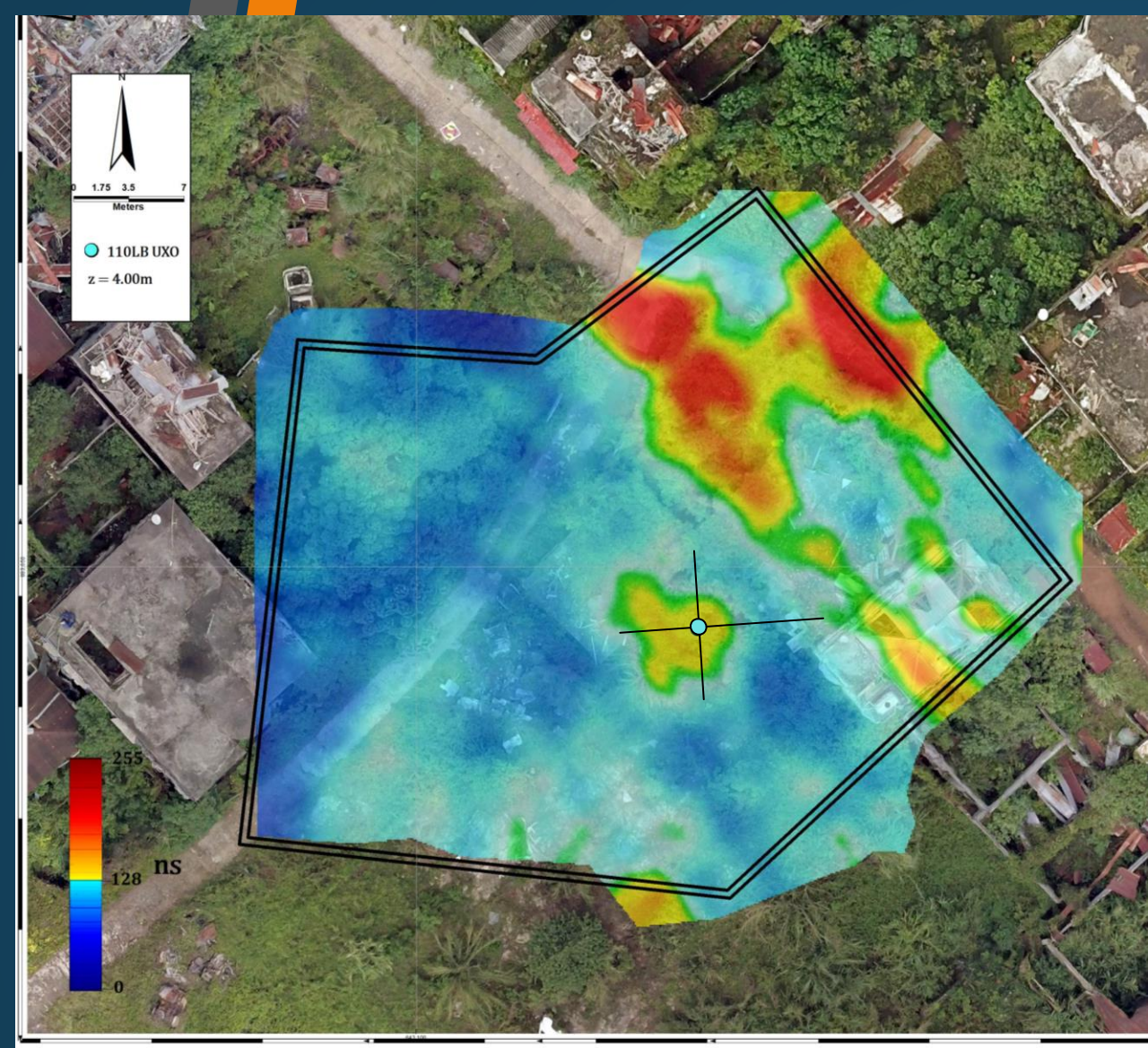


AFP DROP POINT

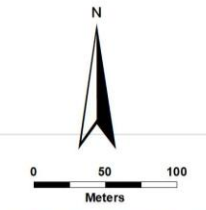
 110LB UXO







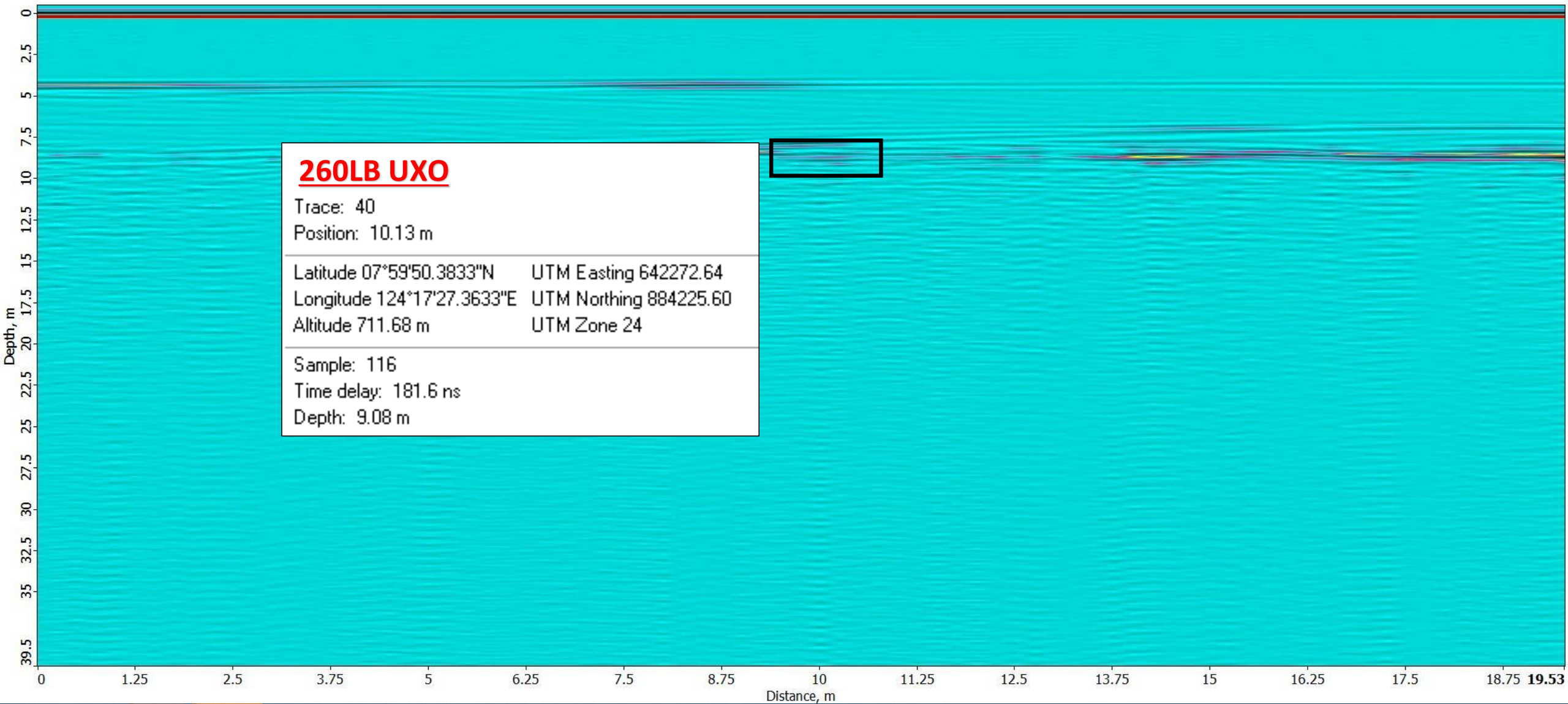


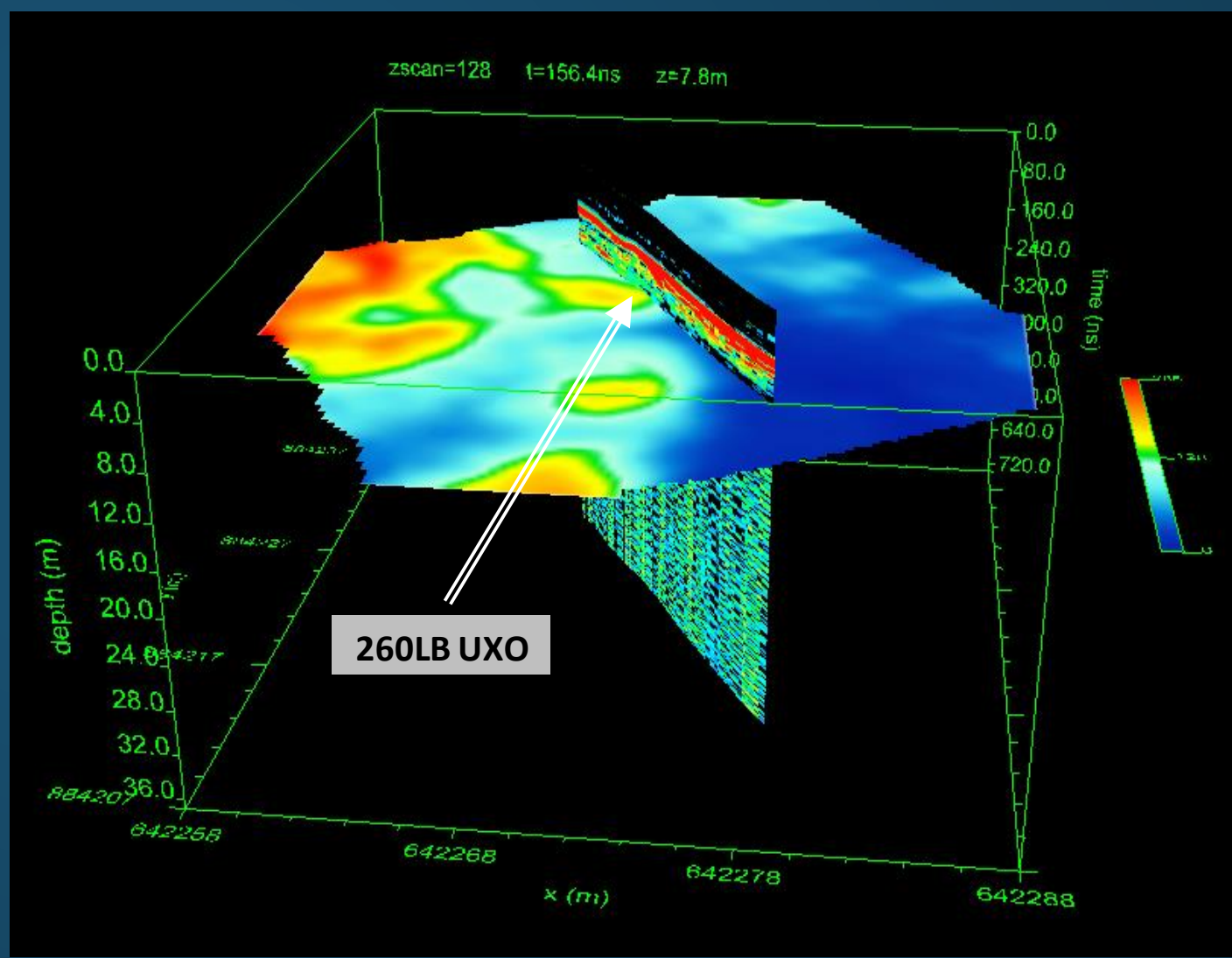
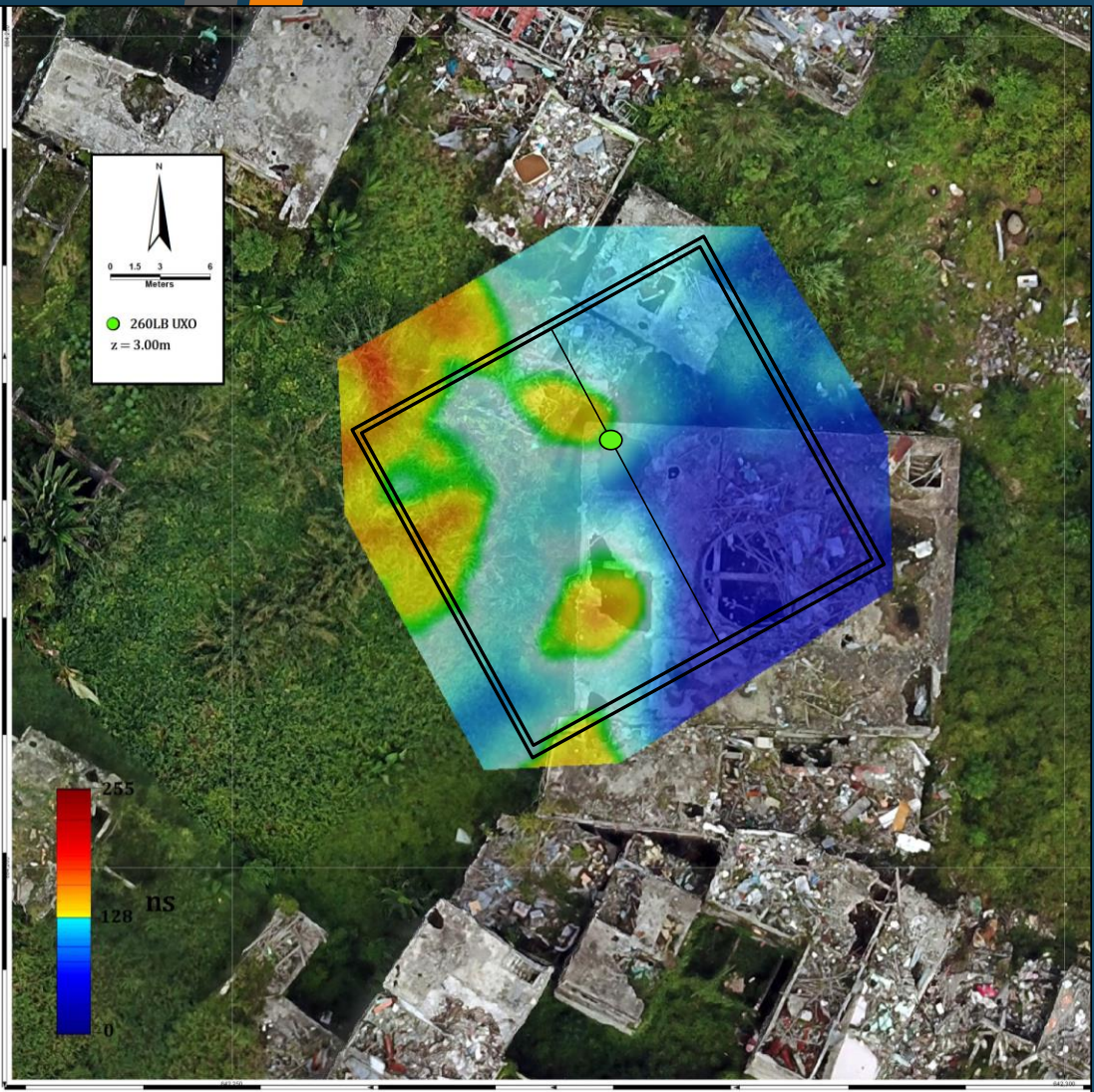


AFP DROP POINT

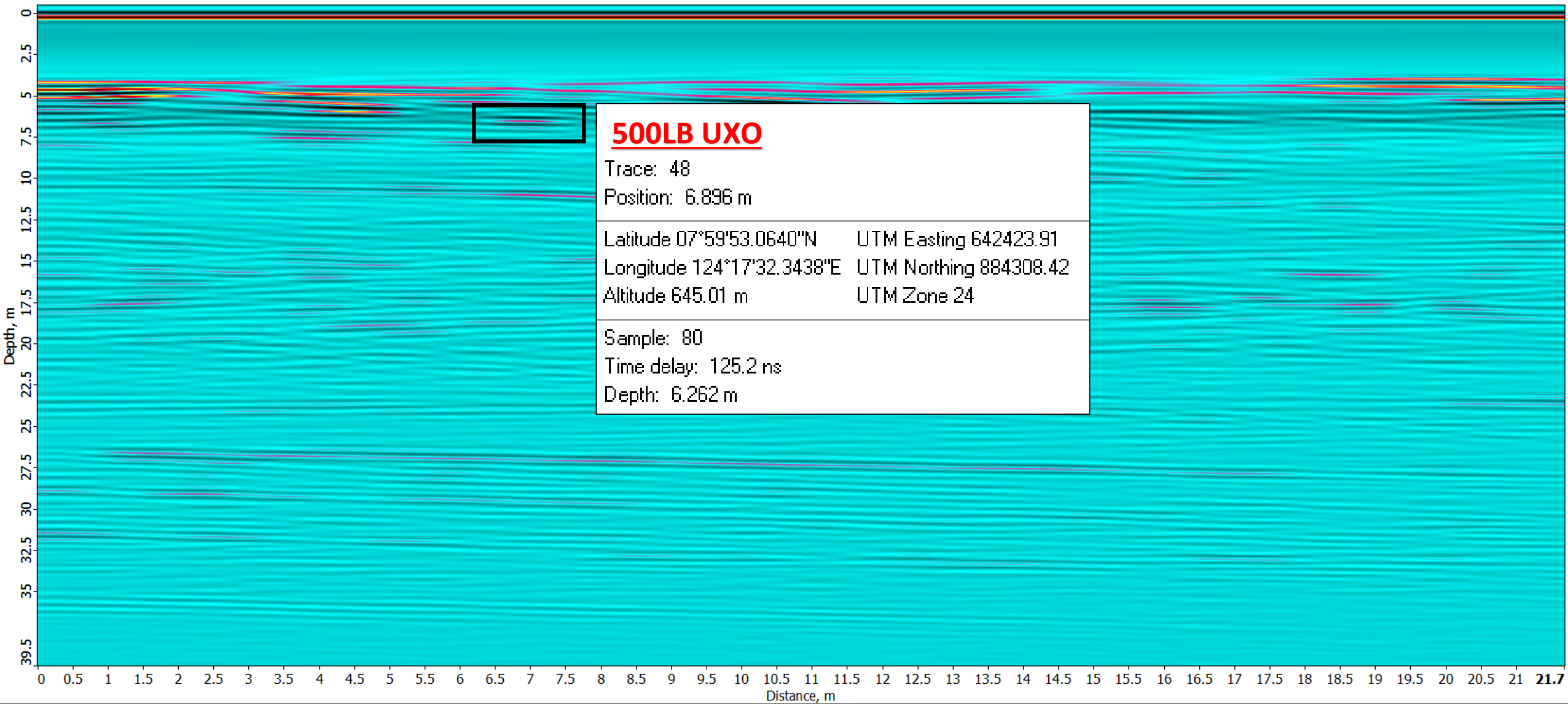
-  260LB UXO
-  500LB UXO

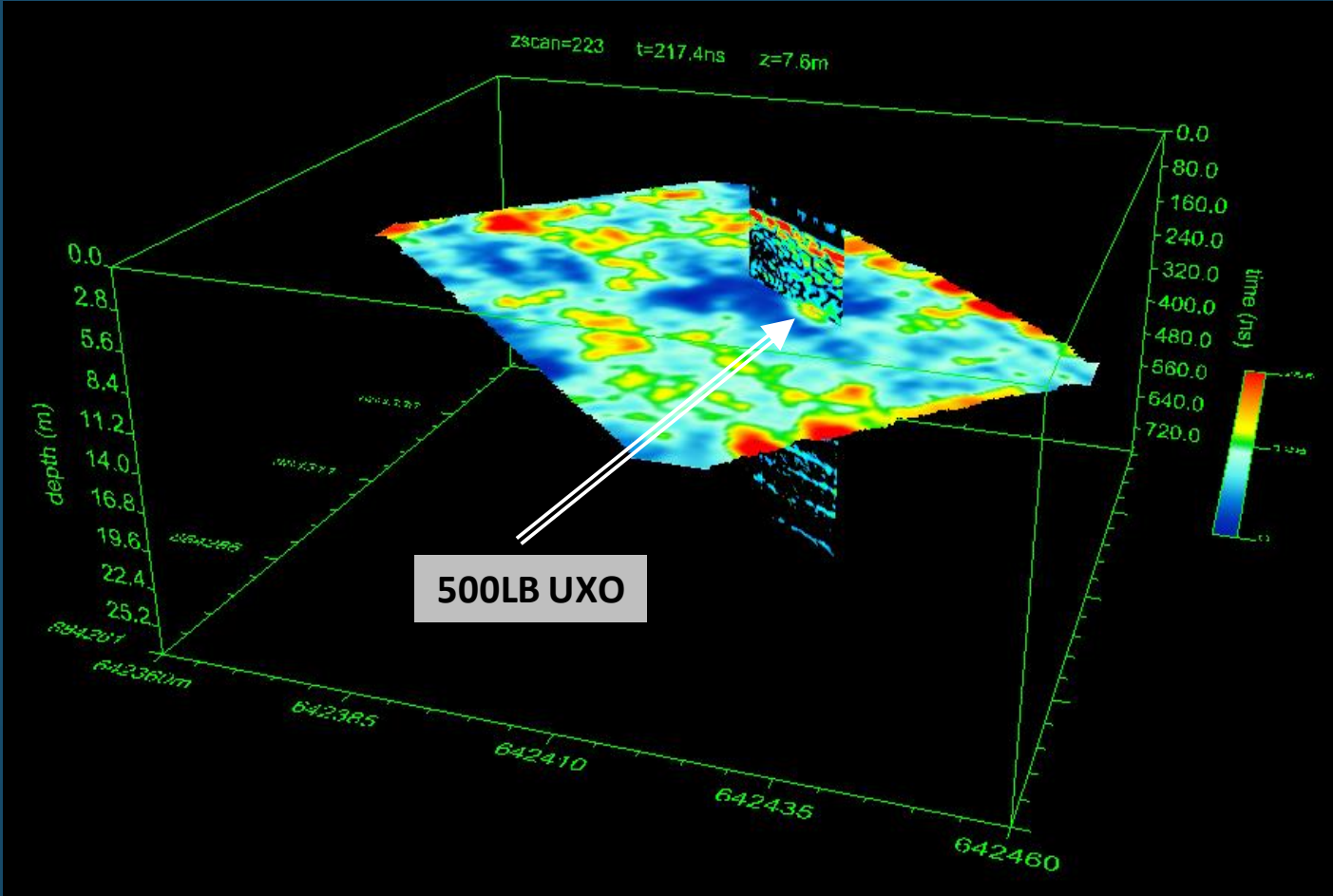
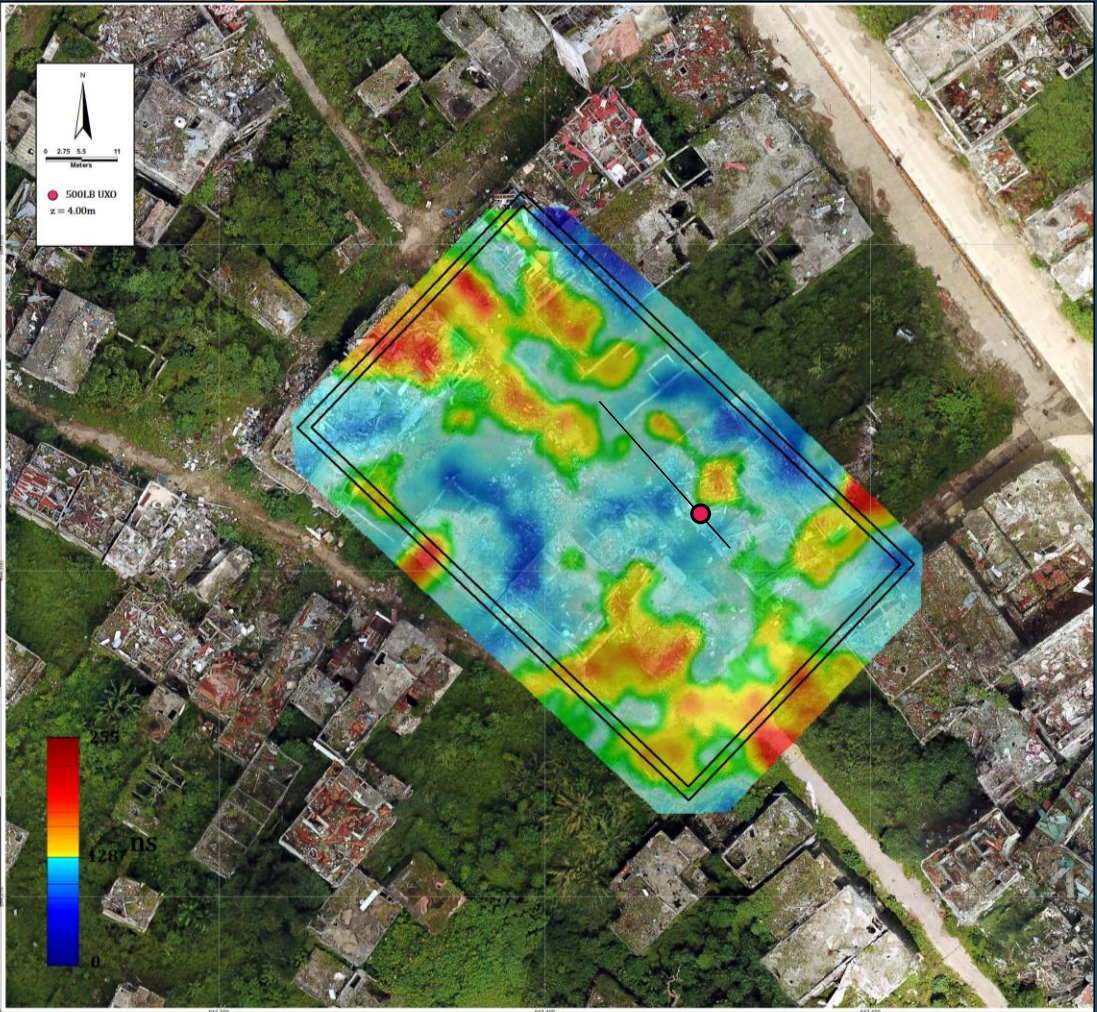




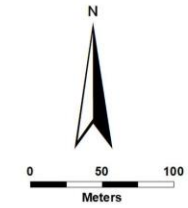









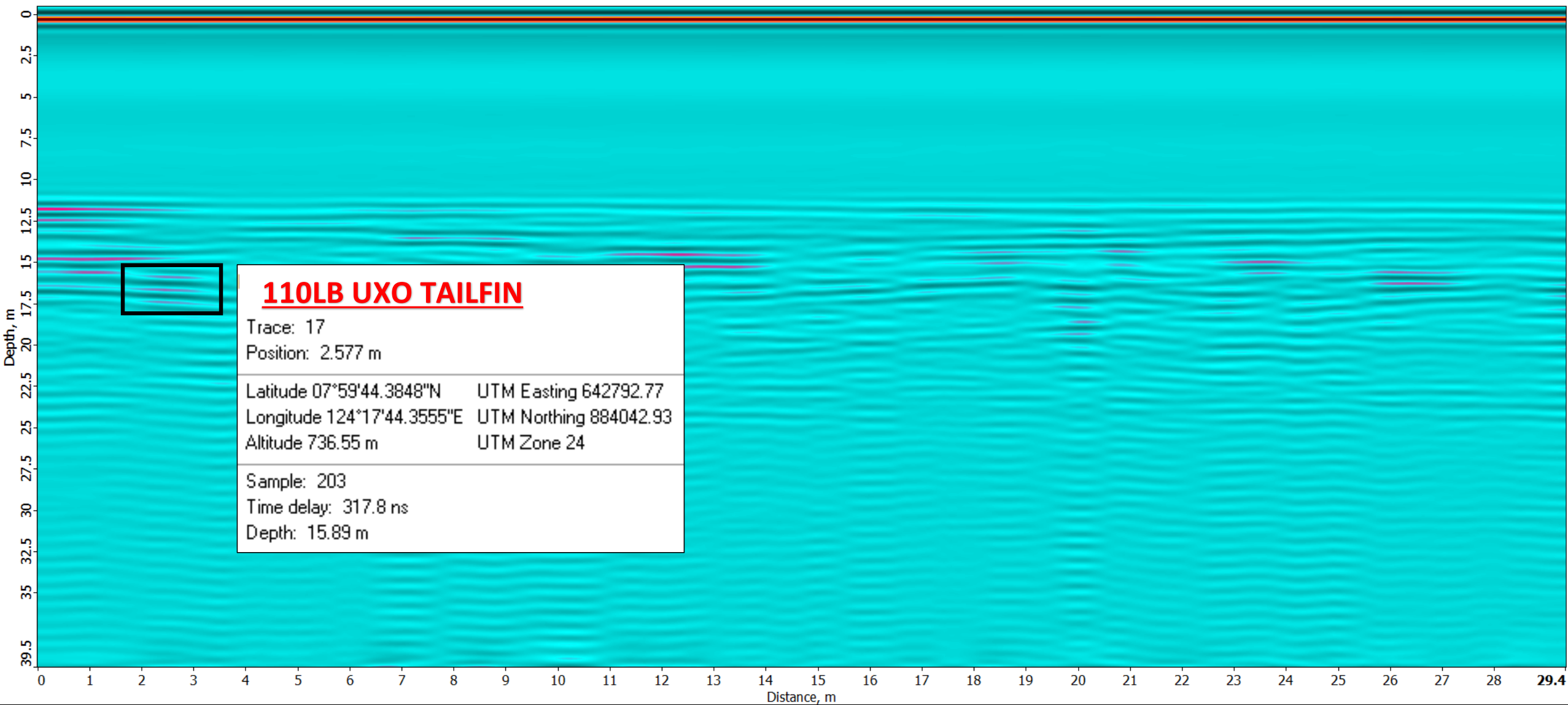


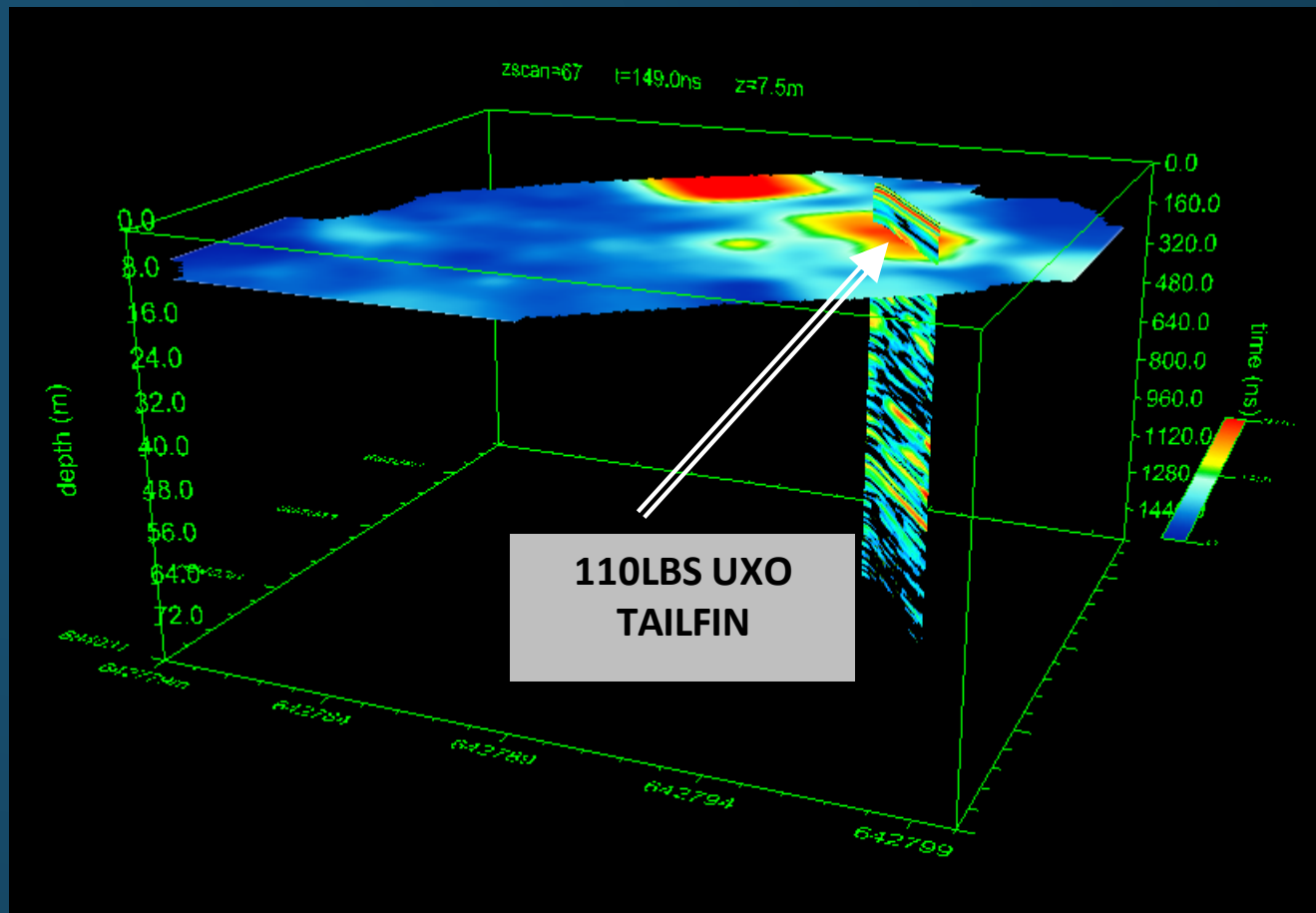
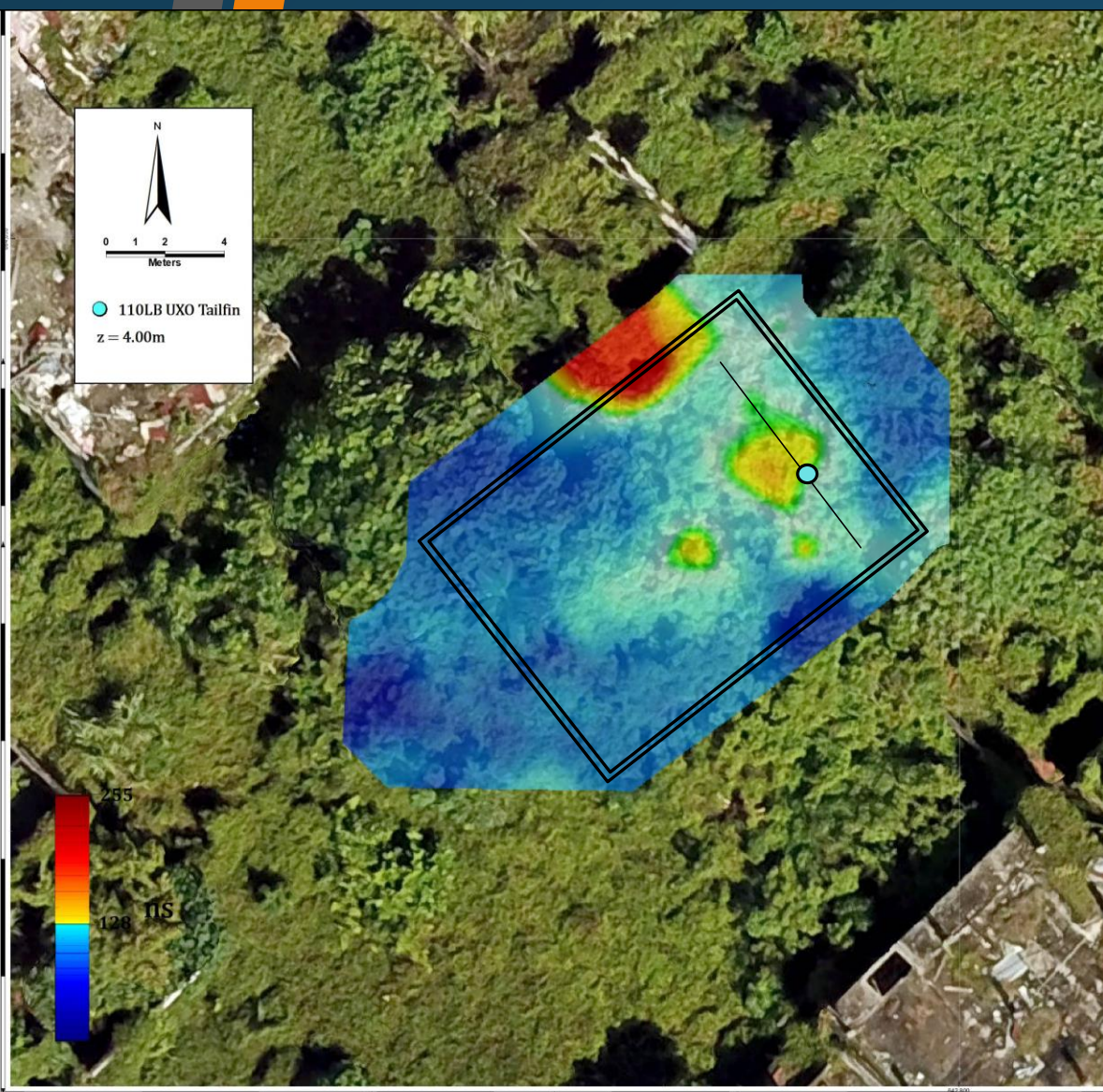


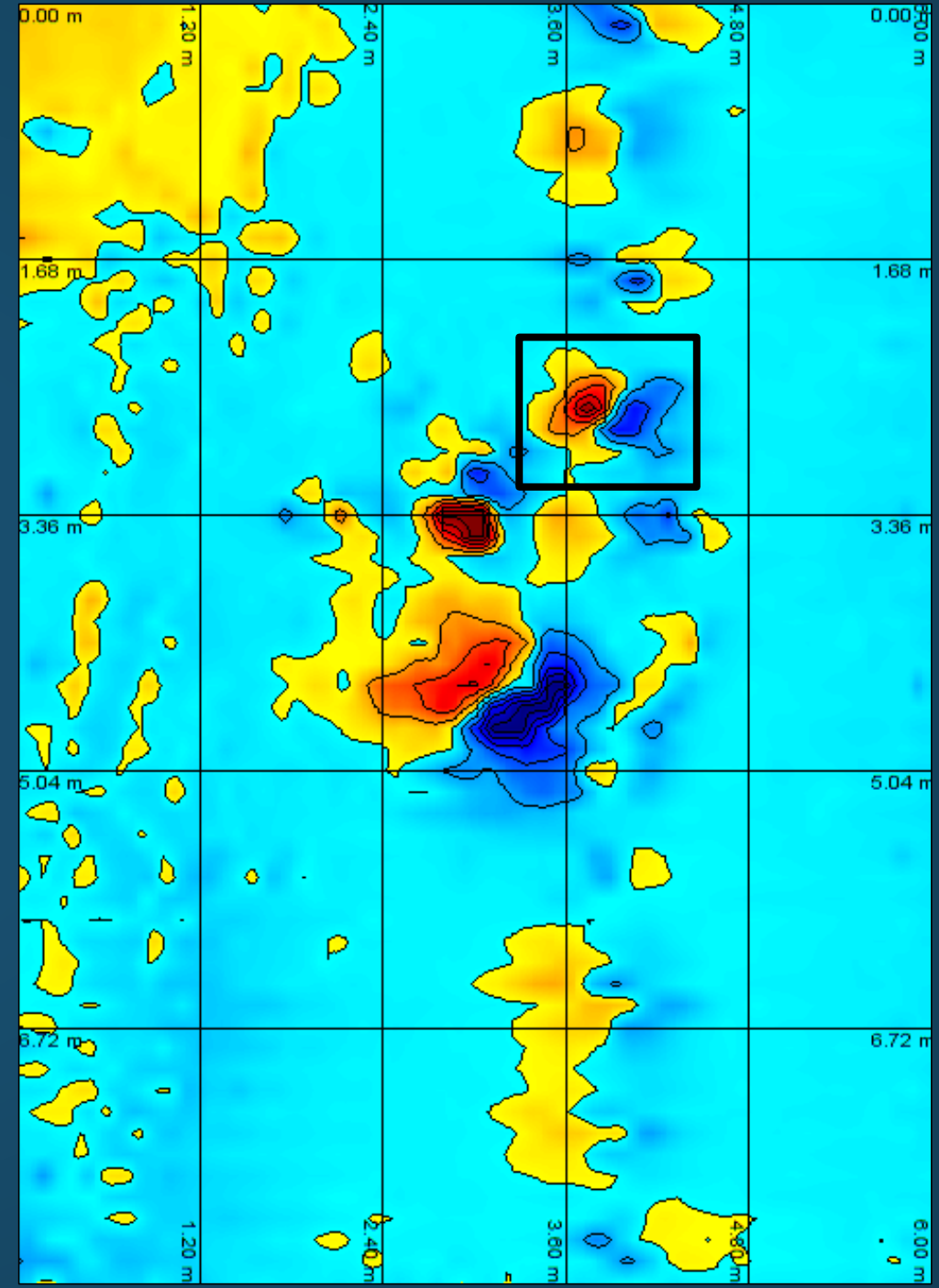
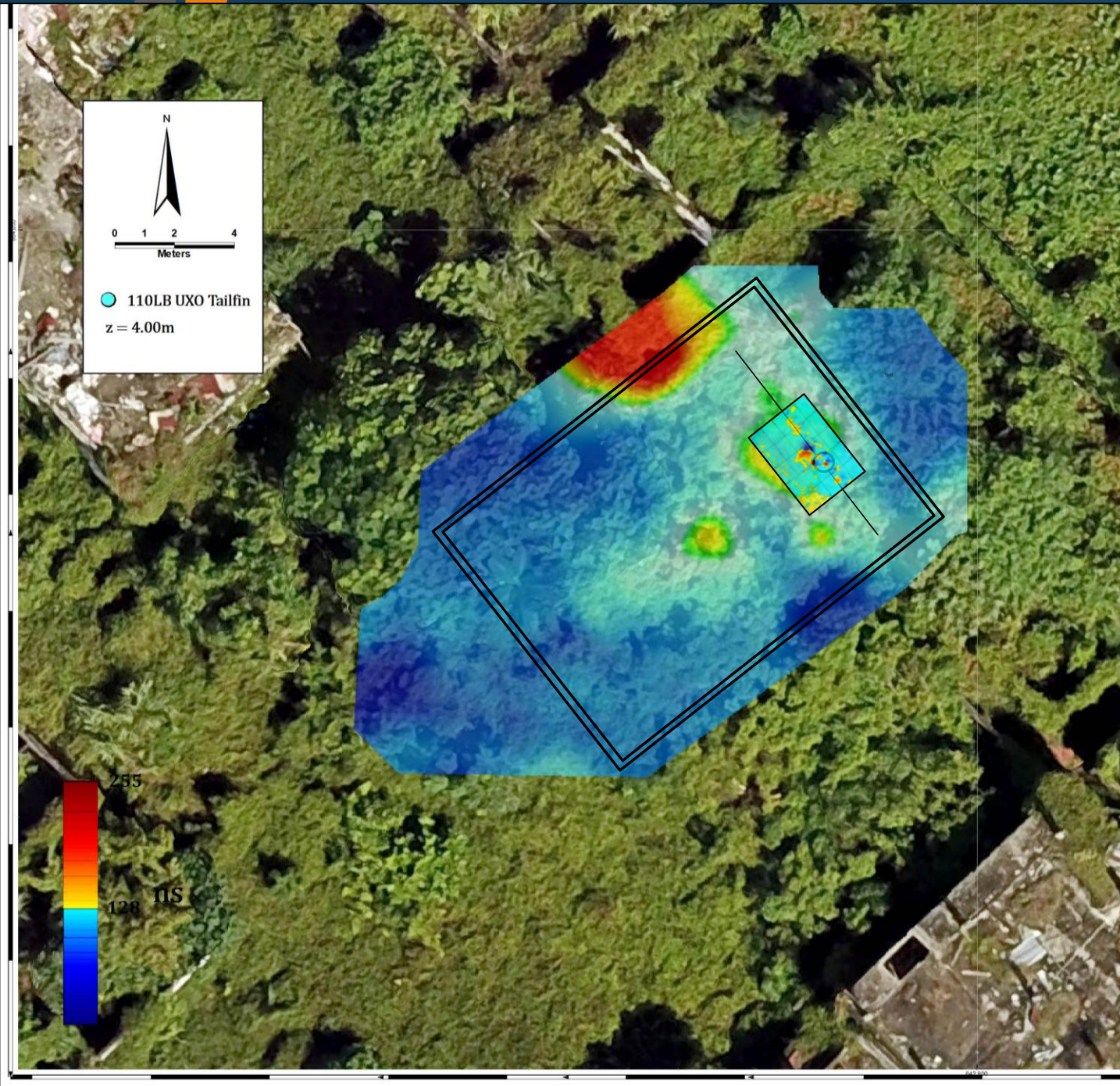
AFP DROP POINT

 **110LB UXO**













Way Forward

Conclusion | Recommendation | Other Applications

“At 90% success rate,
aerial GPR and
magnetometry capable
of detection and
identification of UXO

“The combination of
techniques applied
proved effective on
military purposes

Conclusion

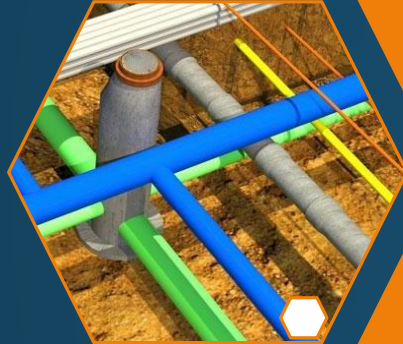




Recommendation

“Extended scanning area(>50m), since UXO can travel several meters from the entry point depending on ground conditions

“Clearing and excavation of areas to be scanned for deeper penetration of EM waves and higher data resolution



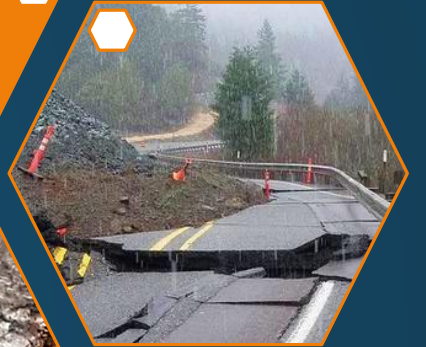
Geohazard
Mapping (e.g.
Fault mapping)



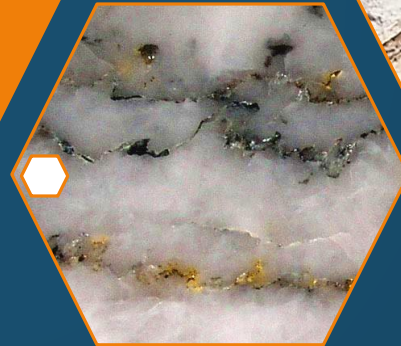
Archeological
Studies



Structural
Analysis (e.g.
void detection)



Mineral
Exploration



Utility Mapping
(e.g. tunnels,
pipelines,
reinforcement
bars)

Other Applications



**T
h
a
n
k
Y
o
u**



AERO 360
SOLUTIONS BEYOND DRONES

