Engineering Geological Survey and Related Others Work in Rural Parts of MSDP Project Area

Presented by
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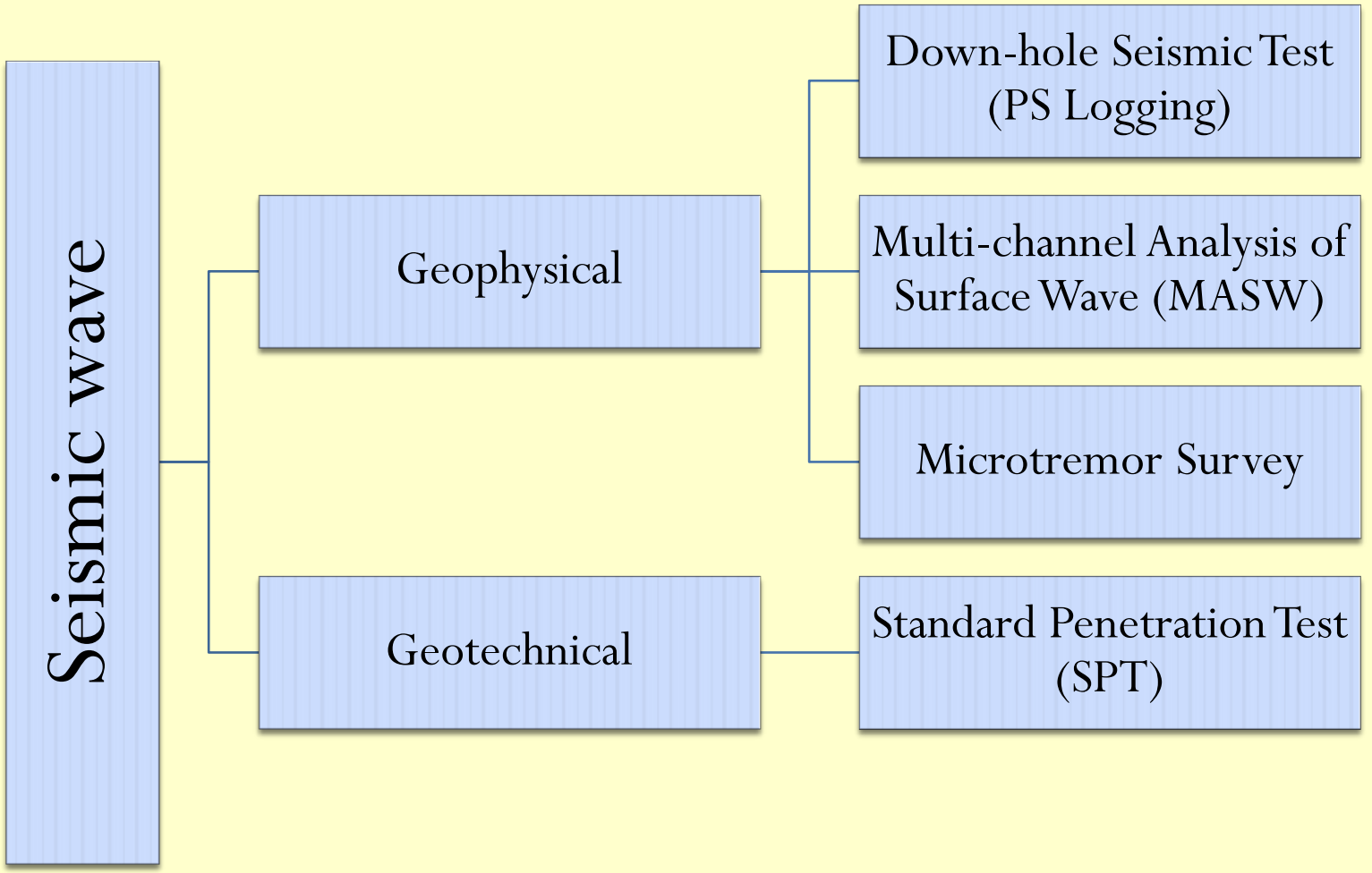
1/18/2015

Purpose of the Geological Work

- Determine subsurface soil condition of the project area. For example soft, dense or stiff soil.
- Identify Subsurface layer up to depth 30m.
- Seismic Hazards Assessment.

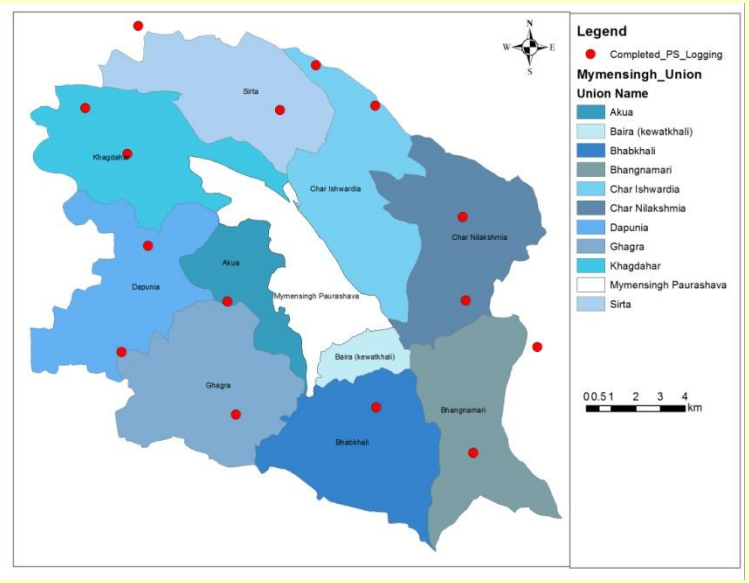
Methodology



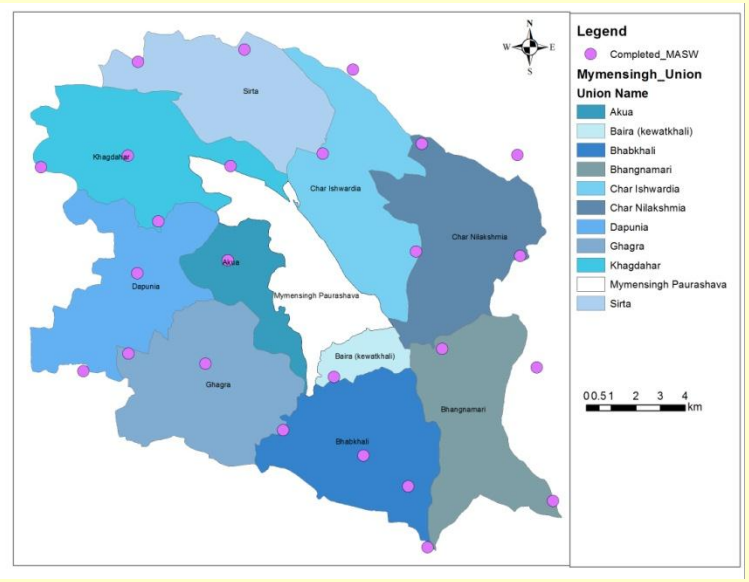
Geophysical & Geotechnical Data Acquisition in This Study

SL No.	Survey/ Test Name	Numbers of Test
1	Down-hole Seismic test (PS Logging)	15
2	Multi-Channel Analysis of Surface Wave (MASW)	25
3	Single Microtremor Survey	40
4	Microtremor Array	4
5	Standard Penetration Test (SPT)	70

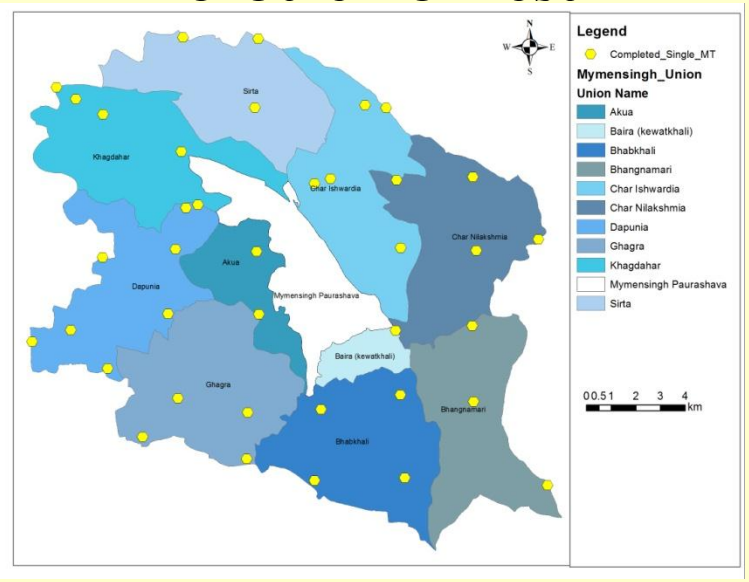
PS Logging Test



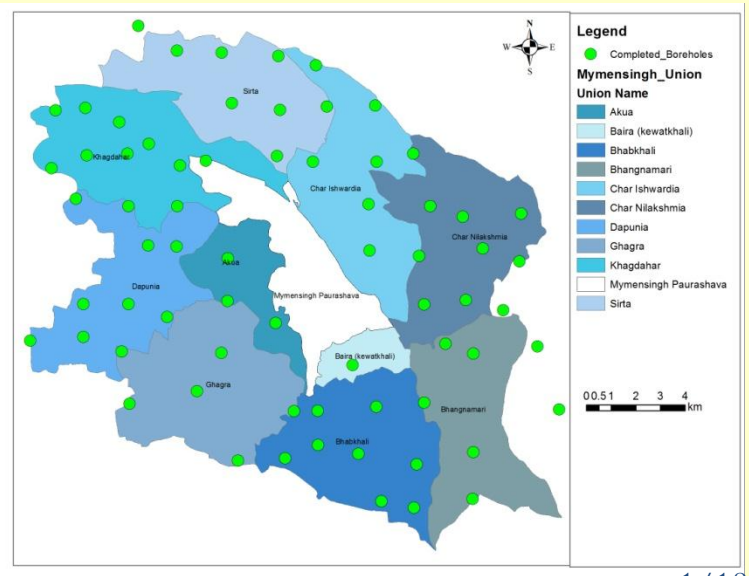
MASW



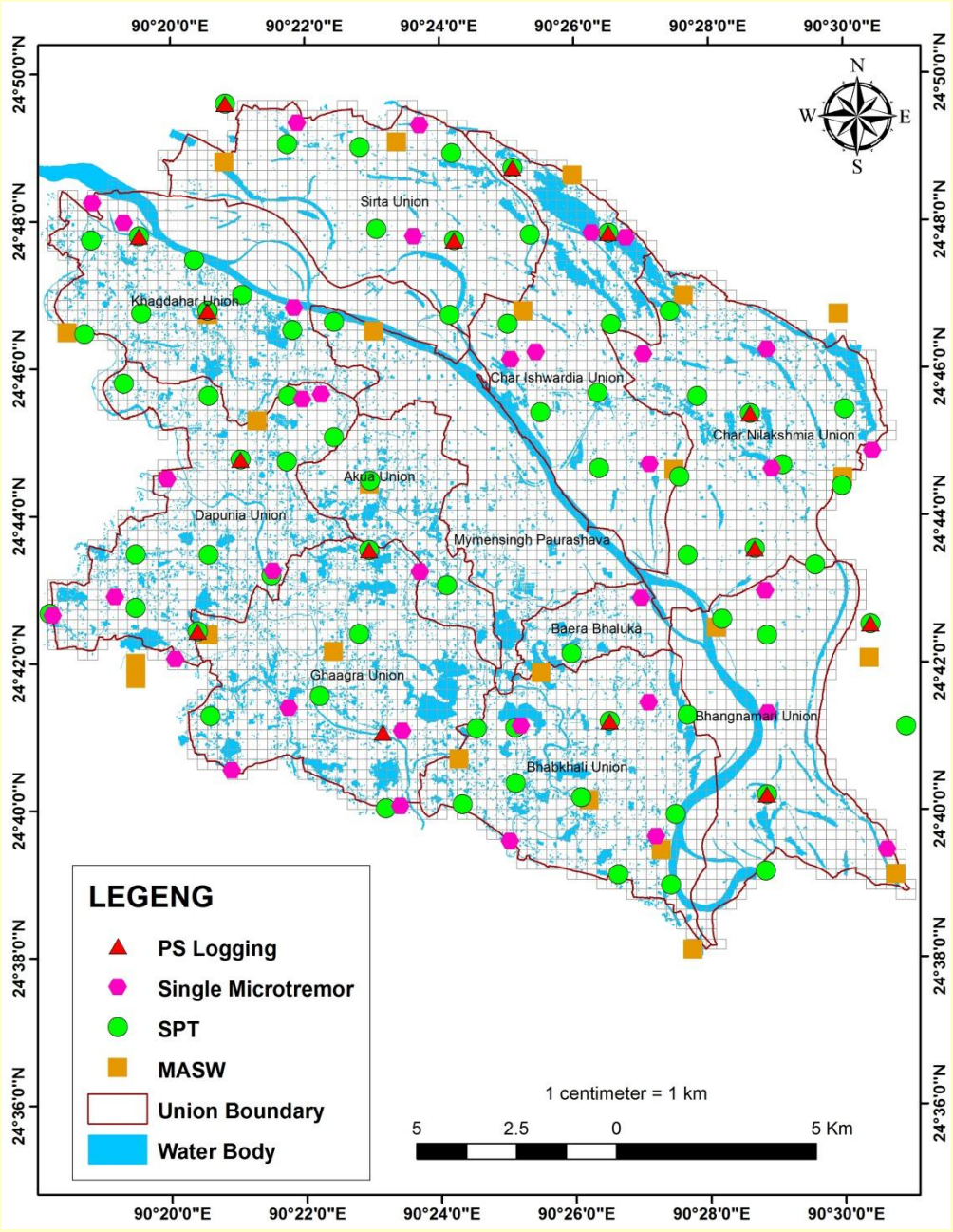
Microtremor Test



Standard Penetration Test



All Test Locations



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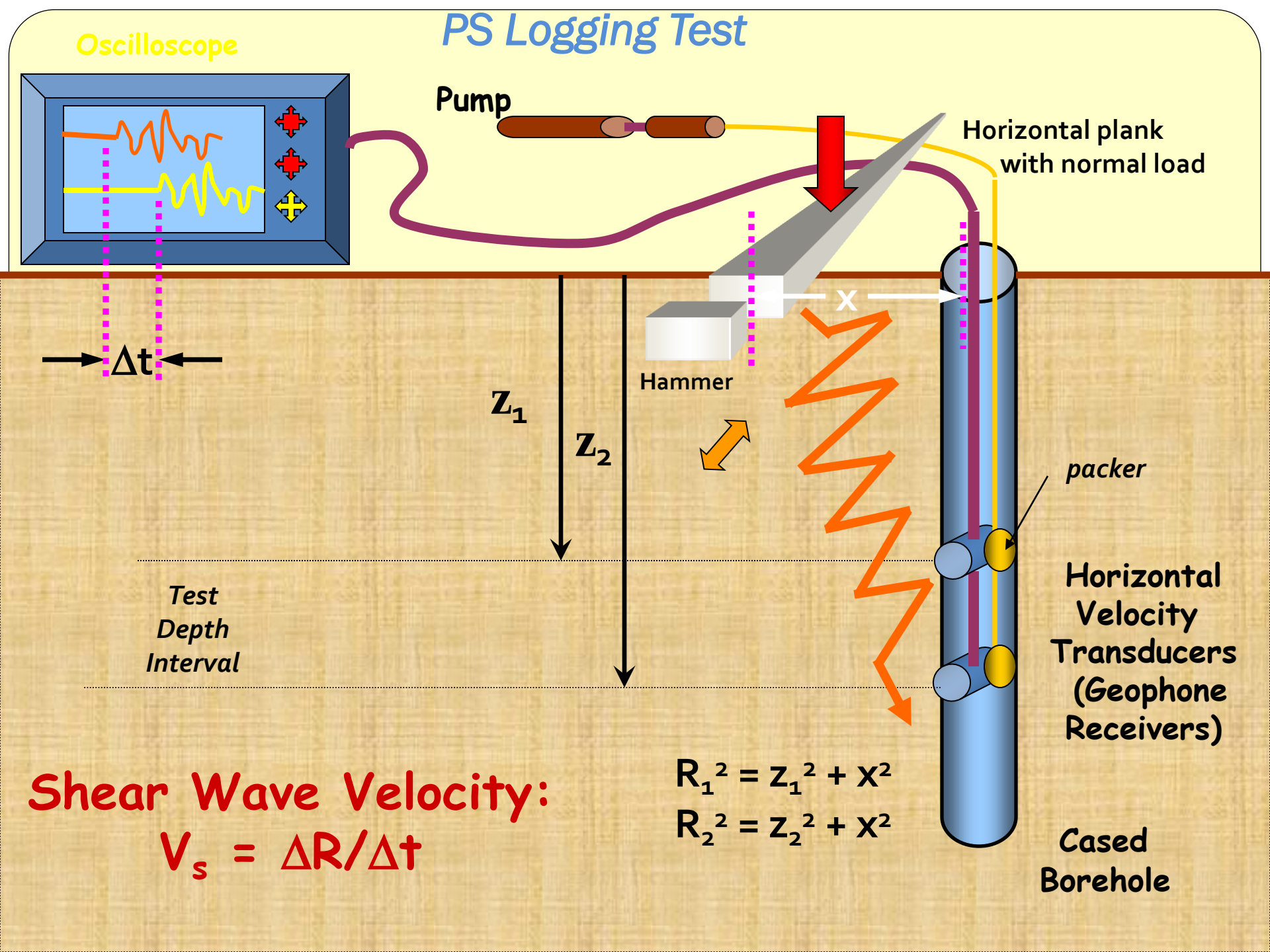
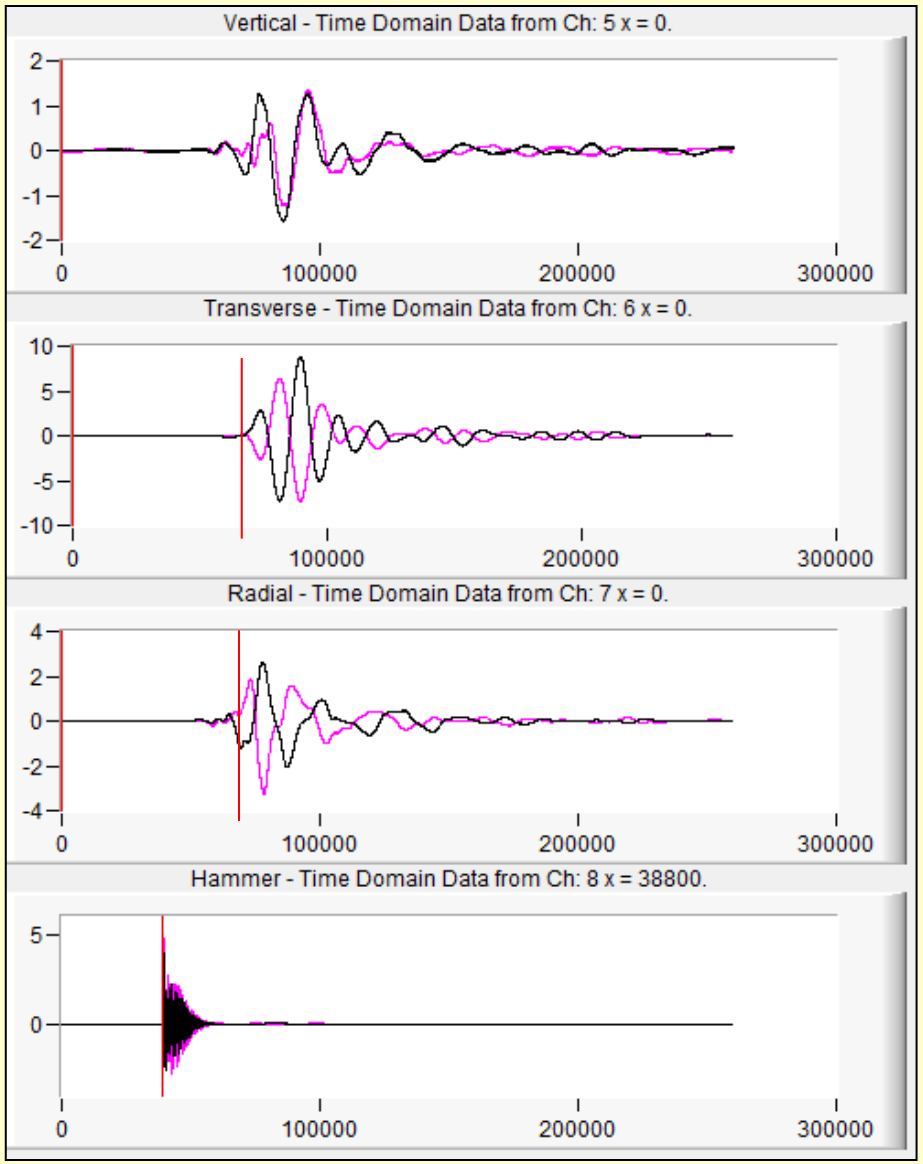
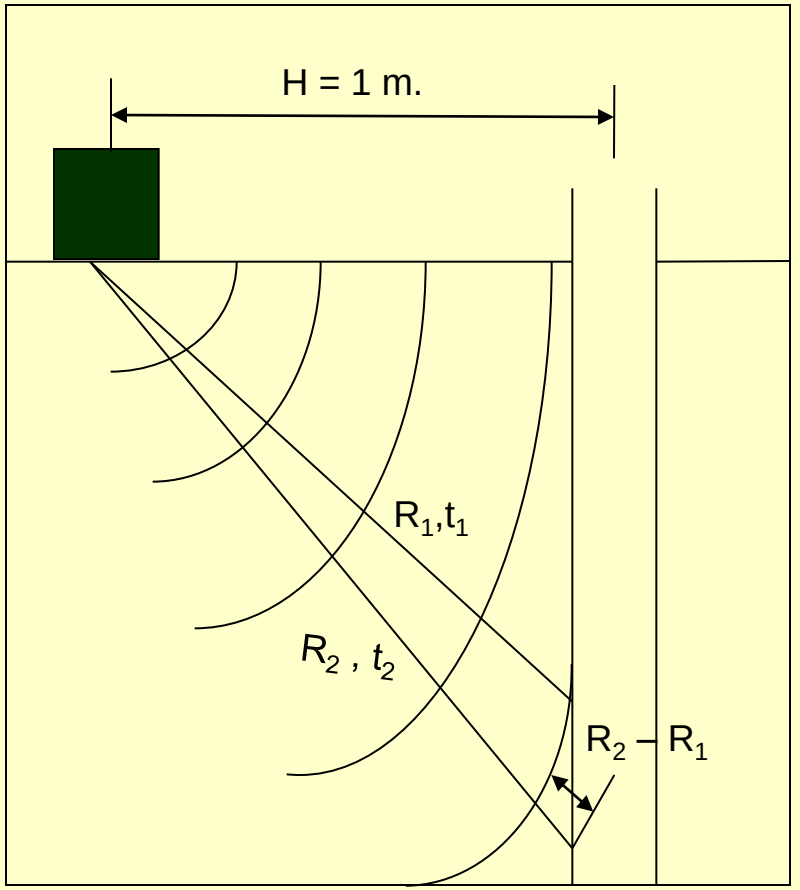

PS Logging Test
Oscilloscope
Pump
Horizontal plank
with normal load
Δt
Hammer
X
Z_1
Z_2
packer
Test
Depth
Interval
Horizontal
Velocity
Transducers
(Geophone
Receivers)
Shear Wave Velocity:
$V_s = \Delta R/\Delta t$
$R_1^2 = Z_1^2 + X^2$
$R_2^2 = Z_2^2 + X^2$
Cased
Borehole

Field Data Acquisition Parameters

- Used Two High Sensitive geo-phone and two receivers (Geo-phone) spaced 1.5 meter apart.
- Wooden plank along with 7.2kg hammer was used to produce vibration which was placed 1m apart from the cased Borehole.
- Velocity are measured at 1m interval upto depth 30m

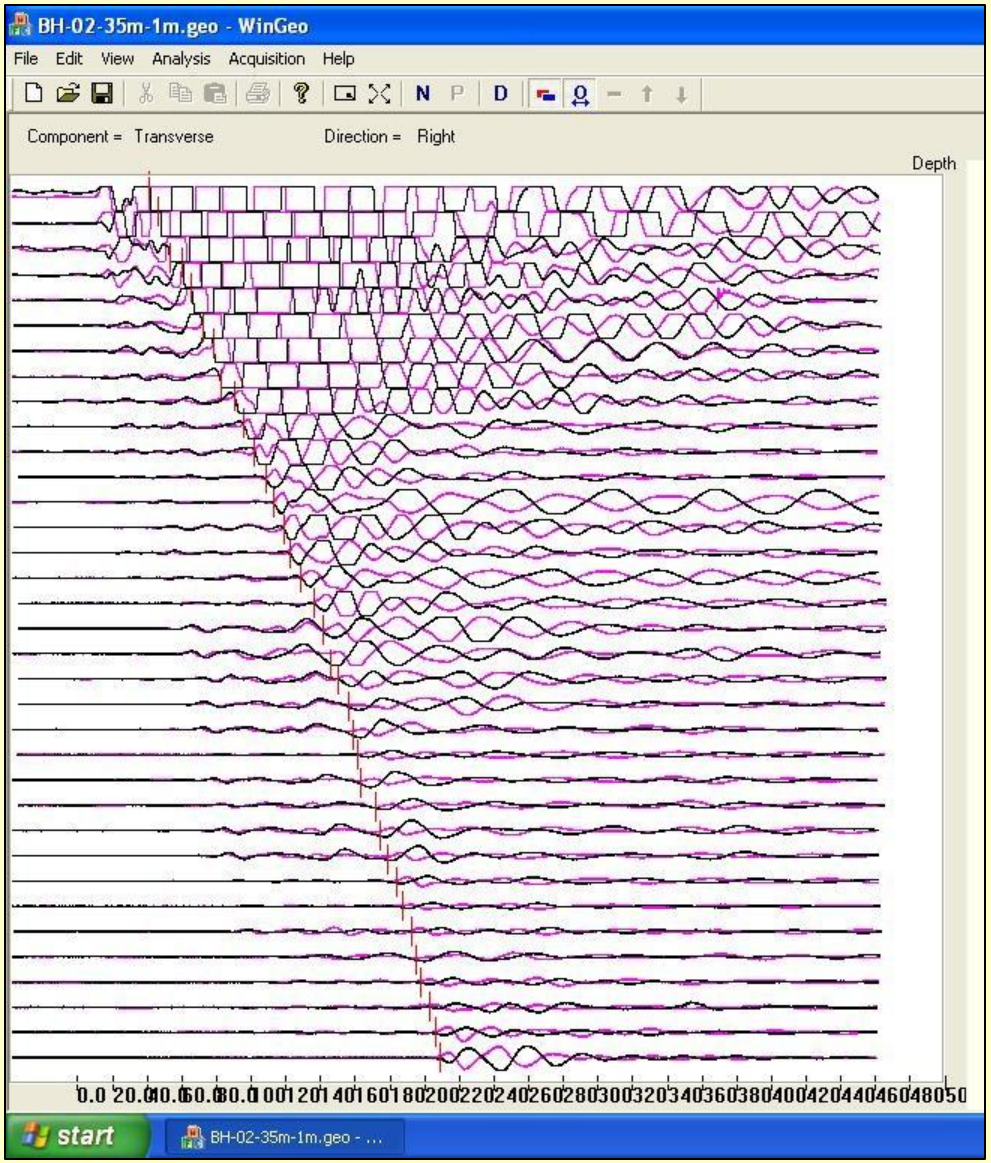
Detected Shear Waves

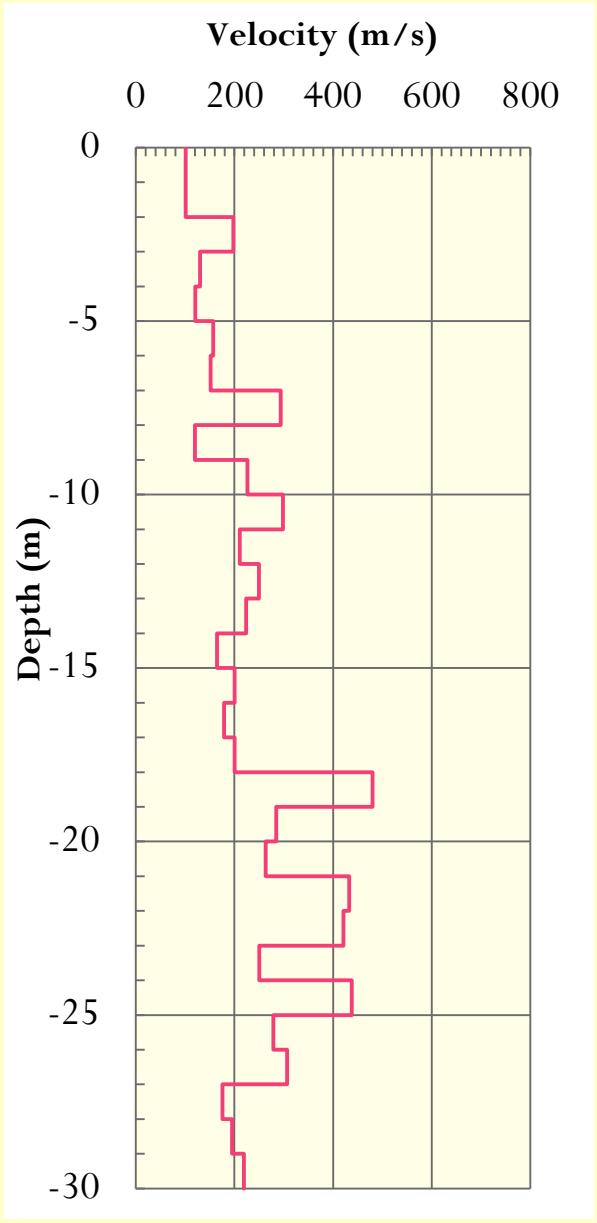




$$V_s = (R_2 - R_1) / (t_2 - t_1)$$

$$G = \rho V_s^2$$


BH-02-35m-1m.geo - WinGeo
File Edit View Analysis Acquisition Help
Component = Transverse
Direction = Right
Depth
start
BH-02-35m-1m.geo - ...


Velocity (m/s)
0
200
400
600
800
Depth (m)
0
-5
-10
-15
-20
-25
-30

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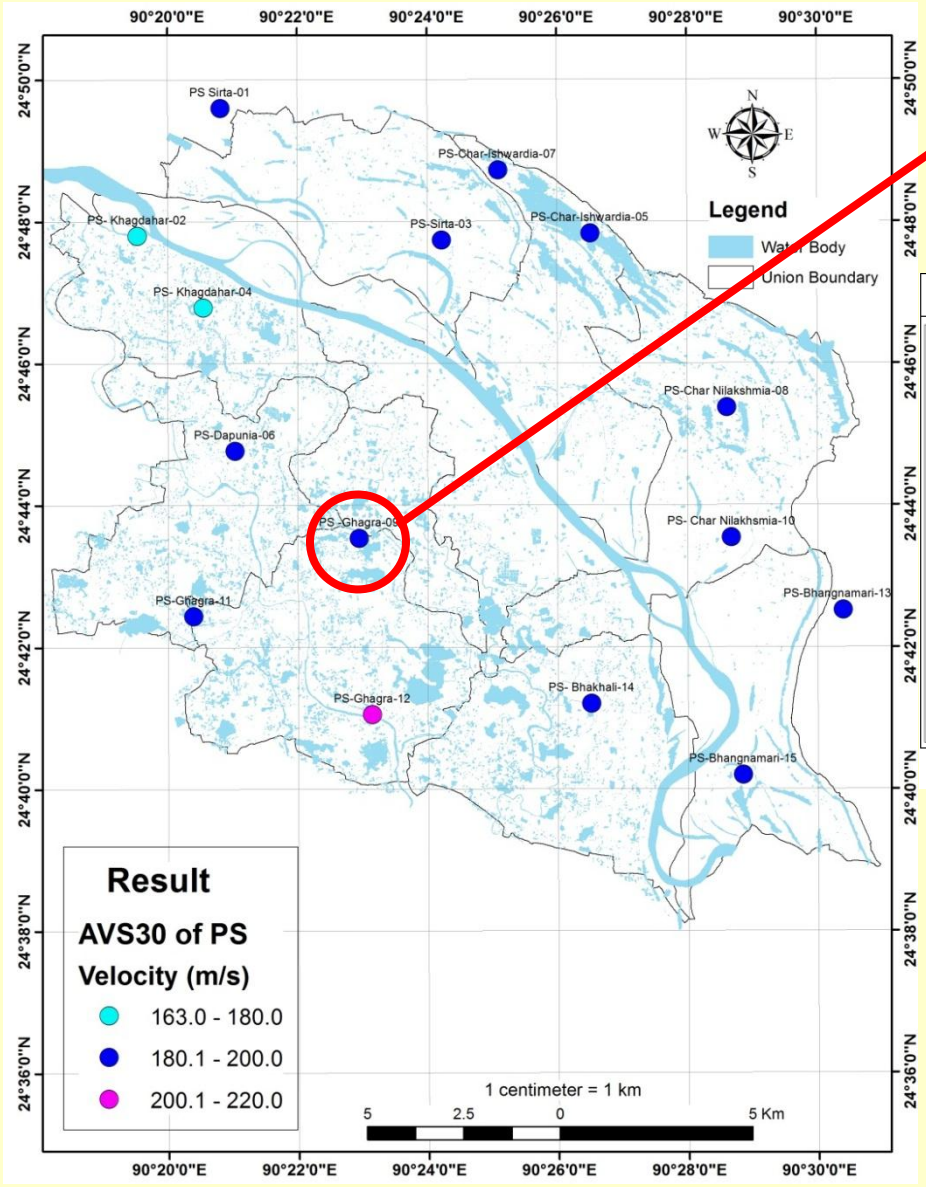
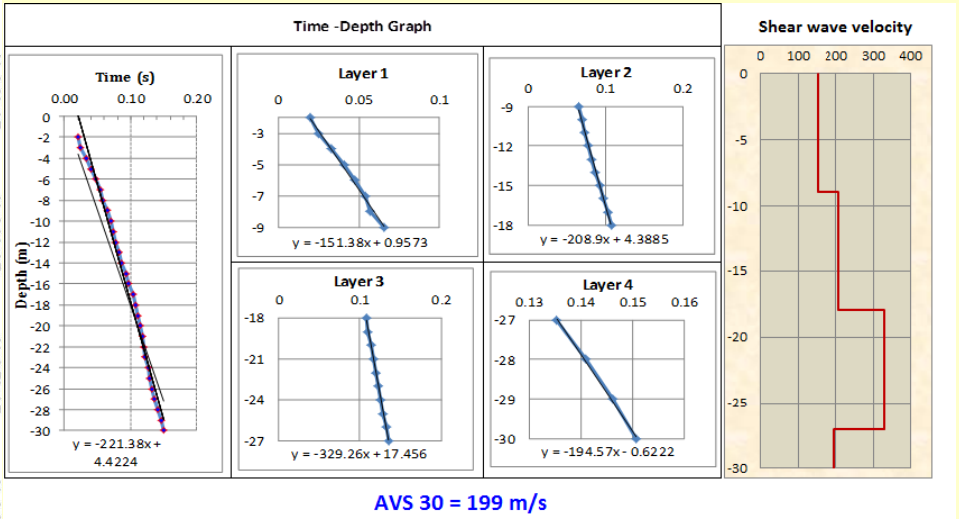
PS Logging Test Result



Test ID : PS-Ghagra-09
Location : Modhobarra, Ghagra
Lat- 24°43'32.006"N
Long- 90°22'56.175"E



AVS 30 = 199 m/s

AVS 30

199 m/s

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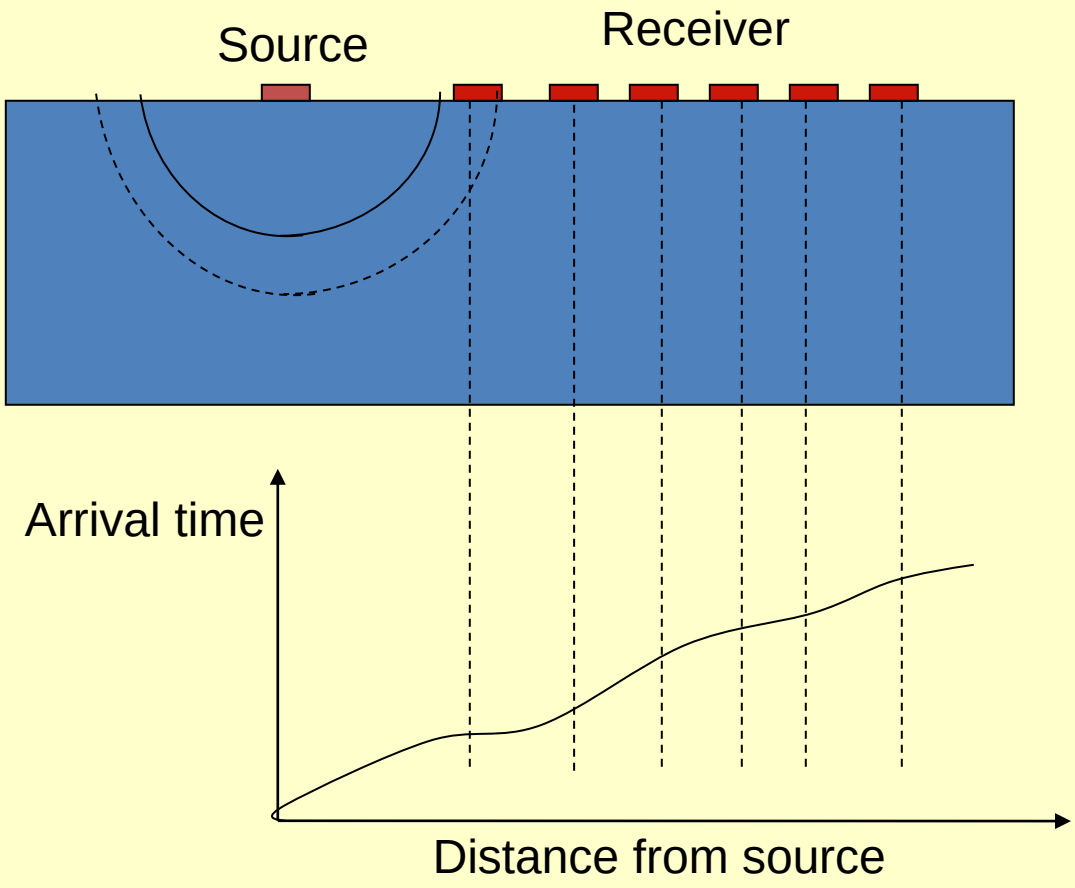
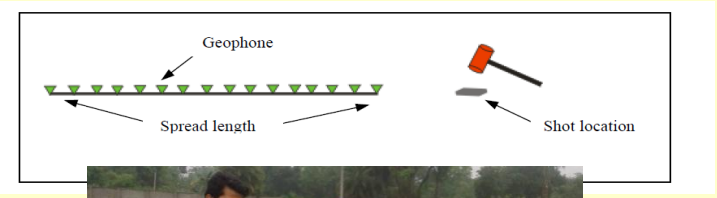
Field Measurement of MASW

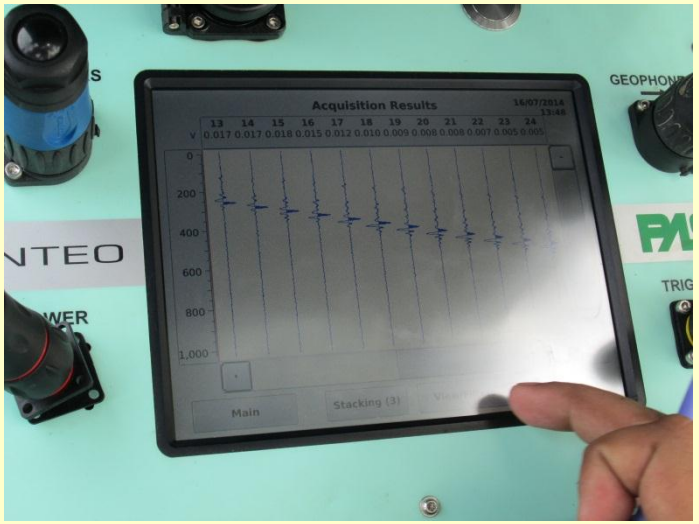
- seismic refraction test

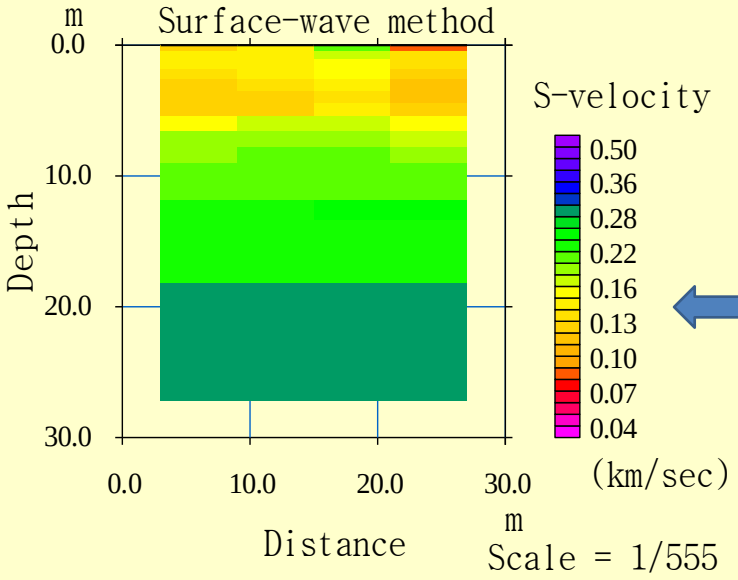


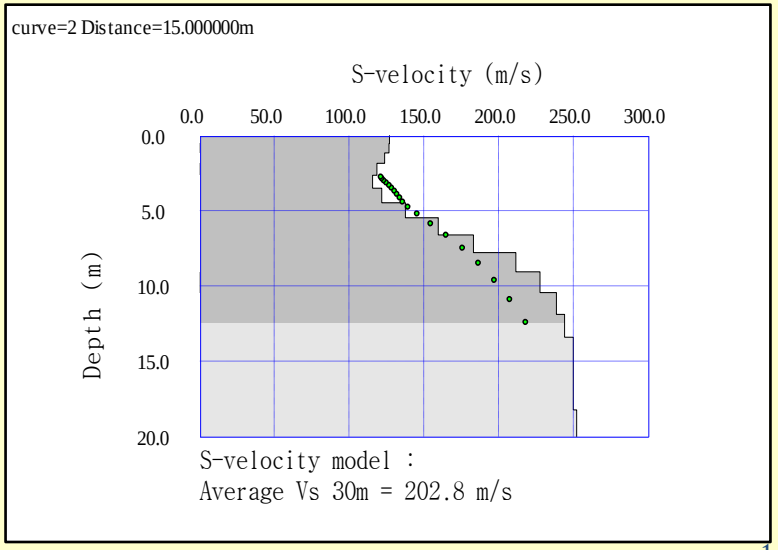
- Seismic source: Hammering(artificial)
- Geophone spacing: 3m
- Number of Geophones: 24
- Measuring line length: 72m
- Shot number: 25 points, 23 between geophones and 2 outside of measuring line.
- Natural frequency of Geophone: 10Hz
- Sampling rate: 500us-2000Hz
- Measurement duration: 1024ms

- surface wave test

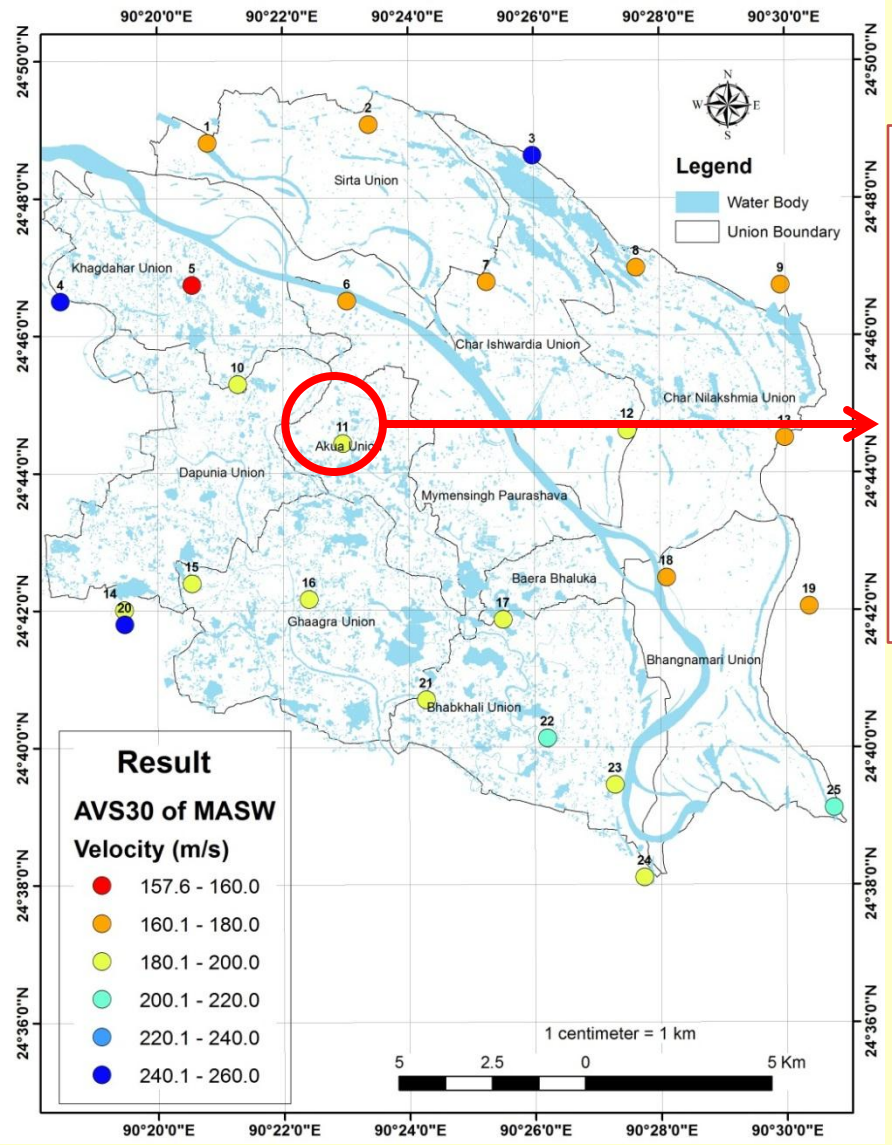

Geophone
Spread length
Shot location


Acquisition Results
GEOPHONE
Main
Stacking (3)


Surface-wave method
m
0.0
10.0
20.0
30.0
Depth
0.0
10.0
20.0
30.0
m
Distance
S-velocity
0.50
0.36
0.28
0.22
0.16
0.13
0.10
0.07
0.04
(km/sec)
Scale = 1/555


curve=2 Distance=15.000000m
S-velocity (m/s)
0.0
50.0
100.0
150.0
200.0
250.0
300.0
Depth (m)
0.0
5.0
10.0
15.0
20.0
S-velocity model :
Average Vs 30m = 202.8 m/s

MASW Survey Result

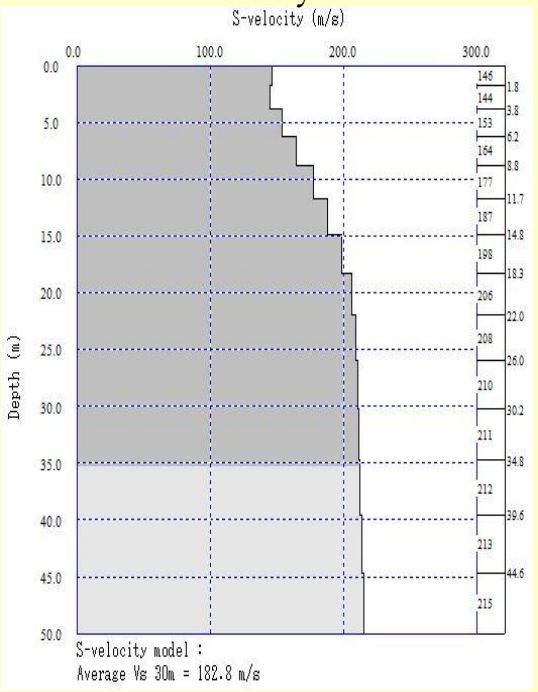


Survey Id: 11
Union Name: Akua
Lat:24.740444
Long:90.382467

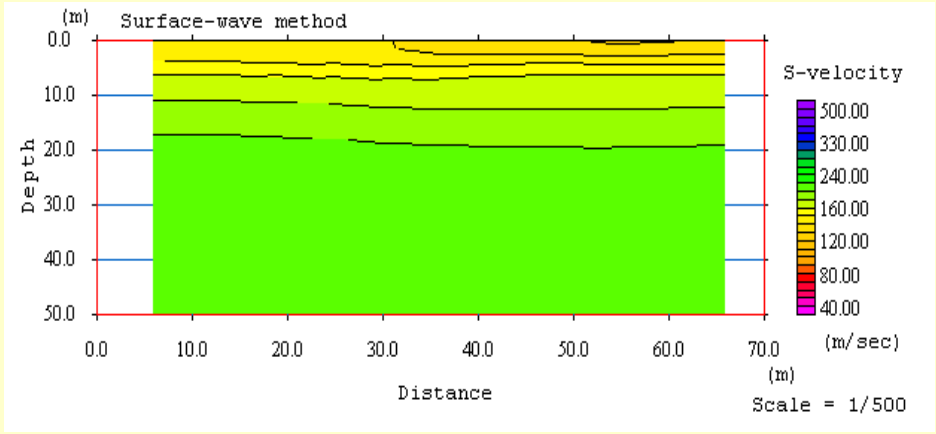
AVS 30

182.8 m/s

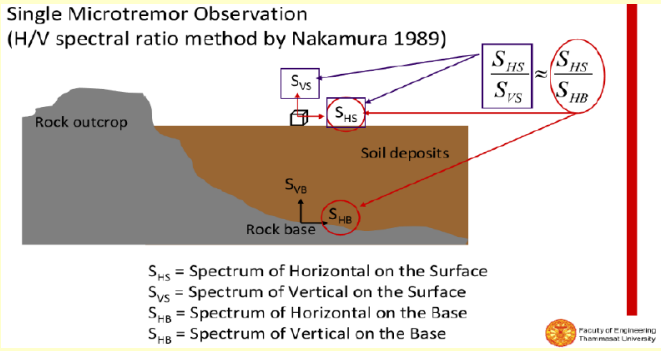
1D Velocity Model

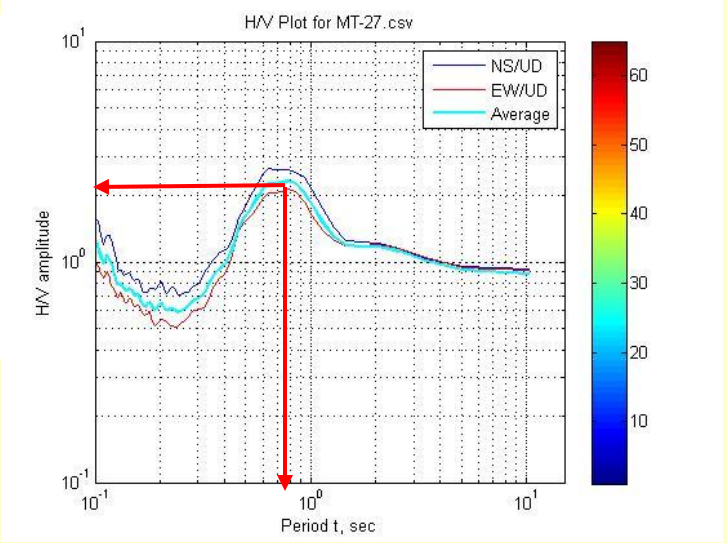


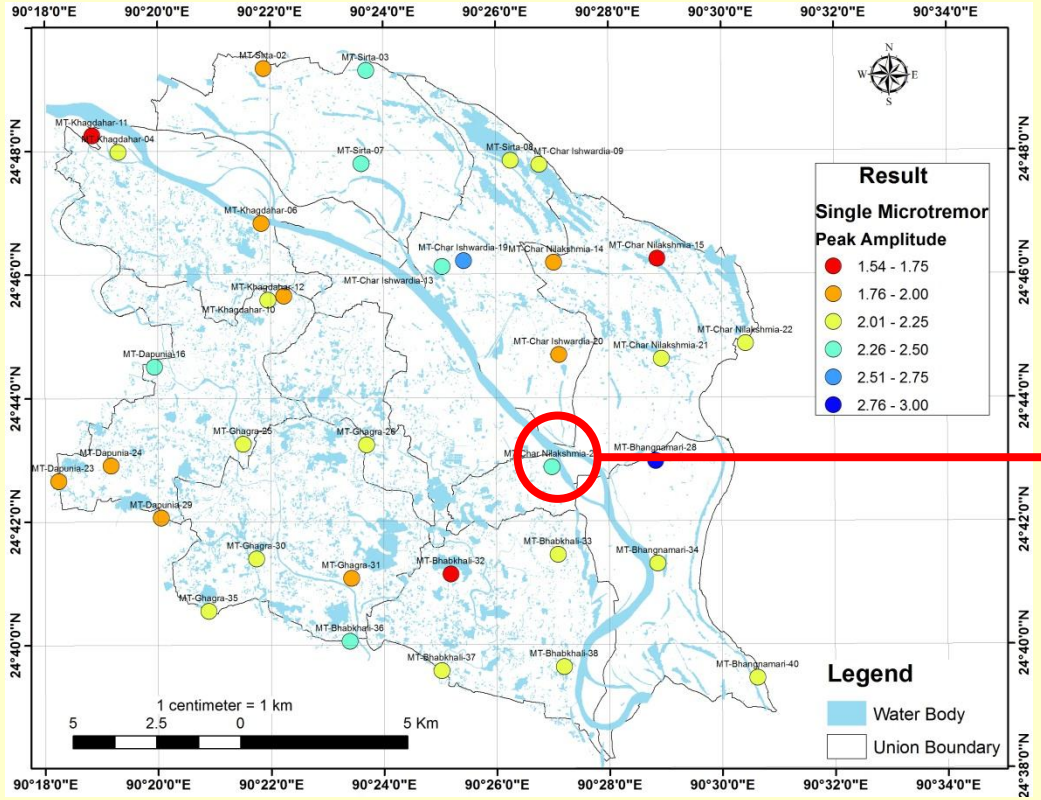
2D Velocity Model



Single Microtremor Survey and Result







ID:**MT-27**

Location:

Agricultural University

Coordinate:

Lat- N 24°42'52.40"

Long- E 90°26'58.85"

Result:

Peak Amplitude- 2.330

Peak Period- 0.79

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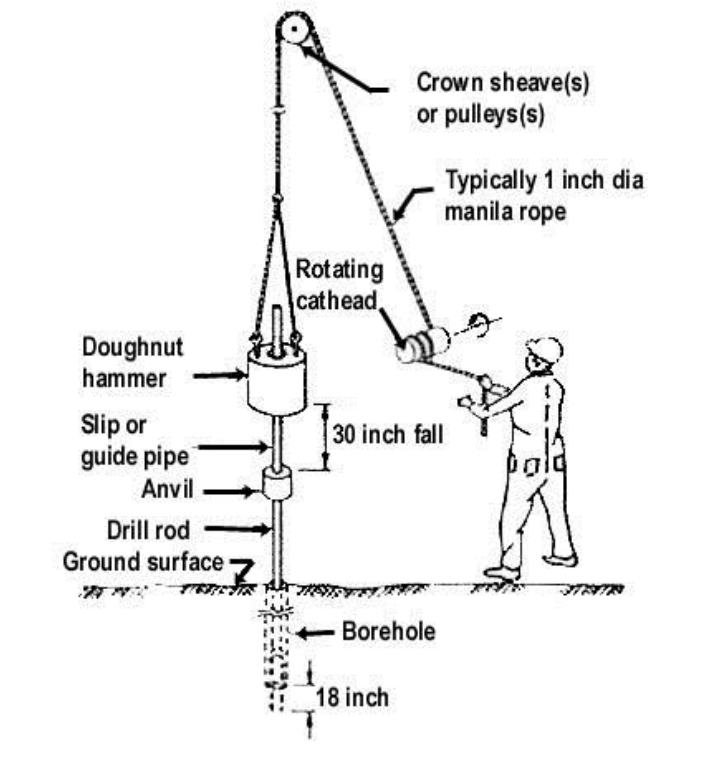
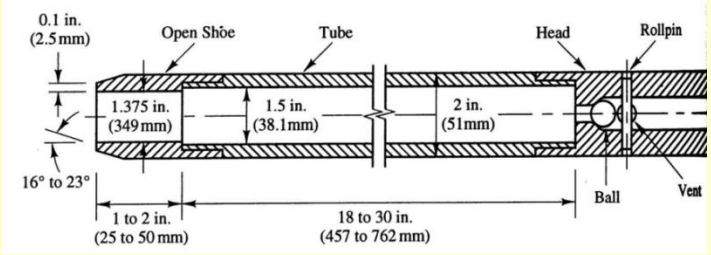
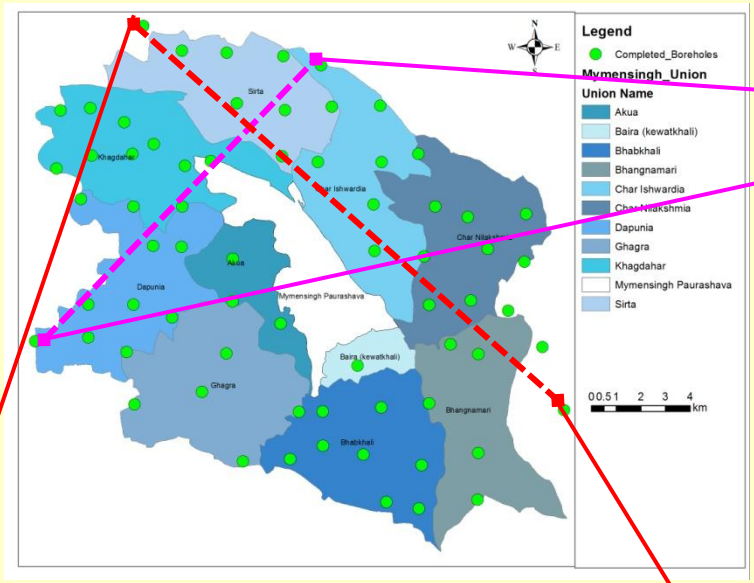
Geotechnical Method: Standard Penetration Test (SPT)

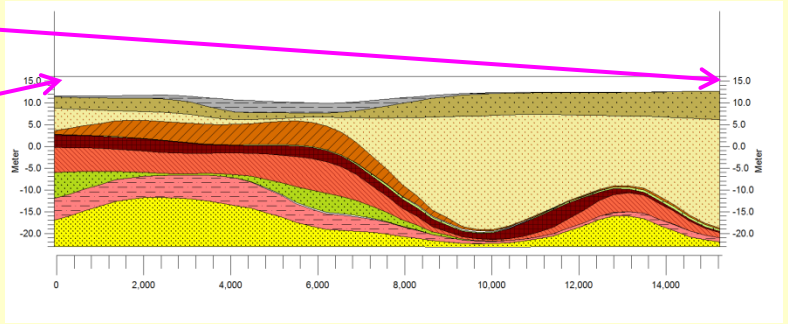
The Standard Penetration test (SPT) is a common in situ testing method used to determine the geotechnical engineering properties of subsurface soils.

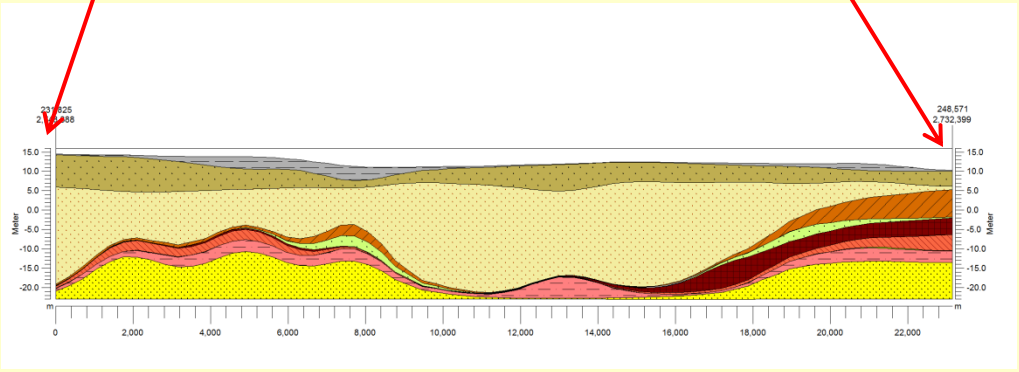


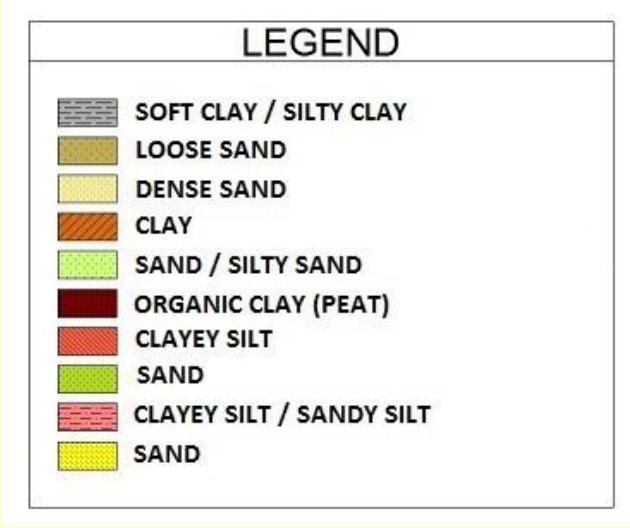


Subsurface Lithological Layers

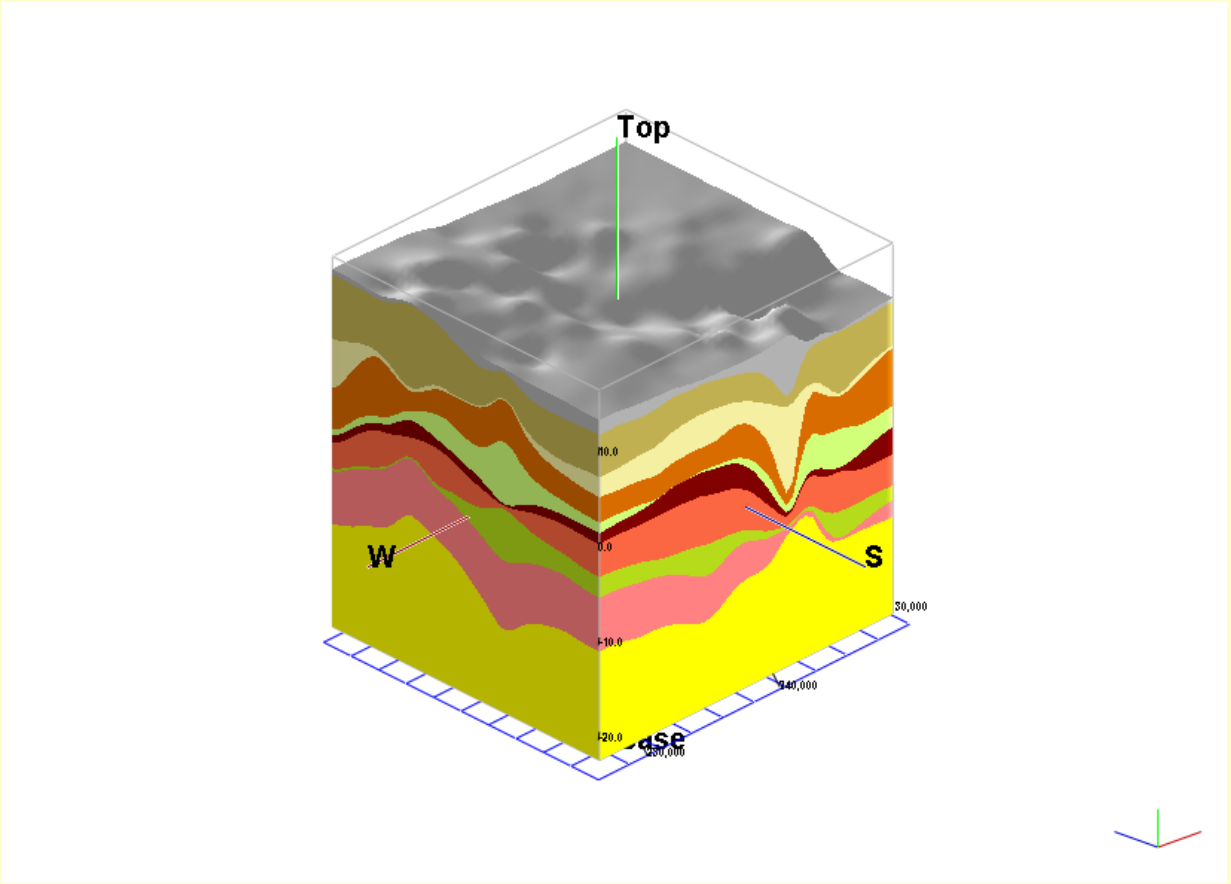






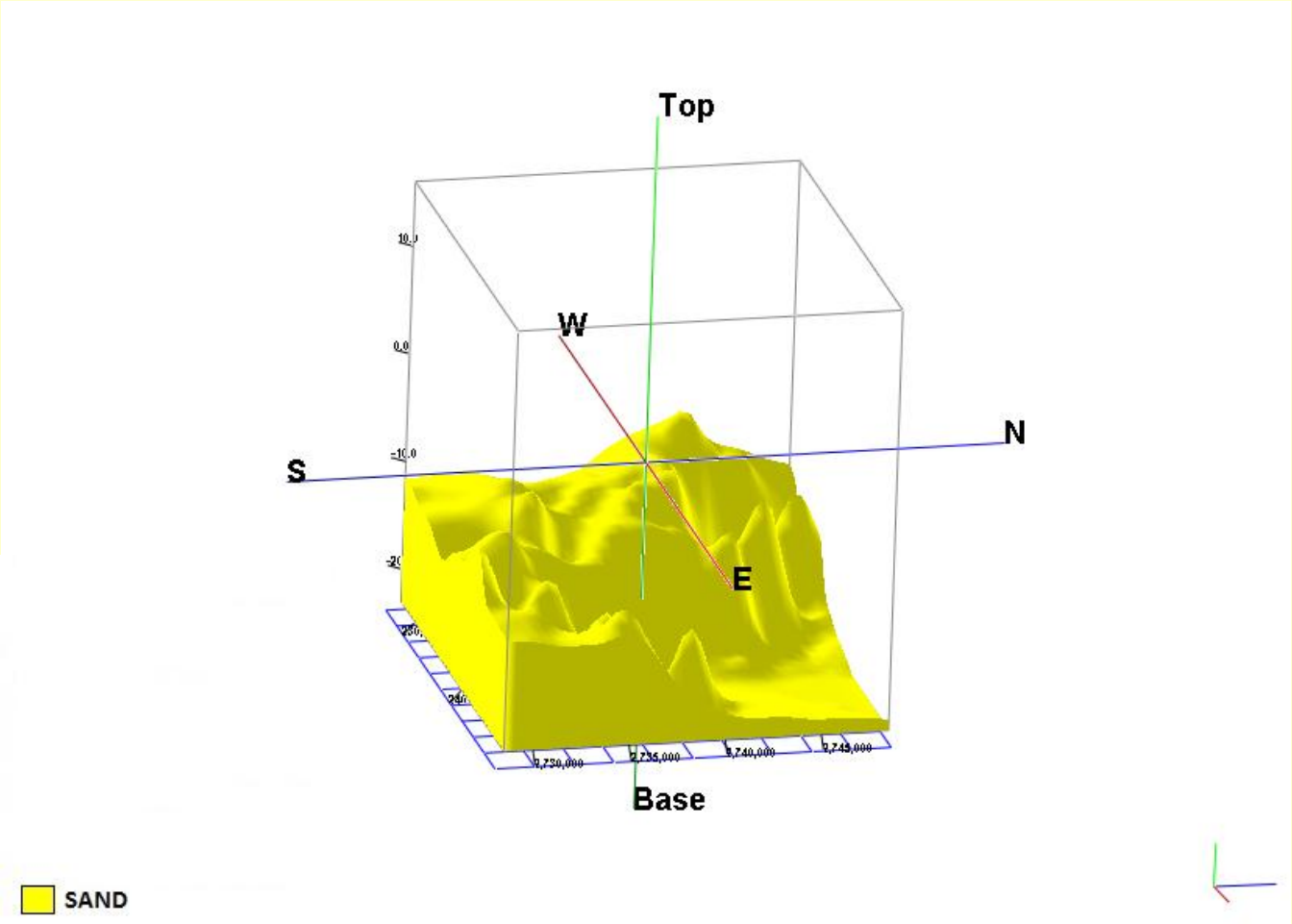


Outcome1: Subsurface 3D Model

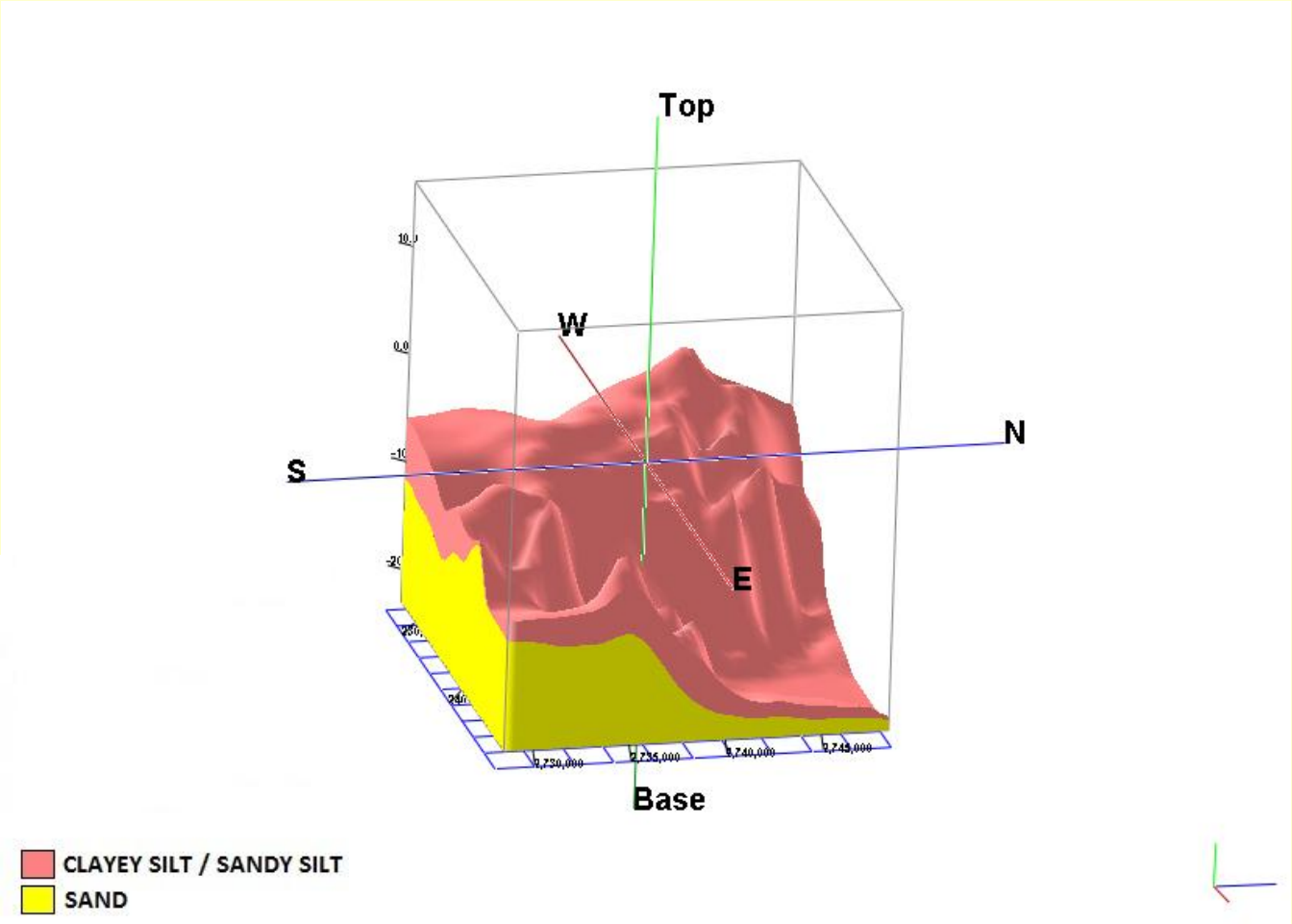


SOFT CLAY / SILTY CLAY
LOOSE SAND
DENSE SAND
CLAY
SAND / SILTY SAND
ORGANIC CLAY (PEAT)
CLAYEY SILT
SAND
CLAYEY SILT / SANDY SILT
SAND

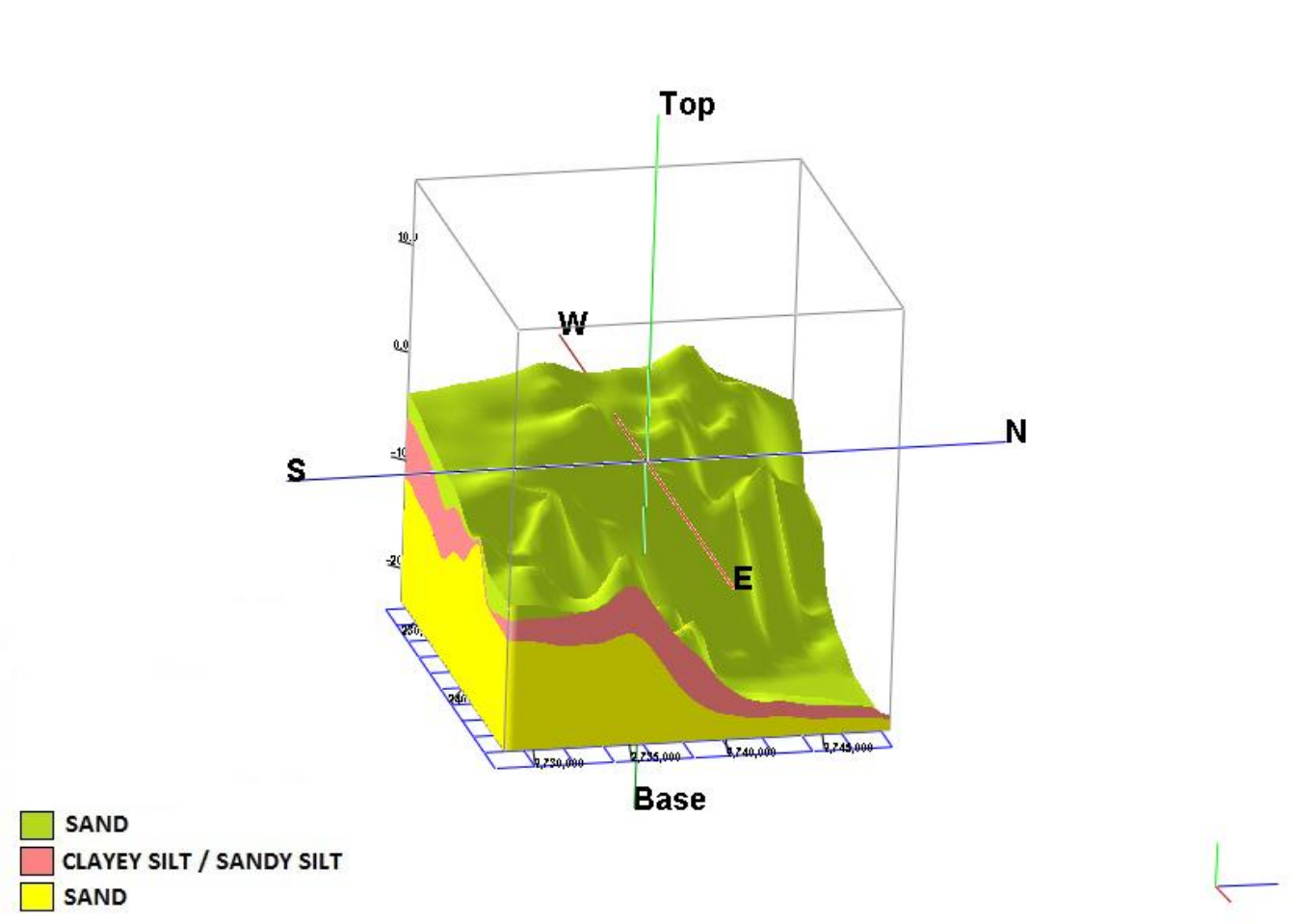
Outcome1: Subsurface 3D Model



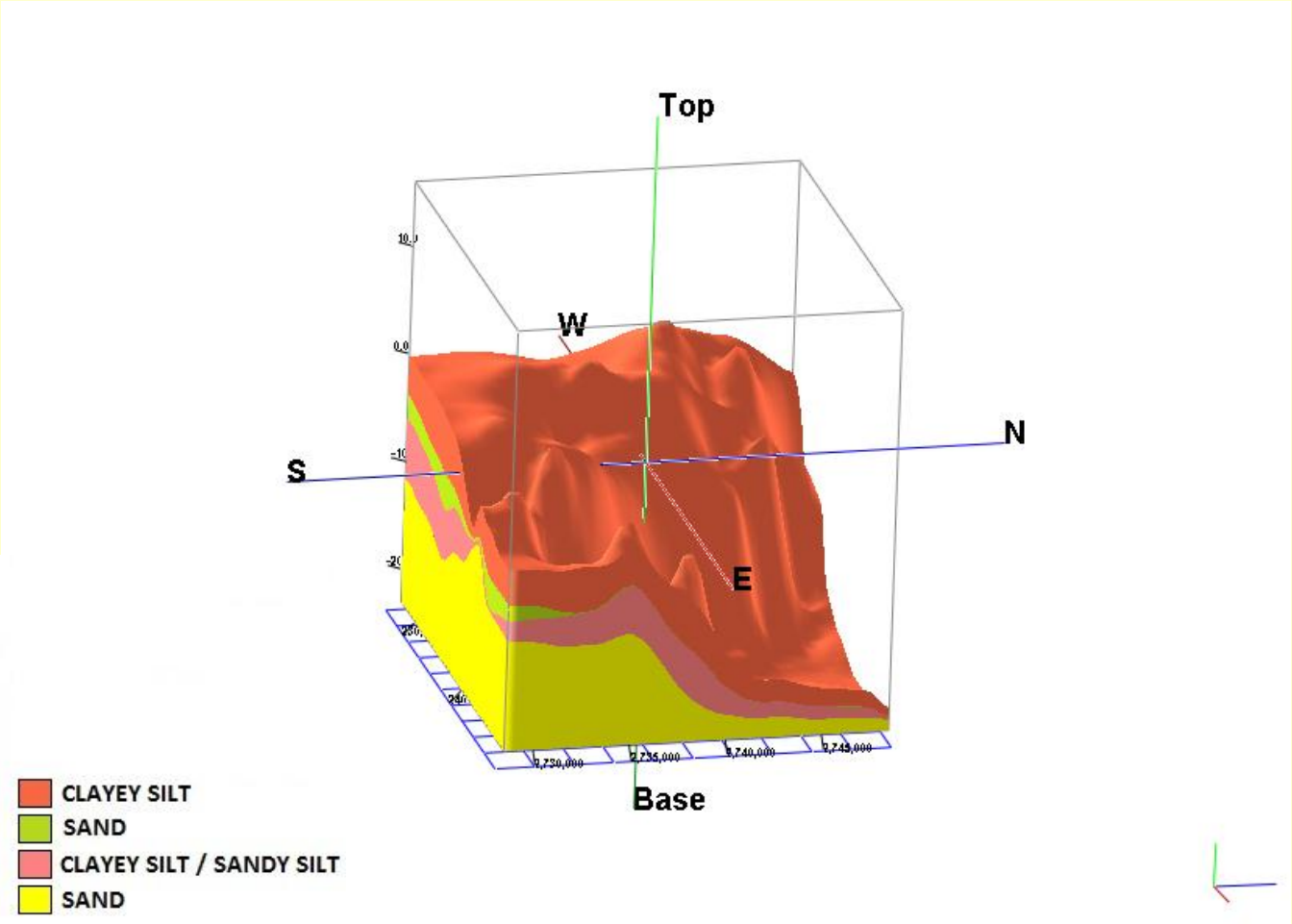
Outcome1: Subsurface 3D Model



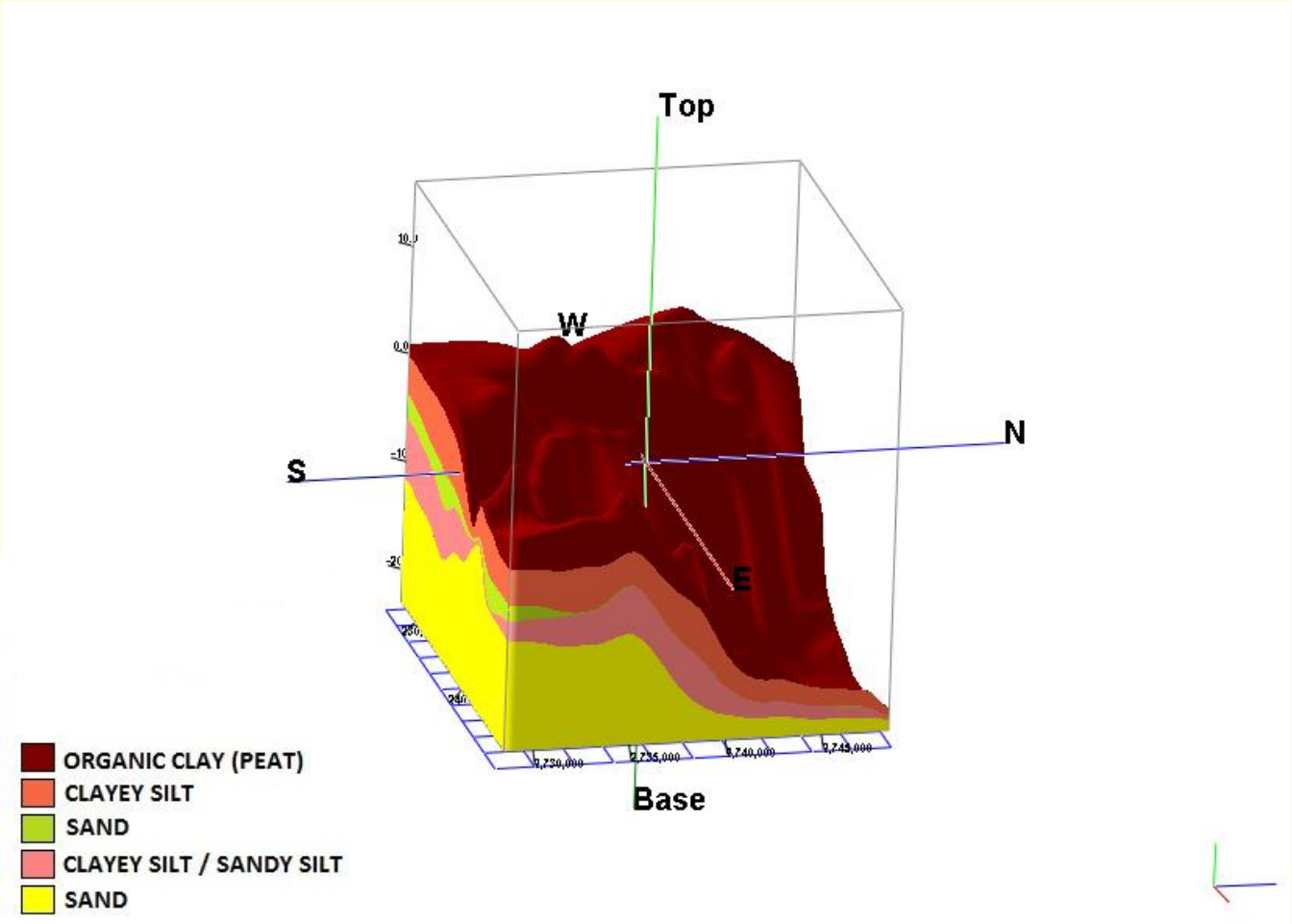
Outcome1: Subsurface 3D Model



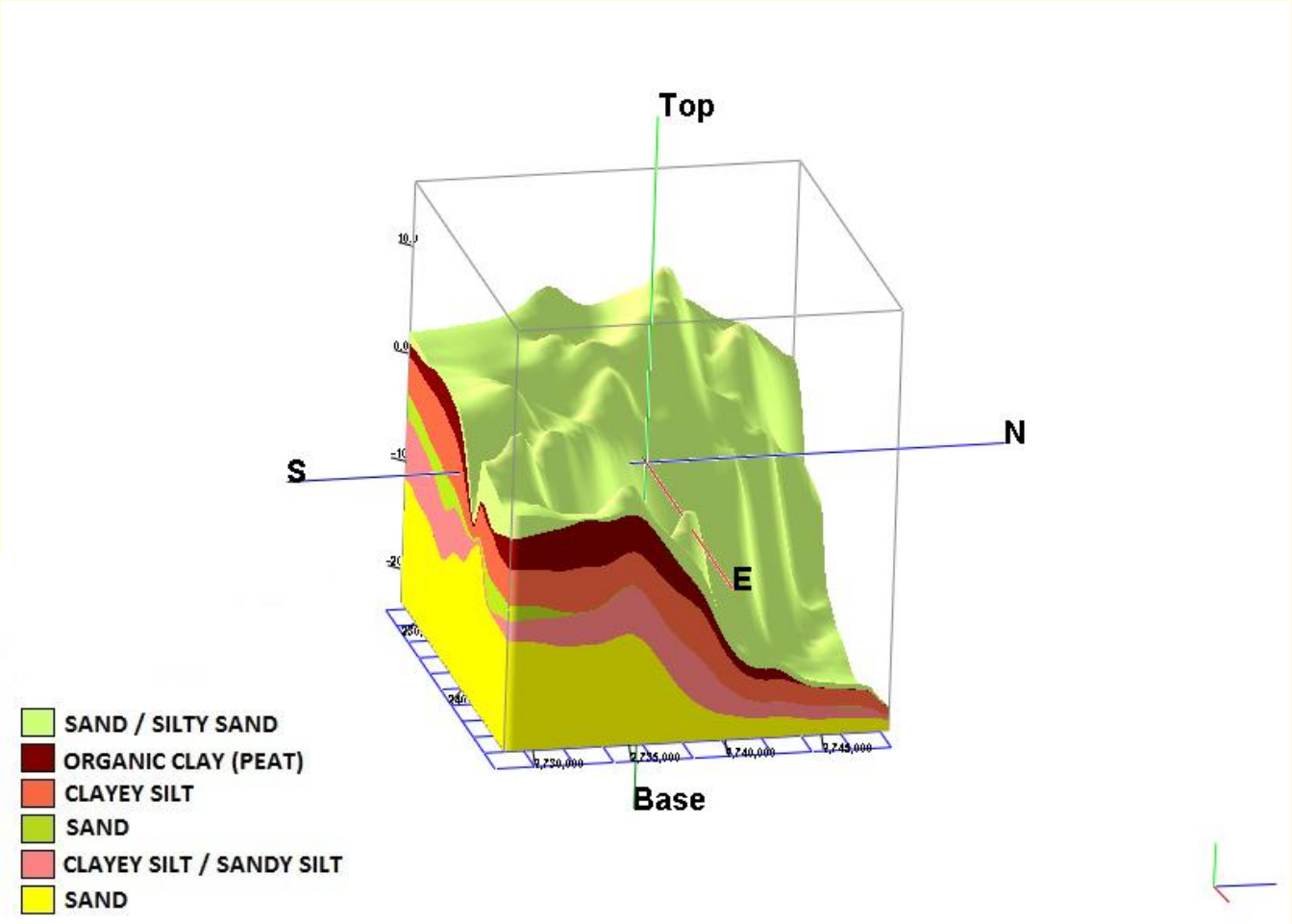
Outcome1: Subsurface 3D Model



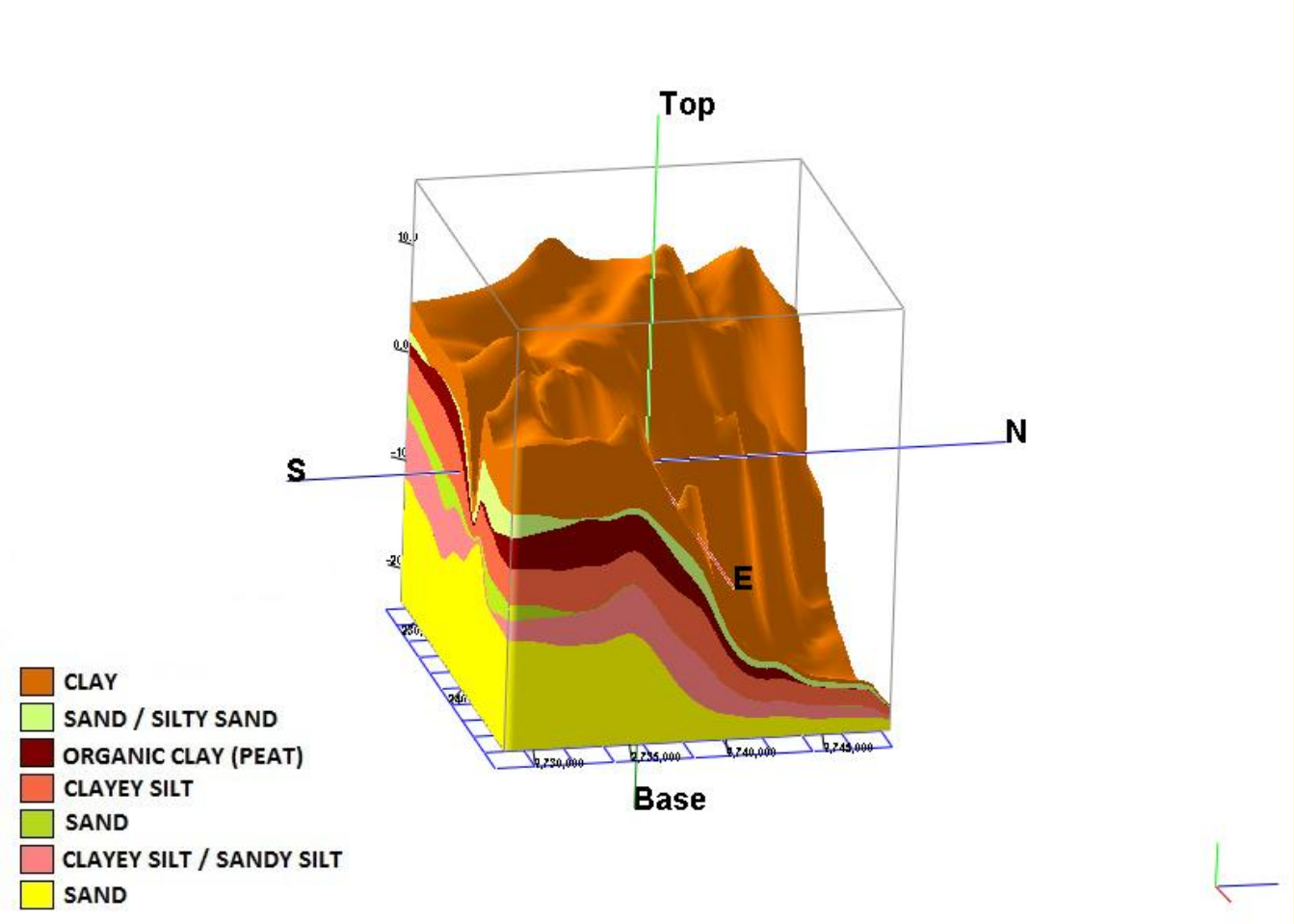
Outcome1: Subsurface 3D Model



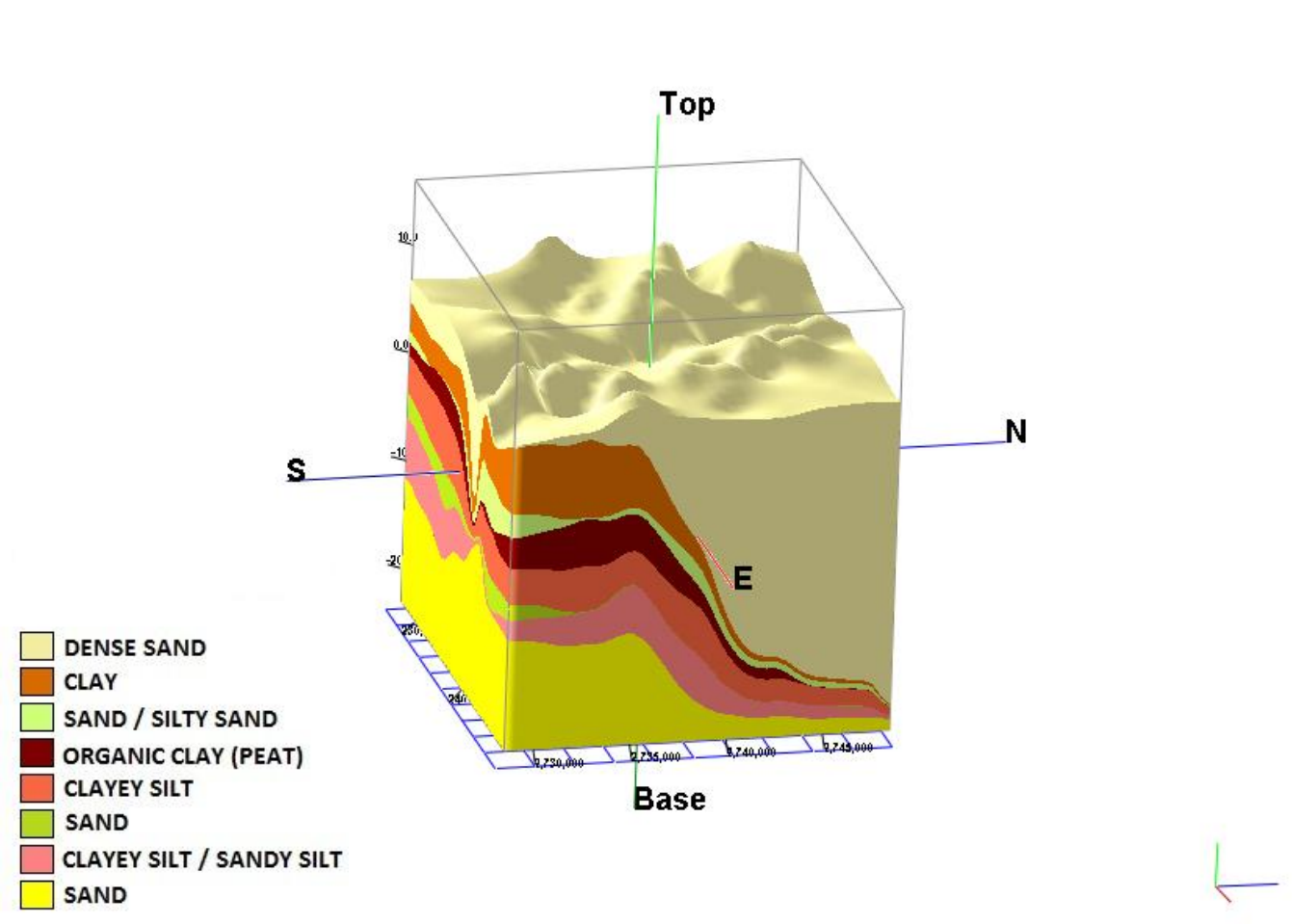
Outcome1: Subsurface 3D Model



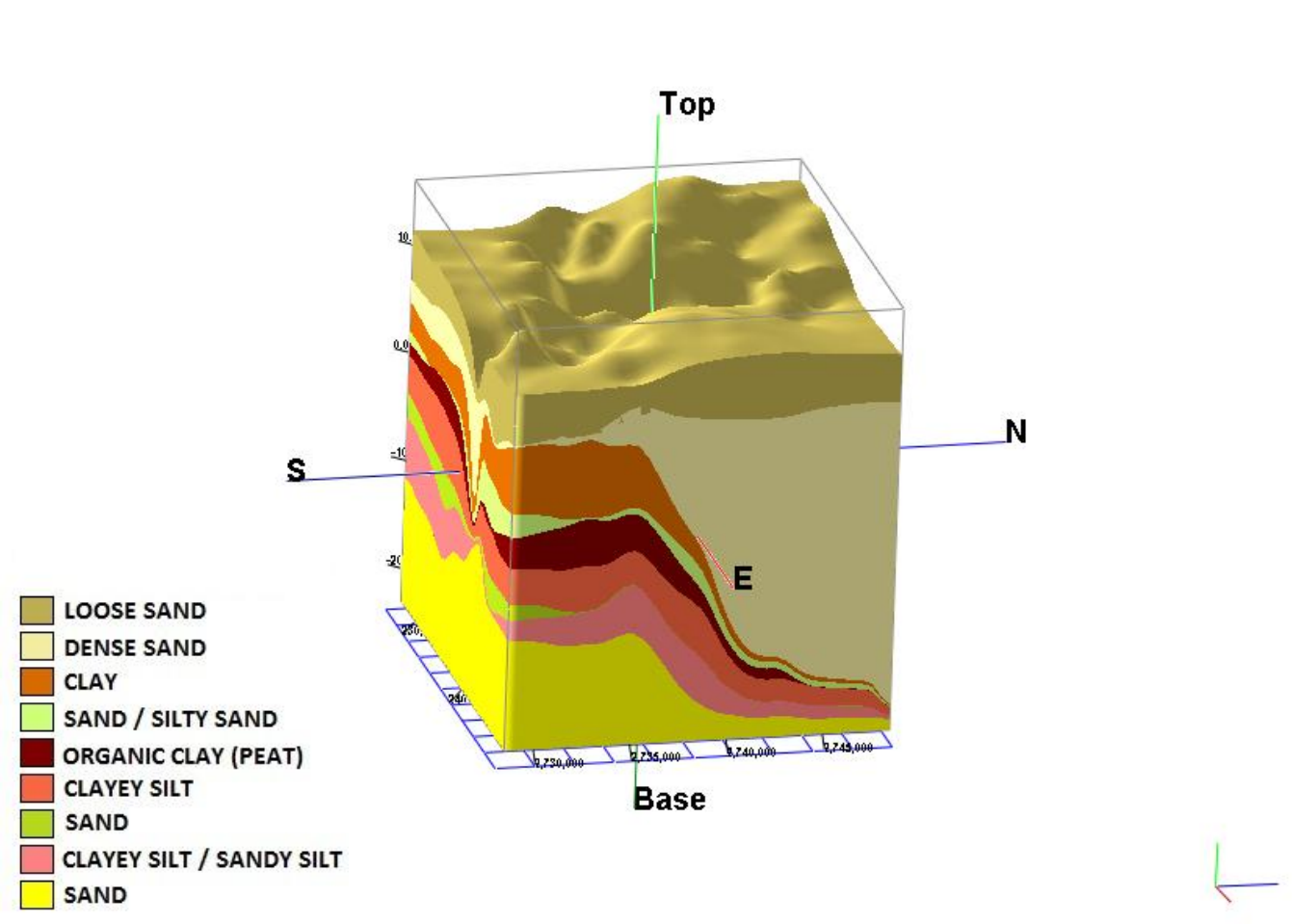
Outcome1: Subsurface 3D Model



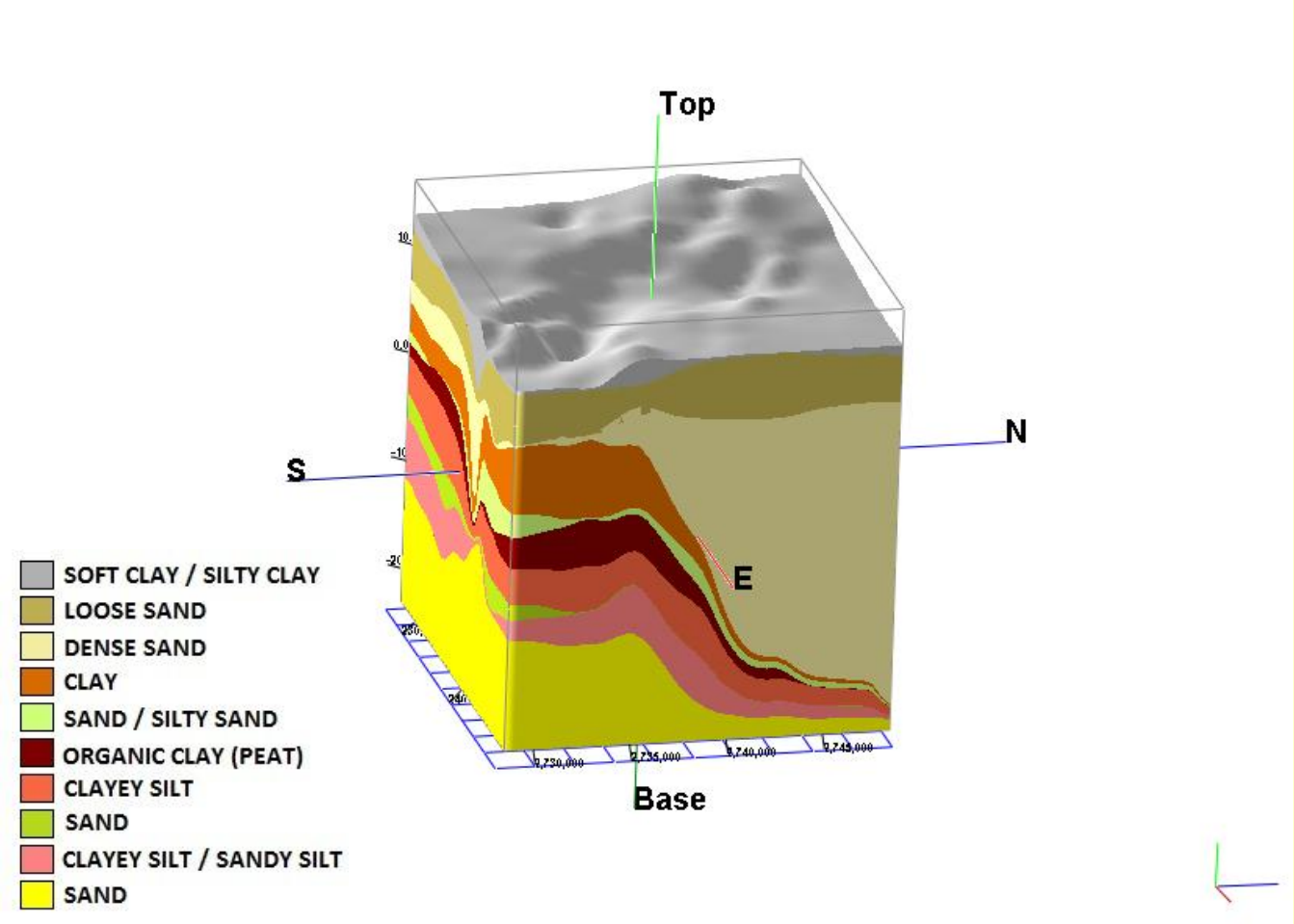
Outcome1: Subsurface 3D Model



Outcome1: Subsurface 3D Model



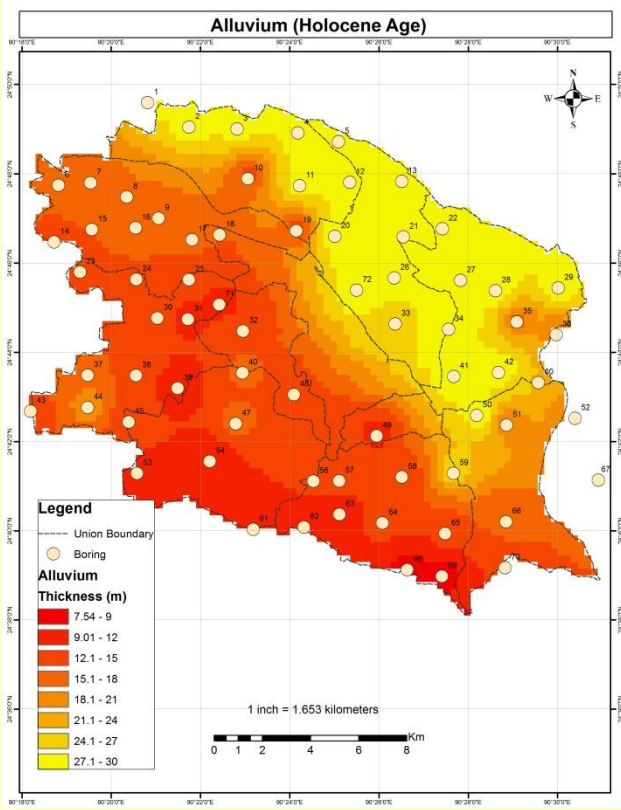
Outcome1: Subsurface 3D Model



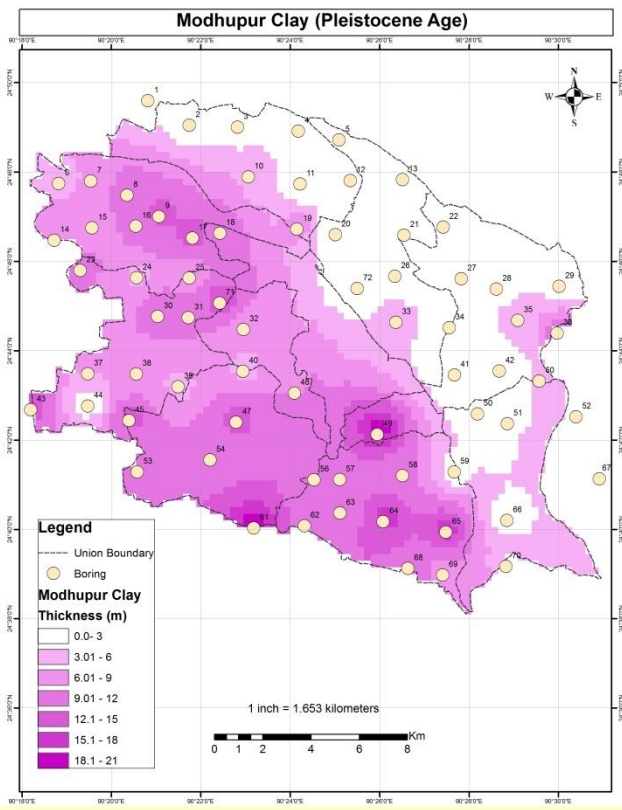
Outcome2: Identifying Geological Formation up to Depth 30m

Using Data

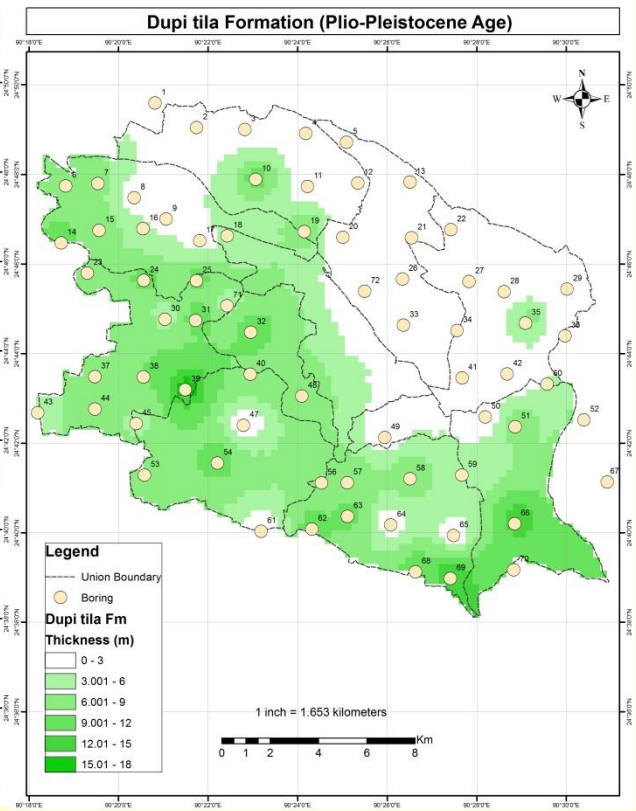
- Lithology
- N values of Standard Penetration Test (SPT)
- Correlation with existing Stratigraphy in and around of the study area



Thickness Distribution Map Of Alluvium (Recent)

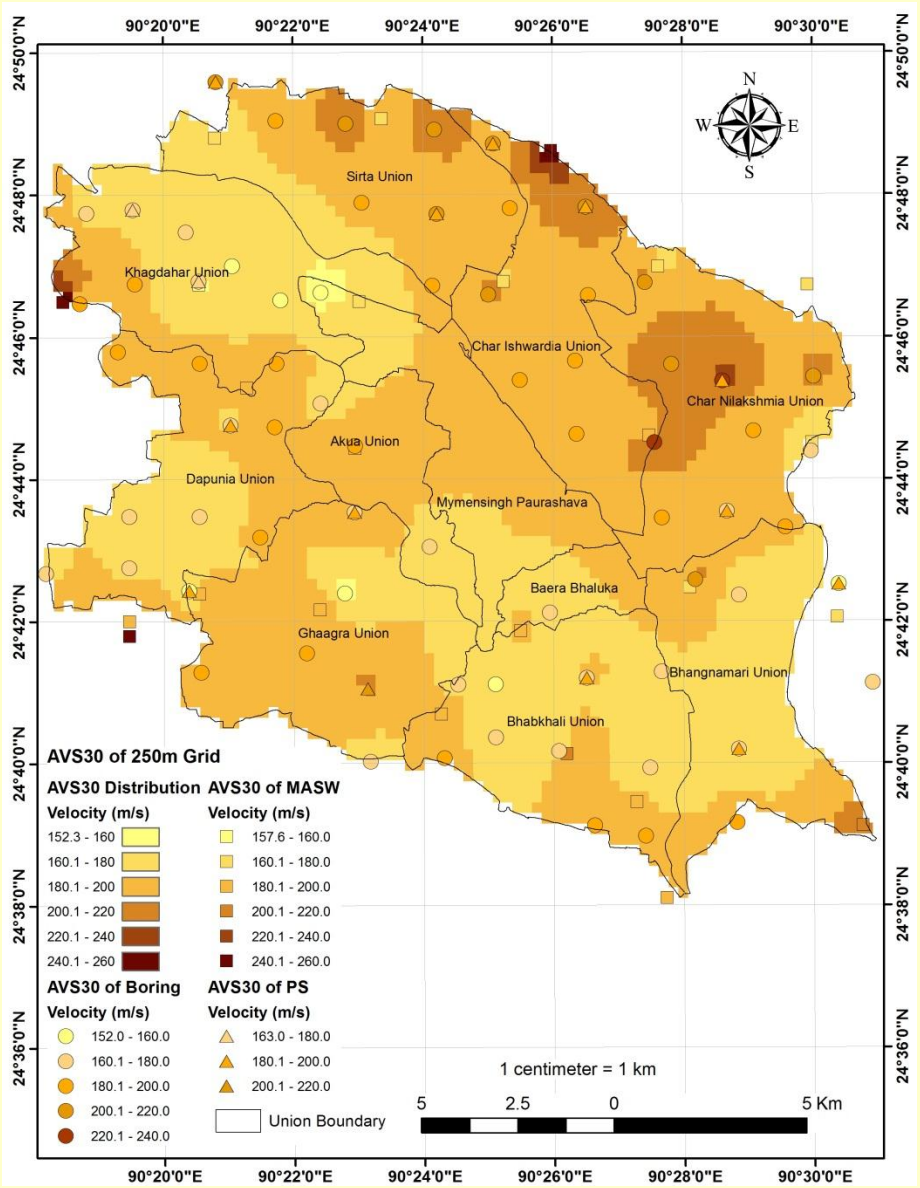


Thickness Distribution Map Modhupur Clay Formation (0.97 to 0.90 million years ago)



Thickness Distribution Map Dupi tila Sand Formation (Around 5 million years ago)

Outcome3: Engineering Geological Map Base on AVS 30 at 250m Grid



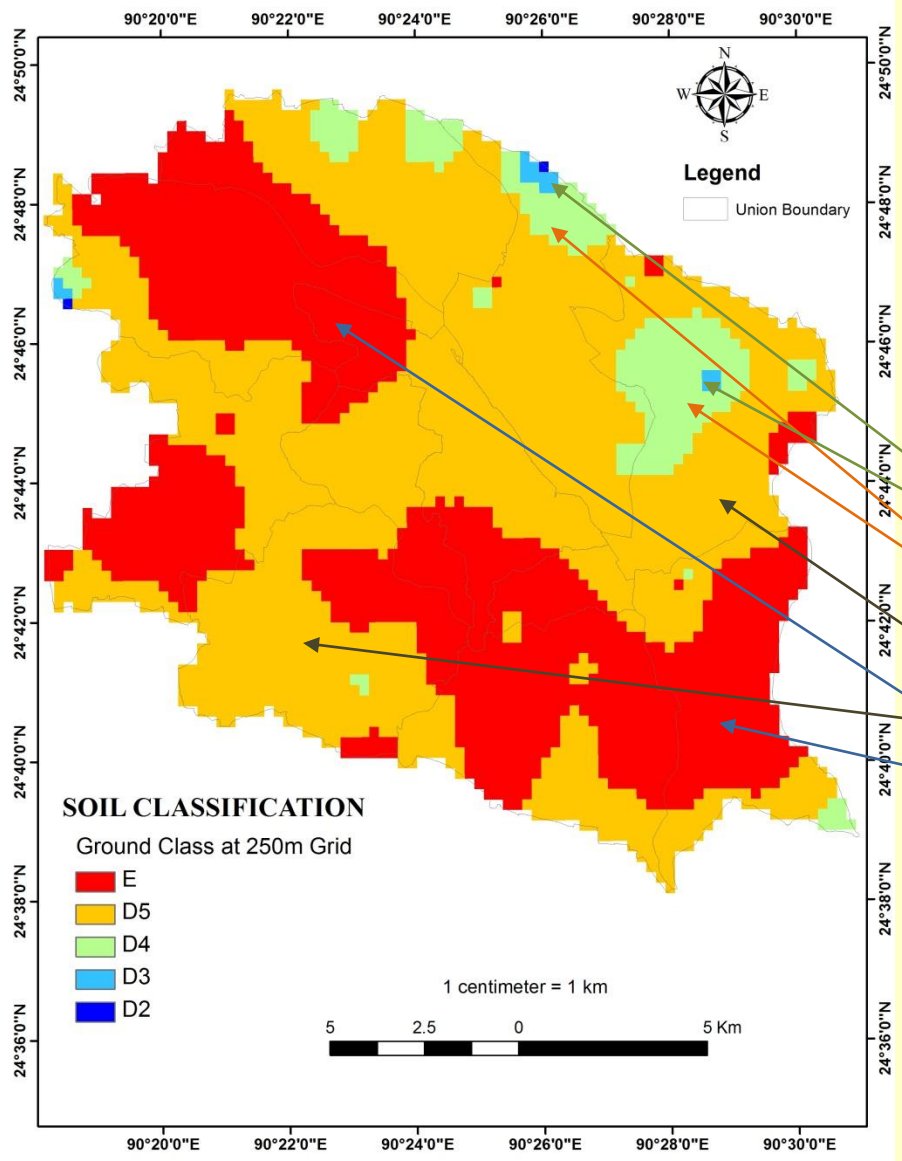
Average Shear Wave Velocity (AVS30)

- PS Logging Test
- MASW Survey
- SPT Boring

Definition of site class based on AVS30 (Source: UCB 1997)

Class	Site Class Description	Shear Wave Velocity (m/sec)	
		Minimum	Maximum
A	**HARD ROCK**	**1500**	
B	ROCK	**760**	**1500**
C	**VERY DENSE SOIL AND SOFT ROCK** Untrained shear strength us>2000 psf (us>100 kPa) or N >50 blows/ft	**360**	**760**
D	**STIFF SOILS** Stiff soil with undrained shear strength 1000 psf <us<2000 psf (50 kPa <us<100 kPa) or 15 <N <50 blows/ft	**180**	**360**
E	**SOFT SOILS** Profile with more than 10 ft (3 m) of soft clay defined as soil with plasticity index PI > 20, moisture content w> 40% and undrained shear strength us< 1000 psf (50 kPa) (N < 15blows/ft)		**180**
F	**SOILS REQUIRING SITE SPECIFIC EVALUATIONS** 1. Soils vulnerable to potential failure or collapse under seismic loading: e.g. liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays 3. Very high plasticity clays 4. Very thick soft/medium stiff clays		

Outcome 4: Soil Type Map



Ground Classification Applied in this Study

Ground Class	Vs30
C	360 - 760 m/sec
D1	300 - 360 m/sec
D2	250 - 300 m/sec
D3	220 - 250 m/sec
D4	200 - 220 m/sec
D5	180 - 200 m/sec
E	- 180 m/sec

Preparing Hazard Map

MSDP Project Area

1/18/2015

Necessary Data for preparing Hazard Map

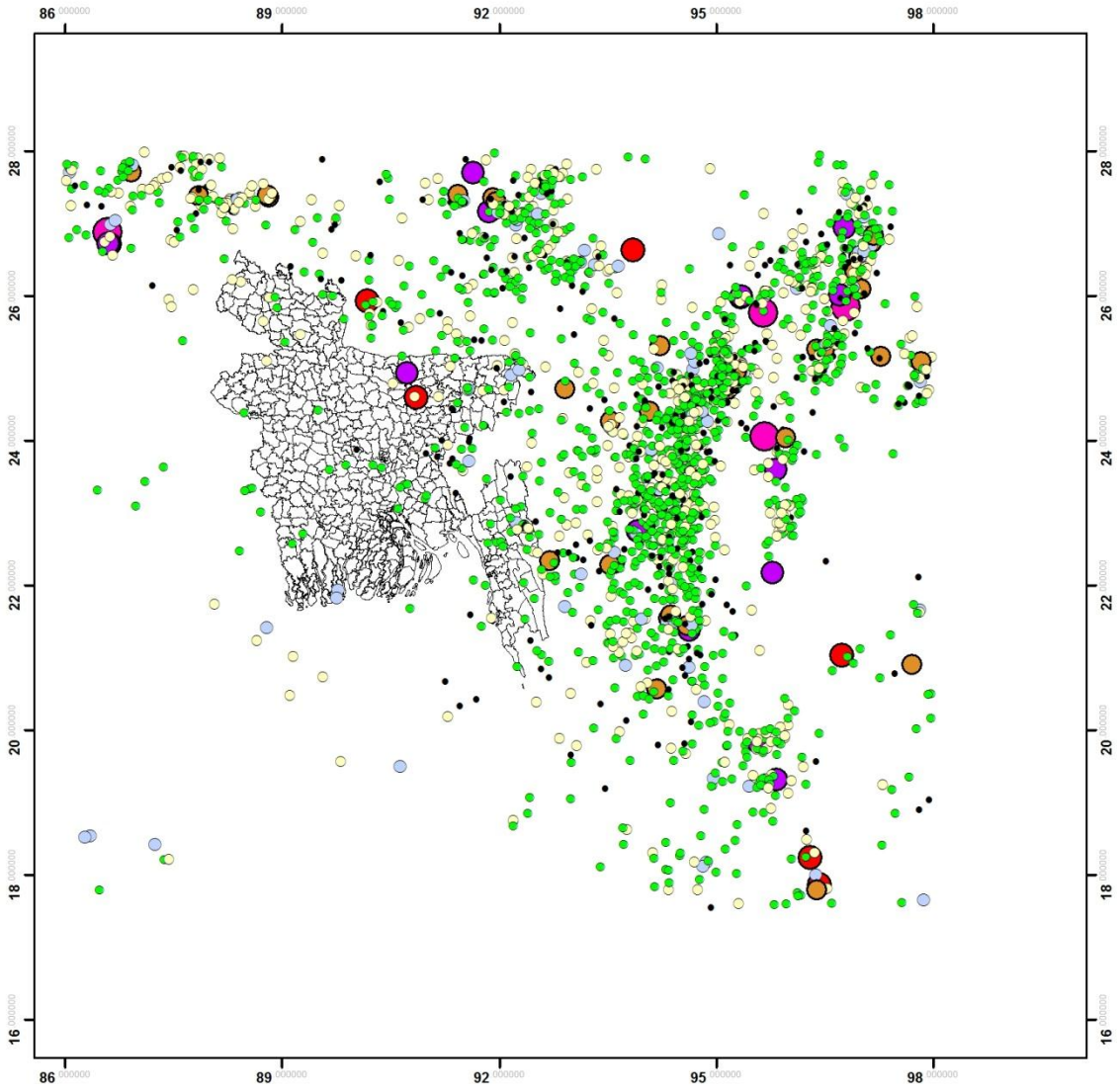
- Previous Earthquake History (Last 100 years).
- Fault Mechanism and identifying earthquake source zone.
- Source to site distance.
- Description of the local site conditions

Previous Earthquake History (Last 100 years).

Fault Mechanism and identifying earthquake source zone.

Source to site distance.

Description of the local site conditions



Legend

Previous Earthquake

Mw

- 4.00 - 4.49
- 4.49 - 5.00
- 5.00 - 5.49
- 5.49 - 6.00
- 6.00 - 6.49
- 6.49 - 7.00
- 7.00 - 7.49
- 7.49 - 8.00
- thana490

Source:

US Geological Survey(USGS)

International seismological Centre (ISC)

Bangladesh Meteorological Dept. (BMD)

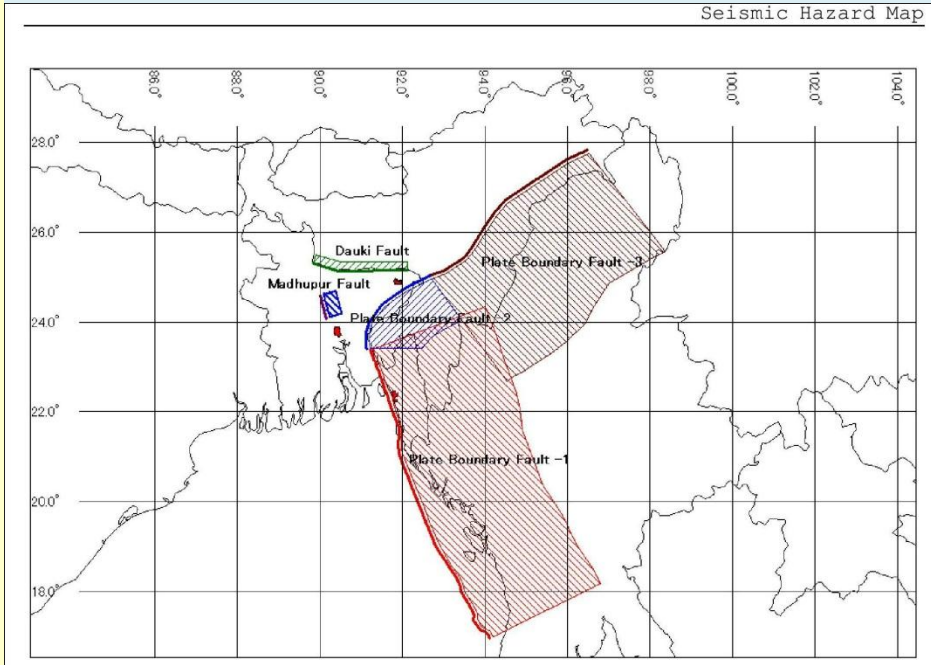
1/18/2015

Previous Earthquake History (Last 100 years).

Fault Mechanism and identifying earthquake source zone.

Source to site distance.

Description of the local site conditions



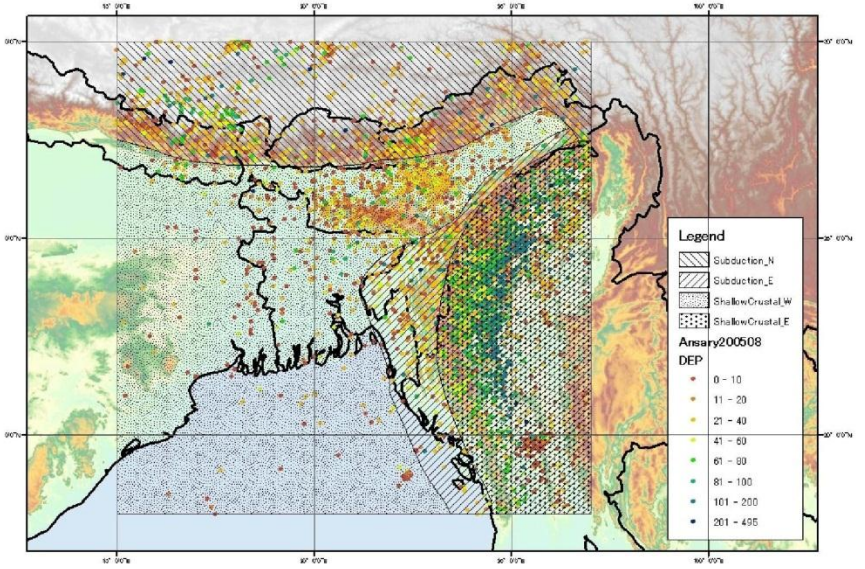


Figure 1-28 Seismic Source Zones in Bangladesh and its Surroundings

Table 4 Potential earthquake magnitude of major structures near Bangladesh based on the empirical equation of Strasser et al. [2010]

Name	Length (km)[A]	Dip	Locking depth (km)	Fault width (km)	Slip rate (mm/yr)	M_{max}	Average slip (m)	Recurrence interval (yr)	Date of last event (AD)
Main Frontal Thrust	~500	~10	20	115	21	8.6	6.3	300	1100(?)
Dauki fault	~270	~45	35	50	11	8.3	7.5	680	1897
Arakan megathrust (Rahkine section)	~500	~16	30	108	23	8.6	6.7	290	1762
Arakan Megathrust (Chittagong section)	~500	<10	20	~200	10	8.6	3.6	360	Unknown, but perhaps1548?
Naga thrust	~400	~23	20	50	5	8.5	11	2200	unknown

Source:

CDMP report Seismic Hazard Assessment of Dhk, Chg, Syl.2009.

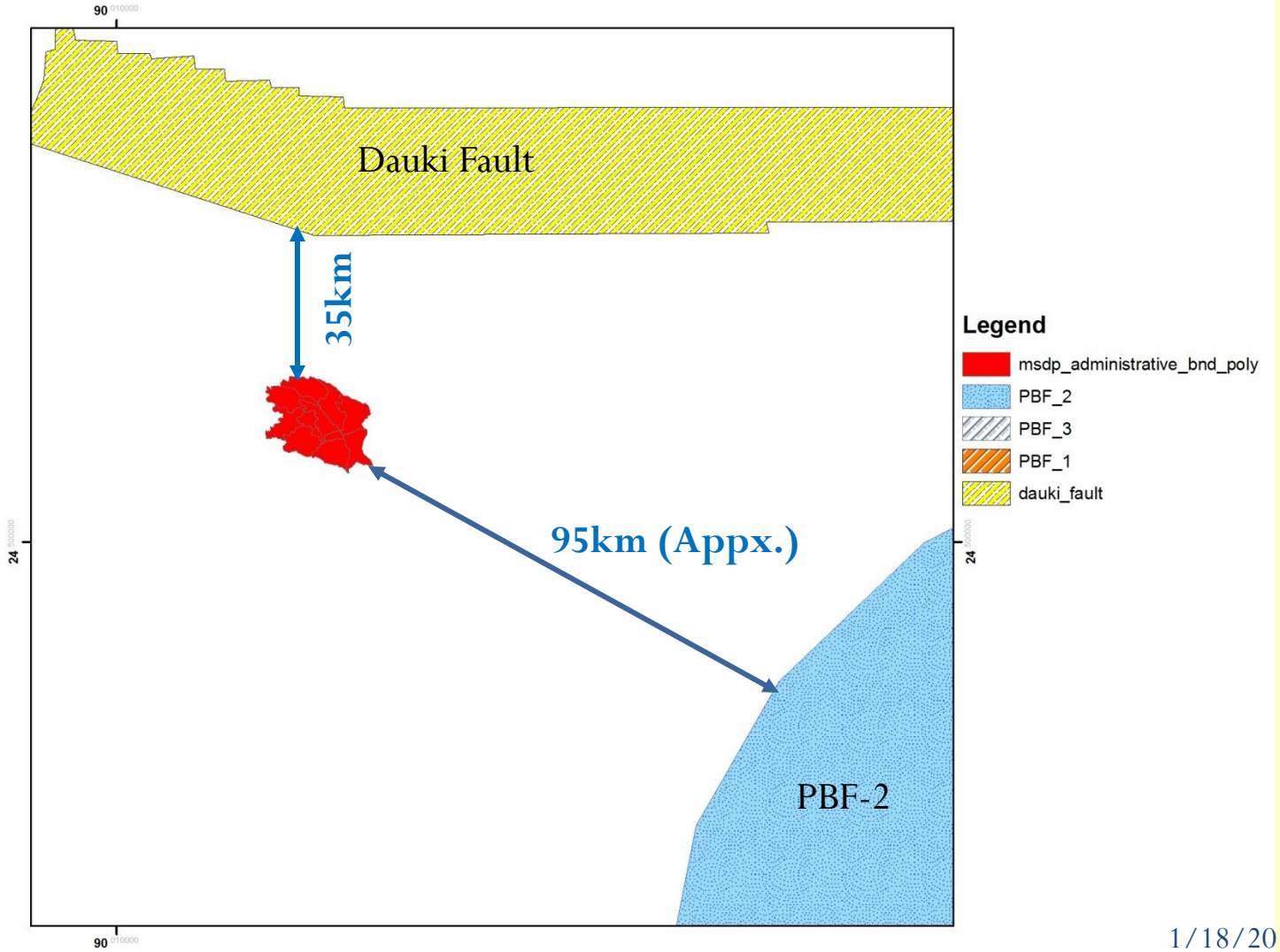
CDMP report Active tectonic features, 2012

Previous Earthquake History (Last 100 years).

Fault Mechanism and identifying earthquake source zone.

Source to site distance.

Description of the local site conditions



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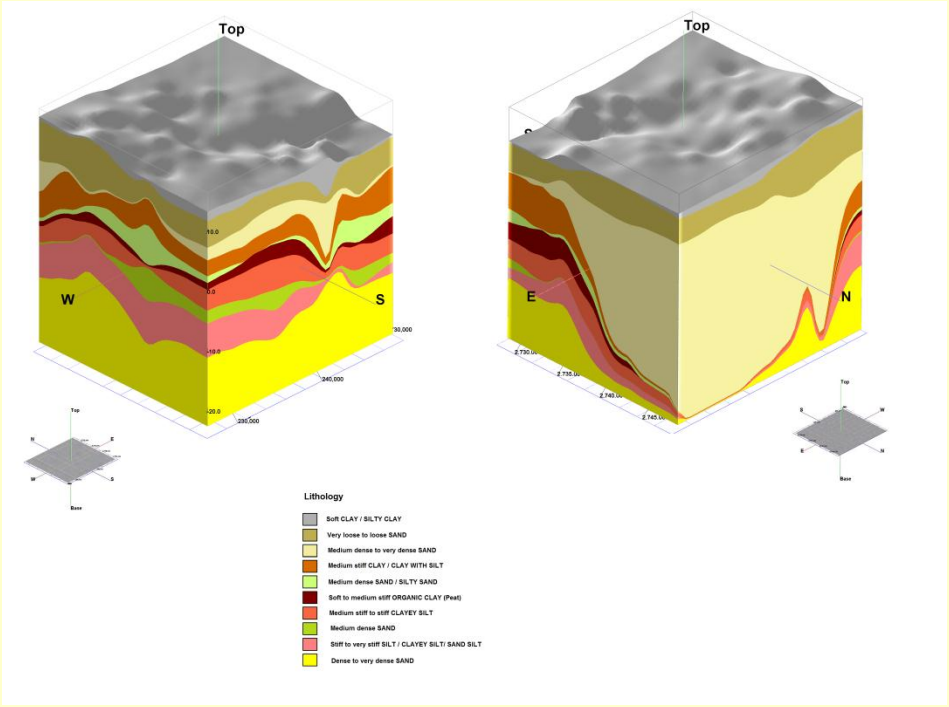
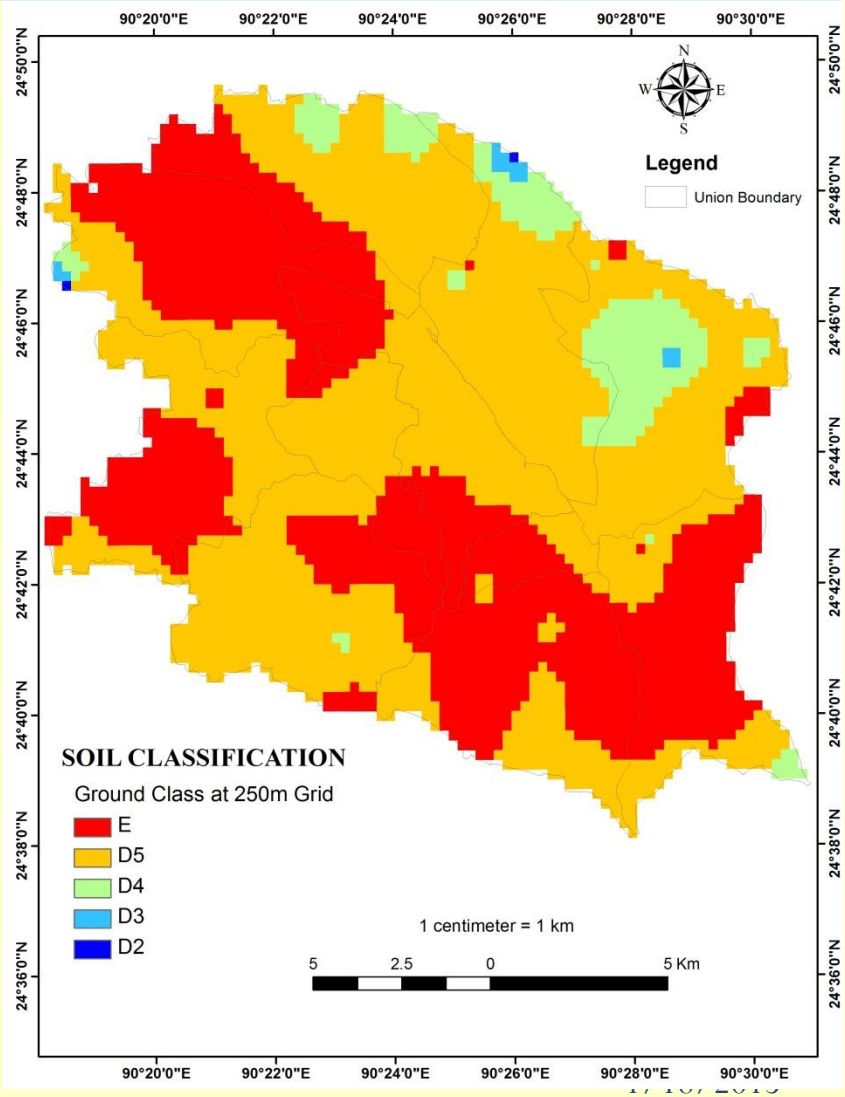
Previous Earthquake History (Last 100 years).

Fault Mechanism and identifying earthquake source zone.

Source to site distance.

Description of the local site conditions





Finally Integrated all those Primary and secondary Data by using GIS , Rockwork and Crisis 2007 Software, we will get seismic hazard map of the project area.

Example:

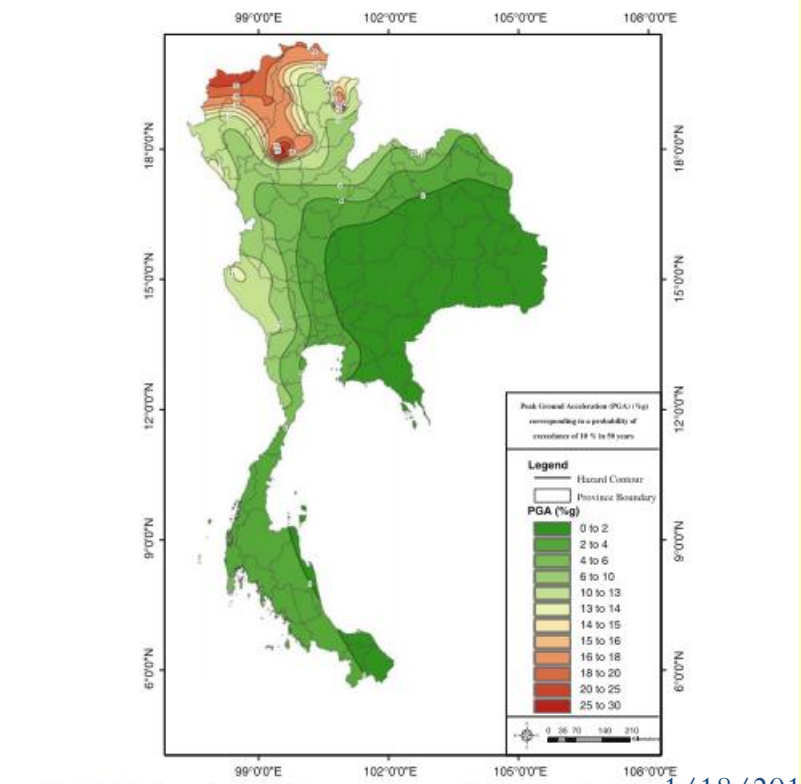


Fig. 8 Thailand hazard maps for PGA corresponding to a probability of exceedance of 10% in 50 years

1/18/2015

1/18/2015


BH:Char Nilakshmia
BH-28
Date: 19-07-14


BH- Khakdahan-16
Depth - 18m
Madhupur Clay


THANK YOU ALL