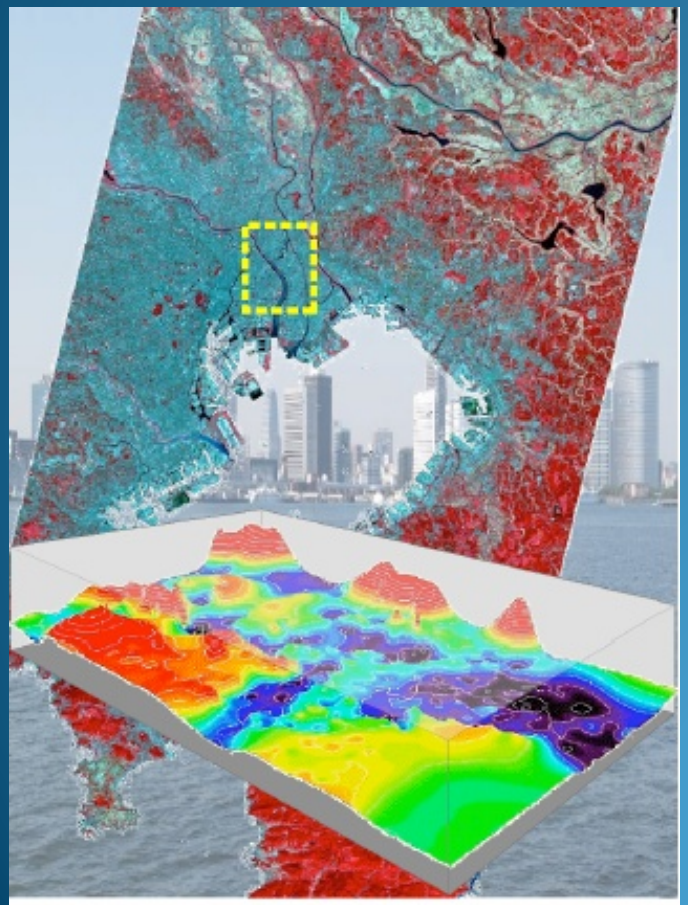
Toward open data for borehole database and 3D geological modelling for seismic hazard assessment in the costal plain adjacent to the Tokyo Bay


ASTERで見る東京湾岸域と低地に伏在する埋没谷構造

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8th EUREGEO 2015.06.15

Purpose and Content

Borehole data are indispensable in the urban area in Japan,
not only for geotechnical information of city planning and building construction,
but also for 3D geologic modelling for the seismic hazard assessment and
groundwater hydrology.

Our presentation consists of
(1) Preface: What is borehole data?
and How to use them for seismic hazard assessment ?
(2) Toward open data of borehole log data
(3) 3D subsurface geologic modeling based on borehole data
: a case of the coastal urban area
Chiba City, facing to the Tokyo Bay

Borehole data have been offered from Chiba Prefecture and
Ctiy government offices.

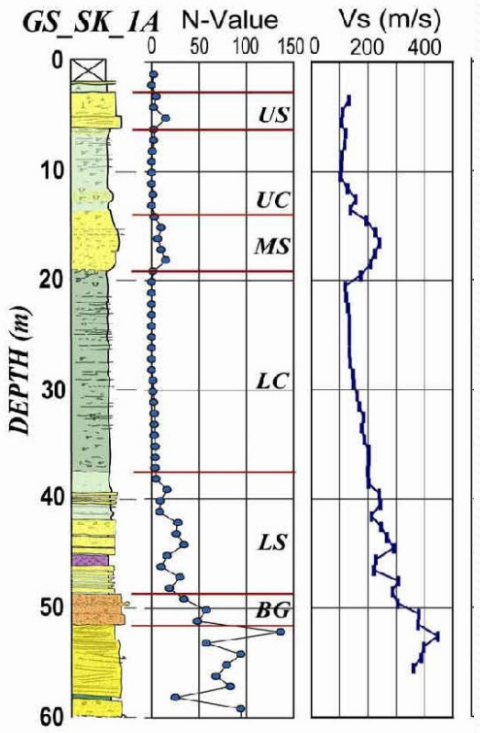
(1) Preface

Borehole data from Standard Petration Test(SPT)

SPT 1) most popular test of ground for geoengineering purposes in Japan (from10 to 70m long in depth)

2) to offer lithology, N-value of ground and soil sampling for test. N-value > 50 is an index of the horizon of the loard bearing

the column of the lithology and soil properties (N-value)



This data are based on Borehole logs from the Holocene deposts.

Standard format of Borehole data

Digital format: Japanese standard, encoded by XML
(Extensive Markup Language) , which has been offered by Government, Ministry of Land, Infrastructure and Transport since 2001

```
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                <調査位置住所>東京都墨田区</調査位置住所>
        </調査位置>
```

An example of actual data formated in Japanese standard XML

Japanese version only

This format has been set up for geoengineering reports, but including the formal tag and code for the stratigraphic horizon and lithologic facies.

From Borehole log data to Physical properties of ground model for Sesimic response analysis through Empirical formula

N-value・lithology・age⇒Vs

Typical empirical formula :
Ota and Goto (1978)

$Vs = 68.91 \times N^{0.173}$

× dep

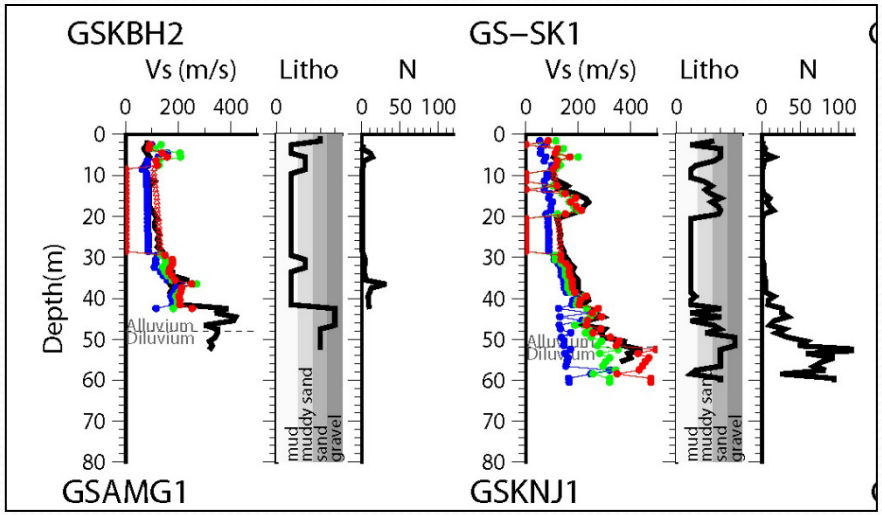
× 1.00(

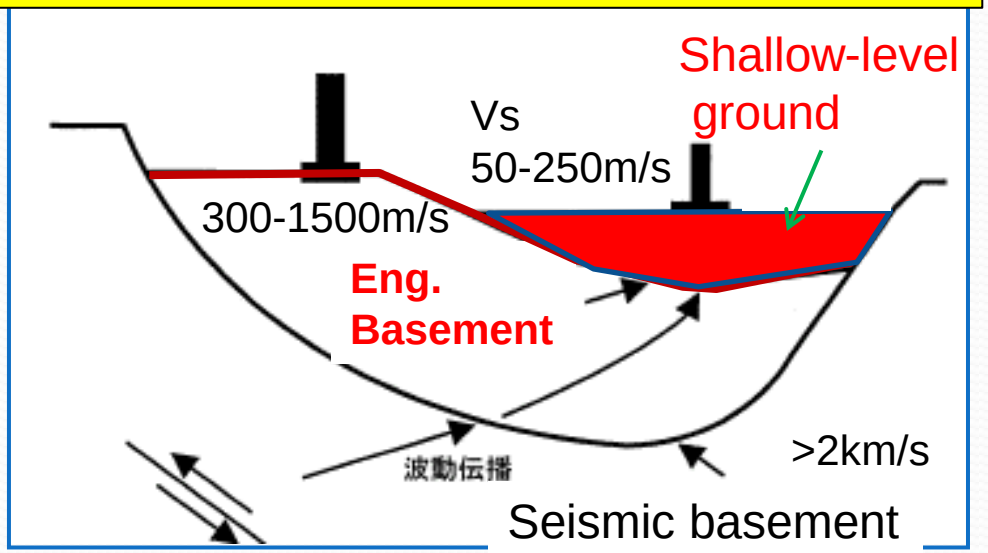
1.306(diluvium) 1.085(sand)

1.189(gravel)

Low N-value (clay less than 5 of N-value means low velosity of share wave of less than 150m/s.

We can construct geology-depend 3D physical property model of ground for seismic hazard assess.

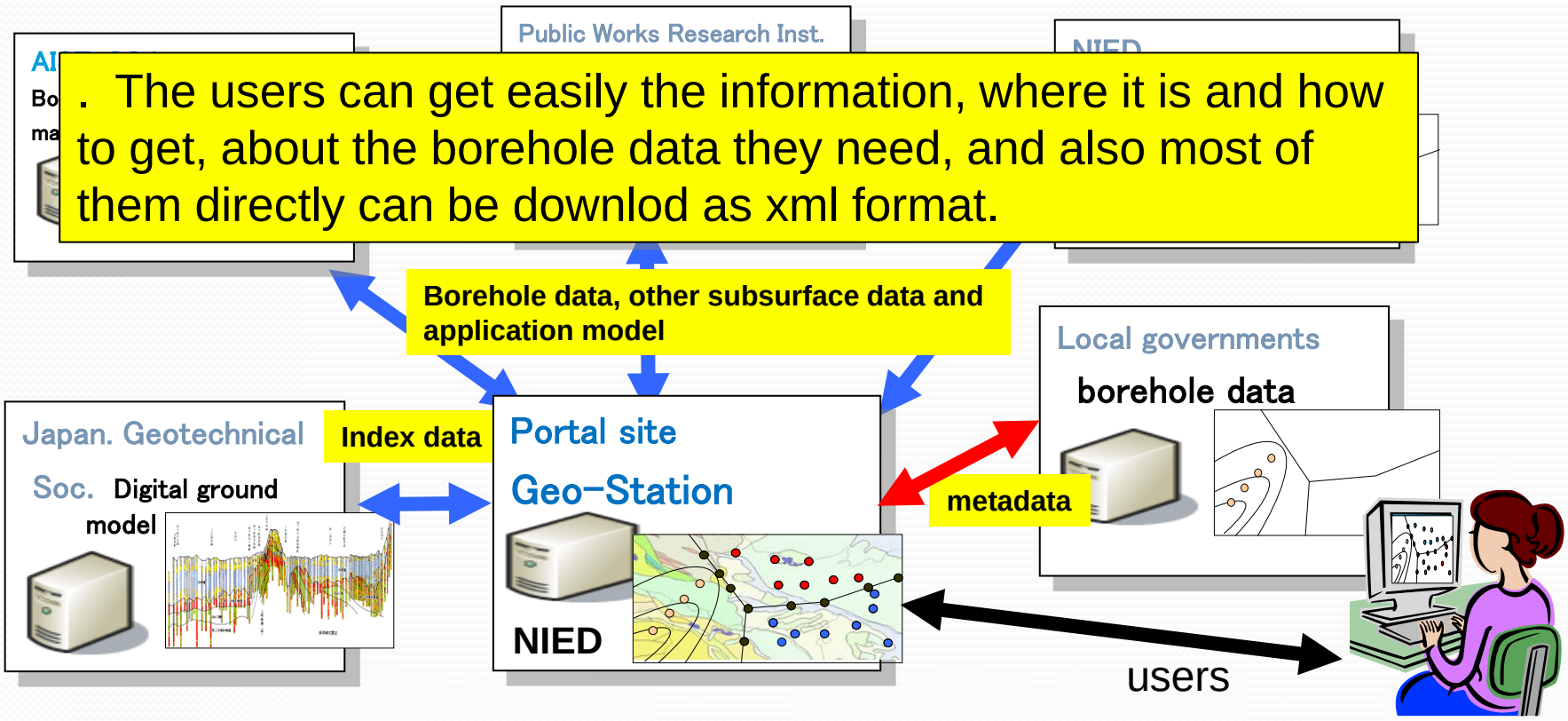




(2)Toward open data of borehole data

WEB open data system :
We have maintained portal site “Geo-Station” in cooporation with stakefoleders, , which includes more than 200 thousands of borehole data (standard format)

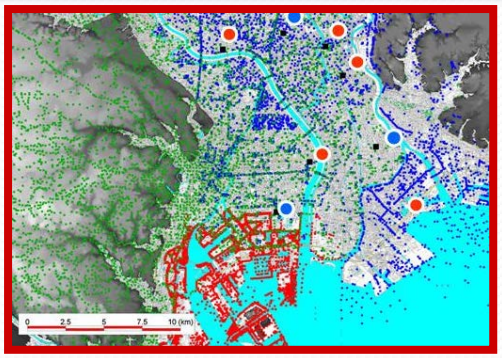
Dipersion and management system of web servers



(3) 3D Subsurface Geologic Modeling : a case of the coastal urban area: Chiba City facing to the Tokyo Bay, based on borehole data,

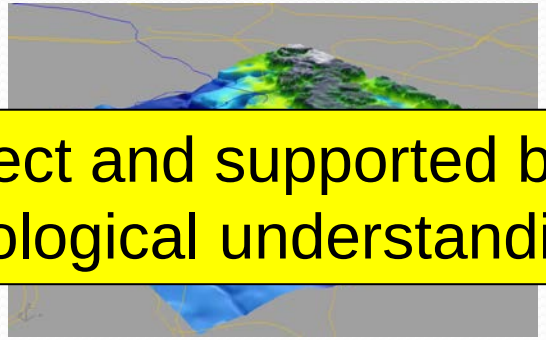
Methodologies of 3D modeling in this study

Construction of database of borehole data



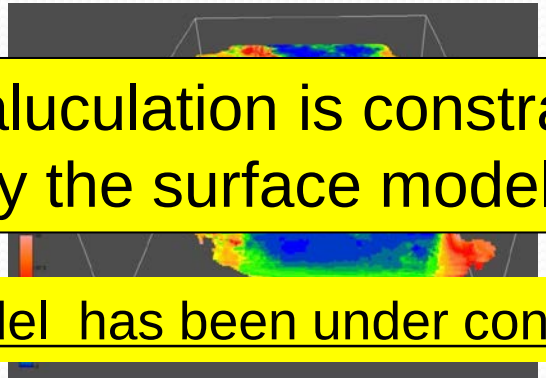
Comprehensive databese of geomorphology, geology and land use by GIS

Construction of surface models of major stratigraphic boundaries
> including the base of embankment



to reflect and supported by the geological understanding

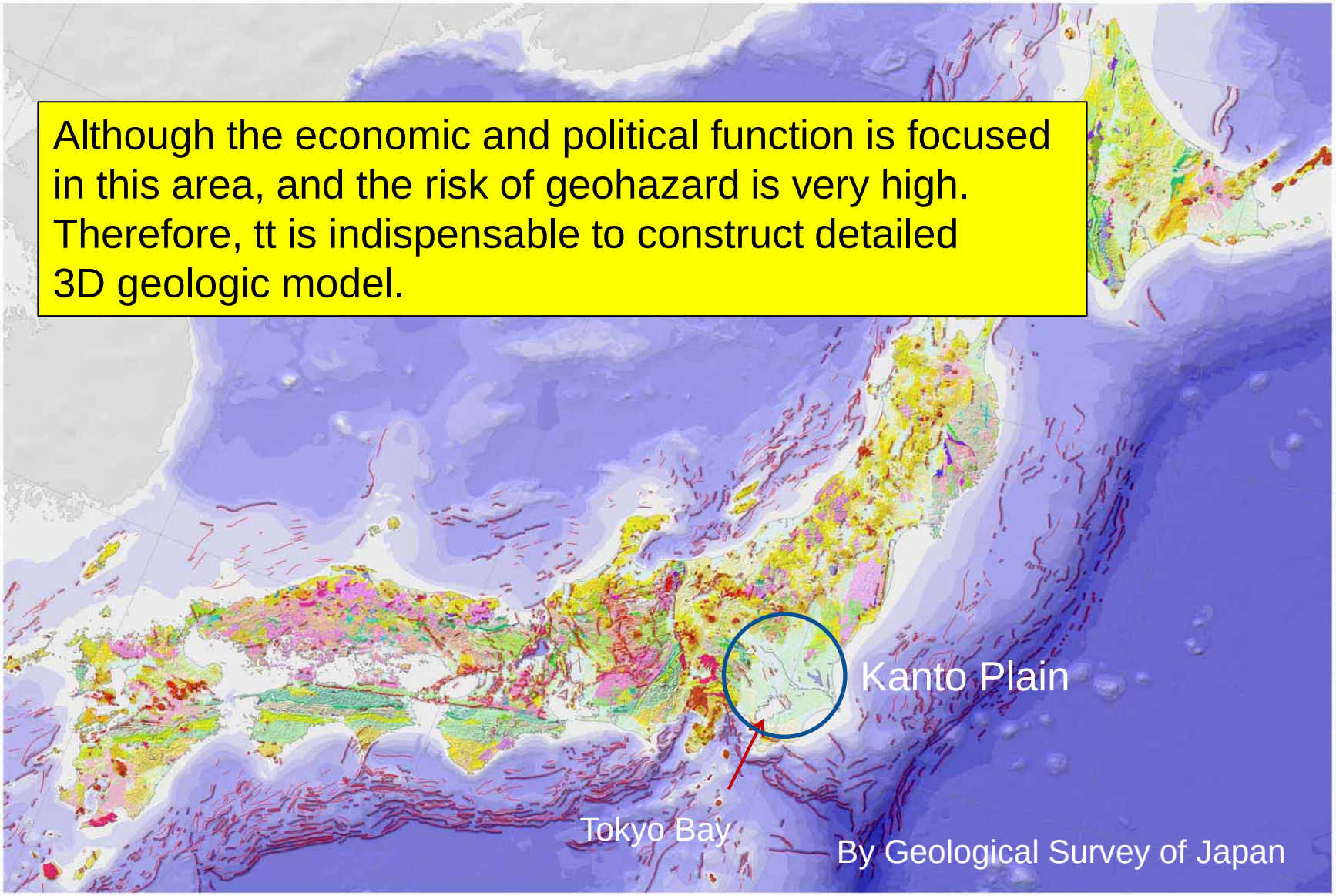
Construction of 3D grid model with attributes of stratigraphic horizons, lithologies, N-values



Grid caluculation is constrained by the surface model

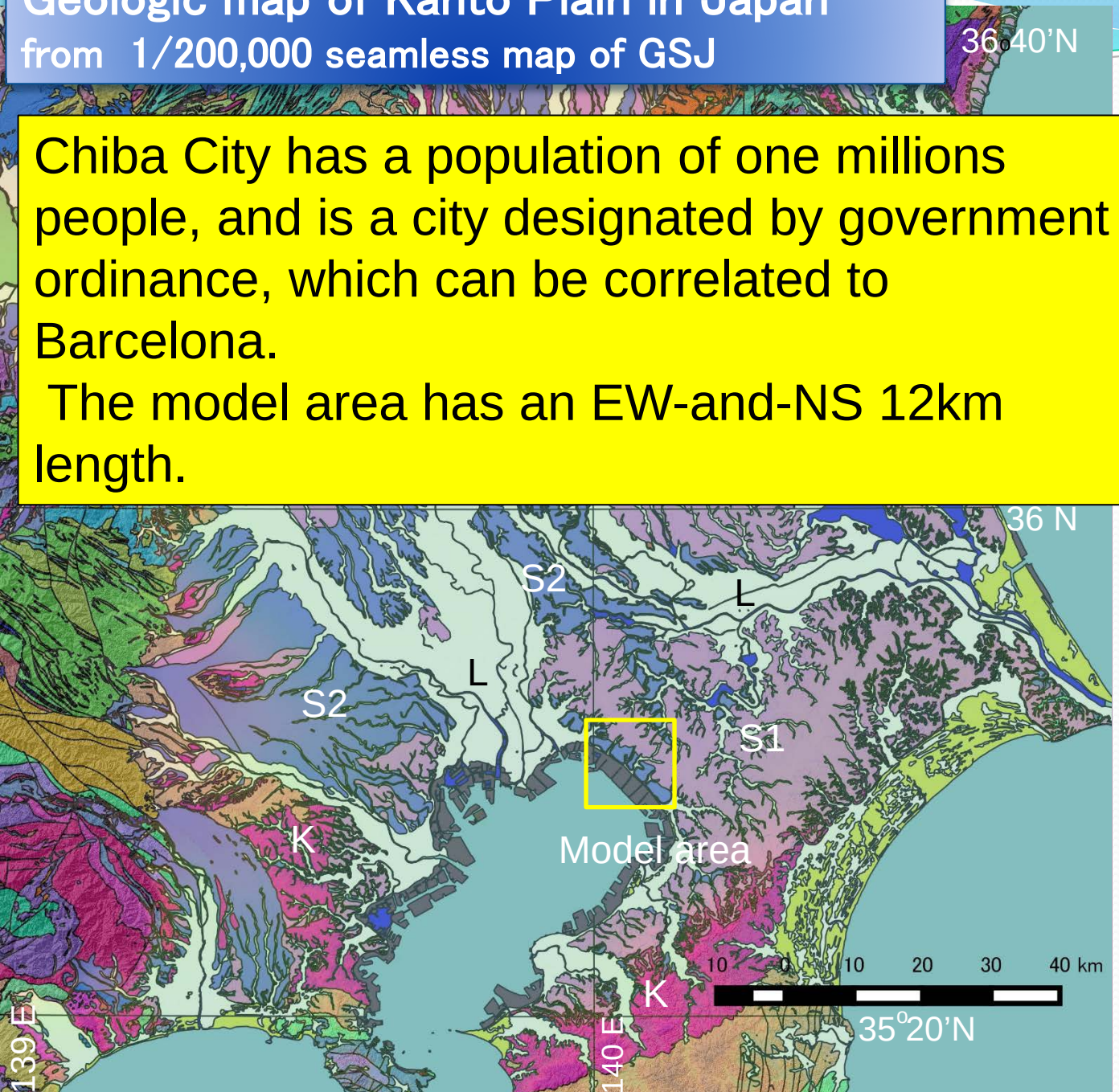
Sorry, the grid model has been under construction.

Index map : Geologic map of the Japanese Island by AIST, Geol. Survey of Japan



Geologic map of Kanto Plain in Japan
from 1/200,000 seamless map of GSJ

Chiba City has a population of one millions people, and is a city designated by government ordinance, which can be correlated to Barcelona.
The model area has an EW-and-NS 12km length.



L

olocene Lowland plain
lluvial and coastal plain
latest Pleistocene to Holo-
cene incised-valley fills

S2

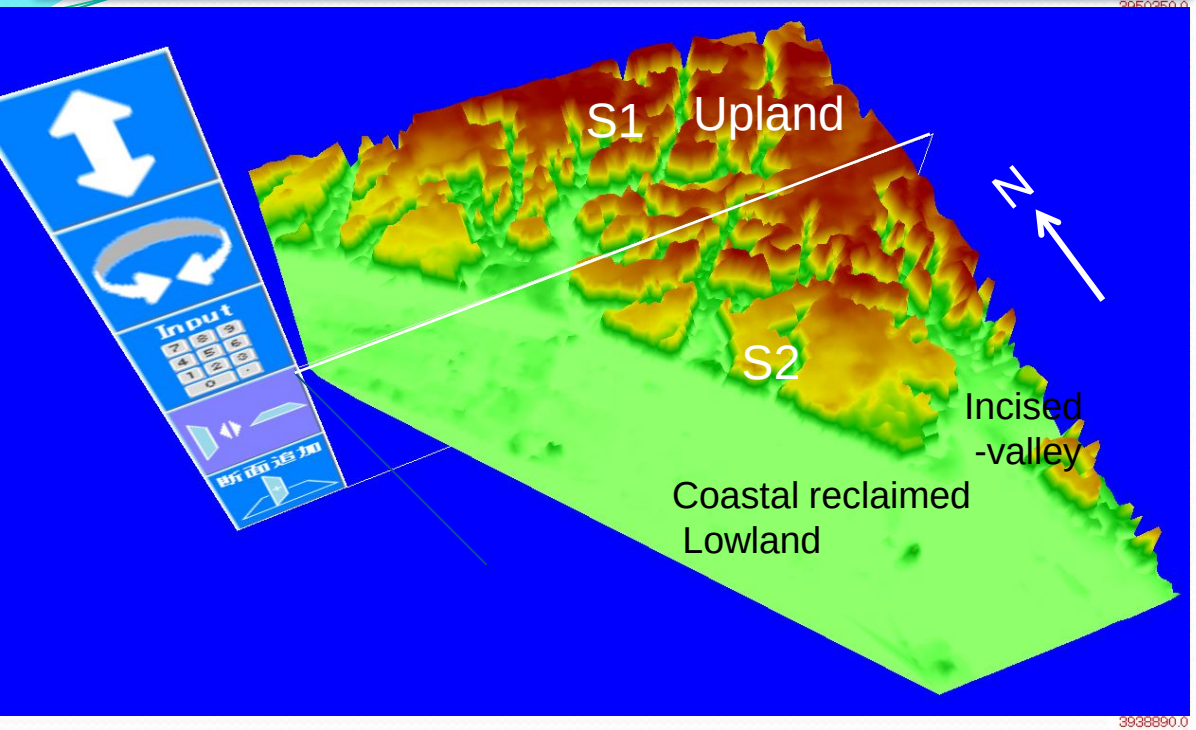
S1

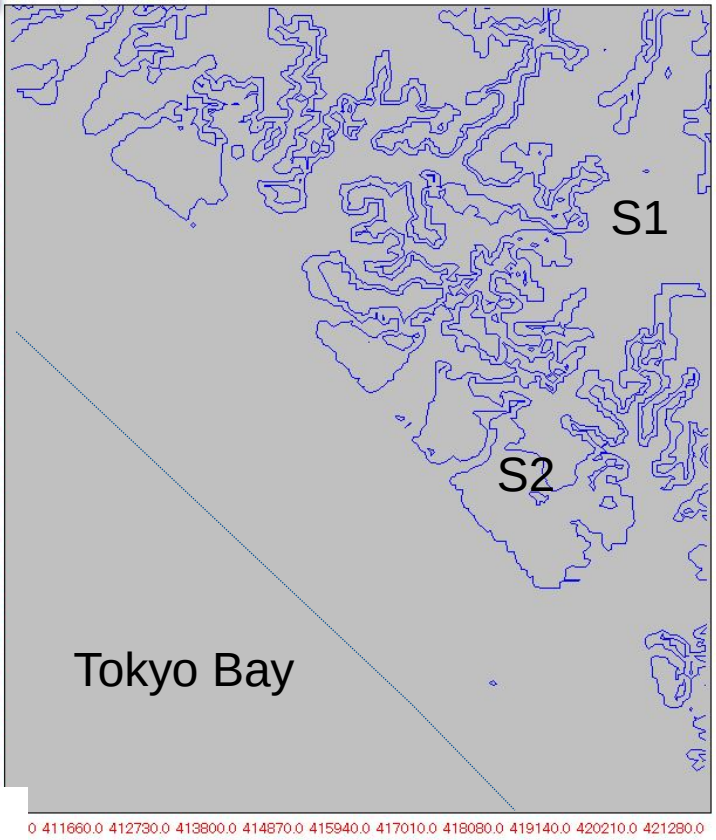
Loam upland
T2 Lower terrace:
MIS5c-a fluvial deposits
T1 Middle terrace:
MIS5e shallow-marine deposits

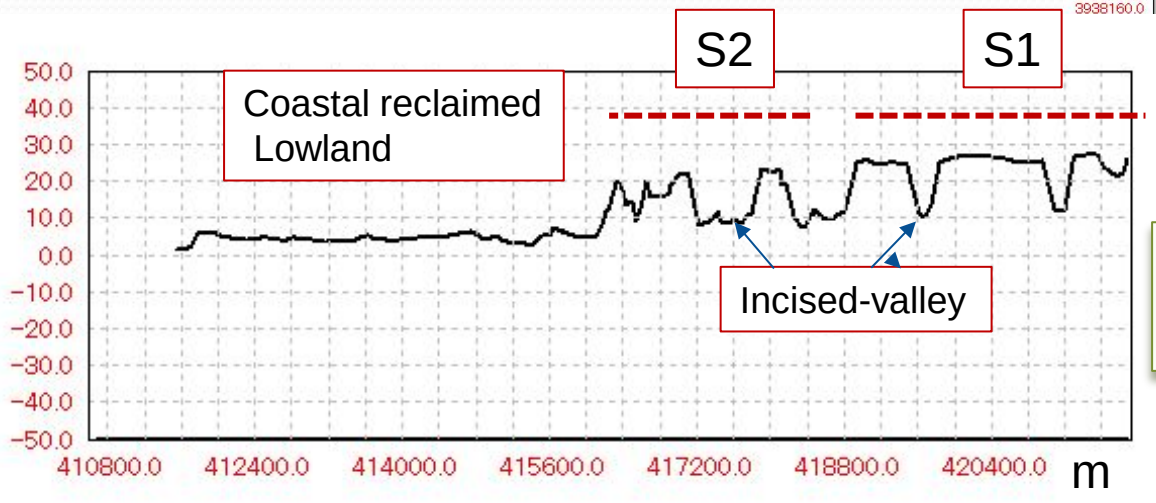
K

Hill : Lower to Middle Pleistocene marine strata

Model area : Chiba City
1) Topographic surface model : Lowland–Upland





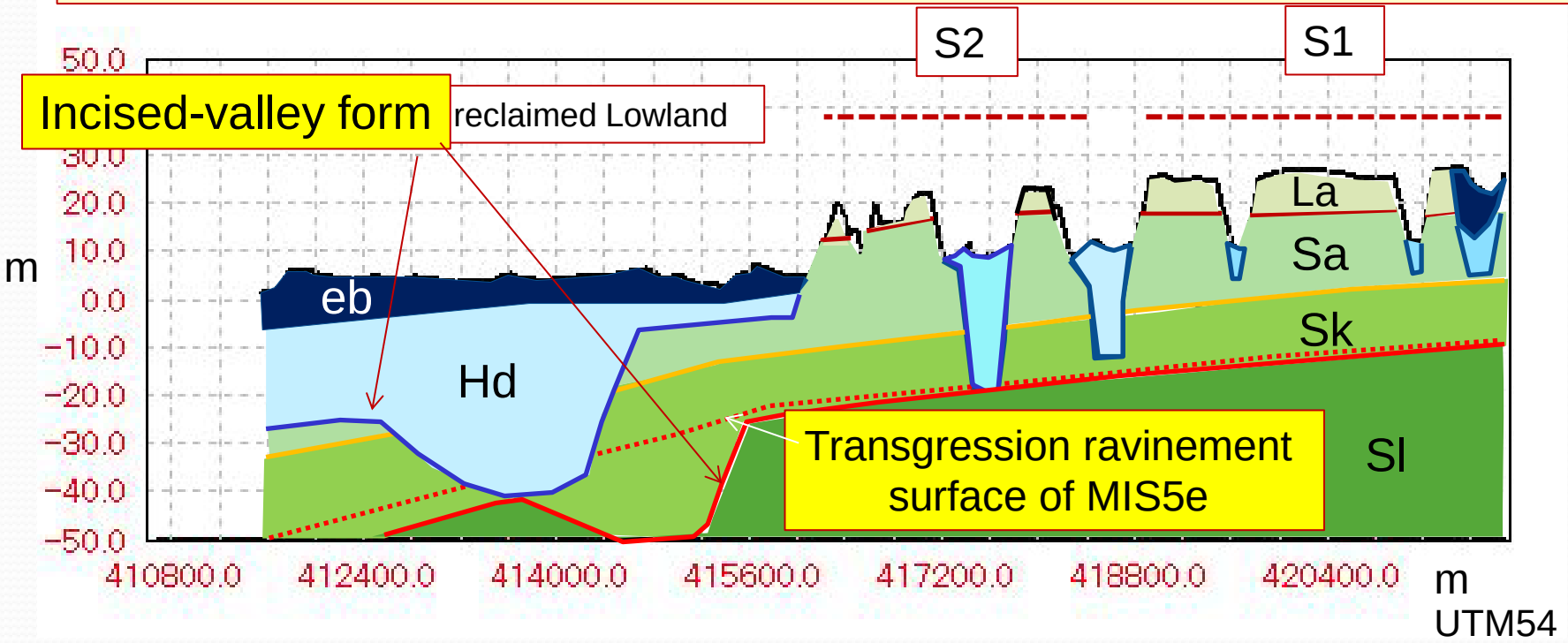


by 3D modeler (MakeJiban: Godai Kaihatsu Corp.)

UTM54

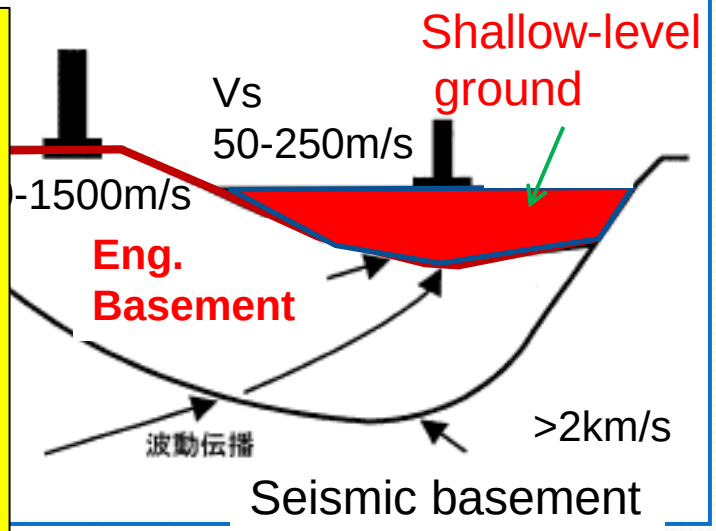
Stratigraphic divisions of model area

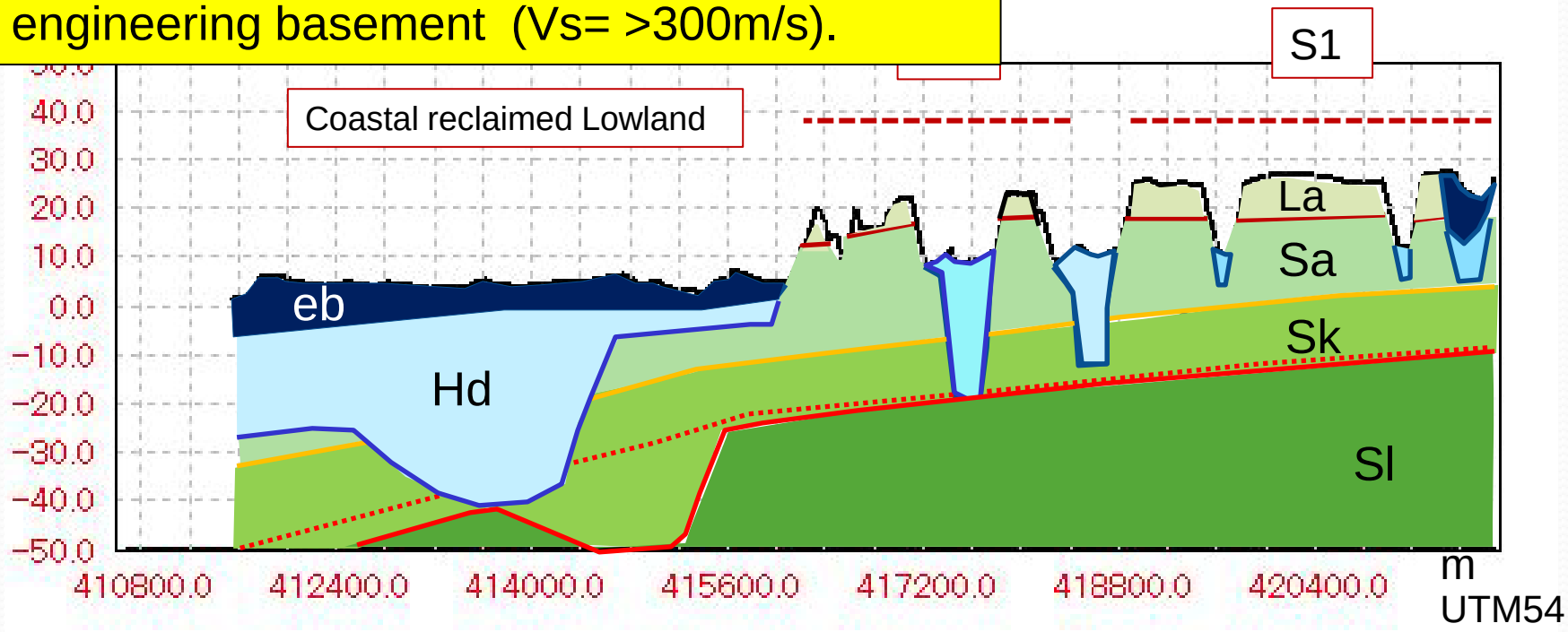
1) eb : Filling soil and embankment
2) Hd : Holocene deposits: incised-valley fills of latest Pleistocene to Holocene
3) **La** : Kanto loam beds Late Pleistocene volcanigenic and aeolian deposits
4) Shimosa Group Mid. to Late Pleistocene strata : Shallow-marine to fluvial deposits
   5 to 6 Regression-Transgression sequences
   - 4_1 Sa : Anezaki Formation: fluvial deposits (120 to 100 ka)
   - 4_2 Sk : Kioroshi Formation: latest Pleistocene shallow marine strata (MIS5e)
   - 4_3 Sl : the other Shimosa Group: strata under the Sk



Geoengineering characters of the stratigraphic divisions

1) eb, which is mostly liquefacted by earthquake shaking
2) The Hd is remarked by soft ground, and the thickness and properties strongly influence amplitude of the earthquake shaking.
The basal surface figures an incised-valley form .
3) Basal surface of Sk is close to the engineering basement (Vs= >300m/s).





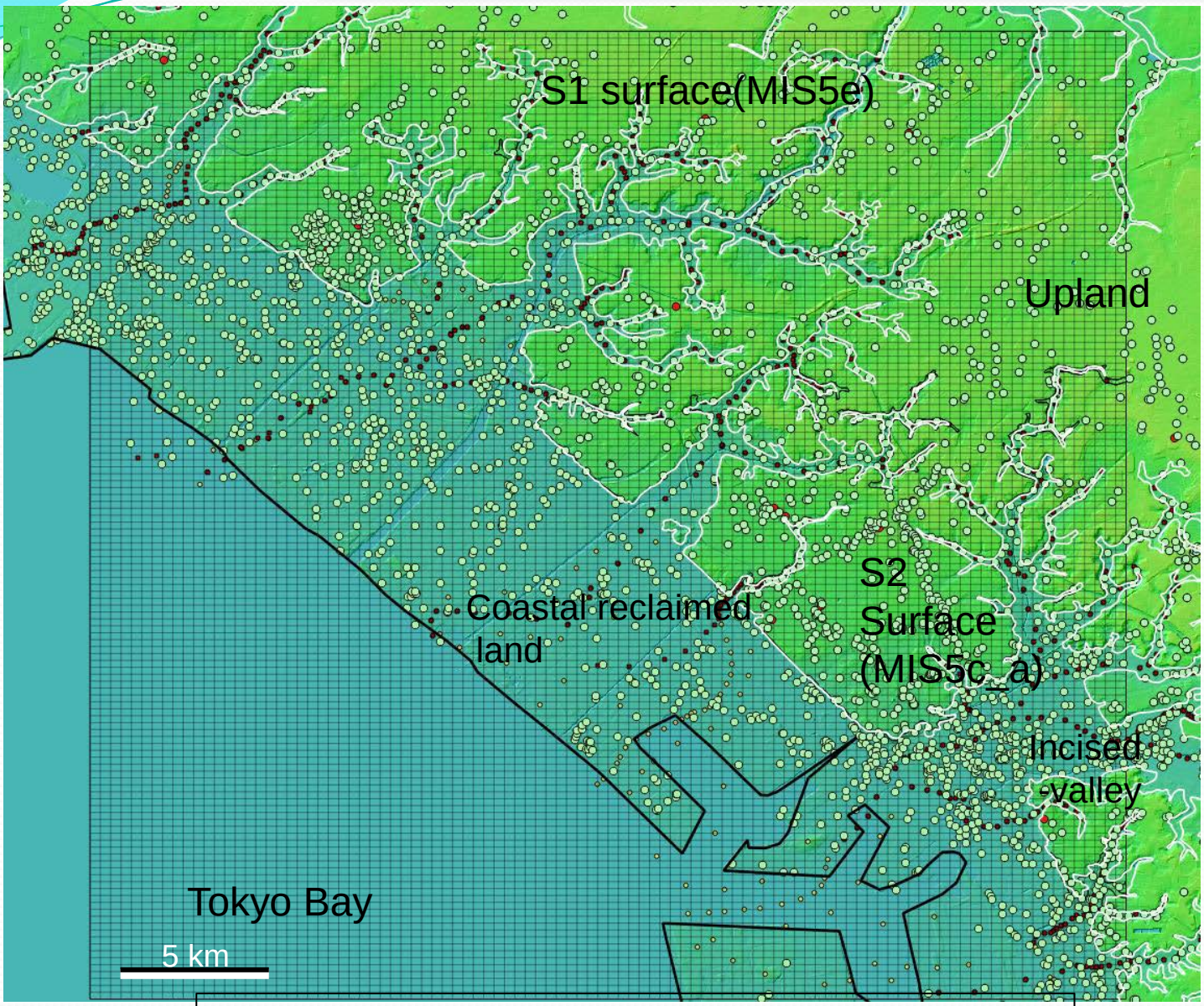
Three-types of point data for calculating the surface models

1. Point data indicating some stratigraphic horizons determined on borehole log columns (2,000 points for Hd)

2. Point data on control lines for Hd :
a boundary line between lowland and upland (14,000 points for 50m interval on the lines)

3. Additional secondary points controlling the surface model (appropriate continuity of incised-valley form and boundary form of geomorphic plains: 1300 points for Hd)

Location of borehole data used for modeling



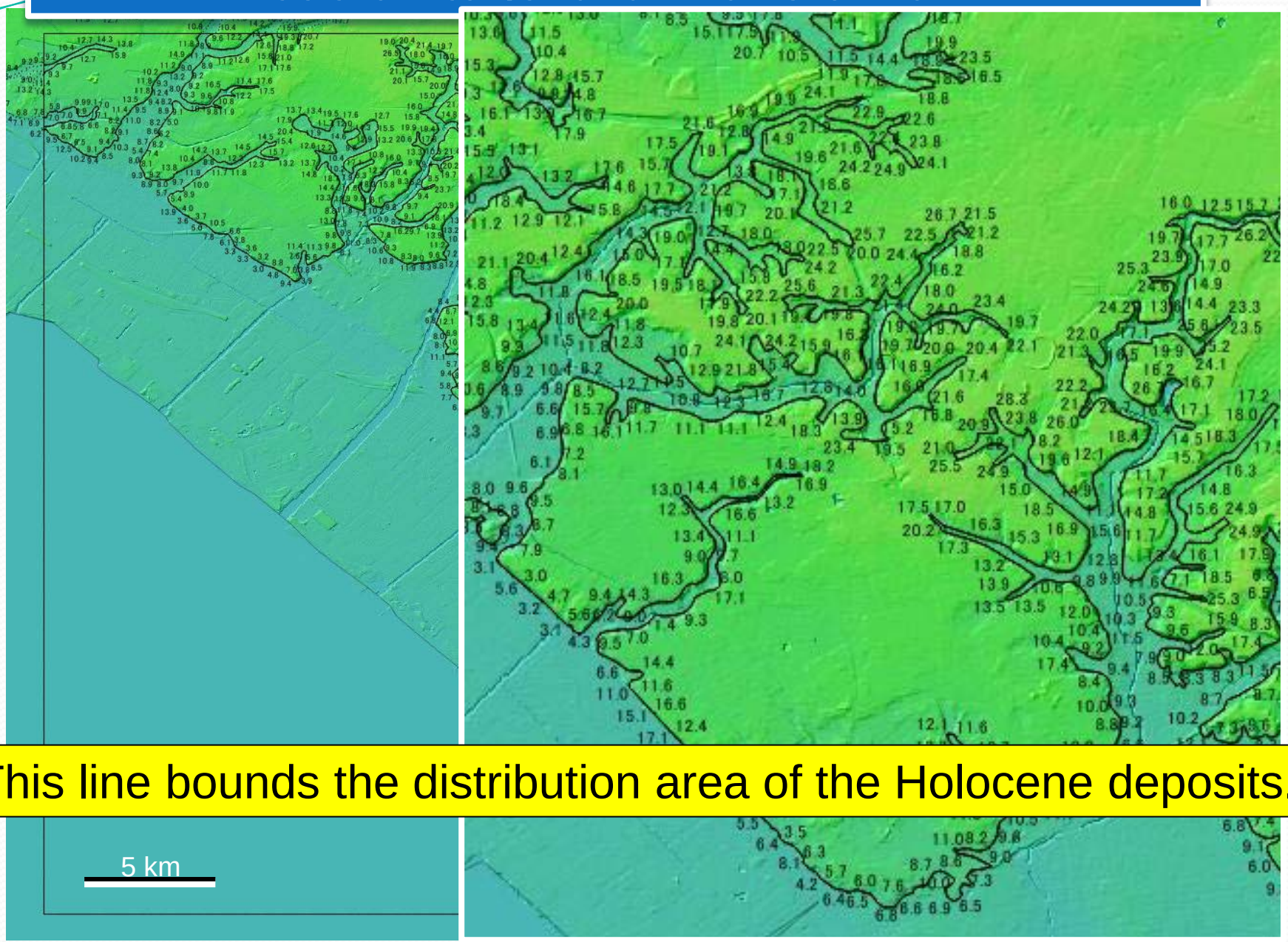
Topographic elevation map based on 5mDEM

Area:
15*13km ,
160km^2

○ Borehole data :
3400 numbers

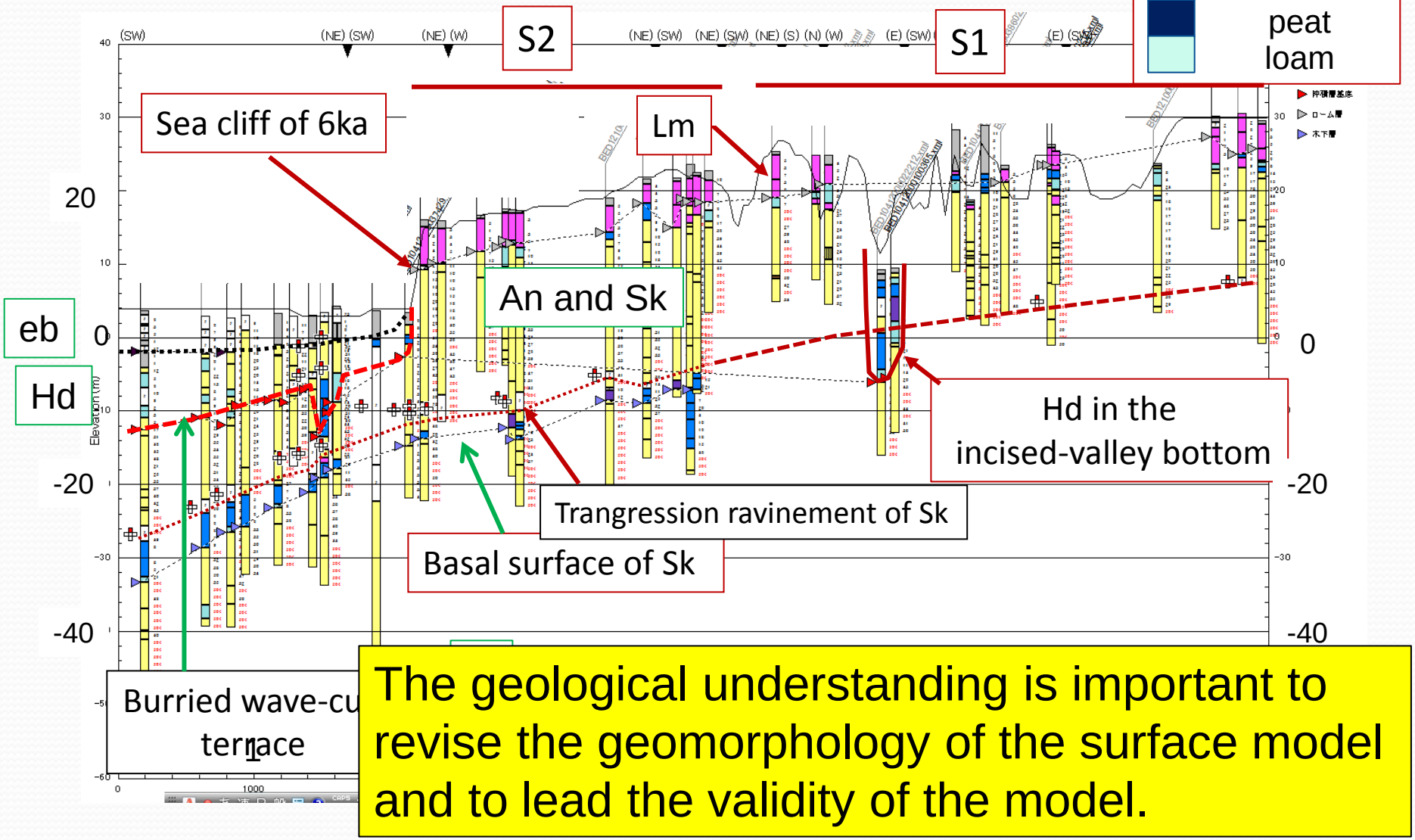
● Addit. secondary points :

Lowland–Upland boundary line and points with elevation at the interval of 50m on the line



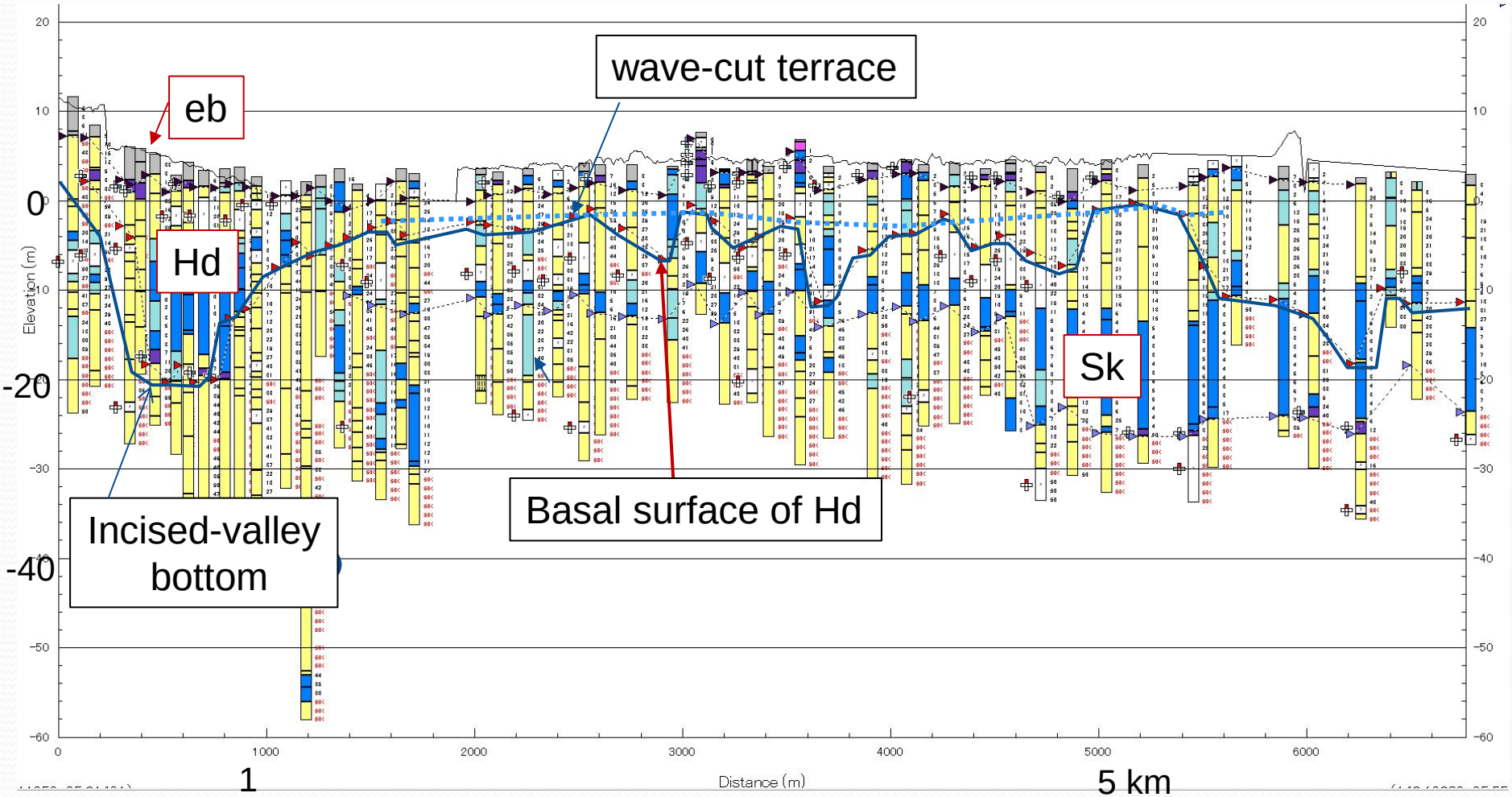
This line bounds the distribution area of the Holocene deposits.

Profile section cross to the coastal line



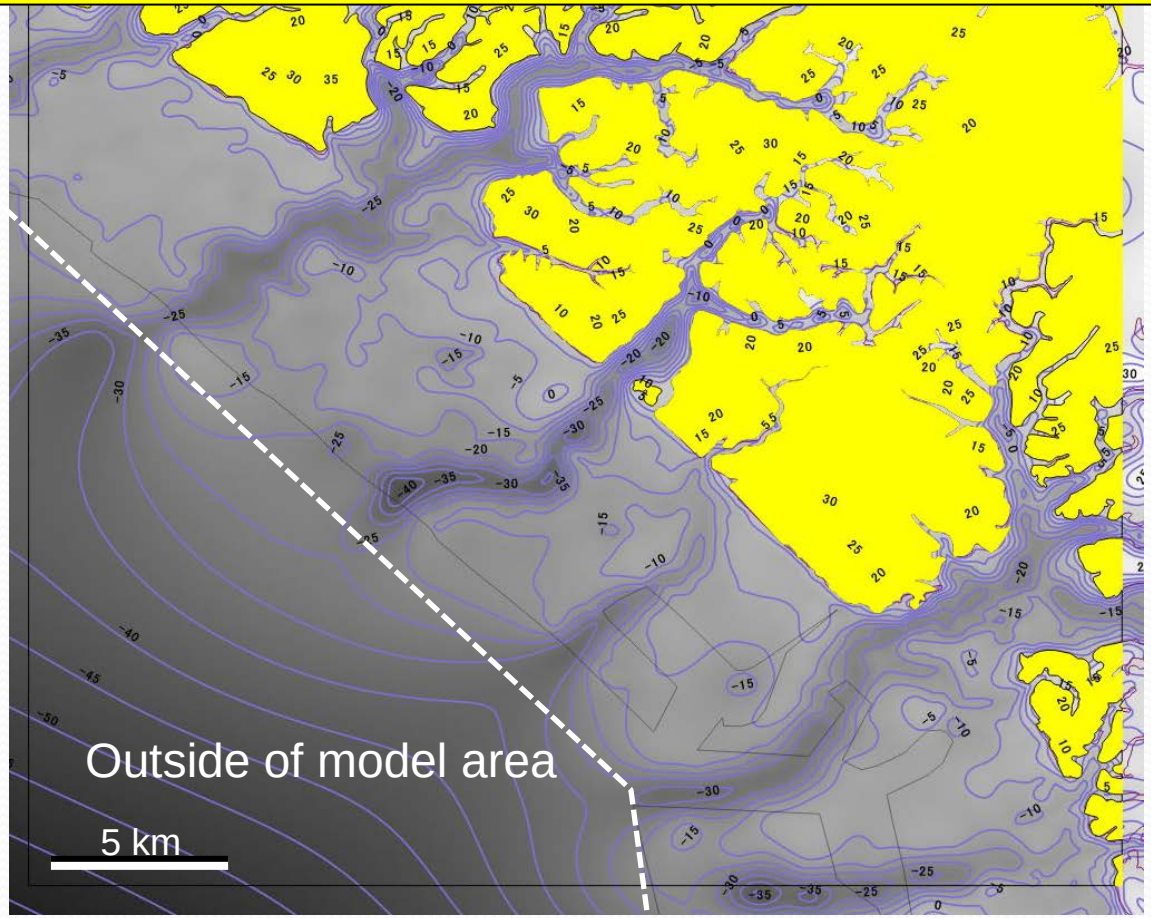
The geological understanding is important to revise the geomorphology of the surface model and to lead the validity of the model.

Profile section parallel to the coastal line



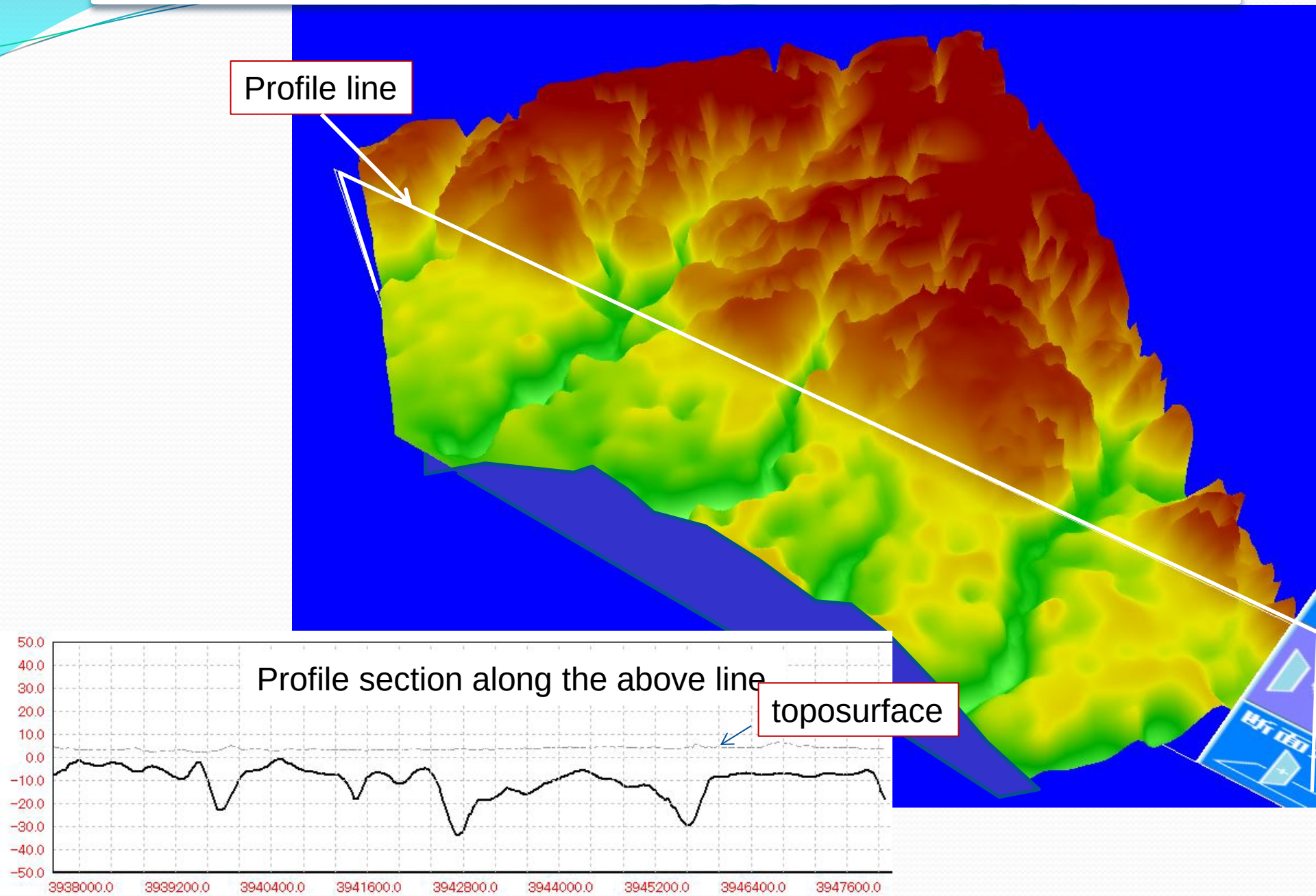
Surface model of the Holocene deposits

Notice the continuous incised-valley form from upland to lowland.
It is supported by additional points.

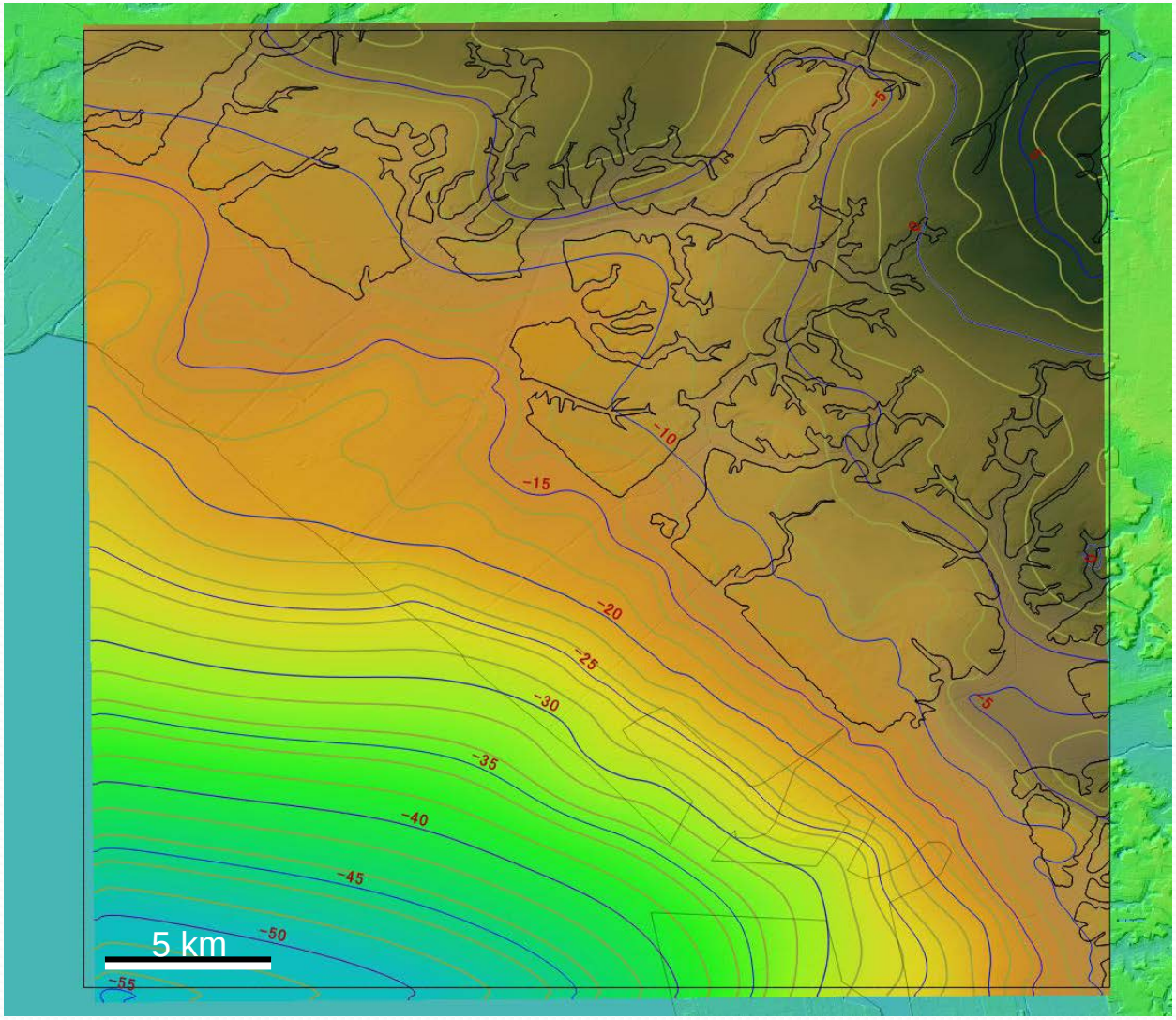


Contour lines of elevation at the interval of 5m and graded color image

3D view of surface model of the Holocene deposits



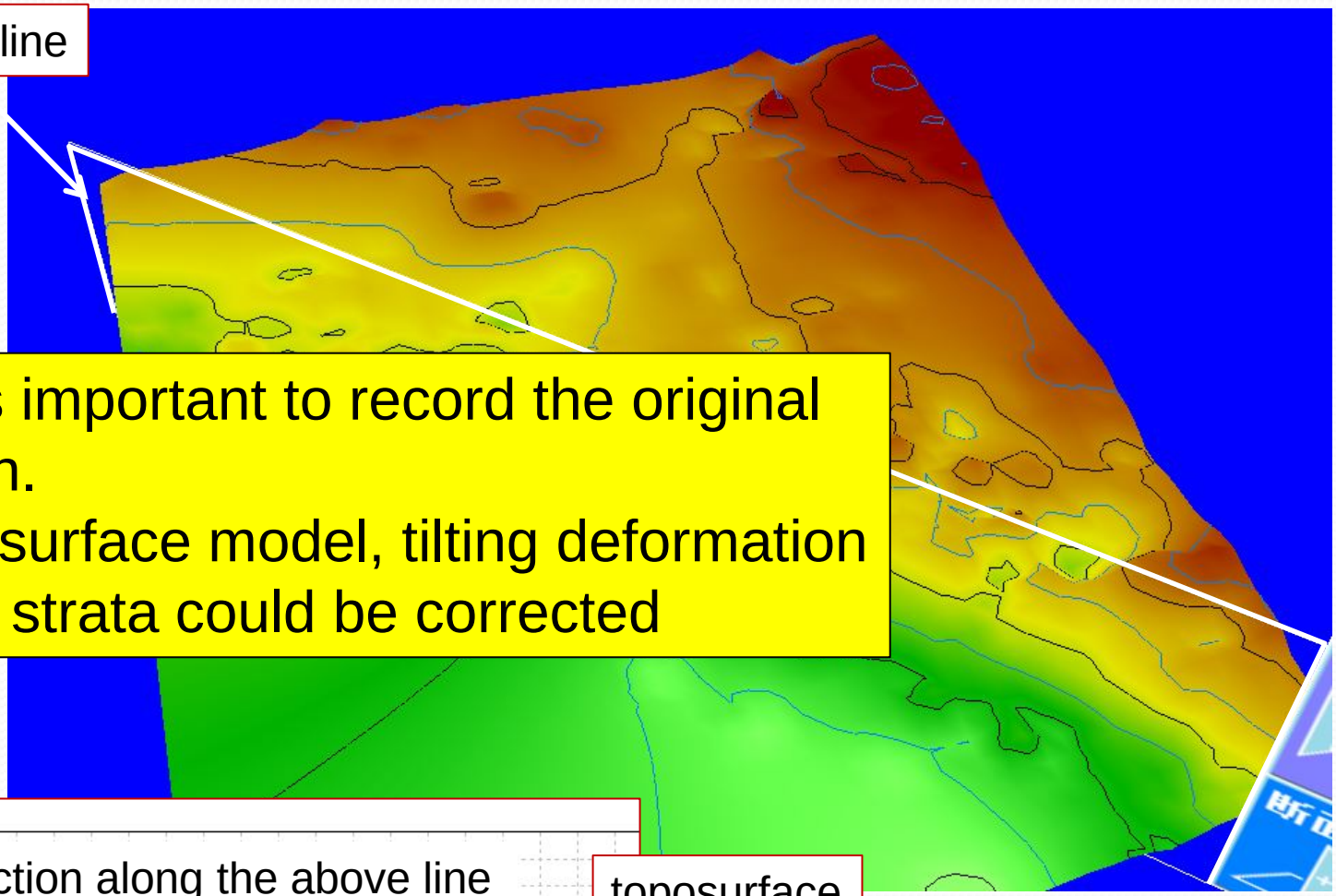
Surface model of the transgressive ravinement horizon of Sk



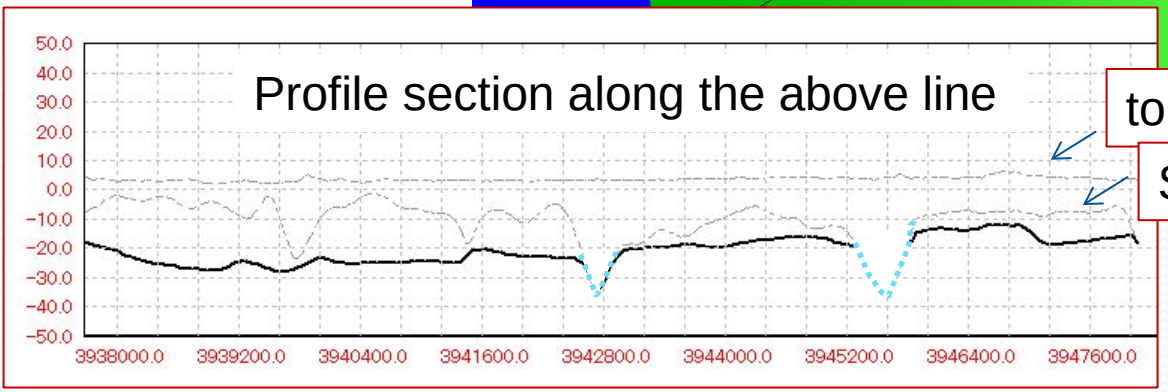
Contour lines of elevation at the interval of 5m and graded color image

3D view of surface model of the ravinement horizon of Sk

Profile line

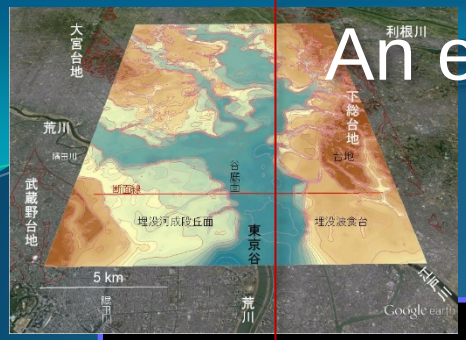


This surface is important to record the original horizontal plain.
Based on this surface model, tilting deformation of Pleistocene strata could be corrected



toposurface

Surface model of the base of Hd



An example of 3D grid model with attributes of lithology and N-value: A case of Tokyo Lowland (Kimura et al.2014)

12/145

mesh

Lithology

荒川↓

江戸川↓

Hd

Pleistocene

Basal surface of Hd

N-value

50

0

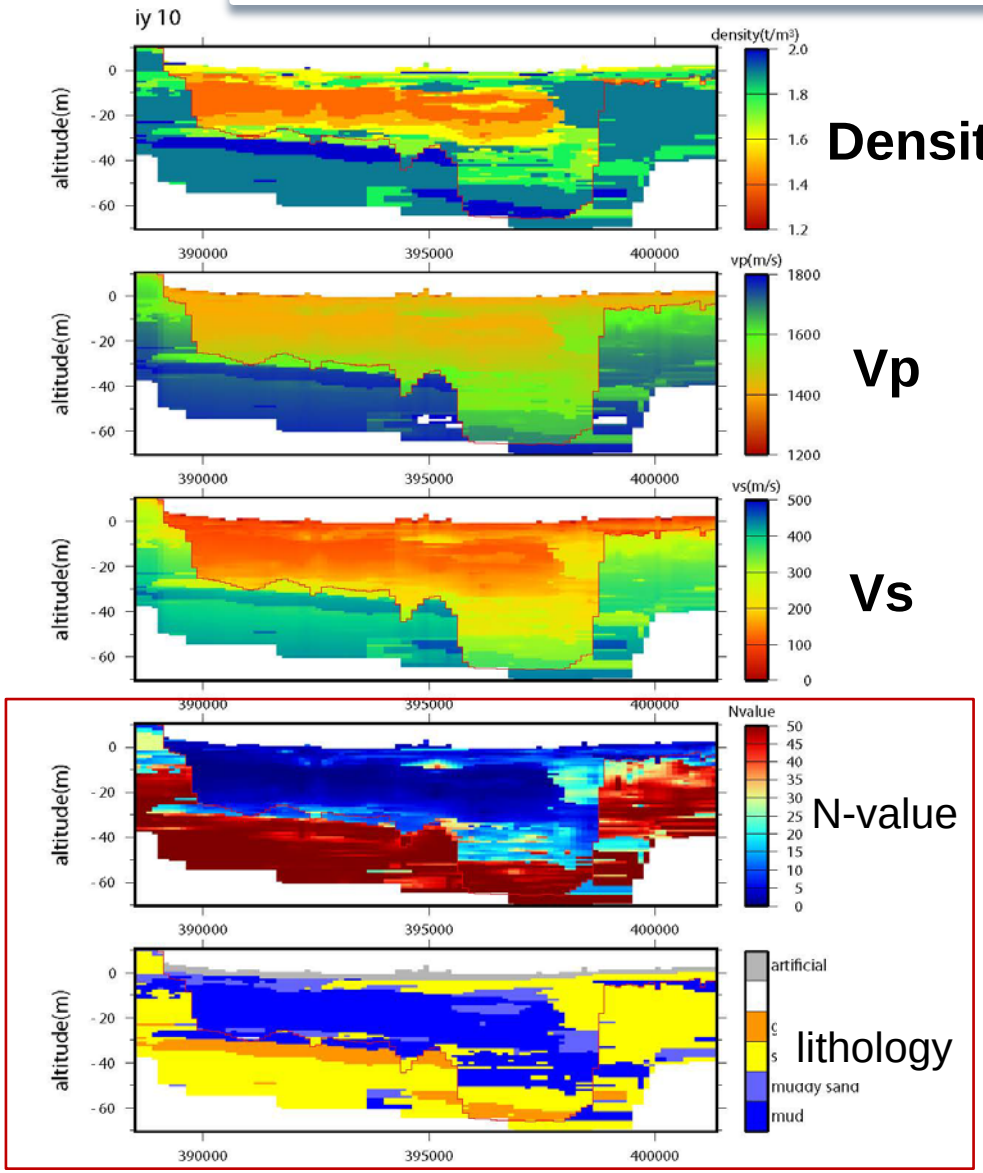
Hd

Pleistocene

0 m

-50

An example of physical property model for assessment of seismic hazard Sekiguchi et al (2014)



Empirical formula

N-value, lithology, age ⇒density

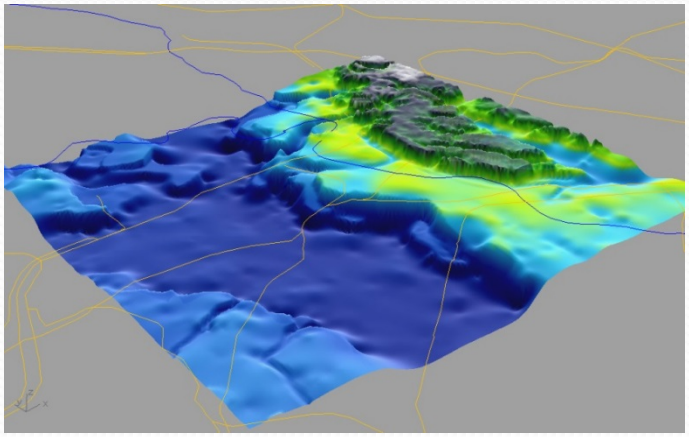
Vs⇒Vp

N-value, lithology, age ⇒Vs

Conclusion

- Borehole data are very useful for 3-D subsurface modeling, and have been used widely as open data.
- Metholodology and a example of 3-D modeling based on borehole database have been introduced.
- This methodologies introduce the enhanced geologic understanding to control the surface model,
- The surface model is very useful to control the 3D grid model (with attributes).

Thank you for your kind attention.



Someone ?

Borehole database and geological view points