Improve the reliability of Vs30 distribution map by considering geological uncertainty —a case study of Taipei Basin

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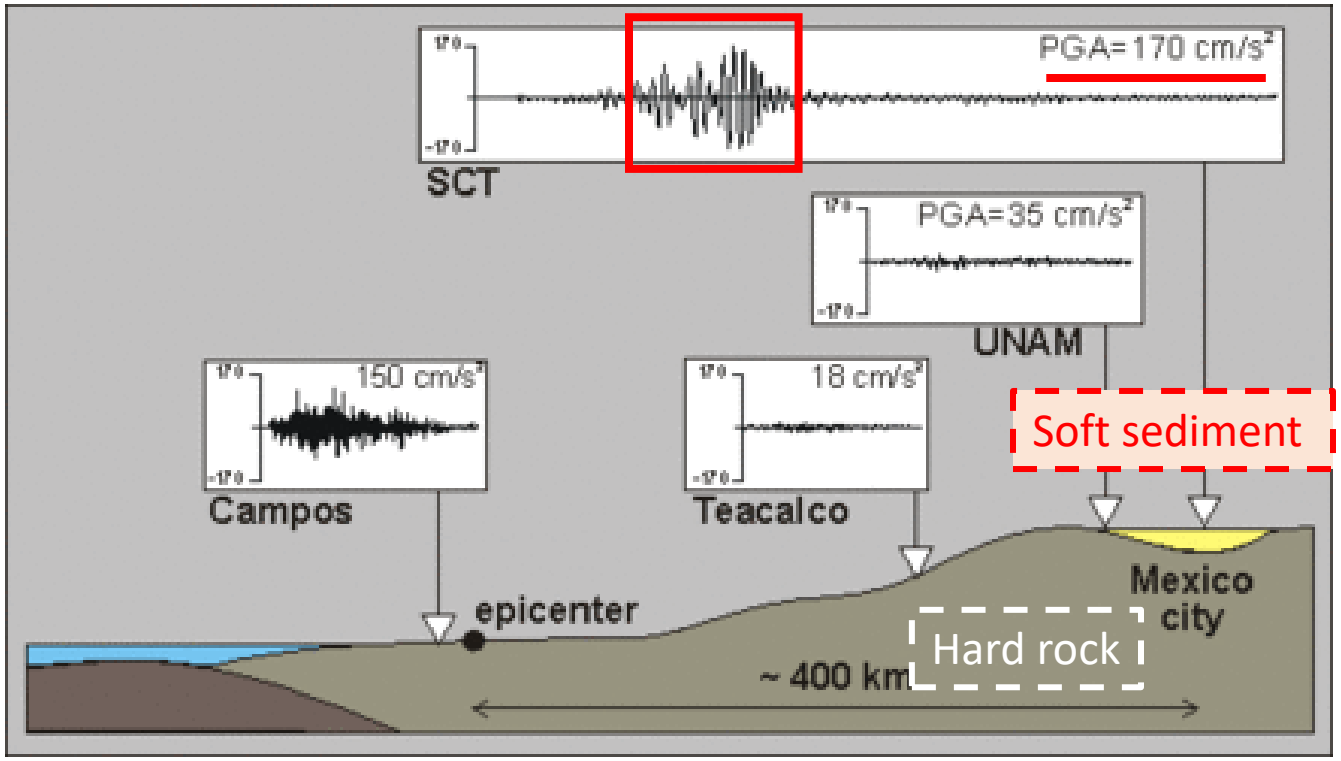
Seismic site effect

Wave slows down → Amplitude increase → **Cause serious disaster**

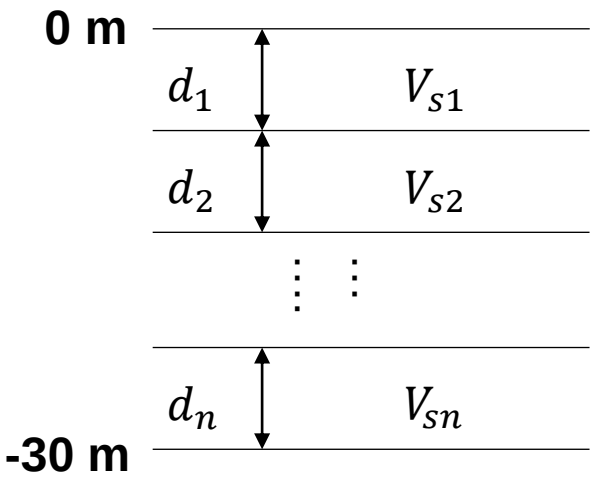
1985 Mexico City earthquake, Mw 8.0



(Jean-François Semblat, 2014)

Evaluate the Influence of Site Effect - Vs30

Vs30: the average **shear wave velocity (Vs)** of **upper 30 meter.**



$$V_{s30} = \frac{30}{\sum_{i=1}^{n} \frac{d_i}{V_{si}}}$$

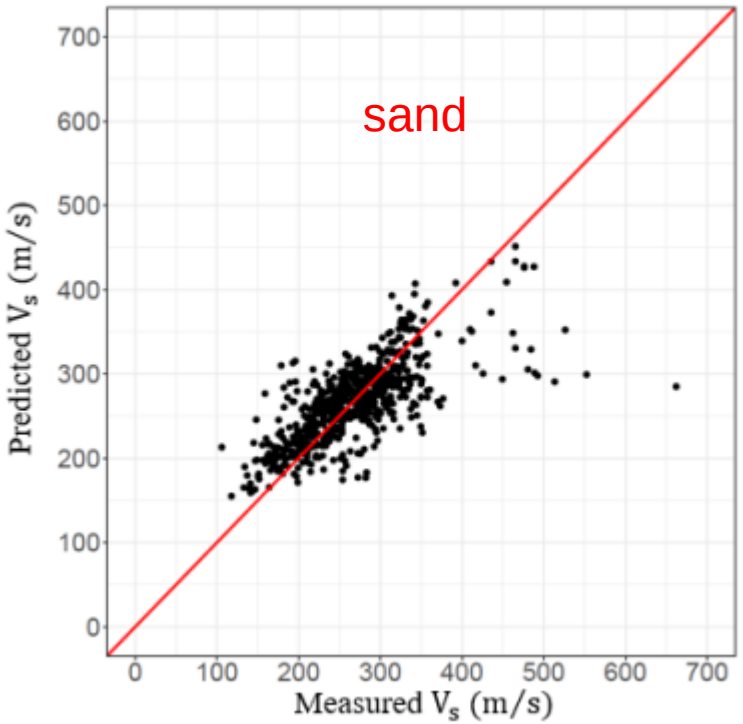
Vs30 is an important parameter in seismic hazard analysis.

Empirical formula between Vs, e and σ'_v

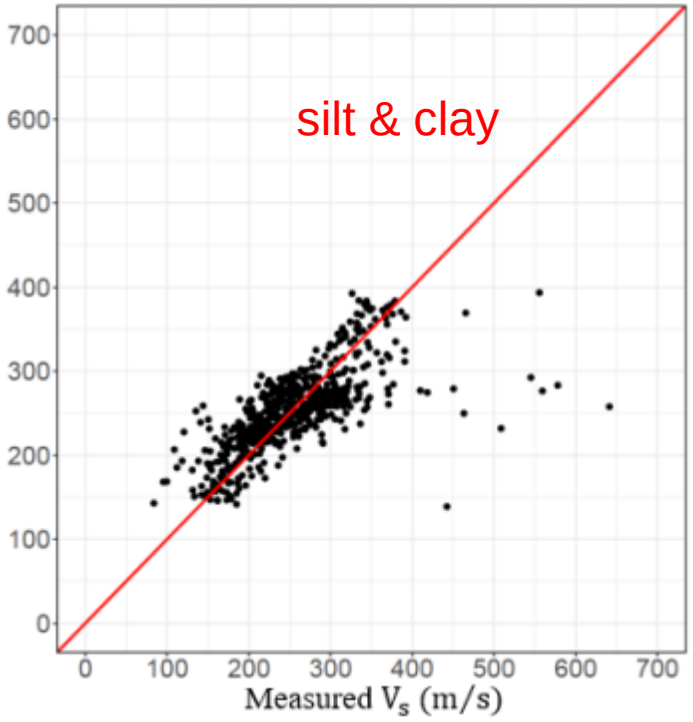
There is a **high correlation** between **shear wave velocity(Vs), soil void ratio(e) and effective stress(σ'_v).**

Roesler (1979), Robertson et al. (1995)

$$V_s = (241.6 - 39.9e)\left(\frac{\sigma'_v}{P_a}\right)^{0.30} \qquad P_a = 100\text{kPa, constant}$$

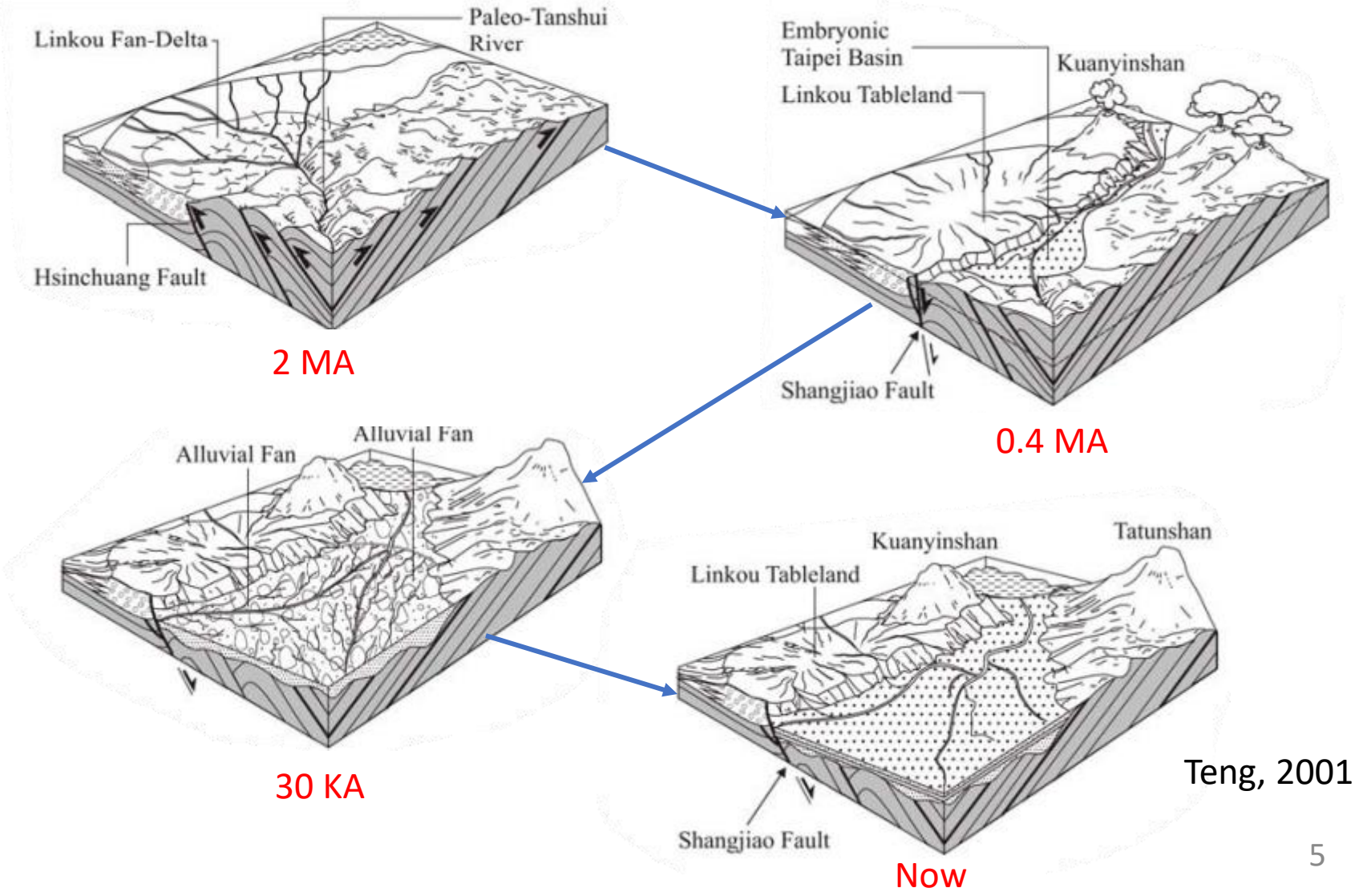


$$V_s = (199.2 - 2.9e)\left(\frac{\sigma'_v}{P_a}\right)^{0.31} \qquad P_a = 100\text{kPa, constant}$$



Kuo, 2021

Evolutionary history of Taipei Basin

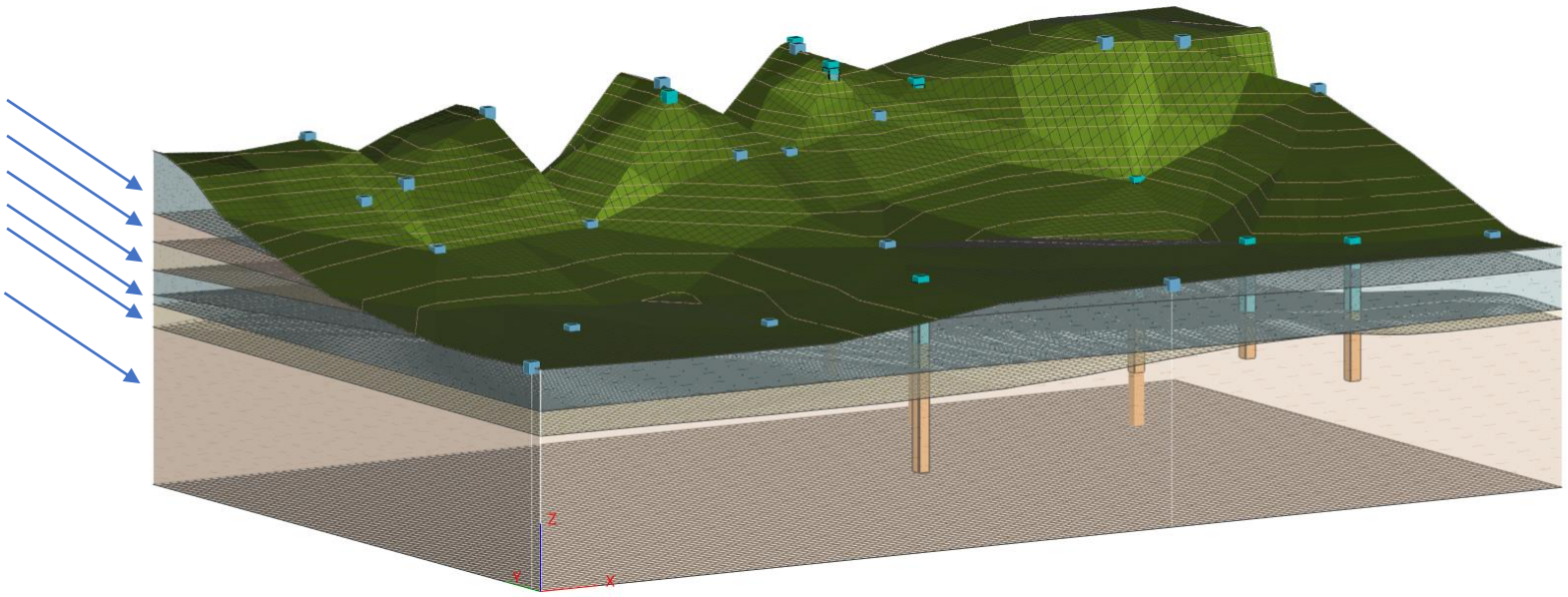


Teng, 2001

Objective

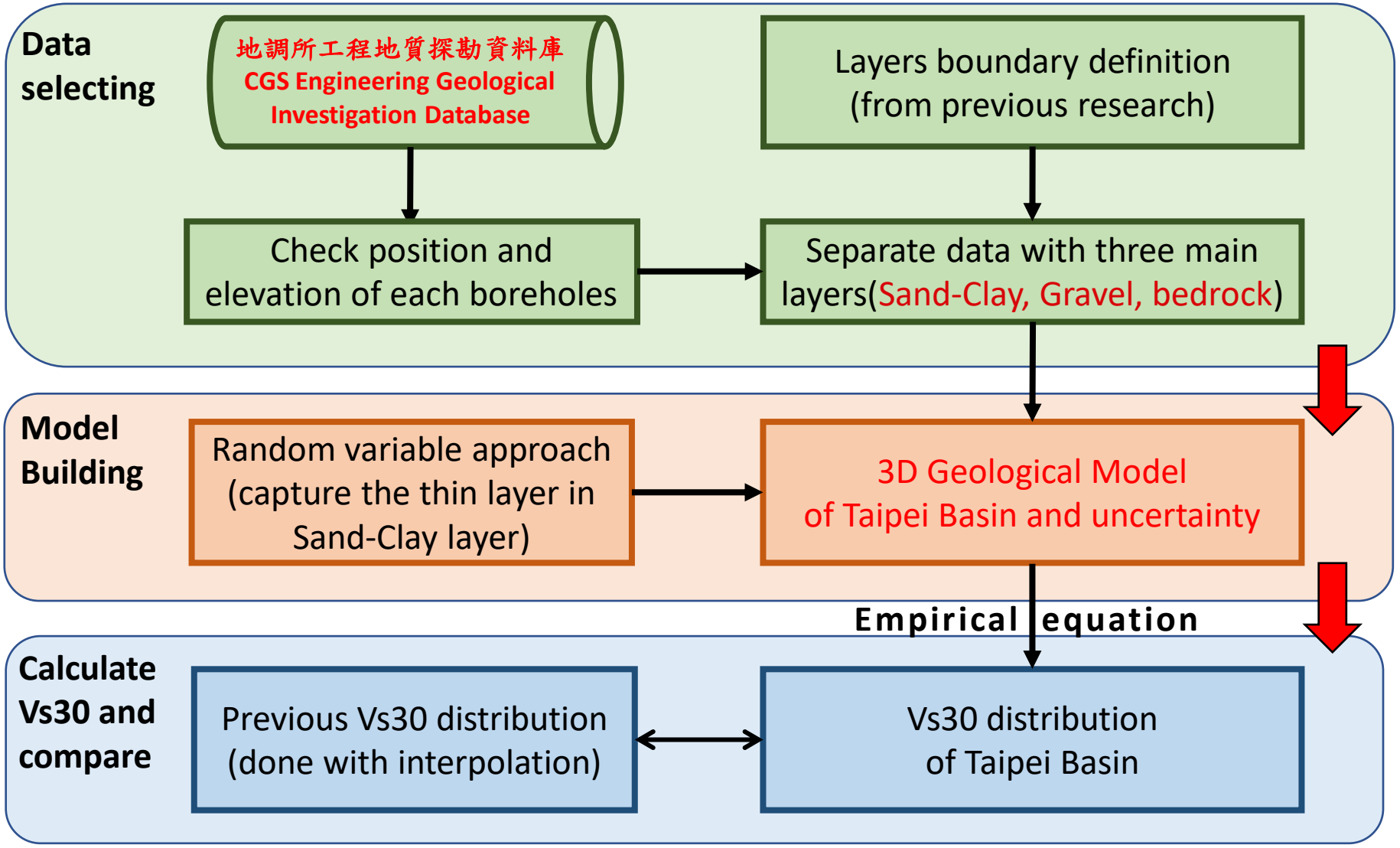
1. Build the 3D geological model of Taipei Basin
2. Calculate Vs(shear wave velocity) and Vs30 from previous empirical equation according to the geological model .
3. Demonstrate the uncertainty of the geological model.

Layer 1,2,…



Example diagram

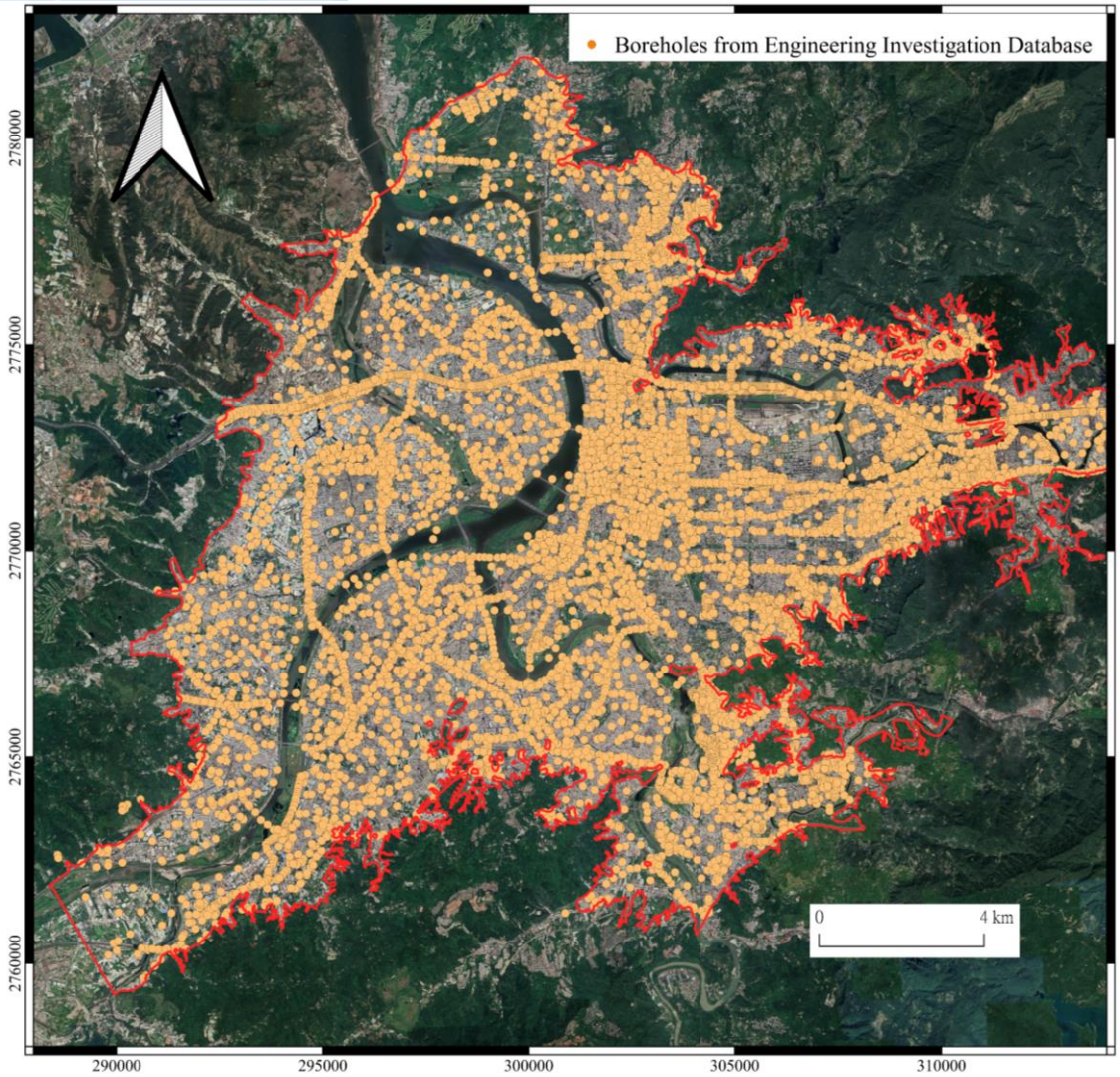
Work Procedure



CGS Engineering Investigation Database 工程鑽探資料庫

工程地質探勘資料庫

Borehole data: ~2020 **Total 10,768 holes**



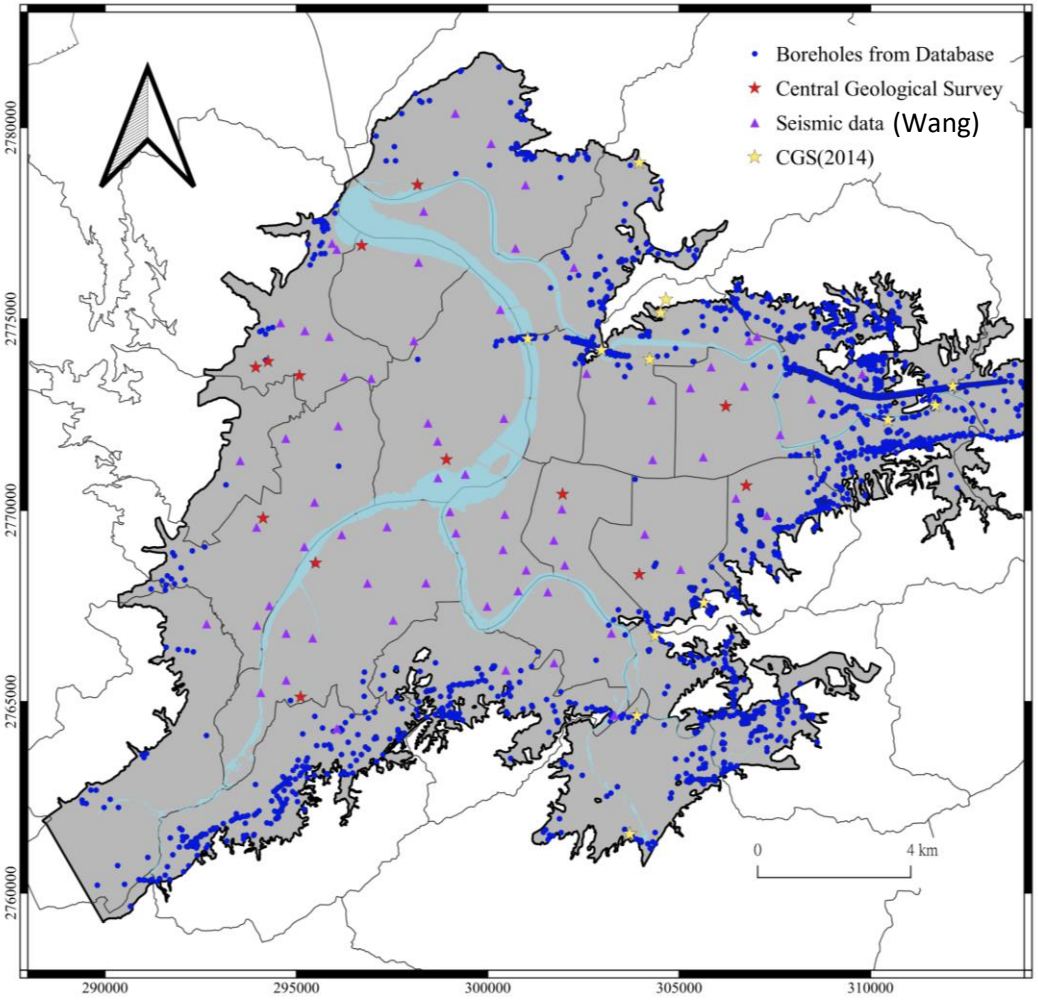
Soil Data: Total 10768 holes

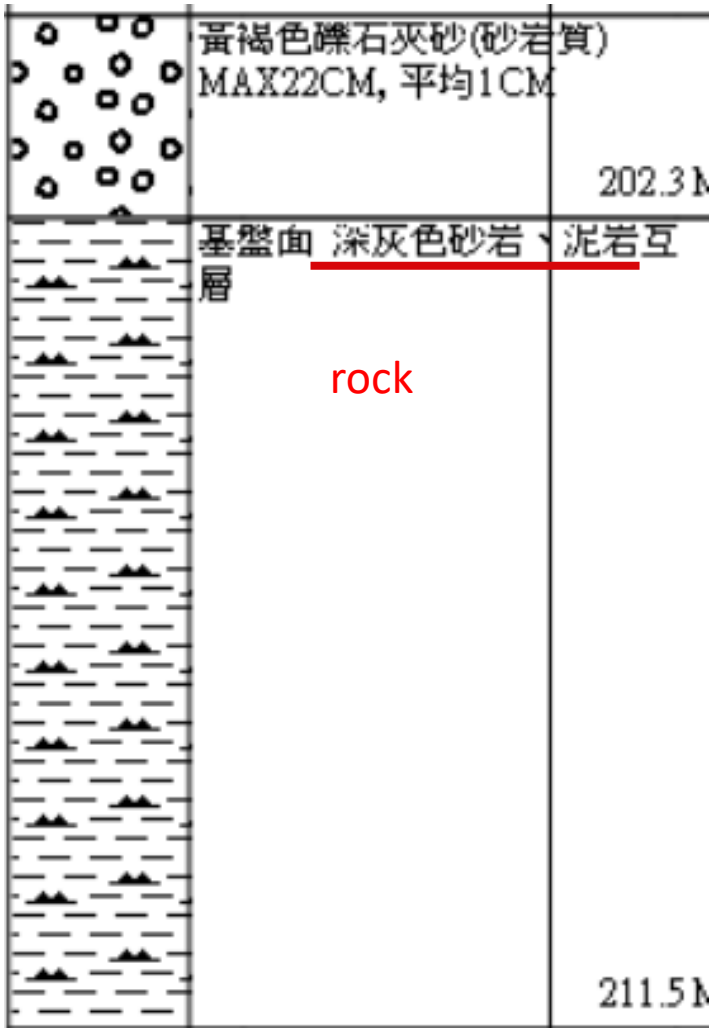
top_depth	bottom_depth	description
0	1.7	混凝土舖面、回填礫石、混凝土
1.7	4.6	棕灰色砂質粉土，極疏鬆
4.6	7.6	灰色粉土質黏土，中等堅實
7.6	8.4	礫石夾灰色粗中細砂
8.4	12.2	灰色粉土質粗中細砂，中等緊密
12.2	15.9	灰色粉土質細砂，中等緊密
15.9	24.3	灰色粉土質黏土夾粉土質細砂，軟弱至中等堅實

Basement selecting: 2337 holes

Criterion:

1. The description contains “Rock”.
2. Thickness of the rock layer larger than 3m.

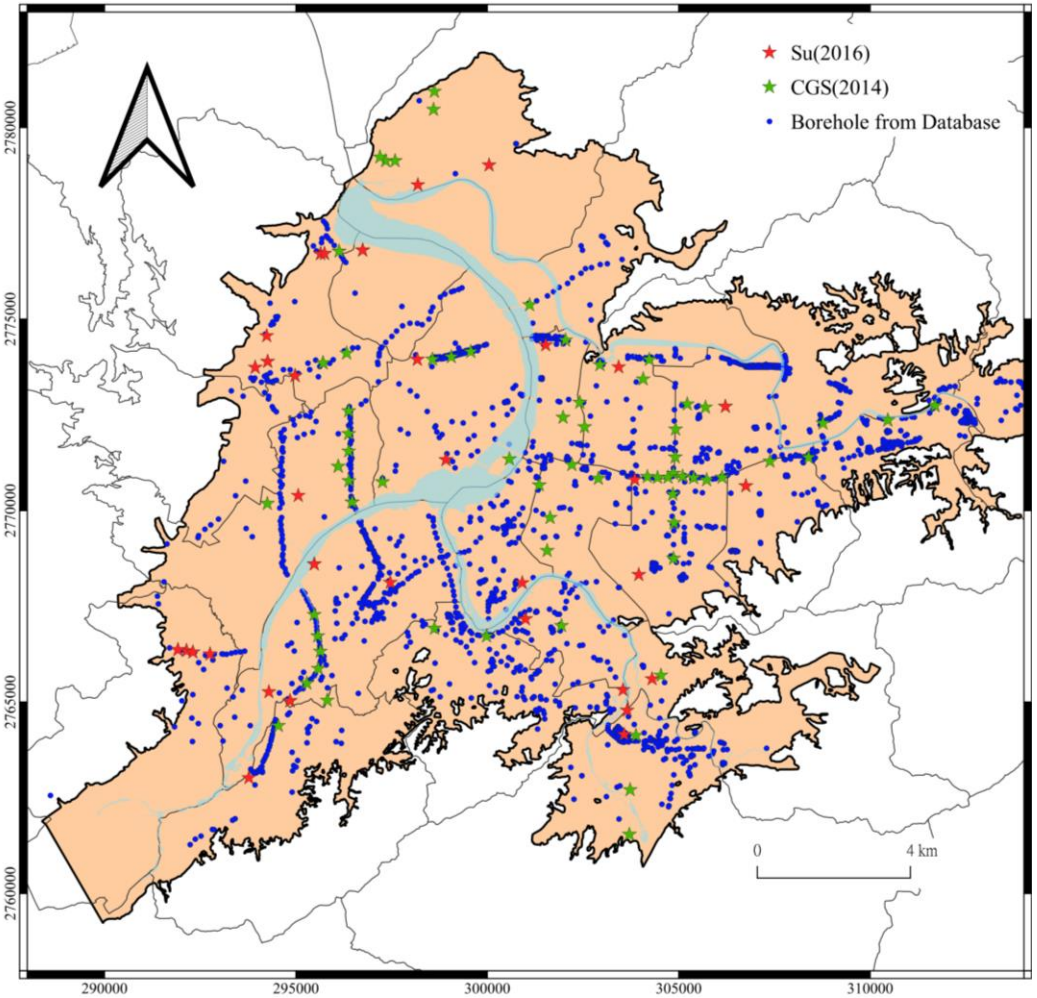


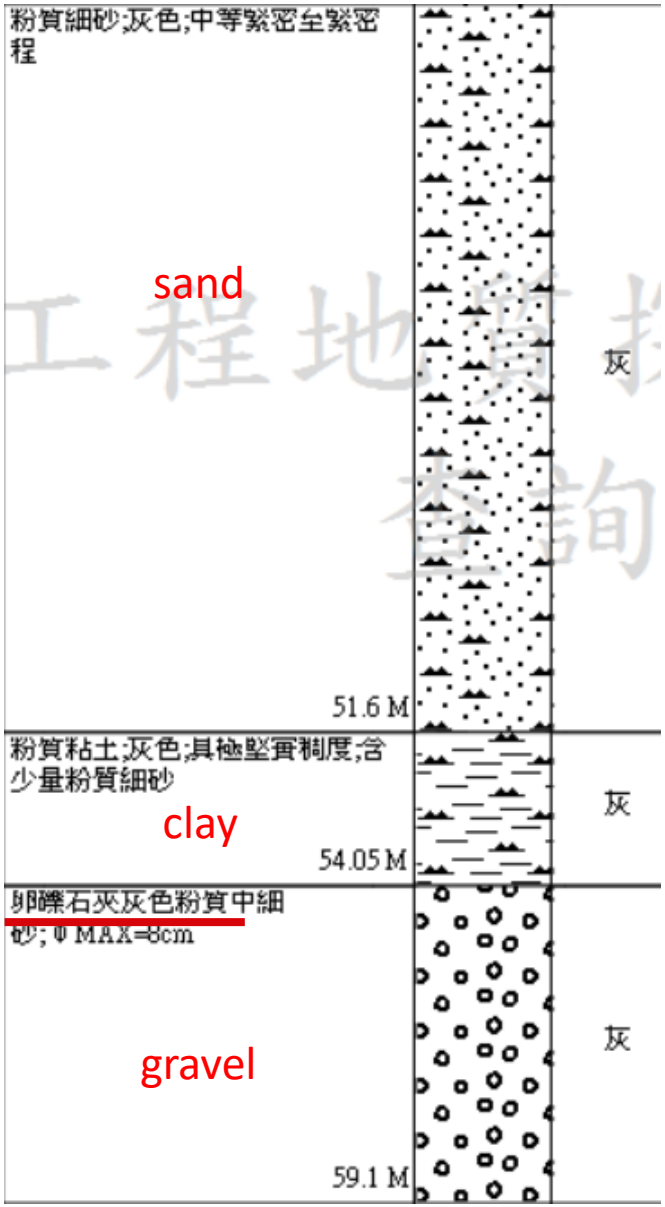


First gravel layer selecting: 1930 holes

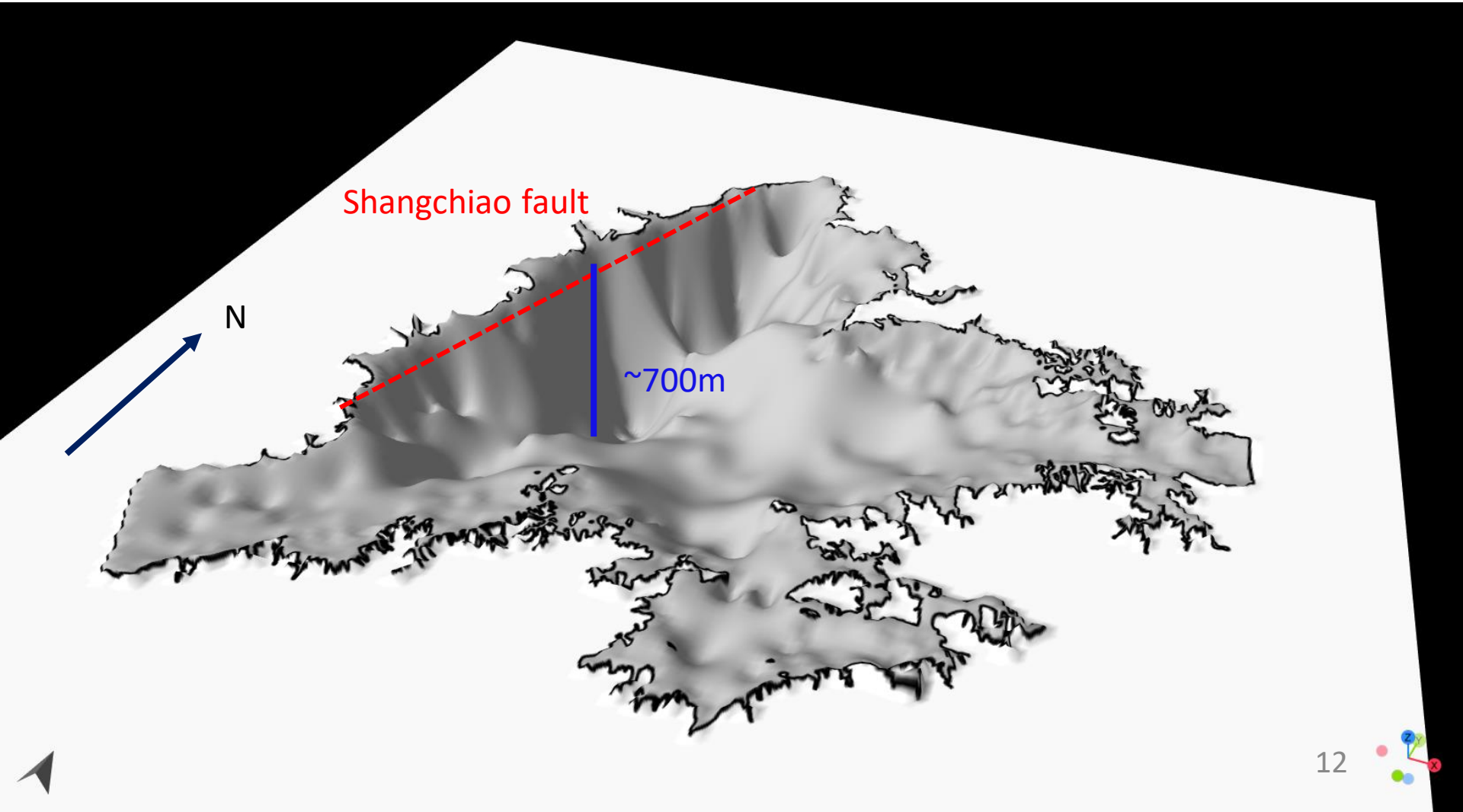
Criterion:

1. The description contains “Gravel”
2. The “first” gravel layer under the sand-clay layer.

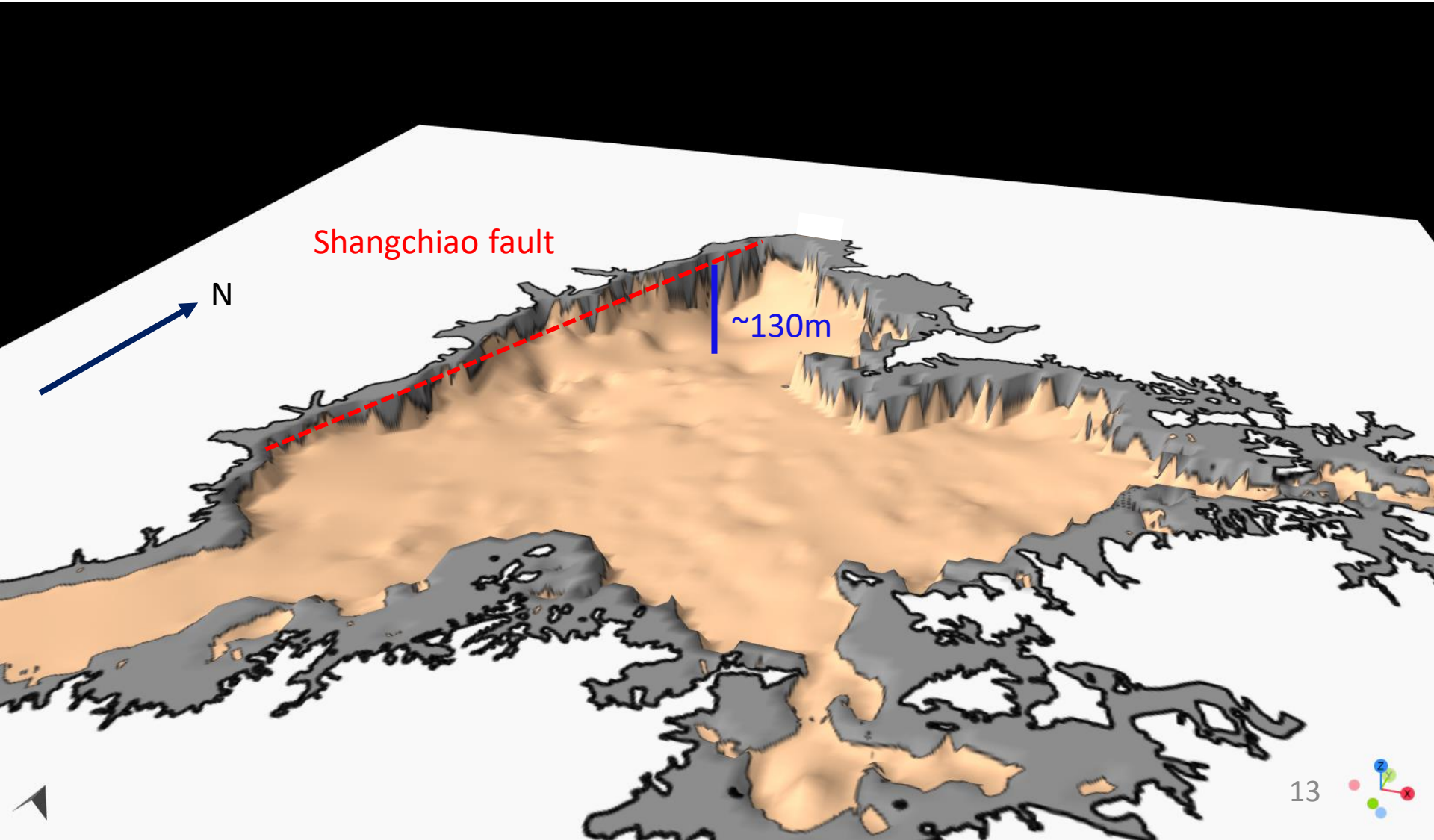




Basement of Taipei Basin (amplify x10 in z-axis)

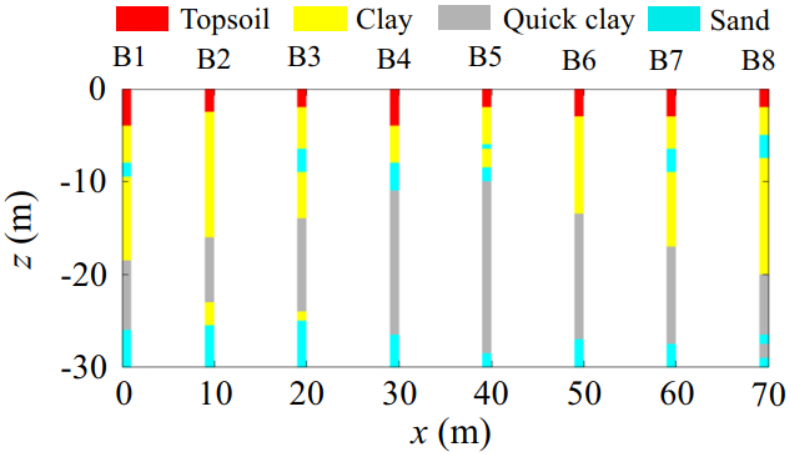


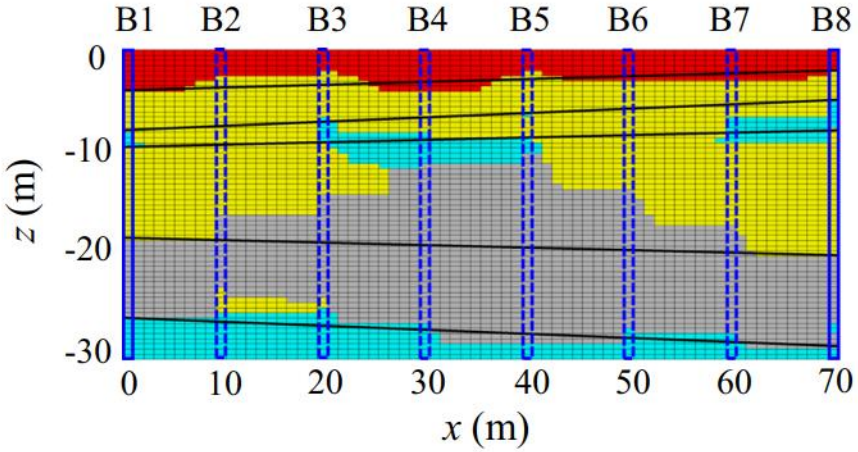
First Gravel Layer of Taipei Basin (amplify x15 in z-axis)



Future work

1. Adding electric resistivity data and also do the validation of model by comparing with cross section done by previous research.
2. Using random variable method the build the sand-clay layer in the top of Taipei Basin and also demonstrate the uncertainty.
3. Import the empirical equation to make a Vs30 distribution map and do the comparison.





Zhang et al., 2021

Thanks for your attention