Realize the softness of Ariake clay in Saga lowland

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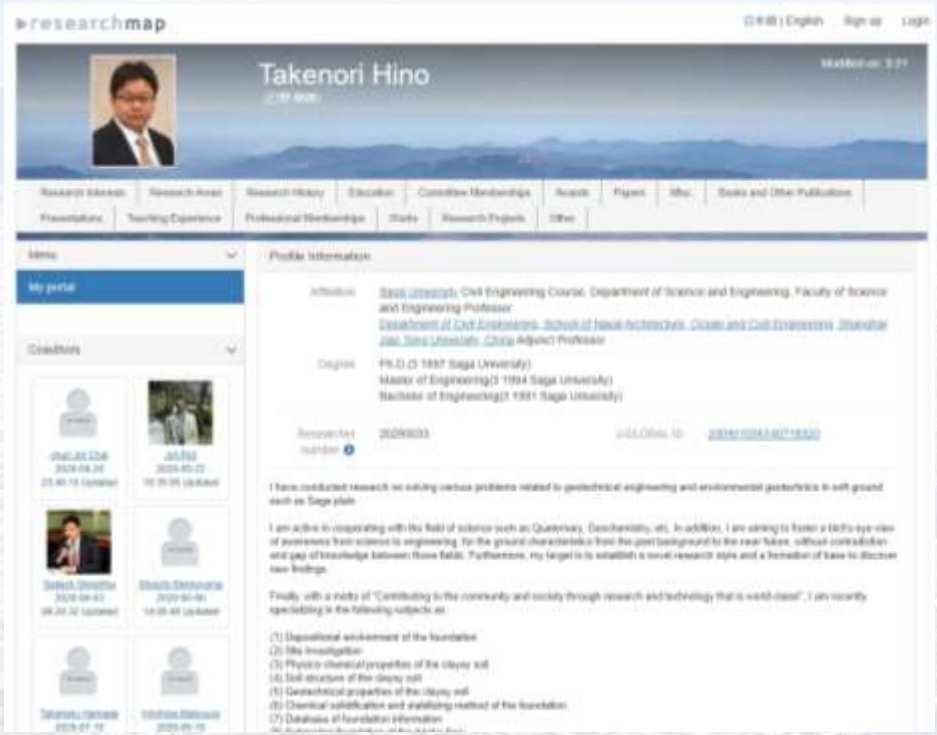
Who is Hino?



researchmap

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Outline

1. Parameters related to soil condition
2. Sensitivity of soil
3. Landslide disasters associated with recent earthquakes
4. Concluding remarks

1. Parameters related to soil condition
1.1 Representation of soil condition

■The sticky soil is juicy. The dry soil has few water. Hard soil is well compacted. Soil with high compressibility have large void. There is hardly any void in hard soil like stone…

■Even if we explain by the words, how to understand the degree of the state depends on each person. It is necessary to quantify the state of soil and express.

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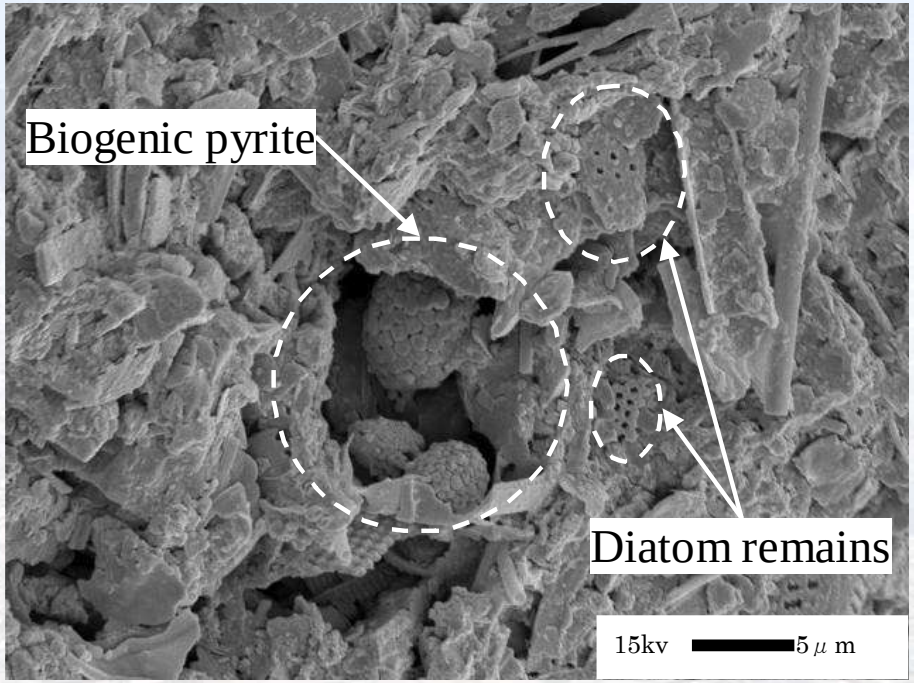
1. Parameters related to soil condition
1.2 Elements representation of soil condition



SEM observation of Ariake clay
(×3,000 times magnification) (Negami et al., 2003)

Elements representation of soil condition:

■Water inclusion
(Relationship of mass)

→Water Content, w (%)

■Clogging condition (Mass/Volume)

→Wet density, ρ_t (g/cm^3) or γ_t (kN/m^3):
Dry density, ρ_d (g/cm^3) or γ_d (kN/m^3)

■Amount of void (Relationship of volume)

→Void ratio e

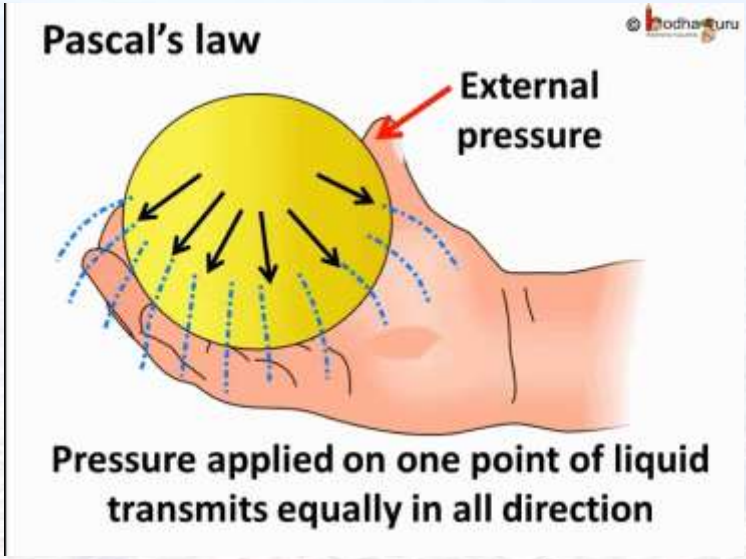
■Percentage of water in void
(Relationship of volume)

→Degree of saturation S_r (%)

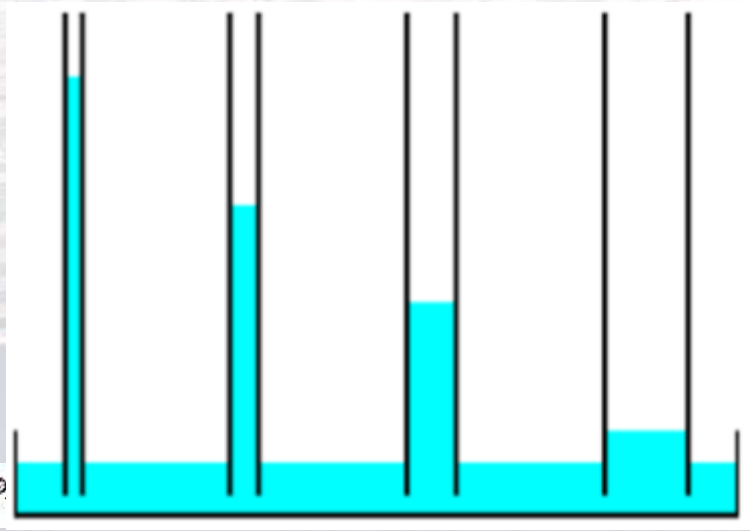
■If Sr=100%: "Pascal's law" is established in the mechanical behavior of the soil. Therefore, we can simplify the mechanical behavior of the soil and think.

■If Sr<100%: "Capillary action" occur in the soil, and the mechanical behavior becomes complicated…

1. Parameters related to soil condition
1.3 Pascal's law and Capillary action



■Pascal's law (also Pascal's principle or the principle of transmission of fluid-pressure) is a principle in fluid mechanics that states that a pressure change occurring anywhere in a confined incompressible fluid is transmitted throughout the fluid such that the same change occurs everywhere.



■Capillary action (sometimes capillarity, capillary motion, or wicking) is the ability of a liquid to flow in narrow spaces without the assistance of, or even in opposition to, external forces like gravity.

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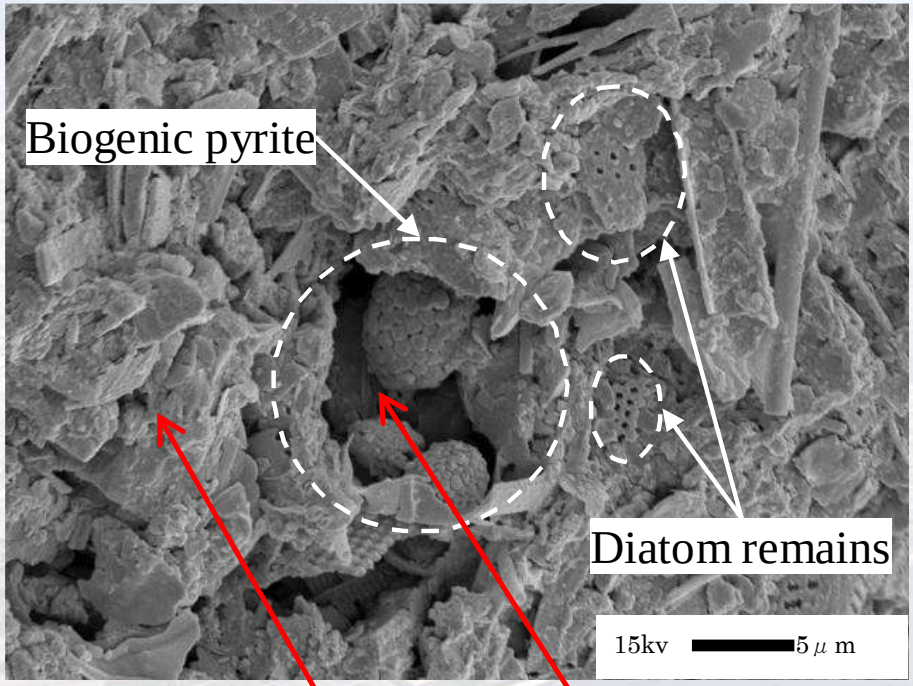
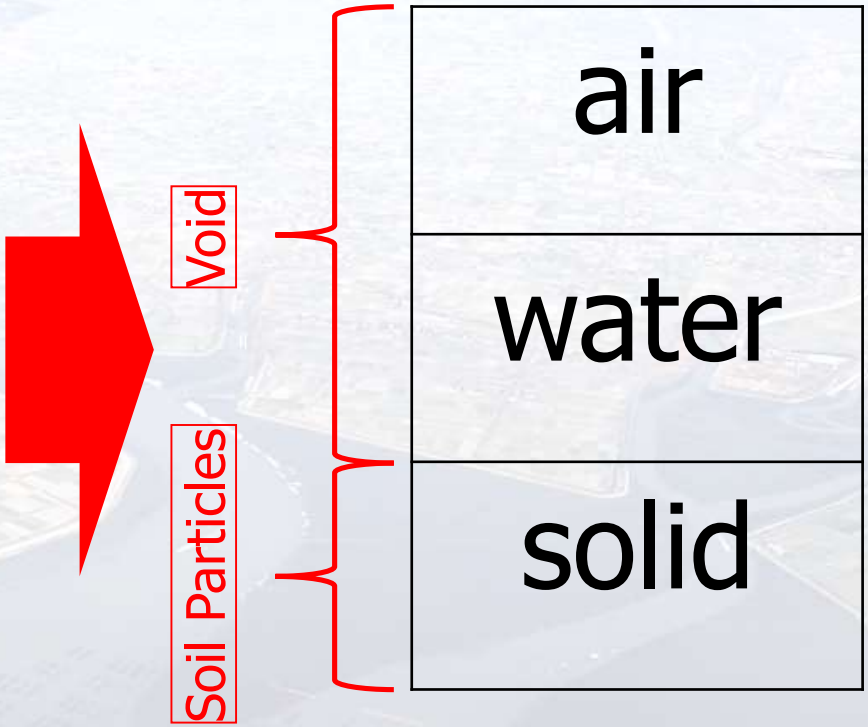
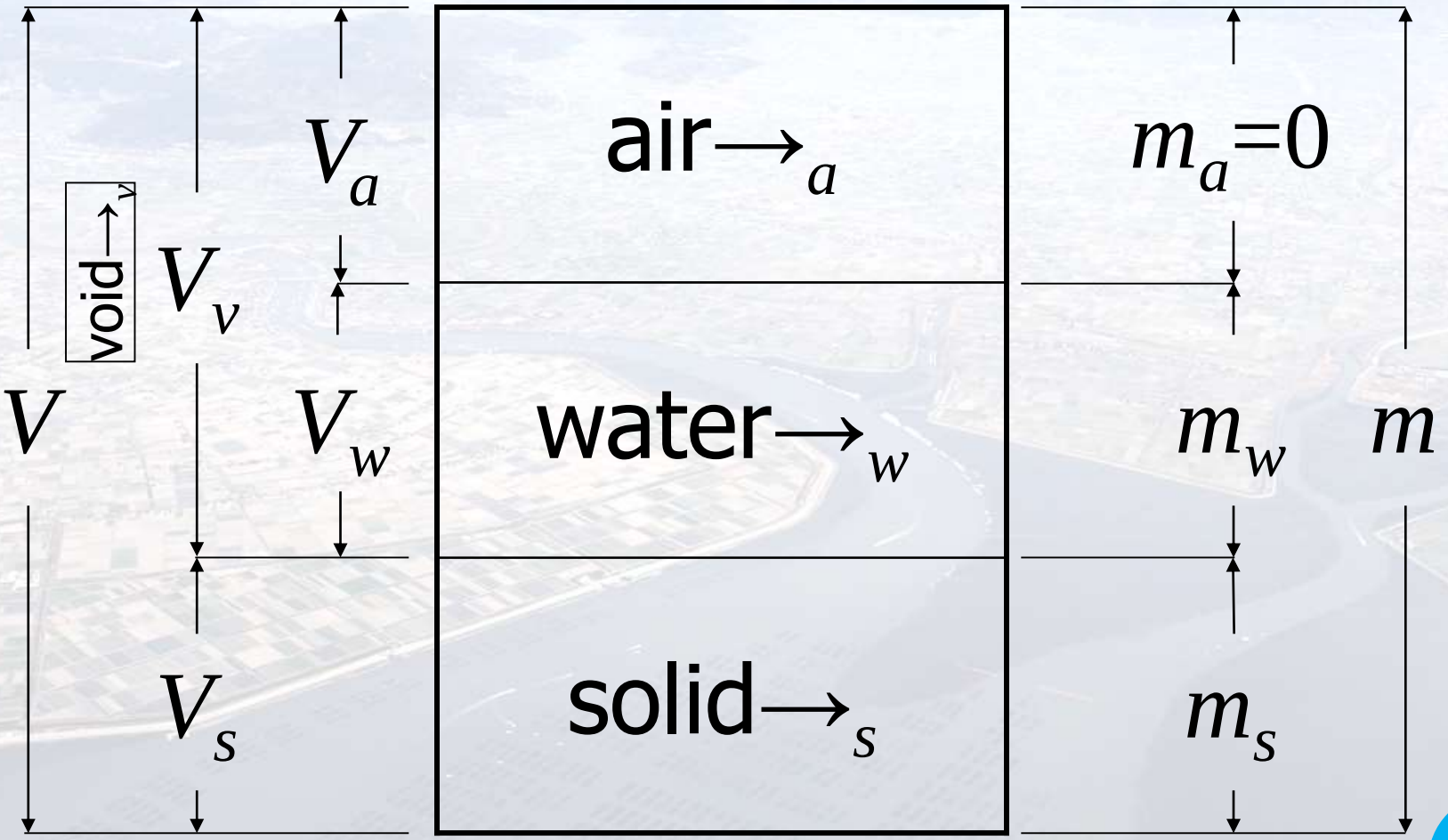
1. Parameters related to soil condition
1.4 Modeling of soil

■Even soil with complicated structure can be modeled based on three phases of soil particles, water and air.





1. Parameters related to soil condition
1.5 Relationship between mass and volume in soil model



1. Parameters related to soil condition
1.6 Knowledge derived from calculation results of state parameters

(a)

(b)

Ariake clay: (a) Undisturbed (b) Disturbed

ρ_s = 2.65 g/cm^3 ρ_d = ____ g/cm^3
w = 150 % e = ____
ρ_t = 1.30 g/cm^3 S_r = ____ %

■Each value of ρ_s, w and ρ_t can be obtained by experiment. On the other hand, Each value of ρ_d, e and S_r can not be determined experimentally. Why?

Decomposed granite soil:
(Playground in the sports festival)

ρ_s = 2.65 g/cm^3 ρ_d = ____ g/cm^3
w = 10 % e = ____
ρ_t = 2.00 g/cm^3 S_r = ____ %

■The density of soil particles is a parameter unique to soil. It is not a value that changes depending on the clogging condition of the soil.

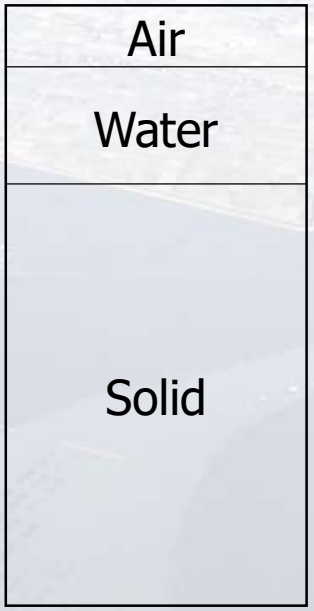
ρ_s: Density of soil particles, w: Natural water content, ρ_t: Wet density, ρ_d: Dry density, e: Voild ratio, S_r: Degree of saturation

1. Parameters related to soil condition
1.7 Three-phase image of each soil obtained from the calculation result


Ariake clay

Decomposed granite soil

■What kind of information should we derive from the consideration results of the soil parameters?



2. Sensitivity of soil

2.1 The quick clay landslide at Rissa, Norway-1978

Source: NGI, The Quick Clay Landslide at Rissa-1978 (English commentary), YouTube (Reference 2019.05.09)

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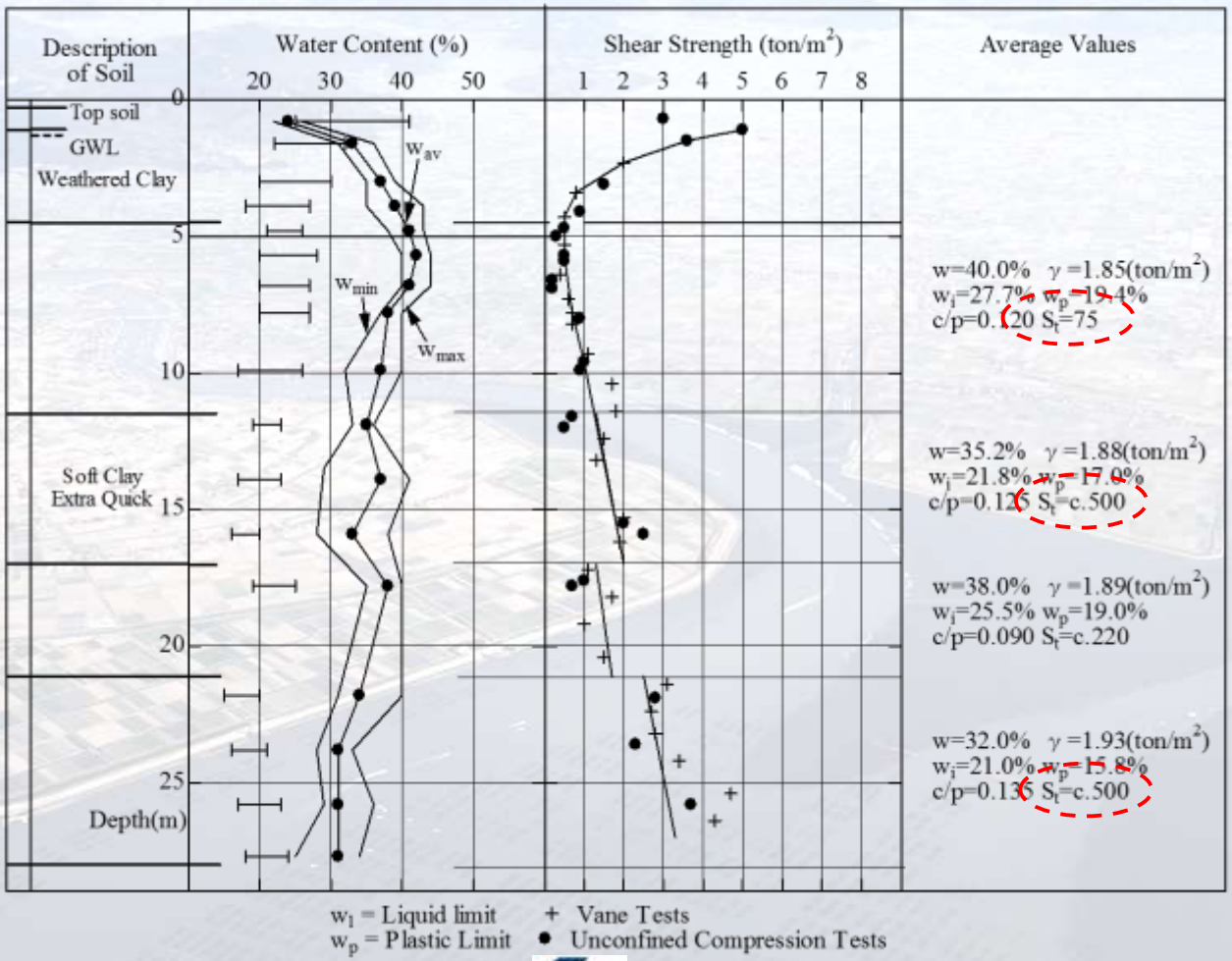
2. Sensitivity of soil

2.2 Clay characteristics at Manglerud in Oslo, Norway (Bjerrum, 1954) (Re-draw Figure 4.29 in James K. Mitchell, 1993)



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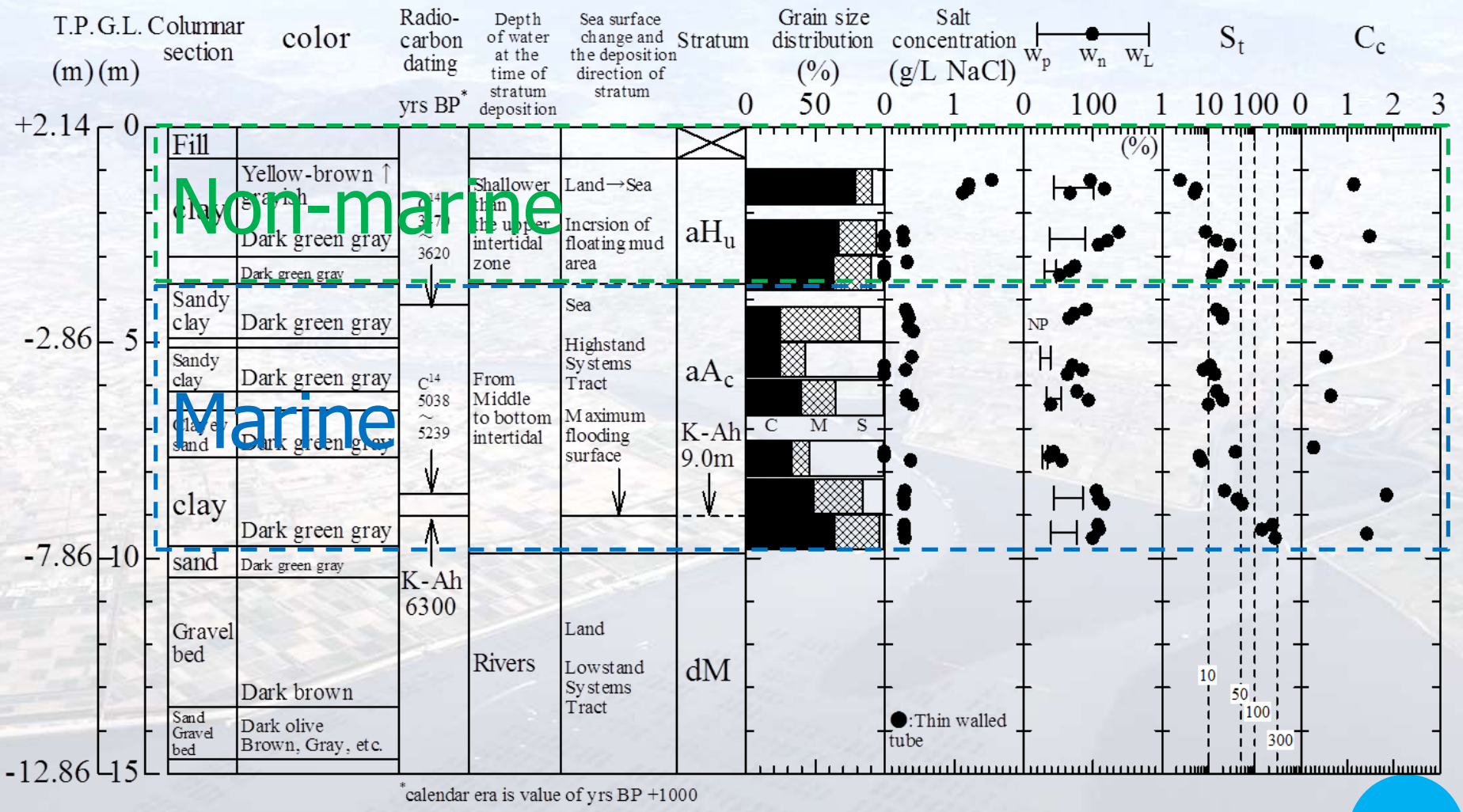
2. Sensitivity of soil

2.3 Sensitivity and compressibility of Ariake clay (Hino et al., 2014)



2. Sensitivity of soil
2.4 Measurement method of the sensitivity of soil

■Equation of the sensitivity of soil

$$S_t = \frac{q_u}{q_{ur}}$$

where St is the sensitivity of soil.

q_u is the unconfined compression strength of undisturbed soil (kN/m^2).

q_{ur} is the remolded strength of disturbed soil in unconfined compression test (kN/m^2).

2. Sensitivity of soil

2.5 Sensitive soil requires application of laboratory vane shear test

Source: Marutani Co., Ltd.

(1) After unconfined compression test using undisturbed soil, this specimen and its shavings (stored in the water content (w_n) –invariant state) are added, and these are put into a plastic bag and milled until the feel of aggregates is lost.

(2) After measurement of the w_n, it is packed in a cylindrical container (D=70mm × H=70mm (for vane (4 blades: D=10mm, H=20mm or less)). However, it conforms to JGS 0821-2009 and packs over 3 layers by tapping about 30 times/layer.

(3) Finally, the upper surface of the cylindrical container is smoothed, and after measurement of the wet density γ_t (kN/m^3), it is set in the apparatus.

(4) Vane-rotate to 90 degree (15 minutes) at the rotational speed of 6 degree/min based on ASTM D4648/D4648M-16 to obtain the results.

2. Sensitivity of soil

2.6 Equation of the sensitivity of soil when laboratory vane shear test is used

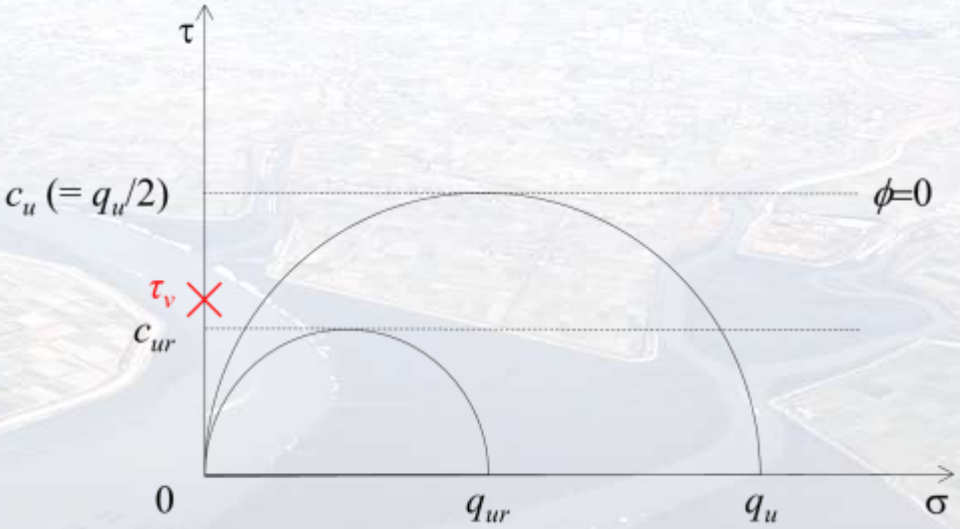
■Equation of the sensitivity of soil

$$S_t = \frac{c_u}{\tau_v}$$

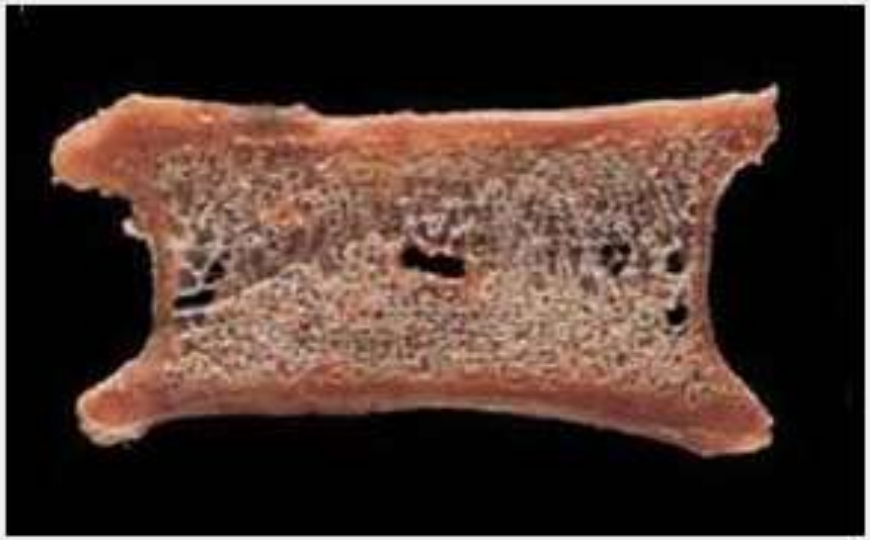
where St is the sensitivity of soil.

c_u is the undrained shear strength of undisturbed soil ($q_u/2$) (kN/m^2).

τ_v is the remolded strength of disturbed soil in laboratory Vane shear test (kN/m^2).



2. Sensitivity of soil
2.7 Image and mechanism of high sensitivity of soil (Osteoporosis)

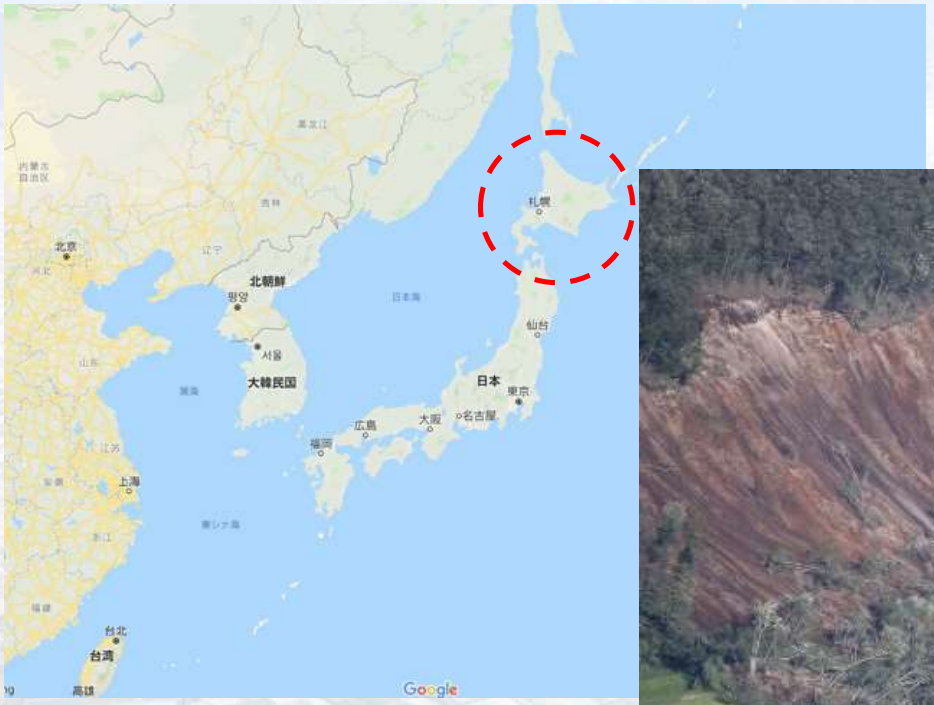


Healthy bone composition
(Low sensitivity)

Osteoporotic bone composition
(High sensitivity)

3. Landslide disasters associated with recent earthquakes

3.1 2018 Hokkaido Eastern Iburi earthquake (Yufutsu-gun Atsuma-cho)



Source: The mainichi, https://mainichi.jp/articles/20180907/k00/00m/040/023000c (Reference 2019.05.09)

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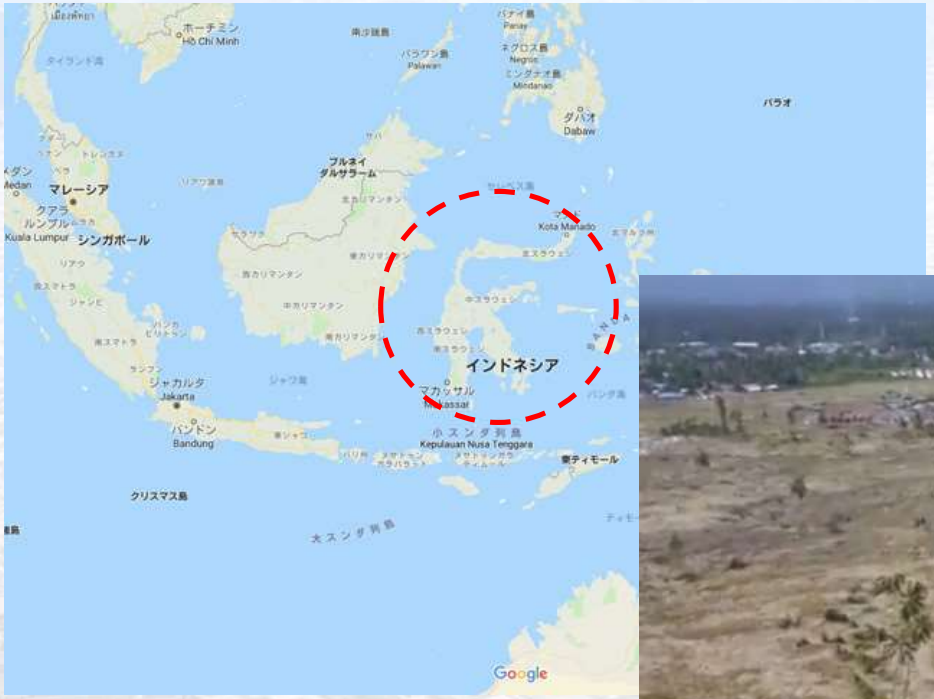
3. Landslide disasters associated with recent earthquakes
3.2 2018 Indonesia Sulawesi earthquake (Petobo, Palu, Indonesia)



Source: Suttisak Soralump, Petobo liquefaction and lateral spreading, YouTube (Reference 2019.05.09)

4. Concluding remarks

■Among the various soil data introduced in previous soil mechanics, it is thought that there are many opinions that are being guided without well understanding of the sedimentary environment.

■Reconstructing the initial depositional environment for comparison with the current geoenvironment, clarifying the mechanisms of processes that caused such differences, and clarifying the effects of such mechanisms on the current geoenvironment are the unique approach adopted in the Saga lowlands area. Such an approach has been possible for the area because the area is blessed to have retained its original plain landscapes since it was formed.

■We hope the data are collected based on a similar approach of this study nationally and internationally, and we hope to have opportunities to discuss this at the same bases of research.