28 Nov 2019

Landslides induced by typhoon Hagibis, 2019

- Typhoon Hagibis crossed the Japanese Islands from 12 to 13, October 2019, and brought record-breaking rainfall and strong wind.
- This typhoon induced river floods and landslides in eastern Japan and caused tremendous damage with 93 fatalities and 3 missing.
- This paper reports the characteristics of 3 fatal landslide areas, referring to the possibility of their prediction.

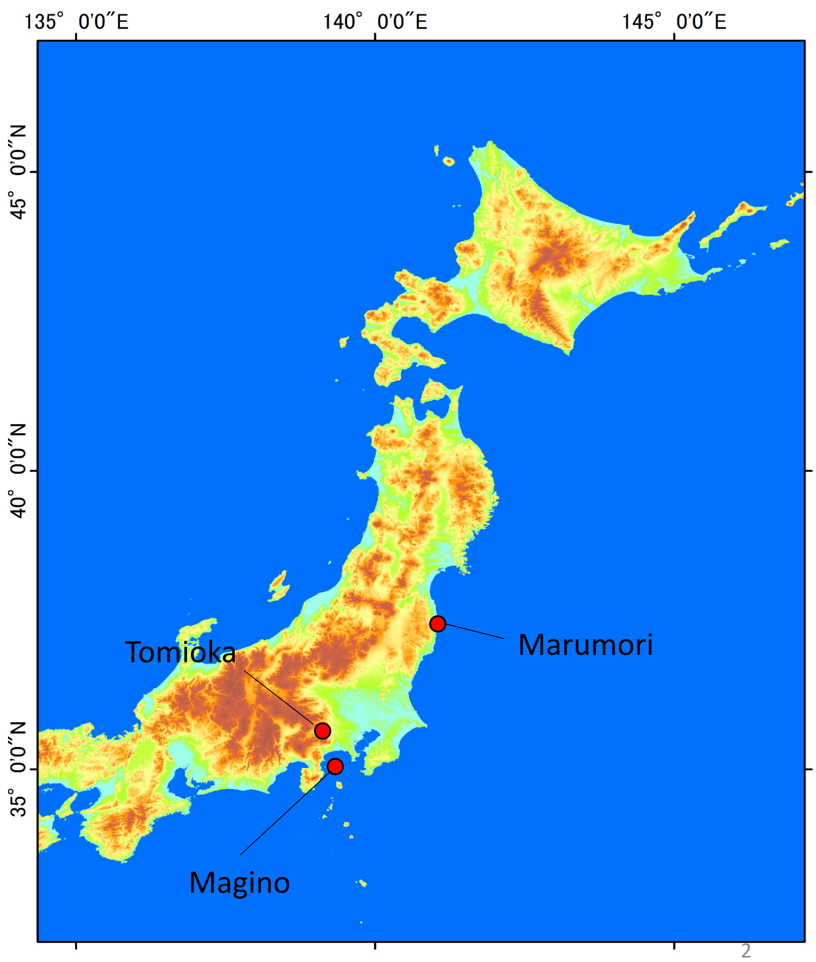
Chigira et al. (Disaster Prevention Research Institute, Kyoto University)

Locations of fatal landslides induced by typhoon Hagibis

Tomioka: 4:32 pm 12 Oct
Pyroclastic fall
3 fatalities

Marumori: about 10:30 pm 12 Oct
Weathered granite
4 fatalities

Magino: 9:45 pm 12 Oct
Andesite lava and volcanic soil
2 fatalities

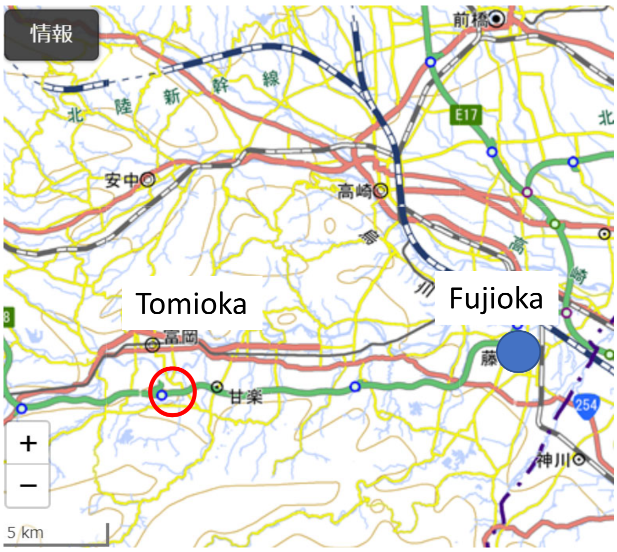


Landslides induced by typhoon Hagibis in Tomioka, Gunma

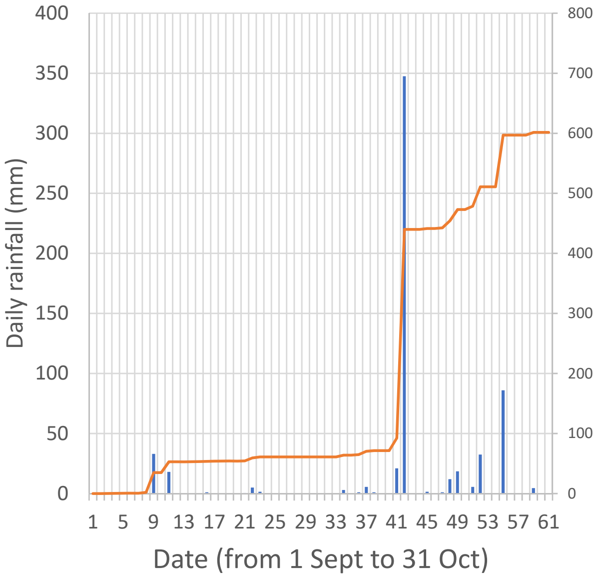
Masahiro Chigira
(Division of Geohazards, DPRI-KU)

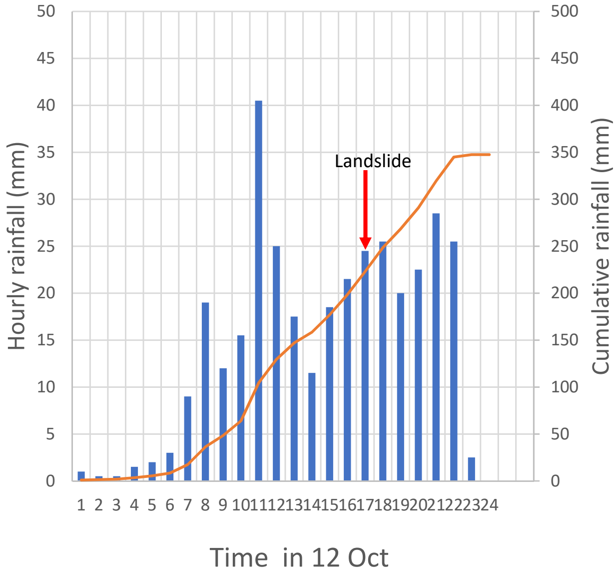
19 October, 2019

- Location: Takumi, Tomioka, Gunma Prefecture
- Occurrence: 4:30 pm, 12 October, 2019
- 3 fatalities



Rainfall at Fujioka (AMEDAS) 15 km east of Tomioka



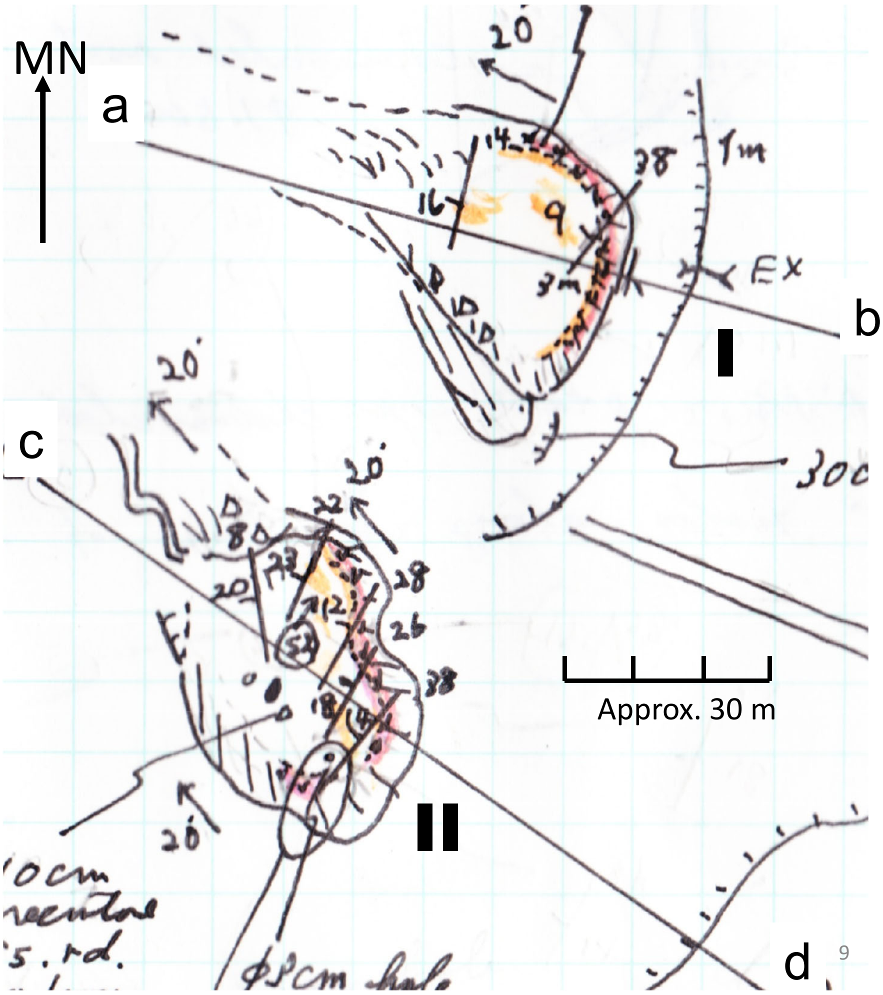


350 mm at 12 Oct. Before that almost no rain in one month.

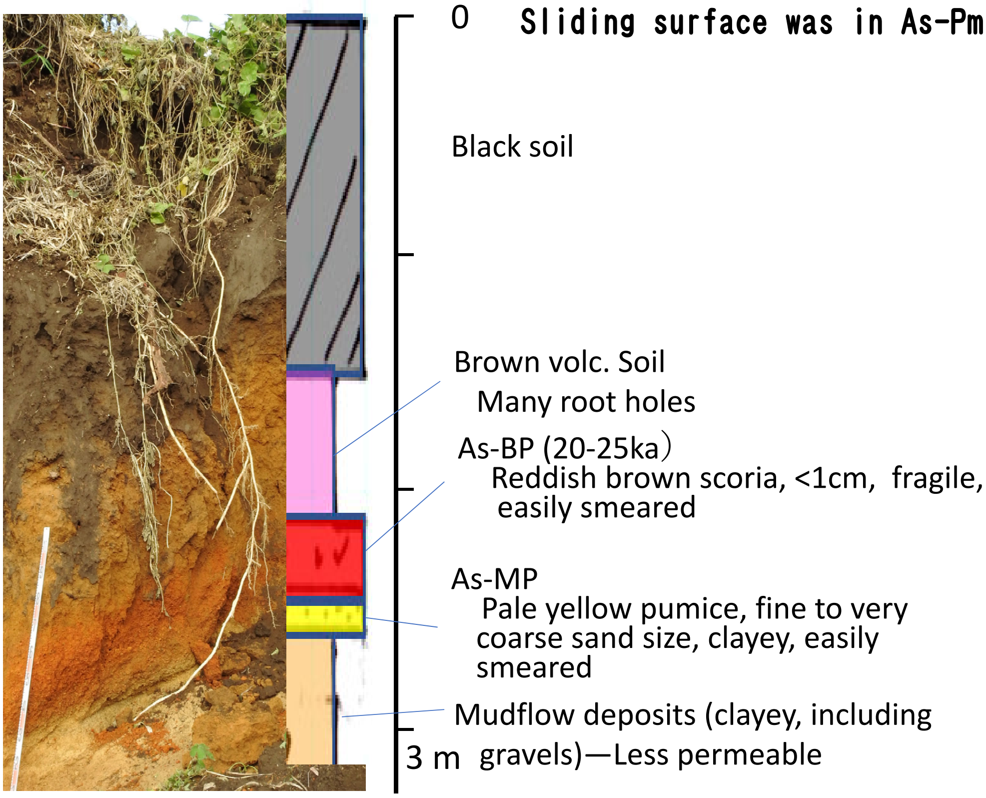
Made from the data of Japan Meteorological Agency（http://www.data.jma.go.jp/obd/stats/etrn/index.php）


I
II

Plan view

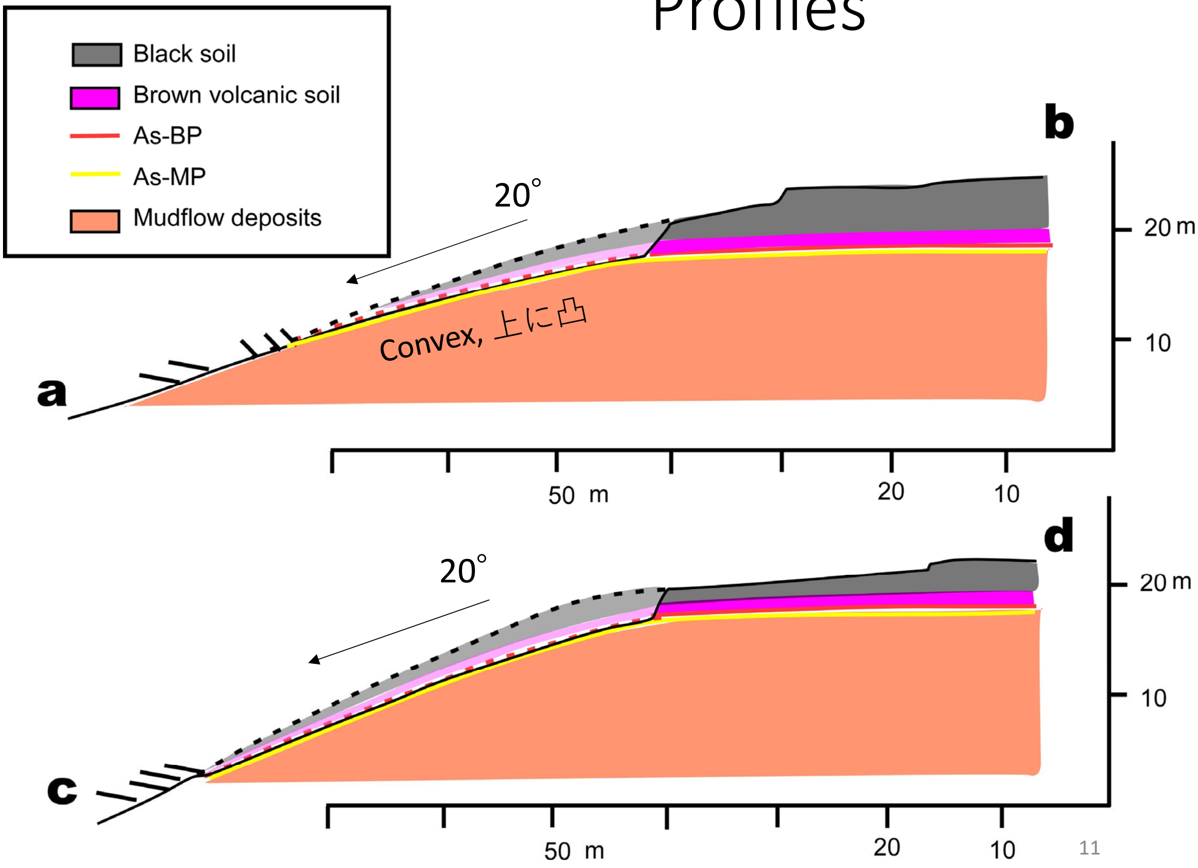


Materials that slid were from the Asama volcano



As-BP, As-MP: Tajikara et al. (2011) Quaternary Research, 50, 21-34.

Profiles

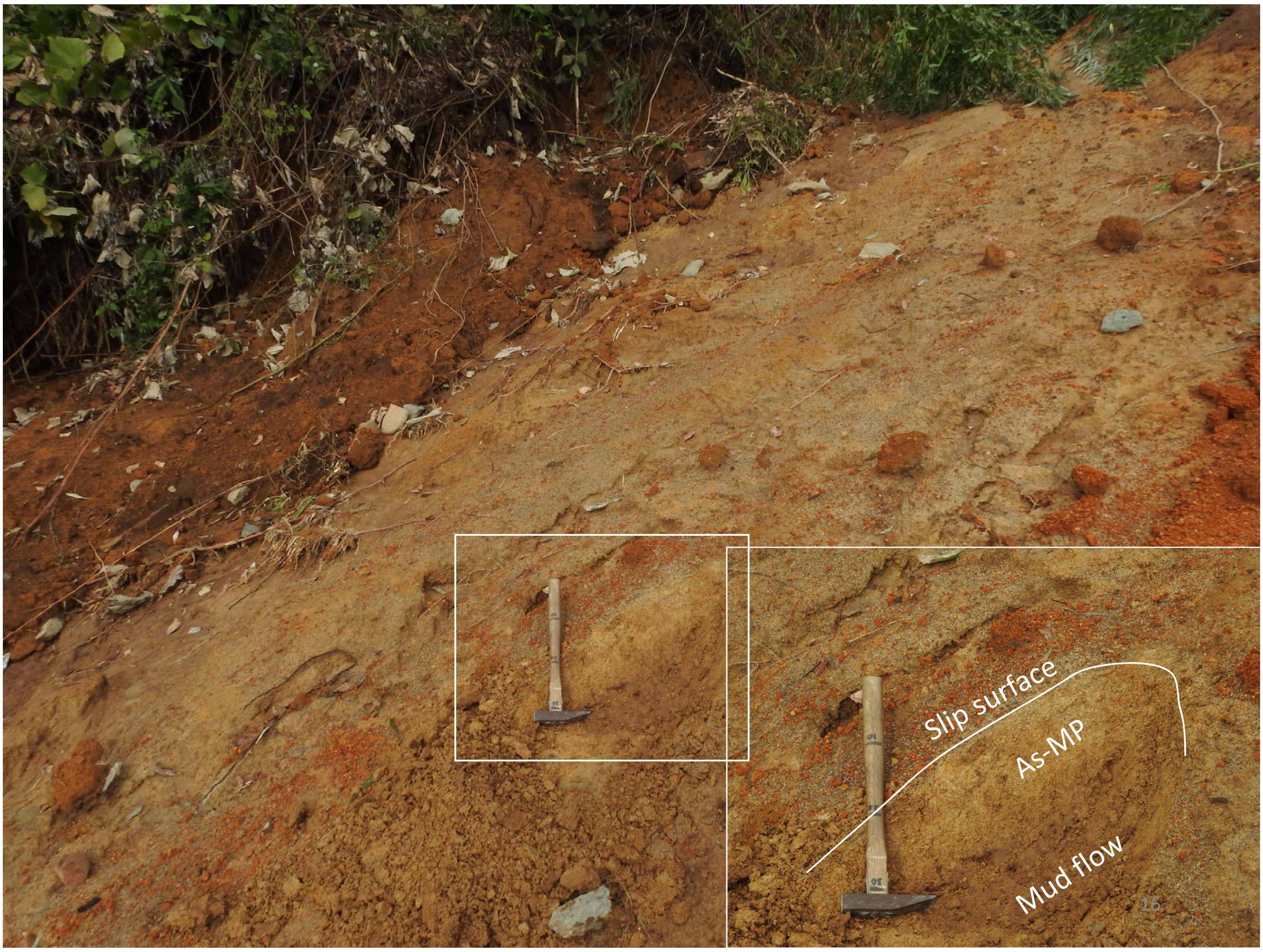

Black soil
Brown volcanic soil
As-BP
As-MP
Mudflow deposits
b
20°
20 m
10
Convex, 上に凸
a
50 m
20
10
d
20°
20 m
10
c
50 m
20
10


Black soil
Brown volc. soil
1m
As-BP
As-MP
Root hole


Water flowing out


As-MP was washed away to make a hole
As-BP
As-MP
Mudflow


Piping holes
Underground erosion of As-MP was more intense downslope


Slip surface
As-MP
Mud flow

Summary

- Landslide occurred on gentle slopes with 20° angle on a margin of a terrace.
- Slid materials were pyroclastic fall deposits up to 3 m thick on less permeable mudflow deposits.
- Sliding surface was made in the lower part of As-MP (pumice), which was weathered to be clayey materials.
- As-MP layer was eroded underground at the rim of the terrace, where bedding dip becomes steeper toward downslope.
- This underground erosion formed piping holes, where water pressure could have been buildup to trigger the landslides.

Points to be noted

- Slid materials and sliding horizons were of pyroclastic materials from the Asama volcano, which must be distributed around the landslide slopes.
- The reason why only these slopes slid is assumed to be:
  - Beds warped convex upward, steepening downslope.
  - So, the groundwater velocity must have been faster downslope, which facilitated underground erosion.
  - The vegetations on the landslide slopes seem to be less than the surrounding.
- The underground erosion we observed suggests that water springs must have been at the foot of the slopes. Behavior of the spring might have been a key for the landslide prediction.

Landslides induced by typhoon Hagibis in Marumori, Miyagi

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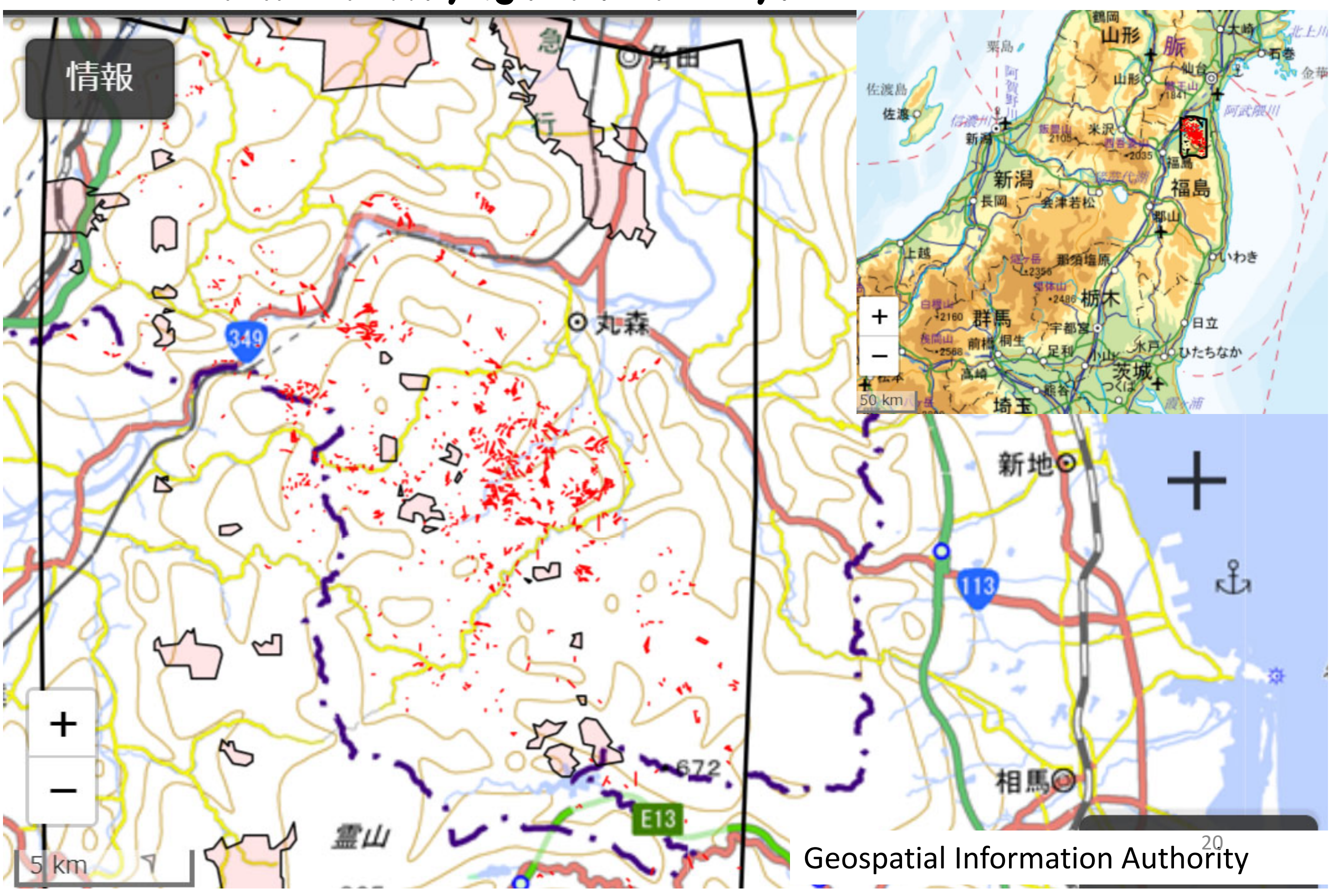
Yasuto Hirata
(Central Research Inst. Electric Power Industry)
Hirokazu Furuki
(Nippon Koei Co. Ltd)

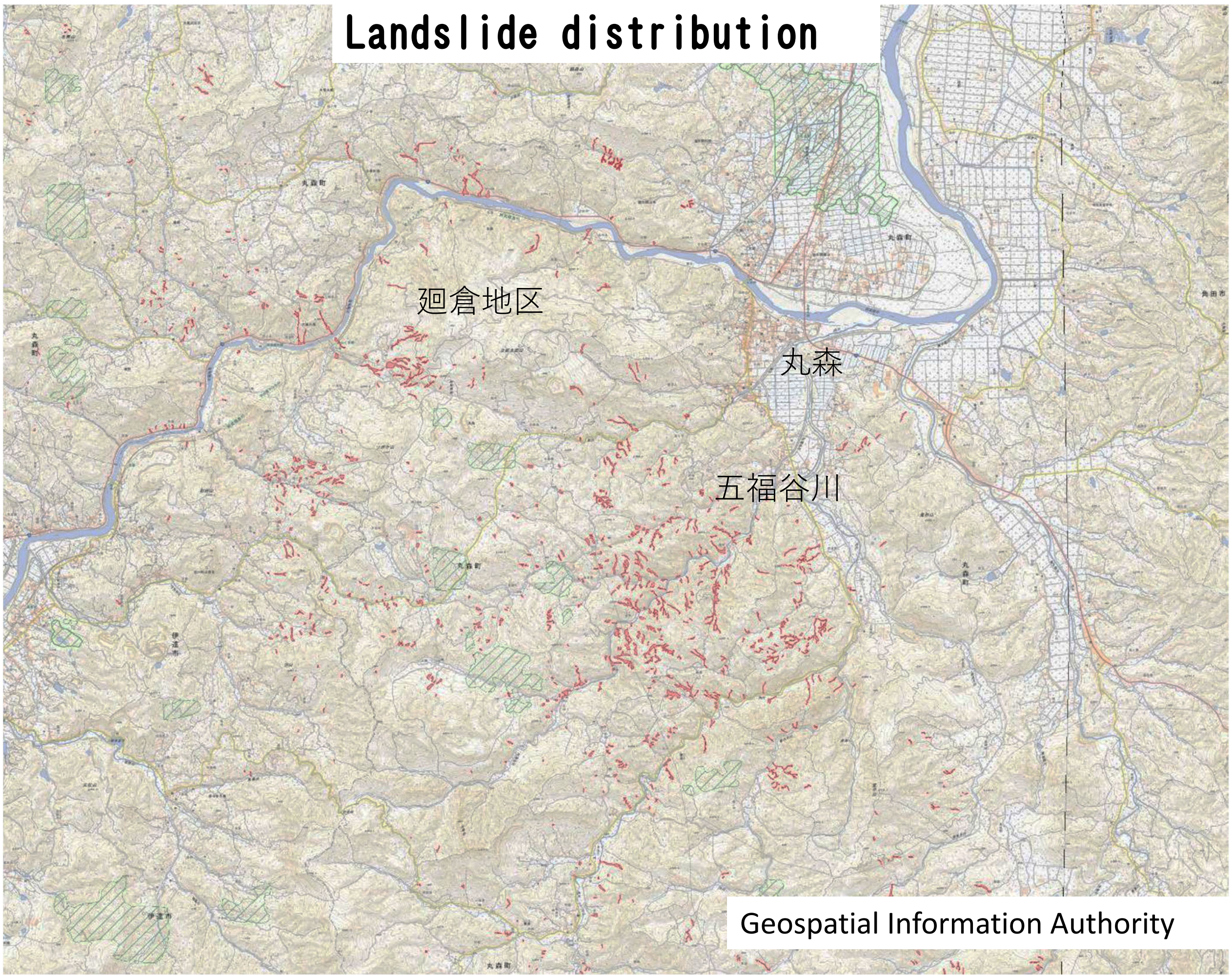
2 and 3 November, 2019

Landslides occurred as a cluster in the south of Miyagi Prefectyre



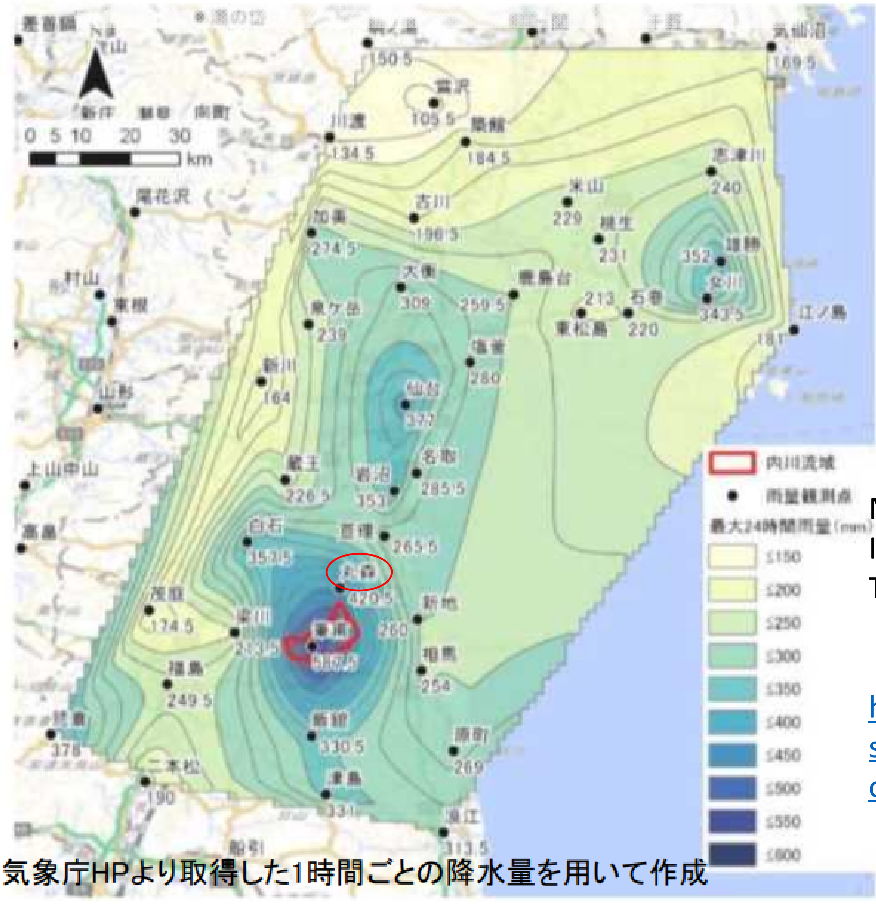
Geospatial Information Authority

Landslide distribution



Geospatial Information Authority

Maximum rainfall (mm) in 24 hours



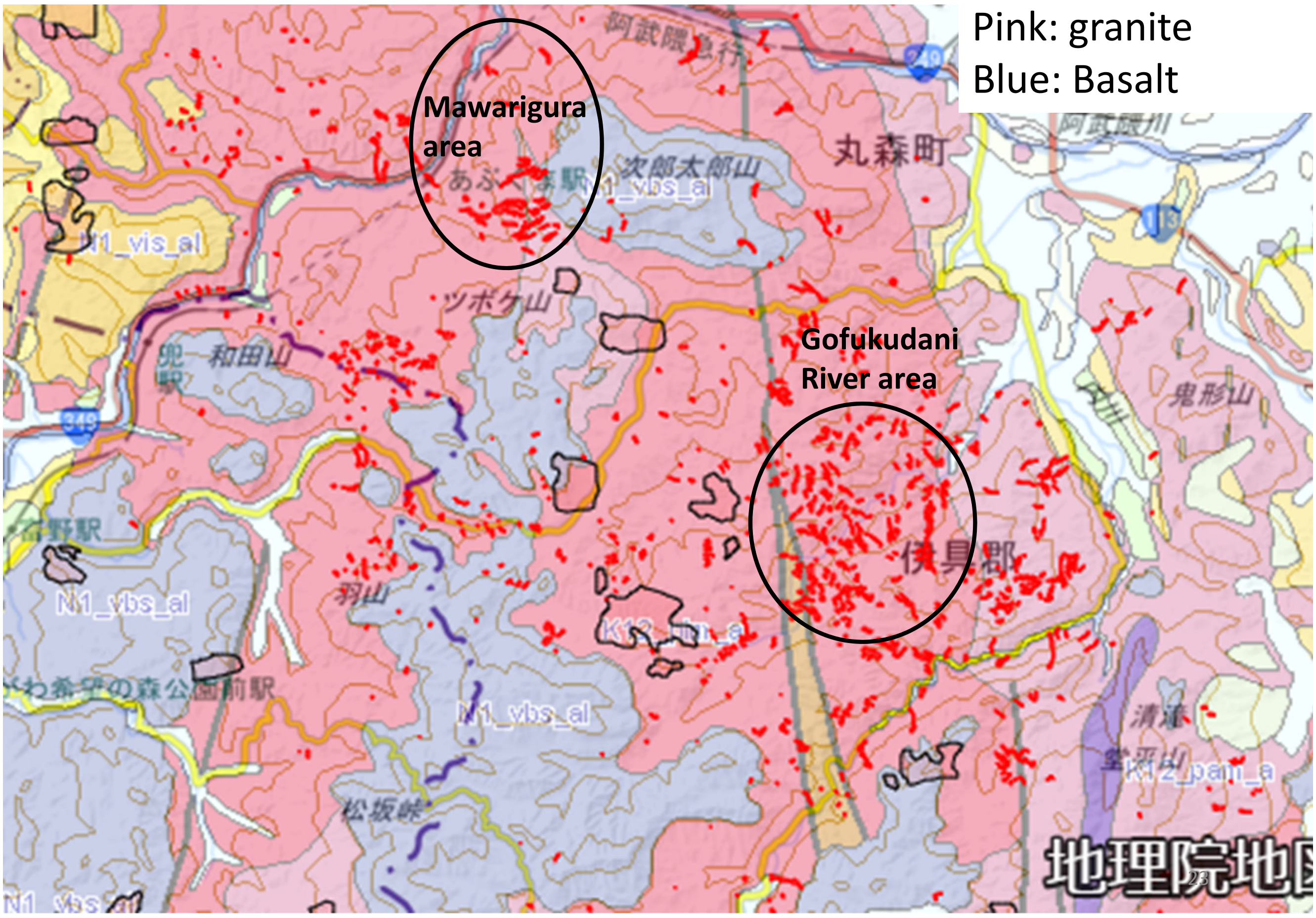
Landslides concentrated in an area with over 400 mm/24h

Ministry of Land Infrastructure, Transporttation, and Tourism

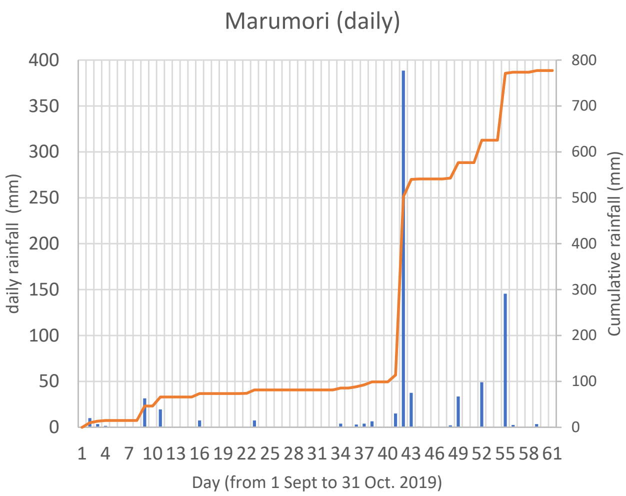
http://www.mlit.go.jp/river/sabo//jirei/r1dosha/r1typhoon19_gaiyou191105.pdf

Landslides occurred densely in granite areas

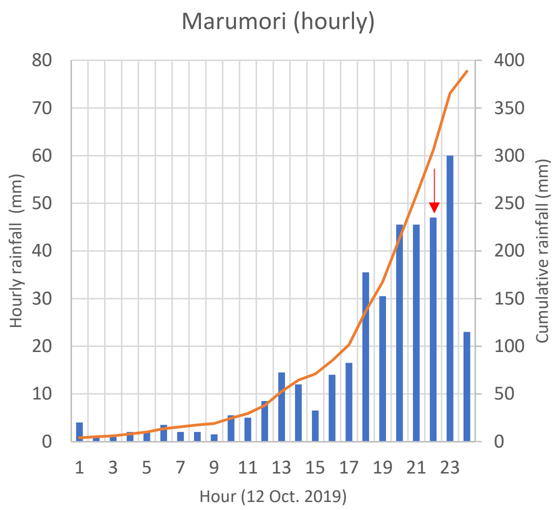
Legend:
Pink: granite
Blue: Basalt



Rainfall at Marumori (AMEDAS)



400 mm at 12 Oct. Before that almost no rain in one month.

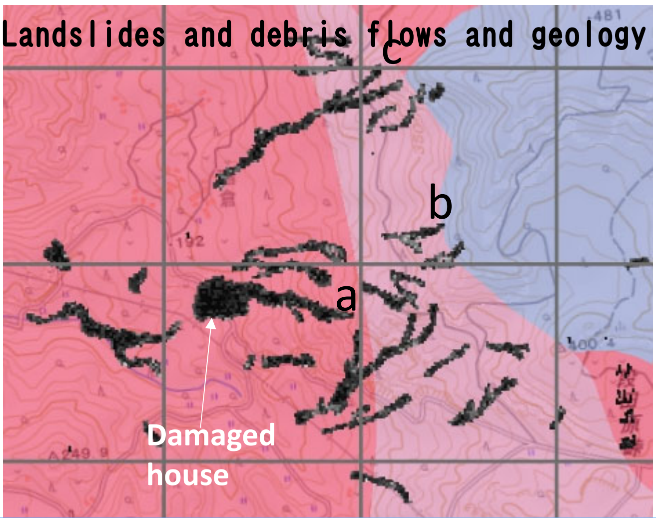


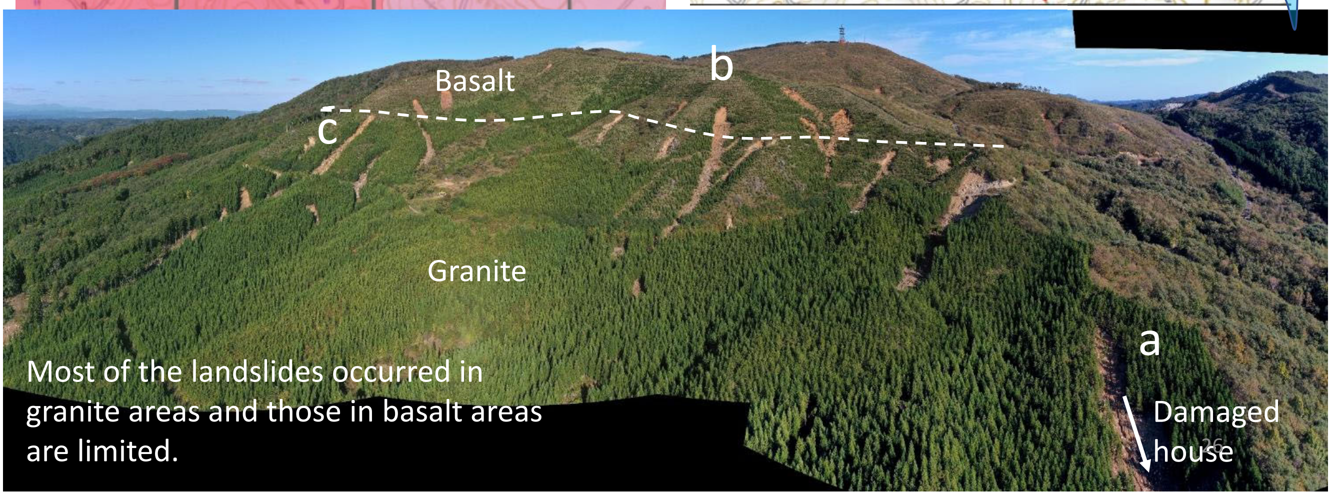
Rainfall (30-60 mm/h) almost continued 6 hours.

Made from the data of Japan Meteorological Agency（http://www.data.jma.go.jp/obd/stats/etrn/index.php）

Mawarigura area

Landslides and debris flows and geology

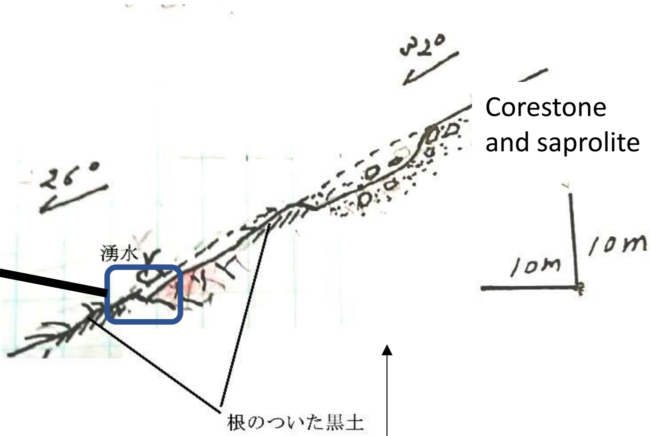


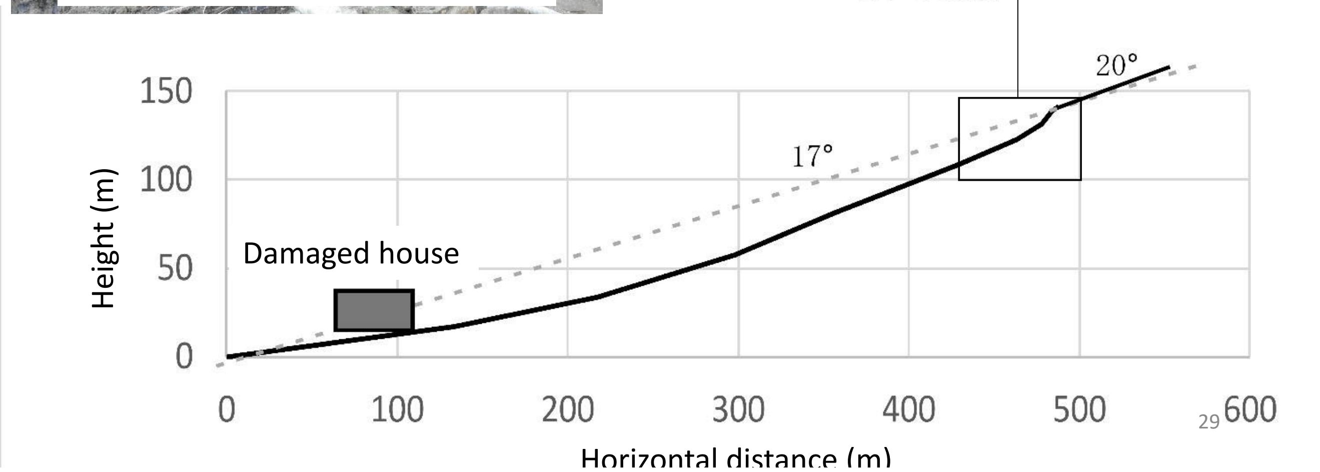



Landslides in basalt areas (reddish)
Landslides in granite areas are whitish and contain core stones.

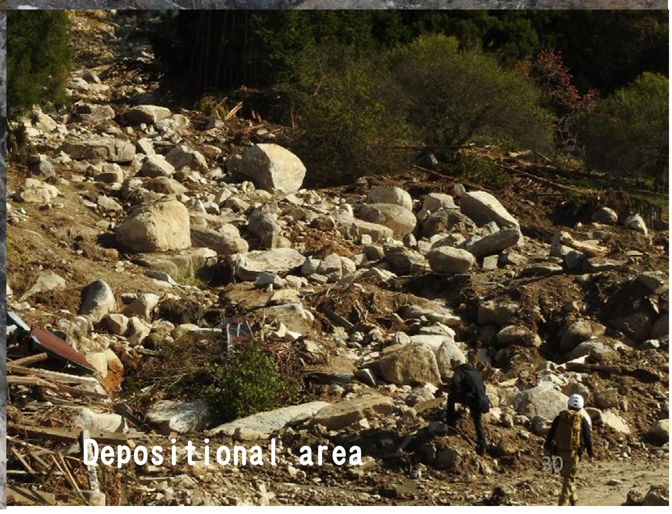

Side slopes failed to increase the volume.
DJI_0327
DJI_0327
Damaged house

Profile of the landslide and the debris flow



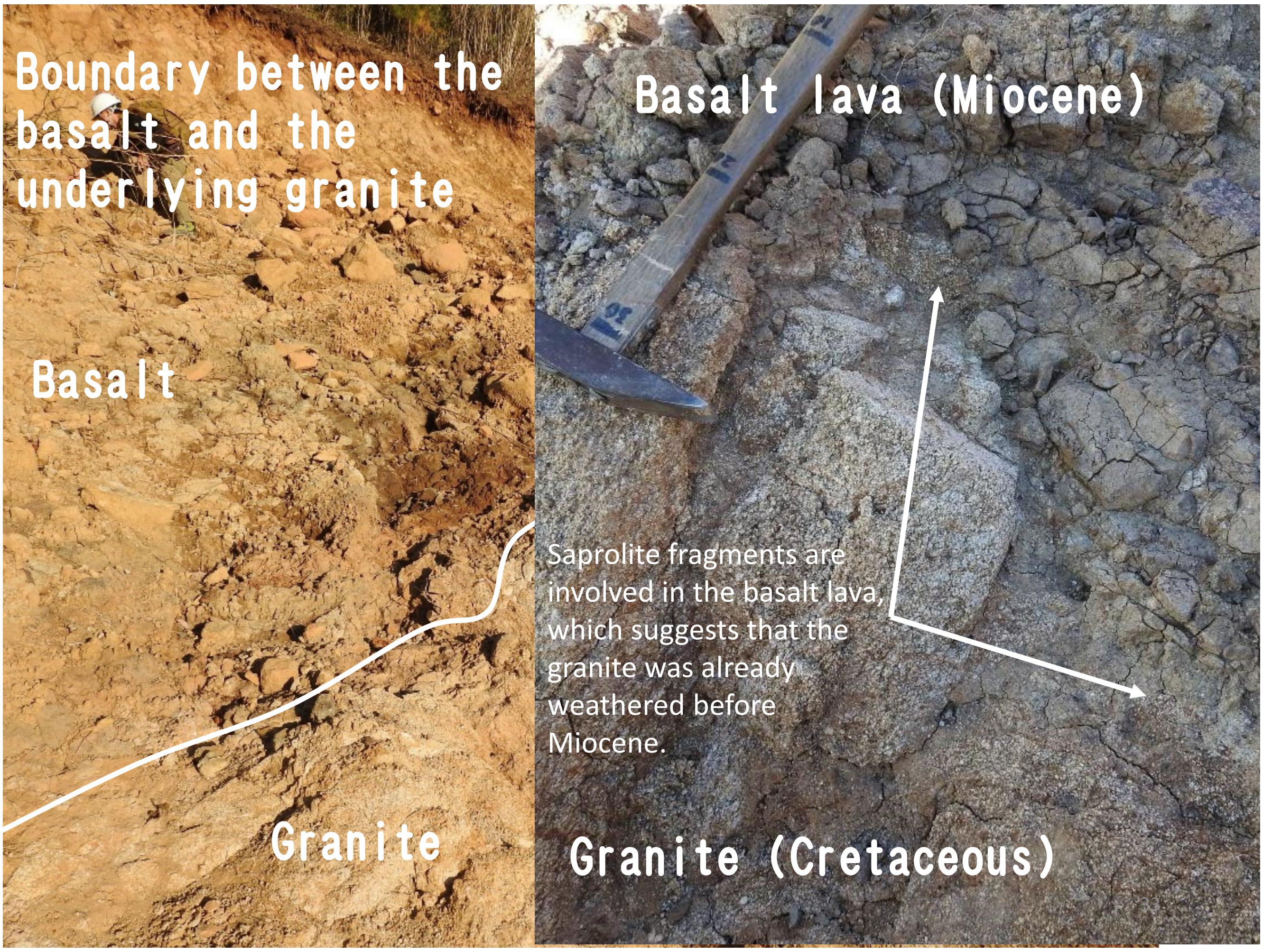


Springs from fractures and openings between core stones caused the landslide.



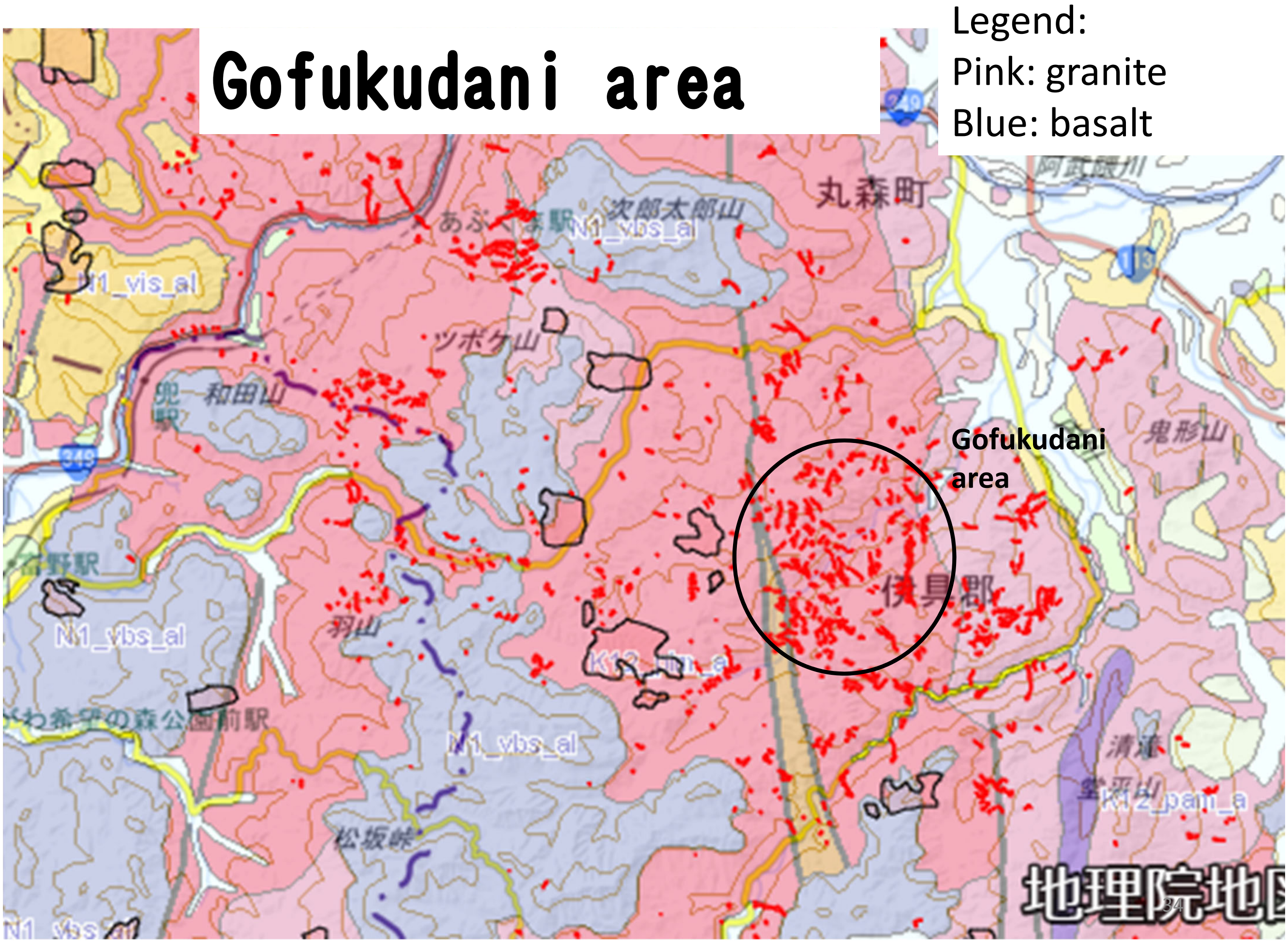

Nearby landslides are of core stones and saprolite
31


Landslide of basalt
Relatively small and short runout
32

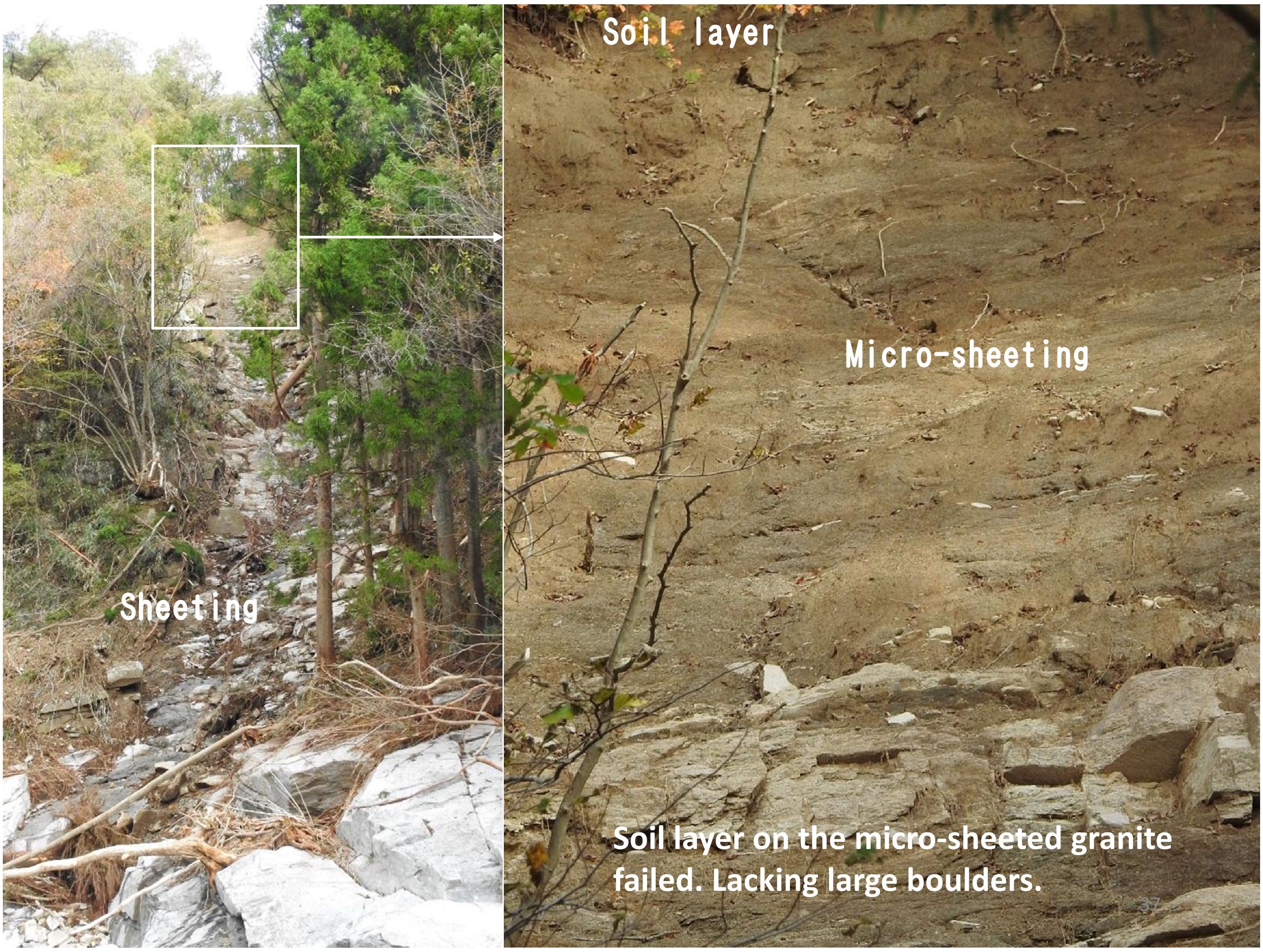


Gofukudani area

Legend:
Pink: granite
Blue: basalt



Huge volume of sand



Summary

- Shallow landslides and debris flows occurred mainly in granite areas with a rainfall over 400 mm/24 h (particularly Mawarigura and Gofukudani areas).
- Weathering styles are different between the Mawarigura and Gofukudani areas.
- Core stones and the surrounding saprolite failed in the Mawarigura area, and the core stones must have made the debris flow more destructive.
- Major type of the landslides in the Gofudani area likely is a shallow landslides of soil on micro-sheeted granite.

Summary (continued)

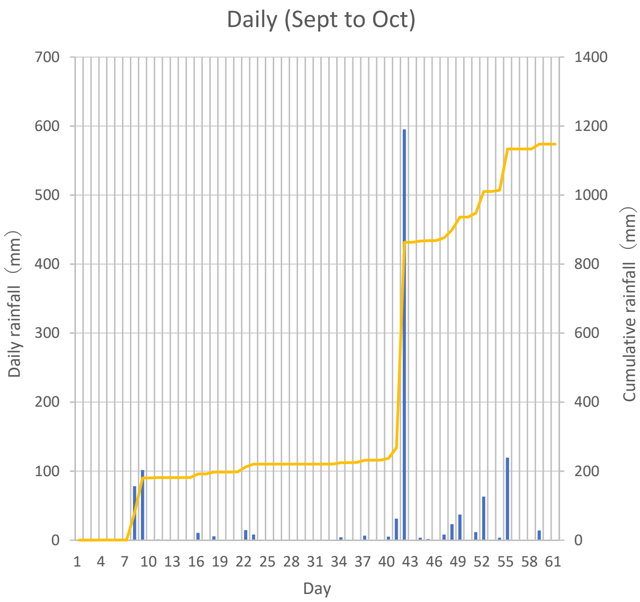
- Landslides in the Mawarigura area are similar to those induced by the 2017 western Japan rainstorm (Kumano and Yano-E in Hiroshimna)
- Landslides in Gofukudani area are similar to those induced during the 1999 Hiroshima rainstorm disaster and 2002 typhoon Rusa disaster in Korea.

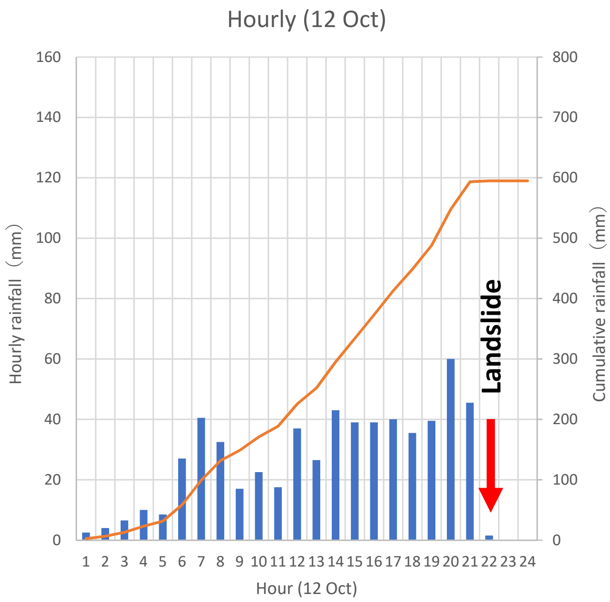
Landslide induced by typhoon Hagibis in Magino, Midori ward, Sagamihara

Masahiro Chigira
Noriyuki Arai
(DPRI-KU)

15 November

Rainfall (AMEDAS Sagamiko)





Almost no rain for one month before the event

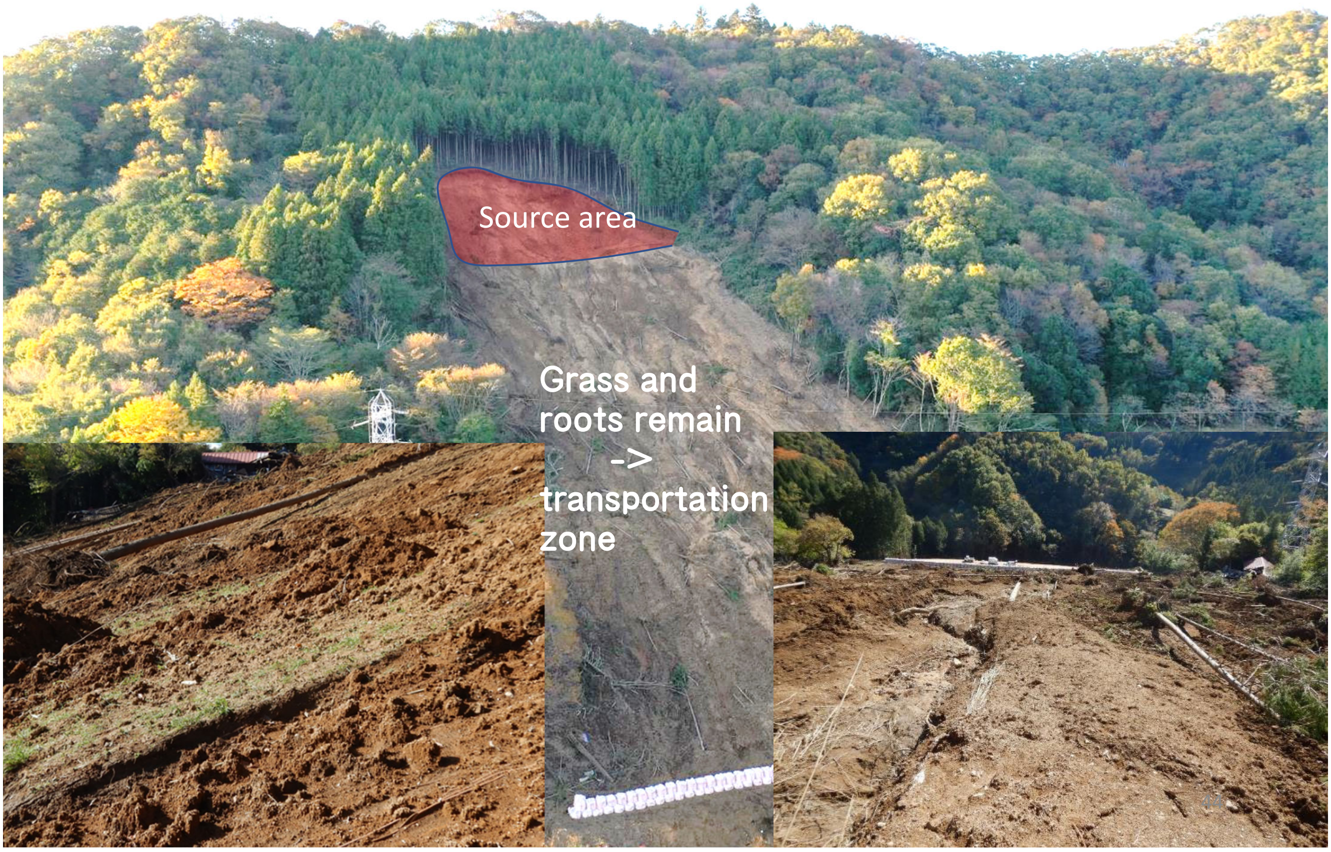
20－60㎜/h continued 15 hours.

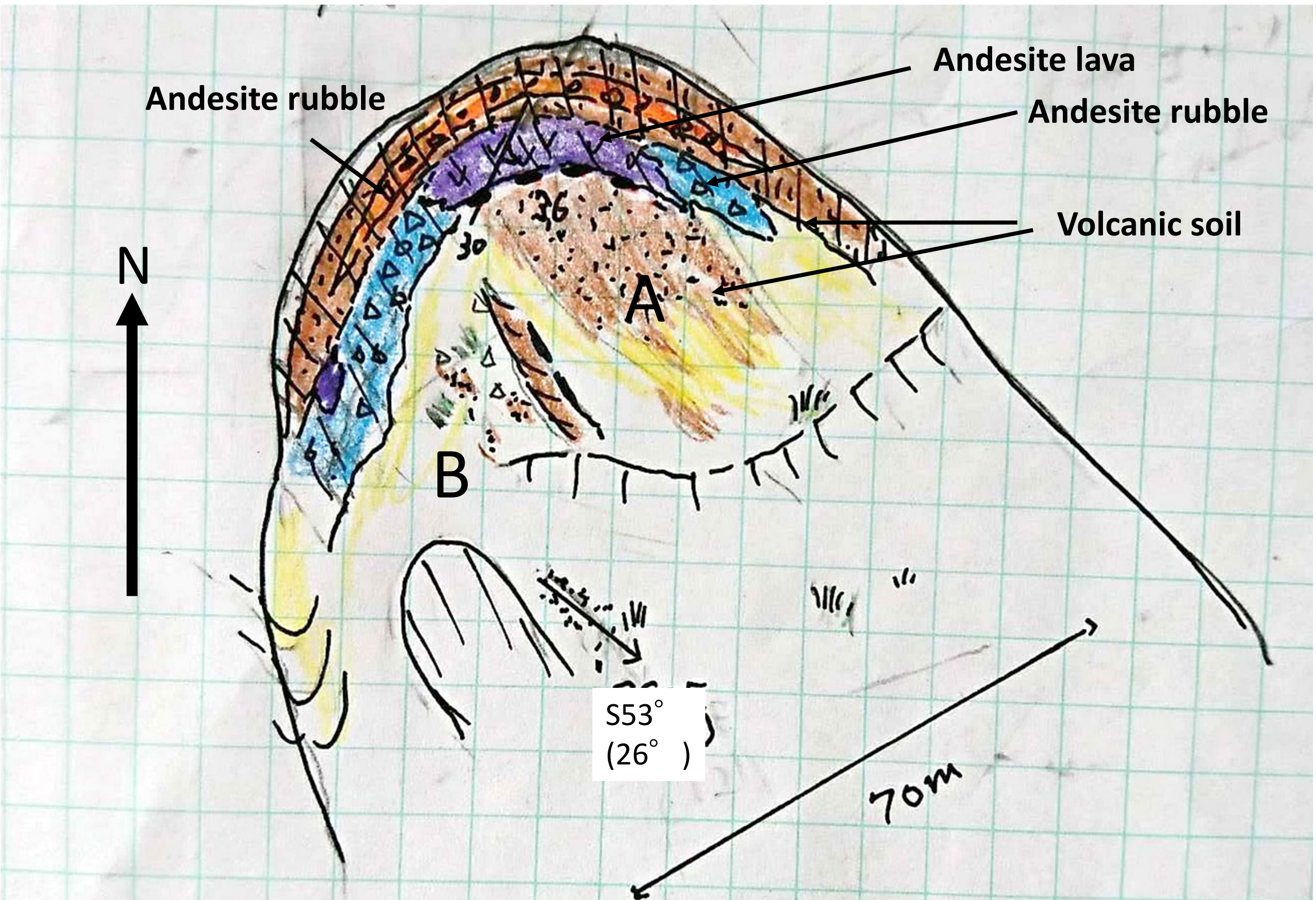
Made from the data of Japan Meteorological Agency（http://www.data.jma.go.jp/obd/stats/etrn/index.php）

Overview of the landslide at Magino

(occurred 9:45 pm, 12 Oct)

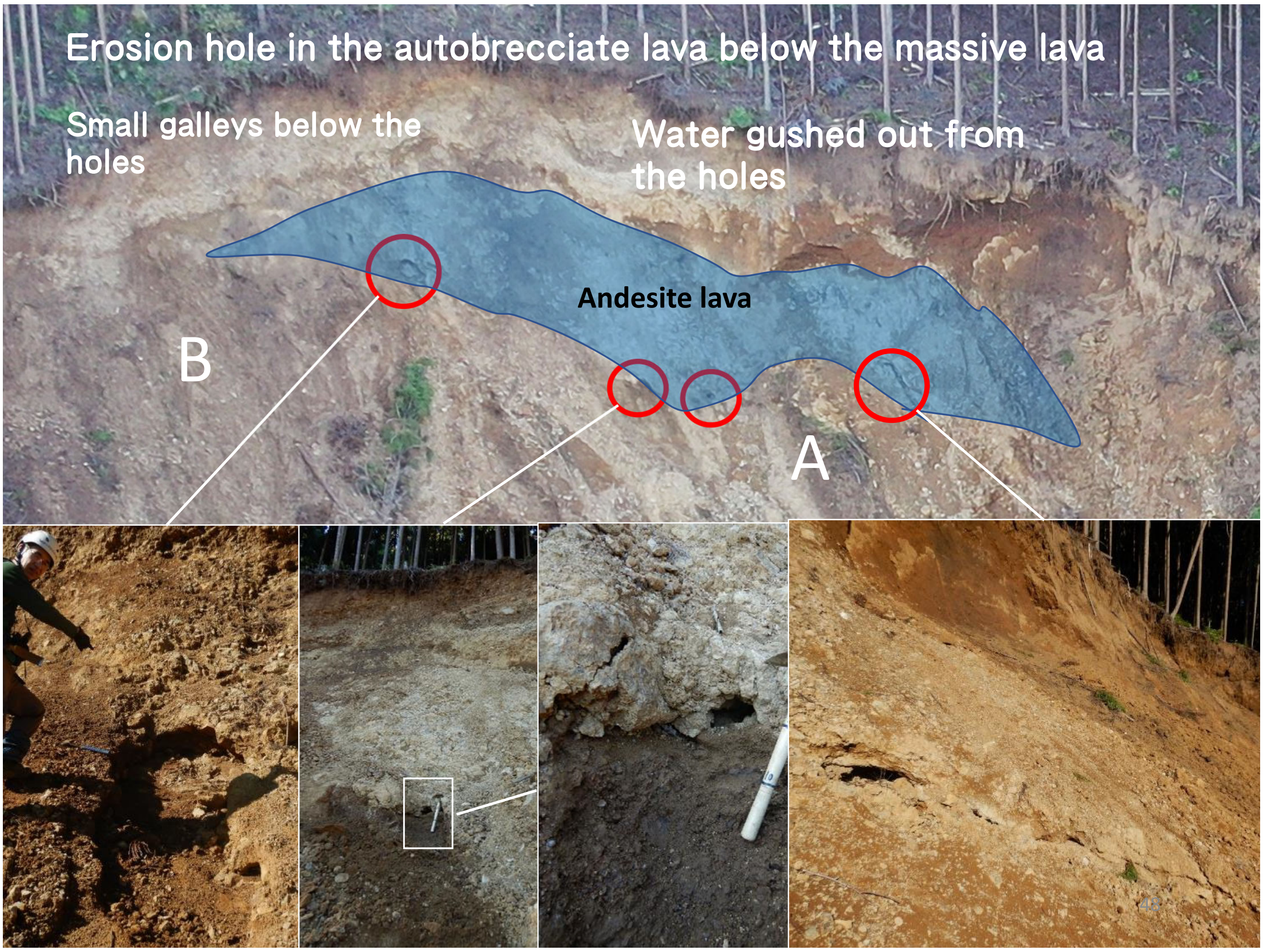
Source area is at the top



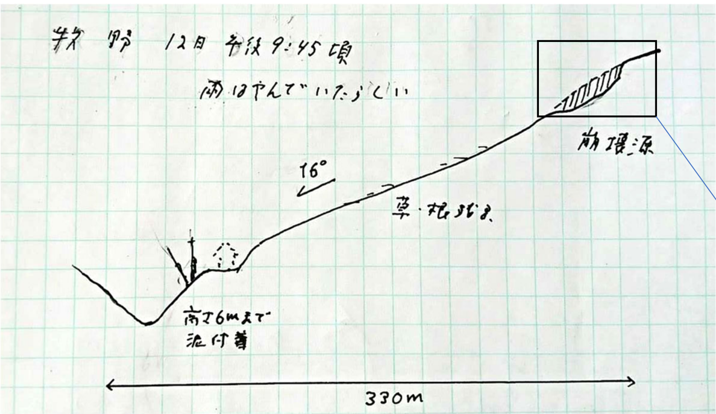


The source area is divided into deeper A and shallower B.

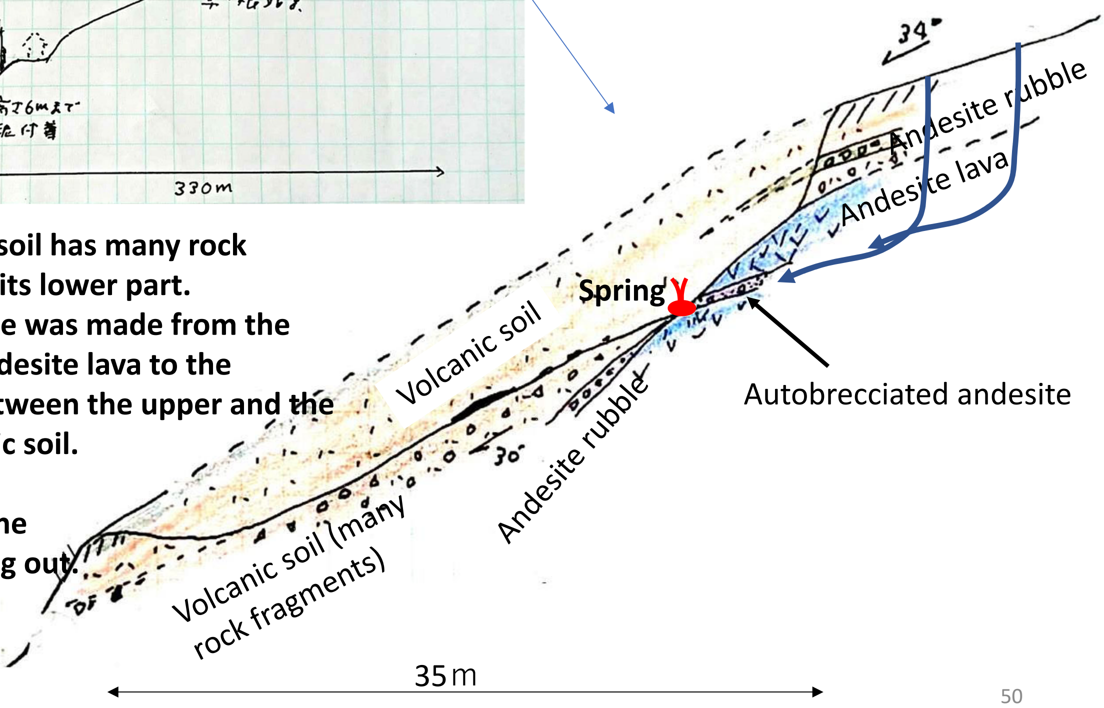

B
A


Erosion hole in the autobrecciate lava below the massive lava
Small galleys below the holes
Water gushed out from the holes
Andesite lava
B
A

Erosion holes and the galleys



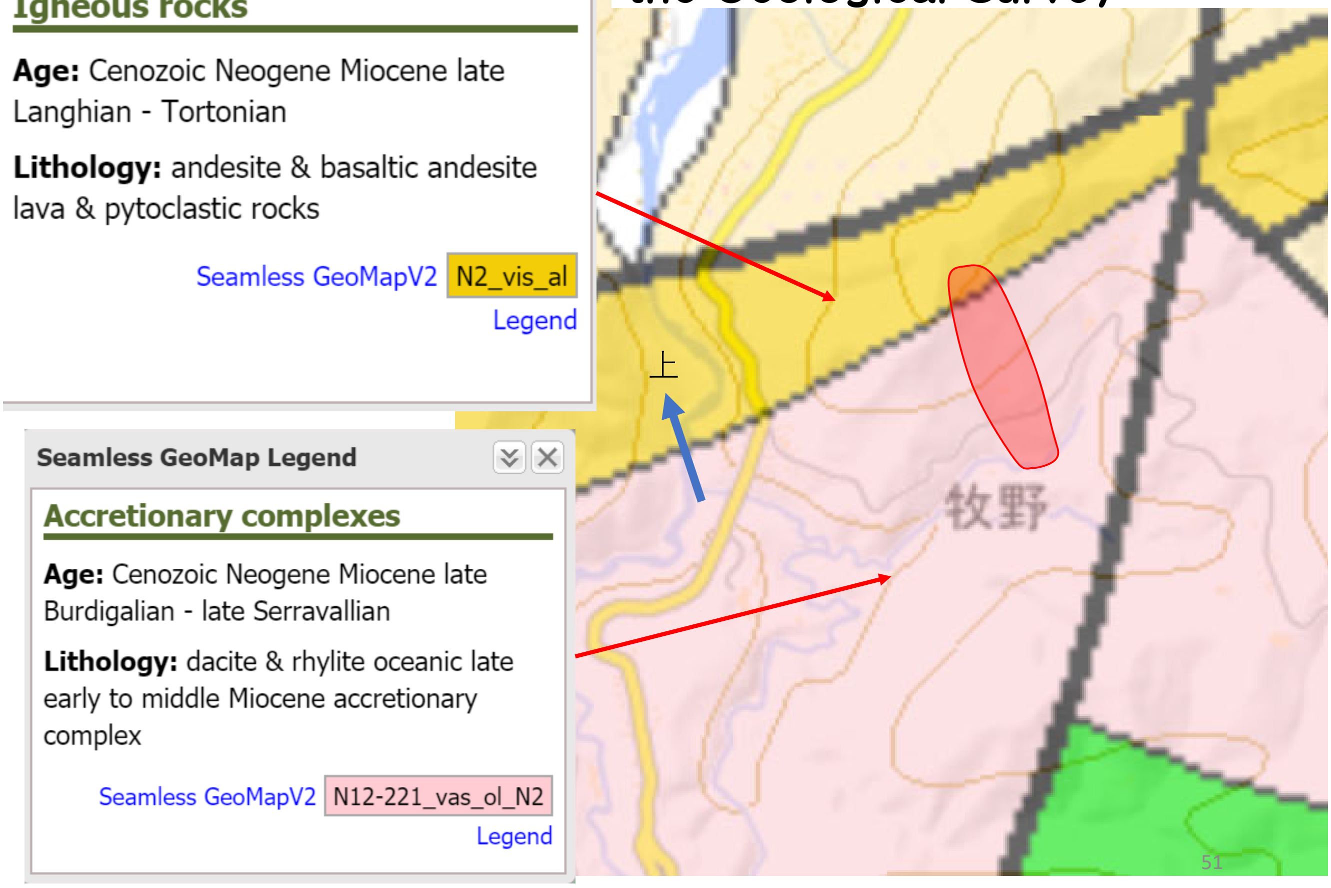
Profile

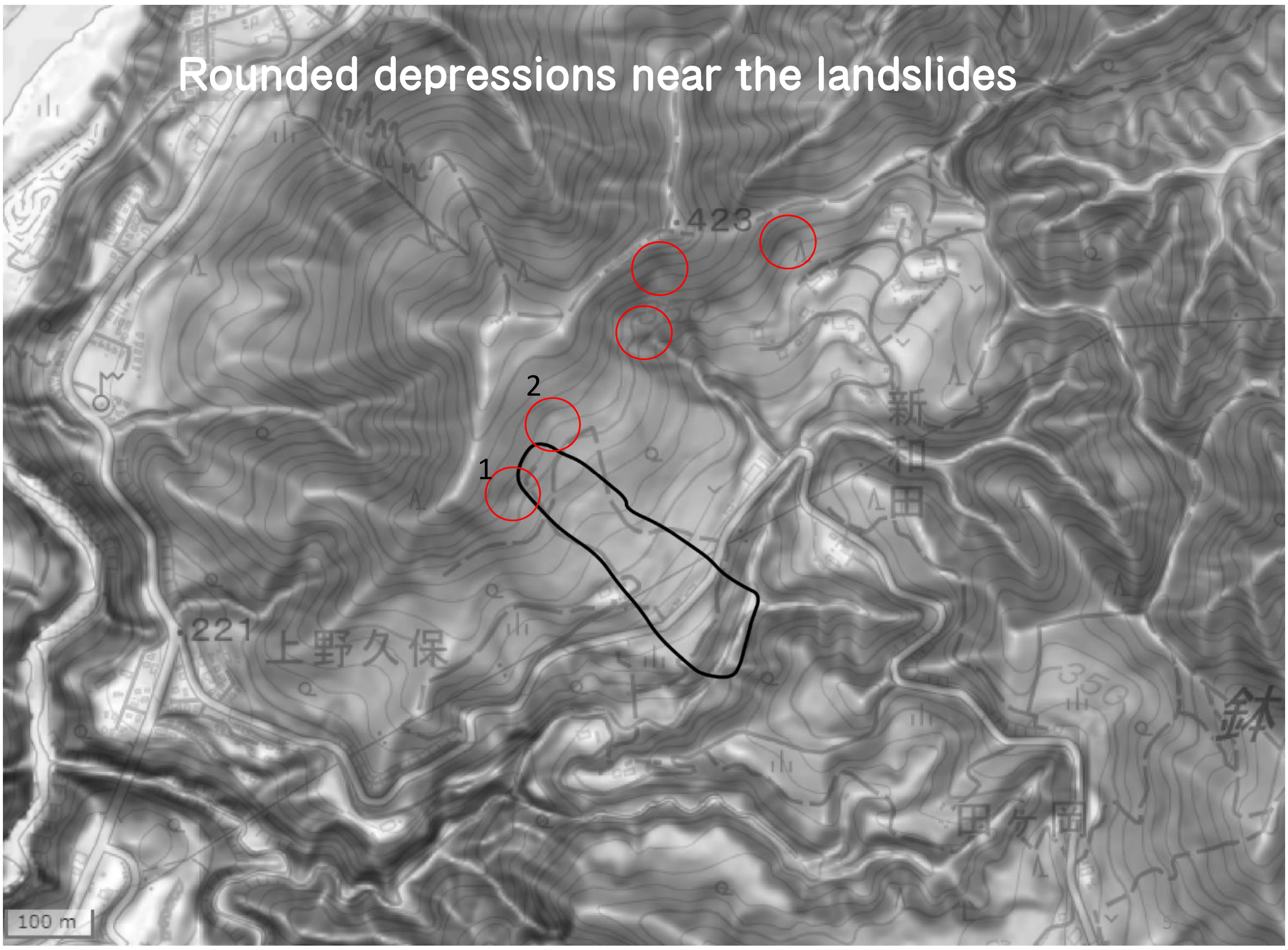


The volcanic soil has many rock fragments in its lower part. Sliding surface was made from the surface of andesite lava to the boundary between the upper and the lower volcanic soil.

Trigger was the spring gushing out.

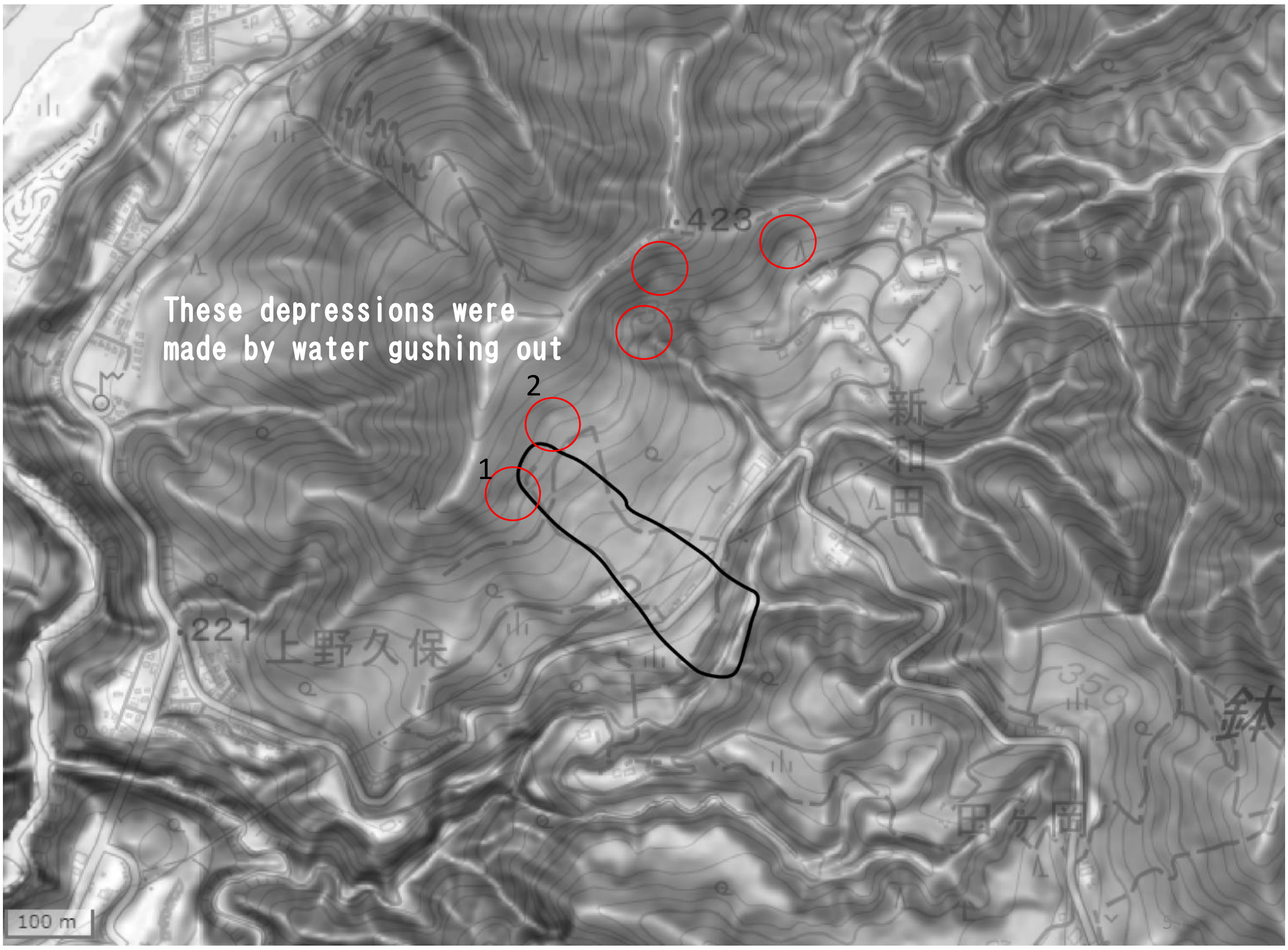
Seamless geologic map from the Geological Survey






Depression 1
Evidence of water gushing out from the bottom
Trace of water gushing out
53


Depression 2
Trade of water gushing out at the surface of andesite lava
Tree branches and soil are trapped on the upslope portion of tree trunks.
54



Conclusions

- The source area of the Magino landslide was its top.
- Erosion holes were made in the weathered autobreccia below massive andesite lava.
- Water gushed out from the autobreccia and induced the landslide.
- Near the landslide source are at least five circular depressions, from where water gushed out.
- These depressions are inferred to be made by water gushing probably from autobreccia like that in the landslide this time.
- These depressions could be a clue to predict the landslides of similar type.