2008/07/20

Quick report of the 2008 Iwate/Miyagi Earthquake（Ver. 2.1）

Kazuo KONAGAI, Tomohiro FUJITA,Fumihiko, NOMURA,Yuriko TOMIYASU
Masaki DATE, Yoshimitsu TAJIMA and Toshihiko KATAGIRI

The above were members in the field reconnaissance from June 15 to 17 and from July 12 to 14, and have compiled the results in forms of figures shown below. The latest version can be found at:
http://shake.iis.u-tokyo.ac.jp/home-new/
At this moment, the drawing reflects the authors own opinions and views, but the figures will be updated with the help of more detailed field information and other experts' opinions.

1. Landslide at Aratosawa dam

Fig. 1. Landslide at Aratosawa dam: Aerial photo of the largest landslide with Kurikoma Volcano rising behind. The terrain here is suggestive that similar landslides have been reactivated. A wide-spread and almost horizontal laminar structure of lose volcanic sands and ashes is being exposed on the escarpment. When wet, some pieces of light-gray rock fragments taken at the toe of the landslide mass smelled strong hydrogen sulfide (see Fig. 3). (Photo by K. Konagai)

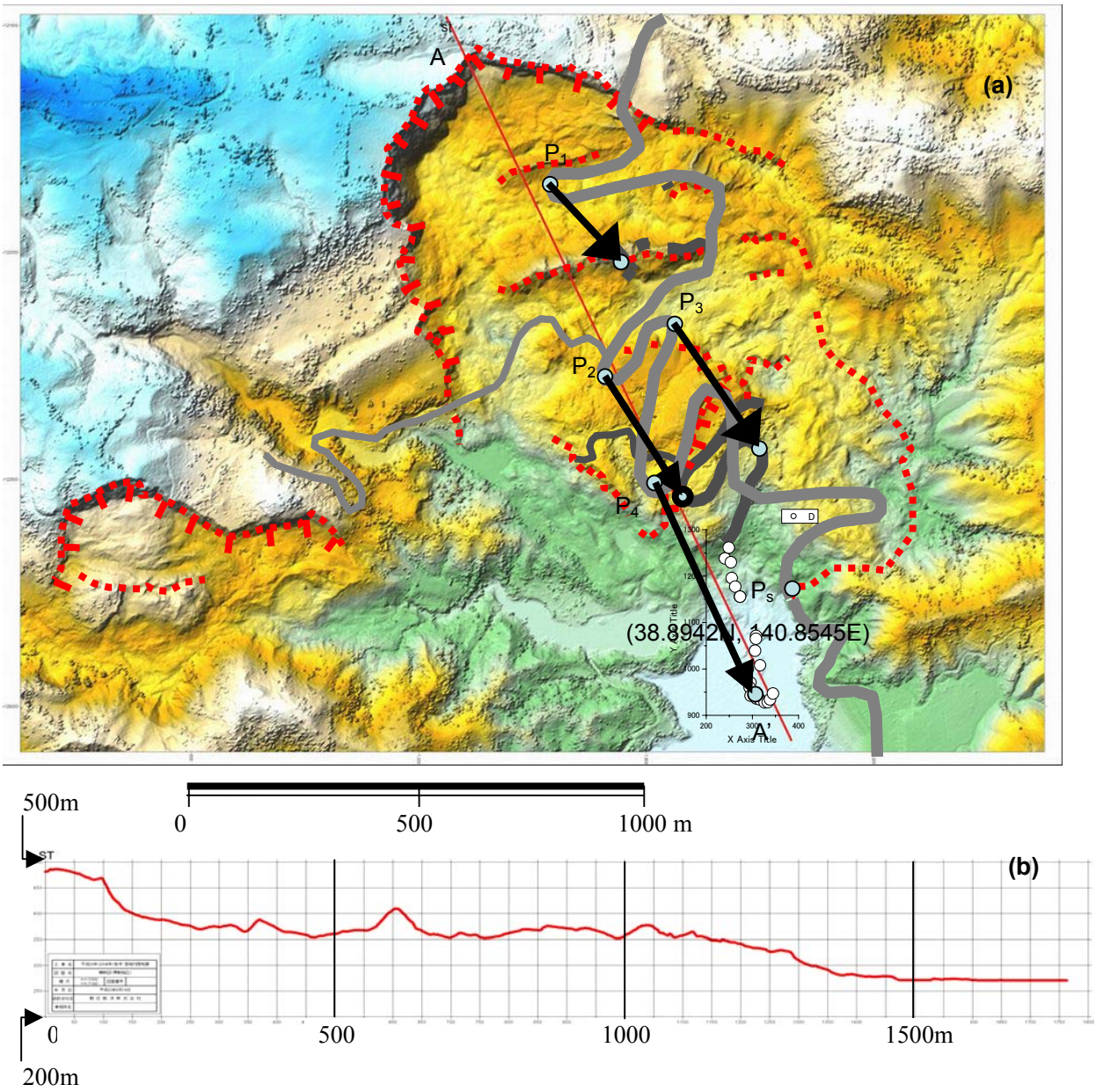


Fig. 2. Landslide at Aratosawa dam. The road locations after and before (gray) the earthquake were drawn upon the DEM by using images from helicopter survey, photos (black lines), and field GPS survey (open circles) etc. The arrows show that Points P_1 P_2 and P_3 have respectively moved about 200m, 300m and 500m SSE towards the dam lake. The slid blocks are lined up in a succession. The cross-section A-A' Figure 2b) shows a gradient of about 3-4 degrees. Even though the base slope was very gentle the soil masses have moved some 200 to 500 meters. (Aero Asahi Co. provided the digital elevation model).

(a) Sample dried in oven

(b) Sample put again in water

Fig. 3. Rock sample taken from Point Ps in **Fig. 2**:
Location of Ps: 38.8942N, 140.8545E
Specific gravity immediately after the sample was taken（2008/06/16　18:00）= 1.78 g/cm^3
Specific gravity after the sample was dried one day at 105 degrees C in oven.　= 1.18 g/cm^3
Specific gravity after the sample was again soaked up in water for three hours.　= 1.69 g/cm^3

When soaked up with water, the sample smells hydrogen sulfide, evidencing that the materials were from volcanoes. It is remarkable that the specific gravity of the dried sample is quite small, indicating the presence of large volume of voids.

As can be seen in Table 1 the lake elevation increased from 268.5 m before the earthquake to 270.9 m after the earthquake. This increase in lake elevation is due to the plunge of the landslide mass and possibly also due to some tectonic deformation.

Table 1. Dam Lake elevations measured by Dam Managament Office.

Date	Height [m]	Remark
06/14/2008	268.5	Before Earthquake
06/14/2008	270.9	After Earthquake, water level increased due to land-sliding and possibly due to tectonic deformation
07/12/2008	261.4	Reference elevation for measurements on July 12
07/13/2008	261.2	Reference elevation for measurements on July 13 (Lake is being emptied slowly)

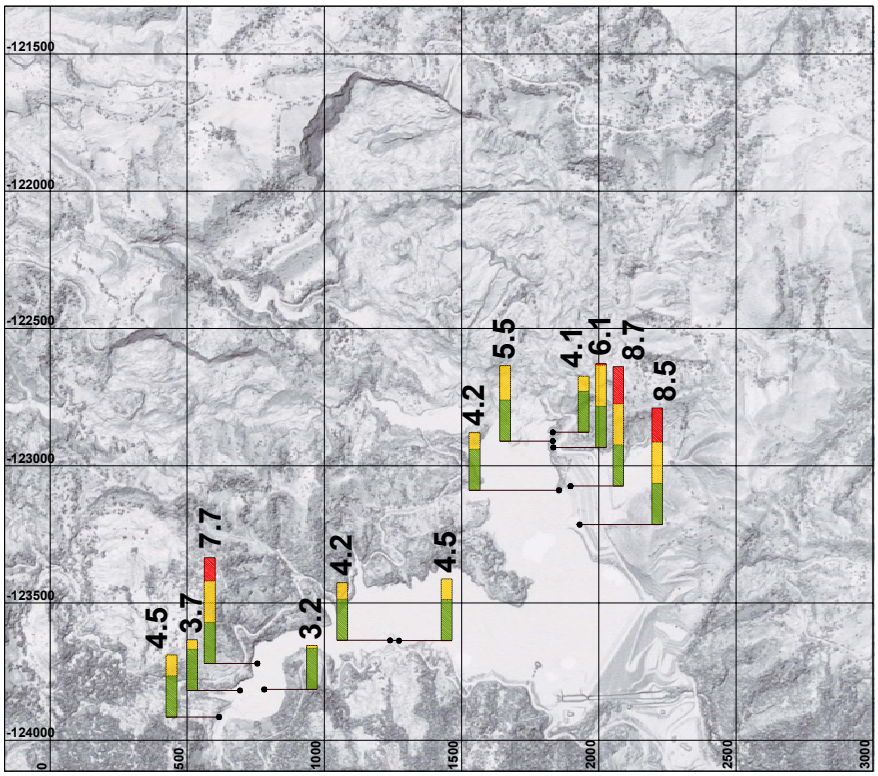


Fig. 4: Seiche high water marks above the lake elevation of 259.7m on July 12 and 13

2. Debris flow surged up to a hot spa.

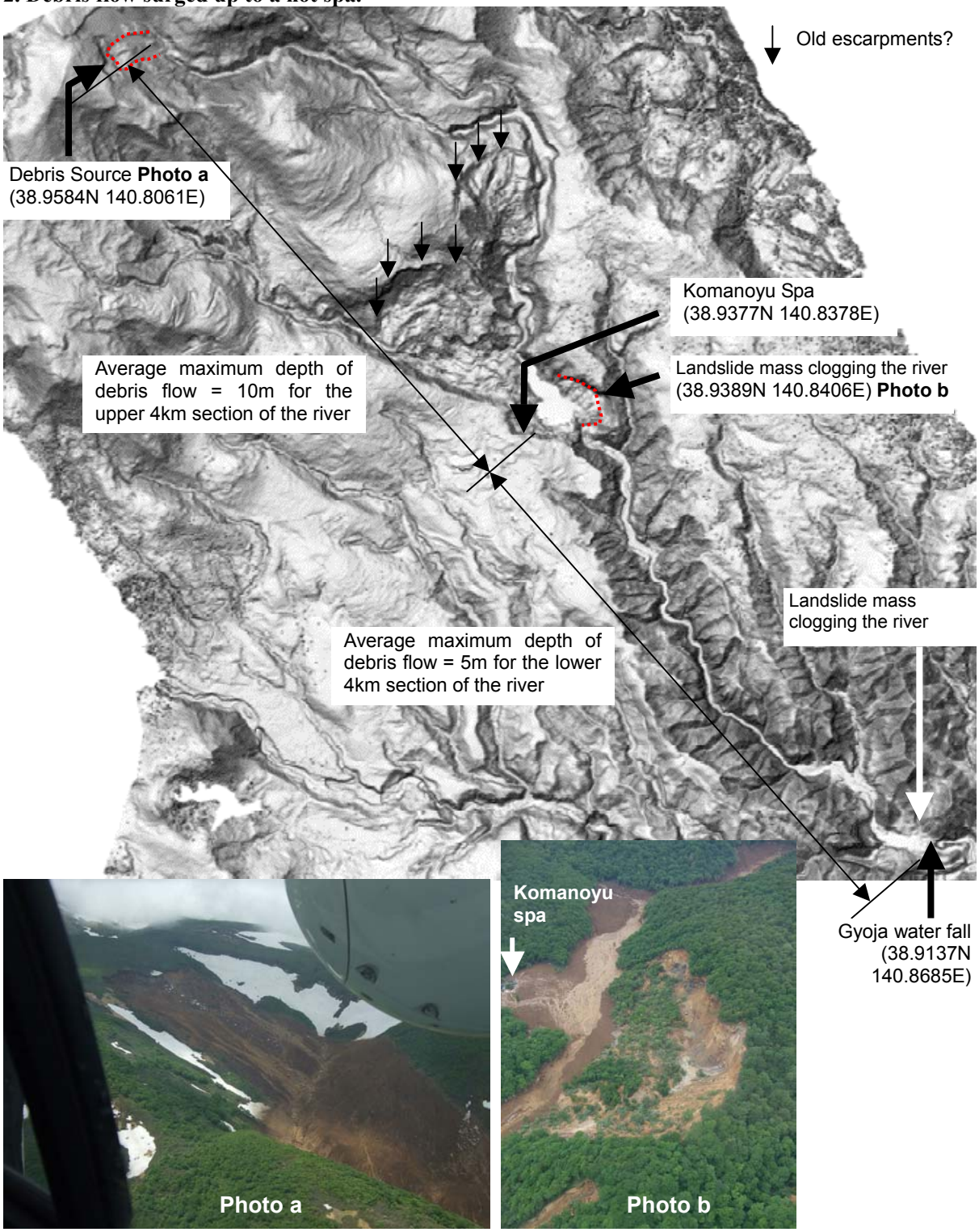


Fig. 5. Debris flow along Dozo and Ura Rivers: A deep scar was created immediately beneath the snow remaining near the eastern peak of Mt. Komagatake (**Photo a**, 38.9584N 140.8061E). The debris flow from this source swept into Dozo River, and scoured sediment and vegetation from along the channel. The mud flow, with its channel clogged with another landslide mass （**Photo b**, 38.9389N 140.8406E）, surged up to a hot spa resort "Komano-Yu" （**Photo b**, 38.9377N 140.8378E）, where seven people were trapped in soil and rubble. The average maximum debris flow depth for the 4km-long upper stream reach of Komanoyu spa was visually estimated to be about 10m, while it was about half for the lower stream reach probably loosing its momentum. The flow was stopped at Gyoja waterfall (38.9137N 140.8685E). (DEM provided by Aero Asahi Co.)

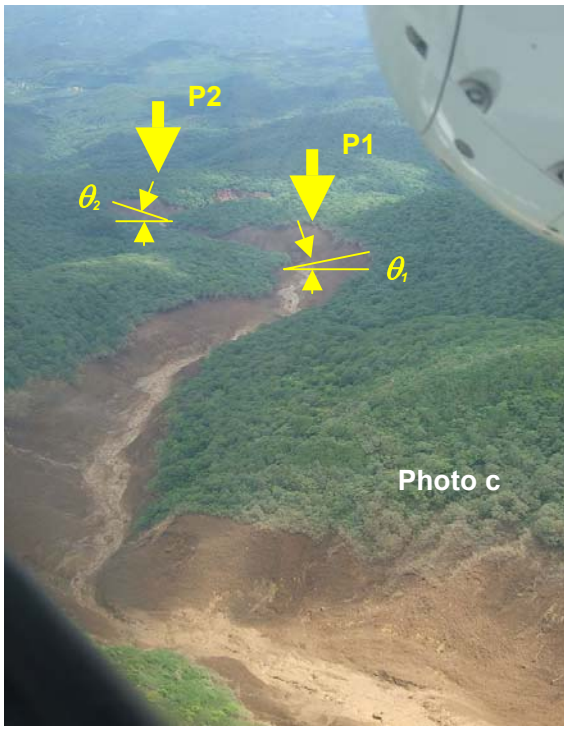


Fig. 6. Estimation of debris flow velocity v: This wet flow along a curved channel had enough momentum to surge up along its outer wall (See photo). Assuming that walls of the channel covered with mud show the inclined mud flow surface, the following equation is obtained.

$$\theta \cong \text{centrifugal force / gravitational force} = \left(\frac{mv^2}{R}\right)/(mg) \quad (1)$$

where, R = curvature radius, and one obtains:

$$v \cong \sqrt{Rg\theta} \quad (2)$$

Necessary parameters for Eq. (2) at Points #1 and #2 are roughly made out from the photo (left) and the topographical map (below) as:

$$\theta_1 \cong 0.12, \quad R_1 \cong 200\,\text{m},$$
$$\theta_2 \cong 0.3, \quad R_2 \cong 120\,\text{m},$$

Substituting these parameters in Eq. (2) yields:

$$v \cong \sqrt{Rg\theta} = 15 \sim 19\,\text{m/s} \quad (3)$$

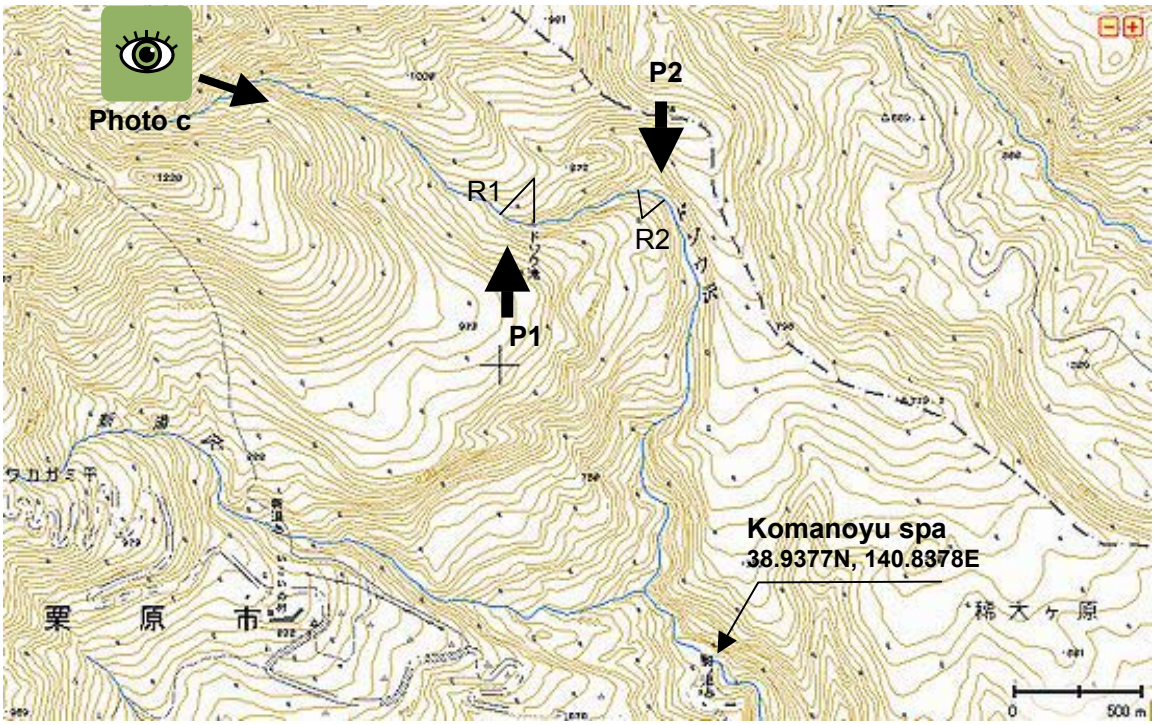
This velocity is near to that estimated by PWRI.

Sabo Technical Center uses the following equation for estimating debris velocity:

$$v \cong \sqrt{\alpha \cdot Rg\theta} \quad \text{with} \quad \alpha \quad \text{empirically set at 10} \quad (4).$$

And the velocity will be:

$$v \cong = 5 \sim 7\,\text{m/s} \quad (5)$$



3. Shin-Tamayama Tunnel

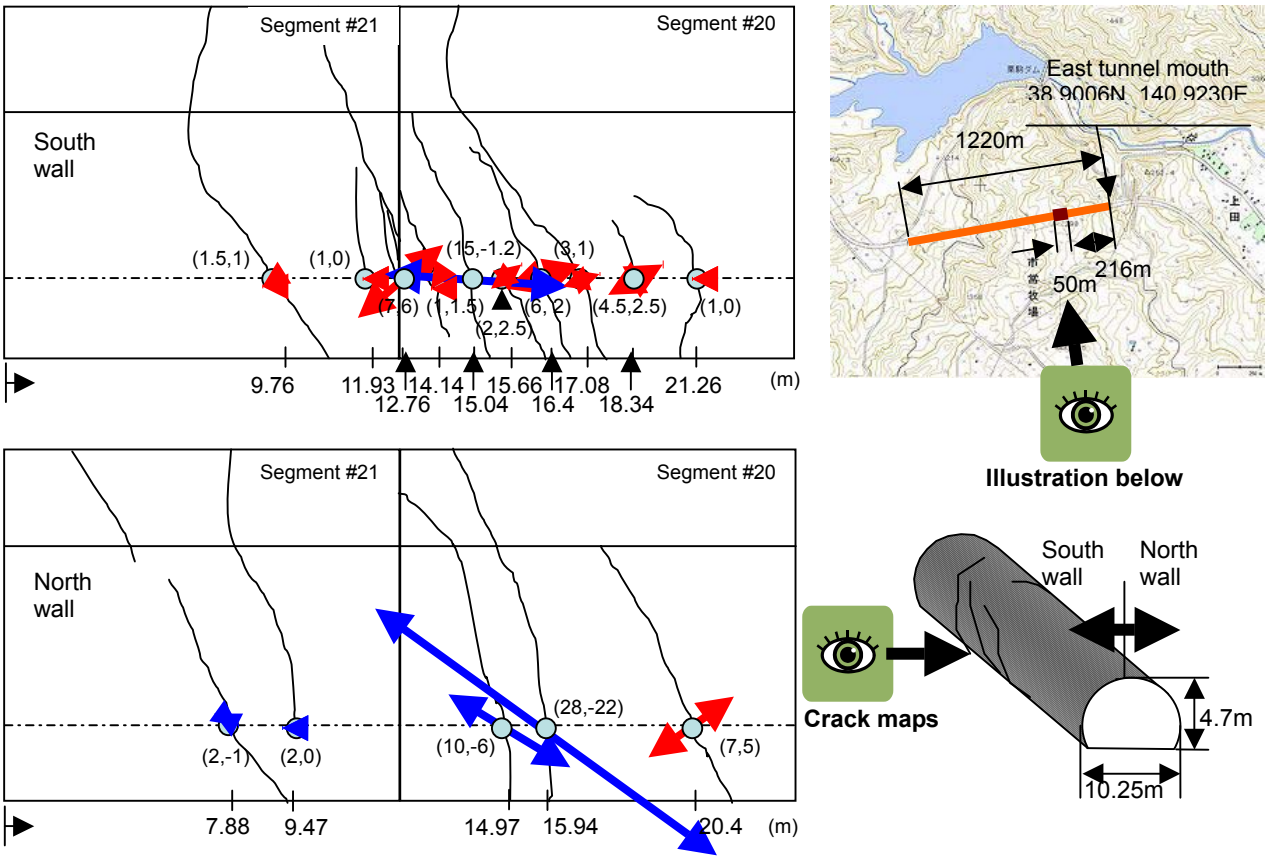


Fig. 7. Cracks in Shin-Tamayama Tunnel: A 36m-long segment 216m inside the eastern mouth (38.9006N, 140.9230E) of the total 1220-m-long tunnel was diagonally cracked. The above two figures show projections of the cracked south and north walls on a virtual screen put north behind the tunnel. These cracks were all opened. Blue allows show that the eastern segment moved down with respect to the western segment, while red ones show the opposite. Numbers in parentheses show these relative displacements in mm. If a deep-sheeted landslide was the cause, long-term monitoring will be a must for rational repairs.