Tracing groundwater vein in a schist landslide area

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INTRODUCTION:

‚Tsurii landslide' is located on the crystalline schist zone in Shikoku Island, Japan. The most important inducing factor of the landslide movement is the groundwater. By now construction of the drainage works had been normally conducted to eliminate the effect of groundwater, and then identifying the locations of groundwater vein effectively will be of great importance. For this purpose, we have executed hydrochemical analysis of water taken from torrents, spring points and drainage works (Hexa-diagram investigation, EC and pH measurement), groundwater dating (Purge and Trap-GC-ECD method) and the underground temperature survey together with the geological, lithological and geomorphological investigation of the landslide on site. The results are as follows;

GEOLOGY AND THE SLIDE MODEL:

According to the field investigation together with previous interpretation of aerial photographs round Tsurii landslide area, three faults and slide units were detected (Fig.1). By the lithological observation on site, authors have concluded that faults have been existed before the landslide activities. The landslide lies within a rectangular area composed of three faults (F1, F2 and F3 on Fig.1) and River Kumatani, which flows through the foot of the slide. The formation consists mainly of pelitic schist, siliceous schist and basic schist, and the beds strike N67°W and dip 36°NE. The head scarp of the slide occupies a part of the scarp of ‚F1 fault' which develops from SW to NE direction and perpendicular to the moving direction of the slide units.

GROUNDWATER AND THEIR SOURCES:

From one spring point (S1 on Fig.1) among 17 points and 6 points of the drainage works among 34 points in the slide area (Fig.1), abundant water which seems exceed the recharge of the entire slide area was drained. Thus, from topographical point of view, two possibilities of the source area of the groundwater were supposed; the first one is from Northern torrent to the landslide as indicated by B-B' section (Fig.1 and 2). The possibility of this route is identified by the underground temperature survey. Although from the view point of geological structure, the groundwater of transverse direction from Northern torrent was difficult to think of. The second possibility is the route along fault scarp which can be traced on the aerial photography and

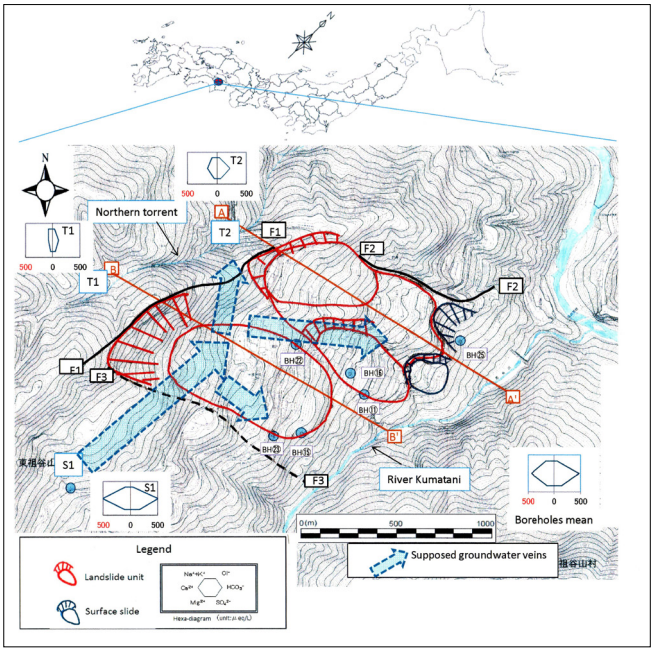

Figure 1. Plan of Tsurii landslide, slide units, estimated fault, drainage boreholes, hexa-diagrams and inferred underground water veins.

the topographic map and the fault F1 is also included. Somewhere at the upper part of the River Kumatani, water has infiltrated into the ground and flown underground along the fault mobilized zone and then recharged the landslide area.

WATER TYPE AND THE VEIN:

Hexa-diagram is used to represent water type using three main cations (Ca2+, Mg2+, Na+) and three main anions (HCO3 -, SO42 -, Cl -). Major water type was the Ca-HCO3 type. All of above mentioned one spring point and 6 are of Ca-HCO3 type and show similar hexa-diagrams (Fig.1,Σ(ion) mean=53.8mg/L). During 8 years' monitoring, authors have confirmed that the quality of water at

erery sampling point has indicated no remarkable change. The hexa-diagram at T1 point (Σ(ion)= 27.4mg/l) at the Northern torrent is indicated on Fig.1, whereas water sampled at point T2 contains more nutrients(Σ(ion)=52.2mg/L). Thus, as for the difference of the content of the nutrients between T1 and T2, we have concluded that more concentrated water has joined before point T2. Consequently, at present, we inferred that source area of the groundwater could be at far south-western part in the upper stream region of River Kumatani, and from there groundwater flows to the north-east direction along fault scarp, then at the slide area recharges slides´ units widely, whose evidence is that the drainage boreholes of abundant water locate at the border of the slide units, and then after joined the Northern torrent at a lower stream region.

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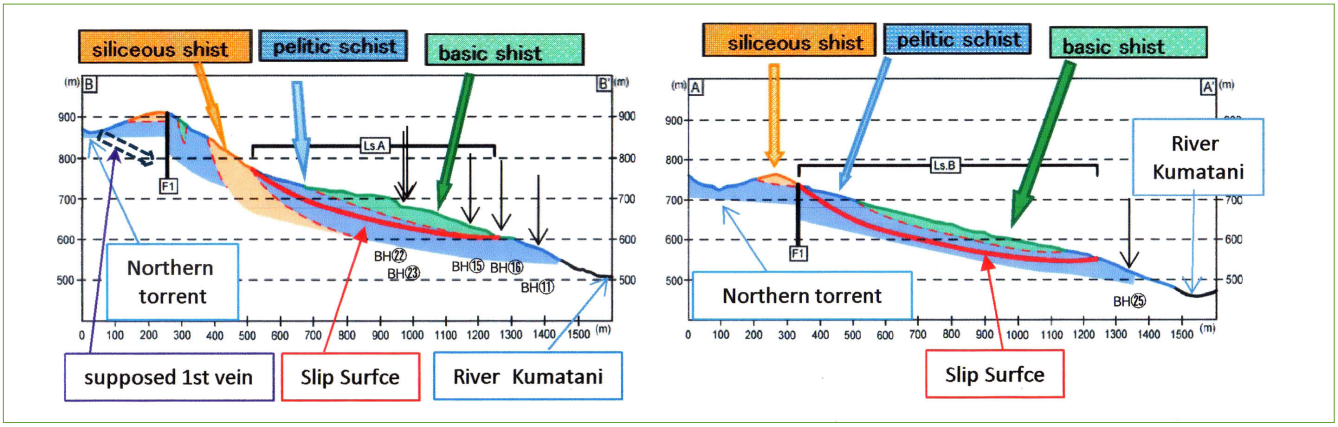

Figure 2. Transverse profile of A-A‘ and B-B‘ sections, geology, location of slip surfaces, supposed 1st vein, location of drainage boreholes.

KEYWORDS

Landslide; Groundwater vein; Hydrochemical analysis; Groundwater dating; Underground temperature survey

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