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新潟大学災害・復興科学研究所
共同研究報告書

沼沢火山におけるダム湖決壊洪水のダイナミクスの解明と災害マネージメント
Understanding Numazawa Breakout Flood Dynamics for Disaster Management

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研究要旨

After the temporary blockage of the Tadami River by an ignimbrite that originated from Numazawa Volcano (5,400 years ago), a consequent breakout flood swept the Tadami and Agano rivers, reaching the Niigata Plain more than 100 km downstream [1], in one complex event dominated by hyperconcentrated-flow transport. This flood was a single event and was characterized by mass transport of light volcanic pumice material. These materials can vary in density in contact with water, and change mode of transport during flowage due to water absorption in the pores. Because of those particularities, field investigation is essential to unveil the detailed dynamics of the event and how it flowed through the Tadami and Agano rivers. Completing previous research carried out from Niigata University, this collaborative research project investigated the internal structures of the pumiceous flood deposits at (1) the Tadami-Agano river confluence to understand the role of both the Tadami River and the Agano River in the flood propagation and transformation, and (2) near the Nozawa area to study the internal structure of the deposit, to increase detail knowledge about the flood event. The research method combined GPR (Ground Penetrating Radar) and GNSS (Global Navigation Satellite System) investigation. Collected data were processed to obtain images of the subsurface, from which inferences of the depositional pattern were assessed.

A. Aim of the study

The aim of the research was to expand the present understanding of how the breakout flood, which occurred 5,400 years ago, evolved during its flowage. The subobjectives were: (1) to confirm the flood extent as it has been previously described using mostly outcrops at different elevations along the valley slopes [1] and (2) to investigate the internal structure of the deposit to understand whether the confluence and the gorges caused an effect on the flowage and deposition patterns at the Nozawa site, and whether runup deposits could be found as the flood exited the Tadami River and entered the Agano River.

B. Methodology

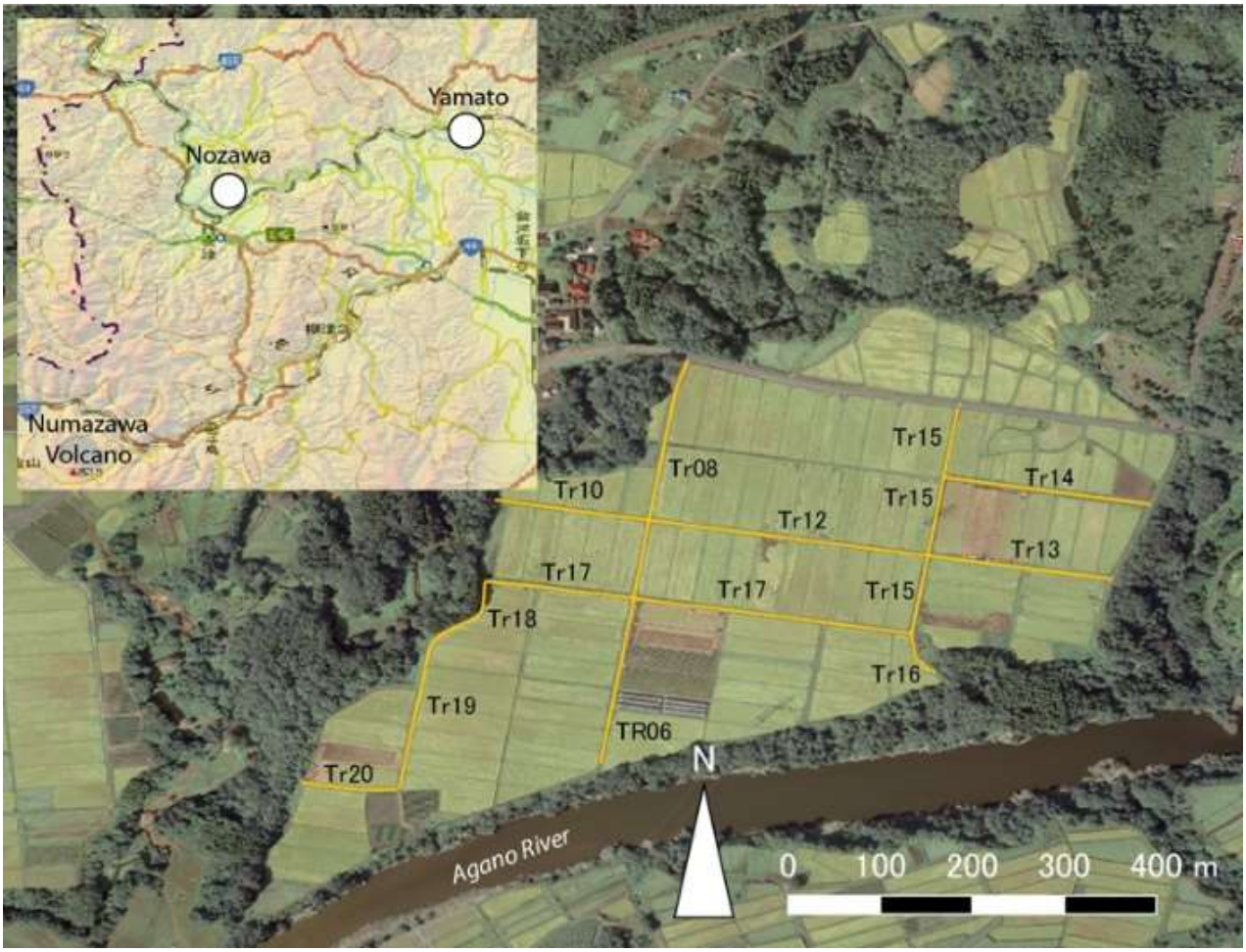

Fig 1 Yamato Location on the Agano River with the GPR transects

This study relied on the Ground Penetrating Radar (GPR) surveys at two areas along the Agano River: the Yamato and Nozawa sites (Fig. 1 & 2 respectively).

The GPR used in the present survey (Fig. 3) is the Pulse-Ekko Pro operated with 2 sets of unshielded antennas at 100 MHz and 200 MHz. The GPR was coupled with a GNSS-PPK (Global Navigation Satellite System - Post-Processing Kinematic) of one antenna mounted on a pole 1 m over the GPR. Another fix-GPR antenna was also set in the field. The most radargrams were collected on surfaces close to the horizontal.

Fig 2 Nozawa Location and GPR transects

Fig 3 GPR unit mounted with the GNSS.

After collection, the radargrams were processed and corrected using : DEWOW to remove excess illumination, then the loss of energy was compensated using an energy-loss function plotted over the travel time, and the signal was enhanced by increasing the gain. Then the signal was processed using an average subtraction over 100 traces to suppress any ringing effect that would create horizontal banding. Topography obtained from GNSS-PPK was then inserted, and time converted to depth based on the Common Mid Point (CMP) method.

C. Results

Results at the Nozawa site have shown the presence of a paleotopography partly filled up by sets of horizontal layers, with the presence of buried terraces (Fig. 4).

At the Nozawa site, the radargrams have displayed typical elongated layers that have a semi-horizontal architecture with long-wavelength across several hundred meters. Those results are concordant with the radargrams collected upstream in the Tadami River, where the flood deposits display similar facies (as confirmed from the outcrop analysis).

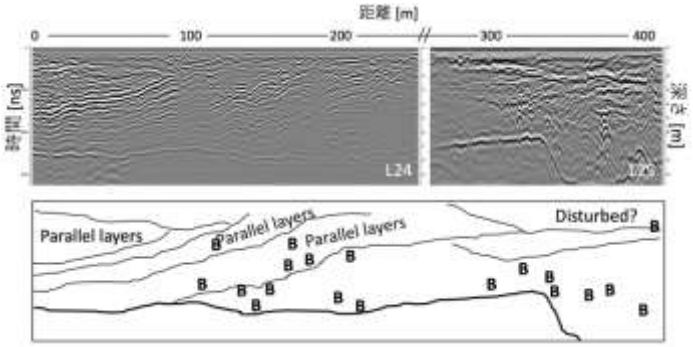

Fig 4 Radargram showing buried terrace nose.

D. Discussion

The structure detected by GPR confirms outcrop analysis [1]. The subhorizontal layers are very different from the typical Newtonian flows or debris-flow structures as it has been shown at volcanoes with higher-density material [2].

E. Conclusions

The results confirm that the Numazawa flood did occur as a progressive and continuous process without any interruption over several hours. Despite the extent of the deposits, it did not occur as a simple waxing-waning type flow with a sharp peak discharge, rather the flow may have had a prolonged peak period during it traveled. It also shows that nor the confluence nor the narrow sections of the valley did not influence the deposition. The valleys were chocked by sediments but not in a wave and waning type event but a long and progressive event. Further investigation downstream of Nozawa is still necessary to attempt finding a threshold as per when the flow started to change and whether it became more diluted flow before entering the Niigata Plain.

References

[1] Kataoka et al., 2008. GSA Bulletin 120, 1233-1247.

[2] Gomez et al., 2018. J. Volc. Geotherm. Res. 353