

Possible Geological Cause of Rock-Ice Avalanche on Langtang Lirung and "Geopark" Approach to Devastating Disasters in Japan

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Abstract: A possible geological cause of the rock-ice avalanche that occurred on Langtang Lirung on August 26 2026 is hydrothermal alteration associated with the intrusion the Miocene leucogranites. To understand geohazards in the Himalayas, it is important to comprehend not only the rapid glacial melting caused by global warming, but also the geological processes of uplift and collapse in the mountain range. In Japan's Geoparks, past devastating disasters are key theme. To coexist with the diverse geohazards of the Himalayas, the "Geopark" approach is crucial, and engineering geology is expected to play a foundational role.

Keywords: Himalaya, Hydrothermal alteration, leucogranite, Rock-ice avalanche, Geopark

Introduction

On 26 August 2026, a catastrophic debris flow and flood was triggered by a giant rock-ice avalanche on Langtang Lirung, near Nepal and Tibet border. This debris flow and flooding travelled nearly 100 km and impacted populated areas downstream along the Lende Khola and Trishuli Rivers. This paper will estimate the geological cause of rock-ice avalanche on Langtang Lirung, and introduce examples of Geoparks in Japan that pass on such rare but devastating disasters to future generations and utilize them for disaster education.

Possible geological cause of rock-ice avalanche on Langtang Lirung

The video took by Dr. Guoxiong Zheng shows the disaster area from the source of the ice-rock avalanche (Fig.1). Although the surrounding bedrocks are fresh and black in color, the slip surface is nearly vertical and brown in color. This brown slip surface suggests the effect of hydrothermal alteration, because the source area of rock-ice avalanche is located in the Higher Himalaya where chemical weathering is hard to occur.

The source area of rock-ice avalanche is located at Langtang Lirung where the Miocene leucocratic granite emplaced into the Higher Himalayan high-grade metamorphic rocks. The hydrothermal alteration must be caused by the Miocene granitic magmatism. A tatopani (hot spring) which is located about 5

kilometers south of Nepal and Tibet border suggests the effect of hydrothermal activity associated with the Miocene granitic magmatism.

Hydrothermal alteration as geological causes of deep-seated landslides

Hydrothermal alteration associated with the Miocene granite is a contributing factor to deep-seated landslides in the Himalayas. Furthermore, the Miocene leucogranites distributed in Higher Himalayan Zone have played important roles in mountain building and engineering geology. Upheaval of the Higher Himalaya are closely related to the Miocene leucogranites. The Miocene leucogranites in the Higher Himalaya are inferred to be tips of icebergs.

The occurrence of many hot water springs in Higher Himalayas (Bhattarai, 2020) indicate are closely related to the Miocene leucogranites. The comparatively low cooling rate of leucogranite could be a thermal source of such hot spring.

Rainfall-induced large-scale landslide occurred at Jure along Arniko Highway in 2014. Hydrothermal alteration is recognized along joints of meta-sandstone. Quartz crystals are observed in quartz vein which suggests the Miocene volcanism. The Sunkoshi River is known as placer (sandy gold) mining which is related to quartz vein formed by the Miocene magmatism.

Hasegawa et al. (2009) have suggested that the substantial hydrothermal alteration in the central Nepal had been caused by during and after the advancement of the MCT. Clay mineralization in sliding zones of large-scale landslide are the main causes of large-scale landslides. This hydrothermal alteration is estimated as the results of the Miocene magmatism.

Kambara Debris Avalanche and Teimei Mudflow caused by Eruption of Asama Volcano in 1783

Although Japan has no large-scale glaciers, a similar disaster occurred at Mt. Asama in 1783. Mt. Asama (2,568 m), located approximately 200 km northwest of Tokyo, is one of Japan's most prominent active

volcanoes. The Tenmei eruption in 1783 was a massive magmatic event that caused catastrophic damage—including pyroclastic flows, debris avalanches triggered by the collapse of lava flows, and extensive debris flows and floods resulting in a death toll exceeding 1,500 people.

Kambara Village is known for having been virtually destroyed by the debris avalanches at that time. 477 people approximately 80% of the village's population lost their lives. Furthermore, the debris avalanche dammed the Agatsuma River (a tributary of the Tone River) and the subsequent collapse of the resulting dammed lake unleashed a massive debris flow (mudflow) that caused catastrophic damage as far as 100 kilometers downstream, while the floodwaters reached as far as Edo (Tokyo), 200 kilometers downstream.

The people of Kambara rebuilt their village on the buried land over a hundred years through a combination of self-help, mutual aid, and public assistance. Although nearly 240 years have passed since the disaster, the community continues to honor the memory of the 1783 debris avalanche and pass down its story in the form of nenbutsu (Buddhist chanting). Furthermore, descendants of the 93 survivors formed an organization called the Hoshikai (Service Association) to ensure that the history of the disaster and the village's recovery is handed down from generation to generation.

In 2016, the region at the northern foot of Mt. Asama Northern area was certified as a Japan's Geopark. The Mt. Asama North Geopark comprises six areas, along with 39 geo-eco-cultural sites and viewpoints. Tsumagoi Local History Museum features exhibits centered on the 1783 eruption that buried Kambara Village due to debris avalanche. The Yamba Tenmei Mudflow Museum features exhibits based on archaeological findings from a village buried by the "Tenmei Mudflow" (debris flow) triggered by the massive 1783 debris avalanche. Visitors can learn the reality of the disaster, the lives of the people just before they were buried, and how they responded to the sudden attack of the debris flow.

Turning devastating disasters into Geoparks - examples from Japan-

UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development. A UNESCO Global Geopark uses its geological heritage, in connection with all other aspects of the area's natural and cultural heritage, to enhance awareness and understanding of key issues facing society, such as using our earth's resources sustainably, mitigating the effects of climate change and reducing natural hazard-related risks.

Unzen Volcanic Area Geopark in Kyushu Island is one of the first UNESCO Global Geoparks in Japan. Coexistence of People and the Volcano" is the main feature of the Geopark. One of the main attractions is Mt. Heisei Shinzan, the newest volcano in Japan, along with the reconstruction process following the disasters caused by its eruption from 1990 to 1995. The large-scale pyroclastic flow that occurred from Heisei Shinzan on June 3, 1991, and claimed the lives of 43 people.

Coexistence with natural disasters and the tale of rich land is the main feature of Mt. Kurikoma Area Geopark in Tohoku district. Numerous large-scale landslides were caused by the 2008 Iwate-Miyagi Inland Earthquake. This Geopark aims to develop community sustainably by utilizing volcano and landslide topography on education, academic research, tourism, and disaster risk reduction.

Conclusion

1) A possible geological cause of the rock-ice avalanche that occurred on Langtang Lirung is hydrothermal alteration associated with the intrusion of the Miocene leucogranites.

2) To understand geohazards in the Himalayas, it is important to comprehend not only the rapid glacial melting caused by global warming, but also the geological processes of uplift and collapse the mountain range.

3) In Japan's geoparks, past devastating disasters are key theme. To coexist with the diverse geohazards of the Himalayas, the "geopark" approach which views the region holistically, starting with its geological origins is crucial. Thus, engineering geology is expected to play a foundational role in this regard.

Acknowledgment

We would like to thank those who cooperated with our research works, especially Prof. Atsuko Nonomura of Kagawa University, Dr. Manita Timilsina of Geotech Solutions International.

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