

Sector Collapse of Inagodake in Kita-yatsugatake Volcano and Landslide dams outburst disasters

Kimio Inoue^{1*}

¹Sabo Frontier Foundation

1. Introduction

Yatsugatake Volcano in Nagano Prefecture was violently shaken by an earthquake on 22 August, 887, which caused a large-scale sector collapse (Ishibashi, 2000, Inoue, 2010). The collapse flowed down the Otsuki River in the form of a large-scale debris avalanche and blocked the Chikuma River upstream of the Shinano River, forming a gigantic landslide dam. In the area from Sakudaira to Nagano Basin along the Chikuma River, Ninna Flood sand covered rice paddies and houses.

2. Topographical feature of large-scale landslide dams

This disaster is mentioned in many historical materials, including records from the 887 earthquake and from the flood disasters of 888. These materials can be interpreted to show that on 22 August 887, in addition to the disaster caused by a violent earthquake (mega ocean-trench earthquake) that affected most of the main Japanese islands, a massive collapse occurred in the Yatsugatake Volcano, which blocked the Chikuma River and resulted in the formation of a huge landslide dam. Subsequently on 20 June, 888 (303 days later), the landslide dam collapsed, causing a heavy flood that washed away both houses, castles.

The altitude of the river bed at point of the river channel blockage was 1000 m above sea level. Debris including avalanche sediment present along the Otsuki River and there are many mudflow hill landforms and lakes including Lake Matsubara, resulting from the debris avalanche. Considering the existing of extrusive landforms such as mudflow hills near Lake Matsubara, I estimated an inundation height of 130 m and volume of 580 million m³, which would make it one of the largest landslide dams known to have occurred in Japan. This landslide dam formed along the Chikuma River and had an extremely large inundation volume, which gradually collected water for about ten months. The dam eventually became filled during torrential rainfall in the rain season. It suddenly failed 303 days later, caused a secondary debris avalanche. The water collapse behind the landslide dam flowed for over 100 km down the Chikuma River, which resulted in flooding and the deposit on the Ninna Flood sand (Kawasaki, 2010).

The landslide dam failure caused a secondary debris avalanche, which blocked the Aiki River near Koumi and formed Old Lake Aiki, which remained for over 600 years. Although Old Lake Chikuma 1 collapsed, Old Lake Chikuma 2 (50 m height) existed for 123 years. Various place-names related to the lake; including Uminokuchi (enter the lake), Umijiri (exit the lake) and Koumi (small lake) still exist in the upper reaches of the Chikuma River. These names could be constructed as records of the landslide dam.

3. Sector collapse in the Kita-Yatsugatake and mega moved rock body in Inagodake

Kawachi (1983) suggested that the collapse of the eastern flank of Yatsugatake Volcano resulted in the formation of a horse-shaped caldera of 2.25 km in north-south length, 3.5 km in east-west length and 350 m in maximum relative height and estimated that the sediment from the Otsuki River debris avalanche amounted to 350 million m³. We later estimated the volume of the horseshoe-shaped caldera as over 1 billion m³ and postulate that this landform was a repeated debris avalanche as large as that which occurred in 887, along with volcanic activity.

Mt. Inagodake remains at the head of the caldera as a massive moved rock body, with an approximately 1000 m long axis, 200 m height, and 140 million m³ in estimated volume. This moved rock body may have been formed at the time of the sector collapse in 887. Alternatively moved rock mass may have existed earlier and the sector collapse may have occurred on a large scale that included is almost completely separated from the bedrock and may collapse significantly in the future as a result of earthquake activity, or post-volcanic activity. Consequently, we had to investigate the situation of mega moved rock body in Inagodake by GPS.

Keywords: Yatsugatake, Inagodake, sector collapse, landslide dam, debris avalanche