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Prehistoric and 1933 debris avalanches and associated eruptions of Harimkotan Volcano (Kurile Islands)

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INTRODUCTION

On the Earth the most voluminous failures occur on active volcanoes. Failured material transforms in a fast moving debris avalanche that spreads on a distance that can exceed 100 km. Impact of debris avalanche into a sea produces tsunami. Failures on active volcanoes are usually accompanied by strong explosive eruptions. Such as a lot of volcanoes are located in densely populated areas these events belong to the most dangerous natural phenomena. First direct evidence of this was provided by the famous 1980 eruption of Mount St.Helens (Cascade Range, USA). In 20th century large scale failures of volcanic edifices also occured during the strong explosive eruptions of Harimkotan, Bezymianny and Shiveluch volcanoes that are situated in Kurile-Kamchatka region. Harimkotan (Severgina) volcano is a small uninhabited island (10 km across) in the northern part of Kurile arc. First descriptions of the 1933 eruption were made by Miyatake [1934] and Gorshkov [1967]. We report the results of recent investigations of deposits of 1933 and ancient debris avalanches of Harimkotan volcano that occured more than 5 times during the last 10 000 years of its history. Deposits of two events (1933 AD and 2000 BP) are well preserved and were studied in detail.

1933 DEBRIS AVALANCHE AND ASSOCIATED ERUPTION

The first event of January 8, 1933 eruption was the edifice failure with a volume about 0.5 cub. km that occured in the eastern direction. The entry of the debris avalanche into Pacific ocean was the reason of tsunami up to 20 m high. Victims of this tsunami were woman and child lived al the nearby island. As a result of the failure the pre-1933 shoreline was extended to 1 km. Hummocky avalanche deposit formed a broad fan with an area of 20 sq. km. The heights of hummocks are 3-15 m. The distinctive hummocky topography forms multiple lakes along eastern coast beyond pre-1933 shoreline. Avalanche deposit is represented mostly by coarse-grained, unsorted debris of strongly altered andesite of volcanic dome that existed before 1933 failure. Most of the avalanche is composed of block facies. Mixed facies forms a layer with a thickness up to 1 m along the lower contact of the avalanche deposit. A layer of relatively well sorted, normal graded yellow-grey sand with a thickness 10-30 cm rests in the upper part of avalanche deposit. Origin of this layer was probably connected with "dust cloud" rising above the avalanche during its motion. Sector failure was followed by strong explosive eruption that continued till January 12, 1933. At first pyroclastic flows of dacitic pumice with a volume 0.03 cub. km were deposited on the debris avalanche. They covered an area 6 sq. km on the surface of avalanche with a thickness 1-10 in. After deposition of pyroclastic flows a Plinian eruption started. It left a layer of coarse pumice with a thickness up to 1 m and a total volume about 1 cub.km. Fallout tephra was

emplaced at the northern sector of volcano. As a result of this eruption a horseshoe-shaped crater 1.7 km across breached to the east was formed and the height of the volcano was diminished from 1213mto 1145 m. After that a volcanic dome was extruded in the crater. Its growth occured during several months and accompanied only by weak explosive activity without generation of pyroclastic flows. The pre-1933 topographic map clearly shows that old horseshoe-shaped crater opened to the east and partially filled by dome existed before 1933. There are several outcrops where ancient debris avalanche deposit underlies the 1933 deposits. The C14 age of this event is estimated as 1100 BP on the base of dating of well-traced fallout tephra of eruption that probably was connected with this failure.

NORTH-WESTERN DEBRIS AVALANCHE AND ASSOCIATED ERUPTION

Partly buried horseshoe-shaped crater and distinctive hummocky topography with multiple lakes near shoreline are also well detected at the north-western sector of Harimkotan volcano. The sector failure of north-western slope and associated eruption occured in 2000 BP according to C14 dating of peat covering the debris avalanche deposit. Scale and characteristics of north-western debris avalanche are similar with the 1933 one. Heights of gently sloping hummocks arel5-20 m. NW debris avalanche is mostly composed of block facies. A discontinuous layer of yellow-grey normal graded wave-laminated sand with a thickness up to 10-60 cm mantle the upper part of the avalanche. Possibly it was deposited from "dust cloud" rising above the avalanche. Plinian eruption followed this failure. Coarse fallout pumice of this eruption distributed around the island and its maximal thickness is up to 1.5 m in the NW direction. Pyroclastic flows with a thickness up to 2 m were erupted in the final stage of eruption.

VOLCANIC HAZARD

Harimkotan is a very active volcano. Multiple thick coarse-grained layers of fallout pumice in outcrops around the volcano are the evidence of its frequent strong explosive eruptions in Holocene. Historical eruptions took place in 1713, 1846, 1848, 1883. 1931 and 1933. Volcanic ash of eruptions at Harimkotan volcano provides serious hazard for airplane traffic, which is very intensive in this region. In spite of severe hazard of debris avalanches these events would have no direct impact on human population because Harimkotan island is uninhabited. The indirect hazard of these events is tsunamis caused by the entry of debris avalanches into the sea. Tsunamis can “transport” the hazard at large distances to nearby islands.

CONCLUSIONS

Sector failures accompanied by strong explosive eruptions and tsunamis occured repeatedly at Harimkotan volcano. The frequency of debris avalanches at Harimkotan volcano is comparable with highest currently known frequency of avalanches that found at Mount St. Augustine - small voicano-island in Alaska (Siebert *el at.*, 1989). Volcanic ash of eruptions at Harimkotan volcano can provide serious hazard for airplane traffic.

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