DEBRIS AVALANCHE OF THE 19S6 BEZYMIANNY ERUPTION

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Bezymianny is one of the volcanoes of the Klyuchevskoy volcanic group located in the central part of the Kamchatka peninsula. Until 1955 the volcano was considered extinct. In the historic time (in this region beginning from 1697) the volcano did not exhibit the signs of activity. According to tephrochronological studies the latest eruption at the volcano occurred about 1,000 years ago (Braitseva and Kirianov, 1982). Before the catastrophic eruption of 1956 this was a stratovolcano 3.085 m high composed of basaltic andesites and andesitic dacites. Several extrusive domes were observed in the crater and on the slopes of the volcano.

The volcano manifested its activity in 1955. From September 29 frequent local earthquakes under volcano were recorded. On October 22 the eruption started. Before March 30, 1956 ash outbursts occurred with a height occasionally exceeding 6 km. During this period a crater with a diameter of 500-600 m was formed at the summit. At the end of January an extrusive dome started to form in the crater. Concurrently with the explosive activity bulging of the south-eastern slope took place. The deformations estimated from photographs constituted about 100 m.

On March 30, 1956 a catastrophic directed blast occurred. As a result a horseshoe-shaped crater 1.5x2.8 km in size opened to the south-east formed at the summit of the volcano. The volume of the thrown part of the volcanic edifice was 0.74 km^3 (Seleznev et al., 1983). The explosive cloud rose to a Height of 35-40 km. After the blast a Plinian eruption commenced forming lengthy pyroclastic flows. The juvenile products are hornblende andesites. Based on studies of this eruption' G.S.Gorshkov and G.E.Bogoyavlenskaya singled out a new independent type of eruptions- a "directed blast" type. A specific type of deposits produced by such eruptions was also identified. Directed blast deposits consist of two facies which were . called "directed blast sand" and "directed blast agglomerate".

"Directed blast sand" covered an oval-shaped area about 500 km^2 located at the eastern foot of the volcano. The distribution of "sand" generally coincided with the region devastated by the explosion. The thickness of "sand" was about 7 0 cm near the volcano gradually decreasing with distance to 1 cm. The deposits represent a gravel-sand mixture of juvenile and resurgent -material and scattered rock fragments up to 20 cm across. The volume of "sand" was estimated as 0.2 km^3.

The "directed blast agglomerate"deposits are generally represented by resurgent material of the old volcanic edifice. The deposits tend to occur close to the axis zone of the directed blast region. Earlier these deposits were considered as part of the volcanic edifice thrown by the explosion. Proceed from this, G.S.Gorshkov estimated the velocities (360-500 m/s) and pressure (up to 3 Kbar) necessary for such outburst (Gorshkov and Bogoyavlenskaya} 1965).

In recent years the interest to the March 30, 1956 Bezymianny eruption arose in relation to Mount St. Helens eruption. One of the most interesting problems was the one about the manner of transportation of the "agglomerate" material from the volcano to the place of its deposition. The earlier interpretation (thrown by explosion) seemed doubtful for the following reasons:

- the air waves recorded during the eruption could not be generated by the explosion to perform such an outburst (Adushkin et al., 1984);
- very high pressure and velocities are needed to implement such a large-scale outburst;
- the formed "directed blast agglomerate" deposits resembled debris avalanche deposits.

In this connection investigations of the Bezymianny directed blast deposits continued. The success was provided by deep erosion that cut the pyroclastic flow deposits which earlier nearly completely overlaid the "agglomerate" deposits. The work resulted in obtaining the following data: the great bulk of the "agglomerate" deposits is located in three large river valleys which take start on the southeastern slopes of the volcano. The deposits form three branches: the southern (area 4.5 km^2, volume 0.04 km^J) , central (area 29. S km^2, volume 0.4 km^3), and northern (area 2 km^2, volume 0.06 km^3).

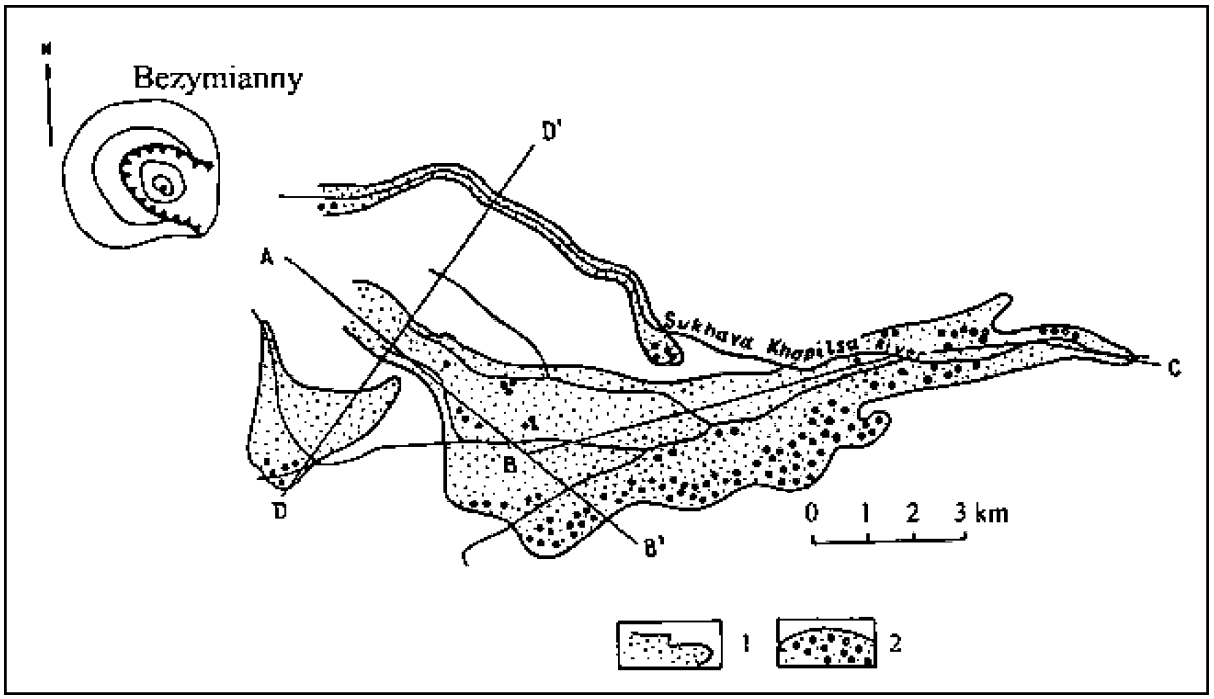

Fig. Sketch map showing the debris avalanche deposits ("directed blast agglomerate") of the March 30, 1956 Bezymianny eruption.1- boundary of the debris avalanche deposits; 2- regions of "agglomerate" deposits on uplands.

The largest central branch extends for 22 km from the volcano. Partly the "agglomerate" is deposited on uplands.-This was observed at places of abrupt turns of river valley where the "agglomerate" is deposited. The amplitude of the material run up reaches 200 m. The deposits have a typical hummocky surface. Most hummocks are nearly conical in shape, generally 2-10 m high. The "agglomerate" deposits consist of lenses up to 100 m in size, composed of strongly crushed but not mixed and commonly petrographically homogeneous (within the limits of the lense) material of the old volcanic edifice. Frequently these lenses are separated by "agglomerate" with admixture of soil and rocks from the foot; admixture of juvenile material may also be present. The materials of the "agglomerate" are commonly fractionated to gravel-sand condition. The predominant size of angular fragments presented is 5-40 cm and does not exceed 1-1.5 m. The thickness of the "agglomerate" deposits is 3-30 m. The largest thickness is observed in deep canyons and depressions. "Agglomerate" deposits lie on various older deposits and commonly are overlaid by "directed blast sand" and/or by pyroclastic flow deposits.

The given characteristics of the "directed blast agglomerate" deposits are similar to those of the debris avalanche deposits described in volcanological literature, especially the debris avalanche of Mount St. Helens. The distinguishing feature of the Bezymianny deposits is high degree of fractionation of material

due to which megablocks are practically absent. Instead, large lenses of commonly petrographi-cally homogeneous material composed of gravel and sand with angular rock fragment inclusions are present.

Using the value of the material run up Cup to 200 m) at the places of valley turns and formula $v=(2gh)^{1/2}$, we can estimate the velocity of "agglomerate" transportation (h- the height of material run up, g- free fall acceleration). It was found to be close to 60 m/s. The vertical drop (H) vs the travel distance (L) ratio is 0.12 for the "directed blast agglomerate" deposits. This implies that mobility of "agglomerate" during migration was similar to the mobility of debris avalanches of volcanic origin.

Conclusions

1."Directed blast agglomerate" of the 1956 Bezymianny eruption is debris avalanche deposits with parameters given in the Table:

Travel distance (km)	Thickness (m)	Area (km^2)	Volume (km^3)	H/L	Velocity (m/s)
22	3-30	36	0.5	0.12	60

2.Analysis of the relationship between the "directed blast agglomerate" deposits and other types of deposits from this eruption allows us to suggest the following succession of the eruptive events during the March 30, 1956 Bezymianny eruption:

a) formation of debris avalanche;
b) catastrophic directed blast proper;
c) Plinian activity and formation of pyroclastic flows.

References

Adushkin V.V., Gostintsev Yu.A., and Firstov P.P., 1984. On the origin of air waves during violent explosive eruptions. Volc. and Seis., No 5, p. 3-11 (in Russian).

Braitseva O.A. and Kirianov V.Yu., 1982. On the past activity of Bezymianny from tephrochronological data. Volc. and Seis., No 6, p. 44-55 (in Russian).

Gorshkov G.S. and Bogoyavlenskaya G.E., 1965. Bezymianny volcano and features of its latest eruption (1955-1963). Moscow: NAUKA (in Russian).

Seleznev V.I., Dvigalo V.N., and Gusev N.A., 1983. Development of the Bezymianny volcano from the stereophotogrammetrie data obtained during aerial survey in 1950, 1967, and in .1976-1981. Volc. and Seis., No 1, p.52-65 (in Russian).