Seismic Studies of Piip Crater Break-through *

S. T. BALESTA and A. I. FARBEROV

Abstract

To establish the structure of volcanic vents in adventive craters, seismic studies have been carried out on Piip crater break-through formed in October-December 1966 on the northern flank of Kliuchevskoi volcano.

The studies were carried out by refraction method on longitudinal and nonlongitudinal profiles. An approximate seismic section has been obtained together with several refracting horizons. An injection area of magmatic melt is established and its size in plan is 100 × 40 m, which is identified with the upper part of the channel feeding Piip break-through with magma. By parametric measurements on an incandescent lava flow the longitudinal wave velocities V = 750-850 m/sec have been computed. Special investigations established an area of microearthquakes located on the northern extension of explosion funnel line.

At the present time there is no common concept on the mechanism of adventive crater formation of Kliuchevskoi volcano. To establish the structure of volcanic vents of adventive craters, seismic studies have been undertaken in April, 1967 on Piip break-through formed during October-December, 1966 on the northern flank of Kliuchevskoi volcano. The purpose of the studies was:

1) to determine the possibility of using the seismic method in studying the structure of the break-through;

2) to study the travelling of seismic waves through the area of magma injection.

The studies were done by means of a seismic prospecting station CC-2411 and seismic detectors HC-3. On account of a complex dissected relief a method of mobile shooting stations was used. Ow-

* Paper presented at the 14th General Assembly of IUGG, IAVCEI Session, Symposium on Physical Volcanology (Zürich, Sept. 1967) and accepted for publication by the organizing committee.

ing to the given tasks a network of longitudinal and nonlongitudinal profiles has been given intersecting the explosion funnels and the cone of the adventive crater (Fig. 1).

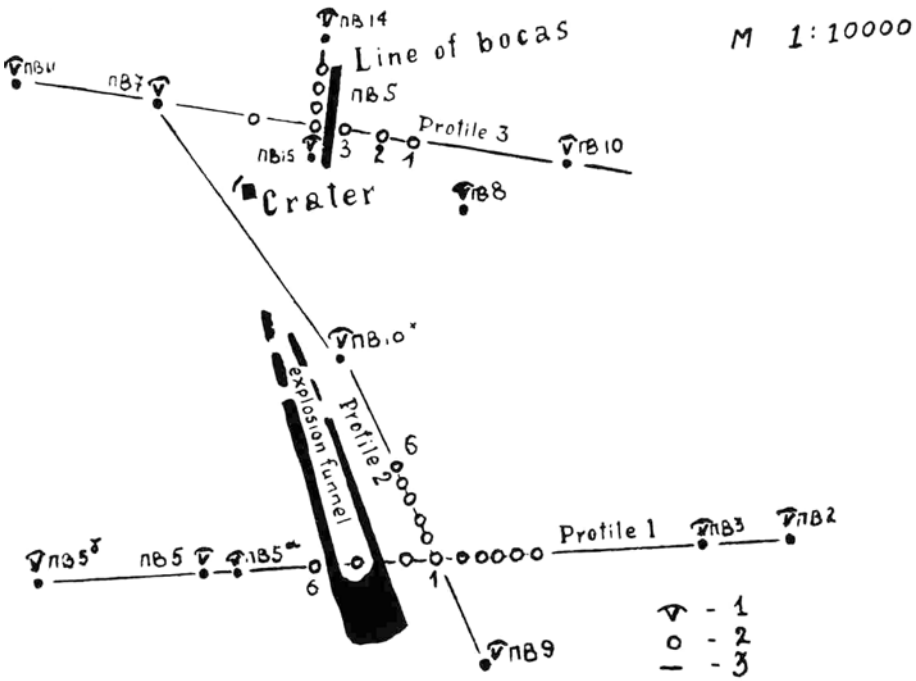

FIG. 1 - Scheme of seismic profiles.
1. explosion points - 2. location of instruments - 3. seismic profiles.

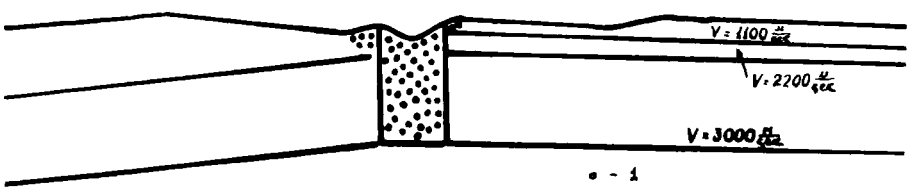

FIG. 2 - Seismic section along profile 1.
1. break-through fracture.

Profile 1 was laid out across the line of explosion funnels, profile 2 — through the cone of the adventive crater, profile 3 — across the line of lava boccas.

The seismic section along profile 1 is shown in Fig. 2. The character of seismic wave propagation along the upper refracting horizon (depth 25-30 m, V = 1100 m/sec) and lower refracting horizon (depth 120-130 m, V = 3000 m/sec) is essentially different. For the waves propagation along the upper refracting horizon much weaker signals are recorded on instruments located on the other side of the funnels in respect to the explosion point. At the explosion on the opposite side a reverse picture is observed: the wave signal becomes weaker on the instruments that had a « normal » level of recording in the preceeding case (Fig. 3). Besides the wave to these instruments comes

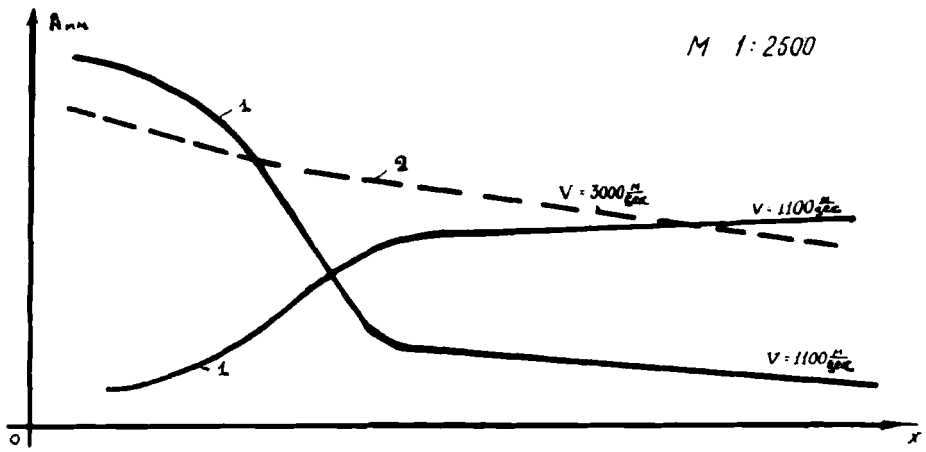

FIG. 3 - Amplitude diagrams for longitudinal waves in profile 1.
1. amplitude diagrams of waves from the upper refracting horizon.
2. amplitude diagram of waves from the lower refracting horizon.

with a considerable delay of 0.02-0.03 sec, which can indicate the presence of an area with lower velocity of longitudinal waves under the funnels. Along the lower refracting horizon the attenuation of seismic waves is « normal » (Fig. 3). In the profile 3 there is a similar picture of seismic wave attenuation along the two refracting horizons.

The examined kinematic and dynamic features in the records of longitudinal seismic waves in profiles 1 and 3 allow us to assume that the injection area of the magmatic melt under the upper explosion funnels along the flank and under the lava boccas does not extend beyond the lower refracting horizon.

Profiles 1 and 3 have been also used as nonlongitudinal at the explosions from stations 7,8 and 5,3 correspondingly. During this studies on the seismographs located on the opposite side of the crater break-through relatively to the explosion point a considerable weakening of waves was observed; these waves travelled along the lower refracting horizon.

On the longitudinal profile 2 at an explosion behind the adventive crater cone there is also a strong attenuation of waves associated with the lower refracting horizon. The pattern of seismic wave at-

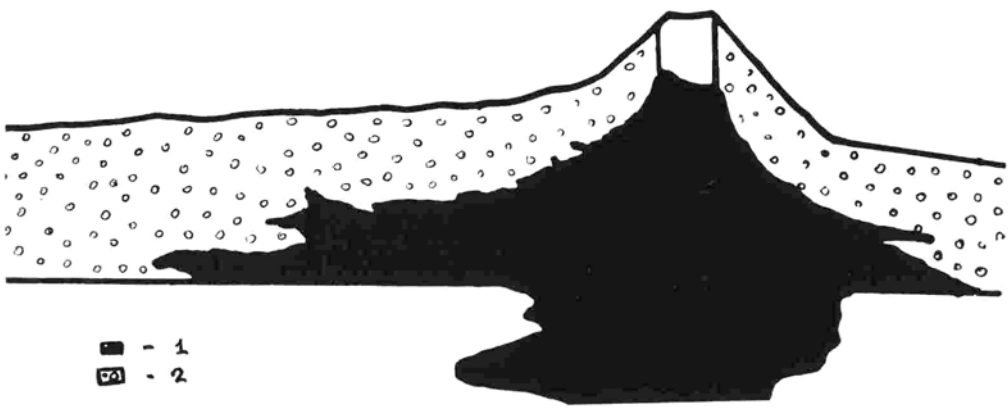

FIG. 4 - Schematic section in the plane of the break-through fracture.
1. lava injection - 2. pyroclastic material.

tenuation observed on nonlongitudinal profiles (1 and 3) and on the longitudinal profile 2 allows us to speak about magmatic melt injection that broke through the lower refracting horizon. The injection area elongated along the break-through line with a size in plan of 100 × 40 m, represents apparently the upper part of the incurrent channel feeding Piip crater break-through with magma (Fig. 4).

Parametric measurements of the longitudinal wave velocity have been made on a flat portion of the surface of the incandescent lava flow (thickness of the cooled crust 20-30 cm. Apparently the obtained values V = 750-850 m/sec can be explained by the « granular » texture of the upper part of the incandescent lava consisting of separate particles of a rounded shape with dimensions of 5-20 cm. By the data on seismic wave attenuation in profiles 1 and 3 the viscosity coefficient has been calculated on the assumption that the abnormal

attenuation is mostly determined by viscosity losses during the propagation of the waves through the magmatic melt. The viscosity coefficient is equal 0.6×10^{10} poise.

By means of directed explosions the *SH* waves have been obtained and a possibility in principle has been proved of investigating the structure of the crater break-through by this type waves.

Highly sensitive seismic instruments permitted to determine a low seismic activity of Piip crater break-through. By special investigations an area of strongest microearthquakes has been established located on the northern extension of the line of explosion funnels.

Manuscript received February, 1968