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## **Determination of the explosion energy in some volcanoes according to barograms.**

(With 3 text-figures)

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With the development of volcanophysical methods, qualitative descriptions of volcanic phenomena begin to be in a greater degree substituted by their quantitative characteristic. For evaluating one of the most important parameters of explosive eruptions — of explosion energy — there exist several methods. Most convenient and, perhaps, the more precise one among them is a determination of the explosion air wave energy according to records of barographs.

The air wave energy is evaluated according to Taylor's formula (5)

$$E = \frac{2 \pi \cdot RH \cdot \sin \varphi}{\rho_0 V} \int p^2 \cdot dt \quad [1]$$

where  $R$  is the globe's radius ( $2 \pi R = 4 \times 10^9$  cm);  $H$  — the height of the homogeneous atmosphere layer ( $1.3 \times 10^6$  cm);  $\rho_0$  — air density at the earth's surface ( $1.3 \times 10^{-3}$  g/cm<sup>3</sup>);  $V$  — sound speed ( $3.2 \times 10^4$  cm/sec);  $\varphi$  — distance from the explosion source in degrees;  $P$  — pressure;  $t$  — duration of vibration.

By substituting numerical signification of values entering into formula [1] by replacing in it  $P = A \sin \omega t$ , where  $A$  is the alteration of amplitude in pressure (expressed in meteorological millibars) and by intergrating, we reduce the Taylor's formula to

$$E_{(\text{ergs})} = 1.25 \times 10^{20} \sin \varphi \sum \frac{A^2 t}{2} \quad [2]$$

Here  $A$  is the amplitude of each separate half-wave on the barogram, whereas  $t =$  its duration.

Formula [2] allows to determine the energy of air waves according to barograms in a sufficiently rapid and precise way.

Thus, according to the barograph's record in Pulkovo (former

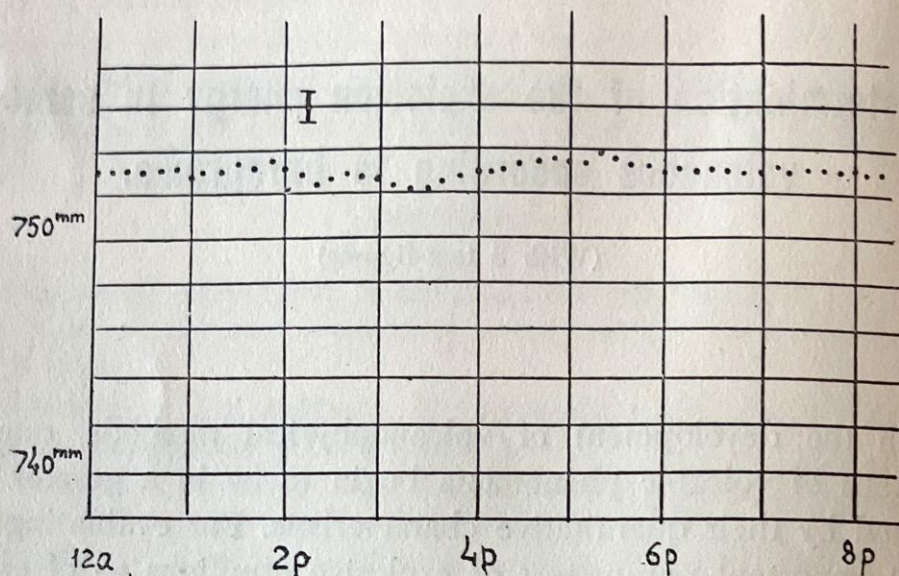


Fig. 1 - Record of the Krakatau explosion on August 27, 1883, Barogram of Pulkovo Station (4).

Pavlovsk) (fig. 1), situated at a distance of about 9.800 km from the isle of Krakatau, the energy of the air wave of the Krakatau explosion

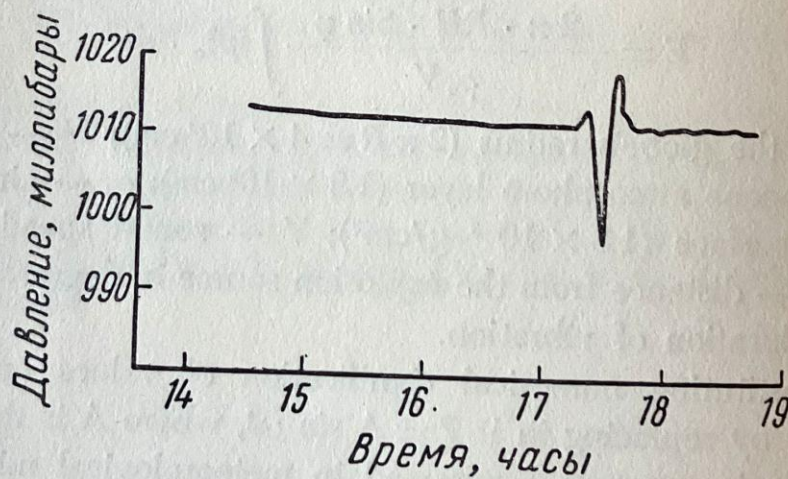


Fig. 2 - Record of the Bezymianny Volcano explosion on March 30, 1956, barogram of Kliuchi Meteorological Station (1).

on the 27 August 1883, is evaluated as  $8.6 \times 10^{23}$  ergs. The same value was calculated by PEKERIS (3). Air wave energy of the Bezymianny volcano explosion (30 March 1956) in Kamchatka according to the

record of the meteorological station Kliuchi (45 km from the volcano) was  $6.4 \times 10^{22}$  ergs (fig. 2); the mean of data, obtaining at eight stations situated at distances from 45 to 760 km, being equal to  $3 \times 10^{22}$  ergs. The barograph's record in Fort-de France (fig. 3) allows to evaluate the air wave energy during the explosion of the Mont Pelée Volcano on the 30th August 1902 as  $4.7 \times 10^{21}$  ergs.

Cited calculation allow to compare with sufficient precision these explosions in absolute or relative values; this would be impossible to do simply according to available descriptions.

The course of a direct definition of the air waves energy allows

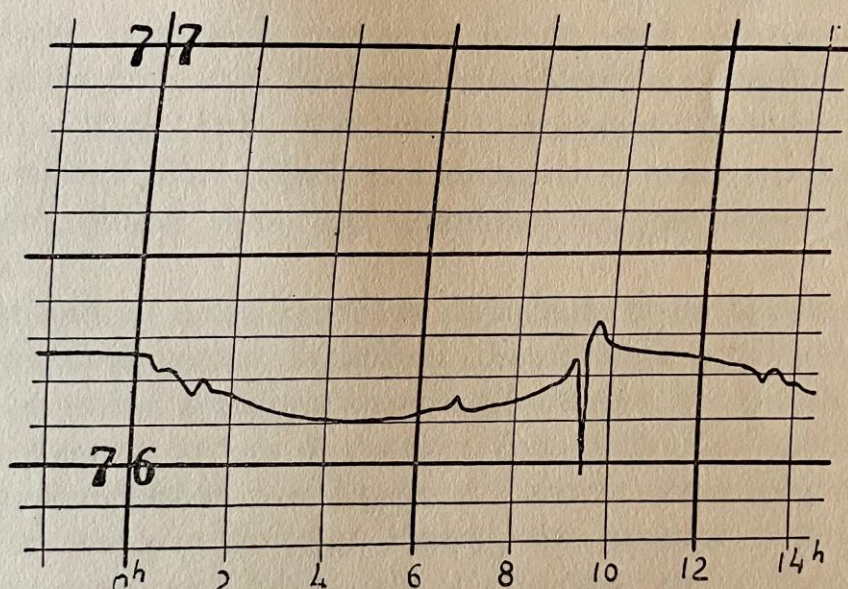


Fig. 3 - Record of the Mt. Pelée explosion on August 30, 1902, barogram of Fort-de-France Meteorological Station (2).

to compose a very simple classification for the strength of volcanic explosions in ergs or other power units, in which each subsequent class will differ from the previous one by one order of values. Thus, it will be possible to evaluate and to compare objectively explosive eruptions of very wide range.

Usual meteorological barographs make records of the air wave in powerful explosions at distances from several dozens up to 1000 km and more, and microbarographs — on the whole surface of the world.

We think rational the recommendation to equip volcanological stations and observatories with barographs and microbarographs. The former allow to record explosion waves of powerful close eruptions, the latter — of weak local explosions and powerful remote ones.

LITERATURE

1. GORSHKOV G. S. - *Gigantic eruption of the Volcano Bezymianny* - Bull. Volc., Ser. II, t. XX, 1959.
2. LACROIX A. - *La Montagne Pelée et ses éruptions* - Paris, 1904.
3. PEKERIS C. L. - *The propagation of a pulse in the atmosphere* - Proc. Royal Soc., London, Ser. A, Vol. 171, No. 947, 1939.
4. BYKATCHEW M. - *Note sur les ondes atmosphériques produites par l'éruption de Krakatoa* - Bull. Acad. Imp. Sc. de St.-Pétersbourg, t. XXIX, 1884.
5. WHIPPLE F. J. W. - *The great Siberian meteor and the waves, seismic and aerial, which it produced* - Quart. Journ. R. Meteorol. Soc., Vol. 56, No. 236, 1930.