550. 834

A SEISMIC SURVEY USING FORCITE BOMBS

by

J. Talvitie

Institute of Seismology, University of Helsinki

Abstract

The seismic survey was carried out in the summer of 1963 on the Obbnäs granite massif, an area where the granite was completely exposed and structurally sound as well as slightly oriented. The forcite bomb proved to be advantageous as an explosive material when detonated on top of glacially polished rock. The speeds achieved were greater in the direction of the oriented granite structure than at right angles to this direction.

Test location and its geology

To the south of Kirkkonummi church is situated the lengthy Obbnäs granite massif, which can be regarded as being anorogenic (Härme [1]). The test area was chosen from this granite massif at the place (Figure 1) where the topography is of level, completely exposed and glacially polished rock. The test area is devoid of faults or noticeable fractures. The granite is coarse-grained, homogenous in structure, and slightly oriented (directional dip $\sim 90°$). Microcline is found in the rock as large cyrstals, the general length of which is mostly about 3 cm. The main minerals are microcline, plagioclase (An_{25}), quartz and biotite (Laitala [2]).

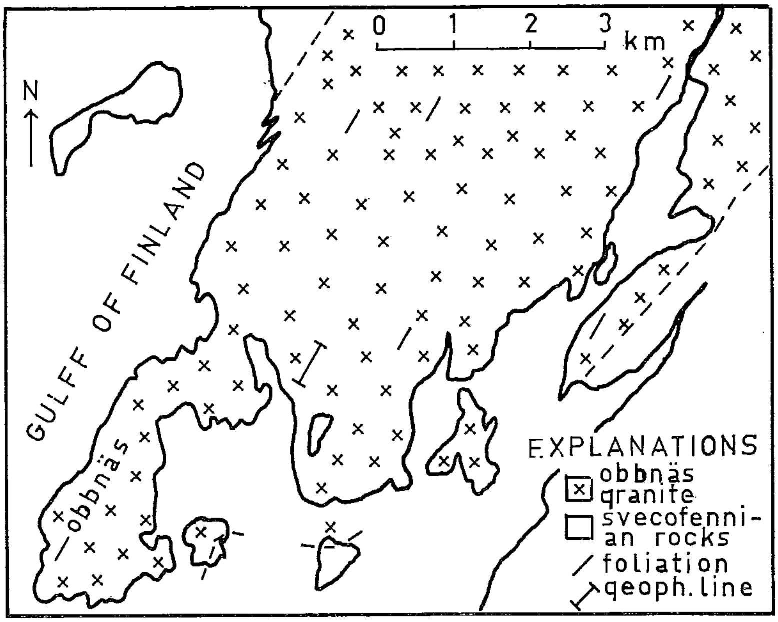

Fig. 1. Test location.

Instrumentation and position of geophones

A High Resolution 12-channel Reflection Seismograph System designed by Texas Instruments Incorporated was used with the following operation settings:

recording amplitude %	=	50
automatic gain control	=	fast
sensitivity	=	—20 db
attenuation	=	0
filter setting	=	40—480 cps
filter type	=	K
paper speed	=	1 m/s

The geophones were arranged parallel to the strike of the oriented granite structure. The locations of the geophones and detonation points were determined with the aid of a steel tape. In the Survey only one position of the geophones was used, but the detonation points were varied. The locations of the detonation points in relation to the line of geophones can be seen in Figure 2.

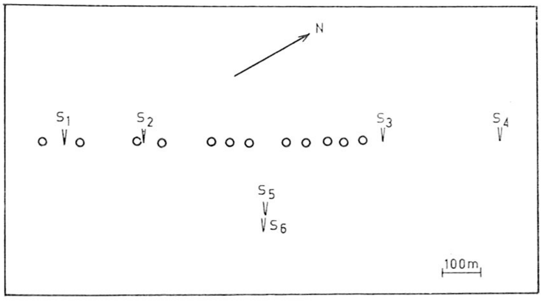

Fig. 2. The locations of the detonation points in relation to the line of geophones
O = geophone
S_{1-6} = shot points

Explosive material

In a seismic survey it is often difficult to find an explosive material suited to the circumstances that would simultaneously be effective, cheap and quick in use. As the fresh granite made it impossible to cover or bury the explosive charges, a series of forcite rock bombs (3 fig.) was chosen as the explosive material. These bombs are manufactured by Suomen Forsiitti ja Dynamiitti Oy at Hanko, Finland.

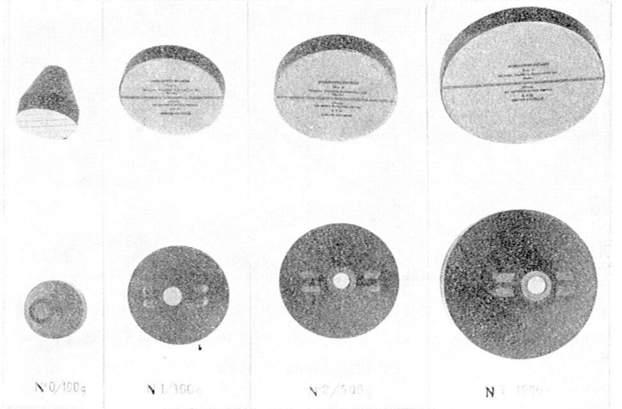

Fig. 3. The forcite bomb series.

The bombs are manufactured in Finland for blasting surface granitic boulders. The explosive material (detonation rate 6700 m/s) is situated inside a bitumen pulp shell in the shape of a fragmented cone, the upper part of the shell having a hole for the blasting cap.

In Table 1 the weights of the forsite bombs, their effectiveness as claimed by the manufacturers, and the price of each bomb in 1964 are presented. The price of common dynamite (45% nitroglyc.) in 1964 was 3.70 Fmk.

Table 1. 1. Weight of bomb. 2. Size of the granitic boulder which the bomb splits uncovered. 3. Size of the boulder which the bomb splits when covered with a wet clay cake. 4. Price of bomb per piece.

1	2	3	4
100 grammes	0.2 m^3	0.3 m^3	0.58 Fmk
300 »	0.4 »	0.6 »	1.54 »
500 »	0.8 »	1.0 »	2.35 »
1000 »	1.5 »	2.0 »	4.34 »

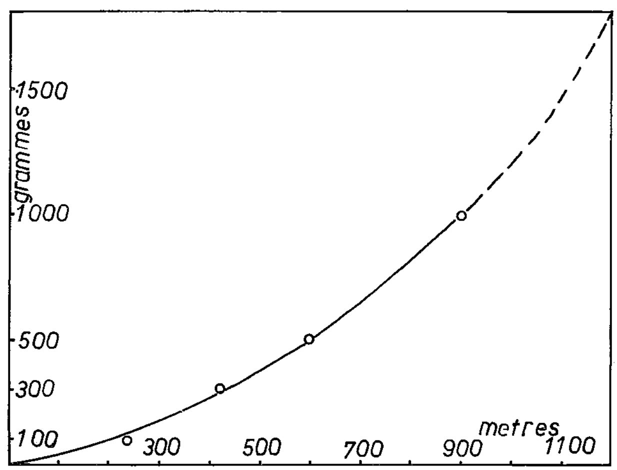

Fig. 4. A graph was drawn with the weight of the bomb as the ordinate and its distance from the geophone as the abscissa, showing the limit of good registration of the first break.

Figure 4 shows the effectiveness of the forcite bomb in the survey carried out when the bomb was covered with a 5 litre wet mud-sand mixture. It is apparent from the figure that when using a one kilogram charge for instance, the first breaks could be clearly read at a distance of at least 900 m from the Shot-geophone. Figure 5 shows a typical registration of this.

Equally good results as shown in Figure 4 were obtained with uncovered forcite bombs when preparation of the charges was particularly successful. An air-tight covering on top of the bomb improved results considerably. This was proved very clearly when the bomb was positioned on a rock slab situated in a lake near the test location. The water covering on top of the one kilogram forcite bomb was 5 cm and the first breaks were particularly clear along the whole length of the geophone line, that is to say at least 1 150 m from the Shot-geophone. In Figure 6 we see the registration obtained from the case in question. The significance of a covering on top of the bomb is also clearly shown in the effectiveness figures given by the manufacturers in Table 1.

On the basis of the foregoing it can be verified that the use of the forcite bomb has proved to be a successful solution with the Obbnäs granite, as it was —

- quick in use,
- moderate in cost,
- effective.

For achieving a good shock effect of the brisance wave the following must be taken into consideration —

- The rock surface on which the bomb is placed must be polished, sound, and as level as possible,
- the base of the bomb should be firm against the rock,
- the blasting cap may not be pressed into the dynamite further than about 1/3 of its length,
- effectiveness is noticeably increased if the bomb is embedded in an airtight covering.

Naturally the result is dependent on the operational setting of the instruments. A change in sensitivity, which in this operation was —20 db, considerably affected the result shown by Figure 4.

Velocity Survey

The main purpose of the work carried out was to obtain velocities for the soundest possible Obbnäs granite. With this in view, a search was made in the massif for such an area where the rock was, topographically level, exposed, and visibly sound throughout the whole area of the survey. Figure 2 gives the route of the survey. The first breaks gave a speed of 5700 ± 20 m/s in the direction of the strike of the oriented granite

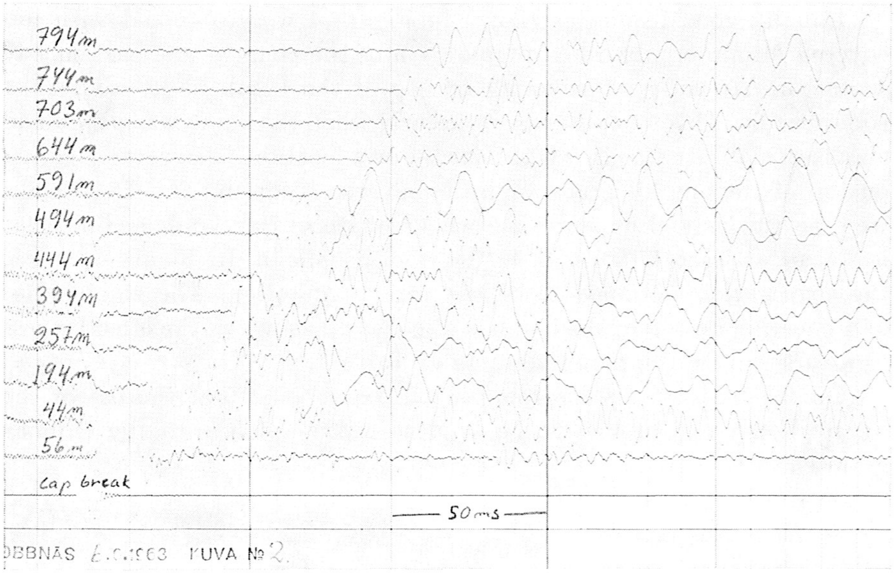

Fig. 5. Registration from the detonation of the one kilogram forcite bomb with 5 litre wet sand-mud covering.

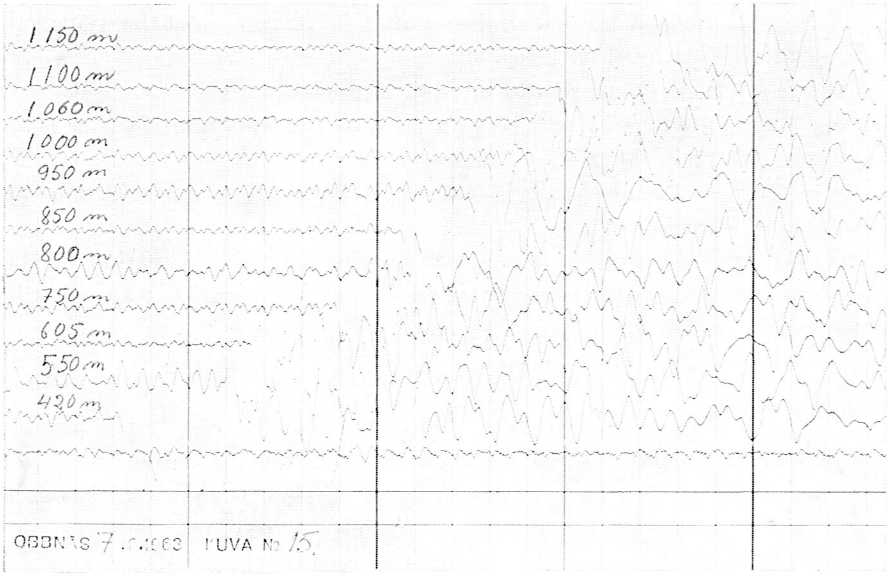

Fig. 6. Registration from the case of 5 cm water covering on the top of the one kilogram forcite bomb.

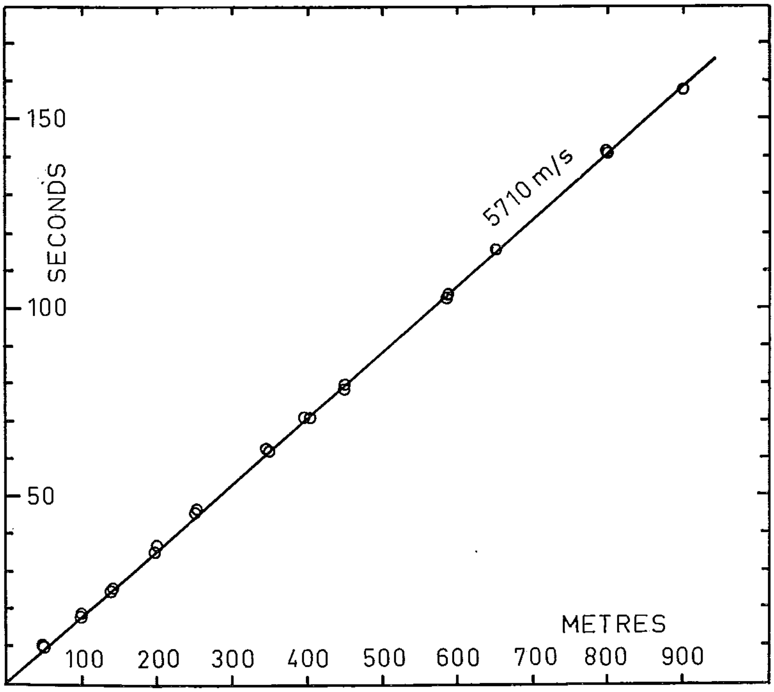

Fig. 7. Time distance graph from the first breaks, two detonations at 2 m from each other at point S_3.

structure. A time-distance graph of the first breaks is presented in Figure 7 when the bomb was detonated at point S_3 (Figure 2).

A velocity of 5590$\pm$30 m/s was obtained at right angles to the strike of the oriented structure, which was at the same time the direction of minimum velocity.

Conclusion

The completed survey gave surface velocities for sound Obbnäs granite as follows:

In the direction of the strike of the oriented structure 5700$\pm$20 m/s
At right angles to the strike 5590$\pm$30 m/s.

The velocities mentioned seem to represent the major and minoraxes of the velocity ellipse for sound Obbnäs granite and the velocity is between 5590—5700 m/s, dependent upon direction. The variation of the velocity probably arises from the fact that in the direction of the greatest velocity the intervals of crystal boundary surfaces, which have to be overcome by the elastic wave, are less in number, while in the direction of the smallest velocity (across the strike) they are more numerous.

Acknowledgement: The writer wishes to thank The National Research Council for Sciences (Valtion Luonnontieteellinen Toimikunta) for financial support for this work.

REFERENCES

1. HÄRME, MAUNU, 1960: Kivilajikartan selitys, lehti B1, Turku. *Suomen geologinen yleiskartta* 1: 400000, Helsinki. (Explanation to the map of rocks, sheet B1, Turku. *The general geological map of Finland* 1: 400000.)
2. LAITALA, MATTI, 1961: Kallioperäkartan selitys, lehti 2032, Siuntio. *Suomen geologinen kartta* 1: 100000, Helsinki. (Explanation to the map of rocks, sheet 2032, Siuntio. *Geological map of Finland* 1: 100000.)
3. Räjähdysainekonttori, 1962: *Räjähdysaineidenkäytön opas*, Hanko.