

SOME REMARKS on a 100 Tons ACCIDENTAL EXPLOSION in
TUNNEL SYSTEMS in 1965

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TWENTY-FIFTH DOD EXPLOSIVES SAFETY SEMINAR

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ABSTRACT

A progressive sequence of accidental explosions in a Finnish underground munitions storage facility occurred in Uusikylä, Finland in 1965. The largest of these sequential events involved the simultaneous detonation of as much as 100 tons of explosives material.

Considerably more explosives material was involved in the total event (in all about 700 tons consisting TNT, RDX and gunpowder).

Soon after the Explosion a special Investigation Committee was nominated. It worked over a year before the investigation report was completed. I refer here to this above mentioned report.

REASONS FOR IGNITION

The real reason for ignition is unknown. The Investigation Committee could only make a list of possible ignition reasons.

These reasons are:

1. Fall of a stone or a block of rock from the tunnel roof upon some sensitive material.
Statistically 1 block falls down in 10 years in these kind of Tunnels.

2. Selfignition
In the tunnels there were materials in which it would have been possible to occur selfignition. The Investigation Committee regards selfignition probability as very low.

3. Lightning (Thunder)
There was no special thunder in the area at that time.

4. Sabotage
A special group of the Investigation Committee and the police worked very much with this reason without finding anything, which would have had connections with sabotage. It is in every case impossible to say, that it was not sabotage by 100 % probability.

In my opinion the reason nr 1 (fall of the block) is the most probable reason.

THE UNDERGROUND AMMUNITION STORAGE (THE TUNNEL SYSTEMS)

The plan of the underground storage is to be seen in Fig 1. The underground storage was only a part of the whole Depot. On the ground there were many workshops, barracks and different kind of storages.

This Tunnel System was consisted of the (so called) main part, of tunnels 1-5 and of two separate-Tunnels numbers 6 and 7. Each one had volyme of 2700 m³.

Tunnels 1-5 included mostly ammunition and gunpowder. In tunnel number 6 there was mostly gunpowder (about 220 tons) and in tunnel 7 mostly TNT and RDX (together 310 tons). There were also small storages numbers 8 and 9, including only some hundreds of kilos explosive material.

The hill where the tunnels were located was about 200 m x 350 m and was about 15-25 m above its surroundings.

The roof of the Tunnels varied from 15 to 22 m. The walls in the main part were 17 m each. The wall between number 5 and 6 was 32 m and the wall between 6 and 7 was 18 m.

THE EVENTS

The assumed series of events are about following:

First it happened something (fire, deflagration, detonations) in the tunnel number 5. The rising pressure in this tunnel opened primary joints in the rock. The Blast Wave carried materials (ammunition etc.) to the connection tunnel, to other tunnels and through cracks to the hill top.

The explosions in the main tunnels caused ignition of gunpowder in tunnel 6, that turned into a detonation. This lifted the rock masses above the tunnel and carried huge

blocks of the slope further down the side. The detonation continued to tunnel 7, the explosion of which caused a crater to form and a heavy rock shower. The block formation around the crater was heavy and fissures and faults followed the tectonic directions of the rock. A primary joint of the rock parallel with the directions of the tunnel 4, determined the movement of the rock masses and spared tunnels 1, 2, 3, and 8 from further structural damage. This joint, which was opened by the blasts in the main tunnels, served as a reflective surface for rock movements from the explosions and for detonation blows in tunnels 6 and 7.

The Investigation Committee had many good reasons to come to above mentioned conclusions of what happened in the Tunnels.

The best information of exact times of detonations was got from the observations of the INSTITUTE of SEISMOLOGY. According the seismological report following happened. The first explosion occurred at 5.25 o'clock in the morning. Its estimated TNT - equivalency was 4 tons. The second explosion happened 27,8 s later and its TNT - equivalency was 100 tons. Seismologists said that above mentioned amounts are not very exact, but their relation 1:25 is more certain.

Further they said, that before the first explosion they would have found explosions which were 1/10 part of the first explosion. Between above mentioned two explosions it would have been possible to find explosion as big as or bigger than the first one. None of these kinds were found. After the second explosion, possible smaller explosions would have been covered up by the second explosion in seismograms.

After above mentioned two explosions there were fire and single small deflagrations and detonations under one week's time in the Tunnels and in the surroundings.

EFFECTS TO THE TUNNELS

Figure 2 shows the situation in the Tunnels after explosions. Tunnels 6 and 7 are wholly destroyed, there is only a crater. The deepest part of the crater is in the middle between the Tunnels. Figure 3 shows the ground profile before and after the explosion.

Tunnels 4 and 5 are only partly destroyed, the rears are damaged only a little.

Tunnels 1, 2 and 3 are in "good" condition, but they are not used any more. Pictures from the tunnel 1 and from the connection tunnel near tunnel number 1 show these being in rather good condition.

EFFECTS TO THE SUBROUNDINGS

The most dangerous effect to the surrounding was a shower of rock blocks and stones. Effects of the Blast wave and the earth vibration are very difficult to see apart from the effects of the rock shower.

In the pictures there are shown the effects of the rock shower to the buildings and surroundings. Specially in this accident the effects of flying stones, blocks and dust were typical effects to surroundings. For example there were hay and berries spoiled by dust in large areas (Fig. 5).

In Fig 4 there can be seen areas, where most of the flown blocks were found. Typically, they have been directed mostly southwest. Also very many windows were broken, the longest distance was 7 km. There were some astonishing features in the effects, for example a brick chimney is almost undamaged although it is near the opening of the Tunnel System.

Now , today there is the Depot of Finnish Defence Forces working at the same, area, where the catastrophe occurred. However, there is now only a little amount explosives material in the Depot.

REFERENCES

The Official Report of the Uusikylä
Accident Investigation Committee 1966
(in Finnish)

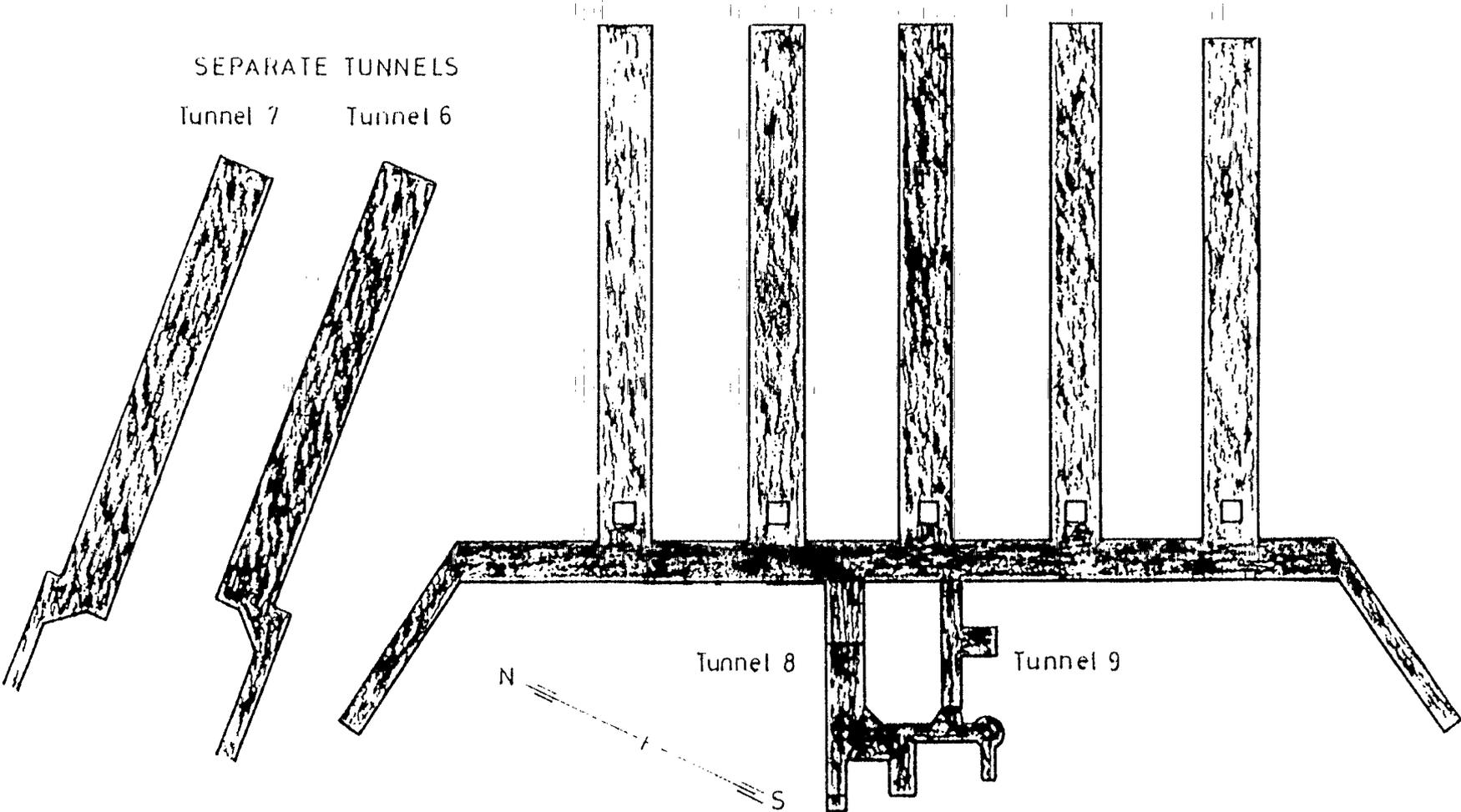
Vähäsarja Pentti
THE EXPLOSION CATASTROPHE AND CHARACTERISTICS OF THE ROCK
AT UUSIKYLÄ 1970
(in Finnish, Abstract in English)

MAIN STORAGE TUNNELS

Tunnel 5 Tunnel 4 Tunnel 3 Tunnel 2 Tunnel 1

SEPARATE TUNNELS

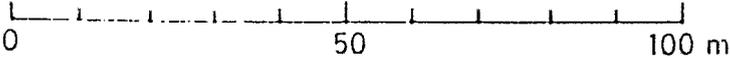
Tunnel 7 Tunnel 6



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Figure 1

SCALE 1:1000



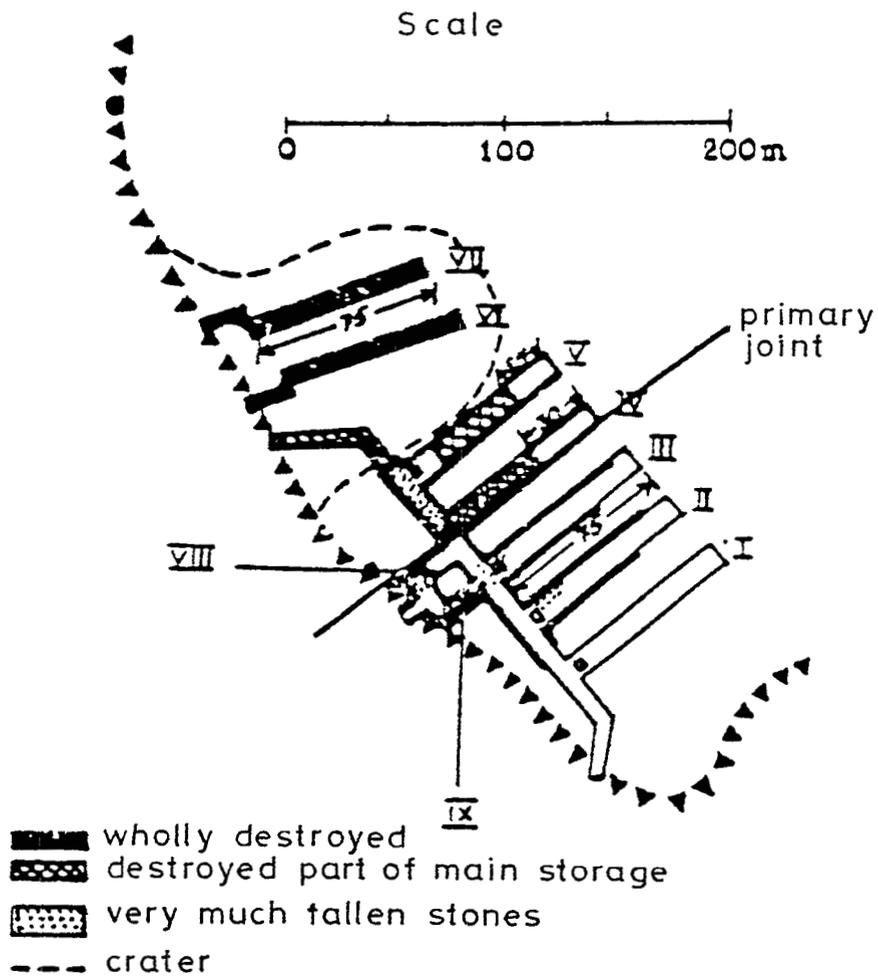
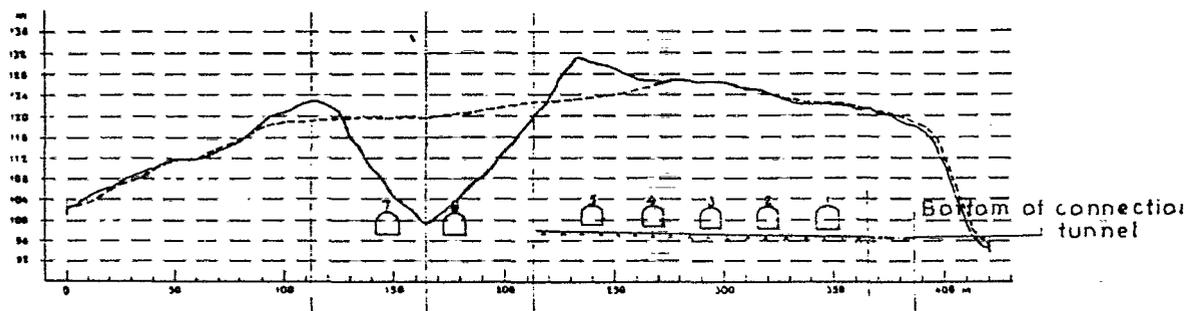


Fig. 2



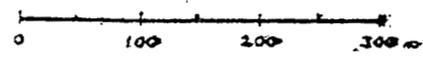
- - - - original ground surface
 ——— ground surface after explosion

IN THE DETONATIONS FLOWN STONES

- ⊗ ○ crater diameter > 3 m
- — " — > 1,5 m
- totally destroyed area
- - - - detonation crater
- - - area, where most of flown stones, are.



Fig. 4



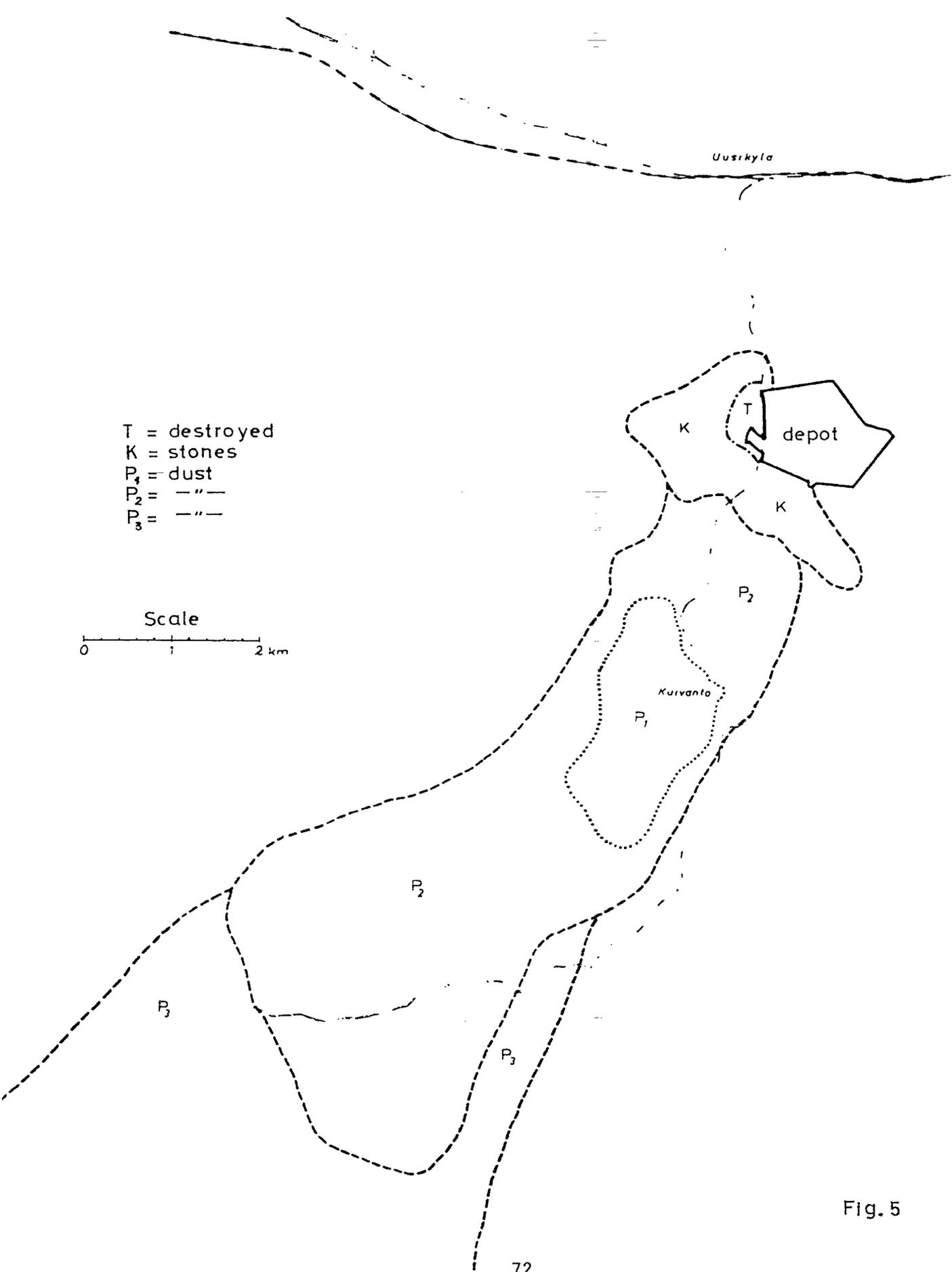
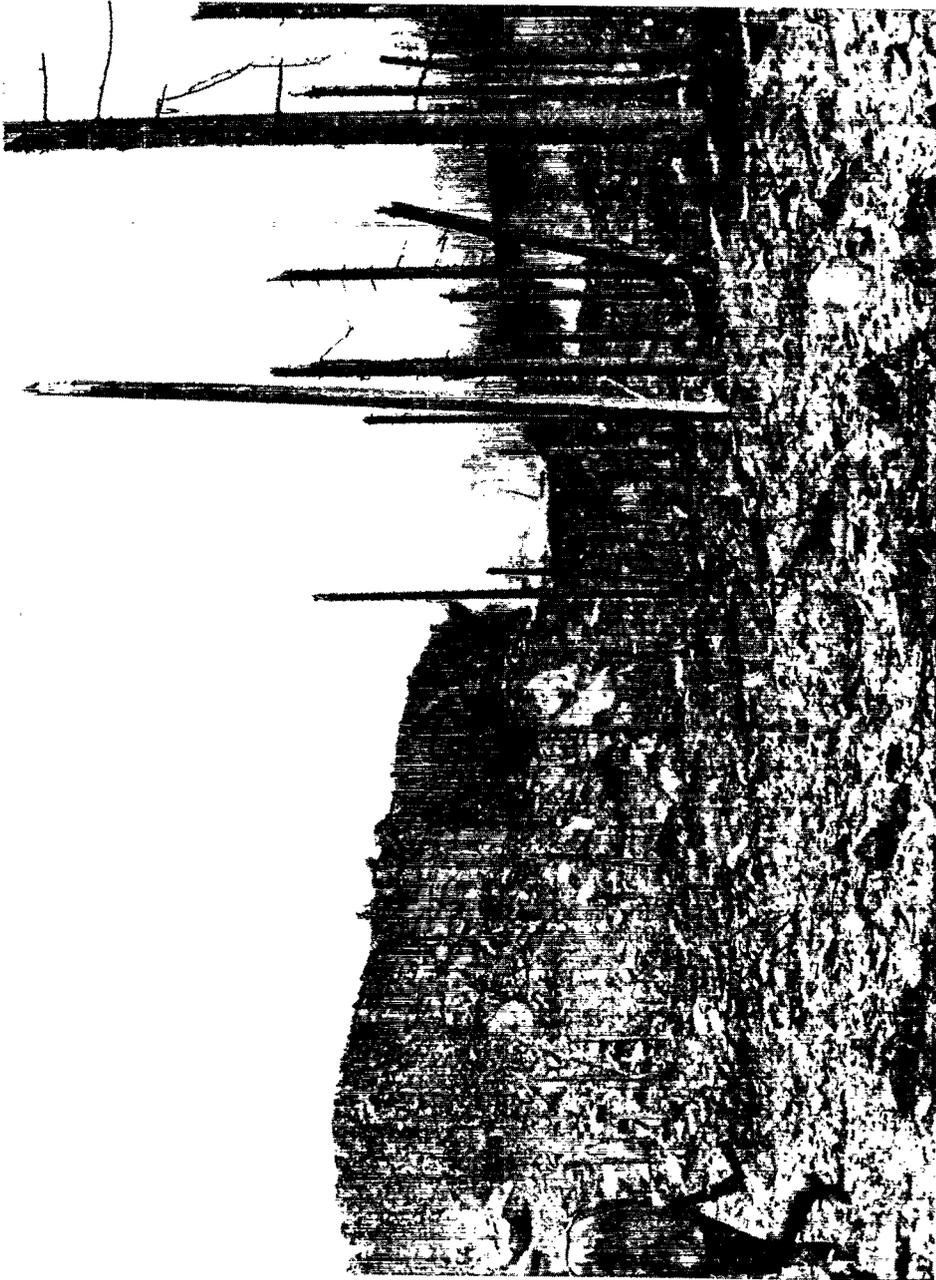


Fig. 5



PICTURE 1

Near the crater. Something is still burning.



PICTURE 2

When the pressure lifted the rock,
the open cracks were filled by stored
materials.



PICTURE 3

This Block's weight is about 1000 ton.
It is on the blockwall.



PICTURE 4

Blocks of rock above the main part of Tunnels. The brick chimney is to be seen in the background. It is a little miracle, that it still is there.



PICTURE 5

The Tunnel 1.



PICTURE 6

This Block has flown about 750 m.



PICTURE 7

The Living house, 650 m from
the Explosion.



PICTURE 8

This House was about 300 m from the Tunnels 6 and 7. One Person was in this House, he survived (badly injured).



PICTURE 9

This Barrack situated 480 m from
the Explosion.