

ACOUSTIC EMISSION AS AN INDICATION OF STABILITY DECREASE IN FRACTURE ZONES OF AVALANCHES

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ABSTRACT. Measurements of the event rate of natural, small-amplitude displacement accelerations in potential fracture zones of avalanches prove to be good indications for decrease of stability.

RÉSUMÉ. Émission acoustique en tant qu'indicateur de la décroissance de la stabilité dans les zones de décrochement des avalanches. L'évaluation de la fréquence des accélérations du déplacement naturel dans les zones de tension d'une couche de neige s'avère être un bon indicateur de la décroissance de la stabilité.

ZUSAMMENFASSUNG. Akustische Emission als Indikator für Stabilitätsabnahmen in Lawinenanrisszonen. Die Erfassung der Häufigkeit von natürlichen Verschiebungsbeschleunigung in Spannungszonen einer Schneedecke erweist sich als guter Indikator für Stabilitätsabnahmen.

INTRODUCTION

Preliminary results of Sommerfeld (1977) and St. Lawrence and Bradley (1977) indicate an inverse correlation between low-frequency noise originating from small displacements and limited fractures in the snow cover at potential fracture zones of avalanches. A verification of these results allows short-time avalanche prediction, to study the coincident stability developments at different slope aspects as well as stability changes induced by unsuccessful attempts to release avalanches artificially by explosives.

MEASUREMENTS

During winter 1976/77 and spring 1977 we were able to record several periods of low stability with a measuring system quite different of those used by Sommerfeld and by St. Lawrence and Bradley. Instead of geophones we used non-resonant lightweight and high-sensitivity acceleration transducers. The piezoelectric transducers are embedded in foam cylinders 0.25 m long and 0.05 m in diameter. The mean density of these transducer systems is about 150 kg m^{-3} corresponding to the density of weakly settled snow. The cylinders were embedded 0.3–1 m below the snow surface in stress zones. The whole receiving system has a flat frequency response from 5 to 100 Hz. The background noise is

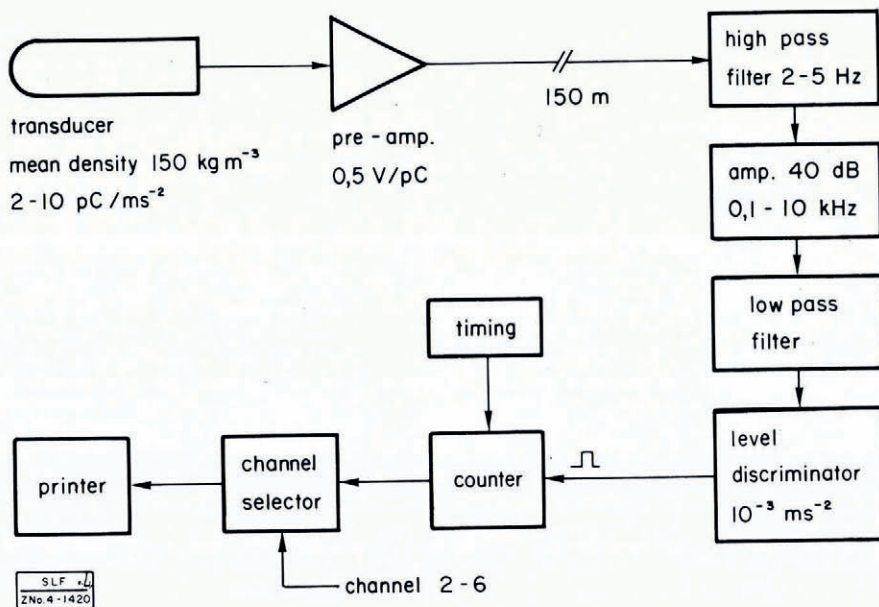


Fig. 1. Block diagram of the electronic set-up of the experiment.

suppressed by a simple level discriminator (Fig. 1). Any acceleration event above the background noise is registered. The event rates of the different transducers (10–50 counts per hour during periods of high stability, 300 to about 1 000 counts per hour during periods of low stability) were printed on paper tape. The discriminator level was set to 10^{-3} m s^{-2} . An increase of the dead time of the discriminator from $2 \times 10^{-2} \text{ s}$ to 1 s decreased the event rate by only 20%.

RESULTS

Eight periods of low stability could be recorded (Gubler, 1976). The reasons for the stability decreases were very different: heavy snowfall, snow displacements by wind action, radiation and warming, rain and warming. In all periods of low stability no avalanche started in the immediate surroundings of the test slope, but avalanches were observed in corresponding larger avalanche paths. An example with the corresponding meteorological data is given in Figure 2.

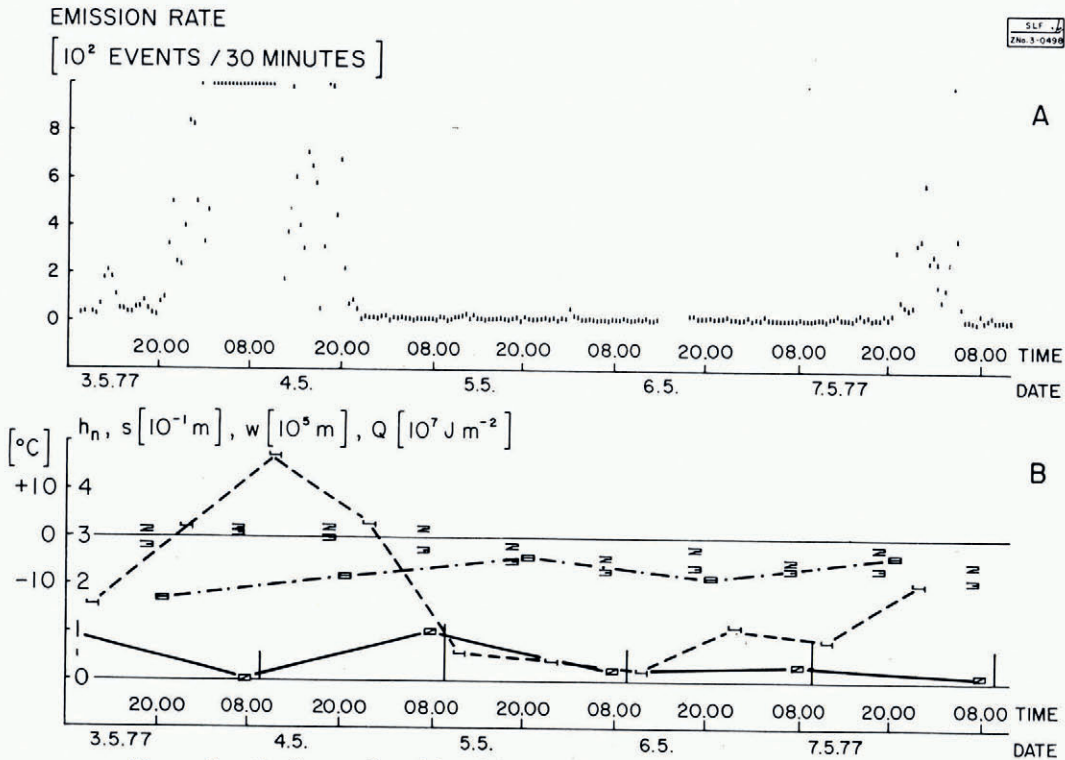


Fig. 2. Example of a recording of the emission rate during 5 d with two periods of low stability.

- (a) Emission rate as a function of time.
 (b) Daily maximum of temperature (2), daily minimum of temperature (3), wind w (4), global radiation Q (8), mean height of new snow h_n (6), penetration depth s (7).

FURTHER STUDIES

An improved system which allows simultaneous stability measurements for different slope aspects, equipped with a seismic system to record avalanche events (St. Lawrence and Bradley, 1977) and provided with different gauges to measure meteorological data, is in preparation and will be installed during winter 1977/78. The data will be telemetered from the test site of the Institut. Additionally we hope to measure stability changes induced by detonations.

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