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## Some current and temperature observations in the Mediterranean outflow west of Gibraltar; a data report

by

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With 45 figures and 1 table

### Beobachtungen der Strömungs- und Temperaturverhältnisse im Mittelmeerausstrom westlich Gibraltar; eine Daten-Übersicht

#### *Zusammenfassung*

Auf der „Nordost-Atlantik-Expedition“ mit F. S. „Meteor“ wurden im Frühjahr 1971 einen Monat lang auf 7 Positionen westlich von Gibraltar mit 29 Strommessern und 5 Thermistorketten die Temperatur- und Strömungsverhältnisse beobachtet. Die Geräte waren vorwiegend zur Registrierung der zeitlichen Veränderlichkeit des durch die Straße von Gibraltar in den Atlantik ausfließenden Mittelmeereswassers bestimmt. In der vorliegenden Arbeit werden die Zeitserien der Temperatur- und Stromvariationen, deren Amplitudenspektren und die aneinander gereihten Stromvektoren als Basis für die weitere Bearbeitung dargestellt. Charakteristische Periodenbereiche der zeitlichen Veränderlichkeit lassen sich aus dem vorhandenen Datenmaterial direkt ablesen.

#### *Abstract*

At seven sites west of Gibraltar current and temperature variations of the Mediterranean outflow were observed during one month in spring 1971. This paper presents the obtained records of 29 current meters and 5 thermistor cables in the form of time series, amplitude spectra, and progressive vector diagrams as a basis for further evaluation. Characteristic features of the currents like mean speeds, mean directions and the periodicity of the variation can be seen directly from the given plots.

#### Introduction

The main problem to be investigated during the “Northeast Atlantic Expedition” with F. S. “Meteor”

was the effect of the Mediterranean water on the stratification and mixing of sea water and on the sedimentation at the continental slope west of Gibraltar. Various time series of temperatures and currents were obtained by means of seven subsurface moorings. They were placed in areas where the undercurrent has close contact to the sea floor, where the outflow starts its horizontal spreading, and in deep water with the Mediterranean core at intermediate levels. Details about the positions of the mooring sites and their relation to the outflow channels are described in the report of the coordinator of the expedition (SIEDLER 1972).

This paper presents the set of data from the moored instruments in graphical form as a basis for further evaluation.

#### Instrumentation

The mooring technique applied in this investigation has been developed at the Institut für Meereskunde, Kiel (SIEDLER et al. 1970, ENGELMANN 1972). The effect of oscillations of the moorings can probably be neglected here because the sensors were mostly placed in the nearbottom Mediterranean outflow. In general, the mooring inclination was mainly controlled by rather strong mean currents. All arrays were equipped with Aanderaa meters and thermistor cables (AANDERAA 1964, 1967). The clocks used were especially developed for these meters by the Institut für Satellitenelektronik (BÜCKLEIN 1971). The main advantage of the crystal clocks is their high reliability. On the average the clocks lost approximately 4 sec per day. The sampling rate of the instruments was once every 5 min. for the current meters and once

every 10 min. for the thermistor cables. The local magnetic deviation for the area of investigation was taken into account during the data processing. Unfortunately it was not possible to recalibrate the thermistors a short time before the cruise. The last calibration was done 14 months before the expedition. Apparently the drift exceeded the specifications over this period, and therefore the mean value at neighbouring levels sometimes differs considerably. E. g. record 20 102 T 1 at 704 m depth on the average is 0.13 °C lower than record 20 101 T at 697 m. It can, however, be assumed that the drift was small for the period of this experiment, and the fluctuations presented here are not contaminated by the drift.

Of 36 instruments moored two gave no data at all. In addition, record 19 102 only lasted for 2/3 of the mooring period because of battery problems. A leakage at the lower end of the thermistor cable 19 104 caused a failure of the lower sensors.

### Presentation of the data

The positions of the moorings are given in fig. 1, the duration of the individual records is indicated in fig. 2. The obtained data are given in the sequence of their IfM reference numbers (19–25) following the Mediterranean outflow from east to west. The mean currents and the mean temperatures were subtracted before plotting the east (U) and north (V) components of the currents and the temperature (T). Data points selected at ten minute intervals were used for the graphical presentation. The vertical reference lines indicate weeks. The amplitude spectra for the period range 2–120 h were computed from the unfiltered time series. Because of the great similarity of temperature spectra for neighbouring depth levels, only selected spectra are given for the thermistor cables. The semi-diurnal M2 period and higher harmonics and the local inertial period (21 h) are given as reference lines. In order to present the predominant current directions, a set of progressive vector diagrams was plotted.

Table 1 Summary of presented data, indicating numbers of figures: U, V – East, north components of current; T – Temperature.

Tabelle 1 Zusammenfassung der dargestellten Daten mit Angabe der Abbildungsnummern: U, V – Ost-, Nordkomponente des Stromes; T – Temperatur.

IfM Mooring No.	Figure No.				
	Time Series		Amplitude Spectra		Progressive Vector Diagrams
	U, V	T	U, V	T	
19	3	4, 5, 6	9	7, 8	10
20	12	11, 13	14	15	16
21	18	17	19	20	21
22	23	22	24	25	26
23	28	27	29	30	31
24	32, 35	33, 36	34, 39	37, 38	40
25	41	42, 43	44	–	45

### Acknowledgement

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Received: 21. 9. 1973

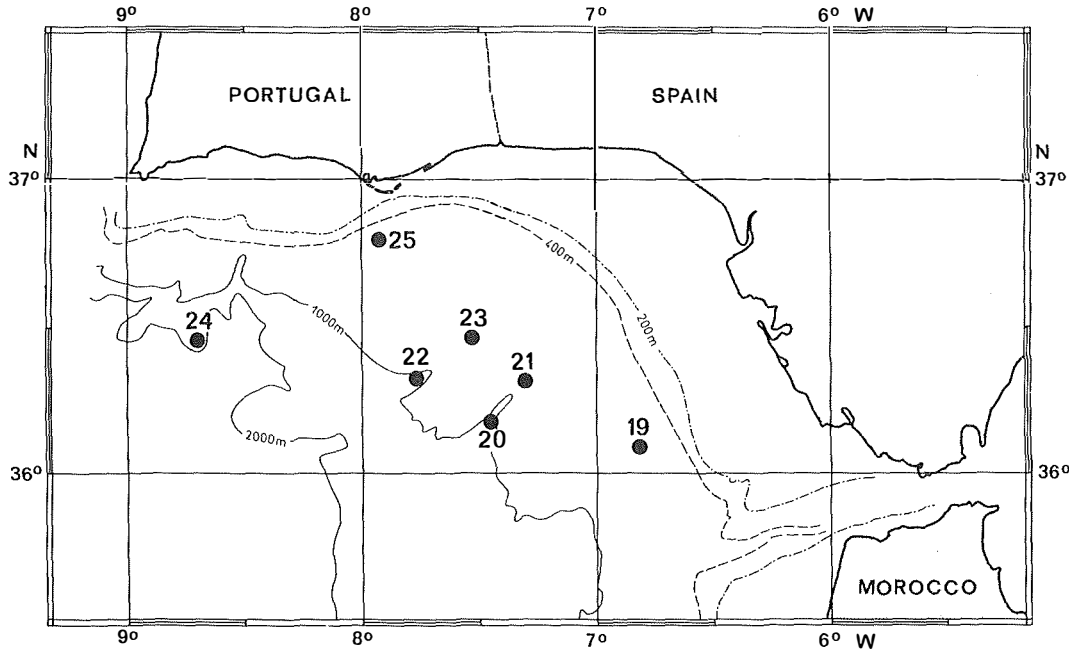


Fig. 1. Map of area investigated by F. S. Meteor in spring 1971. Mooring sites and respective IFM reference numbers are indicated.

Abb. 1. Karte des Untersuchungsgebietes von F. S. Meteor im Frühjahr 1971. Orte und zugehörige IFM-Verankerungsnummern sind gekennzeichnet.

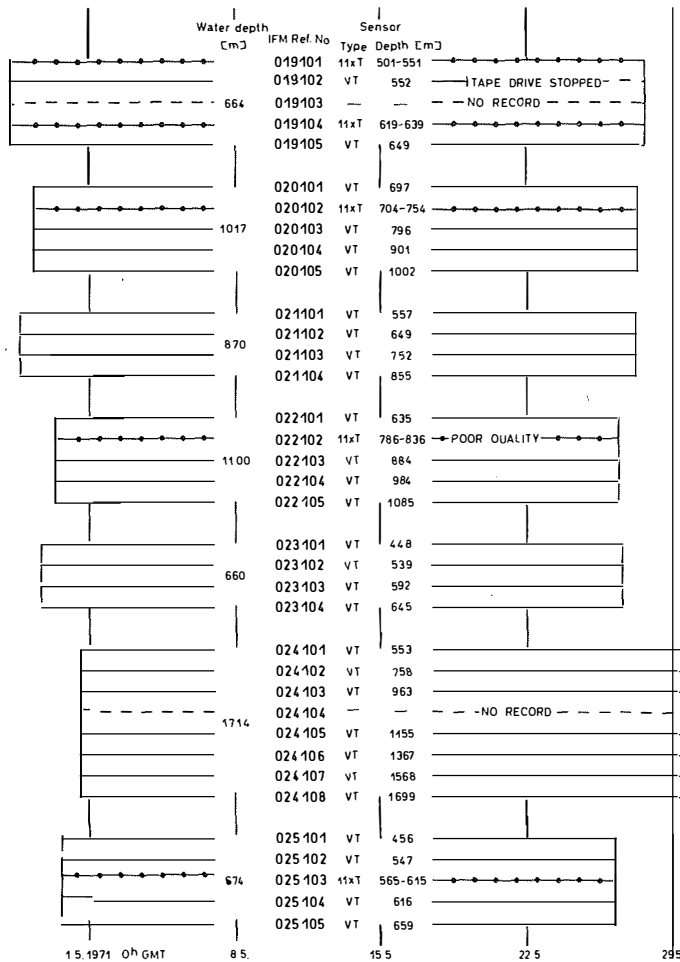


Fig. 2. The duration of the time series. The following abbreviations are used: V - velocity; T - temperature; 11 x T - thermistor cable; - - - - - current meters; - . - . - thermistor cables; - - - - - no data obtained.

Abb. 2. Dauer der Zeitserien. Folgende Abkürzungen wurden verwendet: V - Geschwindigkeitsvektor; T - Temperatur; 11 x T - Thermistorkette; - - - - - Strommesser; - . - . - Thermistorkabel; - - - - - keine Daten.

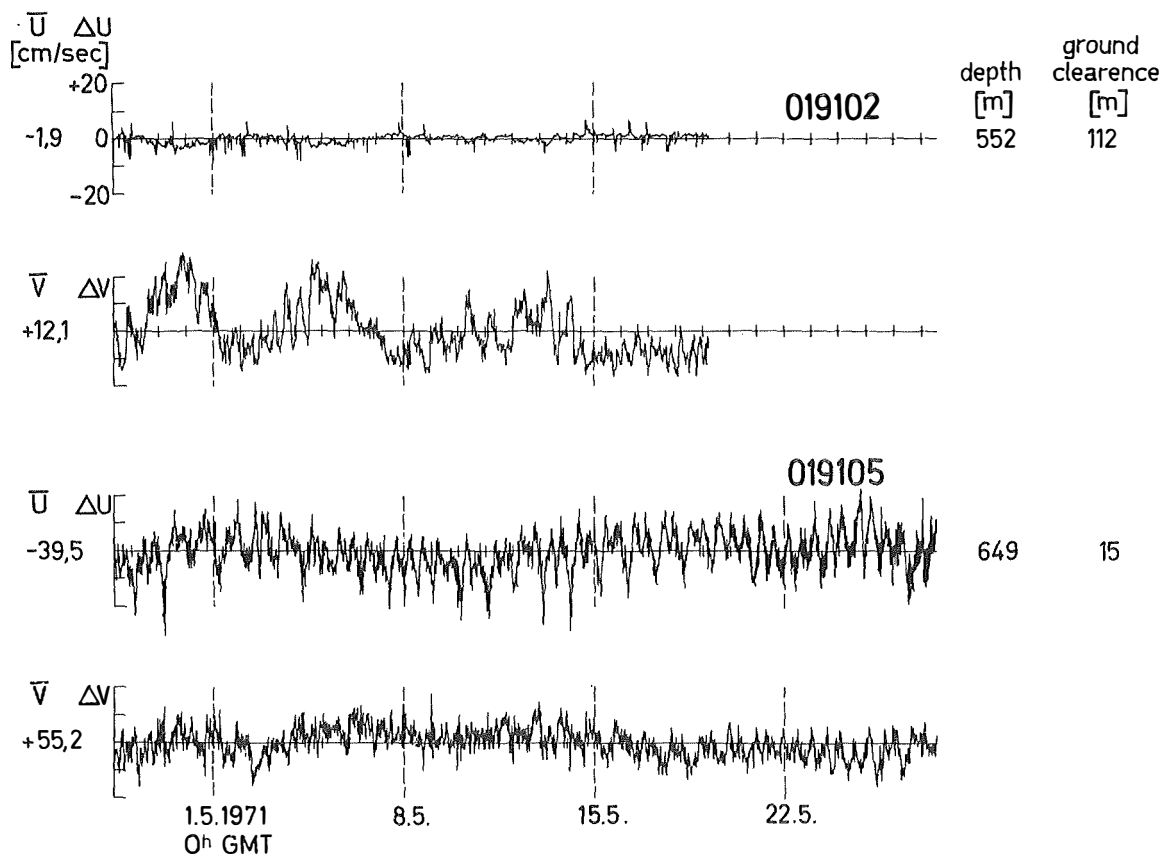


Fig. 3

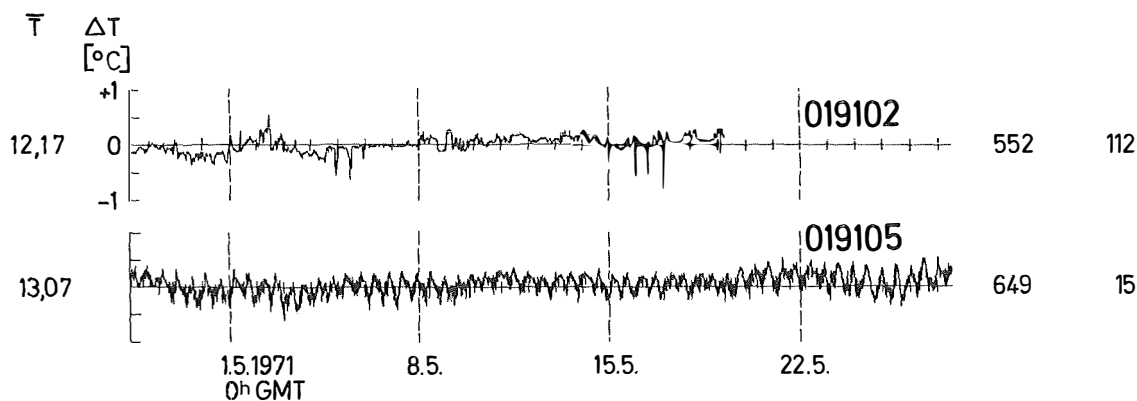


Fig. 4

Explanations for figs. 3—45. The following abbreviations are used in the figures:

- $\bar{U}, \bar{V}$  — Mean east and north components (resp.) of the currents;  
— Mittlere Ost- bzw. Nordkomponente des Stroms;
- $\Delta U, \Delta V$  — Deviations from  $\bar{U}$  and  $\bar{V}$  (resp.);  
— Abweichungen von  $\bar{U}$  bzw.  $\bar{V}$ ;
- $\bar{T}$  — mean temperature;  
— Mittlere Temperatur;

Erläuterungen zu den Abbildungen 3—45. Folgende Abkürzungen wurden in den Abbildungen verwandt:

- $\Delta T$  — Deviation from  $\bar{T}$ ;  
— Abweichungen von  $\bar{T}$ ;
- $A_u, A_v$  — Amplitude spectra of the east and north components (resp.) of the currents;  
— Amplitudenspektrum der Ost- bzw. Nordkomponenten  $U, V$  des Stromes;
- $A_T$  — Amplitude spectrum of the temperature.  
— Amplitudenspektrum der Temperatur  $T$ .

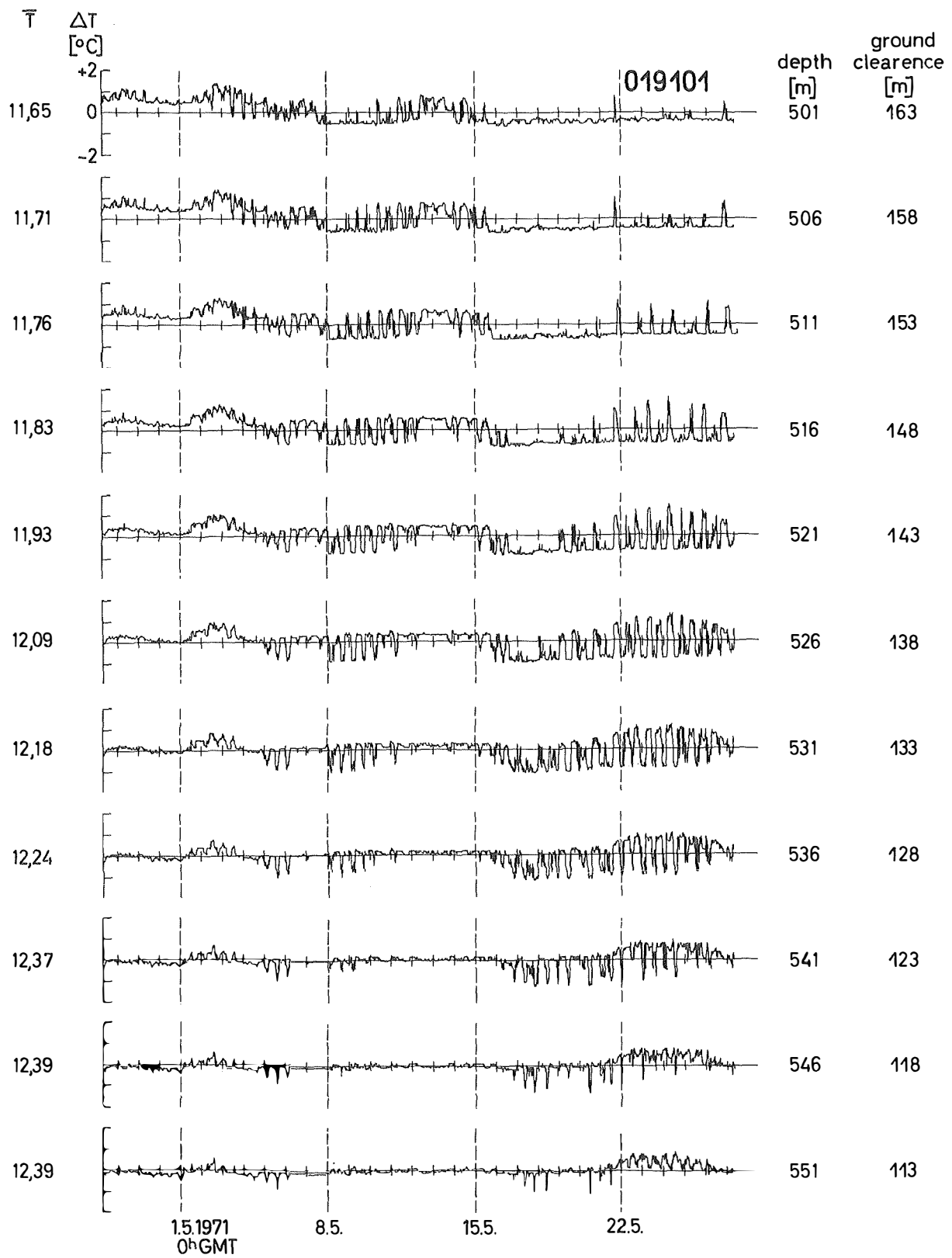


Fig. 5

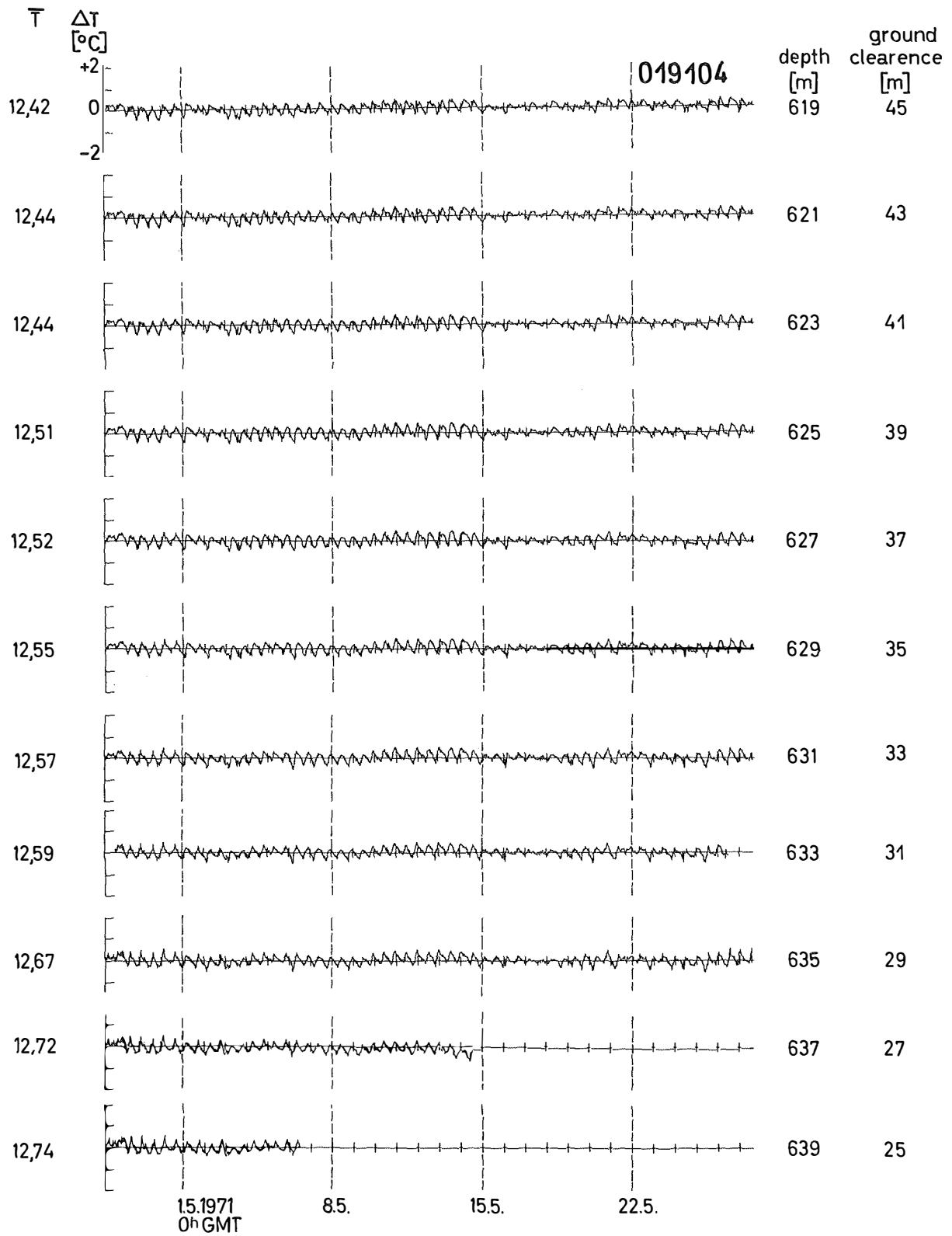


Fig. 6

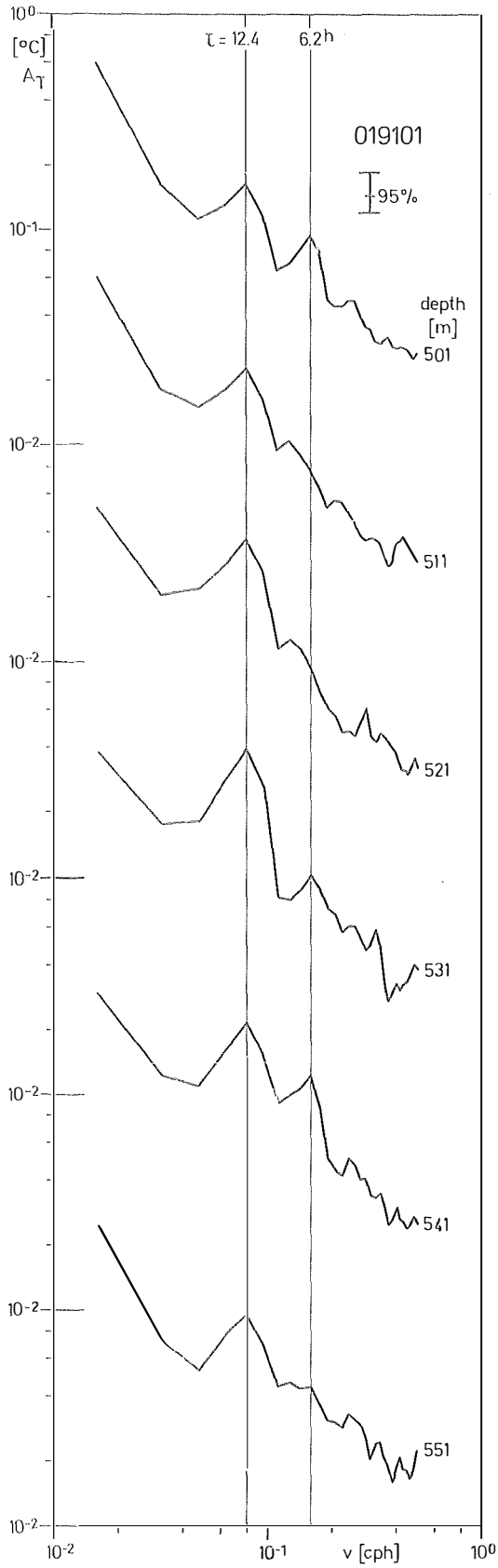


Fig. 7

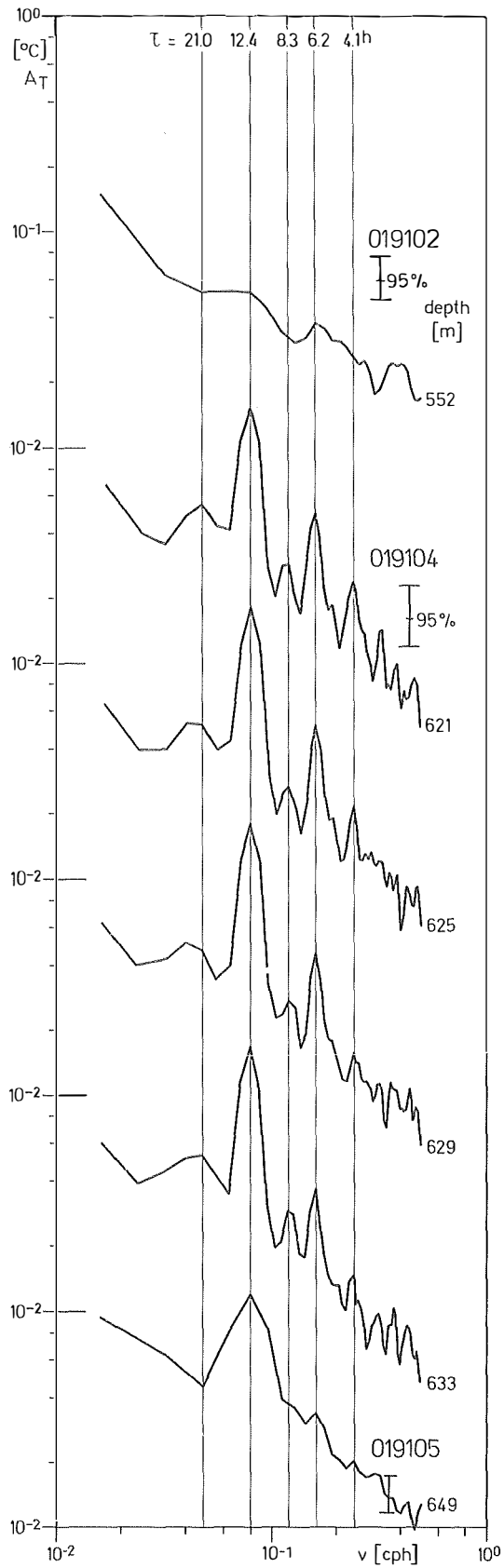


Fig. 8



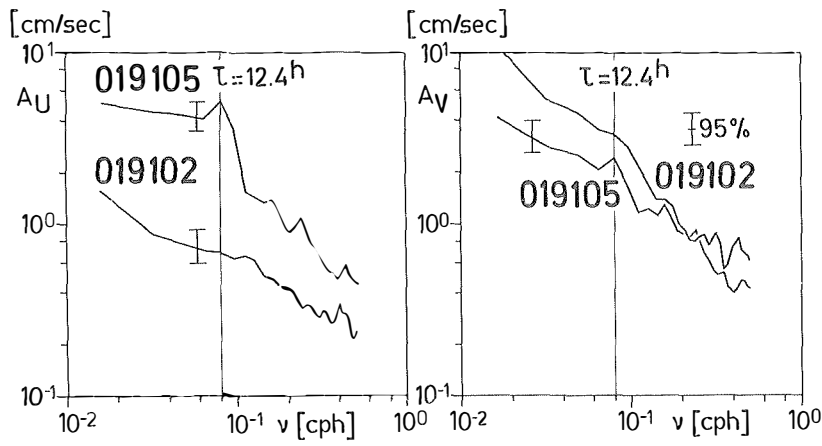


Fig. 9

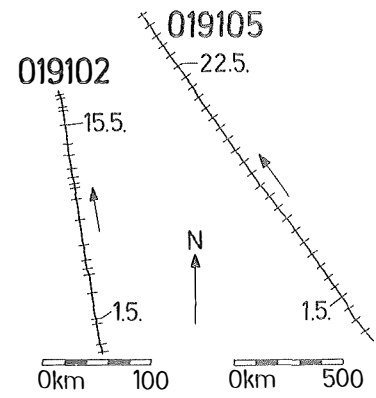


Fig. 10

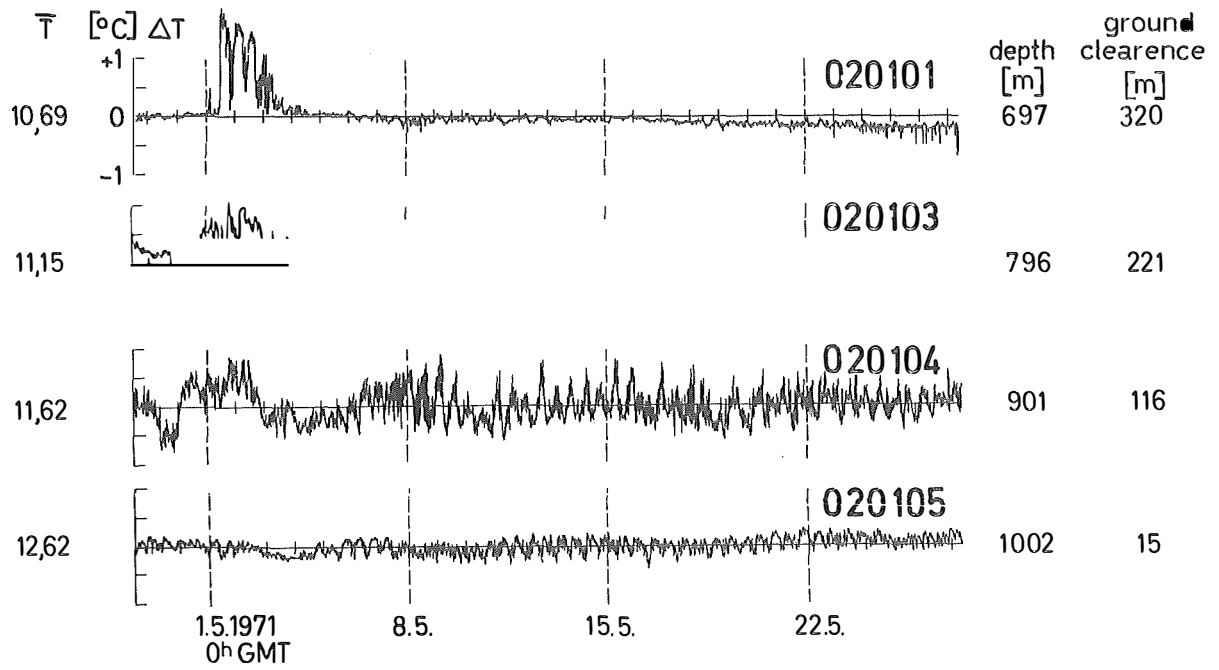


Fig. 11

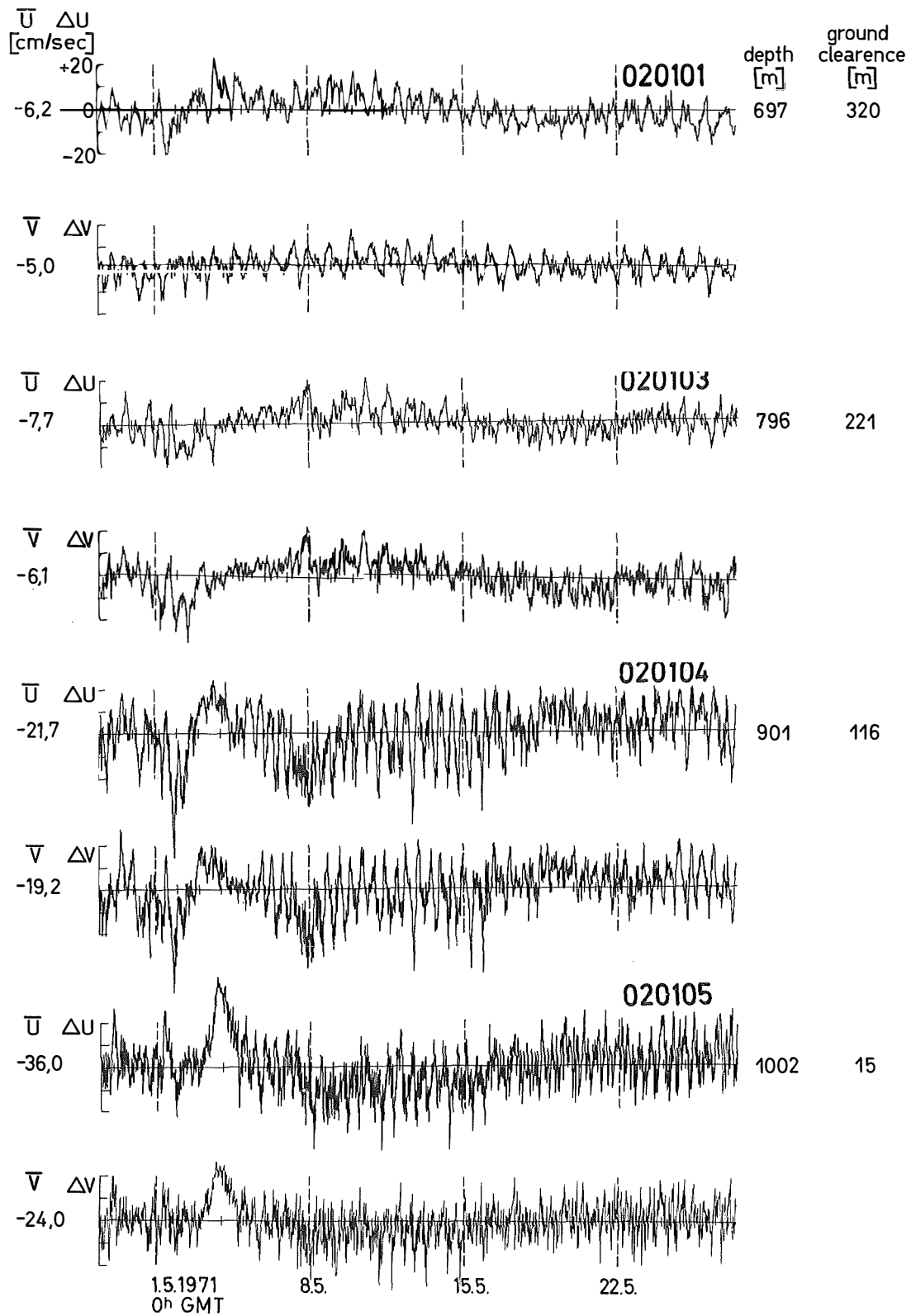


Fig. 12

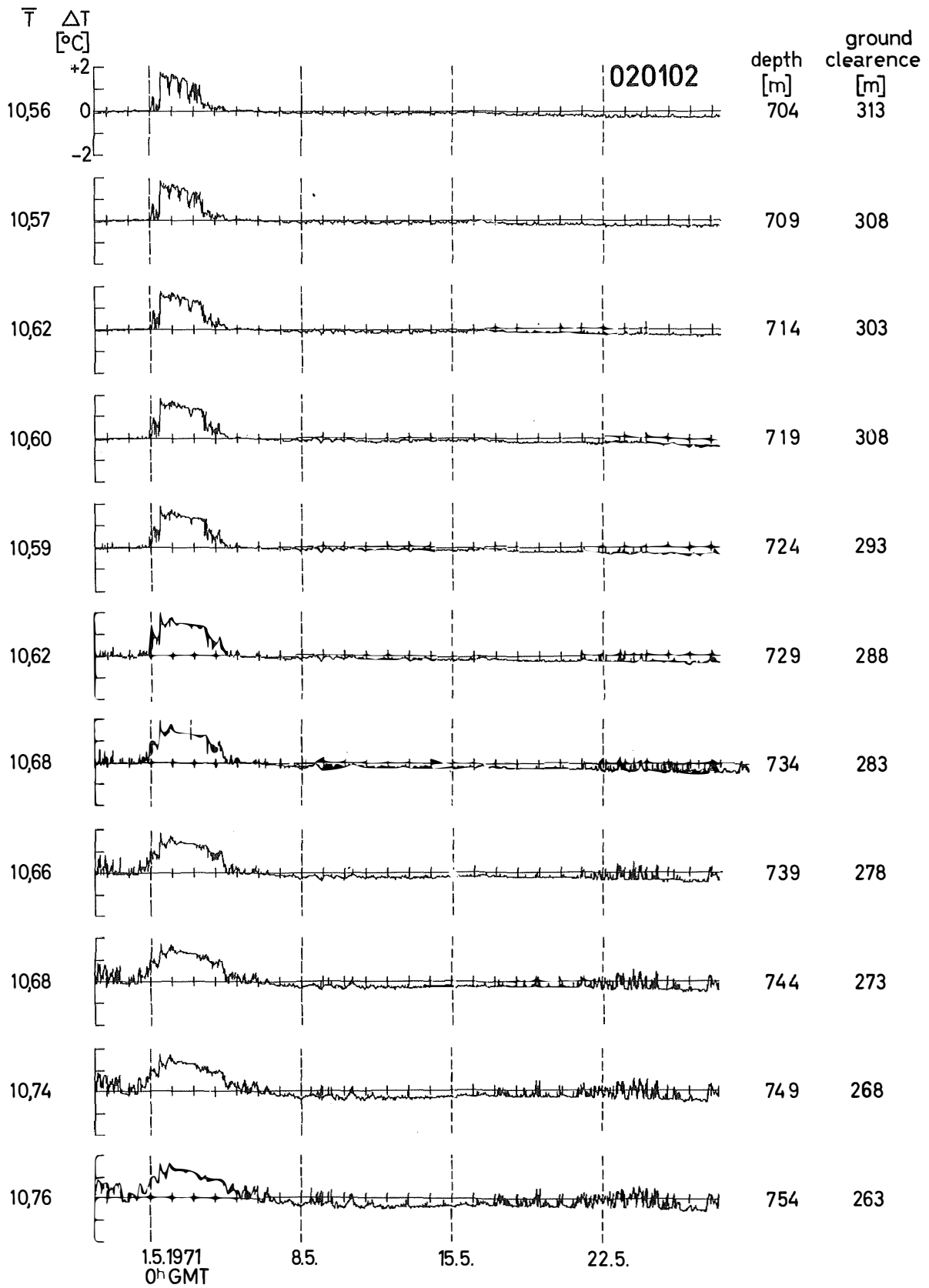


Fig. 13

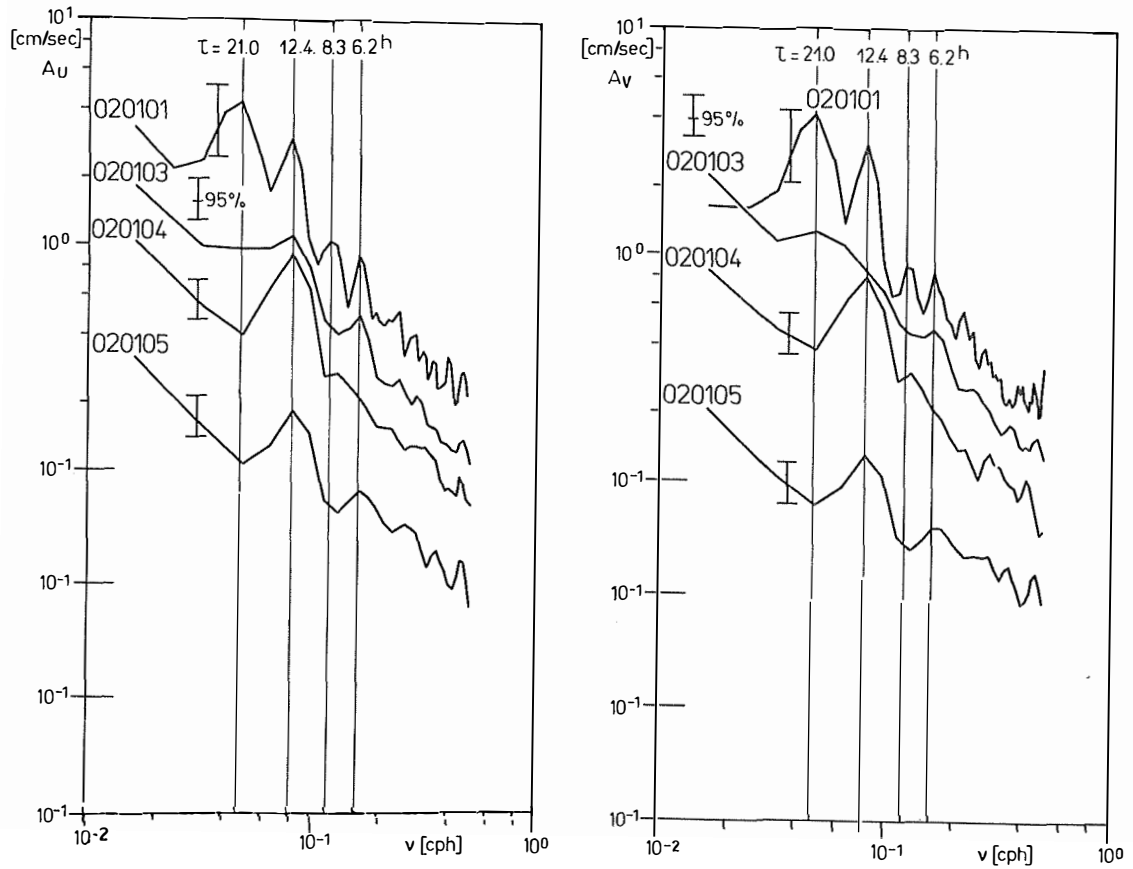


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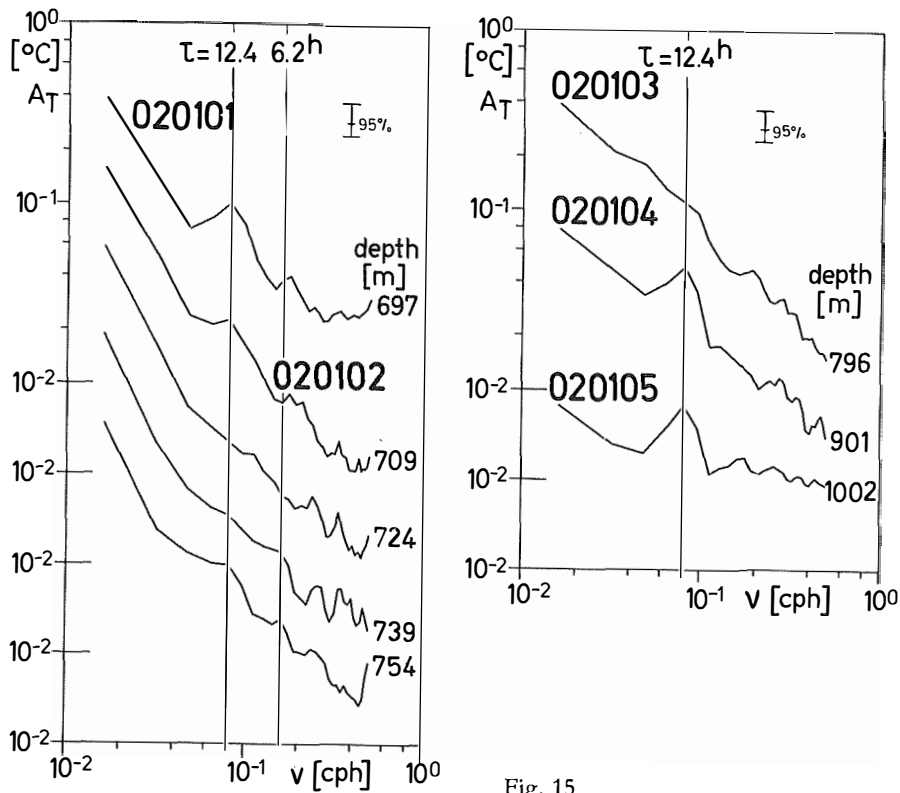


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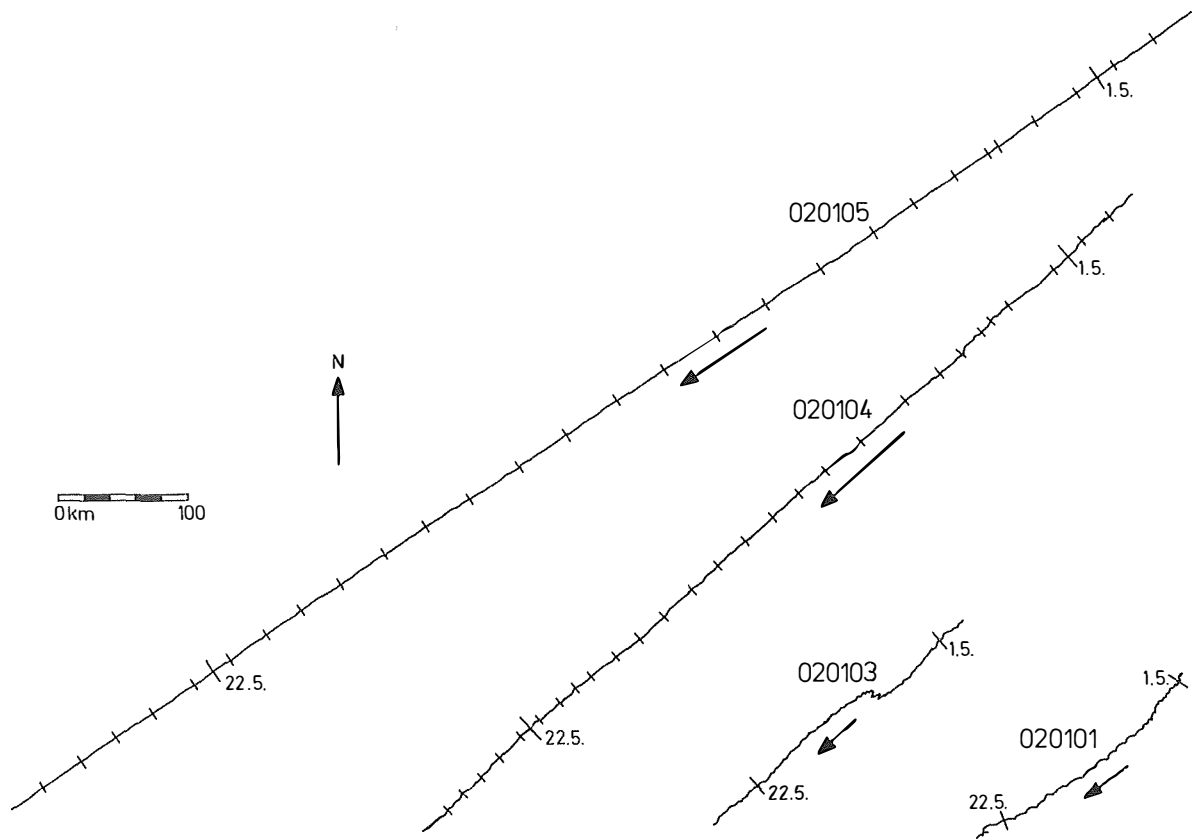


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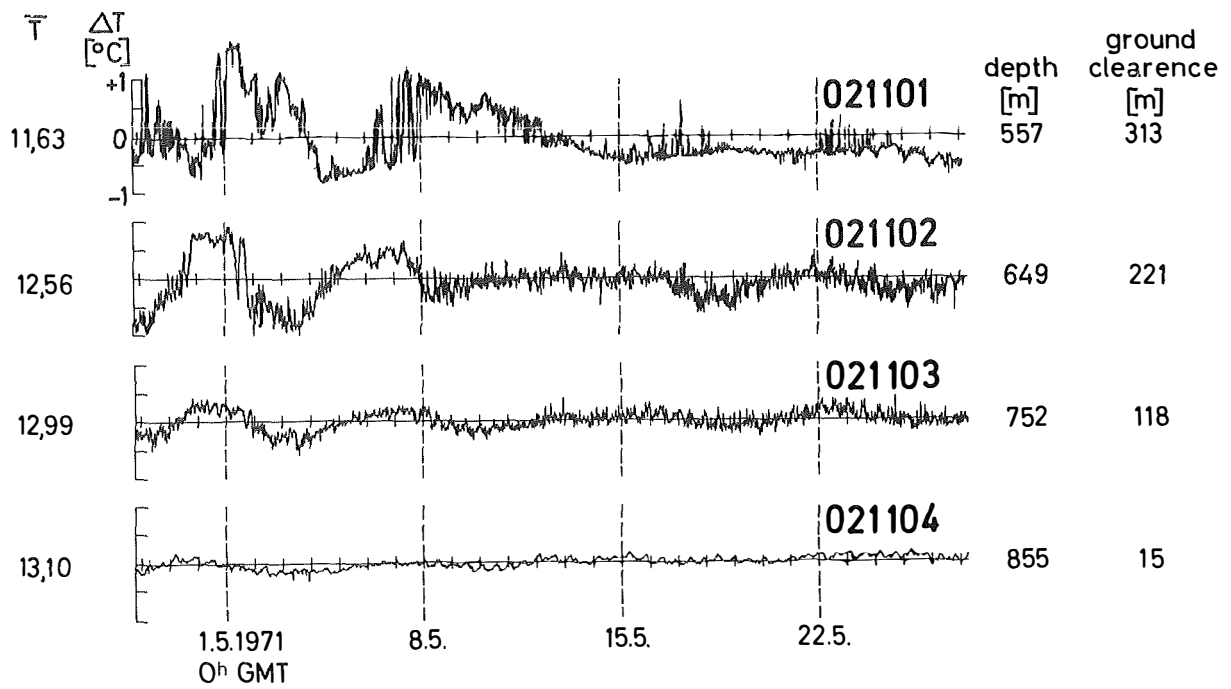


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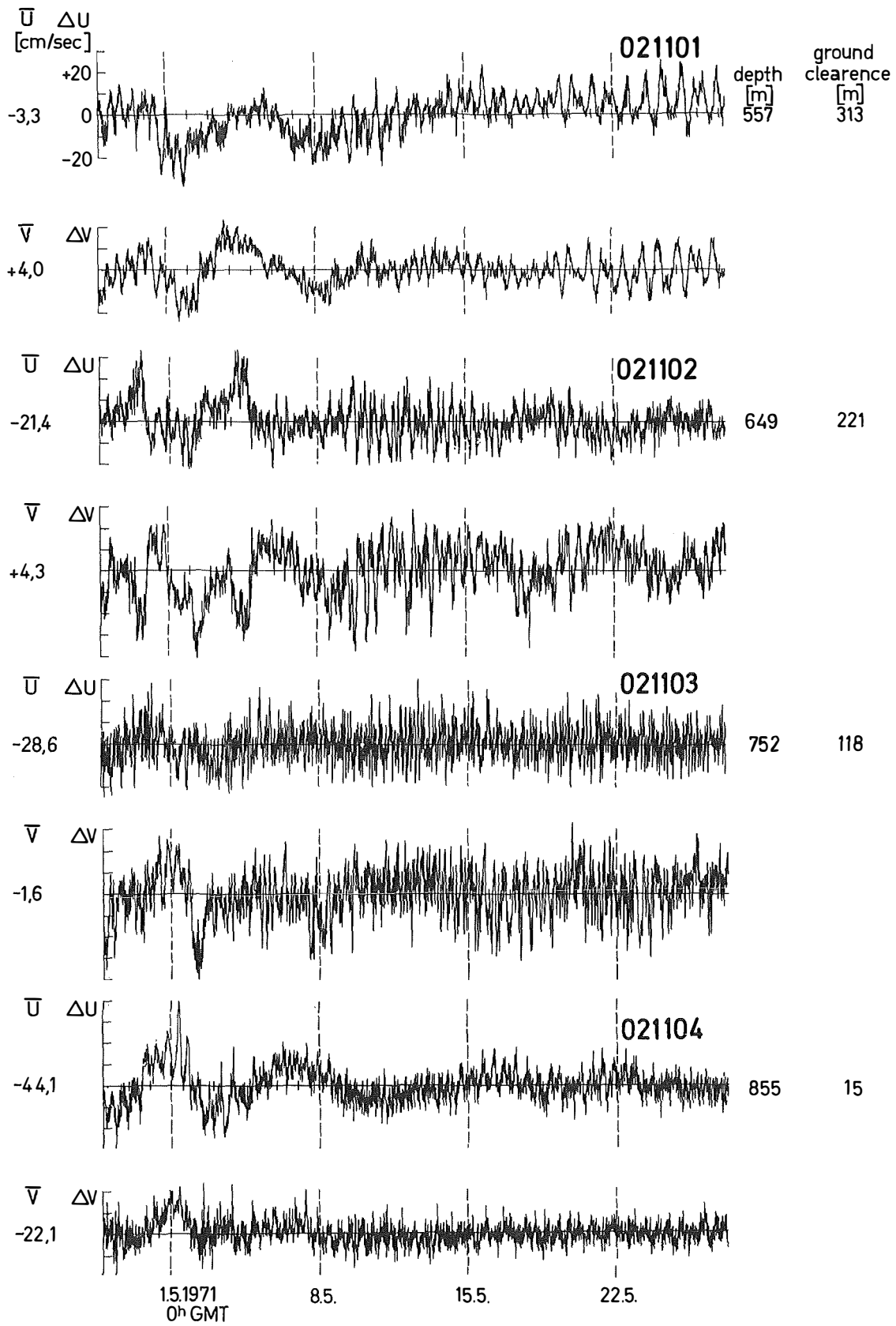


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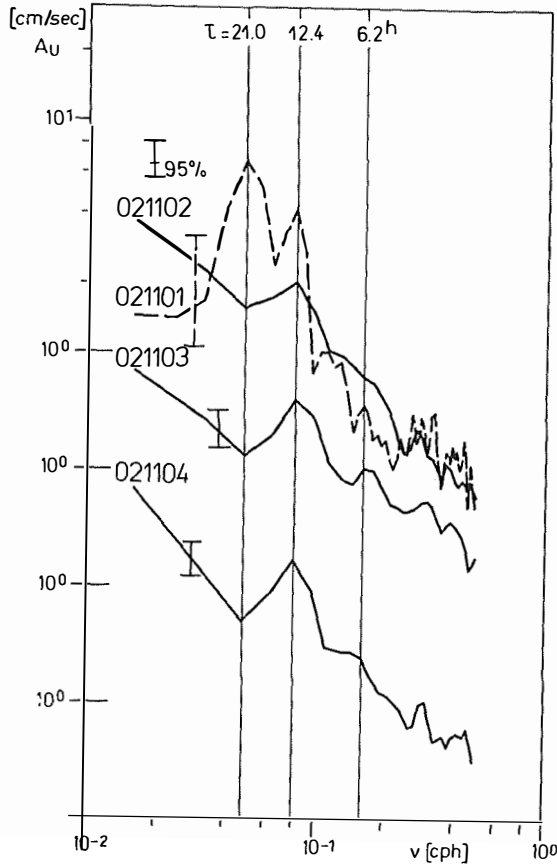


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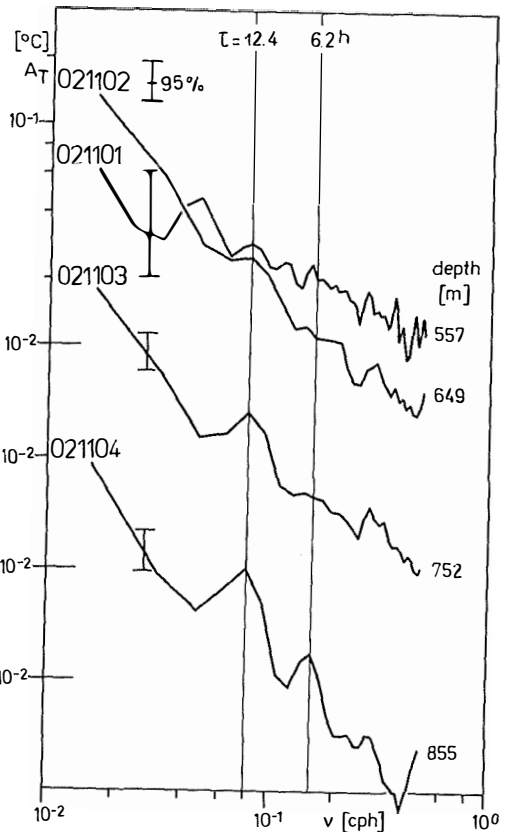
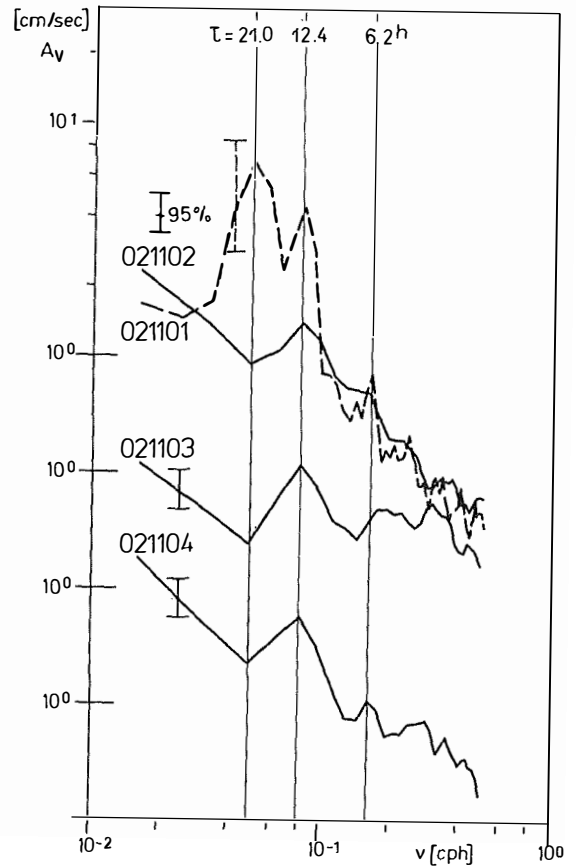


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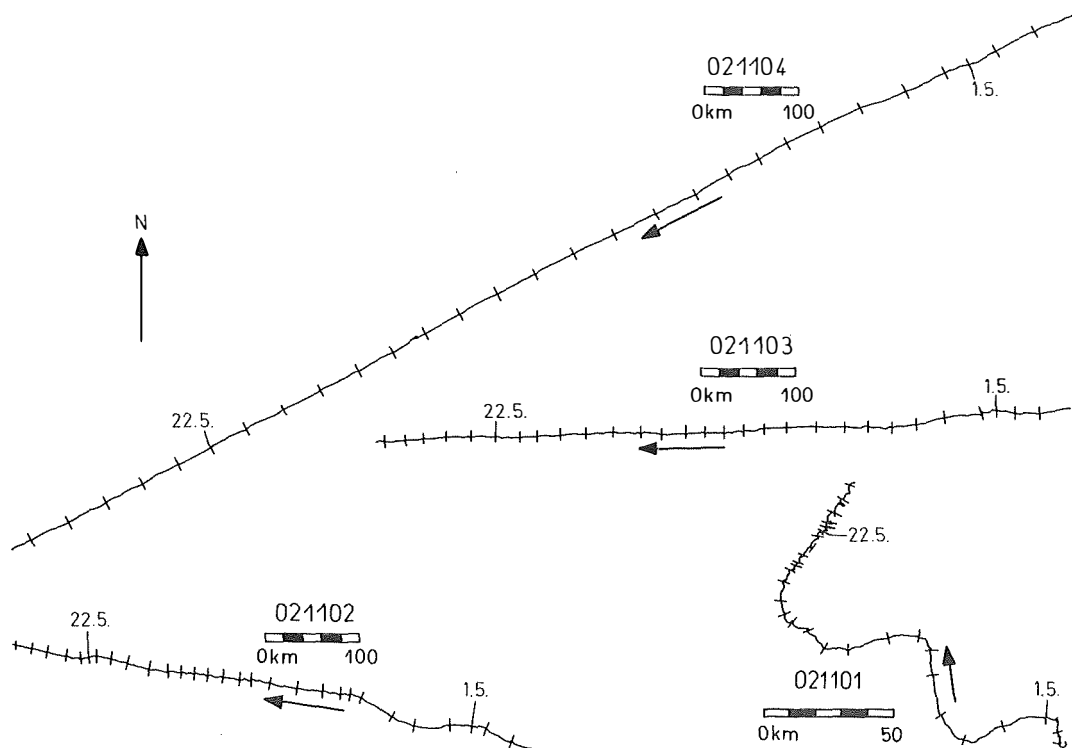


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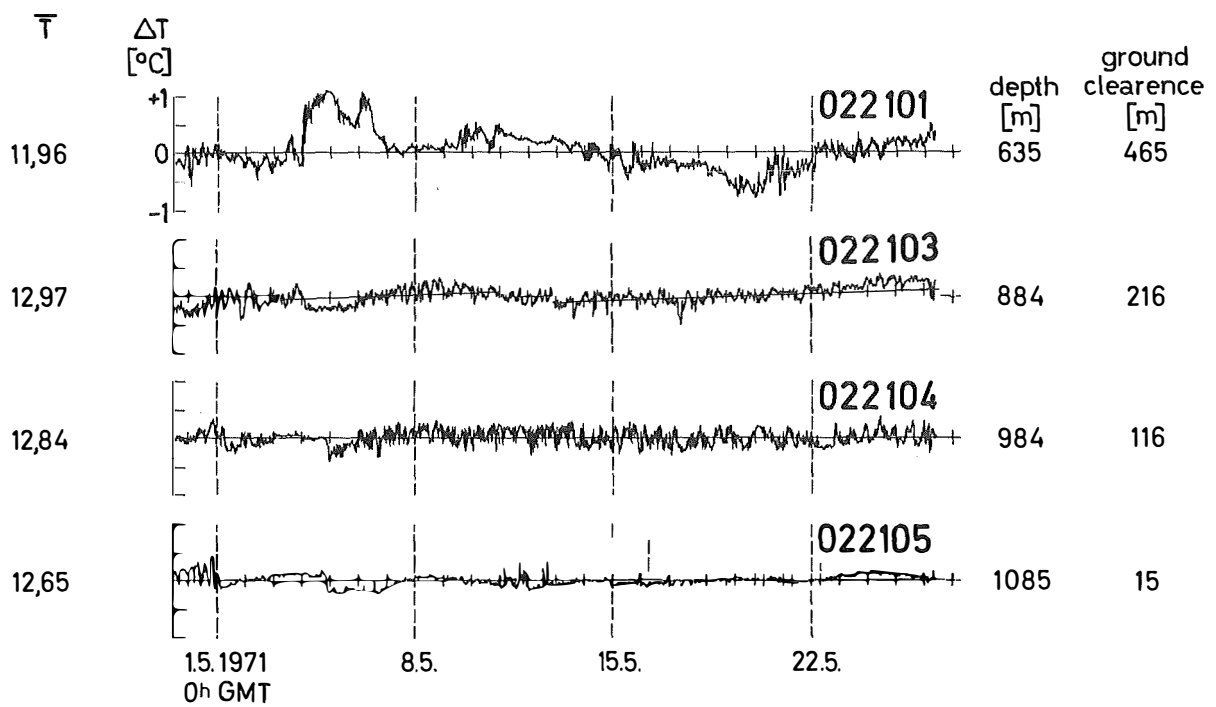


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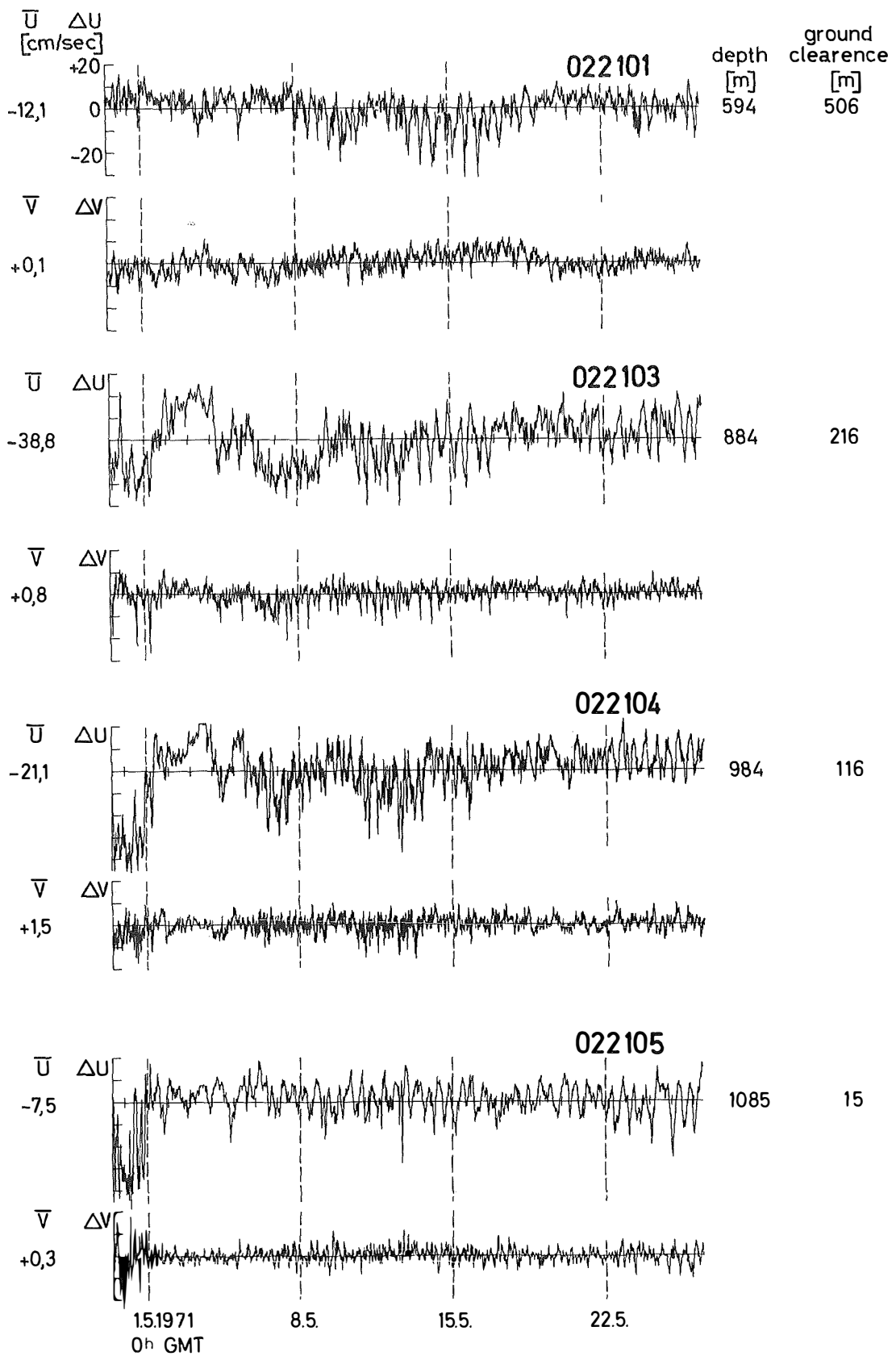


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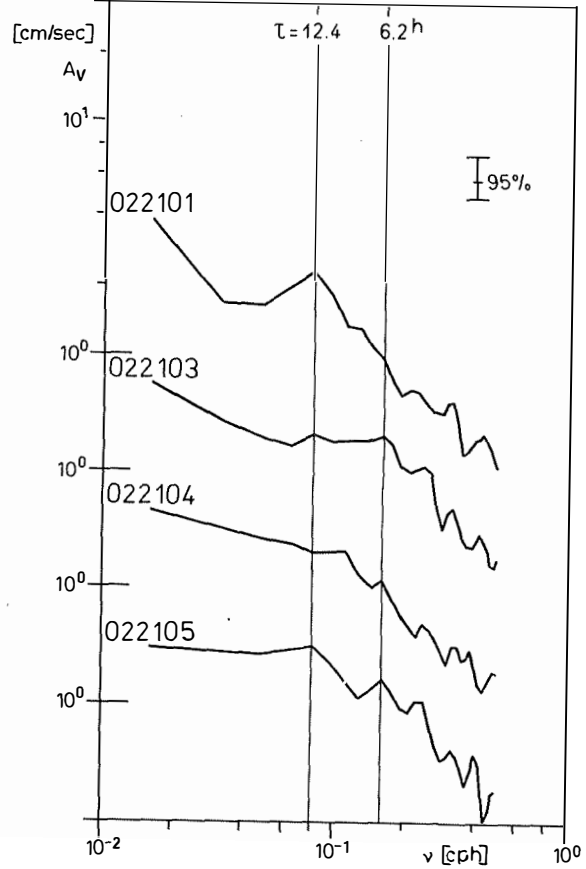
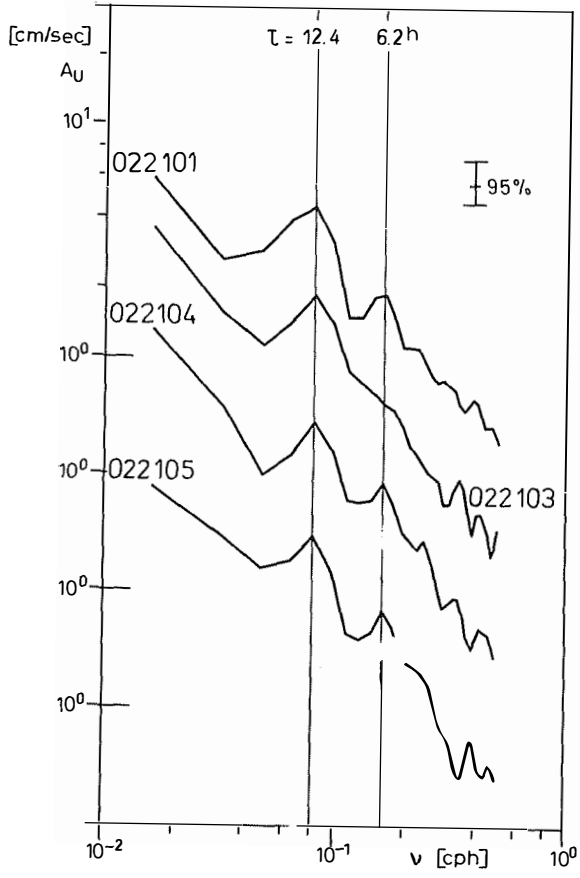


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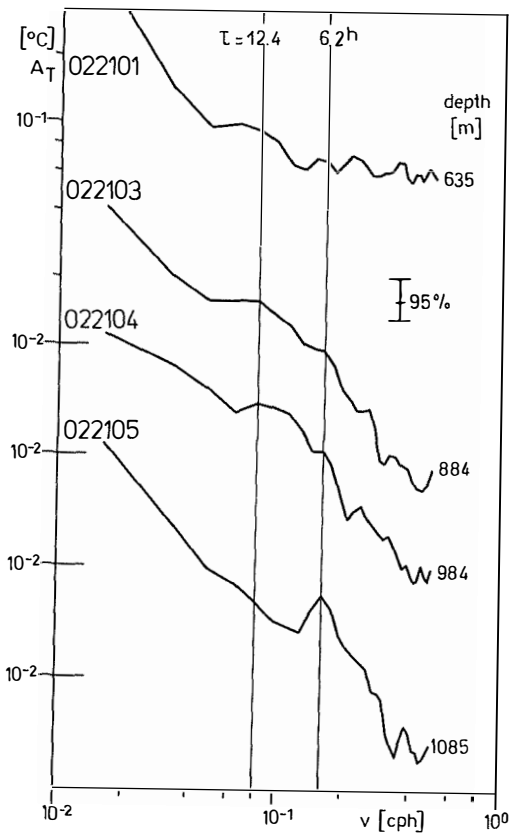


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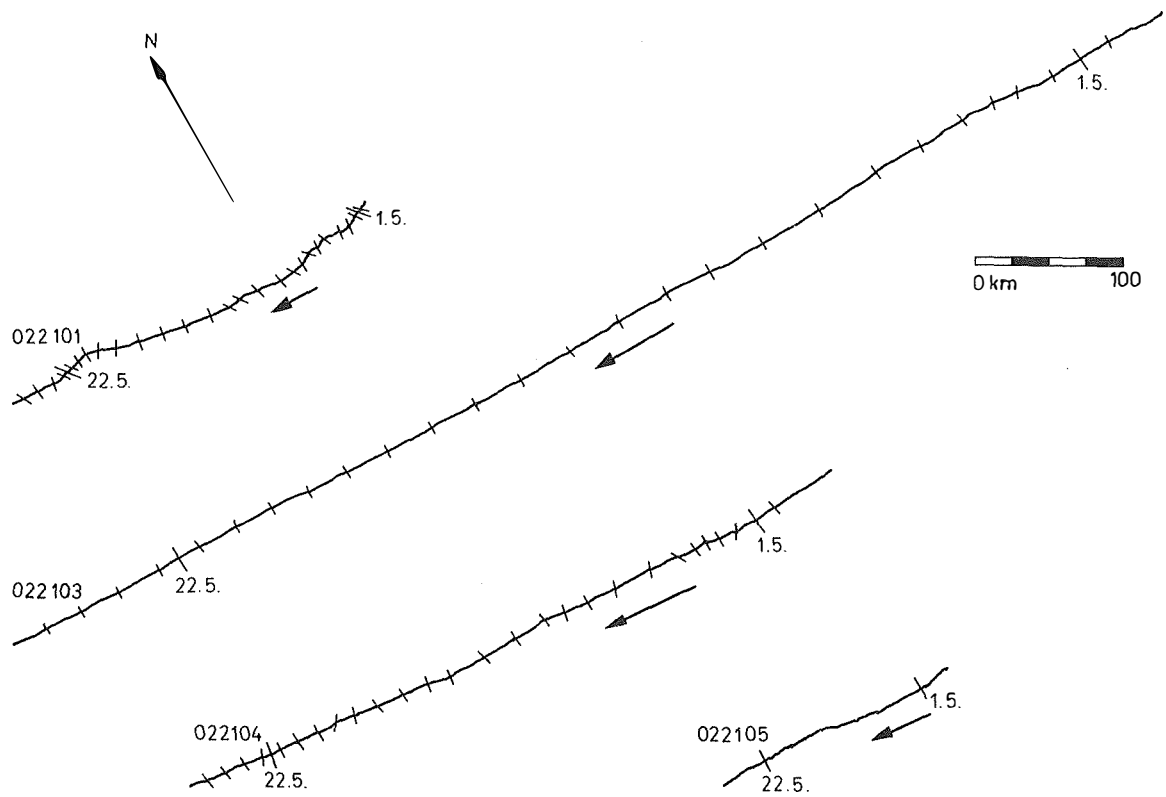


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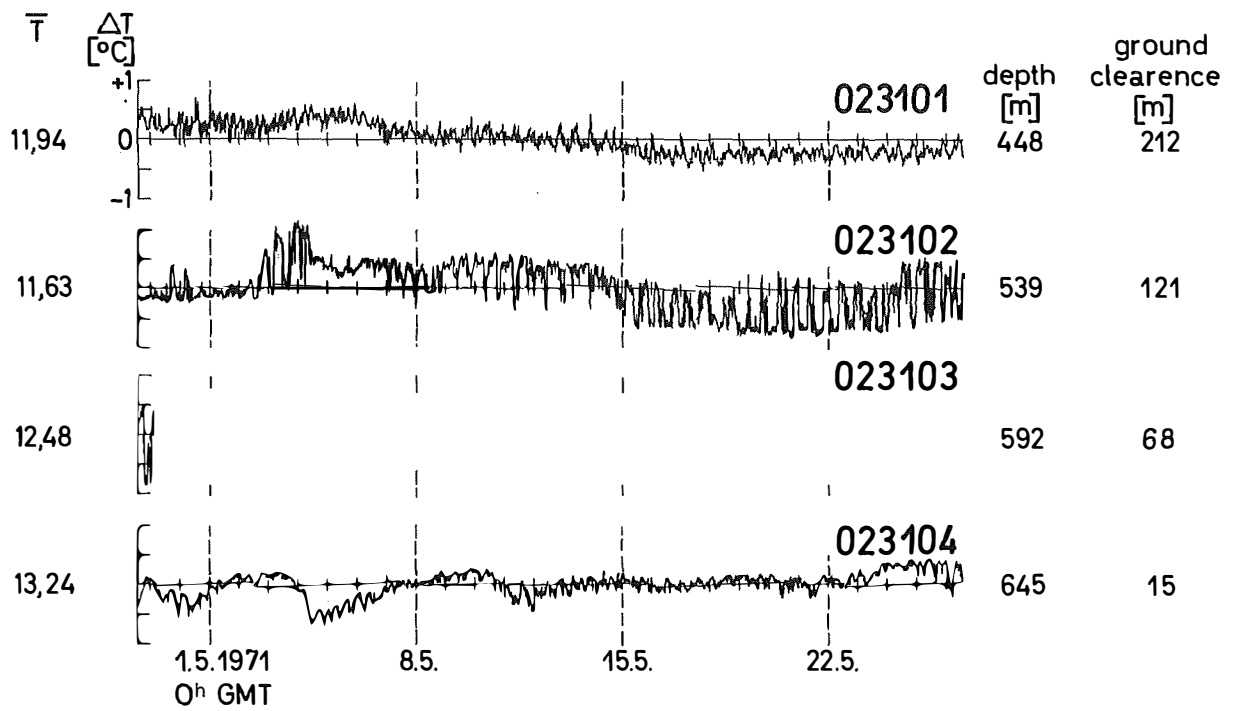


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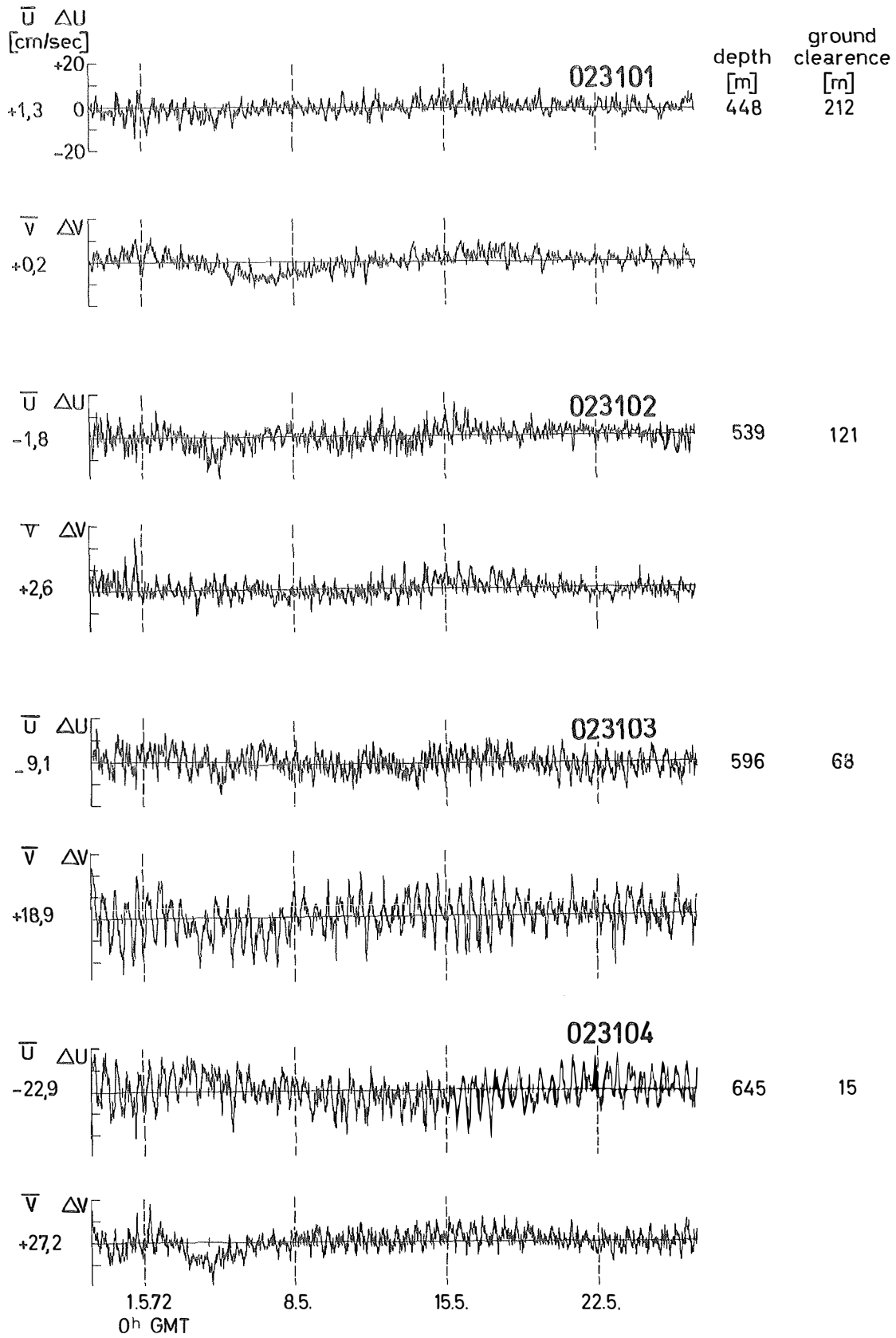


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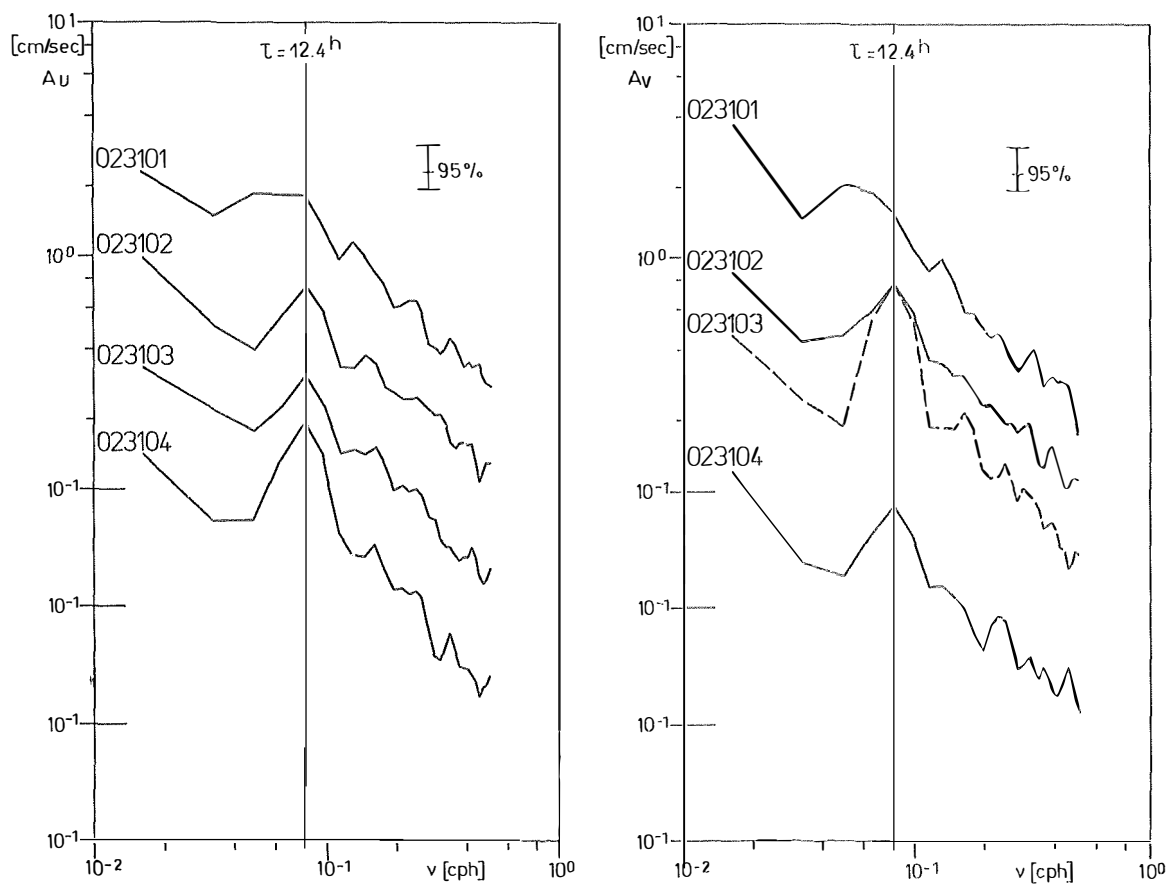


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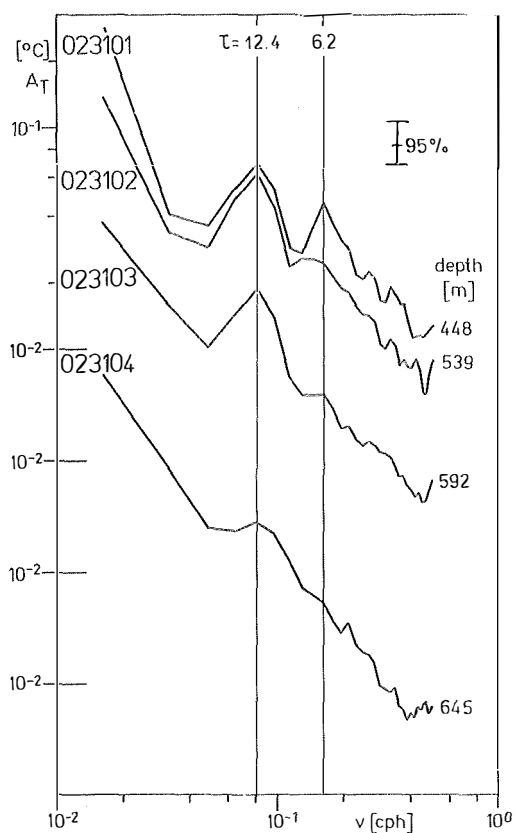


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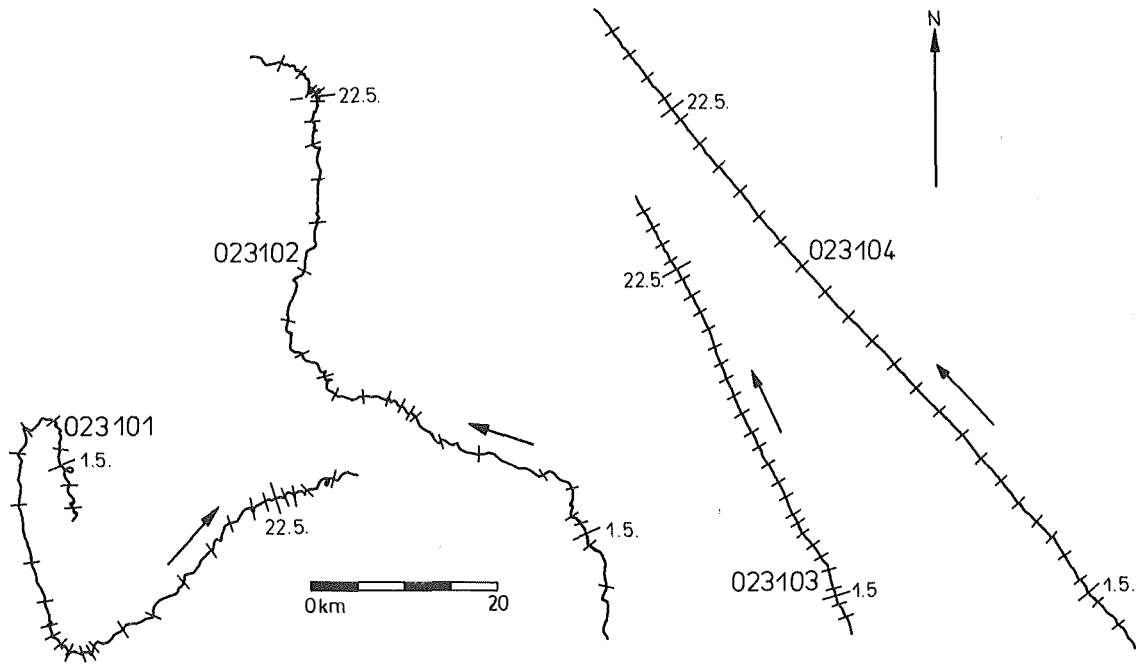


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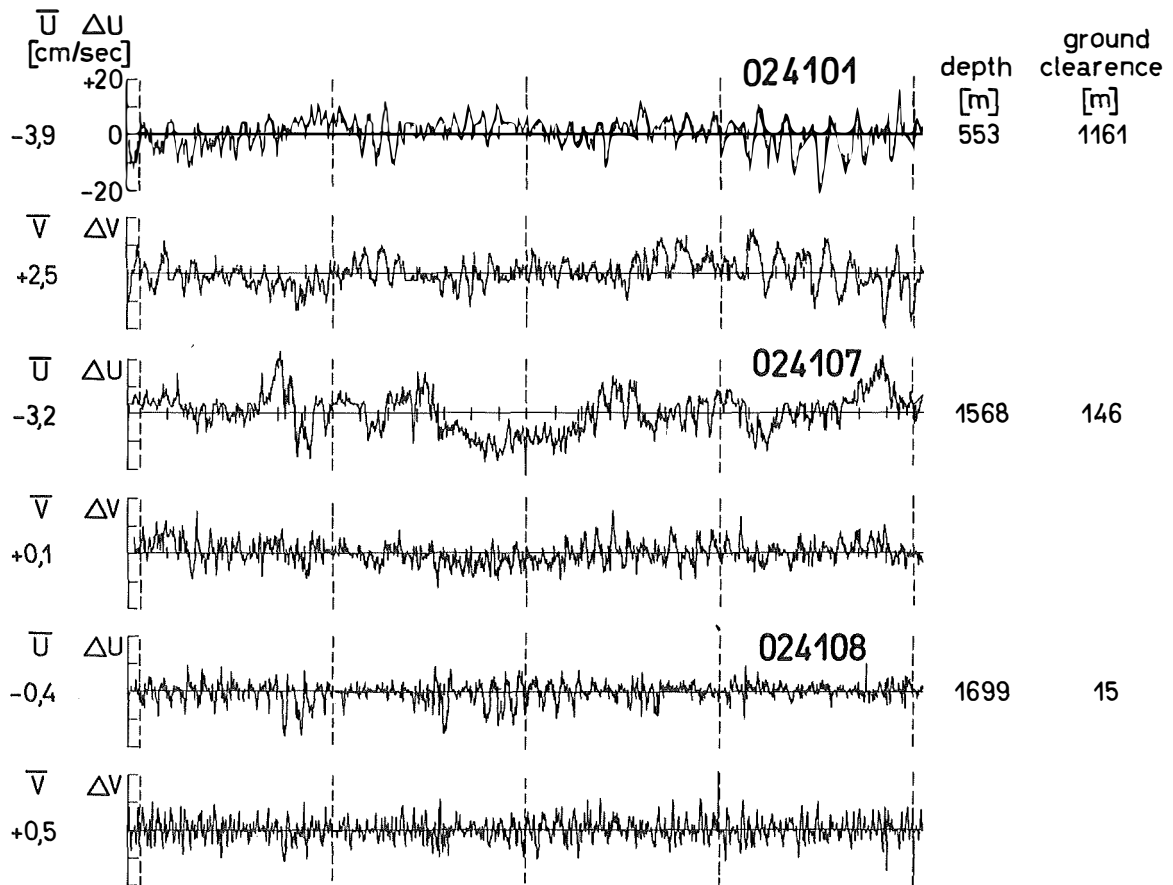


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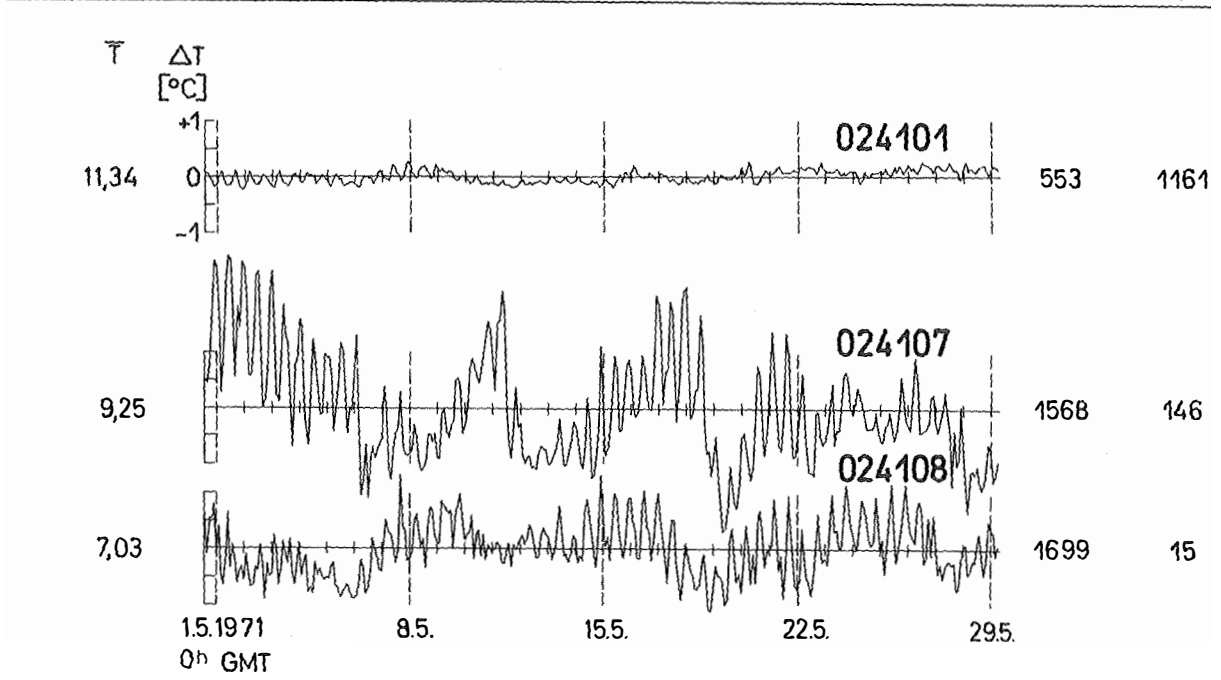


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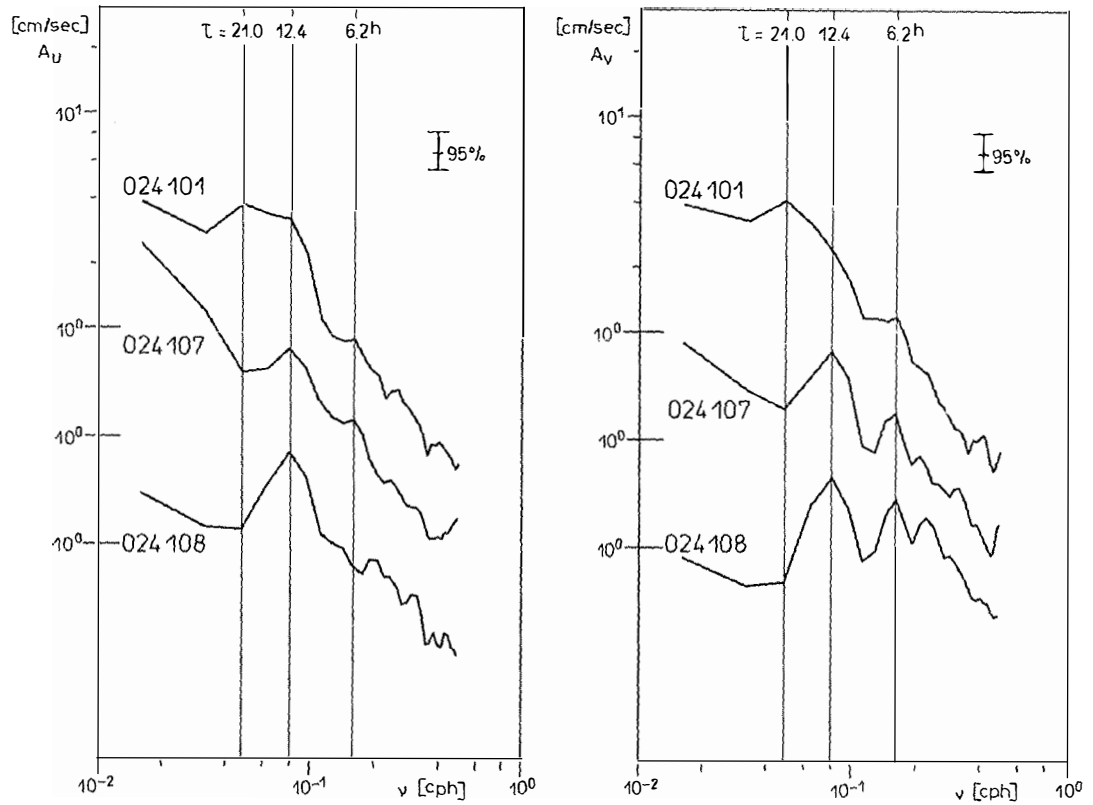


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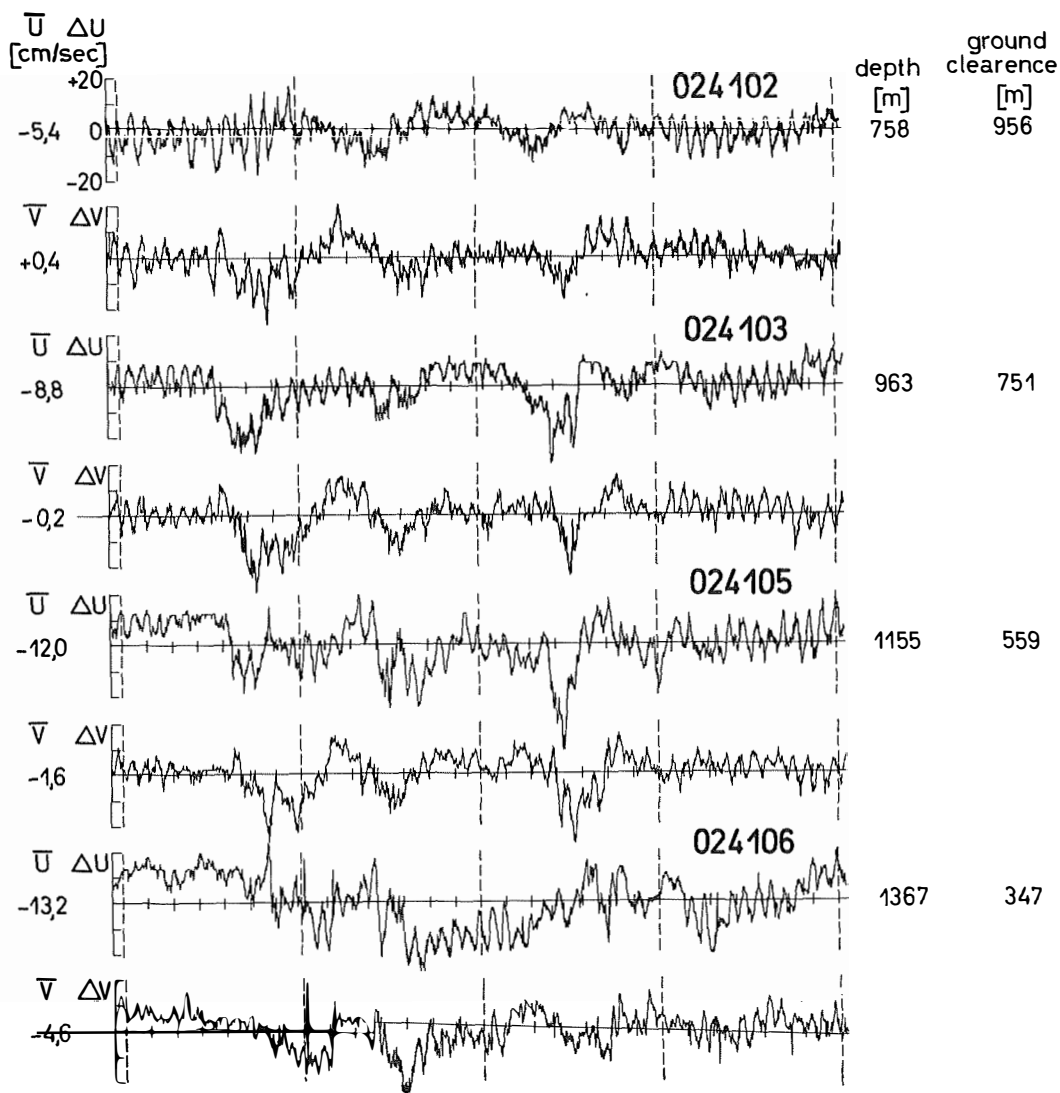


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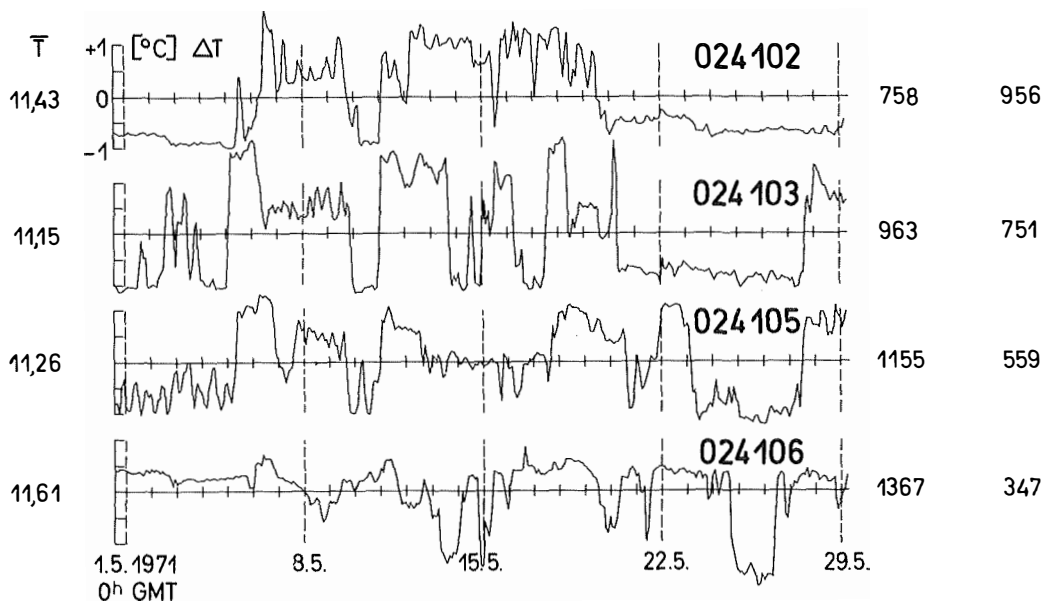


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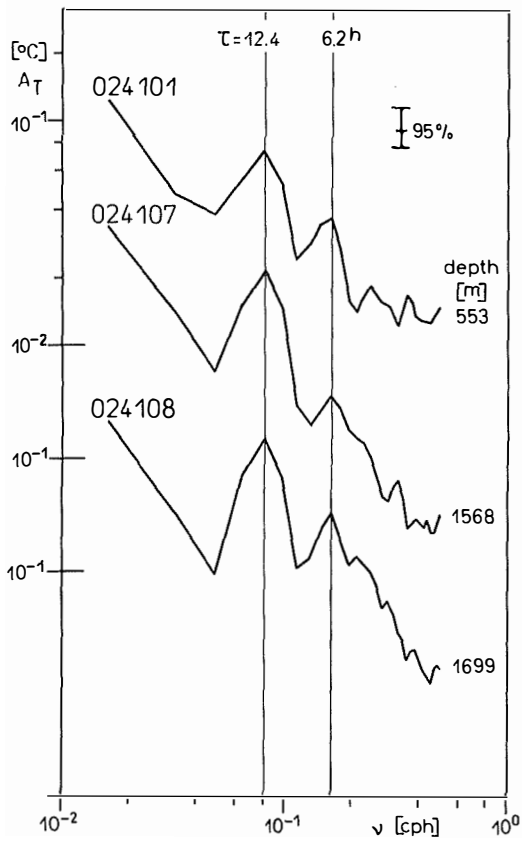


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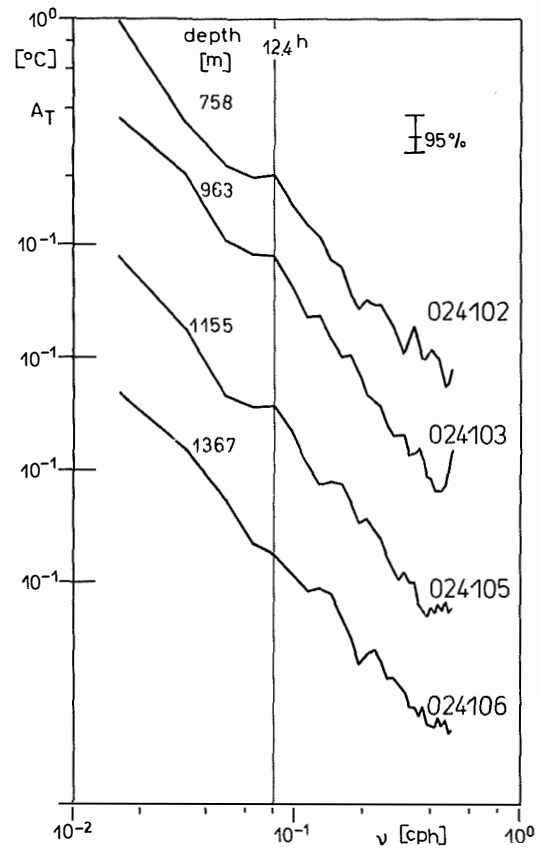


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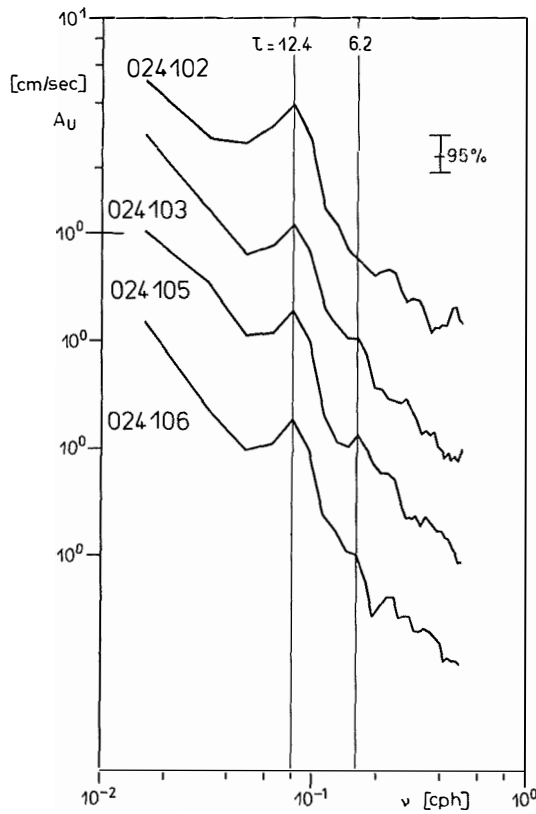
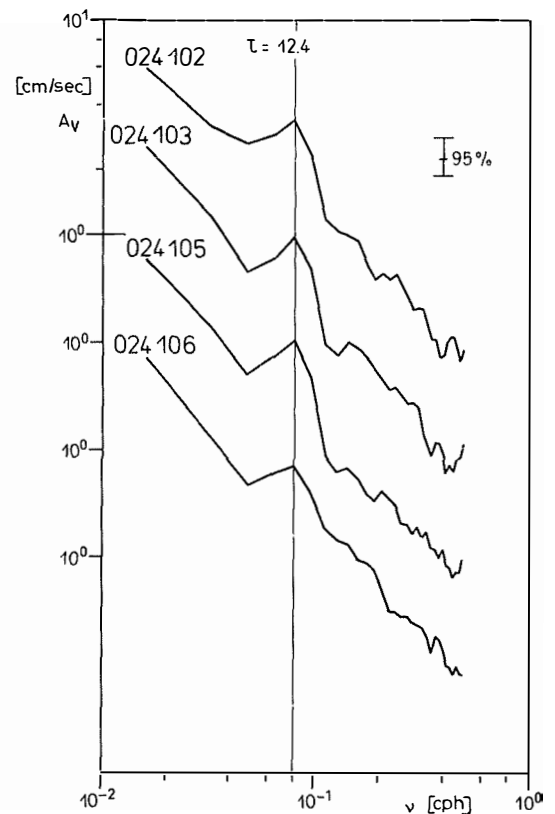


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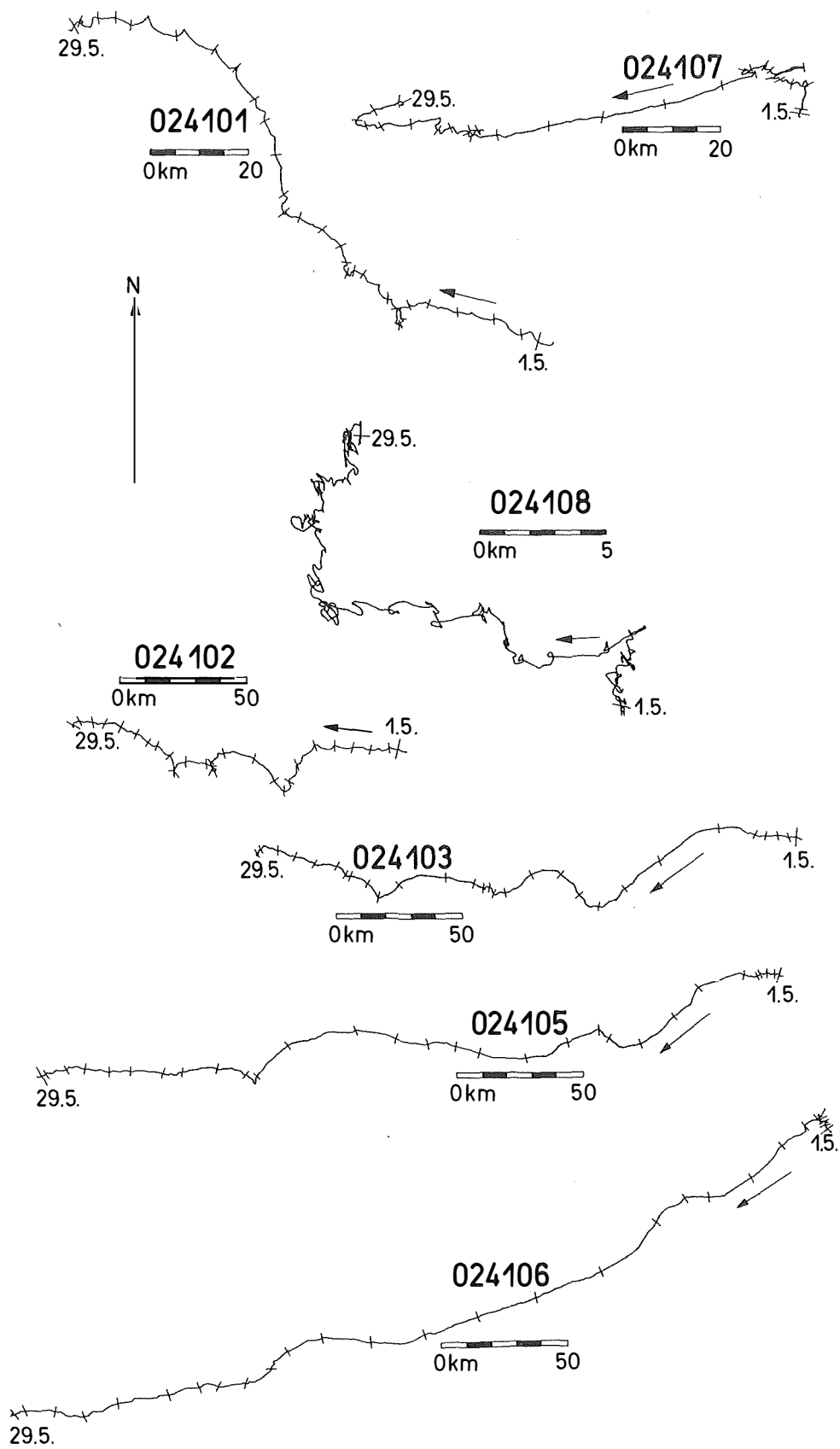


Fig. 40

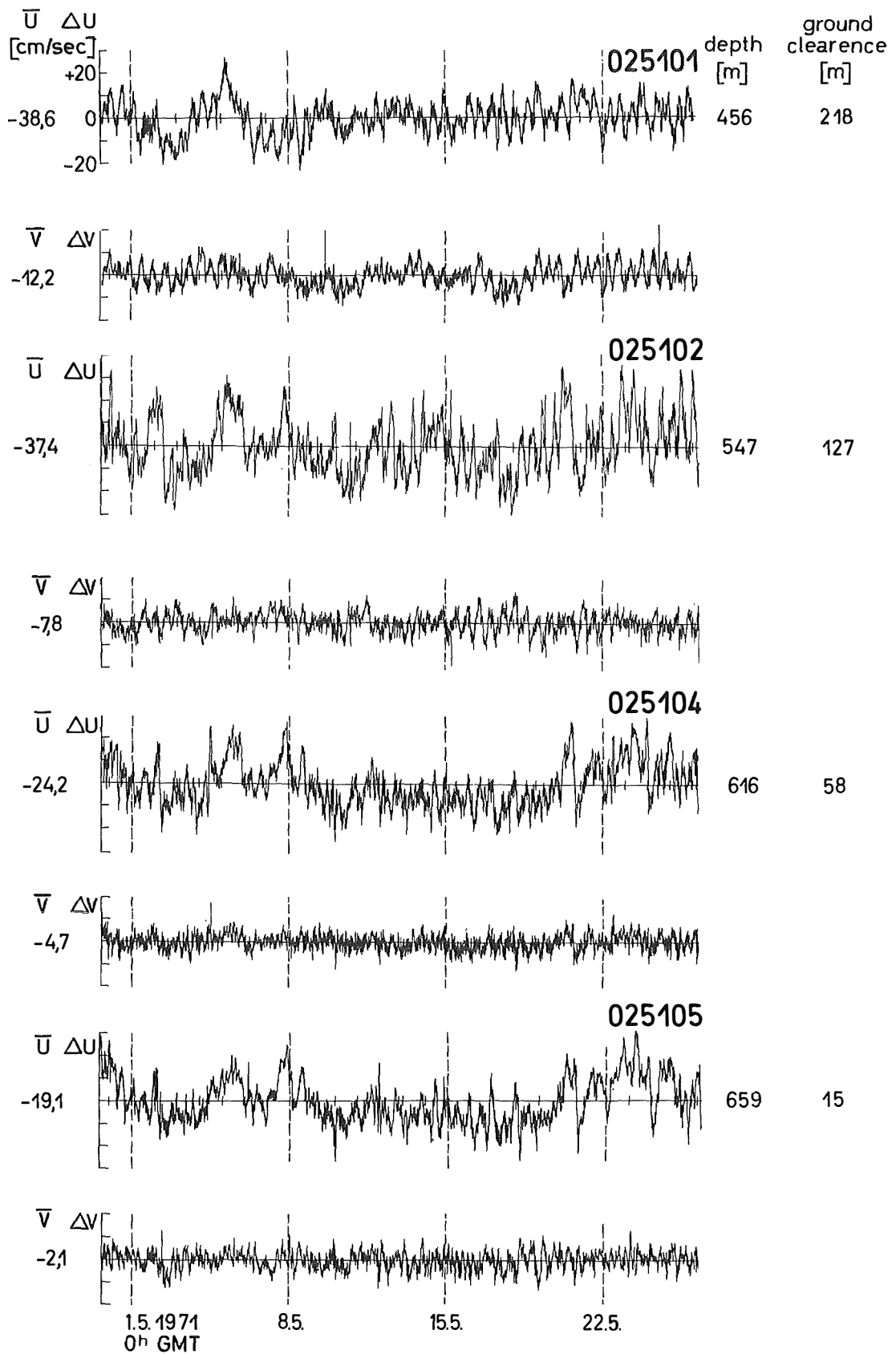


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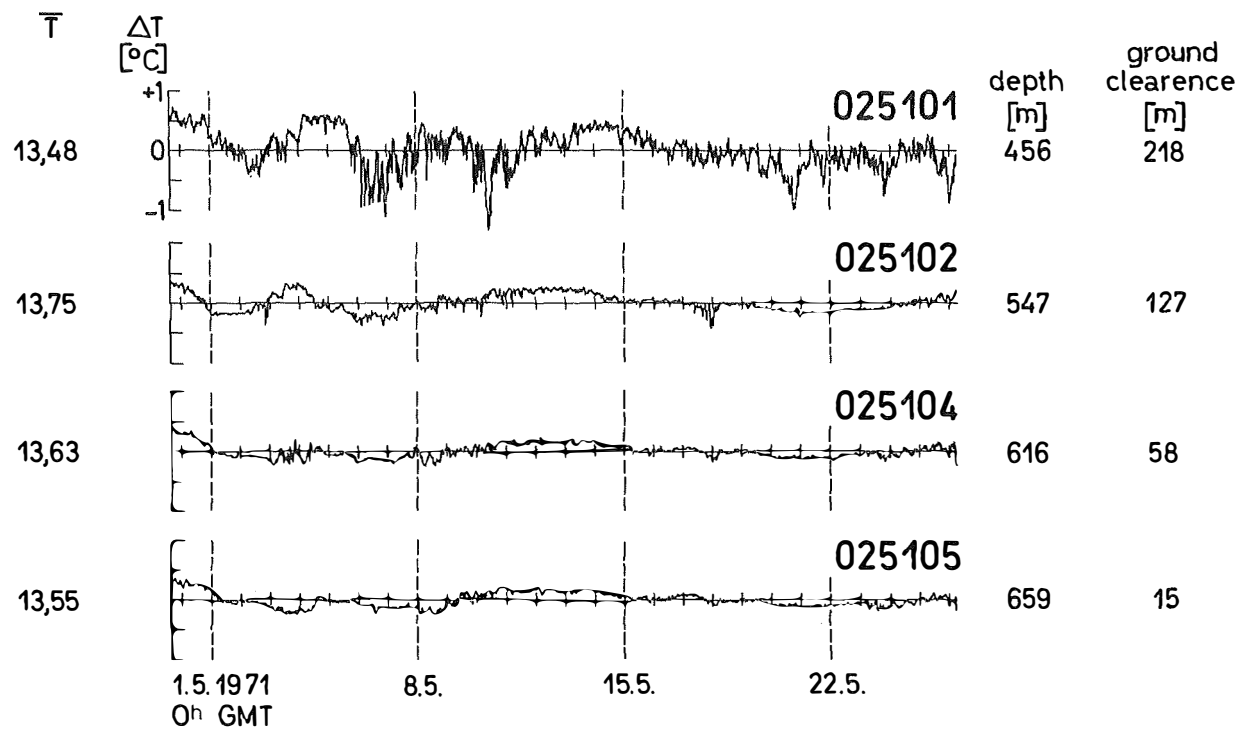


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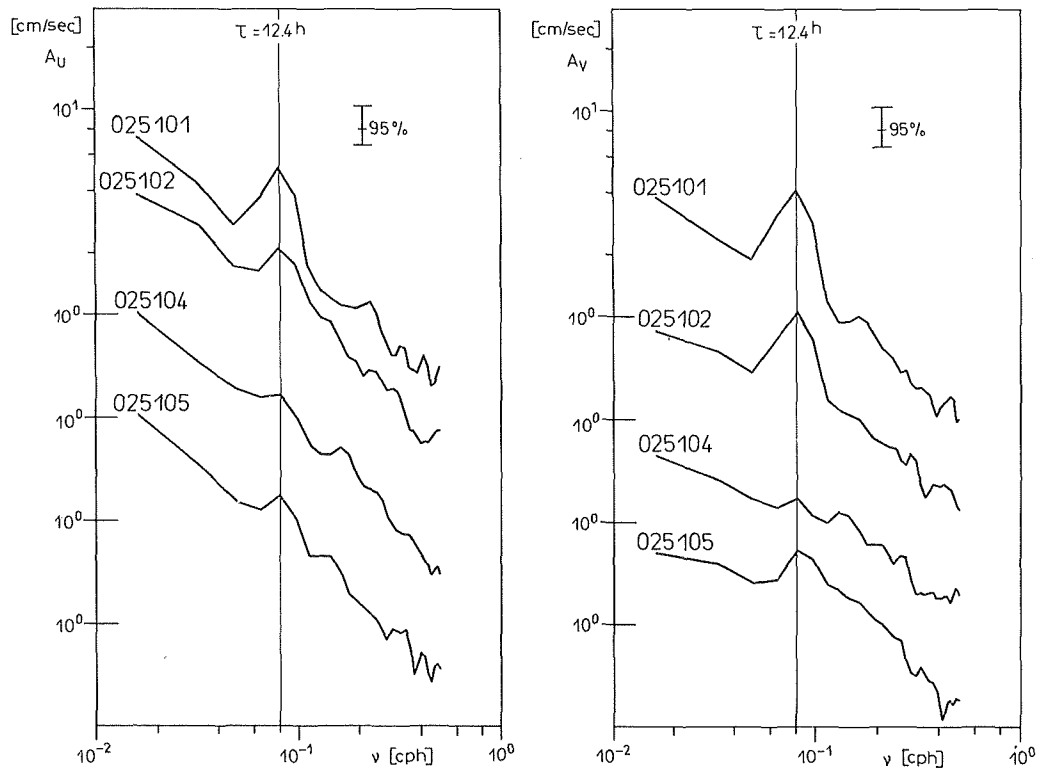


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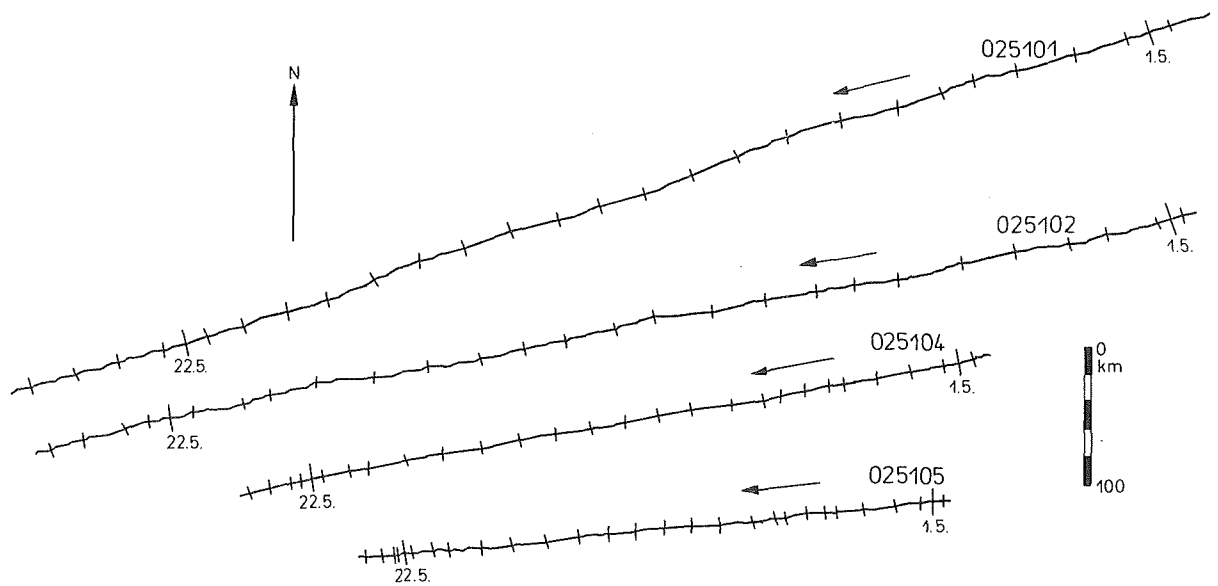


Fig. 45