METHODOLOGY OF FIELD STUDIES

FOSSIL FROST- AND ICE WEDGES

INTRODUCTION

by

ANNA DYLIKOWA

Investigations of the present-day permafrost areas, the intensity of which has remarkably increased during the last 20 years, have greatly contributed to the detailed cognition of the processes occurring in periglacial environment, and to the explanation of the origin of some structures and land-forms caused by frost processes. The results of these investigations bearing the most valuable comparative data for the interpretation of fossil traces of periglacial environment, impose upon the scholars concerned with reconstruction of the Pleistocene periglacial phenomena the obligation of a very accurate interpretation of the observed facts. Our present state of knowledge of the environmental characteristics included into the notion of *periglacial zone*, which are strongly differentiated in geographical space, requires the same differentiation as regards the climatic changes in time during the Pleistocene and particularly during the last cold period (Würm).

The programme of the former Commission on Periglacial Morphology of the International Geographical Union, defined in 1955 (J. DYLIK, R. RAYNAL, *Biuletyn Peryglacjalny*, no. 6), contains a number of problems full of present interest. As the most pressing had been set the task of making an inventory of the Pleistocene periglacial phenomena and their cartographic presentation providing facilities for a synthetic approach to the subject, important not only in the regional scope. Continuation of the work in this sphere of activity has been undertaken by the scholars concerned with the fossil traces of periglacial environment, who are grouped in the Co-ordinating Committee for Periglacial Research of the International Geographical Union.

Progress in the investigations of the present-day periglacial areas, advance of the comparative studies, as well as the more and more ample stock of information about the Pleistocene frost phenomena call for a uniform method of work and a uniform interpretation, which will constitute the most appropriate way for synthetic elaboration. Maybe, it would be purposeful to undertake anew an analysis of at least a part of the already collected material and to check the interpretation in the light of new data and opinions.

In the first stage of work it should be gathered materials dealing with fissure (wedge) structures, for they are leading forms in Pleistocene sediments, bearing the essential witness to the presence or lack of permafrost and other conditions of the environment.

The underneath presented Instruction (prepared by J. S. Goździk) calls attention to these features of fissure structures that are of special importance for determination of their origin and for the paleogeographical interpretation. Characteristics of the structures based on the uniform registration of their essential features will enable collecting of the comparative material and, in consequence, will permit to draw concrete paleogeographical conclusions.

The classification of fissure structures added to the Instruction and worked out by A. Jahn, complements the schemes presented in the Instruction. It would be most desirable to have the gradually collected material published in the *Biuletyn Peryglacjalny*. The meeting that is likely to be held in Poland in 1979, will be devoted to the analysis of chosen examples of fissure structures and to discussion on their genetic and paleogeographical interpretation.

Detailed analysis of fossil contractional frost-fissures, an Instruction

by

Jan Stanisław Goździk

1. In order to eliminate the wedge-like structures from true fissure forms, their shapes should be examined in three dimensions, i.e. the vertical section and horizontal plan at a distance of 0.5 m.

2. To determine geometrical figures formed by fissure structures in horizontal section (polygons, stripes) and their topographic situation. To estimate sizes of the figures in large horizontal sections or from the air photographs. When the observations of the whole structures in horizontal plan is impossible, the outline of forms of figures and their sizes can be determined by measurement of the azimuths of small fragments of fissure structures in horizontal section and by statistical analysis of the data collected[1].

[1] The example of such an analysis is to be found in Gozdzik's paper, 1976.

These determinations are important for confirmation of the contraction origin of fissures as well as for differentiation of the thermal contraction wedge-structures from the dehydrational ones.

3. Characteristics of fissure structures recognized in vertical section facilitate a more accurate defining of the origin of fissures and especially the mode of their infilling.

3.1. Limits of fissure structures with the surrounding material and kind of deformations of the adjoining sediments

3.1.1. Borders of wedge structures

3.1.1.1. material infilling wedges preserves continuity
- with adjoining sediments (fig.: 1, 3, 4, 5, 6)
- with overlying sediments (fig.: 2)
- with overlying and host sediments (fig.: 3)

3.1.1.2. – with sediments underlying the wedge (fig.: 9)
Sediments infilling the wedge are completely alien to the surrounding material (fig.: 7)

3.1.1.3. material in fissure structure is composed of 3.1.1.1, and/or 3.1.1.2

3.1.2. Deformations in sediments adjoining the wedge

3.1.2.1. upturned layers, especially in the upper border of a wedge (fig.: 7)

3.1.2.2. layers turned downwards showing continuity preserved (fig.: 1, 5, 6) or with disjunctive downward dislocations (fig.: 3, 4)

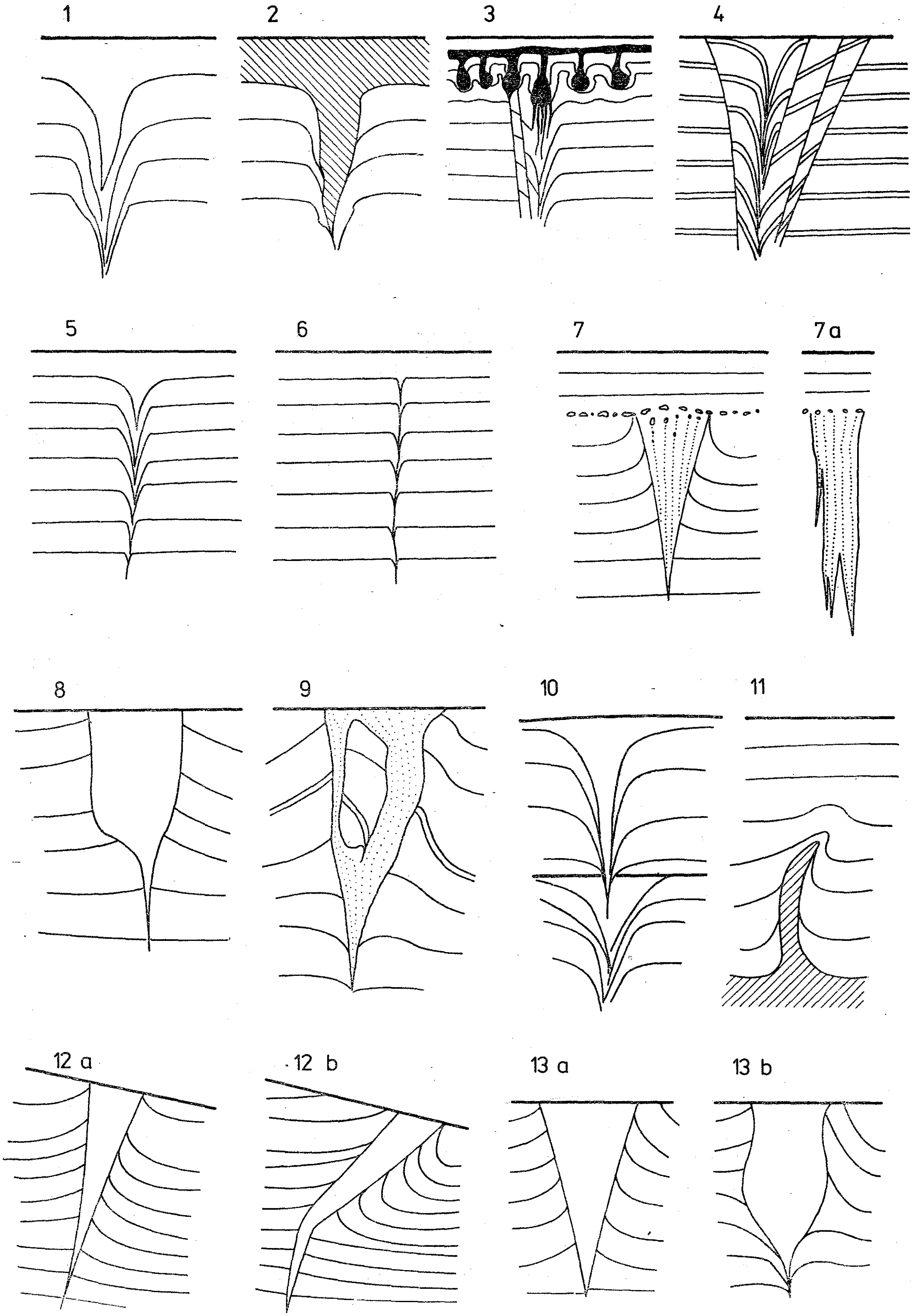
3.1.2.3. composed character of deformations (fig.: 8, 9)

3.2. Depth and width of fissure structures

3.3. Lithological properties of material infilling fissures in comparison with host sediments (especially grain sizes and grain roundness) To state whether:

3.3.1. differences between the fissure infilling and host sediments are insignificant and do not exceed the rate of differentiation of properties mention above within each of material series separately

3.3.2. differences between fissure sediments and host material are significant. In this case it is also useful to analyse the similar properties of fissure- and overlying sediments, even of farther occurrence. If the wedges are filled with sands, it is advisable to compare them with typical eolian sands of the region and to determine possible vertical differentiation in the grain size distribution: remarkable concentration of coarser grains in the top parts of wedges. Essential is also statement whether the wedge material shows a vertical fabric (fig.: 7) and whether the narrow fissures protrude down the wedge (fig.: 7a).


1
2
3
4
5
6
7
7a
8
9
10
11
12 a
12 b
13 a
13 b

3.4. On the basis of essential characteristics to classify the wedge structures into one of main groups of thermal contraction structures:

3.4.1. structures with secondary infilling

3.4.1.1. after ice-wedges (fig.: 1, 2, 3, 4)

3.4.1.2. seasonal (fig.: 5, 6)

3.4.2. structures with primary infilling (fig.: 7)

3.4.3. composed structures (fig.: 8, 9)[2]

4. Stratigraphic position of wedge structures

4.1. To determine the epigenetic or synsedimental (informational) character of structures (fig.: 10)

4.2. To distinguish main horizons of the occurrence of Würmian thermal contraction fissures

4.3. To qualify the genetic type and frequency of occurrence of structures in a given horizon

4.4. To determine stratigraphic position of each wedge horizon in relation to another stratigraphic leading levels (e.g. fossil soils)

5. To determine the secondary deformations of fissure structures

5.1. – associated with the slope mass movement (fig.: 12a ,b)

5.2. – associated with the unstable equilibrium of the infilling and host material (fig.: 13a, b)

CLASSIFICATION OF THE PLEISTOCENE FROST- AND ICE-WEDGE STRUCTURES

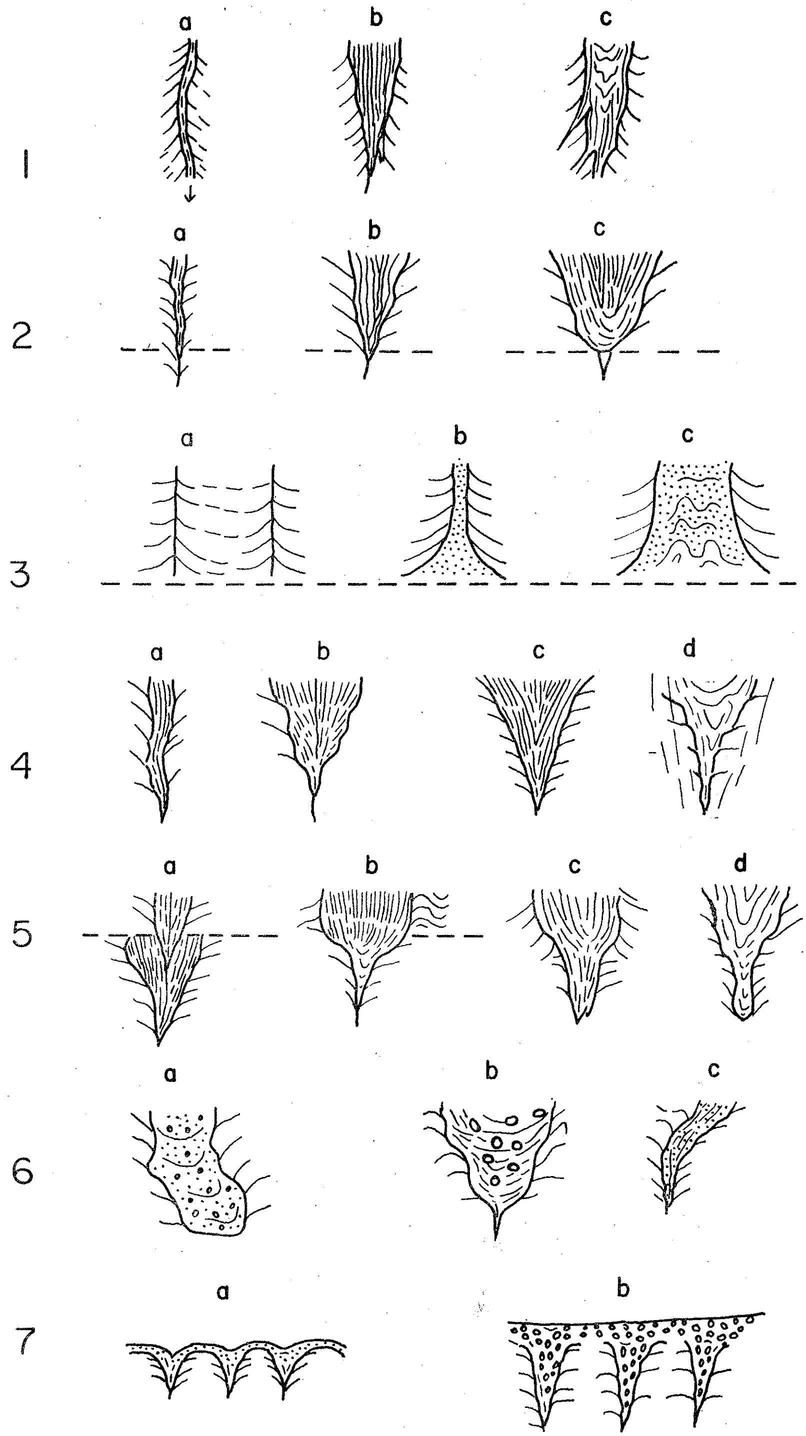
by

ALFRED JAHN

1. Primary non-ice wedges (frost wedges)
   Sand wedges
   a – narrow frost crack, with primary infilling
   b – sand wedge with vertical foliation of the infilling material
   c – sand wedge with a bowl-like structure of the infilling material

[2] Detailed classification may be variously formulated, as the example there has been presented Alfred JAHN's classification (JAHN 1970). The abridgement of this classification see below.

2. Wedges with secondary seasonal infilling
Frost structures in the active layer of permafrost
Ground veins, soil veins
   a — initial frost crack, filled in the active-layer part, "sag" vein
   b — mature wedge with vertical foliation of the infilling material
   c — wide, furrow-like wedge with a bowl-like structure of the infilling material
3. Inverse wedges — wedge intrusions
Fissure-intrusion structures
   a — frost crack warped up due to cryostatic pressure
   b — inverse wedge intrusion
   c — inverse cryoturbation structure
4. Syngenetic and epigenetic ice wedges with secondary infilling
   a — narrow syngenetic wedge, with irregular sides
   b — broad syngenetic wedge, showing a storied pattern
   c — epigenetic double wedge, ("cone-in-cone"), with vertical foliation
   d — epigenetic wedge with a bowl-like structure of the infilling material, connected with vertical frost cracks and micro-faults along the sides
5. Composite wedges
   a — two-storied wedge, ground vein in the upper part (active layer), inactive ice wedge in the lower part
   b — two-storied wedge, very well formed ground wedge in the upper part, and infilled after inactive ice wedge in the lower part. SOERGEL's classical "ice wedge"
   c — wedge consisting of a syngenetic segment (active) in the upper part, and of an epigenetic segment in the lower part
   d — reverse type to "c" — epigenetic segment in the upper part and syngenetic segment in the lower part
6. Wedges of secondary deformation
   a — deformed structure due to thermokarst processes and thermoerosion. Modification of ice wedge into the trench- or sack-shaped form
   b — deformed structure due to gravity, structures formed by subsidence of covering material over the melted ice veins, including load cast structures
   c — deformed structure due to slope processes (gelifluction). Imposed wedges, bending in the line of active horizon
7. Wedge structures in permafrost area, limited or lack of frost action (permafrost decay cracks, non-cryogenic structures)
   a — desiccation cracks (i.a. "cushion" soils in loess)
   b — cracks caused by thermal degradation of permafrost


a
b
c
1
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3
4
d
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