

Thermal regime of coarse-grained slope covers at Mt. Szrenica and Mt. Łabski Szczyt in the Karkonosze Mts.

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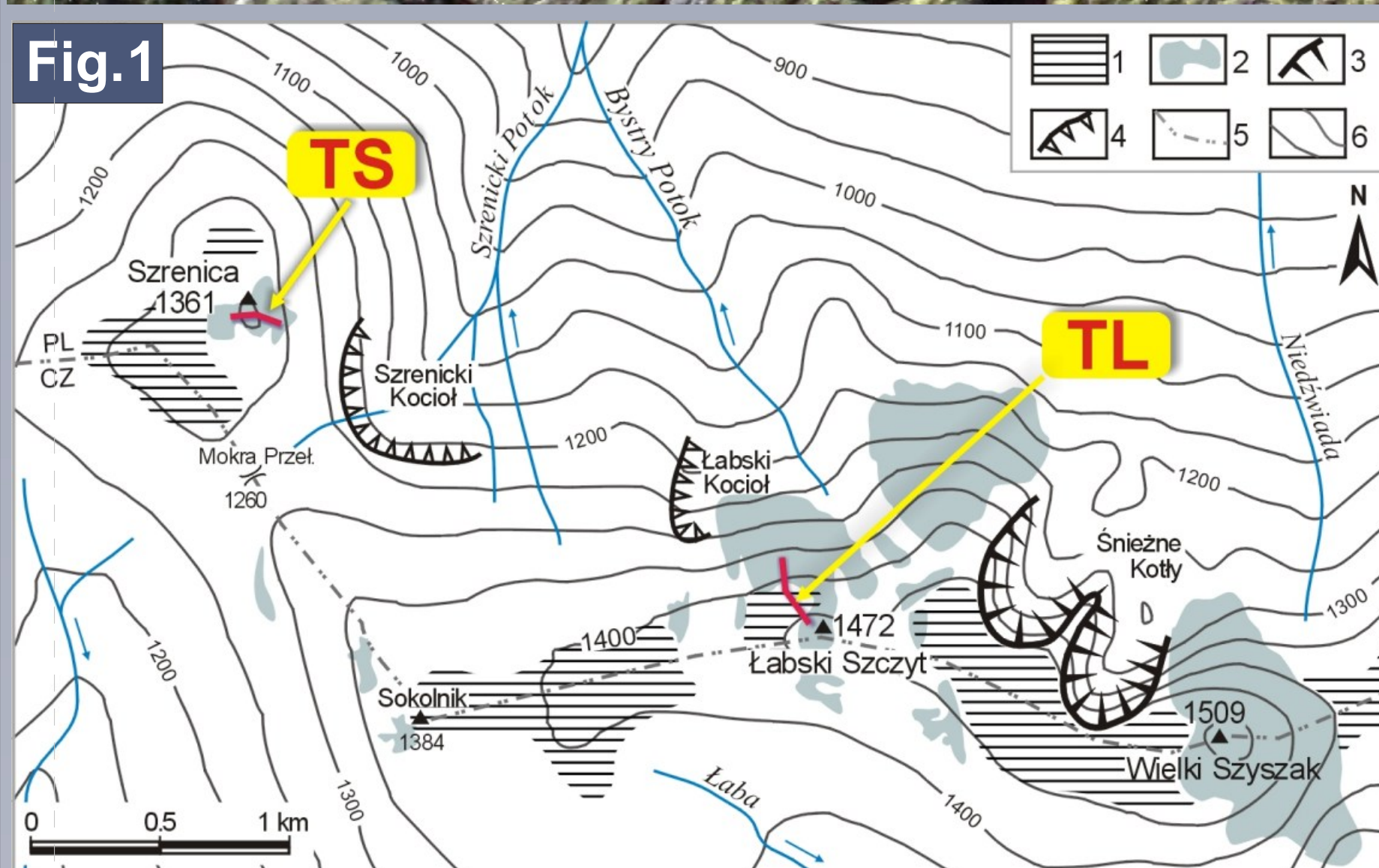


Fig. 1. Location of study area (TS and TL) in the Karkonosze Mts. Explanations: 1-summit planation surfaces, 2-block fields, 3-glacial cirques, 4-nivation hollows, 5-Polish-Czech state boundary, 6-contours (50 m interval).

Fig. 2. Block cover at the summit of Szrenica Mt. Explanations: 1-tors and rock outcrops, 2-extend of block cover, 3-block fields, 4-break of slopes, niches, 5-block lobes, 6-contours (25 m interval), 7-roads and footpaths, 8-state boundary.

Fig. 3. Block covers in the region between Łabski Szczyt Mt. (ŁS) and Snieżne Kotły glacial cirques (MKS). Explanations: 1-breaks of slopes, 2-tors, 3-rock wall of glacial cirques, 4-nivation hollow, 5-chutes and gravitational cones, 6-extend of block cover, 7-block fields, 8-solifluction lobes and tongues, 9-niches, 10-frost riven cliffs, 11-frost sorting forms, 12-erosional channels, 13-contours (50 m interval), 14-roads, footpaths, 15-state boundary.

Fig. 4. Diagram showing the location of thermal sensors in the block cover.

Fig. 4

The aim of the project was to examine thermal properties of coarse-grained periglacial covers (block fields) situated in the western part of the Karkonosze Mountains.

The purpose of the field works was to:

- determine annual ground surface temperature (GST) course and
- frequency of freezing-thawing cycles in the bodies of the block fields.

Up to now comparable works was carried out only by the Czech researchers. They analysed contemporary freezing processes and dynamics of the seasonal permafrost in the summit part of the Karkonosze Mts.

Equipment:

GST measurements were accomplished using Onset Hobo Pro miniature data loggers located in two terrain cross-sections named TL and TS (Fig. 1).

Site locations:

Section TS (Fig. 2) lies across the Mt. Szrenica (1317-1357 m a.s.l.). In this cross-section 4 devices have been installed: one on the western slope (1349 m a.s.l.), two on the slope of eastern aspect (1351 and 1335 m a.s.l.), and one on the top of the Mt. Szrenica at altitude 1357 m a.s.l. (Tab. 1)

Section TL (Fig. 3) was delineated from the summit plateau surrounding the top of Mt. Łabski Szczyt (1451 m a.s.l.) down-slope in the northern direction to the elevation of 1375 m a.s.l. - 5 data loggers.

Sensors:

Logger sensors have been placed in hollows between granitic blocks so that there was no direct access of solar radiation (Fig. 4).

Registration period:

Temperature registration has been carried out at intervals of 10 minutes during the period from the end of May 2008 to the early July 2009.

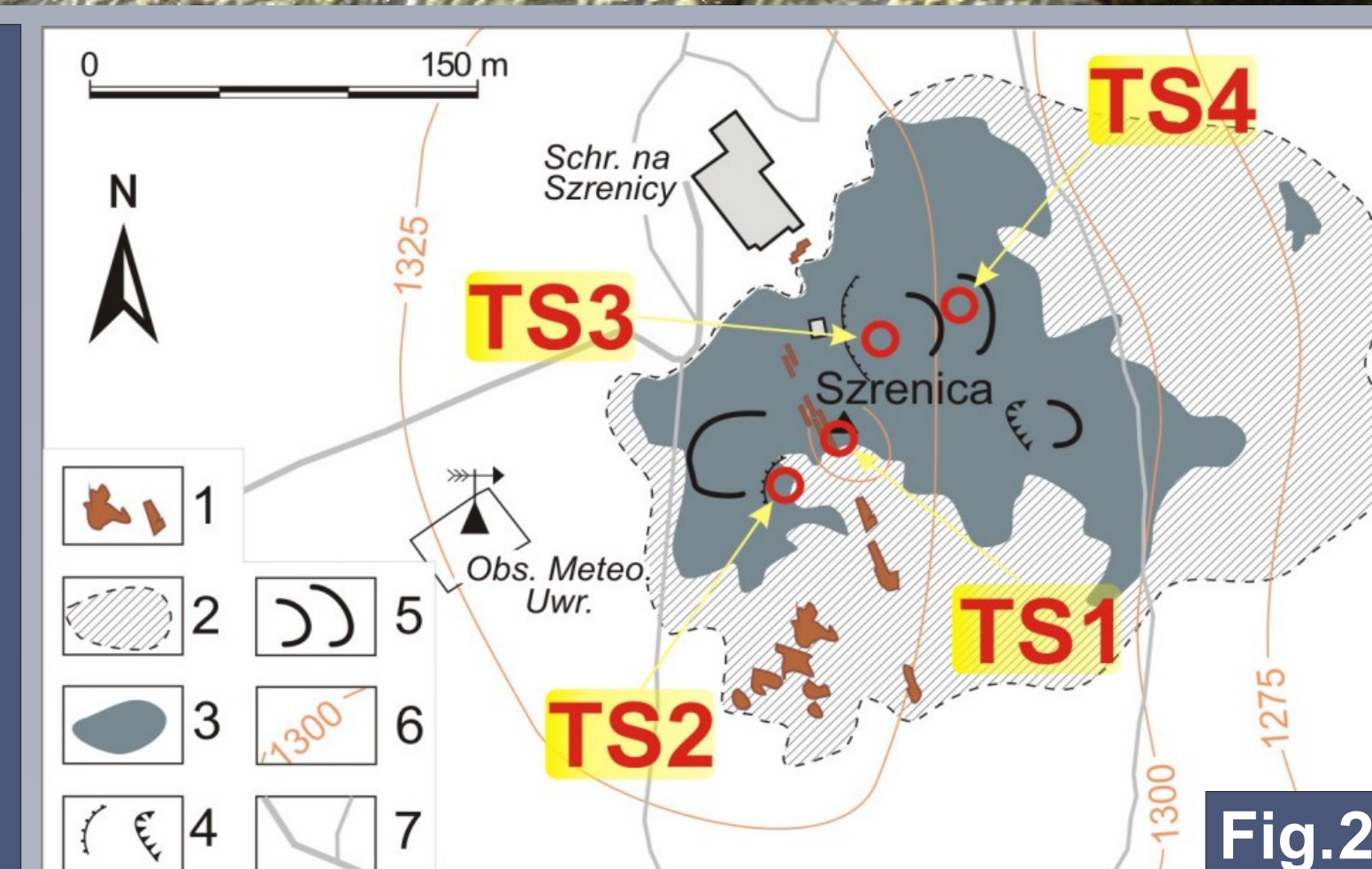


Fig. 2

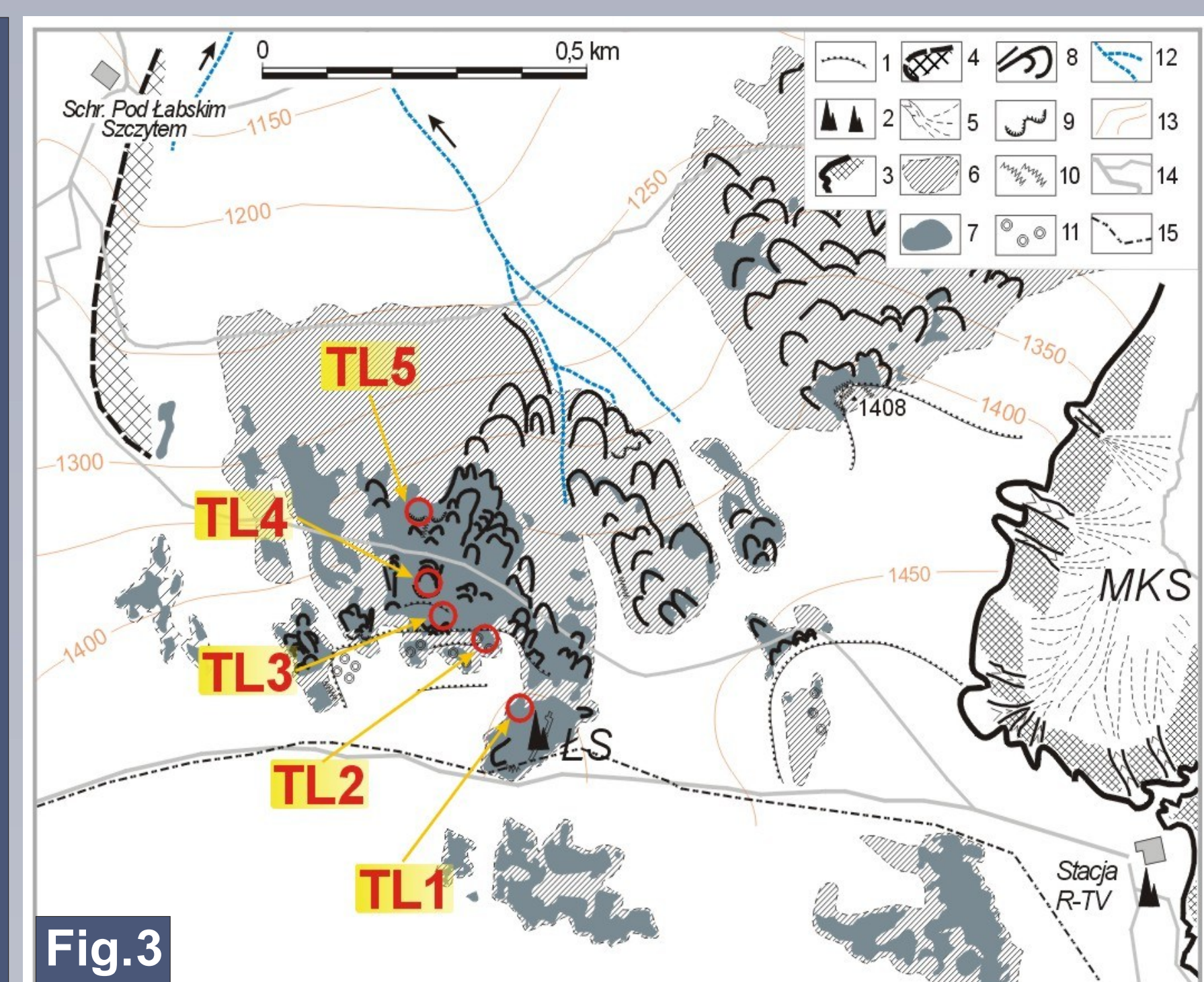


Fig. 3

Results of measurements

Tab. 1. Characteristic of the studied sites at Mt. Szrenica and Mt. Łabski Szczyt

Site	Location	Elevation (m a.s.l.)	Aspect	Slope inclination (°)	Sensor depth below surface (m)	Morphological situation
TL1	Łabski Szczyt	1456	NNW	8-10	1,2	Debris cover below summit tor
TL2		1442	0	6-8	1,5	Debris cover with frost-sorting structures
TL3		1431	N	18-20	1,5	Blocky tongue within debris cover
TL4		1411	NNE	22-24	1	Blocky tongue below slope depression
TL5		1375	N	26-28	2,5	Debris cover - block step
TS1	Szrenica	1357	0	0	2	Shattered summit rock outcrop
TS2		1349	W	14-16	1,5	Block cover - head of solifluction lobe
TS3		1351	E	24-26	1,5	Scree slope
TS4		1336	NEE	20-22	1,6	Block step within scree slope

Tab. 2. Thermal regime of the block covers in the period Oct. 2008 - May 2009 (IIA) and Oct. 2008 - Jul. 2009 (IIB). Explanations: GST - ground surface temperature, MGST - maximal 10 minutes gradients of GST.

Site	Location	Period	No of days	GST (°C)			MGST10 (°C/10 min)	No of days with GST below 0°C
				Min.	Max.	Mean		
TS1	Szrenica	IIA	190	-7,3	11,8	0,14	2,5	143
TS2		IIA	190	-7,33	9,82	0,05	2	145
TS3		IIA	190	-6,31	9,42	-0,89	1,2	159
TS4		IIA	sensor breakdown - lack of data					
TL1	Łabski Szczyt	IIB	225	-7,33	14,47	1	1,7	136
TL2		IIB	252	-6,82	14,09	1,42	2	153
TL3		IIB	252	-6,82	14,47	0,46	0,9	162
TL4		IIB	252	-7,85	15,62	0,74	0,8	161
TL5		IIB	252	-6,31	14,85	1,86	2,1	162

Tab. 3. Freeze-thaw phenomenon at studies sites in the period IIA and IIB (comp. tab. 2). Expl.: W-Winter, A-Autumn.

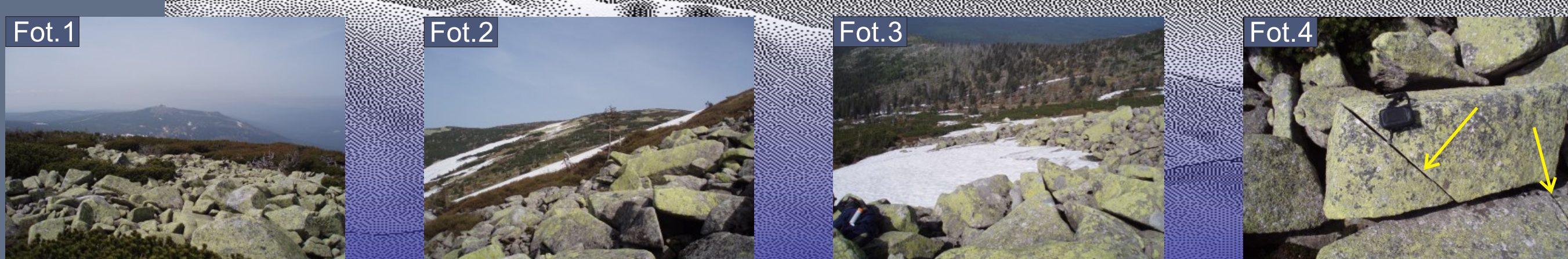
Site	Location	Elevation (m a.s.l.)	Aspect	Relative frequency (%) of the GST ranged from 1°C to +1°C	Number of GST passages over point 0°C	Period with freeze-thaw episodes
TS1	Szrenica	1357	0	40,9	17	A
TS2		1349	W	47,5	20	A
TS3		1351	E	13,8	36	A
TL1		1456	NNW	70,8	28	W-A
TL2	Łabski Szczyt	1442	0	33,1	27	A
TL3		1431	N	15,0	19	W-A
TL4		1411	NNE	13,8	30	A-W
TL5		1375	N	36,1	46	A

Fot. 1 - Summit plateau with frost-sorted structures within block field (site TL2).

Fot. 2 - Block cover on the northern slope of Mt. Łabski Szczyt (site TL3).

Fot. 3 - Snow patches at the base of block cover on the northern slope of Mt. Łabski Szczyt (site TL5).

Fot. 4 - Frost shattered block near site TS1 at Mt. Szrenica.



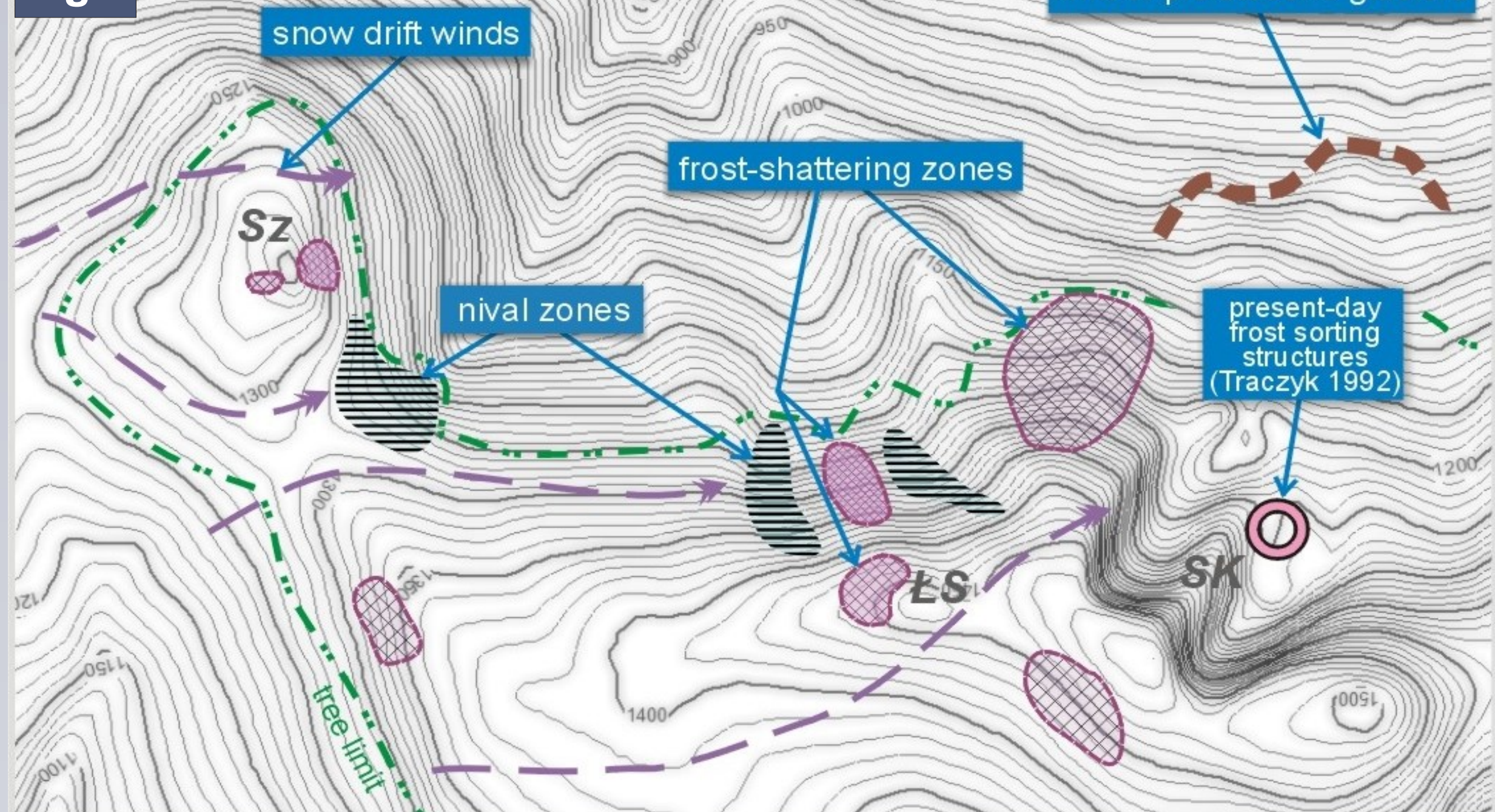
Results:

(i) The results of the study show that the length of the period with GST below 0°C lasted from 143 to 159 days (tab. 2). On the south-west slope of Mt. Szrenica it was 143-145 days, while on the east slope 159 days. The respective period for the TL cross-section lasts from 136 days on the summit plateau to 162 days at the observation site located at the altitude 1375 m a.s.l. For comparison, at the point in the vicinity of Mt. Wielki Szczyk (1505 m a.s.l.) the negative temperature in the ground at a depth of 15 cm remained in the winter season 2008/2009 for 121 days (oral information M. Križek 2009).

(ii) The maximum GST drops were observed at the beginning of winter season (tab. 2). In late winter temperature in the block fields was between 1,5°C on the eastern slope of Mt. Szrenica (TS) to 0,5°C on the northern slope of Mt. Łabski Szczyt (cross-section TL).

(iii) Obtained data indicate that in autumn at Mt. Szrenica there was on average 19 freezing-thawing cycles while on the slope of Łabski Szczyt 17 cycles occurred (tab. 3). This situation changed in the spring. During the period from April to June 2009, 5 cycles on average were recorded on Mt. Szrenica and 13 freezing-thawing cycles occurred on the Mt. Łabski Szczyt.

Fig. 5



Final remarks:

- It can be concluded that thermal conditions of covers lying on the isolated top of Mt. Szrenica are more dynamic than at sites located at higher altitudinal zone on the slopes of Mt. Łabski Szczyt.
- The most favorable conditions for the development of frost processes are on the eastern and northern slopes and are less favorable on the summit plateau (Fig. 5). In this case, probably the diameter of the blocky material and composition of the cover also plays a large role.
- Smaller thermal differentiation was observed within a more homogeneous debris cover on the Mt. Łabski Szczyt slopes than within covers built of large blocks on the eastern slope of the Mt. Szrenica.