Point 2/Point 2A – Forefield of the Renard Glacier *2 – 77° 32' 37" N, 14° 32' 41" E*
2A – 77° 32' 23" N, 14° 29' 47" E

Recession and development of marginal zone of the Renard Glacier

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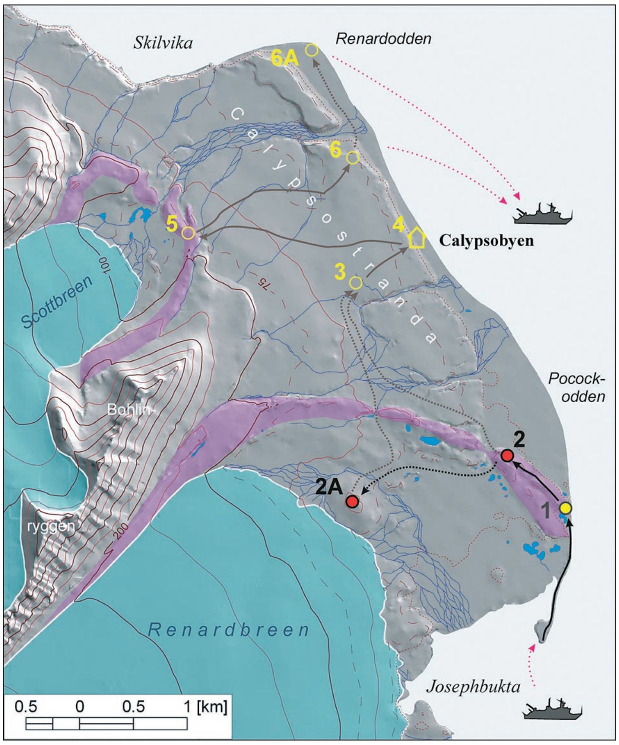

The Renard Glacier, the biggest in the NW part of Wedel Jarlsberg Land region; its area in 2006 was a little over 31 km^2. Its length in axis was about 8.3 km, the width is various, from 2.5 km at the lower part, 7–8 km at the central firn field and its side arms. Tongue of the Renard Glacier covers the valley limited from NW by the Bohlinryggen and Activekammen from SE (Fig. 7, 8).

The largest size of the Renard Glacier was during its maximum spread at the end of XIX century when the glacier front was staying on the line of frontal moraine range and finally formed during the Little Ice Age (Fig. 9). Then the glacier filled the whole area of Josephbukta and its area was 38 km^2. Till 1936 on that area, there was no major change. The glacier was still filling the whole area to the inner side of moraine range. The part escaping right into the fiord underwent the significant recession of nearly 1000 m and exposed a considerable part of the Josephbukta (Fig. 9). In the following period of 1936–1960 the much quicker recession began especially in the land part without direct contact with fiord water (Reder 1996). That recession occurred by frontal receding of the glacier front of 780 m (33 m a^{-1}), and on the southern side of the bay – 1200 m (50 m a^{-1}). Also the receding of 560 m (23 m a^{-1}) was present in the Josephbukta revealing almost all of it. Between 1936 and 1960 the direction of the proglacial water outflow changed. Till that time active outside wide sandur fans became dead and the outflow made directly for Josephbukta (Harasimiuk 1987, Reder 1996, Zagórski 2004).

In the following years, till 1990 the quicker recession of the glacier front underwent mainly land part of maximally 720 m (24 m a^{-1}), while much slower was the recession of the part connected with the bay mouth – maximum up to 450 m (15 m a^{-1}). The Renard Glacier had a mouth to the fiord in the Josephbukta and its front made some metres high ice cliff (Fig. 7, 9). Now the deglaciation of the Renard Glacier has generally a frontal character. Based on observations and GPS measurements from 1990–2006 the glacier front receded of maximum almost 340 m (21 m a^{-1}). Starting from the end of XIX century till 2006, area of 7 km^2 was exposed

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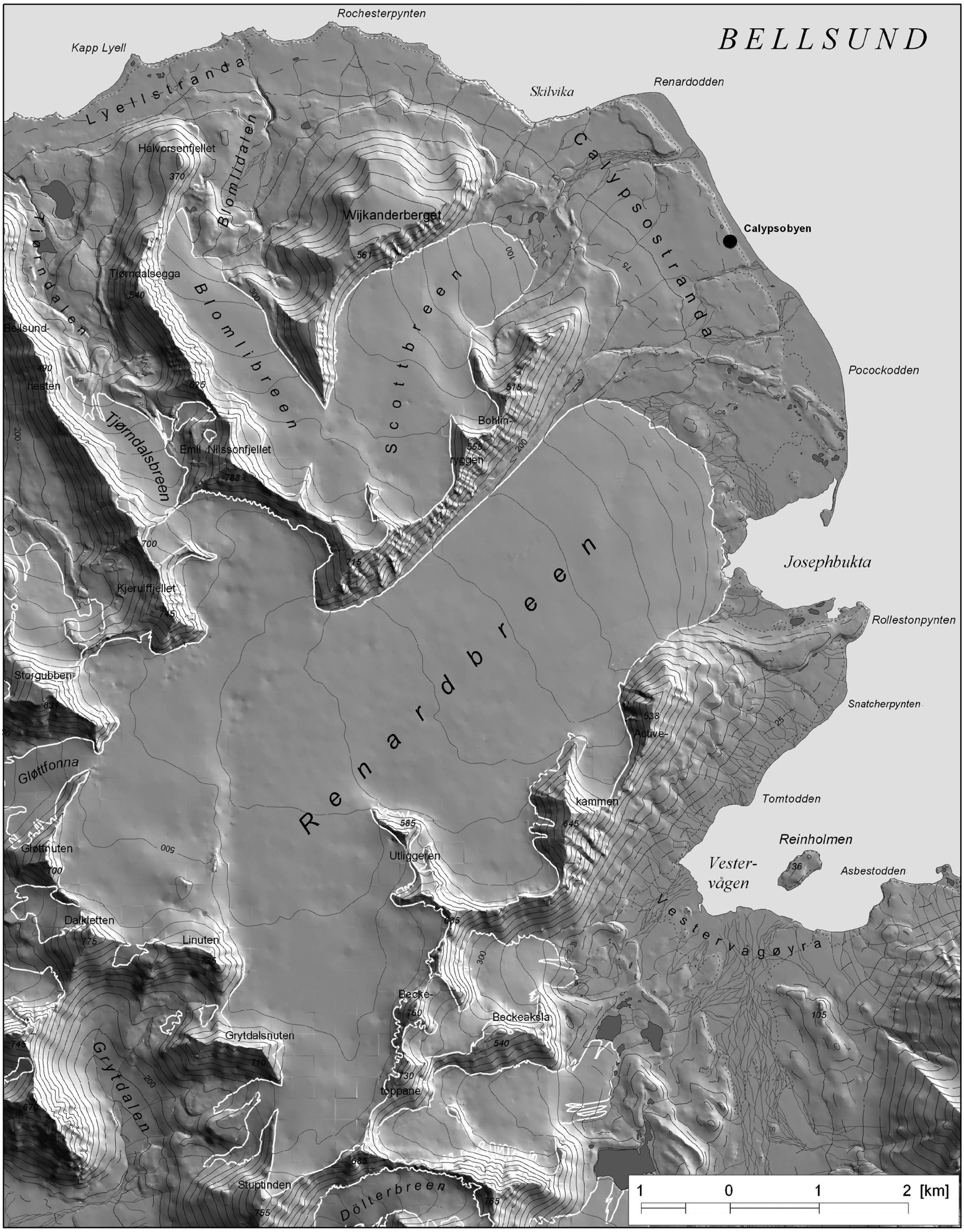

Fig. 7. The Renard Glacier and Calypsostranda Region. The shade map made using the Digital Terrain Model (DTM) obtained from the aerial photos from 1990 (Zagórski 2002)

where 1.5 km^2 was Josephbukta. It has its consequences in the origin and formation of the surface of the forefield of the Renard Glacier limited by frontal moraine ridges (Fig. 9).

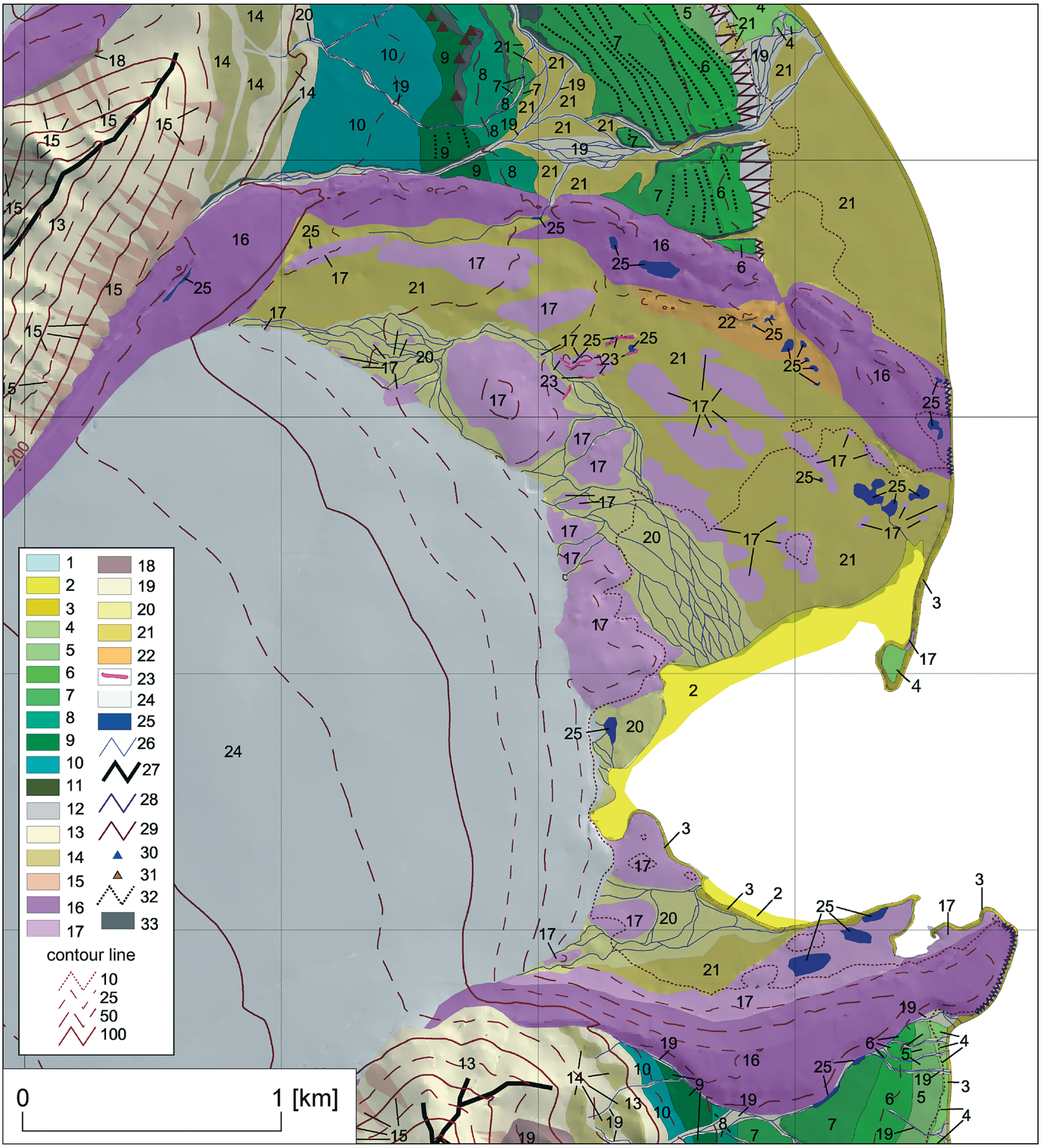

Fig. 8. Geomorphological map of the forefield of the Renard Glacier (Zagórski 2002)
1 – contemporary abrasion platform, 2 – tidal flat, cone of delta, 3 – contemporary storm ridge, 4 – terrace I (2–8 m), 5 – terrace II (10–20 m), 6 – terrace III (25–30 m), 7 – terrace IV (30–40 m), 8-terrace V (40–50 m), 9 – terrace VI (50–65 m), 10 – terrace VII (70–85 m), 11 – terrace VIII (105–120 m), 12 – superficial flattening, 13 – slopes, 14 – denudation-structure level, 15 – talus cones, 16 – ice-cored moraine ridges, push and lateral moraines, 17 – ground and ablation moraines, 18 – rock glaciers (nival), 19 – floors of pronival valleys, 20 – contemporary sandur plains and fans, alluvial cones, 22 – kame, 23 – esker, 24 – glaciers, 25 – lakes, 26 – rivers, 27 – ridges, 28 – active marine cliffs, 29 – dead marine cliffs, 30 – skerries, 31 – paleoskerries, 32 – old storm ridges, 33 – edges.

The frontal moraine of Renard Glacier consists of two genetically and age-old distinct parts: inside of push moraine character and inside neighbouring ice-cored moraine ridges (Fig. 2, 8). The push moraine at N and NW part of the forefield has the surface of mild character, slopes are mild and the tops are not marked sharply. The more varied is southern area with that is only fragmentally preserved part of the moraine. Its surface is characterised by very intensive line of relief in the shape of longitudinal parallel swellings and lowerings. Similar morphological features show frontal moraines of glaciers accumu-

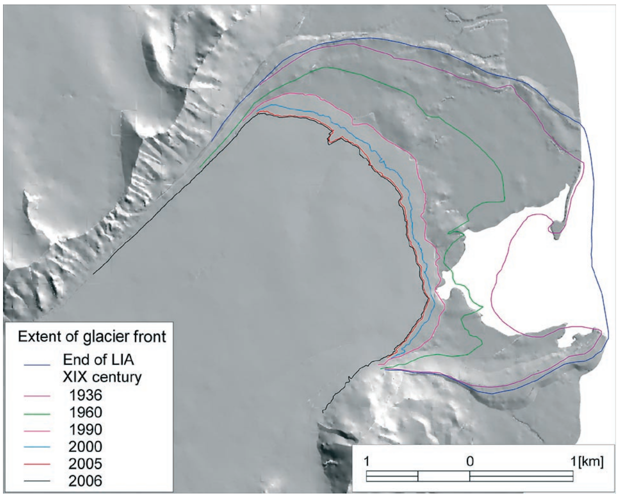

Fig. 9. The extent of the Renard Glacier fronts combined on the basis of archival data (Reder 1996, Szczęsny et al. 1989, Zagórski 2005) and GPS measurement

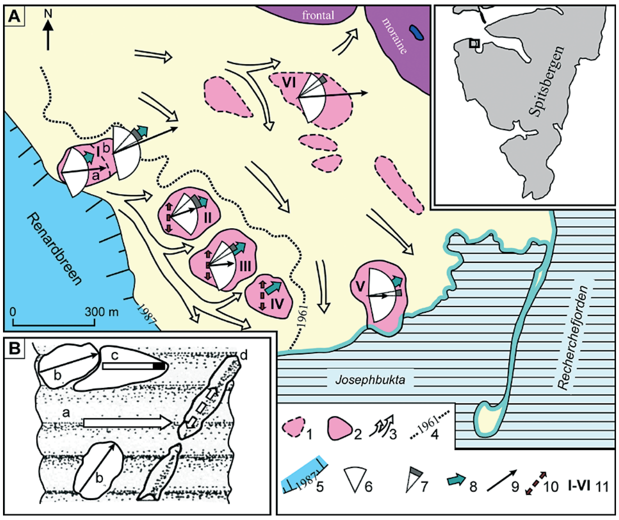

Fig. 10. The sketch of the forefield of the Renard Glacier (Merta 1988)
1 – patches of erosive moraine of compact texture of “fluted” type, 2 – patches of fresh relief of ”fluted type”, 3 – directions of outflow of proglacial water, 4 – location of the glacier front in 1961, 5 – location of the glacier front in the study season, 6 – the range of orientation of the longer axis of free stones (type b2), 7 – the range of orientation of extension of moraine accumulates of type c, 8 – directions of setting of moraine ridges and grooves of the fluted type, 9 – resultant factor of orientation of the longer axis of stones (type b1), 10 – location of uncompleted ridges, 11 – measurement domains I–VI, B: scheme of location of respective types of directional elements, their symbolic and the way of measurement: a – ridges and grooves, b1 – stones with the sediment at their hinterland, b2 – free stones, c – moraine deposits in the shade of stones b1, d – uncompleted ridges.

lated in the conditions of strong compression, so at the surge stage. At the area of ice-cored moraine ridges, even huge denivelations can be seen. Sharp, pyramidal tops and considerable number of cracks and lowerings of thermokarst character (often filled with water) prove the existence occurrence of relict ice inside (Reder 1996).

At the first stage of the recession of the glacier the outflow from moraine ridges was blocked and at its internal side some marginal troughs begin their kelter. Ablation water was taking them to Josephbukta direction (it was parallel to the glacier front). With the growing distance from the glacier tongue in the SW direction, in the lowering between its edge and ice-cored moraine ridges some intensive accumulation processes of the material carried by ablation water began to happen. Then, the kame terrace was formed made of sandy deposits with some gravel infillings and ablation till (Fig. 8). The total obstruction of the outflow in northern direction through the frontal moraine and kame terraces, caused creation of the marginal river, flowing along glacier front in direction of Josephbukta. On the hinterland of moraine series and kame terrace the ablation waters have cut down the deep valley, which present dry floor is covered with sandy-gravel sediments. As the result of progressive recession the set of ground moraine of fluted type was made. That set is on the outcrop of bedrocks of roche moutonnée type (Merta 1988, Reder 1996) (Fig. 10, 11).

The inside set of marginal sandurs consists of three layers correspond with the stages of recession of the glacier. Two upper layers, not active now, compose the forms of the shelf type or terraces connected to the inner slopes of ice-cored moraine ridges. Single packs of sediments that belong to the upper system of cones are universally met at lowerings of the fluted moraine. The third, contemporary sandur layer is made of the series of cones that are in the lowerings between roche moutonnée on the hinterland of the glacier tongue edge. The surface of that sandur is formed by proglacial water of marginal rivers (Fig. 8). At the direct neighbourhood of tongue they have concentrated confluence, huge fall and considerable erosive abilities. Due to a progressive recession of the glacier causes the marginal rivers to move towards the glacier front that receding every year. The traces of older flows recorded as dead, hung riverbeds which location can reconstruct the advance of the glacier front with high probability (Fig. 8).

During the last thirty years the large island mountains of roche moutonnée character were unveiled from the ice, as well as moraine cover of fluted type, which was on. The glacier gradually recedes towards West lost the contact with the water of Josephbukta (Fig. 8, 9, 10). At the direct forefield of the glaciers, between the taking back tongues and frontal moraines (ice-cored moraine ridges) that mark the maximum extend of the last transgression, there were created the zones of ground and ablation moraines, similar to drumlins forms, inner sandurs and sometimes concurrent crevasse forms. Ground moraines, often fully developed as the moraine of the fluted type, stay mainly on the roche moutonnée (Merta

Fig. 11. The fluted moraine covers the proximal slope of roche moutonnée (photo Piotr Zagórski 2006)

Fig. 12. Covers of naledi and the lump of dead ice buried in the sandur sediments (photo Piotr Zagórski 2006)

1988, Reder 1996) (Fig. 11). Proglacial rivers that aggrade and cut sandur surface use the lowerings between them. On the distal side of roche moutonnée, from time to time the ridges of eskers are preserved that were formed in the middle of XX century and their orientation correspond to the direction of crevasses on the glacier and the directions of grooves of the ground moraines on its forefield (Fig. 8). Hypsometric domination of moraine ridges was softened by neighbouring from inside kame terraces. In that zone big morphological importance has universally appeared vast covers of naledi and rarely present clods of dead ice buried in sandur sediments (Fig 12).