Abstract: Weissenkar rock glacier (46°57.5' N, 12°45' E) is situated in a glacially shaped cirque in the Schöber Mountains, Austria. The rock glacier creeps downslope at a comparatively low velocity of up to 1 cm/a. The creeping periglacial body has now reached a flat plateau-like area where its motion is retarded due to low inclination resulting in a very pronounced surface topography.

This paper is based on the documentation of the kinematic state of Weissenkar rock glacier. Geodetic (1997, 2001, 2003, 2004) and photogrammetric measurements (1974, 1998, 2002) were carried out in order to obtain quantitative information on surface deformation in general, and creep velocity and surface height change in particular. Results obtained are presented both numerically and graphically. An orthophoto map of the area of interest was compiled to provide a sound basis for cartographic work.

Finally, the kinematics of Weissenkar rock glacier will be discussed in respect to its morphology and its specific topographic situation.

Key words: Landslide monitoring, aerial photogrammetry, deformation measurement.

1. Introduction

Weissenkar rock glacier is situated in a west-exposed cirque nourished from active scree slopes beyond a steep, glacially shaped cirque with the location of a former perennial snow field. Overall surface lowering suggests permafrost degradation of -2 cm/a for the time period 1999-2002. Recent geodetic measurements (1998-2004) confirm the continuation of periglacial observations. The horizontal creep velocities of the western lobe of the rock glacier are smaller (well below 8 cm/a) than in the central and southern part. The overall pattern of horizontal flow is mainly limited to the southern part of the rock glacier.

2. Geodetic surveys 1997-2004

Two stable reference points, F1 and F2, were selected on bedrock northwest of the rock glacier. These points can be reached easily from the nearby hiking trail. All points were fixed with brass bolts driven into solid rock in the upper part of the cirque.

Orthophoto map showing Weissenkar rock glacier, F1 and F2 are geodetic reference points.

Points 1-118 are object points fixed by brass bolts on large boulders of the rock glacier surface.

The aerial photograph was taken on 18th September 2002.

Photograph (c) Amt der Tiroler Landesregierung, 2004.


Large-scale photographs only were selected for further digital photogrammetric processing. The main task of the photogrammetric work was to derive a dense field of 3D displacement vectors for the time intervals 1974-1998 and 1998-2002 using our in-house developed software package ADVM (Automatic Displacement Vector Measurement). Furthermore, high-resolution OTMs for the epochs were computed, and stereo orthophotos were prepared at 1:5,000 scale for visual interpretation.

Mean annual horizontal flow/creep velocity for the time interval 1974-1998.

Mean annual horizontal flow/creep velocity for the time interval 1998-2002. Notice that the color scales of the figures are different.

Mean annual surface height change for the time interval 1974-1998.

Surface height change has been derived from 3D displacement vectors and surface slope data assuming surface parallel flow.

4. Analysis

Geodetic measurements: The mean annual flow velocity (= average over 18 measurements) of Weissenkar rock glacier has increased significantly starting from 1999-2000. The 2003-2004 flow velocity is about 17% higher than the value measured in 1999. Photogrammetric measurements: Based on averaged values, a significant increase in flow velocity of about 9.3% can also be deduced from the photogrammetric data. The change amounts to +2.6 cm/a.

5. Conclusions

It can be concluded that the flow velocity of Weissenkar rock glacier has increased significantly throughout all time periods for which measurements are available. It is assumed that this increase will continue, and further increase will result in an accelerating flow.

Surface lowering has been observed within the limits of the uppermost, younger lobe and especially at the location of a former perennial snow field. Overall surface lowering suggests permafrost degradation of -2 cm/a for the time period 1974-1998. Recent geodetic measurements (1998-2004) confirm the continuation of periglacial degradation. This statement is rather speculative, however, and is currently a matter of general discussion. The recent increase in surface velocity also remains to be explained.

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