CHARACTERIZING KINEMATIC BEHAVIORS OF PERIGLACIAL LANDFORMS IN THE EASTERN KUNLUN SHAN (CHINA) USING SATELLITE SAR INTERFEROMETRY

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Abstract

A group of periglacial landforms were discovered in the eastern Kunlun Shan of China 30 years ago, but were ambiguously classified as rock glaciers and later gelifluction deposits. Moreover, the kinematic features of the landform had not been fully investigated or understood. Here, we use satellite SAR interferometry to quantitatively characterize the spatial and temporal changes of the surface movement of these landforms. We observe that: (1) the eastern slope is also active with a summer velocity of 20-60 cm/yr; (2) the northern lobes moved at 20-50 cm/yr in summer, which are much larger than the previous in-situ estimation of less than 3 cm/yr near the front; and (3) both the northern lobes and eastern slope are inactive during winter. Based on these observations, we postulate that the northern lobes represent a mixed type of periglacial landform, combining the characteristics of rock glaciers and gelifluction deposits.

Introduction

A group of tongue-shaped periglacial landforms near Jingxian Valley (35°40´N, 94° 00´E) in eastern Kunlun Shan have been reported and classified as “Kunlun-type” rock glaciers due to their unique morphology (Fig. 1) and slow creeping rates (Cui, 1980, 1985). However, the nature of the northern slopes has remained contentious and later been interpreted as gelifluction deposits (Harris et al., 1998).

Figure 1 Photograph of the lobes from the north showing the morphology of the ice-cap shaped deposits in the upper part of the landform and several lobes extending down to the valley. One lobe is outlined in red.

Objective

This study investigates the kinematic characteristics and discusses the seasonal movement variations of the landform using InSAR methods and data.

Methods

Five ALOS-1 PALSAR images over eastern Kunlun Shan area have been used to generate three interferograms to measure the line-of-sight (LOS) velocities of the landform.

One interferogram records the kinematic information during winter/early spring and the other two are averaged to represent the surface movement during summer.

Table 1. List of interferograms generated from ALOS-1 PALSAR data. All the interferograms are in Path 491 and Frame 700 and have the same time span of 46 days.

Interferogram	Perpendicular baseline (m)
20080201-20080318	56
20090621-20090806	382
20090806-20090921	616

Results

The interferograms reveal that besides the northern lobes which have been identified as rock glaciers or gelifluction deposits, the eastern slope is also active during summer (Fig. 2), while during winter both two groups of targets become inactive (Fig. 3).

Table 2. Comparisons of LOS velocities of the two groups of targets between summer and winter/early spring.

Target type	LOS velocity (cm/yr)	
	Summer	Winter/Early spring
Northern lobes	20-50	0
Eastern slope	20-60	0

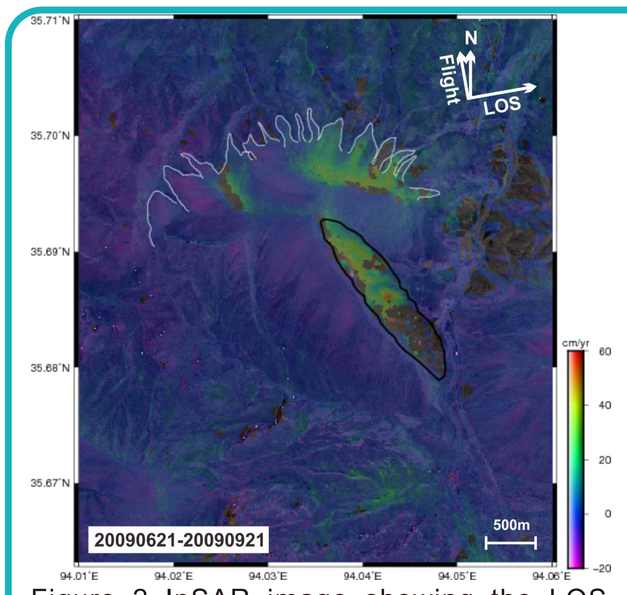

Figure 2 InSAR image showing the LOS velocities of the two groups of landforms near Jingxian Valley during summer in 2009. The northern lobes are marked by white lines and the eastern slope by black polygon.

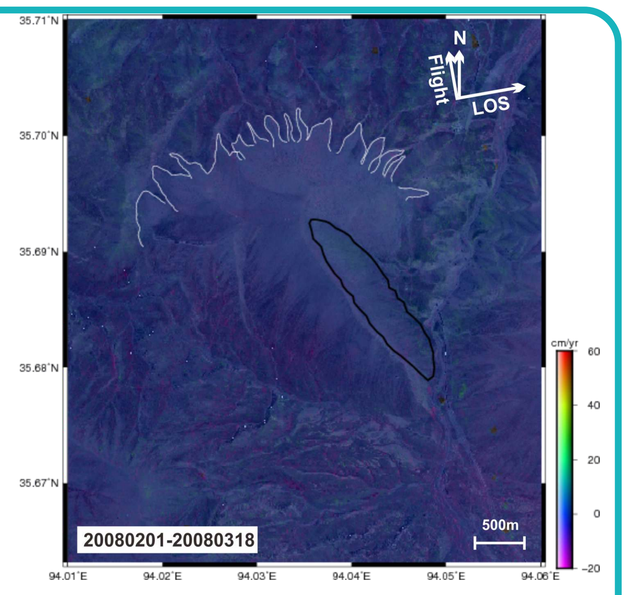

Figure 3 Similar to Figure 2, but showing the LOS velocities during winter/early spring in 2008.

Discussion

Several key evidences, such as (1) the widespread and relatively fast movement and (2) the large-scale tongue-shaped morphology, suggest that the northern lobes are rockglaciers (Matsuoka et al., 2005). The lack of transverse furrows and ridges presumably results from gelifluction processes of the fine-grained deposits covering the slopes, which smooths out the surface of the landform.

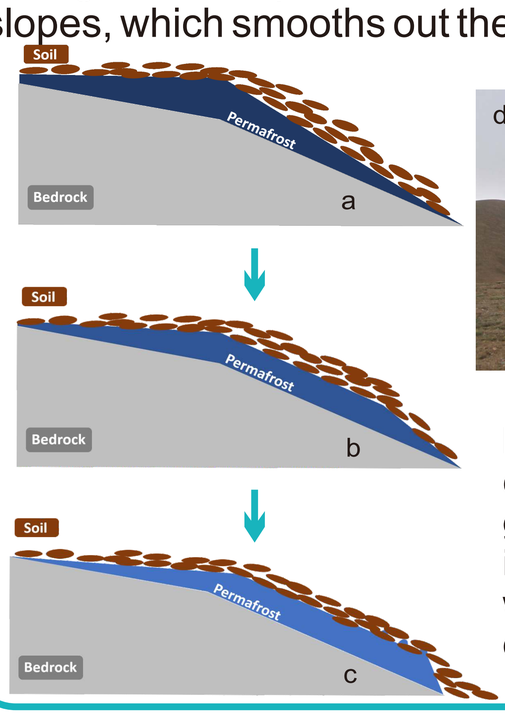

Figure 4 a, b and c show the process combining permafrost creep of rock glaciers and gelifluction on the surface. (d) is a photograph of three lobes, one of which has an oversteepened front and is outlined in red.

Conclusion

With a relatively high surface moving speed and large geometry scale, the northern lobes are unique parts of the alpine permafrost in Eastern Kunlun Shan, representing a mixed type of rock glaciers and gelifluction deposits.

Major Reference

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