Reviewed research article

Surface and geometry changes during the first documented surge of Kverkjökull, central Iceland

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Abstract — *Many surge-type glaciers remain unrecognised because surge events can be short-lived and are rarely captured by satellite or field data. This study reports the first documented surge of Kverkjökull, central Iceland, adding a relatively short, narrow, steep and alpine outlet glacier from the Vatnajökull ice cap to the surge-type glaciers in Iceland. The surge occurred after decades of persistent and recently accelerated terminus retreat. The surge initiated after 2008 and immediately preceded drainage of the Gengissig geothermal lake and a jökulhlaup in 2013. The surge was still in progress in 2013. It caused vertical surface displacements of up to 20 m that were most prominent in parts of the glacier >100 m thick. The magnitude of surface elevation changes, terminus advance and ice surface velocity changes probably reflect a single surge phase. Asymmetry in the response of the glacier terminus to the surge front suggests interaction with near-stagnant ice in a part of the glacier terminus but otherwise the trigger and mechanism of the Kverkjökull surge remain unexplained.*

INTRODUCTION

Glacier surges are events of enhanced ice flow during which ice previously stored at elevation is rapidly discharged down glacier. Surges are important agents of erosion and deposition, they affect the timing and magnitude of meltwater runoff and in areas where surging is common, e.g. Iceland and Svalbard, they represent an important mechanism of glacier mass transfer. Glacier surges may usually be recognised by their distinctive surface morphological expression, and where appropriate data are available, by changes in terminus position, surface velocity and glacier surface elevation.

The flow of a surge-type glacier is periodically interrupted by suddenly-enhanced ice-flow velocities for months or years (Meier and Post, 1969; Thórarinsson, 1969). This behaviour is apparently unrelated to climate change although climate may play a role in determining the periodicity of surges and whether or not a glacier will surge (Sharp, 1988; Hewitt, 2007; Striberger *et al.*, 2011). Surging glaciers tend to cluster in a few geographical areas such as Alaska, Yukon (especially the St. Elias Range), British Columbia, Svalbard, Andes, Caucasus, Karakoram, Pamirs, Tien Shan, and Iceland (Sevestre and Benn, 2015). In contrast, the European Alps, Scandinavia and the Rocky Mountains have very few surging glaciers. Understanding glacier surges is important because they can cause considerable and widespread landscaping (Sharp, 1988) and they affect meltwater runoff regimes, especially notably in Iceland (Björnsson *et al.*, 2003). Furthermore, surges can account for significant glacier mass transport. For example, surges have contributed at least 10% to the total ice transport to the ablation areas of Vatnajökull during the 20th Century (Björnsson and Pálsson, 2008). Understanding of surges is key to understanding glacier dynamics; they can yield important insights into basal processes