



Review paper

Reprint of "Pleistocene and Holocene glacier fluctuations upon the Kamchatka Peninsula"

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ABSTRACT

This review summarises landform records and published age-estimates (largely based upon tephrochronology) to provide an overview of glacier fluctuations upon the Kamchatka Peninsula during the Holocene and, to a lesser degree, earlier phases of glaciation. The evidence suggests that following deglaciation from the Last Glacial Maximum (LGM), the peninsula experienced numerous phases of small-scale glacial advance. During the Late Glacial, moraine sequences appear to reflect the former presence of extensive glaciers in some parts of the peninsula, though little chronological control is available for deposits of this period. During the Holocene, the earliest and most extensive phase of advance likely occurred sometime prior to c. 6.8 ka, when glaciers extended up to 8 km beyond their current margins. However, these deposits lack maximum age constraints, and pre-Holocene ages cannot be discounted. Between c. 6.8 ka and the onset of 'Neoglaciation' c. 4.5 ka, there is little evidence of glacial advance upon the peninsula, and this period likely coincides with the Holocene climatic optimum (or 'hypersothermal'). Since c. 4.5 ka, numerous moraines have been deposited, likely reflecting a series of progressively less extensive phases of ice advance during the Late Holocene. The final stage of notable ice advance occurred during the Little Ice Age (LIA), between c. 1350 and 1850 C.E., when reduced summer insolation in the Northern Hemisphere likely coincided with solar activity minima and several strong tropical volcanic eruptions to induce widespread cooling. Following the LIA, glaciers upon the peninsula have generally shown a pattern of retreat, with accelerated mass loss in recent decades. However, a number of prominent climatically and non-climatically controlled glacial advances have also occurred during this period. In general, there is evidence to suggest that millennial scale patterns in the extent and timing of glaciation upon the peninsula (encompassing much of the last glacial period) are governed by the extent of ice sheets in North America. Millennial-to-centennial scale fluctuations of Kamchatkan glaciers (encompassing much of the Holocene) are governed by the location and relative intensity of the Aleutian Low and Siberian High pressure systems. Decadal scale variations in glacier extent and mass balance (particularly since the LIA) are governed by inter-decadal climatic variability over the North Pacific (as reflected by the Pacific Decadal Oscillation), alongside a broader trend of hemispheric warming.

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1. Introduction

The Kamchatka Peninsula is the largest glacierised area in NE Asia, and is occupied by ~446 small glaciers, covering a total area of ~900 km² (Solomina et al., 2007) (Fig. 1). The peninsula is also occupied by extensive moraine sequences and other terrestrial and off-shore evidence reflecting the former presence of extensive ice-masses (Vinogradov, 1981; Bigg et al., 2008; Nürnberg et al., 2011;

Barr and Clark, 2012a). Despite such information, the extent and timing of former glaciation upon the peninsula remain poorly understood (Stauch and Gualtieri, 2008; Barr and Clark, 2012b), though some key investigations were undertaken in the 1960s and 70s (e.g. Olyunin, 1965; Braitseva et al., 1968; Kuprina, 1970), and have continued episodically thereafter (e.g. Bäumlér and Zech, 2000; Solomina and Calkin, 2003; Barr and Clark, 2012b). Recent studies have focused upon ice extent during the global Last Glacial

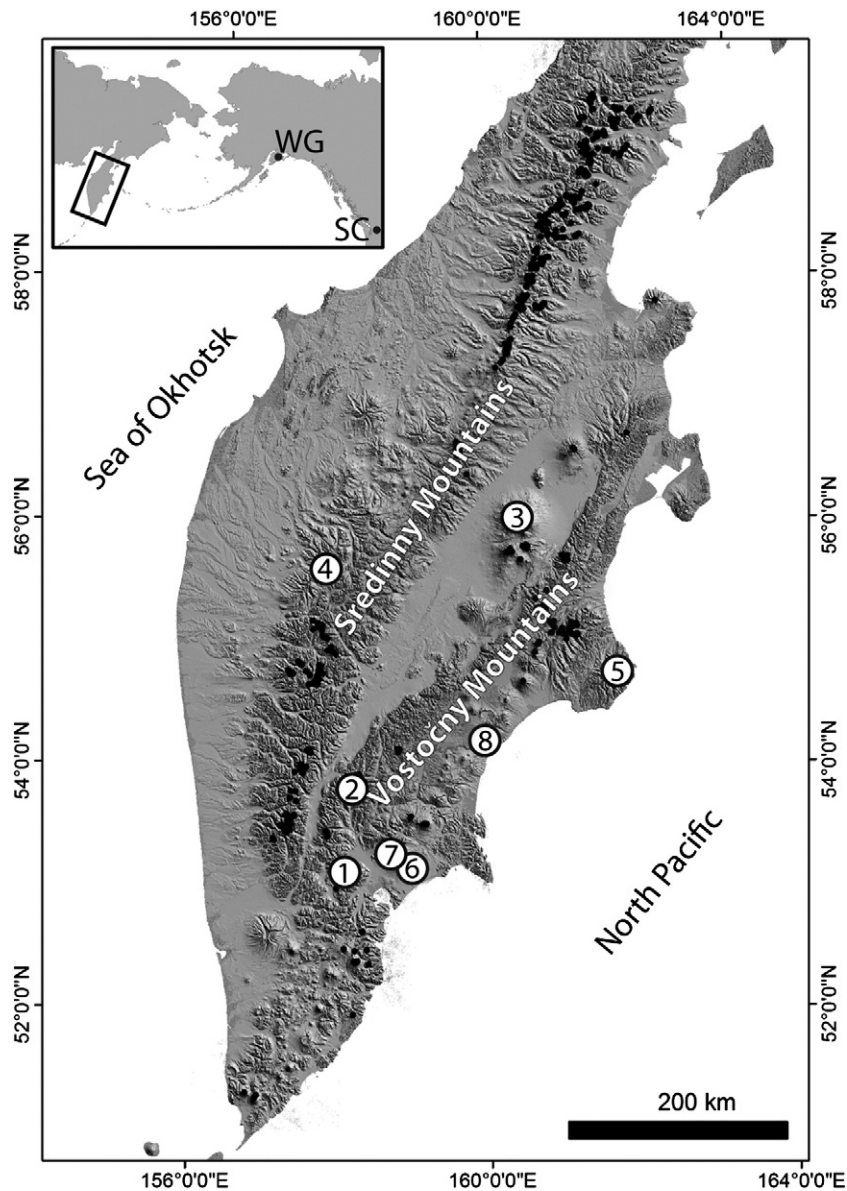


Fig. 1. Map of the Kamchatka Peninsula. Points (black dots) correspond to modern glaciers. Numbered locations are discussed in the text. 1. Topolovaya Valley; 2. Sredniya Avacha; 3. Klyuchevskaya group of glaciers (including those upon Ushkovsky and Bezymianny volcanoes); 4. West Ichinsky Glacier; 5. Kronotsky Peninsula glaciers (including Koryto and Avgusty glaciers); 6. Avacha group glaciers; 7. Koryaksky volcano; 8. Kropotkina Glacier; WG, Wolverine Glacier; and SC, South Cascade Glacier.

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