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Prehistoric human responses to volcanic tephra fall events in the Ust-Kamchatsk region, Kamchatka Peninsula (Kamchatsky Krai, Russian Federation) during the middle to late Holocene (6000–500 cal BP)

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ABSTRACT

Prehistoric peoples in Kamchatka coped with recurrent volcanic tephra fall events during the middle to late Holocene. Recent data collected by the International Collaborative Circumpolar Archaeological Project (ICAAP) between 2009 and 2011 explores the long-term relationships between drastic landscape change and concomitant human response. A combination of new archaeological, paleoenvironmental and tephrochronological data demonstrate how the major Ksudach 1750 cal BP (KS_1) eruption accelerated settlement relocation from the interior to the paleo-coastline.

1. Introduction

The Kamchatka Peninsula is one of the most volcanically active regions in the world with a dramatic geological history driven by large-scale tectonic processes taking place between the Eurasian, North American and Pacific plates (Ponomareva et al., 2007). Across this dynamic landscape, pedogenic sediments have been interspersed with numerous volcanic ash layers (tephra) making the peninsula well suited for the precision dating of archaeological sites. The region has one of the best resolved Holocene tephra stratigraphies in the world due to the presence of well-preserved sedimentary archives such as peat and soil pyroclastic covers. Intensive tephrochronologic, volcanological and seismological research conducted over the past two decades has focused heavily on providing a high-resolution chronology of Late Quaternary volcanism and associated processes (Braitseva et al., 1992a, 1992b, 1997; Pevzner et al., 1998; Ponomareva et al., 2007, 2015; Kyle et al., 2011).

Between 2009 and 2011, the International Collaborative Circumpolar Archaeological Project (ICCAP) (NSF Grant 0915131) conducted a series of archaeological and geological surveys to identify patterns in prehistoric human responses to rapid environmental change. Specifically, the project sought to document the relationship between prehistoric hunter–gatherer lifeways and recurrent landscape disturbance by tephra falls in the Ust-Kamchatsk region of eastern Kamchatka. The majority of tephra falls identified in the study area were produced by the still active volcanoes Shiveluch (~65 km to the west) and Ksudach (~600 km to the southwest). In addition to archaeological and geological surveys, peat cores were collected in 2010 to reconstruct the paleoenvironmental record during the Late Quaternary. The longest core taken near Krutoberegovo village in the Ust-Kamchatsk region (Fig. 1) represents an uninterrupted environmental record spanning the last 15,000 years (Pendea et al., 2012, 2013, in preparation).

Volcanism and associated processes are experienced by human populations in various ways. These natural forcing events differ in their degree of predictability, probability and controllability, their speed of onset, their distribution (i.e. localized vs. diffused), and their adverse effects on people and the natural environment (Fritz, 1968). The impact of these events on human populations is mediated by the type of event (e.g., volcanic ejecta, seismic uplift, tsunamis), and responses vary significantly. This may include the degree and speed of abandonment of an affected area or reliance on larger regional support networks in times of crisis (Neall et al., 2008; Ort et al., 2008; Torrence et al., 2009). Volcanic events are

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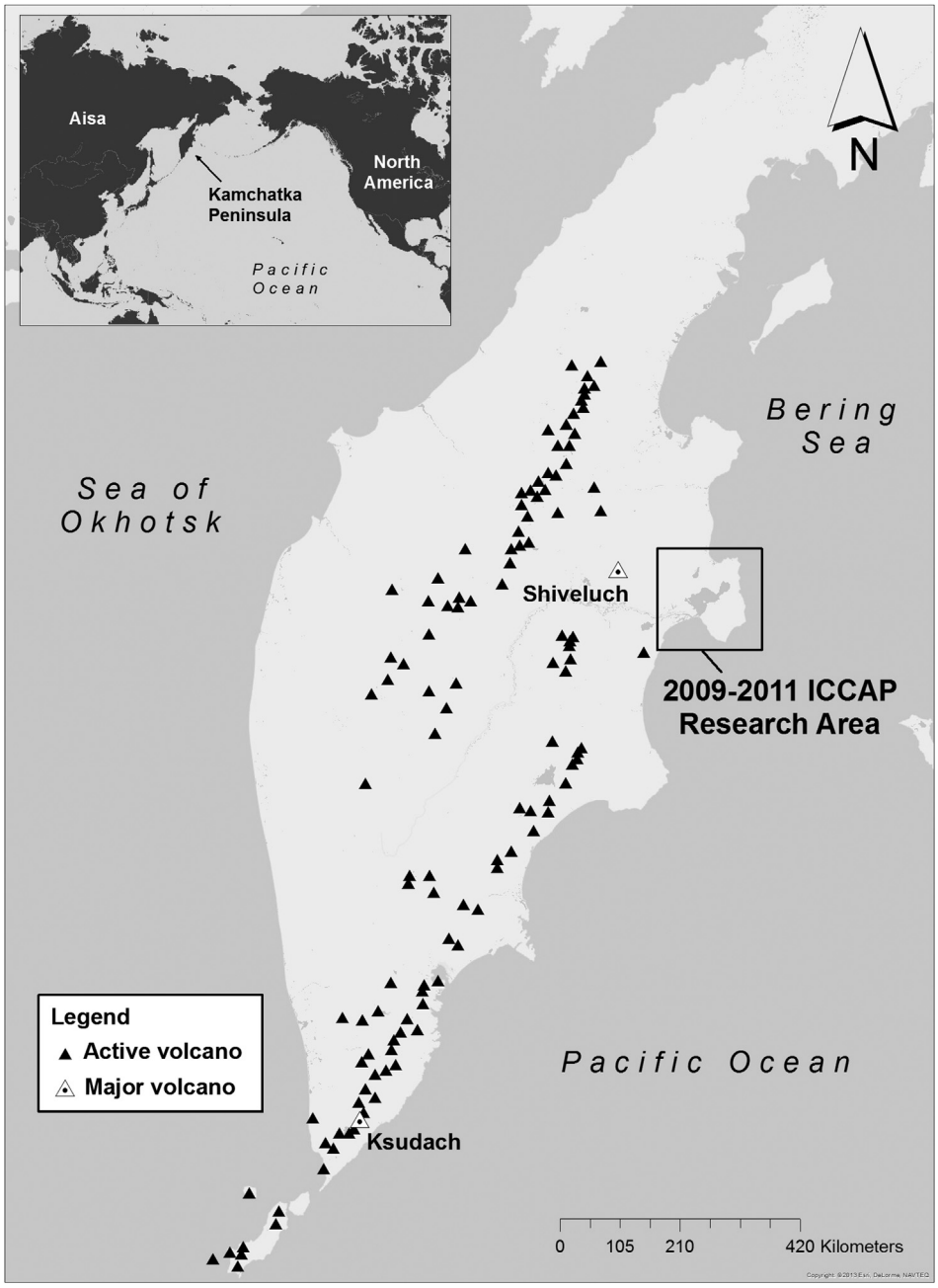

Fig. 1. Kamchatka (Kamchatsky Krai, Russian Federation) with distribution of currently active volcanoes found on the peninsula. The 2009–2011 ICAAP research project was conducted in the Ust-Kamchatsk region on the eastern coast. Inset shows location of Kamchatka peninsula in relation to Asian and North American continents. Volcanological data provided courtesy of the Smithsonian Global Volcanism Program and NOAA's National Geophysical Data Center.

not always catastrophic for human population living nearby. Sometimes a major volcanic eruption or tsunami may lead to a short-term abandonment and then re-occupation followed by social and political reorganization (Grattan, 2006; Begét et al., 2008; Hall and Mothes, 2008; Neall et al., 2008; Torrence et al., 2009).

The effects of large ash falls on terrestrial vegetation range from insignificant, at the edge of the ash plume, to complete obliteration of ecosystems in proximal areas (Antos and Zobel, 1985; Stott et al., 1998). For instance, the Taupo eruption of 1718 cal BP in New Zealand drove widespread forest die-out ~ 160 km around the main eruption vent, and fires continued to affect the dying forest ecosystem for 150 years after the eruption (Stott et al., 1998). More significantly, the Taupo eruption induced a major vegetational shift characterized by the expansion of a single tree species (*Libocedrus bidwillii*) to the detriment of others species over a period of several centuries. The effect of volcanic processes on fauna may be equally dramatic as is demonstrated by historical examples of mass mortality in the Aleutians (Black, 1981). Recovery periods extend into decades or centuries depending on the thickness of the tephra and area of distribution.

Reconstructions of past social–environmental relationships, such as those offered by Adams (1978), Dilehay and Kolata (2004),