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Glacier dynamics, palaeohydrological changes and seismicity in southeastern Altai (Russia) and their influence on human occupation during the last 3000 years

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ABSTRACT

The 3 ka chronology of climatically driven glacier fluctuations and upper tree limit variations, dates of strong prehistoric earthquakes, and fluvial system transformation are established for the SE Altai (mountains of South Siberia) on the basis of radiocarbon and dendrochronological dating. This time period of prosperity of the Altai nomadic cultures is characterized by more arid and cold climate in comparison with the first half of the Holocene. During the last 3 ka, glacier advances occurred at 2300–1700 cal. BP (Historical stage) and 13th–19th centuries (Aktru stage (LIA)). The recurrence interval of strong prehistoric earthquakes is estimated as ~400 years. The final draining of the Holocene lake in the Chuya intermountain depression took place about 1500 cal. BP. All these natural events together with political and social factors controlled the nomadic population, their habitat, and the patterns of evolution and migration of nomadic cultures within the SE Altai. Aridity intensification and cooling enhanced by anthropogenic impact brought deforestation of the eastern part of the Chuya depression.

1. Introduction

Landscape, climate and catastrophic geological processes, such as earthquakes, tsunami, and volcanic eruptions, are the main natural factors that have heavily influenced the existence of human beings as a biological species. These factors also determine natural (geographic) habitat, territorial organization of human society, the way of everyday life, ethnopsychology, religion, and the dynamics of social processes.

The Altai Mountains (South Siberia) has been inhabited since the Palaeolithic (Derevyanko and Markin, 1987). The extremely arid climate, widespread permafrost and low population density of this region support good preservation of archeological sites and offer a unique opportunity to study the rich historical heritage of this center of ancient civilizations located on a crossroad of migrations and cultural interconnections between East and West.

A large number of publications present various archeological surveys including mapping of individual archeological monuments, and analysis of their typology (Derevyanko and Markin, 1987; Kubarev, 1991; Bourgeois et al., 2000; Molodin, 2000; Tishkin, 2007; Gheyle, 2009 and many others), but the issue of chronology of the archaeological cultures in Altai is still debated. The cultures starting from the middle of the first millennium BC are in general referred to a single economic-cultural type – nomads of arid piedmonts and mountains of temperate zone, however, both the history and chronology of ancient cultures is not clearly understood (Tishkin, 2007, and references therein). The Holocene climatic reconstructions within Russian Altai also vary considerably (Agatova et al., 2012, and references therein) which complicates the correlation between climate, geomorphological events and replacement of archaeological cultures. Until now, there are only isolated attempts to provide such correlation (Bykov and Bykova, 2006).

This paper focuses on the study of the southeastern part of the Russian Altai (SE Altai) which represents a combination of landscapes and ecosystems of alpine highlands, vast plateau-topped watersheds and intermountain depressions with unique archeological sites and traditional forms of environmental management of different cultures. Our study is based on different methodological approaches including geomorphological and geoarcheological analysis, radiocarbon and dendrochronological dating. It is focused on: 1) developing the chronology of climatically driven mountain

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glacier advances and variations of the upper forest line; 2) estimating the ages and recurrence interval of strong prehistoric earthquakes that caused landscape changes significant for human beings; 3) timing and patterns of fluvial system transformation in the Chuya basin and 4) analyzing and discussing the environment–human interactions within the SE Altai during the last 3 ka. This period is most richly characterized by numerical dates of archaeological finds and major nature events which control migrations and shifting of Scythian, Hunnu, Turk and later nomadic cultures in the region.

2. Study site

2.1. Geomorphological setting

The Altai Mountains are the northern part of the Central Asia collision belt. They stretch northwest more than 1500 km across the borders of Mongolia, China, Kazakhstan, and Russia, and form a wedge shape narrowest in the southeast and widest in the northwest. The elevation increases in the opposite direction from 400 m a.s.l. to 4000 m a.s.l. The modern climate of Altai Mountains is determined by its intracontinental position, with the main moisture transfer from the west (Atlantic Ocean), and to a lesser degree from the north (Arctic), with a dominant influence of the Mongolian anticyclone, giving rise to increasing aridity southeastwards and complicated latitude–longitude orographic climatic zoning.

The high-mountain southeastern part of the Russian Altai includes the Chuya and the Kurai intermountain depressions surrounded by ridges with altitudes about 3500–4200 m a.s.l. (Fig. 1). Belukha peak (4506 m a.s.l.) is the highest mountain in the Asian part of Russia. Deeply incised valleys represent a system of imbedded troughs including up to 3 generations within the South Chuya range. The floor of the Chuya intermountain depression, the largest in the Altai Mountains, is located at 1750–2000 m a.s.l. lowering westwards where the incision of the Chuya river-bed is about 1735 m a.s.l. The altitude of the Kurai depression is about 1500–1600 m a.s.l. These intermountain depressions are separated by the Chagan-Uzun massif with the highest Sukor summit (2920 m a.s.l.) in its northern part.

In the western part of the SE Altai, the stony steppe on the floor of the Kurai depression grades into taiga vegetation on the ranges slopes. In the western mountains flanking the Chuya depression, forests have an insular distribution, vanishing completely in the southeastern part. The plateau-toppled highlands are covered by alpine meadows. Even today these highlands are used as summer pasture for the cattle which winter in the intermountain depressions. The higher relief layer is represented by alpine landscapes with mountain tundra vegetation changing with height into glacial zone.

In spite of the arid climate (the mean annual precipitation is less than 200 mm in the floor of intermountain depressions), the high altitudes of the ridges are favourable to glacier formation. About 75% of the modern glaciated area in Russian Altai, with a total surface 910 km^2, is concentrated within the SE Altai. Modern glaciers feed the tributaries of the Chuya, Argut and Katun rivers, which basins include most of rivers of the SE Altai.

The ice-sheet mid-Pleistocene and the valley-piedmont late-Pleistocene glaciations greatly affected the SE Altai landscapes (Devyatkin, 1965). Smaller Holocene glaciers mainly occupied the heads of troughs. In some glacial valleys, up to two or three moraine

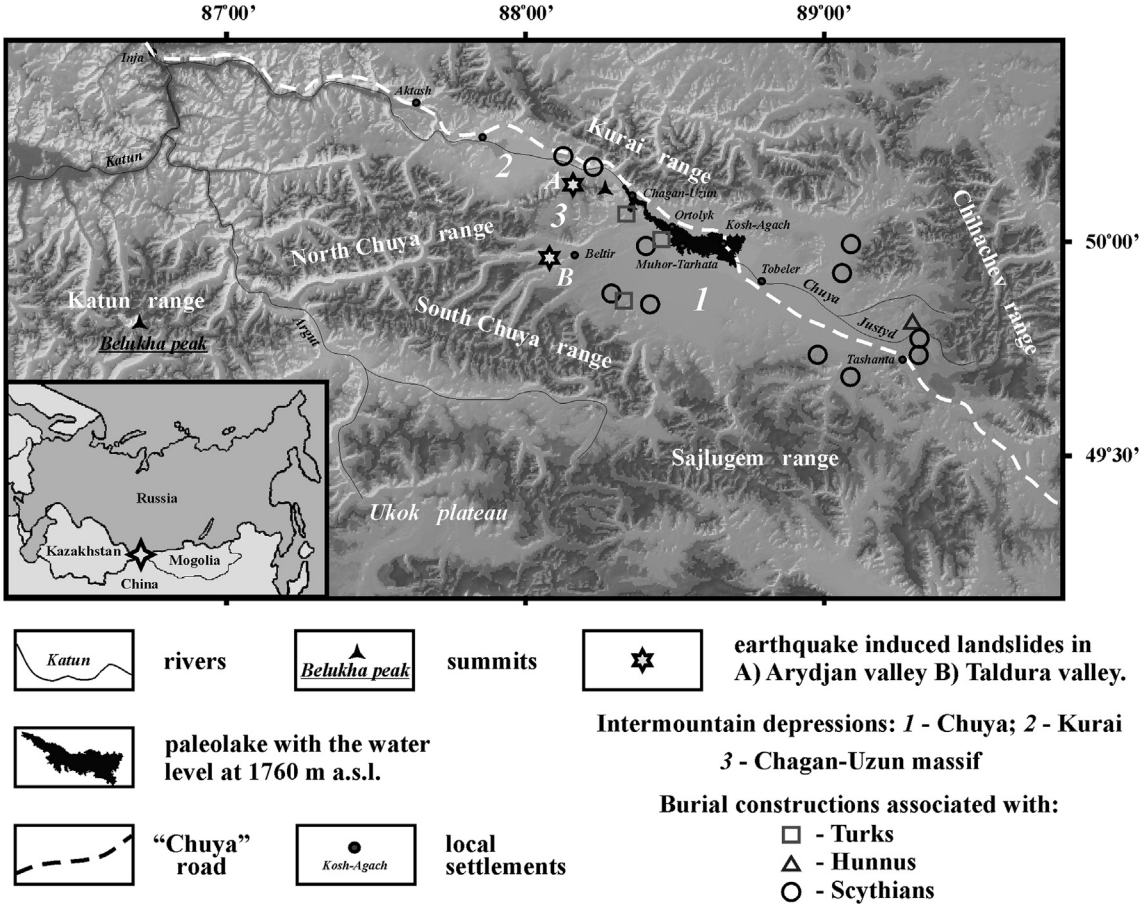

Fig. 1. Southeastern part of Russian Altai.