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## Divnogorie pedolithocomplex of the Russian Plain: Latest Pleistocene deposits and environments based on study of the Divnogorie 9 geoarchaeological site (middle reaches of the Don River)

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### ABSTRACT

Latest Pleistocene fossil soils and deposits have been described in the geoarchaeological site Divnogorie 9 (the Middle Don drainage basin) under the name of Divnogorie pedolithocomplex. For the first time, a soil-sediment series with 2–3 levels of soil formation has been described in the forest-steppe of the Russian Plain and dated to the Bølling–Allerød interval (BØ–AL). That was the last soil formation of Pre-Holocene time. The soils are weakly developed (immature), of meadow and burozem genesis. They formed for a few hundreds of years in periglacial steppe environments, under forest-steppe vegetation. The lower soil (attributed to Bølling) is dated at 13.5–14 ka cal BP and defined as a weakly developed Petrocalcic Skeletic Colluvic Siltic Chernozem. Under coniferous-broadleaf forests the middle soil is described as Umric Calcaric Colluvic Siltic Leptosol and dated at Dryas-2. The uppermost soil dated at Allerød is weakly developed Skeletic Calcaric Colluvic Siltic Cambisol formed under coniferous-broadleaf forest-steppe. The data obtained made possible reconstructions of the Late Glacial climates and landscapes. The underlying sediments are the deposits of Divnogorie paleo-lake. The deposits include seven bone-bearing horizons with Late Upper Palaeolithic lithic tools. They are dated to the interval 17–14 ka Cal BP.

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### 1. Introduction

The Bølling–Allerød interval (BØ–AL) was noted for extremely unsuitable conditions for soil development (Velichko, 2002). In particular, two features of the period should be marked as especially unfavorable: climatic characteristics (low temperatures and insufficient moisture supply) and a brevity of the intervals when the soil formation was possible (that resulted in discontinuity of soil evolution). During that period, no “normal” (mature, with fully developed profile) soils could develop. The leading role belonged to relief-forming processes. New drainage networks developed, and intensified erosion and deposition processes, which suppressed soil

forming processes (Sycheva, 1997, 2006b, 2006c). The soils dated to the Latest Pleistocene warmings (Bølling and Allerød) are of small thickness and weakly developed, occurring in the eolian deposits (dunes) at the periphery of the last ice sheet in northern Germany, Poland, Baltic countries, Belarus and in northwest Russia (Velichko, 2002; Starnberger et al., 2009; Jankowski, 2014). In other regions of the Russian Plain, the soils dated to the Late Glacial occur only occasionally and are most often related to archaeological sites found on low terraces or slopes in river valleys (Aleksandrovskiy, 1983, 2004; Gugalinskaya and Alifanov, 2011). Most often, only one Allerød soil is described or a composite soil of Bølling–Allerød. The Late Glacial soils are still uncertain as to their stratigraphic position, genesis, rank, and history of evolution. The nomenclature and typology of the soils attributed to the BØ–AL interval on the Russian Plain have not been developed as yet, nor were stratotypes properly identified. The Late Glacial soils studies are of considerable

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importance not only for a detailed subdivision of the Late Pleistocene deposits, but they would provide a basis for paleoclimatic and paleoenvironmental reconstructions of the time marked by glacial to interglacial epoch transition, rapid changes in faunal assemblages and initial stages of human activities.

## 2. Purpose and objectives

The purposes of the studies may be stated as follows: to provide substantiation for recognizing the Divnogorie pedolithocomplex, and to determine its age, rank (order), and genesis. The studies of the Divnogorie complex of paleosols and deposits dated to final Pleistocene and occurring in the upper series of the sequence exposed in the Divnogorie 9 gave an insight into succession of natural events and made possible to estimate the environments of the Late Glacial warmings and coolings.

## 3. General characteristics of the Divnogorie 9 site

The studied region belongs to the archeological-paleontological site Divnogorie 9 located on the chalk plateau in the south of the Central Russian Upland (Fig. 1A). The site was discovered in 2004. It occurs in deposits on the right side of a large balka (small flat-bottom valley lacking perennial stream) at the right side of the Tikhaya Sosna River (a tributary of the Don R.) about 1.9 km

upstream of the river mouth. The studied site occurs at about 35–40 m above the water edge of the river (Bessudnov and Bessudnov, 2010; Bessudnov et al., 2012). The locality is noted for an extraordinary diversity of landscapes typical of the southern subzone of the Central Russian forest-steppe. The chalk plateau is at the right side of the Don R. and is bounded by river floodplains: that of the Don on the north and the Tikhaya Sosna on the west. The plateau slopes are heavily dissected by ravines and gullies opening into the river valleys and large balkas. The gullies are up to 60–70 m deep. In many of them, the longitudinal profile reveals a step indicative of at least two stages in their development: an incision and a subsequent infilling. Typical are gullies marked by a V-shaped cross-profile and very steep sides (up to 50°). They are cut into flattened floor of older, partly filled erosional landforms dated to the Late Pleistocene. One such gully, lately known as Divnogorie 9 Gully, appeared to cut into bone-bearing layers with considerable clusters of bones, mostly those of horses (Fig. 1B).

## 4. Stratigraphy and chronology

The stratigraphy of Divnogorie 9 geoarcheological site was described in more detail earlier (Lavrushin et al., 2010, 2011). In the sedimentary sequence, more than 14 m thick, there are two series distinguished: the lower lacustrine and the upper composed of paleosols and slope deposits.

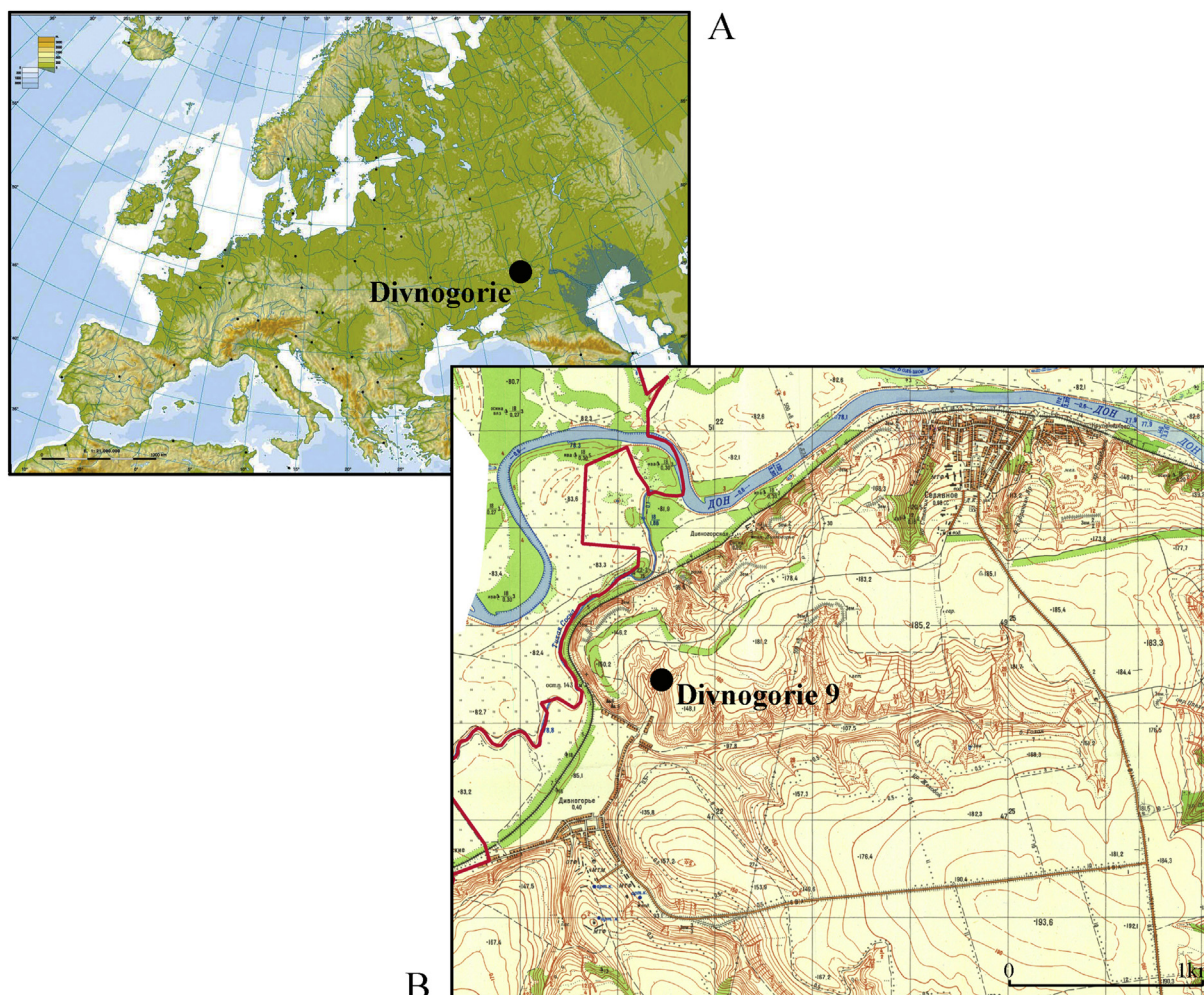


Fig. 1. A. Location of geoarcheological site Divnogorie 9 on the map of Europe. B. Topographic map of Divnogorie farmstead and the location of Divnogorie 9 site.

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