Quaternary International 409 (2016) 50–60

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Pollen evidence for Late Pliocene – Early Pleistocene vegetation and climate change in the North Caucasus, North-Western Caspian Region

O.D. Naidina [a, *], K. Richards [b, c]

[a] Geological Institute, Russian Academy of Sciences, Biostratigraphy and Paleogeography, Pyzhevsky, 7, 119017 Moscow, Russia
[b] KrA Stratigraphic Ltd., 116 Albert Drive, Deganwy, Conwy, LL31 9YY, United Kingdom
[c] Institute for Biodiversity and Ecosystem Dynamics (IBED), University of Amsterdam, 1090 GE, Amsterdam, The Netherlands

ARTICLE INFO

Article history:
Available online 3 January 2016

Keywords:
North Caucasus
Pollen
Late Pliocene
Early Pleistocene
Akchagylian
Apsheronian

ABSTRACT

Pollen and spores have been analysed in deposits of the Akchagylian–Apsheronian in the north-western Caspian Sea region, providing a picture of past vegetation and climate change for the late Pliocene to early Pleistocene. On the basis of pollen assemblages in sediment cores and outcrops from the North Caucasus (the Caucasus Mineral'nyye Vody region, the Tersko-Sunzhensky area and the foothills of Dagestan), climatic fluctuations, and related changes in vegetation can be recognized for the time from 3.6 to 0.8 Ma. The lower Akchagylian is characterized at first by an open landscape dominated by steppe vegetation. In the middle of the lower Akchagylian, the transgression of the palaeo-Caspian spread, and the treeless landscapes of the earliest Akchagylian were replaced by forests with thermophilic relicts. During the middle-upper Akchagylian and Apsheronian periods, the vegetation cover of the North Caucasus gradually changed: forests were replaced with steppe and semi-desert vegetation in response to episodes of aridification, and changes were evident in the structure of the dendroflora. The vegetation of the North Caucasus shows changes consistent with climatic warming at around 3.2 Ma which coincides with a period of warming in the Mediterranean and probable represents the "Mid Pliocene Warm Period".

1. Introduction

Upper Pliocene to lower Pleistocene Akchagylian and Apsheronian deposits are widely distributed within the southeastern part of the East-European Plain, including the oil and gas province of the northern Caspian Region. Economic activity, including environmental protection and management of oil and gas fields, requires geological and palaeogeographical studies, the understanding of environmental changes and the discovery of analogues for the latter. Amongst the various palaeogeographical methods, pollen analyses play an important role since they provide information on changes in flora, vegetation and climate.

The purpose of this paper is 1) to present the upper Pliocene-lower Pleistocene stratigraphy of the North Caucasus region; 2) to provide information on the Plio-Pleistocene flora and vegetation of the region and their changes through time; 3) to document changes in landscape and climate; and 4) to show the inter-relation of changing vegetation and climate and how these are linked with transgressions and regressions in the palaeo-Caspian Sea. This study uses material from the North Caucasus to the west of the northern Caspian Region, where the palynology of the Akchagylian and the Apsheronian has not been previously studied in detail (Fig. 1).

2. Stratigraphy

2.1. Relationships of Russian regional stages to European Plio-Pleistocene stages

According to the stratigraphic framework for Western Europe (Cita et al., 1999) the base of the Piacenzian of the Mediterranean is located at the base of small scale carbonate cycle 77 of Punta Piccola, Italy, which coincides with the Gilbert-Gauss boundary at 3.6 Ma and with the base of the Akchagylian in the North Caucasus region (Zubakov and Borzenkova, 1990). The West European Gelasian stage begins above Gauss/Matuyama boundary at 2.58 Ma. After studying of a large number of pollen diagrams, Suc et al. (1997) proposed lowering the Plio-Pleistocene boundary to

* Corresponding author.
E-mail addresses: naidina@ilran.ru, onaidina@gmail.com (O.D. Naidina).

http://dx.doi.org/10.1016/j.quaint.2015.12.018
1040-6182/

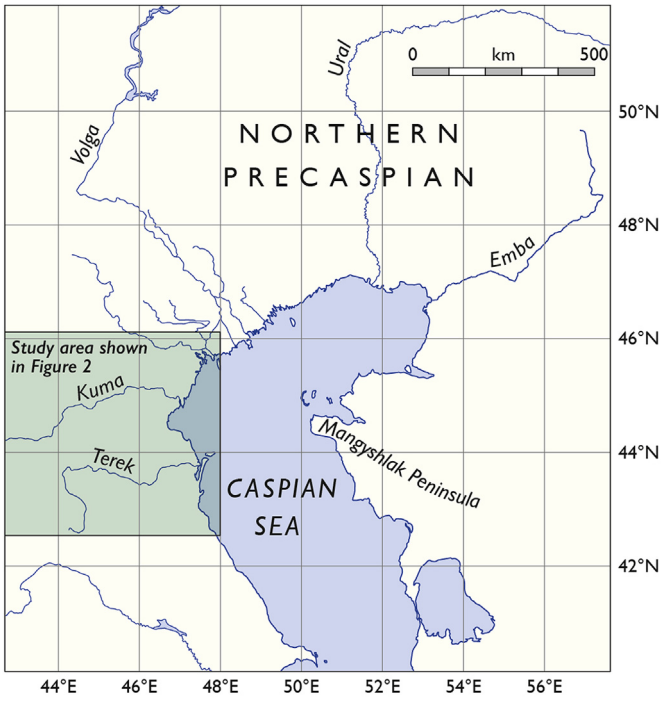

Fig. 1. The northern Caspian region showing the study area in the Terek and Kuma River basins to the north of the Caucasus.

2.6 Ma, to coincide with the Gauss/Matuyama palaeomagnetic reversal. This was subsequently ratified by the International Commission on Stratigraphy in July 2009 and the base of the Quaternary was amended to 2.588 Ma (Gladenkov, 2010). The Gelasian was moved from the Pliocene epoch and now forms the lower stage of the Pleistocene, corresponding to the Russian 'Eopleistocene'.

Although there were variety of opinions on the lowering of the base of Quaternary (Gladenkov, 2010), the decision was ultimately approved by the Interdepartmental Stratigraphic Committee (ISC) of Russia (Zhamoida and Leontieva, 2012). The changes in the Russian Quaternary scale, however, caused a debate (Tesakov et al., 2015) as in the General Stratigraphic Scale of Russia (GSS), the Quaternary traditionally differs from that of the International Stratigraphic Scale (ISS). After a series of detailed discussions, Yu. B. Gladenkov, S. M. Shik, Yu. A. Lavrushin, A. S. Tesakov, A. A.Velichko and T. A. Yanina put forward a revised structure of the Quaternary for the consideration of the ISC Quaternary Commission for the Russian GSS (Tesakov et al., 2015). This incorporated the stages of the ISS and an updated scheme for the traditional domestic stratigraphic units, with the Pleistocene divided into three subseries: Paleopleistocene (Gelasian), Eopleistocene (Calabrian), and Neopleistocene (Ionian to Tarantian). Moreover, the rationale was given in the 'General Stratigraphic Chart of Russia' (Borisov, 2013) to introduce a new unit of 'subdivision', therefore splitting the Eopleistocene into two parts: lower Eopleistocene and upper Eopleistocene subdivisions. The international and domestic stratigraphic sub-divisions of the Quaternary system in Russia remain under discussion and the question of coordinating regional stratigraphic data with the ISS remains open.

2.2. Regional features

The Akchagylian and Apsheronian regional stages have not been consistently defined stratigraphically (e.g. Jones and Simmons, 1996; Forte et al., 2015), and have been variously described as a 'horizon', a 'series' and a 'regioseries', although the latter term has not been widely accepted. There is no universally agreed stratigraphic subdivision of the Akchagylian, nor any definitive nomenclature. A three-fold subdivision (Ak_1, Ak_2 and Ak_3) is the most widely used but even this is not always well-constrained and consistently applied. In this present work, palaeomagnetic boundaries are used to define the late Pliocene and Pleistocene stages, in accordance with published data (e.g. Pevzner and Vangengeim, 1986; Trubikhin, 1987).

The base of the Akchagylian in the North Caucasus region occurs at the base of the Piacenzian, coinciding with the boundary between the Gilbert and Gauss palaeomagnetic intervals at 3.6 Ma. The maximum transgression of the Akchagylian Sea occurred in the Gelasian and this is reflected by the presence of extensive Akchagylian deposits around the Caspian region, for example to the south of the Caucasus in Azerbaijan where the base of the Akchagyl is somewhat younger, dated at between 3.2 Ma (van Baak et al., 2013) and 2.71 (van Baak, 2015). The Akchagylian–Apsheronian boundary coincides approximately with the top of the Olduvai palaeomagnetic episode close to 1.8 Ma, although the interpreted age of the Akchagylian to Apsheronian contact varies within the literature (e.g. Svitoch, 2014). The top of the Apsheronian is close to the boundary between the Matuyama and Brunhes palaeomagnetic epochs at around 0.8 Ma. In the present work the most widely accepted ages based on palaeomagnetic data (Naidina, 2015) are used.

2.3. 'Meotis and Tersky beds'

A feature of the Akchagylian–Apsheronian deposits of the eastern North Caucasus is their transgressive nature, overlying older Cenozoic beds. Directly under the Akchagylian deposits are mainly non-fossiliferous beds of continental or brackish lacustrine origin. In the Tersko-Sunzhensky area, these are the deposits of the "Meotis", which are of late Miocene, Messinian age and therefore probably co-eval with parts of the Maeotian and Pontian stages as defined by Krijgsman et al. (2010). The overlying, younger sediments belong to the so-called "Tersky layers". In the eastern North Caucasus region, these sediments were deposited in the southern periphery of the Tersky gulf, and are made up of mainly of volcanogenic tuffs and high energy sands (Fig. 2). One of the main questions on the Pliocene stratigraphy of the North Caucasus is clarification of the age of these "Tersky layers", which have differing definitions by various authors (Zhizhchenko, 1958; Schneider, 1959; Steklov, 1966). There is, therefore, some uncertainty establishing of the lower boundary of the Akchagylian. Practically, the Akchagylian is recognized by the emergence of a characteristic microfauna, which includes the molluscs *Dreissena polymorpha* (brackish), species of *Unio* and *Valvata* (freshwater) and freshwater to slightly brackish ostracods such as *Cytherissa jushatyrensis*, *Heterocypris incongruens* and species of *Cypria* and *Candoniella* (Schneider, 1959). But this is problematic as microfauna, including ostracods and rare foraminifera, also occur in the "Tersky layers". The upper part of this interval is described by Schneider (1959) as "a zone with rare microfauna", containing ostracods including *Iliocypris bradyi* (freshwater), *Cyprideis littoralis* (brackish), species of *Candona* (typically freshwater) and also brackish marine foraminifera (*Ammonia beccarii*), all of which can also occur in the lower Akchagylian. These "Tersky layers", which are widely developed in Tersko-Sunzhensky area, are considered to represent the oldest sediments of the Akchagylian stage, deposited during the Piacenzian after c.3.6 Ma. They are likely to be partly time equivalent to the Surakhany Formation which is found mainly in the South Caspian Basin (Kroonenberg et al., 2005; Vincent et al., 2010;