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Holocene vegetation history and sea level changes in the SE corner of the Caspian Sea: relevance to SW Asia climate

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ABSTRACT

The palynological investigation of core TM (27.7 m long) taken in a dried out lagoon reveals both Holocene vegetation history in the north-eastern foothills of the Alborz Mountains and past water level changes of the Caspian Sea (CS).

The delay in woodland expansion at the beginning of the Holocene, which is typical of eastern Turkey, the Iranian plateau and recorded in the CS south basin, is only weakly felt as the region is close to glacial refugia of trees.

The succession of the main trees out of their refugia has been established as deciduous *Quercus*, *Carpinus betulus*, *Parrotia persica*, and *Fagus orientalis-Pterocarya fraxinifolia*, presenting therefore close affinities to south European interglacials of the Early Pleistocene. This suggests a similarity in climate.

A *Pterocarya* decline is observed after AD 495. The studied region is close to the easternmost tree distribution; this could explain why it has been affected earlier than elsewhere in the northern Alborz and the Caucasus. In addition human activities during the Sasanian Empire and the subsequent drying of the climate contributed to weakening the spread of this tree.

A maximal sea level occurs in the first part of the Holocene from 10.6 to 7.2 cal. ka. It is suggested that the CS levels were significantly influenced by the monsoon precipitations over the western Himalayas (via the Uzboy inflow). This is followed by low levels from 7.2 to 3.5 cal. ka with a minimum at 3.9 cal. ka.

The Neocaspian period should be considered a biozone rather than a chronozone, as the environmental conditions reconstructed from dinocyst assemblages are different in shallow shelf waters and in the deep basins.

1. Introduction

The extent of the Holocene changes in the Caspian Sea (CS) water level is so far poorly known and subject to intense controversies (Rychagov, 1997; Svitoch, 2009). The water level changes of the CS are not synchronous with the global sea level changes, not even in anti-phase. Its widely changing palaeo-hydrography has often more influence than the simple relationship with precipitation over the catchment-sea level change. Since its formation, the CS has at times had an outflow to the Black Sea; at other times it was a closed sea. The number of large rivers flowing to the sea has also fluctuated over time, usually with the Volga River bringing > 80% of the water but at other times it was under the influence of the Amu-Daria (daria means river) and its catchment in the western Himalayas (Leroy et al., 2007) (Fig. 1A).

Most sea level information is typically derived from sedimentological–palaeoecological analyses of outcrops around the middle and the north basins with only a few cores from the deep middle and south basins. During the Lateglacial, the CS had most likely higher than present water levels due to meltwater from the Eurasian ice sheet. This period is termed the Khvalynian in the Russian stratigraphy of the CS. This was followed by a brief but poorly dated very low level, the Mangyshlak. Then the Holocene intermediate levels were reached; this is called the Neocaspian.

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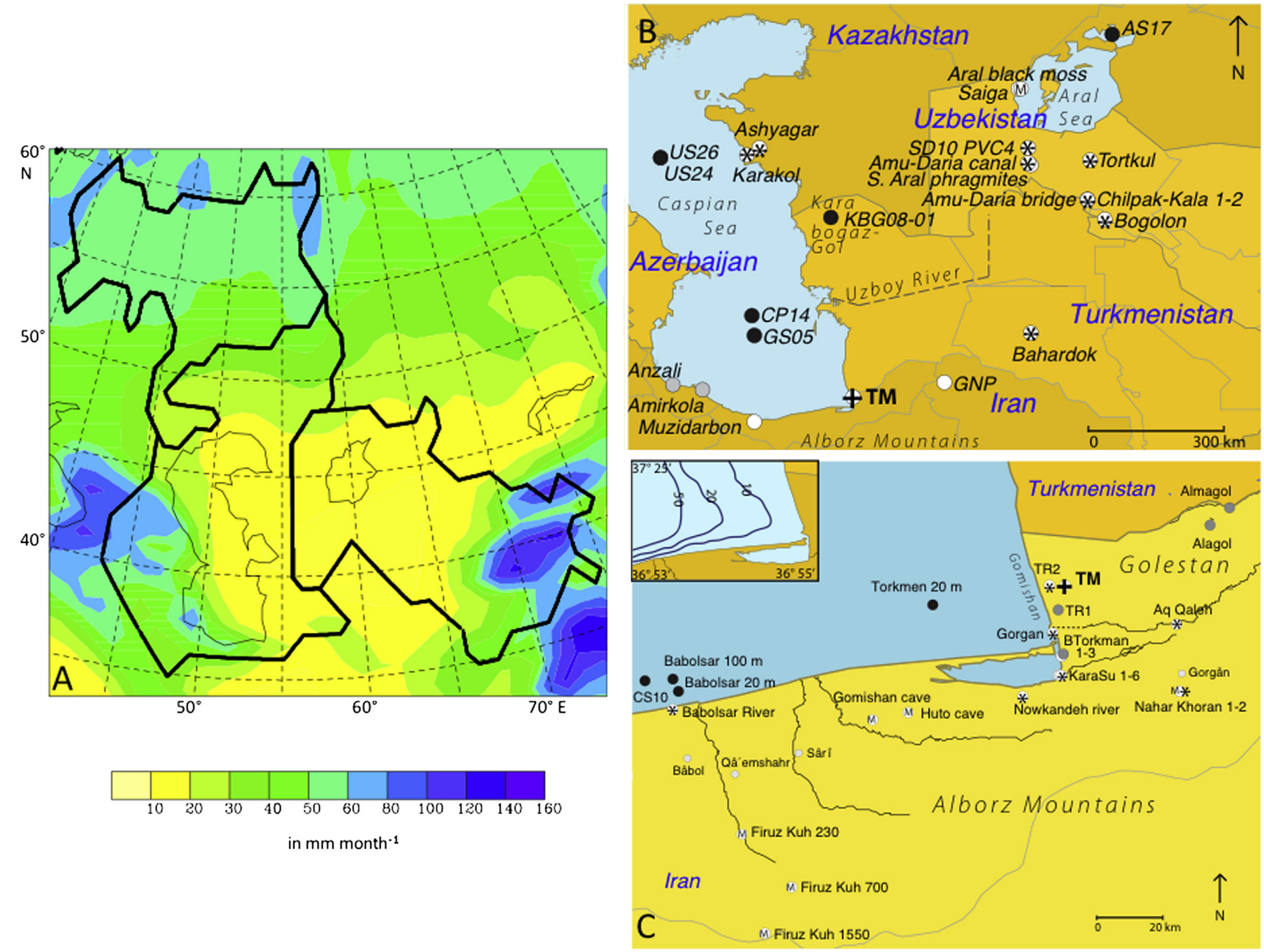

Fig. 1. A: Mean annual precipitations for the area of the Caspian and Aral Sea drainage basins (data from the ECMWF interim reanalysis). Colours are for different mm per month values. Black lines: drainage basin limits. 1B: Location of surface samples in the south-east and east of the Caspian Sea area with river and lagoon names. Black circles for marine sites, grey circles for lagoons, stars on white circles for mud samples, M on white circles for moss polsters and white circles for other sequences cited in the text. 1C: Location of the surface samples and core TM in the south-east corner of the Caspian Sea. Inset showing the shallow shelf in front of the Gomishan coastline, with bathymetric contours for 10, 20 and 50 m. Black circles for marine sites, grey circles for lagoons, stars on white circles for mud samples, and M on white circles for moss polsters. The small light grey circles indicate towns. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

This period may have started anywhere between the beginning of the Holocene and the mid-Holocene according to various authors (Rychagov, 1997; Svitoch, 2009).

The Holocene vegetation history of the CS surroundings is not known. Only short sequences from the south and middle basins have been published, showing a subtle interplay between more or less steppic landscapes (Leroy et al., 2007). In the centre of the Iranian coast, some diagrams covering the last centuries only reveal the existence of a diverse forest (Ramezani et al., 2008; Leroy et al., 2011). However, the probable wide displacement of vegetation belts on the northern flank of the Alborz Mountains, a refugium for some Arcto-Tertiary tree species, is so far totally unknown.

Palynological analyses involving pollen, spores, non-pollen palynomorphs and dinoflagellate cysts (dinocysts) are a powerful tool to reconstruct both terrestrial and aquatic changes. The forest of the south of the CS, i.e. the Hyrcanian forest, is ecologically and palaeo-ecologically interesting as it contains a few endemic species that were widespread in Europe during the Pliocene or even Early and Middle Pleistocene such as *Parrotia persica*, *Zelkova carpinifolia*, *Pterocarya fraxinifolia* and *Gleditsia caspica* (Leroy and Roiron, 1996; Akhani et al., 2010). It is not clear i) when this forest developed after the Last Glacial Maximum in northern Iran, ii) if there was an early Holocene dry period when Europe had a climatic optimum, and iii) what was the succession of trees, out their glacial refugia.

The dinocysts of the CS contain many forms, species and even some genera that are endemic. They have been described in detail recently in Marret et al. (2004). Although it is possible to identify them using a firm taxonomy, their ecological requirements remain at times poorly known. Notwithstanding that limitation, some past sea levels reconstructions may be attempted using the full range of palynomorphs and comparing these with other proxies, such as sedimentology.

The aims of this investigation are therefore to reconstruct i) the Holocene vegetation history in the foothills of the Alborz Mountains and ii) the Holocene water level changes of the CS from the evidence of a 27.7 m long sediment core (TM) taken in a palaeo-lagoon in the SE corner of the CS.

2. Setting

The CS is an endorheic lake, which is the world's largest lake in terms of both area and volume, extending 35–48° N and 47–55° E