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Research paper

Provenance of clay minerals in the sediments from the Pliocene Productive Series, western South Caspian Basin

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ABSTRACT

The research work presents clay mineral composition in the sediment of the Pliocene Productive Series from western South Caspian Basin and identify potential source areas for the different research regions. The Productive Series is a main reservoir unit in the South Caspian Basin and divided into a lower division and an upper division. The clay mineral assemblages document coinciding changes in provenance. At the time of the deposition of the Lower Division, the Russian Platform was a potential source area for the Absheron Peninsula and drained by Palaeo-Volga River. However, at the time deposition of the Upper Division three different sediment source could be identified for the three research areas: Absheron Peninsula – the Russian Platform was drained by the Palaeo-Volga; South Absheron Offshore Zone – the Greater Caucasus was drained by the Palaeo Samur River; Baku Archipelago – the Lesser Caucasus was drained by the Palaeo-Kura River.

1. Introduction

The Caspian Sea is the world's largest lake with a total area of 375,000 km^2 and is located in central Eurasia (Fig. 1. A; Abdullayev et al., 2012). During Oligocene and Miocene times, the Caspian Sea was a part of the Tethys between the Euro-Asian, Indian and Afro-Arabian plates. Paratethys and Mediterranean Seas were disconnected from each other at the peak of Messinian Salinity Crisis, 5.6–5.5 Ma. As a result water level of the Paratethys fell at least 50–100 m (Krijgsman et al., 2010). Further the Black Sea and the Caspian Sea, as part of the eastern Paratethys, separated in the late Miocene time (Krijgsman et al., 2010; Zubakov and Borzenkova, 1990). The development of an oceanic basin which formed the south Caspian Basin was caused by the more rapid rate of spreading (Smith-Rouch, 2006). The South Caspian basin, i.e. south of ca. 40° N, is located offshore Azerbaijan and is the oldest oil producing region in the world (Abrams and Narimanov, 1997). In 1848, the first oil well in the world was drilled in the Bibi-Eibat field on the Absheron Peninsula (Narimanov and Palaz, 1995). The main goal of exploration in the Absheron Peninsula, Absheron Archipelago, South Absheron Offshore Zone and Baku Archipelago in the Azerbaijan part of the Caspian Sea (Fig. 1. B; Kroonenberg et al., 2005) is to discover oil and gas fields within the non-marine clastic sedimentary sequence in the Pliocene Productive Series (Fig. 2. A).

The goal of the study is to investigate clay mineral composition of the Productive Series from the western South Caspian Basin in order to learn whether the clay mineral assemblages varies with stratigraphy. The main tool used in this study is clay minerals, to reconstruct sediment provenance and to establish the distribution of potential reservoir sediments.

The Productive Series (PS) is part of the Pliocene sequence and has a thickness of >5000 m (Abrams and Narimanov, 1997). Based on the microfauna composition, the PS is divided into a Lower Division and an Upper Division (Fig. 2. A). More humid climatic conditions occurred during the deposition of the Lower Division of the PS while more arid climatic ones occurred during deposition of the Upper Division (Hinds et al., 2004). Moreover according to the lithological composition, the Lower Division comprises the Kala Suite, Pre-Kirmaky Suite, Kirmaky Suite, Post-Kirmaky Sand Suite and Post-Kirmaky Clay Suite; and the Upper Division consists of the Fasila Suite, Balakhany Suite, Sabunchy Suite and Surakhany Suite (Fig. 2. A; Vincent et al., 2010; Reynolds et al., 1998). The PS is made up by alternating sandstones-siltstone-shale layers (Fig. 2 B; Hinds et al., 2004).

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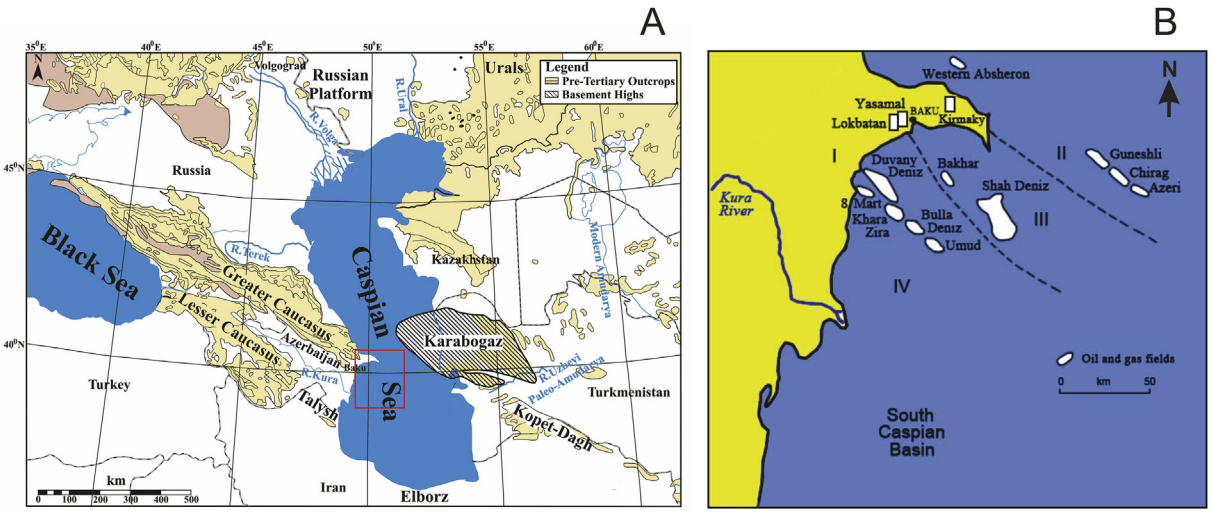

Fig. 1. A-Location map of the working area in the south Caspian Sea showing adjacent mountain belts and major river systems (Abdullayev et al., 2012), red box: research area; B-Location map of the four research areas with the main oil fields and subdivision into I-Absheron Peninsula, II-Absheron Archipelago, III-South Absheron Offshore Zone, IV-Baku Archipelago (after Kroonenberg et al., 2005). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

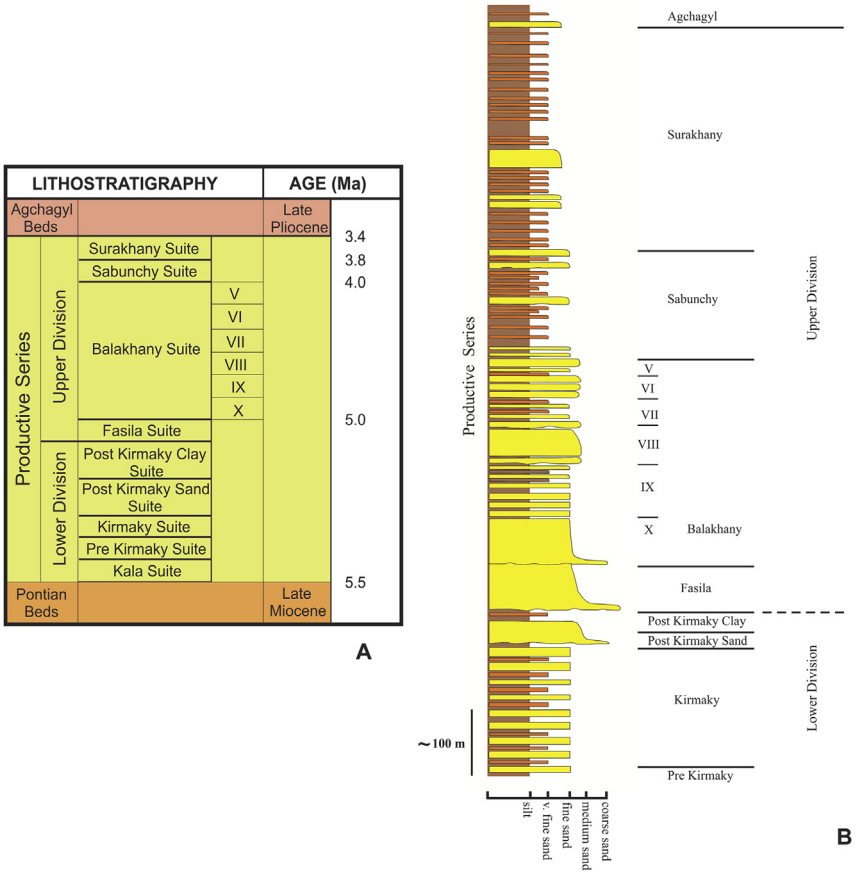

Fig. 2. A-Stratigraphic chart column of the Productive Series (after Vincent et al., 2010), B-simplified lithological column of the Productive Series on the Absheron Peninsula (Hinds et al., 2004).

2. Palaeo-drainages and source rocks

The western flank of the South Caspian basin was supplied with freshwater and terrigenous materials by the rivers from the Palaeo-Volga River system from the north and from the Palaeo-Samur and Palaeo-Kura river systems from the west at the time deposition of the Early Pliocene (Fig. 3; Khalifazade and Mursalov, 2007). These rivers are draining respectively the Russian platform, the Greater Caucasus and the Lesser Caucasus.

The Russian Platform in the North is characterised by