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Western Laptev Sea Region Framework- Structural Style and Timing of Deformation

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SUMMARY

The Laptev Sea region is one of the remote and geologically complex areas of Russian Eastern Arctic. According to the existing seismic data, a number of large offshore sedimentary basins with significant proposed hydrocarbon potential, were revealed on its shelf. No offshore wells were drilled there so far, thus all the information on the regional geology, is based on the very limited amount of marine seismic profiles and our knowledge on adjoining near-coastal areas. This study is based on the series of field works 2008-2009, carried out as a part of TGS-NOPEC Geophysical Company / St Petersburg State University joint project on Geology and Hydrocarbon systems of Northern Siberia. The field observations were done in the Laptev Sea framework, including Taimyr, Verkhoyansk and Olenek fold belts, Siberian craton, Enisey-Khatanga and Anabar-Lena depressions. Here we present some results of structural investigations of the Paleozoic-Mesozoic sedimentary complexes, exposed on Southeastern Taimyr, Bolshoy Begichev Island and Paksa Peninsula/Anabar River mouth. It is shown, that the final stage of compressional deformation in the Western Laptev Sea Region corresponds to Late Kimmerian and so is roughly synchronous with those on the rest of Eastern Arctic area, including New Siberian Islands, Chukotka and Brooks Range.

Introduction

The Laptev Sea region is one of the remote and geologically complex areas of Russian Eastern Arctic. According to the existing seismic data, a number of large offshore sedimentary basins with significant proposed hydrocarbon potential, were revealed on its shelf. No offshore wells were drilled there so far, thus all the information on the regional geology, is based on the very limited amount of marine seismic profiles and our knowledge on adjoining near-coastal areas. This study is based on the series of field works 2008-2009, carried out as a part of TGS-NOPEC Geophysical Company / St Petersburg State University joint project on Geology and Hydrocarbon systems of Northern Siberia. The field observations were done in the Laptev Sea framework, including Taimyr, Verkhoyansk and Olenek fold belts, Siberian craton, Enisey-Khatanga and Anabar-Lena depressions. Here we present some results of structural investigations of the Paleozoic-Mesozoic sedimentary complexes, exposed on Southeastern Taimyr, Bolshoy Begichev Island and Paksa Peninsula/Anabar River mouth (Figure 1).

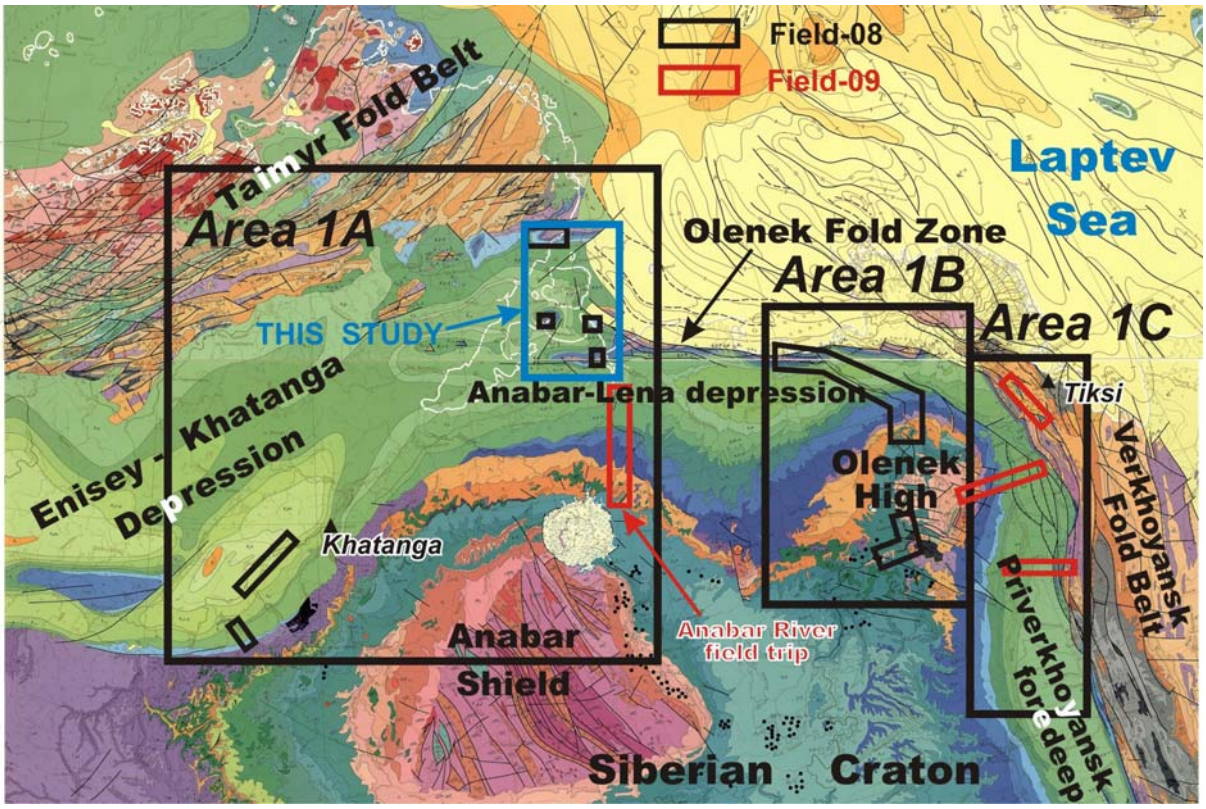

Figure 1 *The fragment of Geological Map, scale 1:2500000 (Petrov, 2004), for Southwestern Laptev Sea region, showing the location of the main areas, studied during 2008-2009 field seasons. The blue rectangle outlines the area, described in this paper.*

Method

In this paper we focus on the problems of structural geology of the region studied. During the field works we have collected significant amount of structural-geological data, including observations and mass-measurements of bedding planes, elements of folds, faults and shear fractures, extensional veins, etc. The data obtained allowed us to restore the main stages of structural/tectonic evolution of the Western Laptev Sea region.

Structural style

According to the previous results of marine seismic data, directly to the East of Southeastern Taimyr, the existence of ~ south-vergent frontal thrust fault and fold zone, separating deformed complexes of

Taimyr fold belt from almost undeformed Paleozoic(?)-Mesozoic sediments of offshore part of Enisey-Khatanga basin (Drachev et al., 2002). Field observations revealed no obvious frontal thrust and fold zone, but we found, that the intensity of the compressional deformation gradually decreases southward from older (Permian, Triassic) to younger (Jurassic-Cretaceous) sequences, towards the offshore part of Enisey-Khatanga basin (Figure 2). Permian strata are deformed in tight to isoclinal folds, complicated by thrusts, often with flat and ramp geometry. Triassic sediments are characterised by open to tight folding with minor thrust faulting. On Paksa Peninsula/Anabar River mouth and Bolshoy Begichev Island the Triassic-Jurassic-Neocomian clastic sequences are involved only in very gentle open folding, complicated by low-amplitude minor opposite-vergent reverse and thrust faults. Based on the measurements of latest extensional mesostructures (small-scale normal faults, extensional fractures) we propose, that the area studied was also subjected by ~ N-S (1) and subsequent E-W (2) extension (Khudoley et al., 2009).

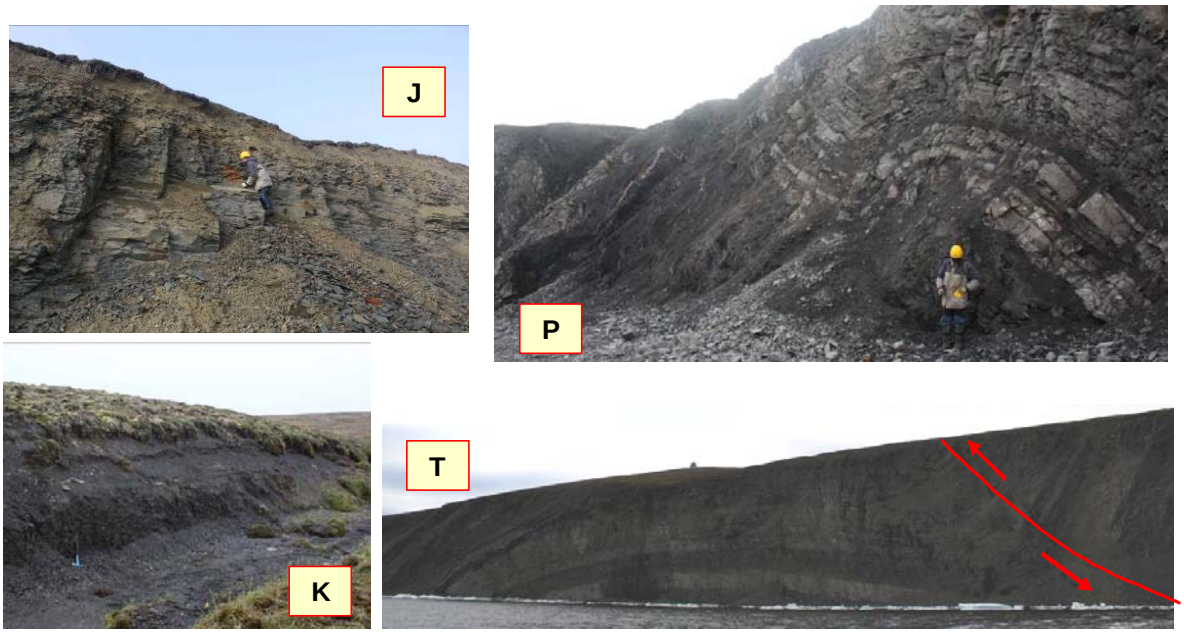

Figure 2 *Structural style of the Tsvetkova Cape area (Southeastern Taimyr).*

Timing of the deformation

It is commonly believed, that formation of the Taimyr orogen, representing south-vergent thrust and fold belt, was caused by collision between Siberian craton and Kara microplate. The earliest syncollisional granitoides in the Northern Taimyr zone are dated as 306-275 Ma, corresponding to Late Carboniferous-Early Permian (Vernikovsky, 2009). In the Late Permian time (264-258 Ma) postcollisional granites and granodiorites were intruded into the deformed Precambrian and Paleozoic sequences of Northern- and Central Taimyr zones (Vernikovsky, 2009). Thus, the deformation occurred corresponds to Late Hercynian (Variscian) orogeny. Although Taimyr thrust and fold belt was in general formed to the end of Early Triassic, the deformation (inversion) was continuing during the whole Triassic period (Vernikovsky, 2009). On the basis on our field observations were concluded earlier, that base-Jurassic unconformity is really exist here, but the basal conglomerates has local source and the could correspond not to compressional, but to extensional event (Khudoley et al., 2009). The discovery of a locally distributed thick Upper Jurassic conglomerate unit in the Tsvetkova Cape area of Southeastern Taimyr (Figure 3a) points to significant uplift and erosion in the Taimyr orogen, located directly to the North from the point of observations. We interpret it as an evidence for the earliest stages of the Late Kimmerian orogeny (Khudoley et al., 2009). South-dipping cross-bedding within conglomerate/sandstone beds strongly supports this idea. We also observed, that Jurassic and Neocomian sequences are also involved in the compressional deformation, but Aptian(?)-Albian sediments are close to subhorizontal and likely post-date the compressional deformation

(Figure 3b). It is interesting to note, that Messoyakh compressional-transpressional zone, complicating the internal structure of Enisey-Khatanga basin, was active during Late Jurassic-Neocomian time (Kontorovich et al., 1994; Kontorovich, Kalinina, 2009).

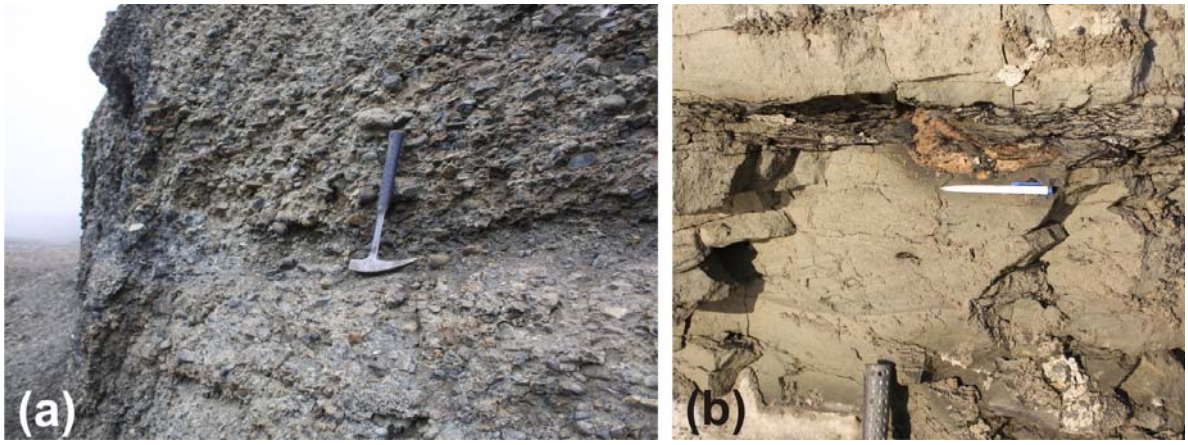

Figure 3 *Evidence of the Late Jurassic-Neocomian regional latest compressional deformation: A - thick Upper Jurassic conglomerate unit in the Tsvetkova Cape area of Southeastern Taimyr; B – Albian subhorizontal coal-bearing strata with cross-bedding on Bolshoy Begichev Island.*

Thus, it is really important, that the final stage of compressional deformation in the Western Laptev Sea Region corresponds to Late Kimmerian and so is roughly synchronous with those on the rest of Eastern Arctic area, including New Siberian Islands, Chukotka and Brooks Range (Alaska), where it took place in the Late Jurassic-Neocomian, pre-Aptian-Albian time (Kos'ko et al., 1985; Parfenov, 1984; Parfenov, Kuzmin, 2001; Sokolov et al., 2002; Kos'ko, Trufanov, 2002; Kuzmichev et al., 2006; Katkov et al., 2007; Zonenshain et al., 1990; Miller et al., 2002; Miller, Verzhbitsky, 2009). This result is necessary to take into consideration for compilation of any regional plate-tectonic reconstructions. The later extensional stage could take place as early as in Aptian time, but it is likely, that it was most active during rifting/spreading processes in Eurasia Basin/Gakkel Ridge in the latest Late Cretaceous-Cenozoic time (e.g., Drachev et al., 1998; Gaina et al., 2002).

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