ISSN 1028-334X, Doklady Earth Sciences, 2014, Vol. 458, Part 1, pp. 1107–1111. © Pleiades Publishing, Ltd., 2014.
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GEOPHYSICS

# A Regional Upper Cretaceous Magnetostratigraphic Section of Southern West Siberia (Omsk Depression)

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Received March 26, 2014

**DOI:** 10.1134/S1028334X14090049

Construction of regional magnetostratigraphic sections and scales for different geological provinces of continents is an important element of investigations aimed at development of the standard geomagnetic scale, which is widely used in geochronological, stratigraphic, and geodynamic studies, as well as in theoretical and applied geophysics. Recent investigations have yielded extensive data on the paleomagnetic properties of Cretaceous sections in the former Soviet Union and around the world. At the same time, the progress in development of the Cretaceous paleomagnetic scale has been determined by the results of paleomagnetic investigations in the most important geological provinces of continents, such as, for example, the West Siberian Basin (WSB). Paleomagnetic data on Cretaceous sections are practically missing from this region, which represents one of the largest petroliferous basins in the world, except for some information in [1–3].

We have studied and analyzed paleomagnetic and paleontological data on Upper Cretaceous sections of the Omsk depression located in the southwestern marginal part of West Siberia.

The geological section of the region in question (Russkaya Polyana area) is represented by Mesozoic–Cenozoic marine and terrestrial sediments that form the platformal cover resting upon the eroded surface of pre-Jurassic sequences. In wells 8, 10, and 2 drilled in the Russkaya Polyana area, Cretaceous sections are composed of the Pokur, Kuznetsovo, Ipatovo, Slavgorod, and Gan'kino formations overlain by Paleogene sediments of the Talitsa and Lyulinvor formations. The sections of all three wells were subjected to detailed paleomagnetic and paleontological investigations. The paleomagnetic characteristics were derived from analysis of the component composition of natural remanent magnetization of rocks. The paleomagnetic sections for all three examined wells were constructed using characteristic (primary) magnetization, which is represented by the high-temperature component determined by terrigenous magnetite and hematite [4]. The palynological data were derived from the analysis of dinoflagellate cysts (dinocysts), spores, and pollen of terrestrial plants. These palynomorphs made it possible to define biostratigraphic units. The marine sediments were dated by correlating them with the dinocyst scale [5] and palynomorph assemblages from reference sections of northwestern Europe. The upper, Maastrichtian part of the Well 8 section contains macrofaunal and nannoplankton remains [6]. The stratigraphic position of palynological assemblages was determined by correlating them with the regional Cretaceous stratigraphic scales of West Siberia [7]. These biostratigraphic and paleomagnetic data provided grounds for correlation of all the examined sections between each other (Fig. 1).

The *Pokur Formation* is dated back to the Albian–Cenomanian with its upper part of the Well 8 belonging, probably, to the Early Turonian [6]. In all three well sections, the unit is characterized by normal polarity of the geomagnetic field with two intervals of reversed magnetization.

The *Kuznetsovo Formation* includes beds with dinocysts characteristic of the Lower (wells 10, 2), Middle, and Upper (wells 8, 10, 2) Turonian sediments.

In all three sections, the Ipatovo Formation contains a very impoverished dinocyst assemblage, which allows it to be dated presumably back to the Coniacian–Santonian [6]. Similar to the Pokur Formation, the Kuznetsovo and Ipatovo formations in the sections of wells 8, 10, and 2 are characterized by normal polarity of the geomagnetic field with three short intervals of reversed magnetization. The Pokur, Kuznetsovo, Ipatovo, and basal overlying Slavgorod formations form a single long magnetozone with normal polarity $N\text{K}_{1\text{-}2}$(al-st) with five intervals characterized by reversed magnetization [4].

In the *Slavgorod Formation*, the dinocyst assemblage becomes more diverse. Despite some differences

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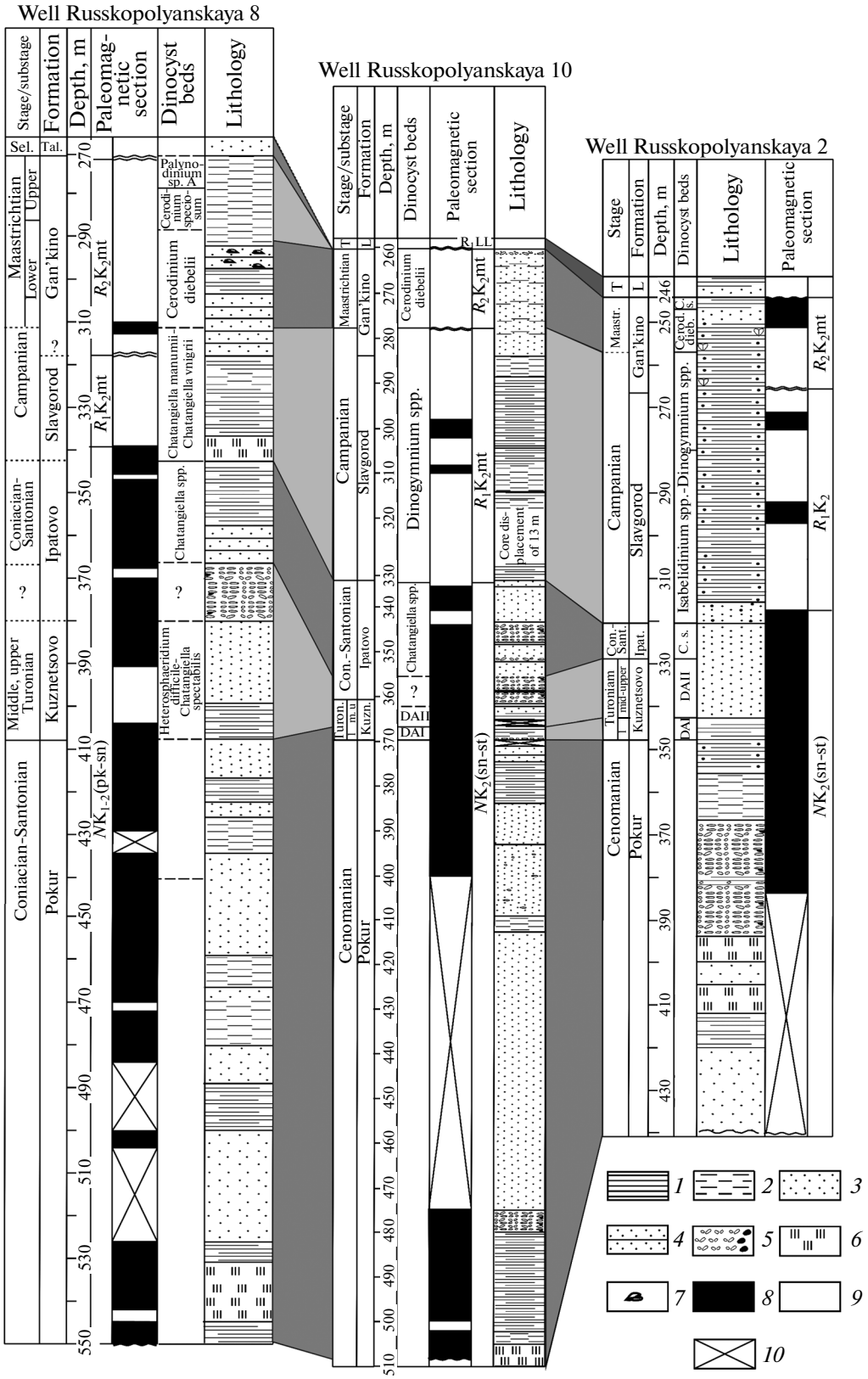


**Fig. 1.** Correlation between Upper Cretaceous sections of southern West Siberia (Omsk depression). (*1*) Clay; (*2*) silt; (*3*) sand; (*4*) sandstone; (*5*) gravel; (*6*) opoka; (*7*) faunal finds. Polarity of the geomagnetic field: (*8*) normal, (*9*) reversed; (*10*) no data. Stage and formation: (Sel.) Selandian, (Tal.) Talitsa, (T) Thanetian, (L) Lyulinvor.

in the compositions of dinocysts in sections of wells 8, 10, and 2, species in common occurring in the Campanian assemblage allow reliable correlation of these sediments in all three sections (Fig. 1). The basal part of the Slavgorod Formation in sections of wells 8 and 2 exhibits normal polarity corresponding to the upper part of the magnetozone $N\mathrm{K}_{1\text{-}2}$(al-st) with normal polarity, while its remaining, largest part in these sections is characterized by reversed polarity. In the Well 10 section, the entire Slavgorod Formation demonstrates reversed polarity. The magnetozone with reversed polarity in wells 10 and 2 includes two short intervals of normal polarity. This formation characterized by reversed polarity forms the magnetozone $R_1\mathrm{K}_2$km [4] (Fig. 1).

The *Gan'kino Formation* in the Well 8 section contains abundant organic remains including dinocysts, spores, pollen, nannofossils, bivalves, ammonites, and gastropods [6]. In wells 10 and 2, this unit yields only palynological evidence. The most complete section of the Gan'kino Formation is recovered by Well 8, where it is dated back to the Late Campanian–Late Maastrichtian. In all three sections, the sediments of this unit are characterized by reversed polarity with a single interval of normal polarity in wells 8 and 2 and form the second magnetozone with reversed polarity $R_2\mathrm{K}_2$mt [4].

In the Well 8 section, the Gan'kino Formation is overlain by the Selandian Talitsa Formation [8]. The hiatus at the Cretaceous–Paleogene boundary corresponds to the upper Gan'kino–lower Talitsa formations. In Well 2, the palynological data imply a substantially longer break in sedimentation (Middle–Late Maastrichtian to Selandian). In the Well 10 section, the Maastrichtian Stage is represented only by its basal part overlain by the Thanetian Lyulinvor Formation [9]. Thus, the hiatus comprises the Lower (partially), Middle, and Upper Maastrichtian and Selandian stages. In the Well 8 section, the Talitsa Formation is characterized by reversed polarity; similar polarity is also characteristic of the lower part of the Lyulinvor Formation in wells 10 and 2, which includes a single interval with normal polarity.

The regional Upper Cretaceous magnetostratigraphic section constructed for the Omsk depression in the southwestern part of the West Siberian Basin (Fig. 2) is based on the paleomagnetic, paleontological, and geological–stratigraphic data correlated with reference sections of three deep wells that recovered Cretaceous strata. The reliability of the obtained paleomagnetic data was controlled by the component composition of natural remanent magnetization, its primary component, and similarity of paleomagnetic polarity patterns obtained for the examined well sections with the magnetostratigraphic [10, 11] and magnetochronological [12] scales.

Three magnetozones are recorded in the regional magnetostratigraphic section: one with normal polarity ($N\mathrm{K}_{1\text{-}2}$(al-st) and two with reversed polarity ($R_1\mathrm{K}_2$km and $R_2\mathrm{K}_2$mt). Each of these magnetozones includes narrow intervals of the opposite polarity. As was mentioned, correlation of the paleomagnetic section with the regional stratigraphic scale was controlled by paleontological data. Thus, the position and succession of the magnetozones in the magnetostratigraphic section is controlled by biostratigraphic data (Fig. 2). The reversed polarity of the magnetozones $R_1\mathrm{K}_2$km and $R_2\mathrm{K}_2$mt dated by the Campanian and Early Maastrichtian provides grounds for the conclusion that the Upper Campanian and Upper Maastrichtian are missing from the regional magnetostratigraphic section of the Omsk depression (southern part of the West Siberian Basin).

Thus, the regional Cretaceous magnetostratigraphic section of the southern part of the West Siberian Basin consists of the standard scale, regional magnetostratigraphic section that includes the regional stratigraphic units and characteristic paleontological assemblages and the paleomagnetic column with the indicated magnetozones and their polarities (Fig. 2). The section comprises the analogs of the Albian–Selandian biostratigraphic units. This section has been correlated with the magnetostratigraphic [10, 11] and magnetochronological [12] scales. The first (from below) long magnetozone $N\mathrm{K}_{1\text{-}2}$(al-st) corresponding to the Upper Cretaceous Jalal hyperzone [10] comprises the Albian-to-Campanian interval. Two upper magnetozones ($R_1\mathrm{K}_2$km and $R_2\mathrm{K}_2$mt) correspond to the interval spanning from the Lower Campanian to the Lower Maastrichtian. The relation of the hyper- and orthozones with their stratigraphic analogs in the Upper Cretaceous magnetostratigraphic scale is as follows (Fig. 2): the Jalal hyperzone (Albian–Santonian) corresponds to Chron C34 in the scale by [12]; magnetozone $R_1\mathrm{K}_2$km is correlated with Chron 33(r); magnetozone $R_2\mathrm{K}_2$mt is an analog of the C31(n) polarity chron. Correlative analysis made it possible to define hiatuses between the Slavgorod ($R_1\mathrm{K}_2$km, Campanian) and Gan'kino ($R_2\mathrm{K}_2$mt, Maastrichtian) formations (chrons C33(n) and C32) as well as between the Upper Cretaceous (Gan'kino Formation, magnetozone $R_2\mathrm{K}_2$mt) and Paleogene (Talitsa Formation, magnetozone $R_1\mathrm{E}_1$zl) (chrons C31(n), C30, C29, C28, and C27; Fig. 2).

The Upper Cretaceous Jalal hyperzone (magnetozone $N\mathrm{K}_{1\text{-}2}$(al-st) includes five narrow intervals with reversed polarities (*R* microzones). The Albian Stage includes the single *R* microzone. An additional *R* microzone is registered at the Albian–Cenomanian stage boundary. A longer interval with reversed polarity is distinguishable at the Cenomanian–Turonian boundary. The next *R* microzone is defined at the base of the Coniacian Stage. The longest *R* interval of the magnetozone is registered in the Upper Coniacian–Santonian stages. The above-mentioned upper four (of five) *R* microzones are correlative with similar *R* microzones defined in the magnetostratigrapic scales of the eastern Caucasus and western Kopetdag–

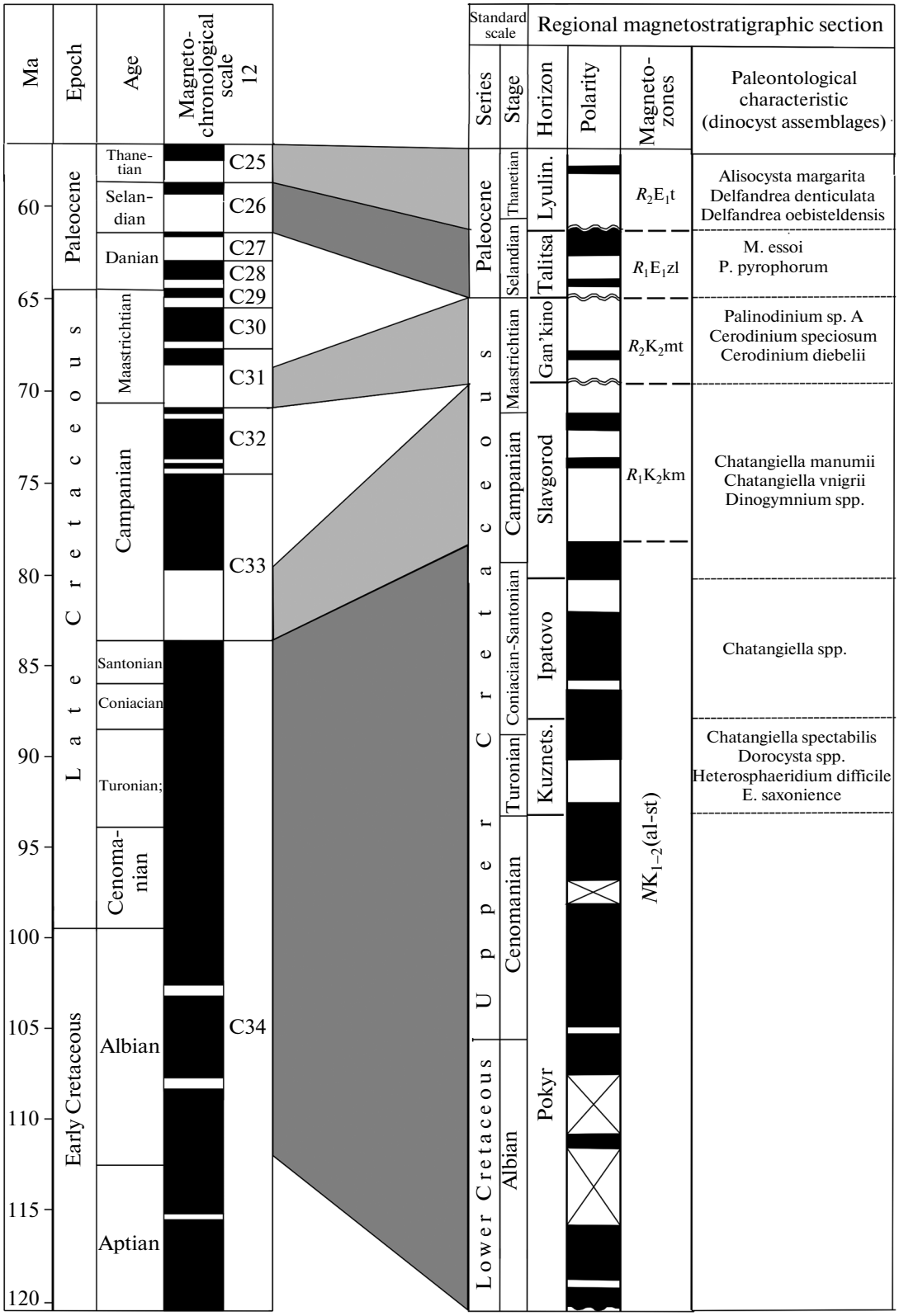


**Fig. 2.** Correlation of the regional Cretaceous magnetostratigraphic section of West Siberia with the magnetochronological scale [12]. For the legend, see Fig. 1.

Tuarkyr [13]; owing to their repeated recurrence, they may be of high correlation significance.

The regional Upper Cretaceous magnetostratigraphic section of the southwestern part of West Siberia represents the first constituent of the Cretaceous magnetic polarity scale, which is developed for the southwestern West Siberian Basin. The significance of this section goes far beyond the West Siberian region, since it represents an important element of the transregional paleomagnetic scale transitional from continental (Tuarkyr, Caucasus, Kopetdag, Volga region [14]) to oceanic paleomagnetic scales that are based on deep-sea drilling data and sea bottom magnetic anomalies.

## ACKNOWLEDGMENTS

This work representing a contribution to IGCP Project 608 was supported by the Russian Foundation for Basic Research (project nos. 10-05-00021 and 13-05-00051) and programs 23 and 28 of the Presidium of the Russian Academy of Sciences.

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*Translated by I. Basov*