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Magnetostratigraphic Timescale of the Phanerozoic and Its Description Using a Cumulative Distribution Function

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Abstract—A method is proposed for quantified structuring of a magnetochronological scale of the Phanerozoic, i.e., the construction of a magnetostratigraphic timescale on the basis of a cumulative function of geomagnetic field asymmetry with regard for the polarity sign. Analysis of the cumulative curve reveals basic characteristic patterns of the field evolution in the Phanerozoic: the reversed polarity being predominant in this epoch, three megachrons of variable polarity are identified against this background: Paleozoic *R*13 (468–315 Ma), Mesozoic *N*6 (258–123 Ma), and Cenozoic *R*10 (83–0 Ma). The megachrons are subdivided into hyper- and superchrons and are separated by single polarity hyperchrons. Most important are changes in the general trend of the polarity bias in the Middle Triassic and at the Paleogene/Cretaceous boundary. Data of fractal and wavelet analyses suggest the presence of two regimes of geomagnetic field generation: chaotically distributed frequent reversals (geodynamo) and a stable polarity.

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INTRODUCTION

The evolution of the geomagnetic polarity regime has been studied over the last half century in two directions, magnetochronological and magnetostratigraphic. The first research area was developed by foreign paleomagnetologists and consisted of the paleomagnetic study of volcanic rocks, invoking radiological datings (e.g., [Cox et al., 1963]) and a wide use of the idea on the relation of linear magnetic anomalies to seafloor spreading [Vine and Matthews, 1963]. As a result, the first magnetochronological scale was constructed for the last ~80 Myr [Heirtzler et al., 1968]. The method of magnetostratigraphy, proposed for the first time by Khramov [1957, 1958], was widely used by paleomagnetologists of the USSR and was then acknowledged throughout the world. Two major stages are well recognizable in the history of magnetostratigraphy. The first stage, distinguished by a rapid accumulation of factual data, encompassed the 1950s and 1960s, and the second stage began in the mid-1970s. Magnetostratigraphic studies of the initial period were restricted to the identification of zones of normal (N) and reversed (R) polarity in sections of sedimentary and volcanic rocks; the numbers assigned to these zones were ordered backward from the present. At that time, the problems of magnetostratigraphic classification, terminology, and nomenclature were discussed only occasionally. Noticeable progress in this area was made in the early 1970s, when active discussions on magnetostratigraphic systematics were conducted in the USSR and abroad. A preliminary variant of the international magnetostratigraphic code was developed (*Paleomagnetic Methods*, 1979). Afterward, the main principles of this document were reflected in special sections of national stratigraphic codes, including the stratigraphic code of Russia. The terms magnetochron and magnetozone were introduced to implement the classification chronologically and stratigraphically. Below, constructing a magnetochronostratigraphic classification and scale, we use the corresponding term chron.

A geomagnetic polarity time scale and magnetochronological scale (distribution of reversals in time) are based on the generalization of magnetostratigraphic or geochronological data from individual and composite sections. The development and construction of the world timescale of geomagnetic polarity were greatly promoted by generalizing works on various parts of the scale [Irving and Parry, 1963; Khramov et al., 1965, 1967, 1974; Pechersky, 1970; Pergament et al., 1971; McElhinny and Burek, 1971; Pechersky and Khramov, 1973]. Some of them are still scientifically significant, while others are of only historical interest.

Based on a significant volume of world data, the first variant of the magnetostratigraphic timescale of the Phanerozoic was developed in [Molostovskii et al., 1976] and its classification was dominated by the concept of A.N. Khramov [Khramov et al., 1965; Khramov and Sholpo, 1967] on three repeatedly changing main states of the magnetic field, namely, the states of predominantly reversed (Rn), normal (Nr), and variable

(RN) polarities. This classification enabled the identification of the Paleozoic, Mesozoic, and Cenozoic stages of geomagnetic evolution, megachrons dominated by the reversed, normal, and variable polarities and equivalent in rank to geological eras. The megachrons were subdivided into 10 (later, 12) hyperchrons equivalent in rank to geological periods [Molostovskii et al., 1976; Khramov et al., 1974, 1981, 1982]. Afterward, the scale has been repeatedly updated but has, on the whole, retained its initial morphology and nomenclature [Molostovskii, 1983; Danukalov et al., 1983; Molostovskii and Khramov, 1984; Khramov and Shkatova, 2000]. Structure-forming elements of the scale were hyperchrons of stable polarity whose overall length was estimated at 350–360 Myr, while the total length of variable polarity intervals amounted to 170–180 Myr. These relationships served as a basis for the concept of stable field periods alternating with shorter dynamic epochs of frequent reversals that played the role of crucial moments in the geomagnetic field evolution [Sheinman, 1975; Molostovskii, 1970, 1987; Kravchinskii, 1979].

The general drawback of all magnetochronostratigraphic scales constructed for the Phanerozoic was their descriptive and often very subjective character and the absence of quantitative criteria of the magnetostratigraphic classification. The determination of magnetostratigraphic boundaries was particularly biased.

NEW MAGNETOSTRATIGRAPHIC DATA AND A QUANTIFYING APPROACH TO THE ANALYSIS OF THE TIMESCALE STRUCTURE

Recent studies have provided a large volume of new information that required supplementing and updating of the magnetochronological scale and, accordingly, the construction of a magnetochronostratigraphic scale.

(a) No less than 80 alternating zones of opposite polarities have been discovered in the Lower and Middle Cambrian of Yakutia [Kirschvink and Rosanov, 1984; Gallet and Pavlov, 1996; Gallet et al., 2003; Pavlov and Gallet, 2005]. Intervals of variable polarity have been established by A. Trench in the Lower Cambrian of Australia [Klootwik et al., 1994].

(b) No less than ten new magnetozones have been fixed in the Upper Ordovician and Lower Silurian of the Urals [Danukalov et al., 1983].

(c) Large N zones have been established in the Eifelian and Tournaisian of NE Asia and the Urals, and a series of N microzones in the Visean of Scotland and the Mississippian of the United States is described in [Danukalov et al., 1983; Kolesov, 2001; Torsvik et al., 1989].

(d) The Permian interval of the Illavara superchron has become somewhat complicated due to additional subzones in the upper Tatarian substage. On the other hand, evidence on the presence of a large interval of variable polarity at the Kiama–Illavara boundary has not been confirmed ["Tetyushi Key Section …," 1991; Bogachkin and Molostovskii, 2001].

(e) Up to 50 previously unknown magnetozones have been revealed in the Triassic of Australia, Austria, Albania, Greece, Spain, the United States, and the Southern Ural region [Galbrun, 1992; Kent and Olsen, 1995; Molostovskii, 1995; Muttoni et al., 1997 et al.].

(f) A group of R microzones absent in the magnetochronological anomaly scale has been fixed in the Aptian, Albian, and Upper Cretaceous of England, Western Turkmenistan, the Volga region, the Northern Caucasus, Tunisia, and Morocco [Vandenberg and Wonders, 1980; Nairn et al., 1981; Krumsiek, 1982; Montgomery et al., 1998; Fomin and Molostovskii, 2001].

The new data appreciably complicated the morphology of the magnetochronostratigraphic scale. In particular, only three (Khadar, Kiama, and Jalal) of seven hyperchrons of stable polarity have remained conformable to their initial definition. However, the morphology of the magnetochronostratigraphic scale has remained, as before, descriptive, although some attempts were made to combine the previous descriptive approach with quantitative criteria (such as the length of single polarity intervals, reversal frequency, polarity bias within magnetozones, and so on) [Molostovskii, 2002]. However, such criteria as the single polarity interval lengths, the relation between the lengths, etc., are very unstable: they vary significantly if even a small number of microchrons are added or removed. The number of reversals per unit time (reversal frequency) is also unstable, appreciably varying with a change in the number of reversals in a given interval, and, moreover, does not take the polarity into account.

The most stable criterion is the *polarity bias*: it varies only slightly with an increase or decrease in the number of microchrons. The bias can be most effectively estimated with the use of the cumulative distribution function in the variant proposed in [Bogachkin et al., 2006]. As distinct from the classical cumulative distribution function, this variant yields a cumulative curve of the total length of N and R polarity intervals with regard for their sign, i.e., the algebraic sum of these intervals. The shape of the cumulative curve is a stable individual characteristic of a magnetozone, whereas sharp changes in the shape define the boundaries of the latter. The total length of intervals of N and R polarities reduced to the length of a given time interval is determined for each magnetozone from the cumulative curve. The sign of this quantity (or the letter N or R) is direct evidence for the predominant polarity, and its numerical value characterizes the bias degree (in %), ranging from zero (the total lengths of N and R polarity intervals are the same; i.e., we have the case of perfect symmetry) to 100% (a single polarity interval). The corresponding index (e.g., R12, N87, etc.) is assigned to each magnetozone (see below). The proposed version of the cumulative curve is very stable because the probability of discovering new large magnetozones is low, while the possible introduction or removal of microchrons will change insignificantly the bias value and, therefore, should not affect significantly the structure of the scale.

Two types of cumulative curve segments are recognizable: (1) a monotonic decrease or increase in the curve (*slope* type) caused by the absence of reversals and the alternation of short subchrons and microchrons whose length is appreciably smaller than the step used for the construction of the cumulative curve and (2) a succession of sharp bends of the curve (*saw* type) due to rather regularly alternating N and R intervals noticeably exceeding in length the step accepted for the construction. A combination of the slope and saw types is possible.

We applied this approach to the restructuring of the Phanerozoic magnetochronostratigraphic scale (figure) on the basis of available results generalized in [Harland et al., 1990; Klootwik et al., 1994; Berggren et al., 1995; Channell et al., 1995; Cande and Kent, 1995; Algeo, 1996; Opdyke and Channell, 1996; Shreider, 1998; Pechersky, 1998; Khramov and Shkatova, 2000; Gradstein et al., 2004; Bogachkin et al., 2006].

Examples of using the cumulative polarity distribution function can be found in [Shreider, 1998; Lowrie and Kent, 2004; and others], but these authors analyzed only classical variants of this function in relation to a single polarity and considered only the Cenozoic and Mesozoic periods. The cumulative curve of the polarity bias is presented in the figure on small (A) and large (B) scales. In the latter case, the single polarity hyperchrons Kiama and Jalal are not shown (they lie beyond the figure area). The cumulative curve exhibits two regular patterns.

First-order pattern. The reversed polarity evidently prevailed in the Phanerozoic: the difference between the times of normal and reversed polarities amounts to ~80 Myr. Probably, this is natural if the Earth always rotated, as at present, counterclockwise, so that the current also flowing counterclockwise creates a magnetic field directed upward along the rotation axis. The symmetry of the equations of magnetic hydrodynamics leads to the symmetry of both geomagnetic polarities; i.e., *the observed polarity bias is not accounted for by existing geodynamo models.*

Second-order pattern. Three intervals of variable polarity are clearly identified in the cumulative curve; these are intervals in the Paleozoic (468–315 Ma, a length of 153 Myr, predominant R polarity, index R13), Mesozoic (258–123 Ma, 135 Myr, predominant N polarity, N6), and Cenozoic (83–0 Ma, predominant R polarity, R10). The megachrons are separated by virtually monopolar hyper- and superchrons.

According to fractal analysis of the scale [Pechersky et al., 1997], two generation regimes of the geomagnetic field existed in the Phanerozoic: a chaotic regime of frequent reversals (the fractal dimension is $d < 0.6$) and a regime clearly dominated by self-similarity (d is close to unity). The results of the fractal analysis are supported by data of wavelet analysis [Galyagin et al., 2000]: reversal and polarity frequency periods <80 Myr identified in the Phanerozoic are short pulsations (one or two oscillations) that are chaotically distributed in time. The observed relatively long oscillations have periods no less than 100–130 Myr, and this corresponds to the second fractal regime with d close to unity. Probably, the two regimes of geomagnetic reversals should correspond to two generation mechanisms of the geomagnetic field; one of the latter is the geodynamo mechanism, associated with the regime of random occurrence of geomagnetic reversals, distributed almost symmetrically within the three megachrons. The geodynamo mechanism is superimposed on the second mechanism generating the main magnetic field.

According to the behavior of the cumulative curve, the megachrons are in turn divided into a series of hyperchrons and superchrons. Below, we present their names in accordance with the priority of their discovery, the index (the predominant polarity and its percentage), the age, and the stratigraphic range in agreement with the recent chronological differentiation of the Russian stratigraphic code (2006). In some cases, the identified superchrons are beyond the rank subordination, which is admitted by the magnetostratigraphic classification (RF stratigraphic code, 1992, 2006).

Vendian hyperchron R91, slope type of the cumulative curve; the age is 600–533 Ma, encompassing the Vendian and Lower Cambrian.

Arginskii hyperchron R32 [Rodionov and Osipova, 1973], slope+saw; the age is 533–494 Ma (Cambrian). Three superchrons are identified in the Arginskii hyperchron: Yakutsk N38 (slope, 533–525 Ma), Batomsko-Ulakhanskii R61 (slope, 525–502 Ma), and Irkutsk N31 (saw, 502–494 Ma). The hyperchron, particularly the Yakutsk superchron, is distinguished by a very high reversal frequency similar to that in the Gissar and Sogdiana hyperchrons. In previous variants of the scale, the Arginskii hyperchron was not divided into superchrons.

Khadar hyperchron R98 [Rodionov and Osipova, 1973], slope; the age is 494–468 Ma. In the stratigraphic scale, the Khadar hyperchron correlates with the entire Early Ordovician and the Llanvirnian of the Middle Ordovician. The validity of the Ordovician R hyperchron, discovered about 40 years ago, was confirmed by recent studies that updated its age and boundaries [Pavlov and Gallet, 2005]. In the previous scale, the Khadar, Irkutsk, and Batomsko-Ulakhanskii superchrons were united to form the Siberian hyperchron. In the proposed variant of the scale, the two latter superchrons are included into the structurally close Arginskii hyperchron and the Khadar superchron is classified as a hyperchron. The Siberian hyperchron is excluded from the scale nomenclature.

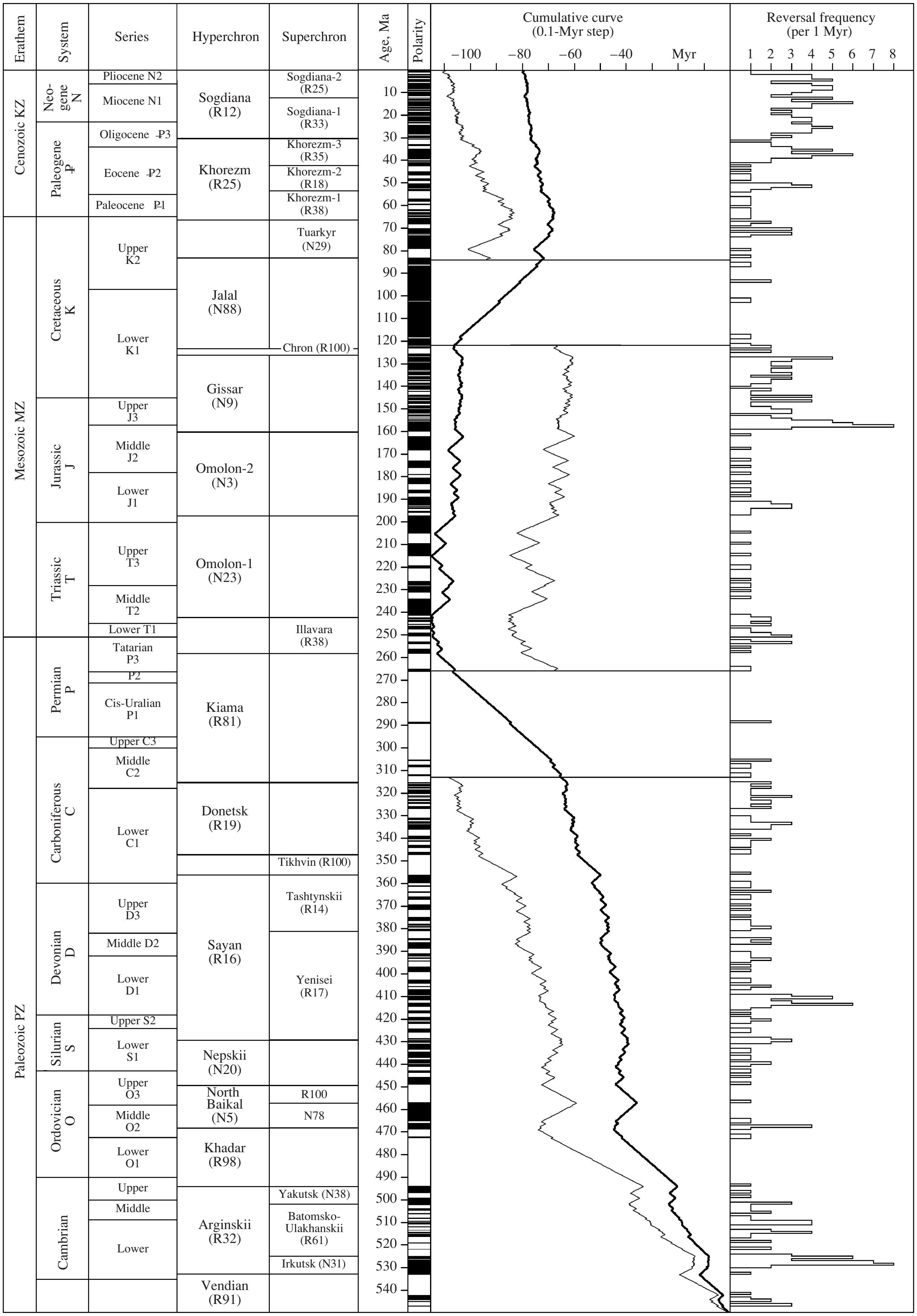
Erathem
System
Series
Hyperchron
Superchron
Age, Ma
Polarity
Cumulative curve
(0.1-Myr step)
−100 −80 −60 −40 Myr
Reversal frequency
(per 1 Myr)
1 2 3 4 5 6 7 8
Cenozoic KZ
Mesozoic MZ
Paleozoic PZ
Neogene N
Paleogene ₽
Cretaceous K
Jurassic J
Triassic T
Permian P
Carboniferous C
Devonian D
Silurian S
Ordovician O
Cambrian
Pliocene N2
Miocene N1
Oligocene ₽3
Eocene ₽2
Paleocene ₽1
Upper K2
Lower K1
Upper J3
Middle J2
Lower J1
Upper T3
Middle T2
Lower T1
Tatarian P3
P2
Cis-Uralian P1
Upper C3
Middle C2
Lower C1
Upper D3
Middle D2
Lower D1
Upper S2
Lower S1
Upper O3
Middle O2
Lower O1
Upper
Middle
Lower
Sogdiana (R12)
Khorezm (R25)
Jalal (N88)
Gissar (N9)
Omolon-2 (N3)
Omolon-1 (N23)
Kiama (R81)
Donetsk (R19)
Sayan (R16)
Nepskii (N20)
North Baikal (N5)
Khadar (R98)
Arginskii (R32)
Vendian (R91)
Sogdiana-2 (R25)
Sogdiana-1 (R33)
Khorezm-3 (R35)
Khorezm-2 (R18)
Khorezm-1 (R38)
Tuarkyr (N29)
Chron (R100)
Illavara (R38)
Tikhvin (R100)
Tashtynskii (R14)
Yenisei (R17)
R100
N78
Yakutsk (N38)
Batomsko-Ulakhanskii (R61)
Irkutsk (N31)
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540

Figure.

North Baikal hyperchron N5 [Rodionov and Osipova, 1973], saw; the age is 468–449 Ma. The hyperchron consists of the N78 (slope, 468–457 Ma) and R100 (slope, 457–449 Ma) superchrons and encompasses an appreciable part of the Middle and Late Ordovician.

Nepskii hyperchron N20 [Rodionov and Osipova, 1973], saw on slope; the age is 449–429 Ma (Late Ordovician–Early Silurian). Previously, the North Baikal and Nepskii magnetozones were parts of the Baikal hyperchron, but their signatures in the cumulative curve are so different that it is more appropriate to classify them as individual units (hyperchrons). In this case, the Baikal hyperchron becomes meaningless and should be excluded from the scale nomenclature.

Sayan hyperchron R16 [Danukalov et al., 1983], saw on slope; the age is 429–356 Ma, encompassing the Wenlockian stage of the Early Silurian, the Late Silurian, the Devonian, and the lowermost Tournaisian. The hyperchron is subdivided into two superchrons slightly differing in the polarity bias: the reversal frequency is higher in the first superchron (figure).

Yenisei superchron R17, saw on slope; the age is 429–381 Ma.

Tashtynskii superchron R14, saw on slope; the age is 381–356 Ma.

Tikhvin superchron R100, slope; the age is 356–347 Ma. The superchron separates the Sayan and Donetsk hyperchrons and is equivalent to most of the Tournaisian. Previously, it belonged to the Donetsk hyperchron, but it is classified as an independent unit in the scale proposed.

Donetsk hyperchron R19 [Khramov, 1976], slope+saw; the age is 347–315 Ma (Early and Middle Carboniferous). The hyperchron corresponds to the Debaltsevskii superchron in the previous classification and completes the Paleozoic megachron.

Kiama hyperchron R81 [Irving, 1966], slope; the age is 315–258 Ma. Kiama is the largest interval of single polarity in the scale and encompasses a large part of the Middle Carboniferous, the Late Carboniferous, the Early Permian, and a part of the Middle Permian (the Kazanian and a part of the Urzhumian). In the international "marine" timescale of the Permian system, the upper Kiama boundary is fixed in the lower Capitanian of the Middle Permian. The Kiama hyperzone has been studied in detail in many geological provinces, but as yet only a few short "pulses" of normal polarity have been revealed within its limits.

Illavara superchron R38 [Irving, 1966], slope+saw; the age is 258–242 Ma (the upper middle and upper (Tatarian) intervals of the Permian, Early Triassic, and lower Middle Triassic). The superchron markedly differs from adjacent hyperchrons by a higher reversal frequency. The Illavara boundary was traditionally fixed at the base of the Severodvinskii horizon (stage) but, according to the cumulative curve and the reversal frequency (figure), it should be placed at the middle of the Tatarian.

Omolon-1 hyperchron N23, saw; the age is 242–197 Ma (most of the Middle Triassic, the Late Triassic, and the lowermost Jurassic). The predominant part of this hyperchron was previously included in the Illavara hyperchron but, according to the shape of the cumulative curve and reversal frequency, Omolon-1 differs sharply from Illavara (figure). According to its index (N23), Omolon-1 obviously belongs to the Mesozoic megachron.

Omolon-2 hyperchron N3 [Pechersky, 1973], saw; the age is 197–160 Ma, including a significant part of the Early and Middle Jurassic. Omolon-2 differs in the shape of the cumulative curve from Omolon-1 (the frequency of sawteeth increases; i.e., chrons shorten).

Gissar hyperchron N9 [Pechersky, 1973], saw; the age is 160–126 Ma. According to the last scale of Khramov [Khramov and Shkatova, 2000], the lower Gissar boundary is fixed at the base of the Bathonian and its upper boundary is close to the middle of the Barremian. The same age and stratigraphic ranges of the hyperchron are obtained in the present scheme. Gissar is clearly distinguished by a further rise in the number of teeth of the cumulative curve and a sharp increase in the reversal frequency as compared with the Omolon-2 hyperchron. It completes the Mesozoic megachron of variable polarity.

The Gissar hyperchron is crowned by the orthochron R100, separating the Gissar and Jalal hyperchrons and distinctly recognizable in the cumulative curve in the interval 126–123 Ma. It is the most probable analogue of the Barremian chron M3 of the magnetochronological scale [Cande and Kent, 1995].

Jalal hyperchron N88 [Pechersky, 1973], slope; the age is 123–83 Ma. In the first variant of the magnetochronological scale, the hyperchron encompassed a large part of the Cretaceous, from the Aptian through the Campanian. The hyperchron separates the Mesozoic and Cenozoic megachrons. A Jalal analogue in the magnetochronological anomaly scale is the single polarity N superchron 34n ("epoch of the Cretaceous quiet field"). No R subchrons are fixed in the Late Cretaceous part of the superchron 34n, but, in paleomagnetic continental sections, they were rather reliably determined in the Coniacian and late Cenomanian and were recognizable in the early Santonian and Turonian [Pechersky, 1970; Fomin and Molostovskii, 2001; Montgomery et al., 1998; Krumsiek, 1980; and others]. In the Early Cretaceous part of the scale, they are fixed in the Aptian and Albian.

Tuarkyr superchron N29 [Molostovskii, 2002], saw; the age is 83–66 Ma (late Santonian, Campanian, and Maestrichtian). It is the last interval of a positive polarity bias. A noticeable increase in the reversal frequency is noted in the upper part of the Tuarkyr superchron.

Khorezm hyperchron R25 [Molostovskii, 1983], slope+saw; the age is 66–30 Ma, from the base of the Danian to the upper boundary of the Rupelian. The reversal frequency increases from bottom to top. The Khorezm hyperchron is distinctly subdivided into three superchrons: Khorezm-1 R38 (slope, 66–53 Ma), Khorezm-2 R18 (slope+fine saw, 53–42 Ma), and Khorezm-3 R35 (slope+saw, 42–30 Ma). The reversal frequency of Khorezm-3 is similar to that of the Sogdiana hyperchron.

Sogdiana hyperchron R12 [Molostovskii, 1983], slope; the age is 30–0 Ma. The hyperchron is characterized by a high reversal frequency and is divided into two superchrons: Sogdiana-1 R33 (slope, 30–12 Ma) and Sogdiana-2 R25 (slope, 12–0 Ma).

CONCLUSIONS

The incorporation of the cumulative curve and the reversal frequency plot into the procedure of magnetostratigraphic reconstructions changed significantly the morphology of the magnetochronostratigraphic scale and freed it from personal judgments of a researcher. In particular, we had to move away from the rigid hierarchy of magnetochrons and supplement the scale with a few key superchrons as independent units. Thus, while 12 hyperchrons formed the basis of previous variants of the scale, the version proposed in this paper includes 13 hyperchrons and 3 superchrons beyond the rank subordination. Boundaries and lengths of several hyperchrons changed significantly and all large magnetozones acquired a more consistent magnetic polarity structure. In previous versions of the scale, the largest units, megachrons, served as an illustration of erathems. In the scale proposed, they have a distinct paleomagnetic meaning; namely, they are long intervals of frequent reversals separated by large hyperchrons of single polarity (Khadar, Kiama, and Jalal). The length of the hyperchrons varies from 20 to 73 Myr, which is similar to lengths of Phanerozoic geological periods (23–80 Myr). However, the boundaries of geological stratigraphic units and magnetozones do not coincide. Wide variations in the lengths of both types of units are evidence for the absence of strict periodicity of processes both in the core (the geomagnetic field) and at the Earth's surface (biota).

The restructuring of the scale does not exhaust the significance of the reconstructions performed. The inferred fundamental patterns in the Phanerozoic evolution of the Earth's magnetic field are of basic importance. These are as follows.

(a) The Phanerozoic was clearly dominated by the reversed geomagnetic polarity. The permanent polarity bias is at variance with the modern theory of the geomagnetic dynamo, according to which the N and R polarities are equiprobable. The conclusion on two generation regimes of the geomagnetic field has a direct relation to the problem under consideration. The first regime relates to the mechanism of the geomagnetic dynamo, ensuring a random occurrence and nearly symmetric distribution of reversals. The geodynamo mechanism is superimposed on the mechanism of the main magnetic field. The latter may be associated with the constant counterclockwise rotation of the Earth. The phenomenon of long epochs of a constant field, when the geodynamo stopped operating and the reversal process was virtually blocked, does not have an appropriate explanation.

(b) A large part of the Phanerozoic history of the geomagnetic field (440 Myr) is characterized by an unstable sign-alternating polarity, while the overall length of three stable field epochs separated in time is 123 Myr. Such a relationship invalidates the concept of short epochs of frequent reversals as key moments in the evolution of geomagnetism, the lithosphere, and the organic world.

(c) In a historical context, the most fundamental events are changes in the general trend of polarity bias dated at 242 and 66 Ma. The Illavara/Omolon-1 boundary fixes the change from the Paleozoic R trend to the Mesozoic N trend, which in turn gave way to the Cenozoic R trend at the Paleogene/Cretaceous boundary. We should note that the reorganization of marine and continental ecosystems at the Paleozoic/Mesozoic boundary by no means coincides with the Permian/Triassic boundary. This circumstance suggests that the corresponding change in the polarity bias trend coincided in time with the final stage of geological reorganizations at the boundary between the Paleozoic and Mesozoic erathems.

Undoubtedly, the magnetochronostratigraphic scale needs to be further improved and updated, particularly in its Lower Paleozoic part. However, one can hardly expect a cardinal change in its structure because of the low probability that presently unknown large chrons of single polarity will be discovered.

The key significance of the results obtained in this work is that we demonstrated the possibility of individualization of magnetozones using quantitative paleomagnetic characteristics whose distribution over the geological timescale reflects the stages and key moments of the geomagnetic field evolution during the Phanerozoic. In other words, the magnetic polarity timescale complemented by the cumulative curve and the reversal frequency plot acquired a geohistorical meaning. In this respect, it has no analogues and significantly changes the traditional ideas of the geomagnetic field evolution over the last 550 Myr.

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