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Paleomagnetic Poles of the Uchur-May Riphaean Hypostratotype and the Drift of the Aldan Block (of the Siberian Craton) in the Riphaean[1]

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Between 1984 and 1992, we investigated the paleomagnetism of the Middle and Upper Riphaean (Precambrian) rocks of the Uchur-May hypostratotype on the formation level, in order to obtain a stratigraphically-checked plot of the apparent migration of the pole during the Middle and Late Riphaean time, as well as to determine the type of horizontal displacement that the Aldan Shield (or perhaps the entire Siberian Craton) underwent in this time interval. We are still uncertain as to the part of the Siberian Craton to which the paleomagnetic poles determined in the above hyperstratotype pertain, but published data and the results of regional geological and geophysical investigations [1-4] suggest that they must pertain at least to the Aldan Block, with an area of about a million km^2, and to some parts of the crust that fringe it.

The stratigraphic basis for this investigation was the scheme proposed by Semikhatov and Serebryakov [5], with minor changes involving the subdivision of the pre-Ignikan part of the Lakhanda Group. The most detailed discussion of the age of these rocks, with an analysis of the isotopic data, is also given in that publication. Here we need to note only that the age of the oldest of the formations discussed therein, the Talyn Formation, is now estimated to be 1210 to 1230 million years, and that of the youngest, the Ust-Kirba Formation, is estimated to be 640 to 670 million years.

We studied about 2400 oriented hand samples from more than 50 exposures (Fig. 1). With rare exceptions, the natural remanent magnetization of the rocks has two components: the ancient magnetization, which is usually determined by high-temperature magnetic cleaning starting at 450° to 500° C, and the present-day magnetization, which breaks down almost completely at lower temperatures. In some exposures, the rocks exhibit metachronic magnetization components resulting from Late Riphaean and Mesozoic tectonomagmatic events occurring both within the region and on its periphery. The ancient component of the magnetization could not be identified in the rocks of the Talyn, Svetlinskiy, and Tsipanda formations.

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[1]Translated from: Paleomagnitnyye polyusy Uchuro-Mayskogo gipostratotipa Rifeya i rifeyskiy dreyf Aldanskogo bloka Sibirskoy platformy. Doklady Rossiyskoy Akademii Nauk, 1994, Vol. 336, No. 4, pp. 533-537.

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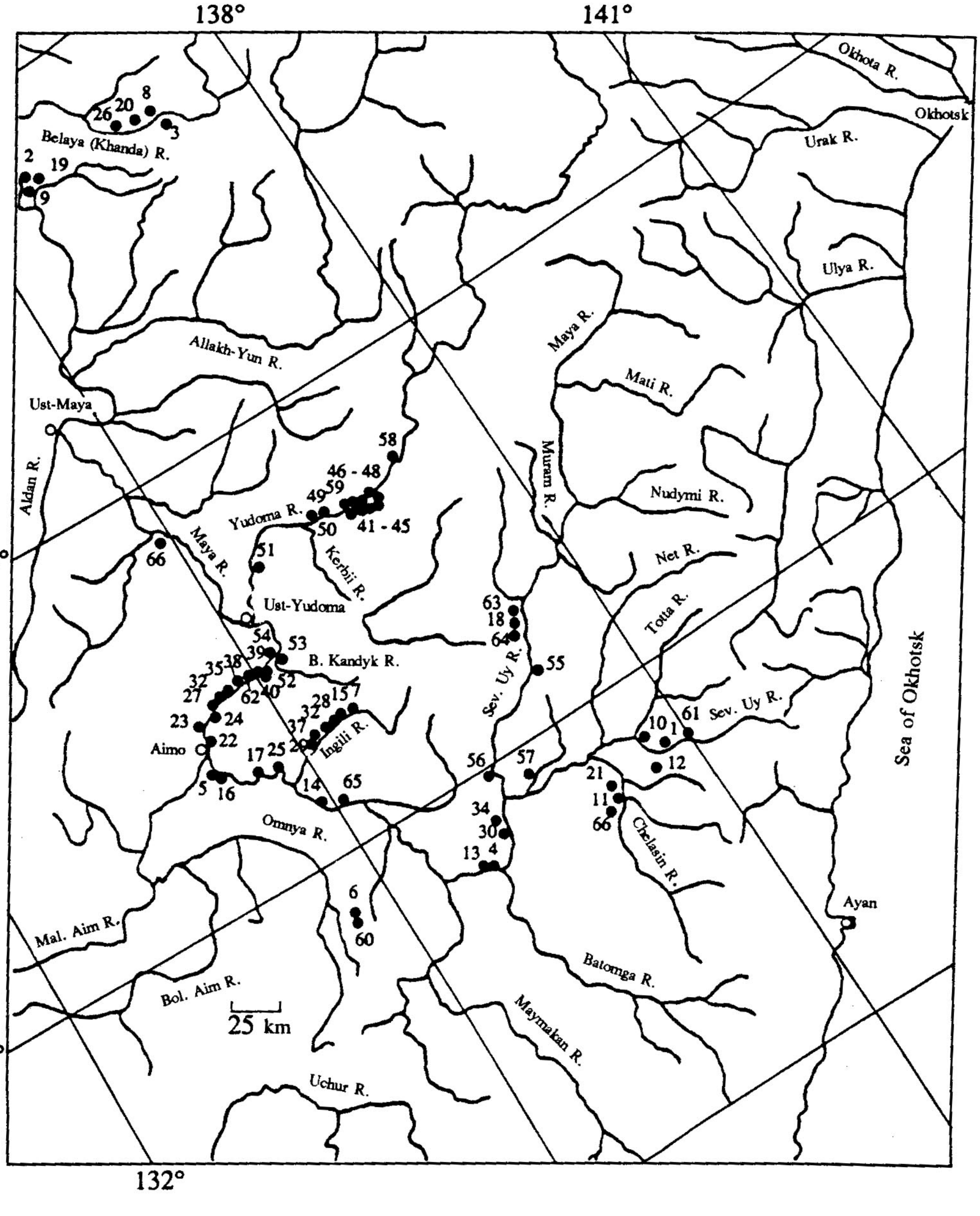

Fig. 1. Locations of exposures studied. Aimchan Formation: 1) Sev. Uy R.; 2) Dyue-Appa; 3) Belaya R. Totta Formation: 4) Khaakhar; 5) Seliya; 6) Konder; 7) Ingili; 8) Belaya R.; 9) Dyue-Appa; 10) Totta projection; 11) Chelasin; 12) Mt. Borya. Malgin Formation: 13) Khaakhar; 14) Emelekeyen; 15) Ayan-Kolyakh; 16) Malgin Rocks; 17) Seliya Rocks; 18) Emtaku; 20) Khanda; 21) Dyue-Appa. Tsipanda Formation: 22) Aim; 23) Kumakhaa; 24) Talaya; 25) Sygyrayaya Rocks; 26) Khanda. Kumakhaa Formation: 27) Neryuyen; 28) Ingili; 29) Khandy-Makit. Milkon Formation: 30) Nelkan-1; 31) Yastakh; 32) Yrytynda; 33) Ingili-3. Nelkan Formation: 34) Nelkan-2; 35) B. Lakhanda. Ignikan Formation: 36) Chuy Lakes; 37) Ingili-4; 38) Yemelekeyen; 39) Krasnyy Rocks; 40) Kandyk. Kandyk Formation and coeval sills: 41) Pukhanil; 42) Sill "110"; 43) Contact K; 44) Sill "S"; 45) Sill "C"; 46) Sill "P"; 47) Sill "I"; 48) Sill "Yu"; 49) Sill "G"; 50) Point 113; 51) Yudoma; 52) M. Kandyk; 53) B. Kandyk; 54) B. Kandyk-2. Ust-Kirba Formation: 55) Kavalkan; 56) Sev. Uy; 57) Nayum; 58) Kyry-Ytyga; 59) Ty'allakh.

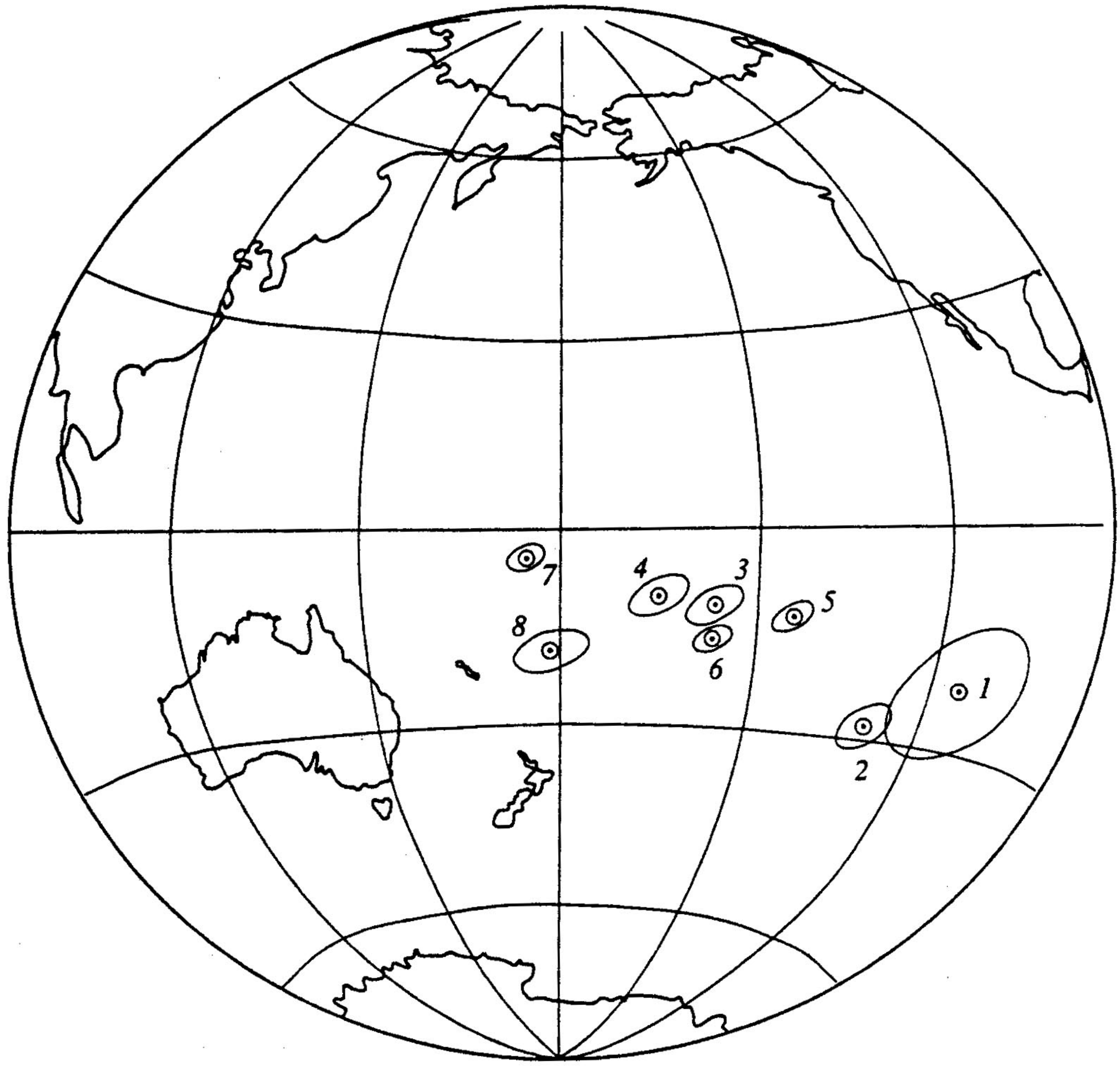

Fig. 2. Paleomagnetic poles for the Middle to Late Riphaean formations of the Uchur-May Riphaean hypostratotype.

One of the main objectives of our research was to demonstrate that the magnetization components thereby identified were primary, or at least to collect the greatest possible amount of geological material indicative of the time during which the components were imprinted on the rocks. The following methods were used: 1) the conglomerate test; 2) the fold test; 3) the contact test; 4) comparison of the directions of magnetization obtained from mutually-distant rocks, different rock types, and different magnetic minerals; 5) comparison of the directions obtained by these methods with the paleomagnetic orientations of younger rocks; 6) comparison of mutually-remote magnetostratigraphic sections; and 7) study of zones of polarity change.

The results are shown in Table 1 and illustrated in Figs. 2 and 3. The data indicate that between the Totta and Ust-Kirba time, there was a significant movement of the pole, generally to the WNW, but with a back-and-forth component.

Table 1

Paleomagnetic orientations and poles

Age	Formation and method of establishing synchrony of identified components[b]	Name of exposure and rock type	Longitude and latitude, deg		Numbers of specimens with normal/reverse polarity	Method of identifying ancient magnetization[c]	Paleomagnetic orientation				Paleomagnetic poles, degrees				Mean paleomagnetic poles, deg		
			λ	φ			D^a, deg	I, deg	K	alfa95, deg	Ψ	Λ	$Θ_1$	$Θ_2$	Ψ	Λ	A95
Upper Riphaean	Ust-Kirba	Yry-Ytyga, siltstone	136.8	59.3	25/-	T-cleaning, 660°C, MCCP*	137.8	7.7	-	8.6	-19	182	9	4	-18.5	178.4	5.5
	S, SNUR	Kavalkan, red siltstone and argillite	137.1	58.1	21/-	T-cleaning, 640°C, MCCP	143.9	14.5	-	10.0	-18	175	10	5			
	Kandyk S, N(t) SNUR SNRUR, K M, SNRM		136.2	59.4	3/-	T-cleaning 500° C	146.9	35.7	28.4	15.2	-6	154	18	10	-4.1	174.8	2.5
			136.2	59.4	7/-	H-cleaning 200 Oe	138.3	27.1	7.5	19.0	-9	177	21	11			
			136.4	59.4	11/-	H-cleaning 200 Oe	132.2	37.2	34.2	7.2	-1	180	8	5			
			136.4	59.4	7/-	T-cleaning 500° C	140.9	36.9	73.0	6.2	-4	173	7	4			
			135.3	59.3	10/-	T-cleaning 500° C	142.8	42.2	6.1	18.0	-1	169	22	14			
			136.4	59.4	21/-	T-cleaning 500° C	136.7	33.8	47.8	4.0	-4	177	5	3			
			136.4	59.4	14/-	H-cleaning 500 Oe	134.9	36.4	33.6	6.5	-2	178	8	4			
			136.4	59.4	21/-	H-cleaning 500 Oe	140.7	33.4	114.	2.8	-6	174	3	2			
			136.4	59.4	16/-	H-cleaning 500 Oe	130.8	36.1	9 30.7	6.0	-3	176	7	4			
			136.4	59.4	22/-	H-cleaning 500 Oe	140.2	34.8		4.0	-5	174	5	3			
			136.4	59.4	28/-	H-cleaning 500 Oe	135.2	33.9	52.3 25.6	5.0	-4	178	6	3			

	Ignikan; S, SNUR, M	Yemelekkeyen, red stromatolitic dolomite and claystone	135.1	58.9	-/17	*T*-cleaning 600° C	117.3	-6.8	11.5	10.0	-17	203	10	5	-16.4	203.2	2.9
		Krasnyy rocks, red stromatolitic dolomite	135.1	58.9	-/27	*T*-cleaning 600° C	120.3	-7.0	14.0	7.2	-18	200	7	4			
		Chuy Lakes, red stromatolitic dolomite	136.3	57.6	-/17	*T*-cleaning 600° C	113.5	-2.9	16.0	18.5	-14	207	9	4			
		Ingili, red stromatolitic dolomite	135.3	58.5	-/11	*T*-cleaning 600° C	117.8	-6.6	12.8	11.8	-17	203	12	6			
	Nelkan; M, SNRM	B. Lakhanda, clayey limestone	134.9	58.9	-/6	*T*-cleaning 550° C	103.1	-9.8	44.9	8.5	-11	216	9	4	-12.6	215.3	3.2
		Nelkan-2, limestone	136.3	67.6	-/18	*T*-cleaning 500° C	107.5	-11.6	13.2	9.1	-14	214	9	5	-13.8	215.2	5.2[d]
	Milkon; S, SNUR, M	Ytyrynda, limestone	134.8	58.7	-/21	*T*-cleaning 550° C	128.1	17.1	18.8	7.0	-11	187	7	4	-10	194.5	4.7
		Nelkan-2, limestone	136.3	57.6	-/23	*T*-cleaning 550° C	118.2	17.1	13.4	8.1	-7	198	4	4			
		Tastakh, limestone	135.6	58.5	-/5	*T*-cleaning 500° C	119.0	9.2	15.8	15.8	-11	198	16	8			
		Ingili-3	135.4	58.5	-/12	*T*-cleaning 550° C	121.9	9.8	22.3	8.6	-12	195	9	4			
	Kumakhaa; S, SNUR, SNRLR	Neryuyen, red claystone	135.1	58.9	-/19	*T*-cleaning 600° C	118.7	-2.0	45.2	4.8	-15	200	5	2	-11.3	203.0	4.6
		Ingili-2, dolomite	135.4	58.5	-/6	*T*-cleaning 550° C	115.1	4.0	49.4	8.2	-11	203	8	4			
		Kandy-Makit, limestone	135.3	58.5	-/11	*T*-cleaning 550° C	110.7	6.8	29.2	7.8	-8	206	8	4			
Middle Riphaean	Malgin; S, G, SNUR, SNRM, KEMP, M, EMP	Khaakhar, mottled clayey limestone	135.4	57.6	10/13	*T*-cleaning 500° C	103.9	-40.8	24.8	5.9	-27	227	4	2	230.6	-27.8	3.5
		Seliya, mottled clayey limestone	134.1	58.7	16/21	*T*-cleaning 500° C	96.7	-44.3	69.7	2.8	-25	233	4	2			
		Emelekeyen, mottled clayey limestone	135.0	58.3	10/13	*T*-cleaning 500° C	97.8	-45.7	48.8	4.2	-27	234	5	3			
		Ayan-Kolyakh, mottled clayey limestone	135.5	58.5	11/12	*T*-cleaning 500° C	105.5	-47.0	12.6	8.2	-32	229	11	7			
	Totta: EMP, SNUR	Chelasin, siltstone and claystone	137.3	57.6	-/18	*T*-cleaning 600° C	86.9	-46.9[e]	12.6	8.6	-21	245	11	7	245.3	-21.3	9.1
		Mt. Borya, siltstone and claystone	137.4	57.5	6/10	*T*-cleaning 600° C											

[a] D, J, K, Alfa95, Θ_1, Θ_2 are characteristics of distribution.
[b] G, method; S, fold test; *N(t)*, *N(t)* method; SNUR, agreement in directions at mutually-remote sections; SNRLR, agreement in directions in different lithologic varieties; K, method of calcined contacts; M, mineralogical data; SNRM, agreement in directions of magnetization in different minerals; KEMP, correlation of magnetic-polarity zones; EMP, presence of zones of magnetic polarity with mean paleomagnetic directions differing by 180°.
[c] *T*-cleaning, thermal magnetic cleaning, *H*, cleaning with a variable magnetic field.
[d] Pole position calculated by determining the mean for virtual poles.
[e] Mean direction calculated with allowance for rotations of blocks as determined from the reference (i.e., Malgin time) position.

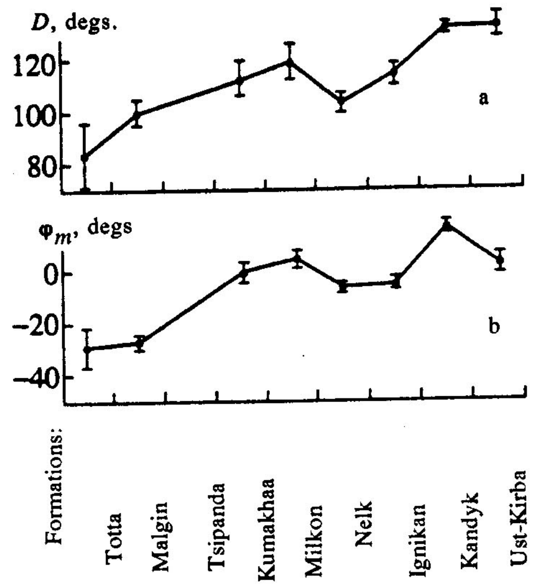

Fig. 3. Rotations (a) and paleolatitude displacements (b) of Aldan Block during Middle and Late Riphaean.

In Totta time, the Uchur-May region lay in the Southern Hemisphere at approximately 28° S (the figures we give are paleolatitudes of the point with coordinates $\lambda = 135°$, $\varphi = 59°$) and was rotated 80° counterclockwise relative to its present-day position.

In Malgin time, the Aldan block moved several degrees to the north and was rotated 60° counterclockwise from its Totta-time position.

The counterclockwise rotation continued, and by Kumakhinskiy time its magnitude exceeded 30° relative to the Totta position. At this time the region virtually overlapped the Equator.

In Milkonian time, the block moved further to the north (to 6° N); then, in Nelkan and Ignikan time, it moved back into the peri-Equatorial region of the Southern Hemisphere (3° to 6° S). At the same time, there were pronounced clockwise and counterclockwise rotations (12 to 17°).

In late Ignikan and Kandyk time, the rate of displacement of the Aldan Block increased, and it again underwent a significant northward displacement. There was a further counterclockwise rotation, which apparently generally accompanied this northward movement.

In Ust-Kirba time, the region moved back to the vicinity of the Equator. At this time, it was already rotated 140° counterclockwise relative to its present-day position, so that it was the southeastern part of the Aldan Block that faced northward.

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