Gondwana Research, V. 7, No. 3, pp. 833-841.

ISSN: 1342-937X

GR Gondwana Research

Comparative Position of Bateny and Biya-Katun' Terrains (Altai-Sayan Folded Area, Russia) in Cambrian Based on Combined Paleomagnetic, Lithologic and Paleontological Data

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(Manuscript received April 7, 2003; accepted November 27, 2003)

Abstract

Cambrian events in the history of the different terranes comprising mosaic-block geological structures of the Altai-Sayan Folded Area is discussed. On the basis of the complex analysis of the paleontological, lithological and paleomagnetic data, the probable territorial proximity of the Biya-Katun' (Gorny Altai) and Bateny (Kuznetsky Alatau) blocks is proved.

Key words: Gorny Altai, Bateny Ridge, Cambrian, paleomagnetic and paleontological data.

Introduction

The South-western frame of the Siberian platform – the Altai-Sayan Folded Area (ASFA) is the most complicated part of the Central-Asian fold belt (see Fig. 1). It is represented by a collage of terranes of different ages developed during Paleozoic time in strike-slip faulting environment. The geodynamic history of individual blocks is still unclear.

At the moment at least three different models of tectonic evolution of this area are known. The basic diversities of the models concerns the following items: (1) initial appurtenance of main sialic (Early Proterozoic or Riphean) terranes to Siberian or Gondwana group of continents; (2) kinematics of accretion process during amalgamation of minor-scale blocks to the Siberian Craton; (3) initial spatial orientation and relative position of different paleoisland arc fragments preserved in the modern structure of ASFA.

According to tectonic reconstructions, all island arc fragments of ASFA are combined into a one extended island arc system marked a subduction zone on the south-western periphery of the Siberian Continent (Zonenshain et al., 1990). The reconstruction supposes submeridional strike of the subduction zone throughout the Paleo-Asian Ocean from North China Block to Eastern Europe. Subduction direction is assumed from east (from Siberia) to west (downwards continental fragments of the Central Kazakhstan). Such kinematics has lead to the reduction of the distance between island arc system and the Siberian Continent a well as adjusting sialic blocks, resulted from break-up of Gondwana. Late Cambrian–Early ordovician amalgamation was related to collision of these fragments with paleoisland arc system and the following consequent reorganization of the arc. However, the modern orientation those fragments had acquired in Devonian.

The origin of the island arc system in ASFA as the result of rifting of the narrow strip of continental crust from the united East-European-Siberian supercontinent, which have served as the basement for the island arc system development, was proposed (Sengör et al., 1993). During Vendian-Cambrian time, this supercontinent and its island arc margin were located between 65° and 15° south latitude with the Siberian part respectively between 40° and 15° S. The strike of subduction zone is supposed to be submeridional. However, the direction of ocean plate downsinking in contrast to Zonenshain's model (Zonenshain et al., 1990) is assumed to be beneath the continent.

Contrary to above-mentioned models, some authors (Mossakovsky et al., 1993; Didenko et al., 1994; Pechersky and Didenko, 1995) consider Cambrian island arc fragments of ASFA as a number of individual island arcs being developed along the periphery of the Siberian Continent. This model supposes that break-up of Eastern Gondwana is associated with the separation of a number of continental blocks and their consequent westward drift has resulted in disjunction of the Paleo-Asian Ocean into series of detached oceanic basins separated by microcontinents. In Vendian-Cambrian, the south-western part of the ocean adjacent to the Siberian Continent was represented by a number marginal seas and variously oriented island-arc uplifts. Such tectonic environment has been retained until the Early Ordovician when

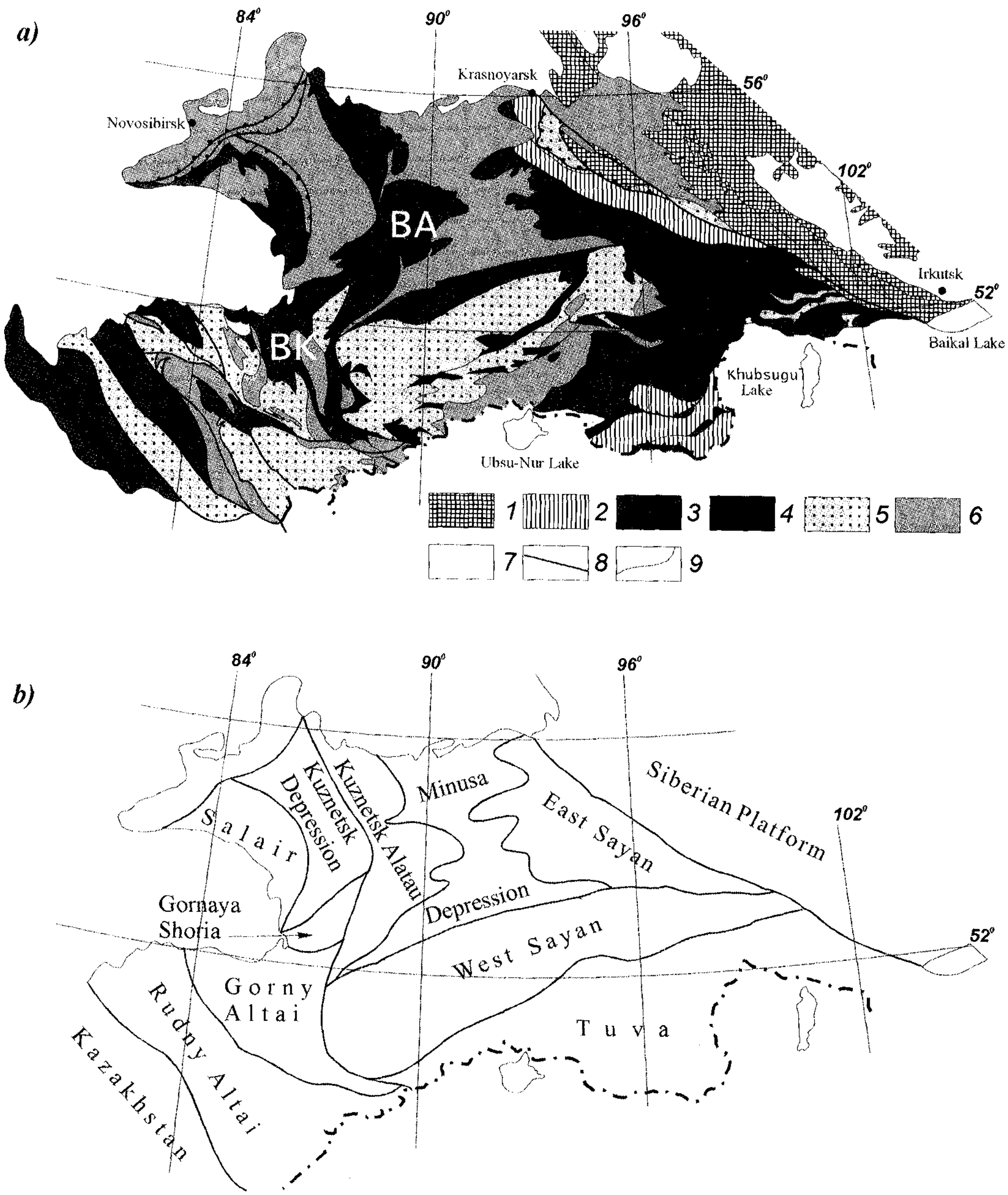

Fig. 1. General outline of the Altai- Sayan Folded Area and surrounding structures. (a) Map of terranes and overlapping complexes of the Altai-Sayan Folded Area, complied by N.A.Berzin with simplification by L.V.Kungurtsev (Kungurtsev et al., 2001). Legend: 1–Siberian Craton; 2–microcontinent with R-Pz_3 cover; 3–island arc and back-arc basin; 4–oceanic and back-arc basin ophiolite; 5–passive continental margin; 6–superimposed Pz_2-Pz_3 trough; 7–Mz-Cz depression; 8–major fault zone; 9–faults and other geological boundaries. Capital letters: BA– Bateny Block, BK–Biya-Katun' Block. (b) schematic diagram of main structural units referred in the text.

reconstruction of the whole system has occurred as the result of accretion stage.

The geologic and paleomagnetic data available at the moment do not allow us to decide which of the proposed models is most acceptable. The first step towards the solution is to determine the mutual position of small island arc terrains tracing the subduction zones along the margin of the Siberian Continent.

The present paper amplifies the authors' current understanding of the tectonic evolution of ASFA by combined analysis of geologic, paleontologic and paleomagnetic data for two outlying terranes – the Bateny block, Kuznetsky Alatau and the Katun' block, Gorny Altai.

Geology and Geodynamics

The Kuznetsky Alatau occupies the central part of ASFA and is characterized by block-mosaic tectonic structure. Rhomboid elongate blocks mainly composed of carbonate and siliceous-carbonate deposits, which are believed to be attributed to the Late-Precambrian mid-oceanic uplift – carbonate platform with horst-graven tectonics similar to modern ones compose the structure (Kungurtsev, 1991; Kungurtsev, 1989; Kheraskova and Gavrilova, 1996). The Bateny block is located in the eastern part of the Kuznetsky Alatau just on the boundary with the Minusa Depression. The Bateny block involved the Late Precambrian rock complexes of mid-oceanic uplifts (Kheraskova and Gavrilova, 1996) and back-arc fragments of Cambrian paleoisland arc (Kungurtsev, 1989, 1991; Berzin and Kungurtsev, 1996).

Three parts with different geological structures can be distinguished in the Gorny Altai region. The first – East-Altai part (Shokal'sky et al., 2000) represents the continuation of paleoisland structures of West Sayan and thus is characterized by the same geology. The second – Central part of the Gorny Altai is generally described as the Katun' anticlinorium, whose geological structure is more close to the Kuznetsky Alatau and Gornaya Shoria. In terms of geodynamics, it is most likely attributed to the structures of back-arc basin, (Yesin et al., 1995). However the presence of magmatic arc fragments in the structure cannot be excluded. The third part includes the so-called Kaim Zone in the north-east of the Gorny Altai, which is very close to the Salair structures and may be attributed to the frontal part of paleoisland arc (Berzin and Kungurtsev, 1996).

During Vendian-Early Cambrian time, all structures mentioned above constituted fragments of a single paleoisland-arc system, framing Siberian Continent (Kungurtsev et al., 2001). Up to Late Cambrian this system was considerably reorganized with closing of back-arc basins also due to obduction of back-arc structures on those of magmatic arc. Subsequent strike-slip faulting resulted in tectonic junction of back-arc basin fragments with accretional complexes of frontal parts of the paleoisland arc.

Stratigraphical and Paleontological Data

The Biya-Katun' block is composed of the Lower Cambrian carbonate-siliceous-terrigenous strata of the Shashkunar Formation, with total thickness between 300 to 500 m. Siliceous layers of the Shashkunar Formation 2–4 m thick are represented by flaggy (3–5 cm), frequently laminated (1–3 cm) grey, green, rarely violet cherts and siliceous shales (Zybin et al., 2000). The Manzherok Formation, 1200–1300 m thick, is represented by porphyric, aphyric sometimes amygdaloidal basalt, agglomerate and tuff which are supposed to be products of a immature volcanic arc underlain the Shashkunar Formation (Decisions..., 1983). The Shashkunar Formation is overlaid by reefogenic limestones of the Cheposh Formation, 250–500 m thick (see Fig. 3). The overlaid Ust'-Sema Formation is composed of pyroxene-plagioclase basalts, clastolavas and tuffs attributed to a normal volcanic arc (Decisions..., 1983; Zybin et al., 2000).

The Shashkunar Formation contains archaeocyaths, trilobites, microphytolites, algae, radiolarians, siliceous sponge spicules and protoconodonts (Zybin et al., 2000; Obut and Iwata, 2000). The age of the Shashkunar Formation is determined on the base of trilobites and archaeocyaths as Kameshki and Sanashtykgol horizons as end of Atdabanian - Botomian stages, Early Cambrian (Decisions ..., 1983). Some authors define the Ulus-Cherga Formation as age analogue for the Shashkunar Formation in the western part of the Biaya-Katun' zone. It is about 2000 m- thick, and is represented by limestones, cherts, sandstones, gravelstones, conglomerates, diabase and pyroxene-plagioclase porphyrites and their tuffs (Repina and Romanenko, 1978; Decisions..., 1983).

Lower Cambrian strata of the Bateny block begin with the carbonate-siliceous-terrigenous Bograd Formation (total thickness 470–570 m), the stratigraphic succession of which is very similar to the Shashkunar Formation. Siliceous layers of the Bograd Formation, 2–4 m thick, are represented by flaggy (2–3 cm, rarely up to 10 cm), frequently laminated (up to 1 cm), yellow, grey, rarely violet cherts, siliceous mudstone and siliceous shales (Khlebnikova et al., 2000) (see Fig. 3). The underlain Martukhina Formation, 500–1500 m thick, is composed of dolomites, limestones, sandstones, conglomerates and cherts. The Martukhina Formation is overlaid by basic volcanic and terrigenous strata of the Loschenkov Formation, which is 400–2000 m thick (Vinkman, 1969; Decisions..., 1983; Astashkin et al., 1995).

Reefogenic limestones of the Usa Formation, 450–700 m thick, overlay the Bograd Formation. Porphyrites, tuffs, tuff breccia, shales and limestones of the Karasuk Formation, 250–300 m thick, occur stratigraphically above the Usa Formation (Decisions..., 1983; Astashkin et al., 1995).

The Bograd Formation strata contain archaeocyaths, trilobites, hyoliths, gastropods, radiolarians and siliceous sponge spicules (Decisions..., 1983; Iwata et al., 2002). The age of the Bograd Formation is determined on the base of trilobites complexes as Ust'kundat, Natal'evka, Kiya and Kameshki horizons – Tommotian and Atdabanian stages, Early Cambrian (Decisions ..., 1983).

The Lower-Middle Cambrian strata on the Kuznetsky Alatau eastern slope are represented by more wide set of formations than the same-age deposits in the Bateny Ridge. It is supposed that on the eastern slope of Kuznetsky Alatau, the complicated lateral face substitution can be observed. However, it should be mentioned that such a facial heterogeneity within the Lower-Middle Cambrian deposits in this part of the Kuznetsky Alatau resulted from the complex structure of the studied region, characterized by spatial junction of different blocks. The Bograd, Usa and Karasuk formations homonymous with stratons of the Bateny Ridge are known in this area. The following formations can be additionally recognized on the eastern slope of the Kuznetsky Alatau: The Kolodzhul Formation of Botomian age, up 650 m in thickness, consists of basalts, limestones, sandstones, mudstones and marls. The Efremkino Formation corresponds to the Toyonian Stage of Early Cambrian and the beginning of the Amginian Stage of Middle Cambrian. It exceeds up to 500 m thick and is represented by andesites and its tuffs, conglomerates, sandstones, siltstones, siliceous shales and limestones. According to some authors it is impossible to distinguish from each other the Bograd and Usa formations mapped on eastern slope of the Kuznetsky Alatau (Decisions ...,1983). In this case the Kurenin Formation is defined as a complete lithological and age analogue of those two stratons.

Despite the above-mentioned diachronous character of the Shashkunar Formation (Gorny Altai) and the Bograd Formation (Bateny Ridge and Kuznetsky Alatau), expressed in longer duration of deposition of the Bograd Formation, it is necessary to emphasize that the upper parts of considered formations might be practically one-age.

At the first stage of the investigations, observed uniform thickness and the common features of stratigraphic succession of two paired stratons form the Biya-Katun' (Shashkunar and Cheposh Formations) and Bateny (Bograd and Usa Formations) blocks allowed to confirm the stated assumption about depositional synchronism of upper parts of the Shashkunar and Bograd formations. Thus, certainly, similarity of sedimentary conditions and close proximity of paleobasins is supposed. It was also supported by the circumstance, that chert and siliceous mudstones of the Shaskunar and Bograd Formations contain abundant radiolarians and well preserved siliceous sponge spicules as against all other siliceous horizons from Lower Cambrian strata in the Gorny Altai and Bateny Ridge. The Shaskunar and Bograd sponge spicules assemblages therewith are quite similar in structure and composition. Representatives of four groups Calcarea, Demospongea, Heteractinida and Hexactinellida were obtained. Among them are monoactines, diactines, triactines, tetractines, pentactines, sravtactines, *Chancelloria*, hexactines, *Dodecaatinella* sp., anchorate, dichotetrates, chiasters and other types, including new genera and species (Zybin et al., 2000; Iwata et al., 2002).

At the second stage of investigations, detailed description for fragments of upper part of the Shashkunar Formation on the watershed of Kaspa and Katun' rivers and upper part of Bograd Formation near Mnt. Blizhnyaya, left bank of Petrov ravine, northward from Verkhnyaya Yerba Village, were complied in order to establish the similarity of structure and identity of taxonomic composition of siliceous sponge spicules complexes. Unexpectedly, it was found that those sections have different lithological patterns (see Fig. 2). These sections vary not only in a succession of siliceous, terrigenous and carbonate interbedding, but also in their thickness. At first sight, this caused some doubts upon the legitimacy of direct correlation of these two sections. Alignments of separate layers from examined sections show several possibilities. For example: (1) the base of the upper part of the third layer from detailed section of the Shashkunar Formation with the base of the sixth layer from detailed section of the Bograd Formation; (2) the base of the upper part of the fourth layer of the Shashkunar Formation with the base of the eighth layer of the Bograd formation; (3) the base of the fifth layer of the Shashkunar Formation with the base of the ninth layer of the Bograd Formation.

At the third stage of the investigations, in order to obtain the more reliable base for direct correlation of two detailed sections, we analyzed four relatively independent parameters: (A) carbonatization, (B) silicification, (C) oxidizing potential, (D) paleobasin's depths and distance from a coast (see Fig. 3). The former was estimated on presence of limestones, calcareous composition of cement in terrigenous rocks and presence of algae traces. The second parameter was defined on

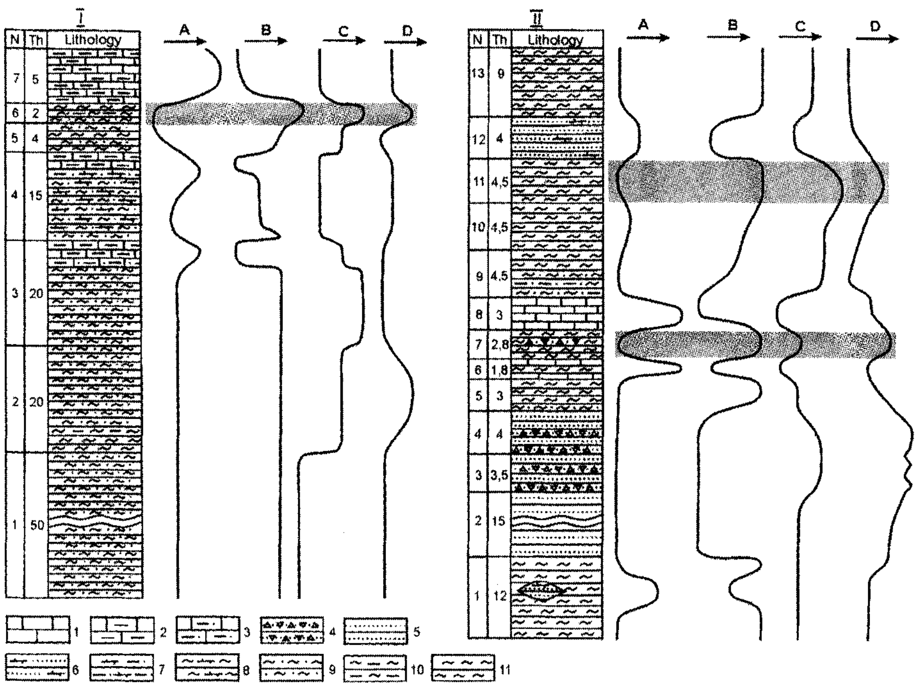

Fig. 2. Sedimentary features of Lower Cambrian siliceous-carbonate-terrigenous sections from the Altai-Sayan Folded Area. (I)– Detailed section of the upper part of the Shashkunar Formation in the watershed of the Kaspa and Katun' rivers, Ak-Kaya, Biya-Katun' zone of the Gorny Altai. (II) – Detailed section of the upper part of the Bograd Formation near Mt. Blizhnyaya, north of Verkhnyaya Yerba Village in Bateny Ridge. A–Carbonate content. The arrow shows relative increase. B–Silicification. The arrow shows relative increase. C–Oxidation potential. The arrow shows transition from H_2S infection (anoxic) to oxic environment. D–Paleobasin depth and distance from paleo-coast. The arrow shows relative decrease in distance. N–unit numbers, Th–unit thickness in meters. Legend: 1-3 – limestones, including: 2–clay limestones, 3–shale limestones; 4–gravel breccia and sand; 5, 6–sandstones, including: 6–sandstones with calcareous cement; 7–siltstones with calcareous cement; 8–siliceous siltstones; 9 and 10–siliceous shales, including 10–with calcareous cement; 11–cherts.

presence of cherts, siliceous mudstone and siliceous composition of cement in terrigenous rocks. The third parameter was determined on a color of rock (from black up to violet and red) and on presence of characteristic minerals. This parameter tooks into account grain size of terrigenous rocks, sorting and roundness of their material, textural features, and also wave marks (regular waves and storms).

Synthesis of diagrams (see Fig. 3) of those four parameters shows two correlation variants: (1) the base of the sixth layer of the Shashkunar Formation with the base of the seventh layer of the Bograd Formation; (2) the base of the sixth layer of the Shashkunar Formation with the base of the eleventh layer of the Bograd Formation. The concentration of siliceous sponge spicules in the specific horizons allow to assume second variant of correlation. This viewpoint is based on the following: both correlative intervals are characterized by a minimum of carbonatization, a maximum of silicification, high oxidizing potential and shallowness of paleobasin and relatively short distance from a coast. Such identity of paleo-environment in the Gorny Altai and Bateny basins is also emphasized by the circumstance that chemical preparation provided the richest similar complexes of siliceous sponge spicules exactly in cherts from the sixth layer of Shahskunar Formation and from the eleventh layer of the Bograd Formation. However, it is necessary to note, that relatively rich siliceous sponge spicules complex from the Bograd Formation was also found in the seventh layer and upper part of the first layer of the section mentioned above.

Thus, the unity of two parts (Gorny Altai and Bateny) of single Early Cambrian basin can be proved by both biological characteristics of taxonomical structure of siliceous sponge paleo-assemblages and sedimentological parameters.

Paleomagnetic Data

At the moment, paleomagnetic data particularly from the Shahkunar and Bograd Formations strata are absent. However available paleomagnetic data obtained from deposits below and above the formations under study can provide the necessary information on the changes in spatial position of the Bateny and Biya-Katun' blocks within the time span from Early to Late Cambrian.

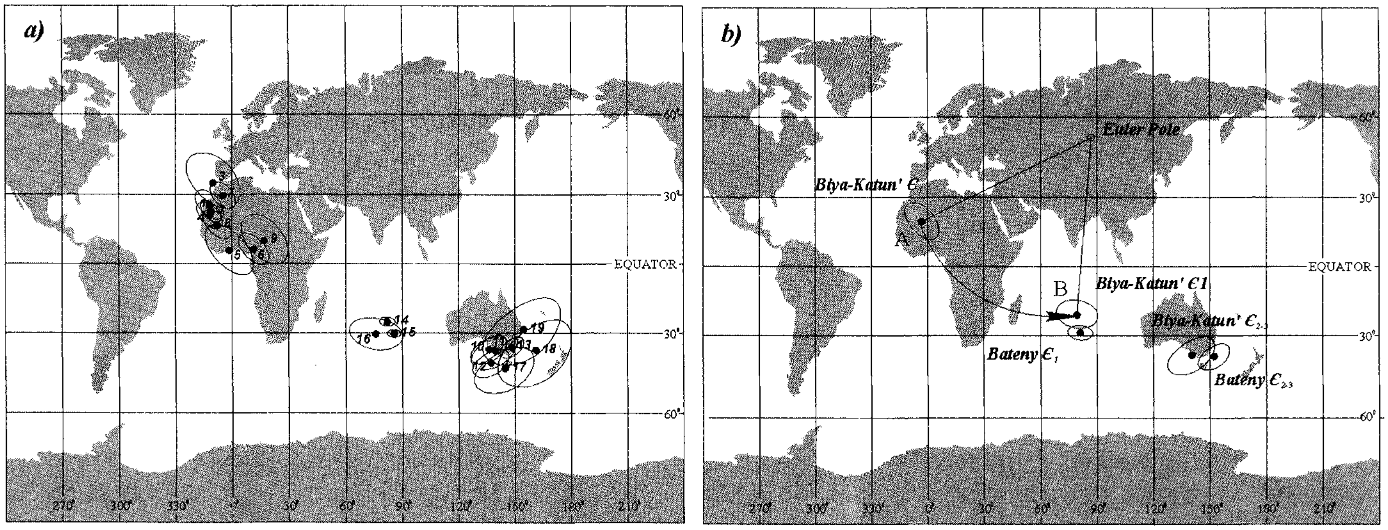

Fig. 3. a) Paleomagnetic data. Numbers of poles correspond to those from Table 2. b) Mean directions and pole positions of Early Cambrian and Middle-Late Cambrian strata from the Bateny and Biya-Katun' blocks before (*a*) and after rotation (*b*) around the Euler pole as proposed in the text.

The paleomagnetic data used for this purpose are listed in table 2 and presented in figure 3. It should be emphasized that all this data has Van der Voo (1988) reliability score nor less than 4 (see Table 2). All data with scores less than 4 were excluded from further consideration.

The principal difference in Paleomagnetic pole positions of the Bateny and Biya-Katun' blocks in Cambrian is evident (Fig. 3a). While Middle-Late Cambrian mean poles of the two blocks are in a good agreement, Early Cambrian pole means differ sufficiently (Kazansky et al., 1996, 1998; Merkulov, 1982; Metelkin et al., 2000). The clearly systematic difference between Early Cambrian poles is associated with tectonic movement of the Bateny block relative to the Biya-Katun' block after Early Cambrian. The concordance of Late Cambrian paleomagnetic data for both blocks implies that up to the end of Cambrian the Biya-Katun' and Bateny blocks have achieved the orientation close to that in the present structure of ASFA. Most likely during the time interval from Early Cambrian to Late Cambrian, the mutual position of the Bateny and Biya-Katun' blocks were changed gradually from adjacent position to that close to a modern one.

Table 1. Brief lithologic characteristics of the siliceous-volcanic type sections of the Shashkunar Formation ("Ak-Kaya" site, Biya-Katun' Block) and Bograd Formation ("Mt.Blizhnyaya" site, Bateny Block).

Formation	Rock color	Thickness of siliceous beds (m)	Thickness of terrigenous beds (m)	Flaggy structure of the terrigenous beds (cm)	Micro-lamination of the siliceous rocks (mm)
Shashkunar	Black	50	-	5-10	-
Bograd		-	-	-	-
Shashkunar	Grey	-	15	-	-
Bograd		3	4	-	0.1-1
Shashkunar	Green	from 4 to 5	20	1-3	-
Bograd		-	-	-	-
Shashkunar (amber)	Yellow -	-	-	-	
Bograd		from 4.5 to 9	from 4 to 15	from 3 to 10	0.1-1
Shashkunar (brown)	Light brown	-		-	
Bograd		from 2.8 to 12	-	from 1-3 to 10	0.1-1
Shashkunar	Lilac	2	-	1-3	-
Bograd		4.5	3.5	-	0.1-0.5
Shashkunar	Dark-red	-	20	-	-
Bograd		-	-	-	-
Shashkunar	Red	-	-	-	-
Bograd		4.5	-	-	0.1-0.2

We attempted to define a rotation pole which would reconcile the two Early Cambrian mean poles and in the same time lead to adjacent position of the Biya-Katun' and Bateny blocks. One of the possible Euler rotations gives the good convergence of Early Cambrian paleomagnetic poles is counterclockwise 95 degrees rotation of the Biya-Katun' pole around the Euler pole located at 53 N, 87 E (see Fig. 3b). On the other hand such rotation leads to the rapprochement of the Biya-Katun' block to the Bateny block and close coherence of their modern boundaries (see Fig. 4). By all means this fact cannot be considered as a contingency because any other possible apposition of Biya-Katun' block with Bateny block does not provide any coherence of paleomagnetic poles. Thus paleomagnetic data gives the strong background to consider that in Early Cambrian Biya-Katun' and Bateny blocks composed the uniform fragment of island arc system. Later the Biya-Katun' block was separated from the Bateny block and

Table 2. Paleomagnetic directions and pole position for Biya-Katun' and Bateny Blocks.

N	Block, Foramtion, site	Lat.	Long.	Direction Ds	Is	α95	field test	Paleomagnetic pole Φ	Λ	dp	dm	References
	BIYA_KATUN' BLOCK											
1	Manzherok Formation, Site SU	52.25	85.7	112	−29	7.3		25.6	347.9	4.4	8.0	Kazansky et al. (1996, 1998)
2	Manzherok Formation, Site EL20	50.2	85.7	290	25	5.6		22.8	348.8	3.2	6.0	Kazansky et al. (1996, 1998)
3	Ulus-Cherga Formation, Site CR	51.6	85.5	117	−41	11.2		34.8	350.0	8.3	13.6	Kazansky et al. (1996, 1998)
4	Ulus-Cherga Formation, Site EL15	51.6	85.5	109	−23	7		21.1	348.1	4.0	7.4	Kazansky et al. (1996, 1998)
5	Manzherok Formation, Site EL2-3	51.7	86.17	92	−12	14.7		6.0	358.4	7.6	14.9	Kazansky et al. (1996, 1998)
6	Manzherok Formation, Site EL7	51.7	86.17	262	27	8.4		6.3	11.3	5.0	9.1	Kazansky et al. (1996, 1998)
7	Manzherok Formation, Site EL8	51.7	86.17	110	−39	5.8		29.4	355.1	4.1	6.9	Kazansky et al. (1996, 1998)
8	Manzherok Formation, Site EL9	51.7	86.17	284	21	8		17.2	352.0	4.4	8.4	Kazansky et al. (1996, 1998)
9	Manzherok Formation Site EL10	51.7	86.17	80	−37	11.9		10.1	16.8	8.2	13.9	Kazansky et al. (1996, 1998)
	Mean for Lower Cambrian						r,f	19.6	356.8	6.8	12.4	
10	Ust-Sema Formation, Site EL11	51.6	85.5	321	17	8.2		−36.6	136.3	4.4	8.5	Kazansky et al. (1996)
11	Ust-Sema Formation, Site EL12	51.6	85.5	319	20	10.3		−37.0	139.4	5.6	10.8	Kazansky et al. (1996)
12	Ust-Sema Formation, Site EL18	51.6	85.5	323	26	7.3		-41.9	137.3	4.3	7.9	Kazansky et al. (1996)
13	Ust-Sema Formation, Site EL19	51.6	85.5	312	25	5.4		−35.6	148.4	3.1	5.8	Kazansky et al. (1996)
	Mean for Middle-Upper Cambrian						r,f,Nt	−37.9	140.4	4.4	8.3	
	BATENY Block											
14	Efremkino Formation	54.3	89.25	6.5	−20	3.5		−25.0	82.0	1.9	3.7	Merkulov (1982)
15	Kolodjul Formation	54.3	89.25	3.	−11	3.1		−30.0	86.0	1.5	3.1	Merkulov (1982)
16	Kurenin Formation	54.25	90.0	12	−9	12.3		−30.0	76.0	6.2	12.4	Merkulov (1982)
	Mean for Lower Cambrian						f, lp	−29.0	81.0	4.5	8.8	Merkulov (1982)
17	Karasuk Formation, site BA-I	54.3	90.5	142	−34	10.8		−44.0	144.8	7.1	12.3	Metelkin et al. (2000)
18	Karasuk Formation, site BA-II	54.5	90.8	307	35	15.2		−36.8	161.1	10.1	17.5	Metelkin et al. (2000)
19	Karasuk Formation, site BA-III	54.5	90.8	307	18	19.3		−28.4	154.4	10.4	20.0	Metelkin et al. (2000)
	Mean for Middle-Upper Cambrian						r,f,Nt	−38.4	152.2	4.9	8.8	Metelkin et al. (2000)

N–pole number (see fig.4), Lat., Long., - site latitude and longtitude; Ds, Is., a95 – remanence declination, inclination and 95% error parameter; field tests for stability: r- reversal, f- fold, Nt – full TRM test after Sholpo and Luzyanina (Sholpo, 1977), lp- long particles test after Pechersky (Pechersky, 1970); F, L, dp, dm – north paleomagnetic pole latitude, longtitude and 95% error parameters.

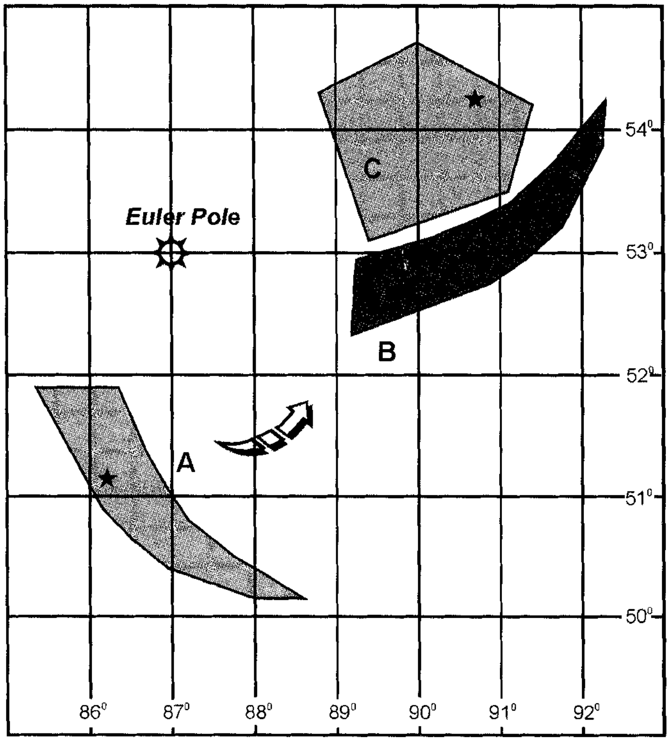

Fig. 4. The mutual position of the Bateny (C) and Biya-Katun' blocks (A)–before and (B)–after rotation around the Euler pole as proposed in the text. Black stars marks faunal localities.

rotated about 90 degrees clockwise up to their modern mutual position. In the reconstruction proposed for Early Cambrian time the distance between fauna localities is reduced form 600 km to 80 km.

Conclusions

Our reconstruction is in a good agreement with the viewpoint of Zonenshain et al. (1990) that island arc fragments of the ASFA are combined into a single extended island arc system, however, we suggest the opposite direction of subduction. Combined paleomagnetic and paleontological data allow to track back the history of two Cambrian paleoisland arc fragments – the Bateny block and Biya-Katun' block which are separated in modern structure of ASFA.

In Early Cambrian time, the Biya-Katun' block and Bateny block composed the uniform fragment of island arc system. The two blocks were in a close adjacency. So the distance between studied fauna localities was 7.5 times shorter than is their modern position. Paleontological data reveal the unity of two parts (Biya-Katun' and Bateny) of single Early Cambrian basin. Sedimentological parameters also testify their unity in Early Cambrian.

After Early Cambrian, the Biya-Katun' block was separated from the Bateny block and rotated about 90 degrees clockwise up to their modern mutual position. The distance between fauna localities increased up to 600 km and the unity of fauna assemblages and sedimentary environments was disrupted.

Acknowledgments

This study was supported by Russian Basic Research Foundation Grants Nos. 02-05-34789, 01-05-65143 and 02-05-64789.

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