A NEW TECTONIC SCHEME OF THE PALEOZOIDES IN MONGOLIA

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1. Introduction

The Paleozoides of Mongolia form one of the nearly complete cross-sections of the Inner-Asian orogen |1; 17| or so-called Altaids |25|, which is situated between the Siberian and Sino-Korean cratons.

In this paper, the author have analyzed the general tectonic zonation of the Mongolian Paleozoides from the viewpoint of the Concept of terrane collage, which has been developed mainly by American and Canadian researchers |3; 6; 10|.

Based upon the Terrane Analysis, the folded foundation of the territory of Mongolia divided into the Northern and Southern superblocks, bordering along newly established Mid-Mongolian Tectonic Line and furthermore are subdivided into numerous vari-aged and vari-typed terranes (Fig.1).

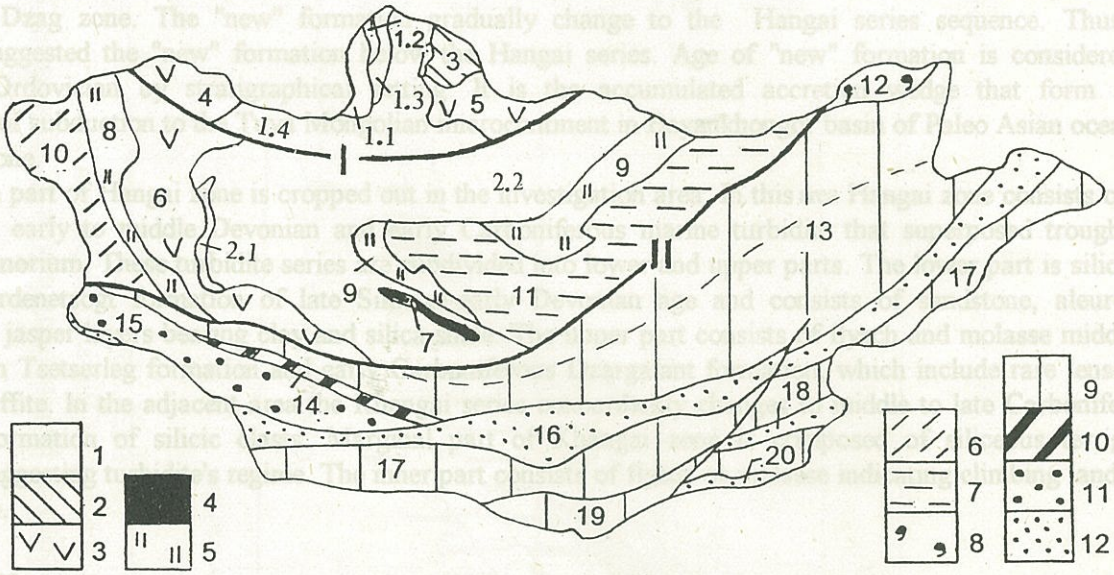

Fig.1. Terrane scheme of the Paleozoides in Mongolia

Northern superblock : 1- superterrane; 2- metamorphic terrane; 3- island arc terranes; 4- terrane of ocean crust; 5- 7- turbidite terranes.

Southern superblock : 8- terrane of accretionary prism; 9- terrane of continental margin; 10- terrane of ocean crust; 11- ensialic island arc terrane; 12- ensimatic island arc terrane.

The figures on the scheme designate as following :

Main lineaments : I- Khangay shear-zone and II- Mid-Mongolian Tectonic Line.

Superterrane : 1-2- Tuva-Mongolian (1- northern and 2- soutnern segments), including the Ulaantaigyn (1.1) and Darkhad-Zavkhan-Orkhon (1.3 + 2.2) terranes of continental margin, as well as the Shishged-Dariv terrane of oceanic crust (1.2 + 2.1) and Khugein-Gol terrane of accretionary wedge (1.3).

Composite terranes : 4-6- Lake-Dzhida (terranes : 4- Uvs Nuur, 5- Eg-Uuri, 6- Lake's), 8-9- Khovd-Kharaa (terranes: 8- Khovd, 9- Zag-Kharaa).

Simple terranes : 3- Eastern Khubsugul, 7- Bayankhongor, 10- Mongolian Altay, 11- Khangay-Khentey, 12- Duch-Gol, 13- South Altay-Ereendavaa (dotted line - Ikhbogd-Kerulen suture), 14- Trans-Altay, 15- Ajbogd, 16- Govian, 17- Govian Tian Shan-Nuketdavaa, 18- Zamin Uud, 19- Toto Shan, 20- Solonkher.

2. Tectonics of the Northern superblock

The Northern superblock of the Mongolian Paleozoides is characterized by distinct mosaic architecture, general nappe structure and large variety of composing terranes, becoming generally younger in the direction to the south.

The most important component for this superblock is the Tuva-Mongolian superterrane (1 and 2 in Fig.1) which has a structure that typical to microcontinents |4; 5; 12; 14; 24; 26|. Its basement is very heterogeneous. Recently it was found that in the compound nappe-folded structure there is combination of four Riphean terranes (from west to east): 1- Ulaantaigyn terrane of passive continental margin (1.1 in Fig.1), represented by the eastern flank of the known Sangilen Precambrian "Mid-Massif" with the Middle-Upper Riphean carbonatic cover often teared away from its metamorphic basement, 2- Shishged-Dariv terrane of ocean crust (1.2 and 2.1 in Fig.1), forming two allochthon structures with the same type metaophiolite complexes , 3- Khugein-Gol terrane of accretionary wedge (1.3 in Fig.1), including widespread diabase-greenschist complex with lenses of blueschists |15|, and 4- large Darkhad-Zavkhan-Orkhon terrane of Andian-type active continental margin (1.4+2.2 in Fig.1), which includes the "Early Precambrian metamorphic core" with "grey" tonalitic gneisses, different type supracrystal complexes (leptynite-amphibolite, quartzite-marble etc.) and intrusions of anorthosites dated as 2646(±45), 2370-1830 and ~ 1700 My respectively |4; 9; 31|, as well as the external folded megazones with widespread Middle-Late Riphean metavolcanogenic-metasedimentary complexes and the numerous intrusions of different type granitoids radiometrically dated from 1300 to 752 My |5; 14; 18|.The postamalgamation complex, link the above-mentioned terranes into the single superterrane, is represented by the transgressive series of shelfian phosphorite-bearing terrigenous-carbonate sediments of Sinian-Early Cambrian (including the Amgin stage) age, containing basal tilloid unit of the Kazakhstan-type |1; 5; 14|.

The Lake's, Uvs Nuur and Eg-Uuri island arc terranes (6, 4 and 5 in Fig.1) are thrusted onto the Tuva-Mongolian superterrane from its western and northeastern sides. The three island arc terranes form the so-called Lake-Dzhida composite terrane which has a distinct nappe-structure and is included the Troodos-type ophiolites dated as 695±25 My (Sm-Nd method). Diagnostic components in it are the lavas of boninite, Ti-high subalkaline and calc-alkaline series, as well as calcarenites, tuffitic turbidites and I-type granitoids radiometrically dated as 480 My |7; 8; 12; 14; 16; 17; 26; 27; 30|. The characteristic features of the ophiolites and island arc complexes of the Lake-Dzhida composite terrane clearly indicate a supra-subduction zone in tectonic setting.

To the north, the Lake-Dzhida composite terrane is emplaced into the East Khubsugul metamorphic terrane which in the regional structure emerges as the south-western end of the Khamardaban cratonic terrane within the southern folded surrounding of the Siberian craton. This metamorphic terrane (3 in Fig.1) consists of the Precambrian-

Early Silurian zonal-metamorphic complex with extensive occurences of granite-dome tectonics |27|.

The eastern edge of the Tuva-Mongolian superterrane is the elongated but narrow allochthonous Bayankhongor terrane of ocean crust (7 in Fig.1). It is represented by a thick zone of a monomictic serpentinite melange, in which an ophiolite section is exposed |7; 14|. The latter includes gabbro dated as 569 My (Sm-Nd method), sheeted dike complex and pillow-lavas of the E- and T-types MORB with marine beds containing remains of the Early Cambrian fossils |7; 18|.

The remaining southern part of the Northern superblock is composed of a system of the Lower and Middle Paleozoic turbidite terranes |1; 11; 12; 16; 17; 29|. Its part, specifically the Khovd-Kharaa composite terrane (8 and 9 in Fig.1), in which main components are the Cambrian-Ordovician volcanomictic turbidides and underlying subduction melange with extensively fractured ophiolite units, is clearly related to the fragment of the accretionary wedge. The same aged Mongolian Altay turbidite terrane (10 in Fig.1) with the melanged ophiolites and thick subarkosic flysch is most probably a buried mid-oceanic ridge. A separate independent structure in the southern system of turbidite terranes is the Khangay-Khentey terrane (11 in Fig.1) which is characterized by thick sections of the extensively dislocated turbidites of the Silurian-Devonian and Lower-Middle Carboniferous. Recently it was revealed that this terrane appears to be a fragment of a small oceanic basin since its Late Silurian-Devonian turbidite Adaatsag-Onon segment is conformably underlain by ophiolite complex with sheeted dike series and pillow-lavas of N-type MORB |14|.

All terranes in the above-mentioned Northern supreblock are covered by the different type overlap complexes, among which main role belongs to the Middle Paleozoic volcanogenic-terrigenous deposits (not including the Khangay-Khentey terrane) and, specially, Late Paleozoic subaerial volcanites associated with different type molasses |2; 11; 12; 16; 17; 26; 29|.

3. Tectonics of the Southern superblock

The Southern superblock of the Mongolian Paleozoides has a completely different structure compared to the Northern superblock. The former shows a linear structural plan and symmetric character, and is formed by a regular alternation (in cross-section) of elongated terranes of continental margin with similar or narrower-sized terranes composed of paleooceanic complexes.

The first class of these structures, consisting of the South Altay-Ereendavaa, Govian Tian Shan-Nuketdavaa and Toto Shan terranes of continental margin (13, 17 and 19 in Fig.1), is the Early Caledonian folded basement which is rather monotonous and therefore it could be suggested that these terranes are fragments of what used to be a single folded region although including various vari-aged complexes. The Late Proterozoic is essentially carbonate-schist complexes which in places are underlying the Early Precambrian polymetamorphic complexes with "grey" gneisses |1; 4; 12|. It was found that the above-mentioned complexes have many features identical to metamorphic rocks of the Zhaertay and Baiyun Obo Groups which fill the "ancient rifts" within the northern margin of the Sino-Korean craton |19; 20|. These terranes lay shelf carbonates of the Sinian-Early Cambrian age with remains of the archaeocyte fauna in the upper section

|1; 12|. Only within the Ikhbogd-Kerulen suture in the basement of the South Altay-Ereendavaa terrane, the above shelf carbonates are abruptly replaced by ophiolites of the same age, which are similar to the ophiolite complex in the Ondor Sum suture to the north from the Sino-Korean craton |1; 12; 14; 19; 20|. The Early Caledonian basement of the described continental margin terranes is intruded by S-type granitoid of Middle Cambrian age |1; 12|.

The sedimentary cover in the above-mentioned terranes of continental margin is included the Middle Ordovician to Early Carboniferous shelfian carbonate-terrigenous complexes. The lower horizons of them are replaced by oligomictic turbidites, and the remaining part of section are gradated by the Silurian-Devonian barrier reefs or Devonian-Early Carboniferous volcanogenic molasse formations |1; 12; 17; 23; 26; 27; 29|. Occasionally, Late Cambrian-Early Ordovician riftogenic volcanogenic-flyshoid complex is present in the composition of the sedimentary cover, and this complex consists of metabasites with petrochemical characteristics of continental tholeiites |23|.

Besides, the terranes of continental margin represent the different type overlap complexes of Late Paleozoic to Early Triassic age. They mainly consist of subaerial volcanics and continental or coastal-sea molasses |1; 2; 12|.

The second class of the terranes in the Southern superblock occurs in the form of paleooceanic sutures |13; 14; 23; 27; 29|. The terranes are characterized by nappe structure and mostly represented by vari-typed volcanogen-sedimentary complexes which are accompanied by Ligurian-type ophiolites with thin ophicalcite-radiolarite horizon in the base of the upper member of the basaltic pillow-lavas. The age interval of these complexes is varying and includes the Silurian-Early Carboniferous in the Trans-Altay terrane of ocean crust (14 in Fig.1), Ajbogd, Govian and Dzamin Uud island arc terranes (15, 16 and 18 in Fig.1), and the Middle Carboniferous-Upper Permian in the southernmost Solonkher island arc terrane (20 in Fig.1). At the same time a typical subduction melange of the Devonian-Early Triassic age is exposed in the northernmost Duch-Gol terrane of accretionary wedge (12 in Fig.1). Here, one can find a think flysh-like section, in which chaotically mixed the greenschist metamorphites and presumable Devonian dismembered ophiolites |17|. It is important to note that the Solonkher and Duch-Gol terranes differ each other in their faunal complexes: the former commonly hosts a typical Tethys fauna, whereas the latter Boreal fauna |1; 17; 23|.

4. Geodynamic model

The formation of terrrane collages in the Mongolian Paleozoides can be interpreted using the following geodynamic model (Fig.2).

In the Early Proterozoic, all the territory of the Mongolian Paleozoides was entirely a part of the Svecofennian-type mobile belt. Initially, this belt most probably resembled a modern geodynamic system of the Western Pacific Ocean type, but later has concolidated as a result of the Grenvillian tectogenesis and became a part of the supercontinent Pangea I.

During the Riphean-Early Ordovician, the territory of the Northern superblock of the Mongolian Paleozoides found itself within the Paleo-Asian ocean in the form of the Tuva-Mongolian microcontinent and its surrounding oceanic basins, whereas the territory of the Southern superblock of these Paleozoides was part of the Govian margin of the

Sino-Korean continent and had undergone destructive effects due to progradation of the Paleo-Tethys ocean into Cathaysia. During these events the ancient-Mongolian segment of the Paleo-Asian ocean acted as an arena for formation of large accretion systems. In the end of the Early Ordovician they joined the Siberian craton, turning into a vast North Asian Caledonian continent.

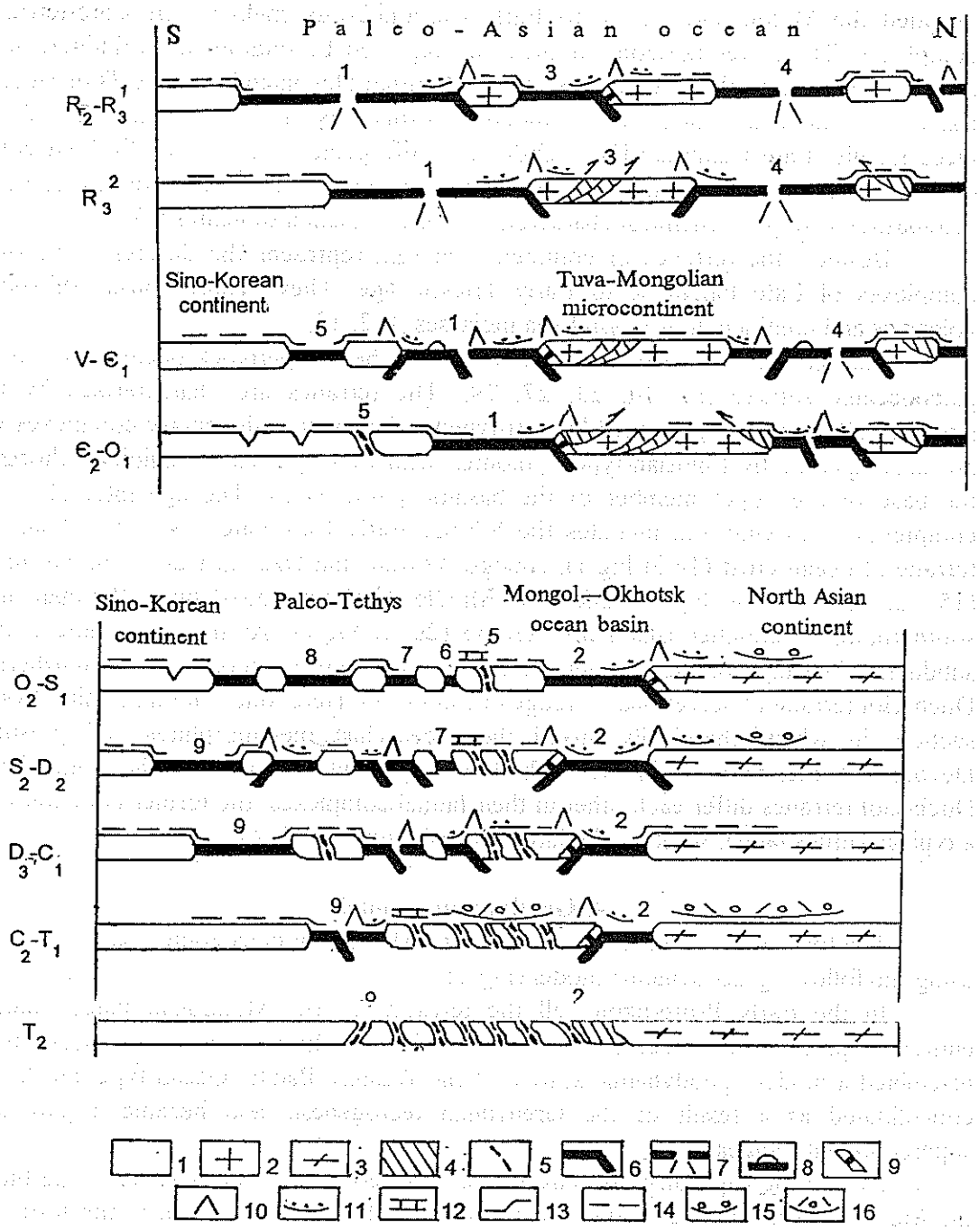

Fig.2. Plate tectonic model for formation of the Paleozoides in Mongolia

1 - Precambrian Cathaysia; 2 - fragments of Precambrian continental crust of Siberian row; 3- Northern Asian Caledonian continent; 4 - accreted terranes; 5 - ophiolitic sutures; 6 - ocean crust; 7 - spreding centers; 8 - seamounts; 9 - accretionary wedges; 10 - volcanic arcs; 11 - volcanogenic-terrigenous and graywacke series of intra- and marginal basins; 12 - barrier reefs; 13 - oligomictic turbidites of continental slope and rise; 14 - shelfian sediments; 15 - molasses; 16 - volcanogenic-molasse complexes.

The arabian figures on scheme are marks the oceanic basins and forming on their place the accreted terranes and sutures : 1, 3 and 4 - oceanic basins of the Paleo-Asian ocean (1 - Altay-Khentey, 3 - Shishged and 4 - Dzhida); 2 - Khangay-Khentey oceanic basin of the Paleo-Pacific ocean; 5-6 - destructive througs with ocean-type crust (5 - Ikh Bogd-Kherlen and 6 - Govi Altay) and oceanic basins (7 - Trans-Altay, 8 - South Mongolian and 9- Inner Mongolian) of the Paleo-Tethys ocean.

In the interval between Middle Ordovician and the beginning of Triassic, the North Asian continent was surrounded in the south by the Mongolo-Okhotsk (Khangay-Khentey) small oceanic basin of the Paleo-Pacific ocean, whereas the Govian margin of the Sino-Korean continent, which was gradually moving toward Siberia, was still undergoing destructive events associated with the progradation of the Paleo-Tethys and was again 'healed' as a result of the "Wilson Cycle".

By Middle Triassic the oblique collision of the North Asian and Sino-Korean continents was completed resulting in the annihilation of the Khangay-Khentey segment of the Mongol-Okhotsk ocean basin that lead to a formation of united continental crust in the Paleozoides of Mongolia.

5. Conclusions

The Terrane Analysis of structures of the Mongolian Paleozoides leads to the following conclusions.

1. The Northern superblock of the Mongolian Paleozoides represents a Paleozoic nappe-folded area and is composed of vari-typed accreted terranes formed on the place of the Caledonian Paleo-Asian ocean (system of the Caledonian terranes) and the Variscan Mongol-Okhotsk ocean basin of the Paleo-Pacific ocean (Khangay-Khentey terrane). In the regional structure of the Inner-Asian orogen, the Northern superblock of the Mongolian Paleozoides is a part of the Central Asian Paleozoic Foldbelt concerning to the southern folded surrounding of the Siberian craton |17|.

2. The Southern superblock of the Mongolian Paleozoides represents the collision-type Variscan foldbelt which was formed during the repeatedly progradation of Paleo-Tethys ocean into the northern (in the modern coordinates) margin of the Sino-Korean paleocontinent, and the event was accompanied by occurences of the "Wilson Cycle" in Early, Middle and Late Paleozoic. In the regional structure of the Inner Asian orogen, the Southern superblock of the Mongolian Paleozoides belongs to the Irtysh-Khingan Foldbelt in the northern folded surrounding of the Sino-Korean craton |28|.

3. The Mid-Mongolian Tectonic Line, which is western extension of known Mongol-Okhotsk Lineament, is the most important tectonic boundary of the above-mentioned accretionary and collisional fold belts of the Inner-Asian orogen. This tectonic boundary is the trace of the oblique collision of the North Asian and Sino-Korean paleocontinents. Consequently, the Mid-Mongolian Tectonic Line represents the segment

of a fundamental suture of ancient continental massifs of the Laurasian and Gondwanian rows.

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