AOGS 2006

Geological Evolution of Paleo-Asia Continent Eastern Margin in Jurassic

ALEXANDER KHANCHUK[1], IGOR KEMKIN[1]

[1] *Far East Geological Institute, Far Eastern Branch, Russian Academy of Sciences*

Jurassic is an important period in the formation and geological evolution of East and Southeast Asia continent margin geological structure. During this time different-age and -facies formations of the paleo-Pacific(fragments of abyssal plain, intraoceanic volcanic seamounts, and oceanic plateaus) were accreted to the eastern margin of paleo-Asia continent as a result of subduction of an oceanic lithosphere. Together with ocean-marginal terrigenous deposits(trench-fill turbidites) they have formed a thick tectono-sedimentary complex of the Jurassic accretionary prism. In the modern structure of East and Southeast Asia the outcrops of this prism are fixed from the Uda Gulf south coast in the north, through the Sikhote-Alin (Russian South East), Nadankhada-Alin(Northeast China), Japan and Ryukyu Islands, up to Palawan Island(Philippines) in the south(Kojima, 1989; Mizutani, 1990; Mizutani et al., 1990; Pre-Cretaceous ..., 1990; Shao et al., 1992; Kemkin, Khanchuk, 1993; Nakae, 1993; Yang et al., 1993; Khanchuk, 1994; Khanchuk, Ivanov, 1999; Khanchuk, 2000; Kemkin, Filippov, 2001; Zamoras, Matsuoka, 2001; Khanchuk, Kemkin, 2003; Zamoras, Matsuoka, 2004 etc.). At present the Jurassic prism is the most investigated in the Sikhote-Alin(Samarka and Nadankhada-Bikin terranes) and Japan(Tamba, Mino, Ashio, Sambagawa and Northern Chichibu terranes). Terranes of the Jurassic prism are characterized by complicated imbricate-thrusted structure, being caused by processes of off-scraping(slicing of subducting trench deposits in the frontal prism) and underplating(duplexing of oceanic rocks in the base of the prism), and also by post-accretionary deformations, such as thrusts, strike-slip faults, etc. Them composing complex of deformed sedimentary rocks forms a package of repeatedly alternating tectonic slices (plates) consisting of same lithology, but different-in-age fragments of paleooceanic plate sedimentary cover cross-section, including the whole sequence of deposits, from pelagic to ocean-marginal ones. Such sequences of deposits were defined as Oceanic Plate Stratigraphy(Berger, Winterer, 1974; Isozaki et al., 1990 etc.) i.e. complex of deposits accumulated on an oceanic plate during its drift from the zone of spreading to subduction zone. The most important group of deposits in these sequences is transitive layers from pelagic to ocean-marginal rocks, i.e. hemipelagic formations, represented by siliceous mudstones and mudstones. On one hand, they fix the moment when any site of a paleooceanic plate approaches the border of convergence, as the smooth change of chert-accumulation at the beginning for the fine-grained, and then coarser terrigenous deposits testifies a gradual change of pelagic sedimentation conditions by hemipelagic and further by ocean-marginal ones. Consequently, the age of transitive layers indicates the time when any site of an oceanic plate approached the subduction zone and, to a certain extent, the beginning of its subsequent accretion. On another hand, knowing the

age of these layers in various tectonic slices (plates) of the prism, it is possible to specify the time when individual paleooceanic fragments accreted, and to dismember the accretionary prism on concrete tectono-stratigraphic units responding the certain stages of its formation. Subsequent mutual correlation and comparison of allocated units helps to reconstruct the succession of the accretion process and, thus, to specify the structure of the prism as a whole, the history of its formation, and geodynamic evolution of the continental margin, along which this prism had formed. For example, detailed biostratigraphic research(using radiolarian analysis) of such transitive layers in various tectonic slices (plates) of the Samarka terrane of the Sikhote-Alin Jurassic prism helped to distinguish five tectono-stratigraphic units reflecting the process of consecutive accretion of different-age and -facies paleooceanic formations. They are allocated into two subterranes - Sebouchar and Eldovaka(Kemkin, Filippov, 2001), that compose, correspondingly, the upper and middle-lower structural levels of the Samarka terrane. The upper structural level is composed of alternating tectonic slices(plates) consisting of terrigenous deposits(turbidites), chaotic rocks(subduction melange), and paleooceanic formations represented by separated fragments of ophiolitic association. The paleooceanic fragments are composed by: 1 - Middle Paleozoic gabbro and ultrmafic rocks(Kalinovka Formation), 2 - basalts, associated with Carboniferous to Permian limestones and cherts, and Late Permian black aleuroargillites(Sebouchar Formation), and 3 - Late Permian greenish grey and light green sandstones alternated with the same color siltstones(Udeka Formation). The slices of ophiolitic association are interpreted as the fragments of paleooceanic plateau(Khanchuk, Panchenko, 1991) that formed as a result of mantle plume intrusion. On heights and islands of this plateau, carbonate rocks formed, while in the hollows, surrounding these heights, cherts and clay deposit accumulated. According to radiolarian fauna extracted from aleuroargillites overlapping ophiolite slices(plates), accretion of the plateau occurred in Early Jurassic. The middle and lower structural levels are composed of repeatedly alternated slices(plates) of Middle to Late Jurassic sandstone and siltstone, chaotic formations and bedded cherts, whose age changes from Late Permian and Triassic up to Early and Middle Jurassic. In some individual slices gradual transitions from cherts to terrigenous rocks are observed. According to the age of transitive layers in such slices, the Eldovaka subterrane is dismembered on four tectono-sedimentary complexes, namely(from bottom upwards): Katen, Breevka, Saratovka and Amba-Matay. The time of accretion of paleooceanic fragments from these complexes, according to radiolarian analysis data, correspondingly is: Oxfordian - Tithonian, Bathonian - Callovian, Bajocian – Callovian, and Toarcian – Bathonian. Despite both, lithological composition and structure of each tectono-stratigraphic unit, are identical, they still reveal small differences reflecting the facies features of different sites of a paleooceanic plate. For example, the Katen complex is characterized by the presence of limestone interbeds within chert layers. The cherts of Breevka complex contain clastic layers with clasts of basalts, cherts, cherty mudstones, volcanic glass, and plagioclases. The Amba-Matay complex contains not only the slices of Triassic-Early Jurassic but also Late Permian cherts. Besides the presence of lumps and block of basalts, the chaotic formations of this complex are characterized by Carboniferous and Permian limestones, Permian and Triassic cherts, gabbro and ultramafic rocks. The Jurassic prism in Japan has also the similar structure. Rock associations comparable

with those of the upper structural level of the Samarka terrane constitute the Ultra-Tamba and, partially, Maizuru terranes (Kemkin, Kemkina, 2000; Kojima et al., 2000; 2002). There the fragments of ophiolitic association are also represented by the slices(plates) of late Middle Paleozoic gabbro-ultrmafic rocks(Yakuno ophiolite), basic volcanites associated with Middle to early Late Permian black mudstones and cherts, and also with Late Carboniferous limestones(Kozuki Formation), light green and greenish gray sandstone, and siltstone yielded late Middle to early Late Rermian radiolarians(Hikami Formation). Chert-terrigenous sequences and melange formations analogous to those of the Eldovaka subterrane(i.e. middle and lower structural levels of the Sikhote-Alin Jurassic prism) compose Tamba, Mino, Ashio, Sambagawa and Northern Chichibu terranes (Pre-Cretaceous . . . , 1990). Practically all these terranes are dismembered on two tectono-stratigraphic units. The upper unit consists of the slices of Late Permian and Triassic – Early Jurassic cherts and Early to Middle Jurassic clastic rocks and melange. Melange formations are represented by aleuroargillites containing the lumps and blocks of Permian and Triassic cherts, Carboniferous limestones, basalts, and also siltstones and sandstones. The lower unit is composed of slices of Triassic to Middle Jurassic cherts alternating with Late Jurassic sandstones and siltstones. Despite the cross-sections of Jurassic accretionary prisms in both regions are rather similar, they, however, differ in one thing. The accreated paleooceanic formations of the upper structural unit of the Sambagawa terrane are represented not only by Triassic to Jurassic cherts, but also by the slices of ophiolite(ultrmafic and basic rocks and basalts associated with Late Jurassic cherts and limestones(Mikabu series)), which are interpreted as a fragment of Late Jurassic oceanic plateau(Kimura, 1997). Analysis of the structure of Jurassic prisms in both regions(Sikhote-Alin and Japan) allows to reconstruct the history of both prisms formation and to allocate the main geological events on the east margin of Paleoasian continent in the Jurassic time. In Early Jurassic the eastern margin of paleo-Asia represented an active margin of Andean-type, along which the oceanic plateau accreted. Being morphologically a positive structure, the oceanic plateau could not completely subduct. It was broken by faults into a series of tectonic slices(plates) with partial thrusting of the higher slice onto the lower one, and accreted to the continental margin(analogous to the contemporary accretion of Daiichi Kashima Guyot in the Japanese trench or Zenisu Ridge in Nankai trench(Fujioka et al., 1988). In the Sikhote-Alin the fragments of this plateau are represented by Kalinovka ophiolite, and in Japan by Yakuno ophiolite. The Middle and Late Jurassic are characterized mostly by the subduction of morphologically even part of paleooceanic plate(i.e. different-age sites of abyssal plain). The accreated paleooceanic fragments the Jurassic prism in this time interval are represented by chert-terrigenous sequences that differ from each other only in the age of from-chert-to- terrigenous-rocks transitive layers(i.e. by time of accretion). At the end of Jurassic the accretion of one more oceanic plateau, whose fragments(Mikabu ophiolites) are described in the Sambagawa terrane, occurred in the southern part of the suduction zone. Thus, during Jurassic, the consecutive accretion of different-age and -facies formations of the paleo-Pacific resulted in essential size increase of paleo-Asian continent, namely the growth of its eastern margin.