Bull. Disas. Prev. Res. Inst., Kyoto Univ., Vol. 35, Part 3, No. 313, September, 1985

On the Character of the Meso-Cainozoic Tectono-Magmatic Activity in East Asia

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(Manuscript received June 11, 1985)

Abstract

The character of the Meso-Cainozoic tectono-magmatic activity that was manifested in the vast area of East Asia is examined by taking into account the general trend of the Phanerozoic geological evolution of the present continents. It is suggested that this activity can be regarded as a manifestation of the epiplatformal tectono-magmatic activity which was associated with the rejuvenation of the asthenospheric layer. It is also suggested that the manner of manifestation of the activity was governed, to a considerable extent, by the low permeability of the mature continental crust and also by the oceanward flows presumed in the asthenospheric layer. On the other hand, it is pointed out that the paleotectonic reconstructions based on the plate tectonics concept have not yet provided any satisfactory explanation of the peculiar features that characterized the Meso-Cainozoic geological evolution of East Asia.

1. Introduction

In the paper previous to this[1], a schematic model of the deep-seated mechanical processes in the mantle was proposed as being responsible for the Meso-Cainozoic structural development of East Asia including not only the active continental margin but also the intracontinental regions extending far into the continent. At that time, however, the specific features of the Meso-Cainozoic tectono-magmatic activity in East Asia was not examined in detail but referred to only briefly. The present paper is devoted to this problem.

It has recently become more obvious that the Meso-Cainozoic geological evolution of the vast area of East Asia has proceeded in a qualitatively different manner as compared with its pre-Mesozoic evolution. In eastern China, for example, the early Mesozoic Indosinian movement and the late Mesozoic Yanshan movement were superimposed discordantly on the pre-Mesozoic structures of various types and brought about a significant remodelling of the crustal structure[2]. As for the geological evolution of Japan, Ichikawa et al.[3] have pointed out that the Meso-Cainozoic history can hardly be explained merely in terms of the ordinary geosyncline concept, while the pre-Mesozoic movements, such as the Honshu movement, can be regarded as typically geosynclinal.

The main purpose of the present paper is to investigate the cause of this substantial change in the features of the structural development of East Asia by taking into consideration the general trend of the Phanerozoic geological evolution of the present continents.

2. The Temporal and Spatial Characteristics of the Meso-Cainozoic Tectono-Magmatic Activity in East Asia

In the first place, it is necessary to get acquainted with the characteristic features of the Meso-Cainozoic tectono-magmatic activity in East Asia. **Fig. 1** shows generalized maps of the Mesozoic to Cainozoic evolution of East Asia compiled from recent publications[4)~6)]. The most salient features of the temporal and spatial characteristics of the tectono-magmatic activity could be summarized as follows:

(1) The predominance of the NE–NNE trending tectonic movements superimposed discordantly on the pre-Mesozoic structures of various types which were characterized by predominantly EW trending movements. It is noticeable that the ancient platforms as well as the younger ones were involved in these movements and became significantly mobile and unstable, which led Chinese geologists to designate them as 'paraplatform'[7)].

(2) The generation (or regeneration) of large graben-like sedimentary basins, such as the Song-Liao Basin, separated from the neighbouring uplifts by NE–NNE striking normal faults and accompanied by significant thinning of the earth's crust below them. It is important to note that most of these basins in eastern and northeastern China are unsymmetrical rather than symmetrical in shape, which has been attributed by Deng and Wang[2)] to the oceanward tensile force acting on the earth's crust during the Mesozoic to early Cainozoic time. According to their opinion, this force gave way to the compressional force from the ocean side since the late Cainozoic time.

(3) The widespread manifestation of vigorous volcanism and intrusive activity accompanying the tectonic movements. The volcanic activity exhibited a gradual change of the chemical composition of magmatic rocks from predominantly andesitic and andesite-basaltic to basic and alkaline. The intrusive activity was represented mostly by the emplacement of granitoid intrusions. On the other hand, it is noticeable that the regional metemorphism did not play an important role in the Meso-Cainozoic structural development of East Asia.

(4) The overall lateral migration of the regions where the most excited tectono-magmatic activity was manifested, mainly from the interior part of the continent to its eastern margin, during the Mesozoic to Cainozoic time. This migration appears to be combined with the above-mentioned change of the chemical composition of magmatic rocks. It also appears to be followed by the extensive development of the Cainozoic tectono-magmatic activity in the East Asiatic transition zone, such as the formation of marginal seas and the development of the so-called Green-tuff and Island-arc Disturbances[8)].

These temporal and spatial characteristics of the Meso-Cainozoic tectono-magmatic activity in East Asia have long since attracted the attention of many investigators who have been concerned with the general problem of classification of the endogeneous geotectonic regimes. Among them, Beloussov[9)] has already asserted

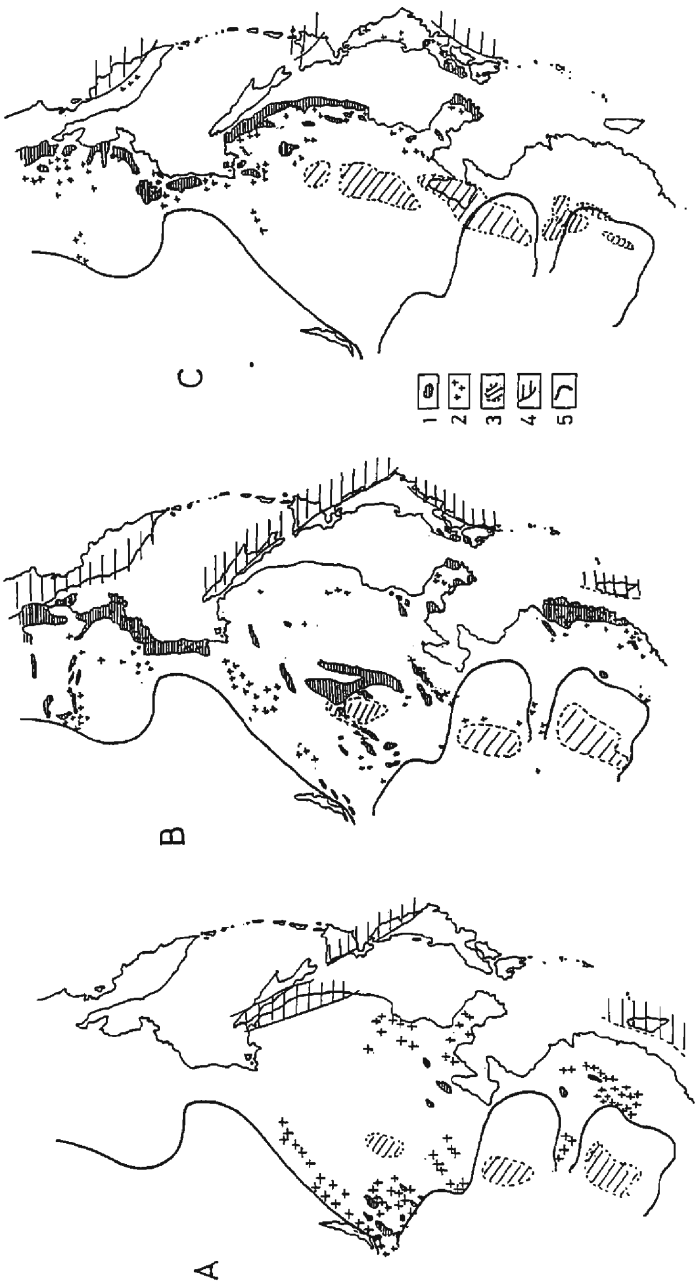

Fig. 1 Generalized maps of the Mesozoic to Cainozoic structural development of East Asia adapted from recent publications:[4)-6)]
A—Late Triassic to Early Jurassic; B—Late Jurassic to Early Cretaceous; C—Late Cretaceous to Early Paleogene.
1—volcanic rocks, mainly calc-alkalic; 2—intrusive rocks, mainly granitoid; 3—sedimentary basins; 4—approximate boundary of eugeosyncline; 5—approximate western boundary of manifestation of Mesozoic magmatic activity.

that the young volcanism and the block-movement of the crust characterizing not only the Meso-Cainozoic evolution of East Asia but also that of the periphery of the Pacific Ocean can hardly be explained in terms of the ordinary geosyncline concept, since there is no evidence for manifestation of the basic features of geosynclinal development; the ordinary development of geosyncline is characterized by the shattering and subsidence of the earth's crust and the rise of mantle-derived basic and ultrabasic magmas at the early stage, and by the uplift and extensive folding of the crust and the manifestation of high-temperature regional metamorphism and granitization at the later stage of development. Later on, he has suggested that the specific tectono-magmatic activity in East Asia, especially in the Transbaikalia and East China, belongs to the group of parageosyncline[10]. In this case, however, the above-mentioned peculiar feature that the vigorous magmatism and intrusive activity accompanied the tectonic movements has compelled him to distinguish a particular subgroup of parageosyncline, 'parageosyncline with volcanic manifestations', from the typical parageosyncline which is lacking in any magmatism. Pushcharovsky[11] has described such extrageosynclinal tectono-magmatic activities as those in East Asia with the use of the special term, 'resonant-tectonic structure', thereby emphasizing its close relationship with the eugeosynclines which were developing comtemporaneously in the adjacent regions. These classifications are characterized by a common viewpoint that the tectono-magmatic activity under consideration is explainable within the framework of the geotectonic regimes associated with the geosynclinal regime. On the other hand, a different point of view has been held by Milanovsky[12], who has regarded this activity as a manifestation of the continental rift regime. Nagibina et al.[13] have considered that it should be regarded as a special type of tectono-magmatic activization and have termed it as granitoid activization or revivification. The 'tectono-magmatic activization' is a comprehensive term which means the rejuvenation of tectonic and magmatic activity in those regions where the mature continental crust has already been formed. Thus, the same term includes another type of tectonic and magmatic activity, such as trap magmatism, which Nagibina et al. have termed as basaltoid activization. In Chinese publications, the special term, 'Diwa movement', which means graben-forming movement, has been utilized for describing the features of this activity and, as mentioned above, an ancient platform involved in this movement has been designated as paraplatform[7]. These latter classifications are characterized by a common viewpoint that the activity under consideration should be regarded as a manifestation of the endogeneous geotectonic regime which is qualititatively different from the geosynclinal regime. Thus, the Meso-Cainozoic tectono-magmatic activity in the East Asiatic continent has been interpreted differently by different investigators. Equally controversial are the role and significance of the tectonic and magmatic events in the Meso-Cainozoic evolution of the transition zone including the marginal seas, island arcs and deep oceanic trenches: one side postulates that they are the typical manifestation of the eugeosynclinal regime, while the other side considers that they can hardly be regarded

as geosynclinal. The character of the so-called Green-tuff and Island-arc Disturbances[8] in the light of the generalized classification of geotectonic regimes still remains open to discussion.

The profusion of terms as cited above reflects the complicated character of the Meso-Cainozoic tectono-magmatic activity in East Asia. Although it is difficult to answer the question which term is most appropriate, it seems unquestionable that the tectono-magmatic events which occurred in the major part of East Asia were so peculiar as to be inexplicable merely in terms of the ordinary geosyncline concept. To the contrary, the geosynclinal character seems to be widely accepted for the pre-Mesozoic tectono-magmatic activity in East Asia.

3. The Character of the Tectono-Magmatic Activity in the Light of the General Trend of the Phanerozoic Geological Evolution

Judging from the fact that the above-mentioned tectono-magmatic activity was superimposed discordantly on the pre-Mesozoic structures of various types, regardless of the time of formation of the mature continental crust, it seems reasonable to ascribe it to a substantial change in the deep-seated thermo-mechanical state of the upper mantle. A question arises, however, whether this change was world-wide or regional in character, in other words, whether or not it conforms to the general trend of the development of endogeneous processes in the history of the earth's crust. The consideration on this problem seems to help us to understand the character of the Meso-Cainozoic tectono-magmatic activity in East Asia. Thus, in the following, we examine the world-wide temporal variations of the tectonic condition and the character of magmatic activity throughout the whole of the Phanerozoic eons by analyzing the Ronov's data[14] pertaining to the quantitative distribution of principal types of lithologic associations in the whole area of the present continents except for the Antarctic.

Fig. 2 shows the results of analysis. In **Fig. 2a**, the line graph A_g/A represents the temporal variation of summation of the area assigned to the geosynclinal regions (A_g) as normalized to the total area of the present continents (A). The bar graph in the same figure represents the temporal variation of the normalized areas of marine basins which covered the geosynclinal regions (A_{gm}/A) and the platform regions (A_{pm}/A). These graphs indicate a remarkable change in the tectonic condition at the beginning of the Mesozoic time, namely a significant decrease in the area of geosynclinal regions and the corresponding decrease in the area of marine basins. This means that the completion of the Hercinian geotectonic cycle was marked by the significant augmentation of the area of platform regions at the expense of geosynclinal regions and also by the world-wide extensive regression. It is important to note here that such an extensive regression could appear only as a result of withdrawal of marine water into vast and deep depressions. Since no depression of this kind is known in the continents, it is natural to consider that those depressions were generated

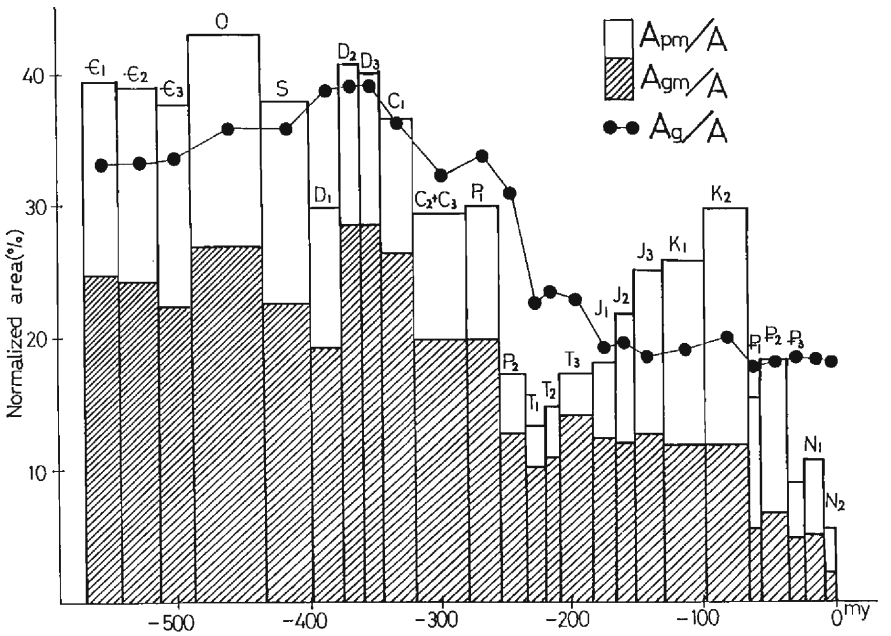

Fig. 2a World-wide temporal variation of the areas of geosynclinal regions (A_g) and marine basins covering platform regions (A_{pm}) and geosynclinal regions (A_{gm}), normalized to the total area of the present continents (A).

or regenerated somewhere within the limit of the present oceans. Thus, it is quite probable that the completion of the Hercinian geotectonic cycle was marked by a substantial change of the tectonic condition not only in the continents but also in the present oceans. However, the problem of formation of the oceanic depressions remains highly debatable, so it is important yet difficult to specify the cause of the extensive regression.

Another observation in the figure is the change of the leading factor in the temporal variation of the area assigned to marine basins: the variation of A_{pm}/A predominated over that of A_{gm}/A in the Mesozoic time, while in the Paleozoic time the latter was predominant. In particular, it is noticeable that the increase in the area assigned to marine basins of the Mesozoic age was governed by the significant subsidence of large portions of platforms. This means that these portions became significantly unstable.

In **Fig. 2b**, the line graphs represent the temporal variation of intensity of magmatic activity, I_g and I_p corresponding to the geosynclinal and the platform magmatism, respectively. The intensity of magmatic activity was estimated by computing the averaged volume of magmatic rocks that poured out during unit time over unit area. This figure demonstrates the well-known fact that the intensity of geosynclinal magmatism (I_g) has been predominant over that of platform magmatism

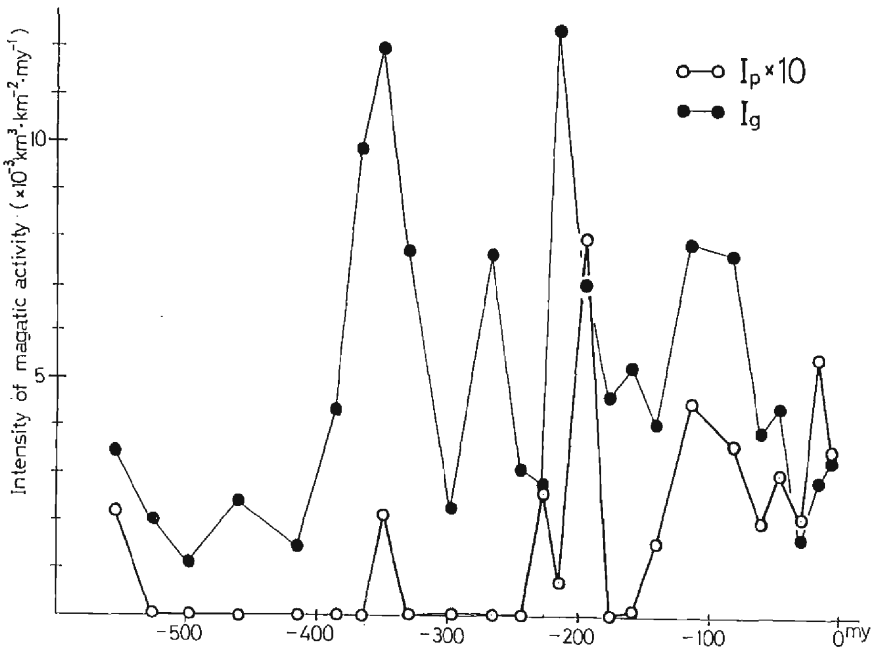

Fig. 2b Temporal variation of the intensity of magmatic activity, I_p denoting the platfom magmatism and I_g the geosyncline magmatism.

(I_p) throughout the Phanerozoic eons. The most interesting feature observed in the figure is that, against the quasi-periodical variation of intensity of the whole magmatic activity, the intensity of platform magmatism (I_p) was remarkably increased in the Meso-Cainozoic time. It should be mentioned here that this intensification took place in different periods on the different platforms and exhibited a somewhat impulsive character, that is, it appeared as a massive outpouring of magma during a relatively short period of geological time. For instance, the most conspicuous peak of I_p in **Fig. 2b** indicates the late Triassic trap magmatism that took place mainly on the ancient platform of East Africa, and the increment of I_p during the Cretaceous period indicates the vigorous magmatism mainly in South America and East Asia. Finally, the late Cainozoic maximum of I_p corresponds to the intensive magmatism that preceded or accompanied the development of continental rifts like the Arabia-Africa rift system. Nevertheless, it is unquestionable that the platform magmatism was remarkably intensified in the Meso-Cainozoic time, while in the Paleozoic time it was quite insignificant.

Accordingly, it is possible to infer from above examination that the manner of manifestation of tectono-magmatic activity was remarkably changed after the significant augmentation of platform regions at the expense of the geosynclinal regions and the world-wide extensive regression that marked the completion of the Hercinian geotectonic cycle. That is, the Meso-Cainozoic evolution of the present continents

was characterized by the widespread manifestation of epiplatformal tectono-magmatic activity which was quite insignificant in the Paleozoic time.

This close correlation between the substantial change of the tectonic condition and that of the character of magmatic activity enables us to offer a possible interpretation of the cause of these changes. It could be supposed that the shattering of the earth's crust as a favorable condition for the manifestation of ordinary geosynclines was restricted by the development of the mature continental crust which was characteristic of platform regions, while, on the other hand, the low permeability of the mature crust for magmas and hot fluids facilitated the accumulation of heat in the upper mantle, which resulted in the rejuvenation of the asthenospheric layer under the platform regions. The reason why we speak of the rejuvenation of the asthenospheric layer is that we can never visualize it as a uniform and permanently existing layer of partial melting. As well known, there is a close correlation between the present-day nature of the endogeneous regime of a given area and the degree of manifestation of the asthenosheric layer below it. Under the quiescent regions like ancient platforms, for instance, the asthenospheric layer is either manifested as a thin layer located at the relatively large depth in the upper mantle or almost absent. It seems reasonable, therefore, to consider that the change in the geotectonic regime from geosynclinal to platform corresponds, in general, to the decreasing in the degree of manifestation of the asthenospheric layer. Such being the case, the manifestation of the vigorous magmatic activity in the platform regions, especially in the ancient ones, is supposed to have been associated with the rejuvenation of the asthenospheric layer. Of course, the degree of heating of the upper mantle is governed primarily by the strength of the heat flow rising from the deep mantle. The quasi-periodic variation of intensity of the whole magmatic activity mentioned above could be attributed to the corresponding variation of the strength of this heat flow. What is emphasized here is the role of the degree of permeability of the crustal rocks as a supplemental factor of heating of the upper mantle. It should be also emphasized that the manner of manifestation of tectono-magmatic activity was governed, to a considerable extent, by the degree of permeability of crustal rocks for magmas and hot fluids. As a matter of fact, the above-mentioned impulsive character of the platform magmatism points to the specific condition that the regular supply of heat and material from the upper mantle to the surface layers was suppressed by the low permeability of the crustal rocks.

The general consideration presented above has a significant implication for the Meso-Cainozoic tectono-magmatic activity in East Asia. It is well known that, except for a few regions such as the Sikhote-Alin, the Sakhalin and the ocean side of the Japanese Islands, the ordinary geosynclinal development in the major part of East Asia was completed earlier than the Mesozoic time with the significant augmentation of the area of platform regions. This means that the tectono-magmatic activity under consideration took place mostly on the mature continental crust. At the same time, this activity can hardly be regarded as a remnant of the preceding geosynclinal

development, since it involved the ancient platforms where the formation of the mature continental crust was completed during the Precambrian age. Therefore, it seems reasonable to suppose that one of the causative factors of the activity was the renewal of anomalous heating of the upper mantle which was facilitated by the low permeability of the mature continental crust and resulted in the rejuvenation of the asthenospheric layer, as evidenced by the manifestation of vigorous magmatism. This provides a plausible explanation of the above-mentioned characteristic features of the Meso-Cainozoic tectono-magmatic activity. The discordant superimposition of the activity on the pre-Mesozoic structures and the resultant remodelling of the crustal structure can be attributed to the substantial change in the thermo-mechanical state of the upper mantle associated with the rejuvenation of the asthenospheric layer. The generation (or regeneration) of the graben-like sedimentary basins being cut by normal faults indicates that the earth's crust was under the effect of tensile forces. These forces could be also attributed to the thermo-mechanical effects of the rejuvenated asthenosheric layer. Accordingly, some basic features of the Meso-Cainozoic tectono-magmatic activity in East Asia seem to be explainable within the framework of the above-mentioned supposition concerning the mechanism of manifestation of the epiplatformal tectono-magmatic activity.

At the same time, however, it should be mentioned that some difficult problems remain unexplained. One of them is the cause and mechanism of the overall eastward migration of tectono-magmatic activity during the Meso-Cainozoic time. Probably, this migration implies the corresponding migration of the most excited part of the asthensopheric layer. Such a migration might be attributed simply to the difference in the time at which the individual portions of heated material rising successively from the deeper shells came up to the level of the asthenosphere. However, the above-mentioned specific featute that most of the graben-like sedimentary basins are unsymmetrical rather than symmetrical in shape seems to compel us to assume some oceanward flows in the upper mantle, as has long been supposed by Chinese geologists (See, Tan and Zhang[4]). It is tempting to speculate that such flows would facilitate the migration and accumulation of the anomalously heated portions of mantle material toward the transition zone where the most excited activity like the generation of marginal seas was manifested in the late Cainozoic time. As a possible mechanism of generation of these flows, a schematic model of the deep-seated mechanical processes in the mantle was proposed in the previous paper of the present writer[1]. Based on simple numerical calculations, it was suggested that the differential density current resulting from the large density contrast in the upper part of the lower mantle would induce some intensified flows in the asthenospheric layer which could be responsible for the specific features of the tectono-magmatic activity under consideration. In this connection, it is interesting to point out that upwelling of a high P-wave velocity layer has been discovered by Bugaevsky[15] within the upper part of the lower mantle beneath the East Asiatic continent. This might be associated with the differential flows such as those presumed in the previous paper.

Unfortunately, the thermo-chemical aspect of the problem, in particular, the cause and precise mechanism of the profusion of granitoid intrusion and the gradual change of the chemical composition of magmatic rocks, cannot be investigated at present. We have to be contended with remarking a few available data which seem to indicate the different stages of reworking of the mature continental crust. According to the chemical and isotopic data given by Xu et al.,[16] most of the Mesozoic granitic rocks from the inner part of South China are of crustal origin, while those from the continental margin indicate a significant role of the mantle-derived material contaminated with crustal rocks.

The remaining part of this paper will be devoted to some discussion about the plate tectonics reconstruction of the Meso-Cainozoic evolution of East Asia, which was not referred to at all in the previous paper.

4. Some Discussion about the Paleotectonic Reconstruction Based on the Concept of Plate Tectonics

Generally speaking, most of the adherents of the plate tectonics concept seem not to be seriously concerned with the general problem of classification and identification of the endogeneous geotectonic regimes. They are inclined to explain the specific features of tectono-magmatic activity exclusively in terms of interactions among some lithospheric plates. As for East Asia, to which our attention is confined, the Asiatic Plate, the Pacific Plate (formerly, the Kula Plate) and the Indian Plate (formerly, the Tethys Plate) are considered to have been relevant to its Meso-Cainozoic evolution. Although there are many divergent interpretations as to the details of paleogeographic reconstruction, it seems widely accepted that the motion of the Pacific Plate turned from northwards to westwards in the middle Paleogene at about 40 to 45 Ma. This is regarded as an inevitable conclusion so far as the hot-spot origin of the Hawaiian Islands and the age progression of the Hawaiian-Emperor seamount chain are accepted[17]. Thus, one of the premises of the plate tectonics reconstruction is that the motion of the Pacific Plate (formerly, the Kula Plate) was kept northward at least during the Mesozoic to the early Cainozoic time. However, it seems difficult to plausibly explain the specific features of the Meso-Cainozoic tectono-magmatic activity in East Asia, especially the overall eastward migration of the most excited activity and the oceanward tensile forces acting on the crust, in terms of the northward motion of the Pacific Plate. Thus, the adherents of the plate tectonics concept, who attach importance to these features, preferred the westward motion of the Pacific Plate even for the Mesozoic time. For instance, Zonenshayn et al.[5] attributed them to the increase of the slope of the westward subducting oceanic plate and the oceanward migration of the trench, as illustrated in **Fig. 3**. Later on, they have accepted the northward motion of the Pacific Plate during the Mesozoic to the early Cainozoic time, but the same diagram still has been included in their global-scale paleogeodynamic reconstructions.[18] A similar con-

clusion has been reached by Zheng[6], who has supposed that there was some difference of plate motion between the center and the boundary of the Pacific Plate, that is, northwards in the center and northwestwards at the western boundary.

At first glance, the paleotectonic reconstruction of this kind appears to plausibly explain the basic features of the Meso-Cainozoic geological history of East Asia. It should be emphasized, however, that no satisfactory explanation has yet been provided as to the reason why the Meso-Cainozoic tectono-magmatic activity in the East Asiatic Continent was superimposed discordantly on the pre-Mesozoic strucures of various types which were characterized by the predominantly EW trending movements. In order to explain this, it seems necessary, from the aspect of the plate tectonics concept, to show the way in which the Pacific Plate camp up to the situation as illustrated at the top of **Fig. 3**. It seems, however, that any paleotectonic reconstruction which is based mainly on the data from the oceans could not explain the above-mentioned peculiar feature, since there is no available data concerning the pre-Mesozoic history of the oceans.

Recently, McElhinny et al.[19] have gone back to the late Paleozoic time and have presented an alternative reconstruction of the geological history of East Asia. On

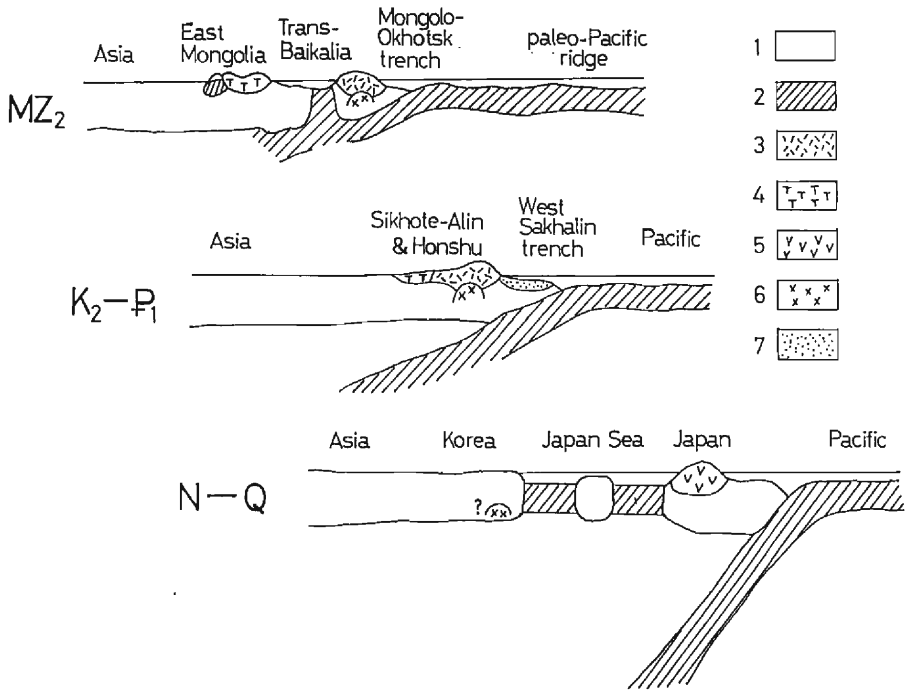

Fig. 3 Schematic diagram of the Meso-Cainozoic structural development of East Asia based on the concept of plate tectonics[5]: 1—continental lithosphere; 2—oceanic lithosphere; 3,4—subaerial volcanism (3—calc-alkalic, 4—alkalic and bimodal); 5—island-arc volcanism; 6—granitoid intrusion; 7—turbidite.

the basis of the paleomagnetic data obtained from various blocks of Asia, they have proposed that the whole Asiatic Continent was formed by the successive accretion of many fragmentary crustal blocks to the Siberian megablock during the period of time from the Permian to the Cainozoic. As for the eastern and northeastern part of the Asiatic Continent, they have divided it into six blocks; namely, from north to south, the Kolyma, the Kamchatka, the Sikhote-Alin, the Japan, the Sino-Korea and the Yangtze blocks. Taking into account the Permian paleomagnetic poles and paleolatitudes calculated for each block, they have concluded that, in the Permian time, all these blocks were situated southward far from their present positions; the Japan, the Sino-Korea and the Yangtze blocks were all situated near the Equator, while the Kolyma and the Sikhote-Alin blocks were situated somewhere near the latitude of 30°N (the Kamchatka block is missing on their paleogoegraphical map). Then, these blocks moved northward, collied with the Siberian megablock one after another, and eventually made up the whole East Asiatic Continent. Similar reconstructions have been offered by various investigators, for example, by Klimetz[20]. At first glance, these reconstructions appear to plausibly explain the above-mentioned eastward migration of the tectono-magmatic activity in terms of the successive accretion of the fragmentary crustal blocks to the Siberian megablock. It should be noted, however, that no satisfactory explanation has yet been provided as to the reason why each of the crustal blocks was able to migrate northward with different speeds and different rates of rotation, whereas they all were displaced equally passively over the surface of the Kula Plate. In order to answer this question, it seems necessary, from the aspect of the plate tectonics concept, to assume that the Kula Plate was subdivided into several microplates by several spreading ridges which also migrated northward. A question arises again, however, what kind of forces could drive the northward motion of the Kula Plate which included several spreading redges. In this case, it is evident that the mantle convection, which has originally regarded as an important driving mechanism of ocean floor spreading,[21),22)] was unable to drive the plate, because its global pattern is generally considered to be fairly stable during a long period of time. This means that the lithospheric plate must have been driven into motion, if it actually moved, by the forces other than the drag forces flom below, for example, by the pulling force from its subducting part[23)]. If so, what was the cause of the bearkup and dispersion of the Pangaea Megacontinent?

5. Summary

In this paper, the character of the specific Meso-Cainozoic tectono-magmatic activity in East Asia was investigated by taking into account the world-wide temporal variation of the tectonic condition and that of the character of magmatic activity throughout the whole of the Phanerozoic eons. It was suggested that this specific activity could be regarded as a manifestation of the epiplatformal tectono-magmatic activity which was associated with the rejuvenation of a large-scale asthenospheric

layer under East Asia. It was emphasized that the low permeability of the mature continental crust which characterized the major part of East Asia was an important factor that facilitated the rejuvenation of the asthenospheric layer and governed the manner of manifestation of the tectono-magmatic activity. In this sense, the present writer is inclined to agree with the opinion that the activity under consideration is a manifestation of the endogeneous geotectonic regime qualitatively different from the geosynclinal regime, though the thermo-chemical aspect of the deep-seated processes remains open to discussion.

Two currently well known versions of the paleotectonic reconstruction based on the concept of plate tectonics were critically examined and it was pointed out that they have not yet provided any satisfactory explanation of the peculiar features that characterized the Meso-Cainozoic evolution of East Asia.

Acknowledgement

The present writer wishes to express his sincere thanks to Dr. Tatsuhiko Wada of Faculty of Science, Kyoto University, who gave much valuable advice and encouragement during the course of this study.

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