MEMOIRS OF THE COLLEGE OF SCIENCE, UNIVERSITY OF KYOTO, SERIES B,
Vol. XXIII, No. 2, Article 1, 1956.

Cyclic Nepton Group of Kinki Area, Japan

By

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(Received Sept. 24, 1956)

Abstract

The geanticlinal quasi-cratonic basins are the sites of the young sedimentary bodies forming a nepton group. Every column of the neptons reveals a pile of incomplete cyclothems. An account of epicyclic development of a partial nepton of the group born in a small basin Ikoma valley near Nara is given for example. A hypothetical origin of such an epicyclic construction is spasmodic movements of the foundation.

Introduction

The definition of nepton and its connective terms used in this paper were given in a former paper entitled "Syntectonic construction of geosynclinal neptons" (MAKIYAMA, 1954),

The geographical name "Kinki" seems to be unfamiliar to foreigners. The word means "provinces near the capital", but, it is wider than "suburban districts". This area covers two urban prefectures Kyoto and Osaka, and five prefectures Shiga, Mie, Nara, Wakayama and Hyôgo. There are several topographic basins in the area, but the Osaka, Kyoto (Yamashiro), Nara (Yamato) and Shiga (Oomi) basins are more important than the others. These are elliptical in plan and surrounded by hills of the late Mesozoic granites and the late paleozoic sedimentary rocks. About half of the Osaka basin is now submerged under the sea (Osaka bay). Lake Biwa is a fresh-water pool in the Shiga basin.

Not only once the sea water has spread over the wider areas than the present Osaka bay during the Pliocene and Pleistocene times. These basins are sites of the nepton group. It is not intentional to discuss here the geological ages and correlation of the strata deposited in the different quasi-cratonic basins. The chief object of this paper is to give a three-dimensional picture of individual neptons the Pliocene and Pleistocene sedimentary bodies. Although the stratigraphy of these veneers of sediment over the quasi-cratonic basement has been worked out by students in this region, it is still premature to come to a final conclusion about the inter-basin correlation.

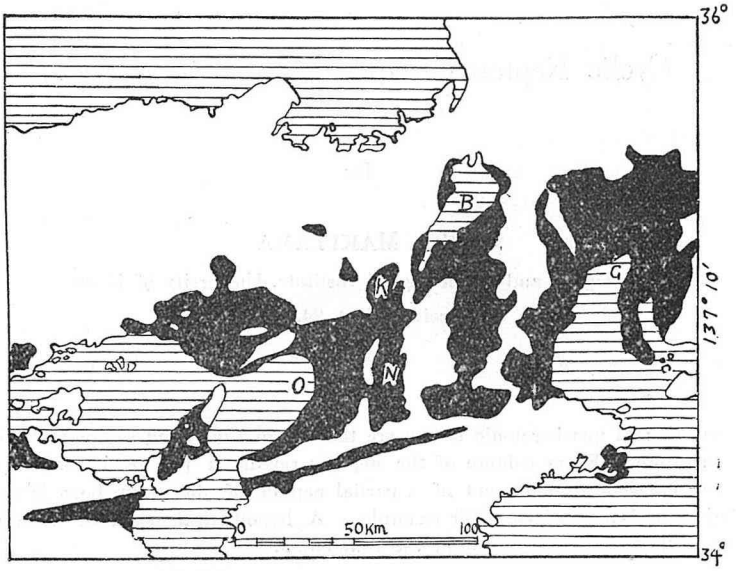

Fig. 1. The nepton group of quasi-cratonic basins in Kinki area, O, Osaka; K, Kyoto; B, Biwa lake; G, Nagoya; N, Nara.

General View

Physical conditions prevailed at the begining of the nepton development were probably not the same as at present, but the change after that time seems to have been not so violent as revolutionary. The continuous change involves vacilating positive and negative movements of the basement which is divisible into various tectonic elements. The tectonic elements are classified in two types of tectotope, namely the basins and hill ranges. The quasi-cratonic basement has been deformed by stress reacted to unknown orogenic forces, so that it has upfolded to make ground-swells dividing the basins. These up and down folds of the quasi-cratonic land surface have given birth of the young nepton group in this area.

The epicyclic movements are inferred from the fact that the neptons are made of several cyclothems. The intense studies by Kyoto and Osaka students have revealed construction of the nepton occupies the Osaka basin. Each cyclothem is by no means complete, but normally it consists of the arenaceous current-bedded lower part and the argillaceous lacustrine or marine upper part. Pyrozones (Makiyama, 1953) are very helpful key beds for the field geologists, especially socalled "Azuki tuff" being specified with its peculiar dark purple coloration and its bone-like vitreous constituents, is the unique mark of the cyclo-

them to which it belongs. The paleontological criteria are rather poor, but mollusks and diatoms indicate past biotopes comparable to those of present bay waters, estuaries, ponds and lakes in this area. Seven cyclothems are detected in the hills north of Osaka. The nepton of Osaka basin has at least 11 cyclothems (at most 16), of which the topmost one is now under construction (the Recent, includes the neolithic relics).

Ikoma Valley

The nepton of Nara basin is similar to the above example, except that apparently it has no salt water deposit. Some cyclothems in the standard column of Osaka basin are lacking here. For instance, the cyclothem with the Azuki tuff has not been shown to extend to this basin. The west margin of the Nara basin is making a narrow meridional partial basin of Ikoma subdivided by Matsuo hills. The partial nepton of Ikoma valley consists of four cyclothems named "Ikoma Cyclothem I. II, III and IV" respectively. The lowest member Ikoma

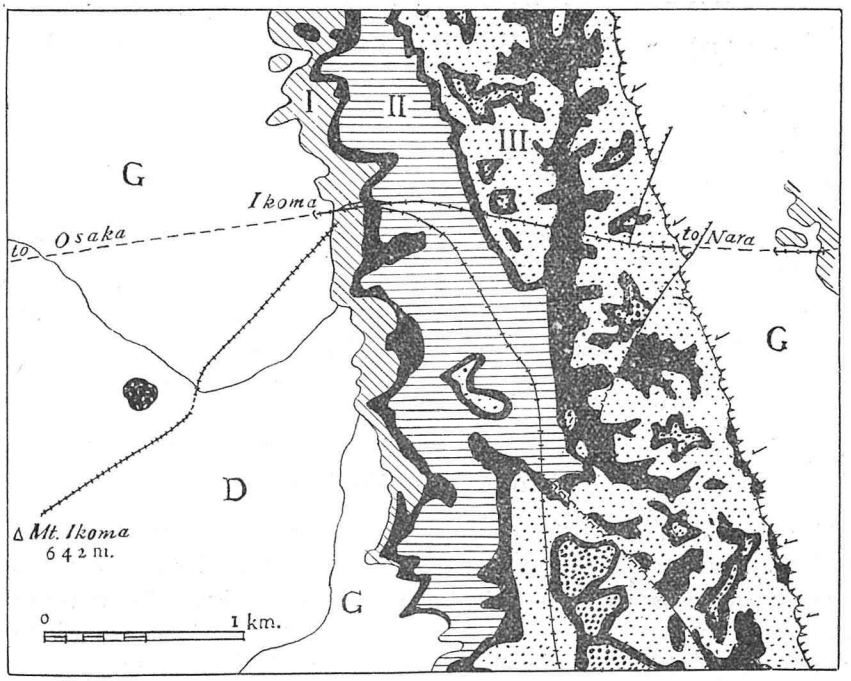

Fig. 2. Geological map of Ikoma basin, Nara prefecture, showing the Ikoma partial nepton of the Kinki Plio-Pleistocene nepton group. G, acid plutonics; D, basic plutonics. I, II, III, Ikoma cyclothems. Black, each argillaceous member. Black with white flakes, andesite neck. Mt. Ikoma (642.3m) is at N 34°41′, E 135°40′.

Cyclothem I is characterized by its arkosic lithology, while the others are felspathic in lithologic association. This speciality seems to be not general to the corresponding strata, inasmuch as any cyclothem, which directly overlies the granitic basement elsewhere near the margins, is rich in arkose. Diastems beween cyclothems have been thought as mere comtemporaneous erosions. Erosion phases of epicycles must not be overlooked in considering the building process of the nepton. In this connection, each extension of cyclothem in various basins also must be deciphered carefully.

Mt. Ikoma to the west and Matsuo hill range to the east of the narrow basin, it has heen erroneously thought to be a graben or a corner of a tilted block. Really the hills are upfolds with clean-cut thrusts. The relief of the basement surface was progressively reinforced during the development of the Ikoma cyclothem. After the cyclothem IV was deposited, the east mass—Matsuo hills—has been broken, forming a wedge of the basement rocks thrust over the epidermic partial nepton. The quasi-cratonic crustal deformation of the Kinki area since the Pliocene was compressive in general; and there is no positive criterion to prove a general tensile effect. The foundation folding is shown not only by observation around Ikoma valley, but also on the other parts of the nepton group.

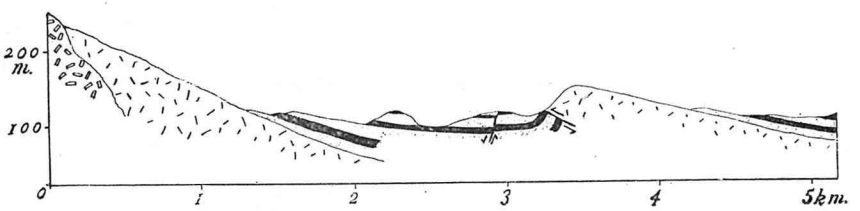

Fig. 3. E–W section, Ikoma basin, cf. fig. 2.
The section cut through Ikoma station and parallel to the top line of the map.

Foundation Folding

The concept of foundation folding was a prognosis induced by observations of various features of the earth's crust (Argand, 1909), But, its application to the quasi-cratonic basement of Kinki area is simply shown by a topographic semblance of the hilly uplands. The west slope of Mt. Ikoma has been deciphered as a fault scarp (Cushing, 1913; Tsujimura, 1943; Makiyama, 1926). However, thorough examination of the slope for many years by the writer and his assistants did not make sure the assumption. There is no normal fault ascertained by geological evidences; but there are a few thrusts along the foothill. The net shifts of these faults do not match the slope. The throw or the vertical

component of the dip shift is scarcely 20 m measured near at Kusaezaka (west entrance of Ikoma tunnel, K. N. Railway), while the slope is about 400 m high in an average.

A transverse profile of Ikoma range will show the general outline of the foundation fold. To eliminate minor topographic configurations due to erosion, a zonal transverse section is prepared, instead of an ordinal linear section. Only the maximum altitude in each quadrangle set suitably along the section line may assumedly represent the point upon the initial ground. The zonal profiles (fig. 4) exhibit asymmetrical gentle upfold of Ikoma range. The west slope is a little steeper than east, but there is no step remindful of a fault scarp.

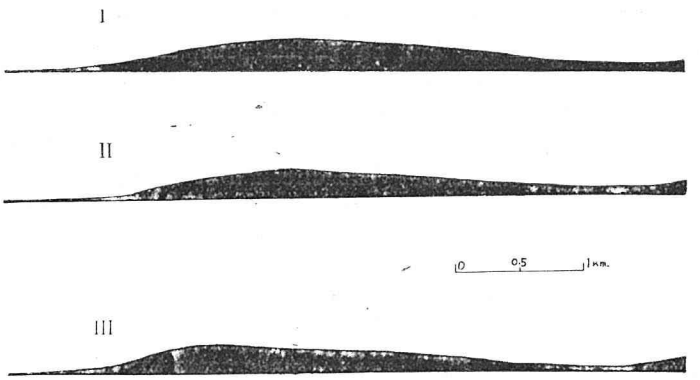

Fig. 4. E–W zonal profiles of Ikoma range. (100m width)

The possibility of the peneplanation before the sedimentation of the nepton has been substantiated by geologists. However, hills in bas-relief were incipient up-folds. The foundation folds were emphasized continuously during the growth of nepton. The synclinal depression between two parallel foundation upfolds became the basin to accept the cyclic sedimentation.

If the movement was perfectly continuous without interrupted by any action, a complete monocyclic nepton would be made in the basin. Was the movement disruptive, then? Alternative positive and negative movements might have been assumed to explain the process of polycyclic construction. Epirogenic up and down movements indifferent to the foundation folding are by no means impossible. The past oscillation of sea-level since the Pleistocene may also be computed, but no evidence to show the similer changes during the Pliocene times has been disclosed as yet.

Another hypothesis that the orogenic movement would have been intermittently accelerated and retardated seems to be natural. A time strain curve of creeping examination with a polycrystalline metal is scalated in detail. The interruption is supposed to due to the hardening. However, the average amount

of interruptions is too small to compare with an epicycle of sedimentation. Although, with deformation of rock in the geological scale, the phenomenon inside a crystal cannot be neglected, practically no aggregate value has been estimated, More important reactions unveiled to science may be aroused during the rock deformation.

Cylindrical Thrust

The Paleozoic geosynclinal sediments in the Kinki area have been intensely folded to accomplish the isoclinal structure, which was intruded later by the acid igneous rocks. The surface of this secondary foundation was uneven in the Miocene, giving a scenery like the present inland sea "Seto-Uchi". Afterwards, it has been degradated, but no perfect peneplane has existed at the begining of the Pliocene. The unstable geanticlinal mass moved ever since the Pliocene. Thus the low initial hills were elevated by compression. The foundation folding is a result of lateral shortening, for it accompanies thrusts, and its sedimentary epidermis is shriveled. The direction of compression around Ikoma is assumed to be latitudinal, so as the general trend of foundation folds is meridional. This direction is quite different from the regional compression in the geanticline of Japan, but is a localized effect of the general operation.

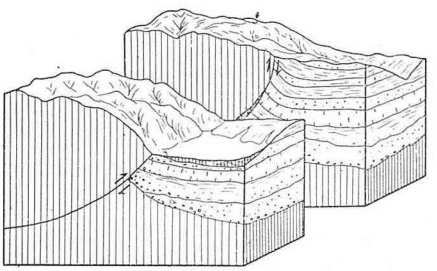

Fig. 5. A prototype of cylindrical faults.

It is not very difficult to show theoretically, that the thrust developed underneath the upfold have a curved surface, facing the concave side upwards. The strike of the thrust is the same as that of the fold, while the dip is reverse to the slope. Similar shearing breaks in small masses of homogeneous materials under compressive forces were revealed by some experiments. (fig. 6). If the initial swell is symmetrical with high steep slopes, then a pair of symmetrical breaks will appear under the lateral compression. The curved surfaces of rupture are

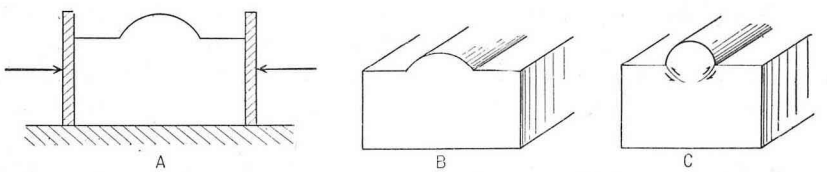

Fig. 6. Shearing breaks of a homogenous matrix under compression.
A. Scheme of experiment.
B. Before operation.
C. After compression.

almost vertical above and low-angled below. These are the cylindrical thrusts.

Mt. Rokko of Kobe is an example of the symmetrical hill with a pair of cylindrical thrust. The vertical top end appears as part of a normal fault in a small exposure. In Daigoyama near Kyoto, a cylindrical thrust line runs along the west slope. At outcrops in a high level, the thrust is very high-angled. The profile of Ikoma is asymmetrical, and there is only one main thrust along the steeper west slope.

Syntectonic Construction of cyclothems

Epicycles of minor submergence and emergence during the growth of nepton are reprsented by alternating cyclothems. A series of minor cyclothems less than 50 m in thickness, such as those of the Kinki nepton, may be built simply by oscillation of the sea-level; and this can be true at least for the Pleistocene parts of the nepton. However, the foundation folding gave many effects to the young sediment as shown by folds and faults not uncommon in the nepton. Therefore crustal movement cannot be disregarded in the consideration.

It has been generally assumed that alternative up and down movements are responsible for epicycles of sedimentation. Although such minor fluctuations as observed on the beaches of Japan by seismologists are not comparable with the epicycles of the past, oscillatory epirogenic movements of coasts are the most possible phenomenon ever happened. The hypothesis is evidently more adoptable for the continents than for the geanticlines. The cyclothems formed upon the continental shelves and intra-cratonic basins may appear very much like the quasi-cratonic cyclothems deposited in the sags upon a mobile geanticlinal bulge. The quasi-cratonic environment is a situation where the orogenic movement overbalance the epirogenesis.

Seeing that the foundation folding was continuously progressive during the construction work, another hypothesis that alternating high and low rates of tectonic intensity show the cause for the epicyclic development of the quasi-cratonic neptons. In this assumption, a time strain curve will show a scalar configurations.

The spasmodic progress of positive movement would have aroused repeated rejuvenescences of erosion on one side and rapid accumulations of clastic sediment on the other. The elevations of the upfolds most probably synchronize the depressions of the basins, though an absolute amount of each vertical negative movement did not match with that of a positive movement, as it be a nature of the surface folding of the earth's crust.

Immediately after a submerging incident in the low-lands, rejuvenated streams transported coarse sediment from the high-lands to the bays and pools. Current-bedded coarse to medium-grained felspathic sands were deposited in this phase, which was followed by a marshy circumstance corresponding to the stage of

declining supply of sediment. Even though the tectonic intensity was accelerated intermittently, sagging work of the basins was continuous any way. The stable marsh land condition may have prevailed untill the second accelerated movement began. Variable sediments, such as fine sand, sandy silt, sandy clay, lacustrine clay and lignite are the product of the marshy phase.

Ingress of the sea water was the final result of a negative movement in the Osaka basin. The salt-water has also invaded the Kyoto basin several times. It is detected in Fushimi and East wards of Kyoto city, that about a meter thick middle part of a clay bed contains molluscan remains lived in the sea. Core examination of a 500m test well at Kônoike-Shinden east of Osaka reveals sediment deposited under the sea surpass the other part in the total thickness. This fact tells that the sea was more persistent here than in other parts of the basin, inasmuch as the place is at the center of the Osaka basin.

The massive or shaly muddy marine strata is overlaid by the coarse sediment of the following cyclothem. This basal part of the next cyclothem is deltaic foreset beds on one side, or current-bedded fluviatile sands on the other. A slight erosion interval intervenes between any two adjacent cyclothems at places. Some cyclothems have been totally removed by erosion, wherever near the margins of the basins far from sea shore. In this last case, the diastem is usually well distinguished by the uneven erosion surface, the clay pebbles and boulders and the abrupt change in lithology. Fanglomerate wedges being the products of ungraded streams pass into the sand beds of the first phase in the main portion of the basin.

Another working hypothesis, that simple gradual orogenic movement and *pari passu* settlement of loose sediment are capable to build such a cyclic formation, seems to be not substantiated. Physical properties of the core samples from Kônoike-Shinden test well do not show any notable compaction has taken place after the deposition (Murakami, 1950). A theoretical volumetric estimation of the subsidence necessary to overcome the filling is incompatible to the facts.

Conclusion

The basement rocks as a polycrystalline plastic (pseudo-viscous) material may flow under a continuative stress condition. The creep is seemingly a continuous motion, but presumably spasmobic in detail, as it will be shown by a scalar time strain curve. The surfacial effect of the creeping rocks under compression is the foundation folding. The cyclic neptons deposited in the sagging basins have the structure related to the movement of the foundation.

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