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11. *Three-layered Distribution of Microearthquakes in Relation to Focal Mechanism Variation in the Kii Peninsula, Southwestern Honshu, Japan.*

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Abstract

Microearthquakes in and around the Kii Peninsula, southwestern Honshu, Japan, have a three-layered hypocentral distribution as presented by the upper crustal, the transitional and the subcrustal seismic zones. Earthquakes of the upper crustal seismic zone are mainly distributed in the northwestern part of the Kii Peninsula at depths of 3-10 km. Their focal mechanisms under the east-westward compression suggest an overwhelming influence of the subducted Pacific plate. On the other hand, earthquakes of the subcrustal seismic zone are distributed with an extensive area coverage over the Kii Peninsula at depths of 35-80 km showing an inclination dipping towards the northwest. The focal mechanisms of the earthquakes in the subcrustal seismic zone indicate either the north westward compression or the northeast-southwestward extension related to the subducted Philippine Sea plate.

In the southern part of the Kii Peninsula, the transitional seismic zone at depths of about 15-35 km is separated from the upper crustal and the subcrustal seismic zones. The different types of focal mechanisms in the transitional seismic zone are classified into two groups belonging to the shallower depth range of 15-25 km and the deeper depth range of 25-35 km. The former tends to be common to the type in the upper crustal seismic zone, while the latter to that in the subcrustal. The complicated focal machanism variation in the transitional seismic zone suggests a mechanical instability on both sides of the Mohorovičić discontinuity at depths around 20-25 km, where the stress field might be abruptly changed. The restricted area coverage of the transitional seismic zone in the southern half of the Kii Peninsula may indicate that the subducted Philippine Sea plate decouples with the overriding continental crust in the northern half of the Kii Peninsula.

1. Introduction

A systematic alignment of the tension axes for the focal mechanisms of the subcrustal earthquakes in southwestern Honshu was shown by SHIONO (1977) as being closely related to the subduction process of the Philippine Sea plate. MIZOUE (1977) compiled the seismicity data provided by J.M.A. (Japan Meteorological Agency) to clarify the regional mode of the subcrustal earthquake distribution running parallel to the Nankai trough. A map of isobaths of microearthquake foci revealed the northwestward dipping of the Philippine Sea plate with its leading edge penertating into depths of more than 70 km beneath the central part of the Kii Peninsula (MIZOUE, 1977).

The crustal and the upper mantle structure in the Kii Peninsula has been studied from travel time analyses of seismic waves recorded by high sensitivity seismic stations (KANAMORI and TSUMURA, 1971 ; MIZOUE, 1971 ; SHIONO, 1974 ; MIZOUE, 1977 ; HURUKAWA, 1981). HURUKAWA and HIRAHARA (1980) made an approach for studying the structure of the Philippine Sea plate by setting up a small array in the central part of the Kii Peninsula. They found remarkable later P phases showing that the interface between the Asian and the Philippine Sea plate was a thin, low velocity zone, dipping northwestward with an angle of about 40°. Recently, HORI *et al.* (1982) discussed the low velocity layer originating from the oceanic crust in the uppermost part of the Philippine Sea plate. HASHIMOTO (1980, 1981) showed the three dimensional stress distribution in the southwestern Japan by using a finite element method. He presented two different models, i. e. one preserves a tight contact between the subducting Philippine Sea plate and the overriding continental plate, while the other has a weak contact between the two plates. The latter was found to be a preferable model to explain the observed focal mechanism variations. It was indicated from the analysis that the observed extensional stress parallel to the leading edge of the subducted Philippine Sea plate may be caused mainly by a negative buoyancy, suggesting that the plate seemed to sink down into the mantle by its own weight.

In this paper, we study the detailed structure of the hypocentral distribution of microearthquakes in the Kii Peninsula in relation to the variation of focal mechanisms based on the accurate hypocentral data obtained from the telemeter network since July 1980. A seismic zone near the Mohorovičić discontinuity is specified at depths between the pronounced upper crustal and subcrustal seismic zones. The types of the focal mechanisms in these seismic zones are compared to see the mechanical interaction between the subducted Philippine Sea plate and the overriding continental crust.

2. Network system for microearthquake observation

The telemeter network for microearthquake observation shown in Fig. 1 has been in full operation since July 1982 by the Wakayama Microearthquake Observatory, E.R.I. (Earthquake Research Institute, Tokyo University). The network covers the entire Kii Peninsula and its adjoining regions with 16 stations equipped with short period, three components seismograms. The overall frequency characteristics of the seismograms have a flat response for the velocity of ground motions in the frequency range of 1-10 Hz as shown in Fig. 2. The station coordinates and magnifications at 1 and 10 Hz are listed in Table 1.

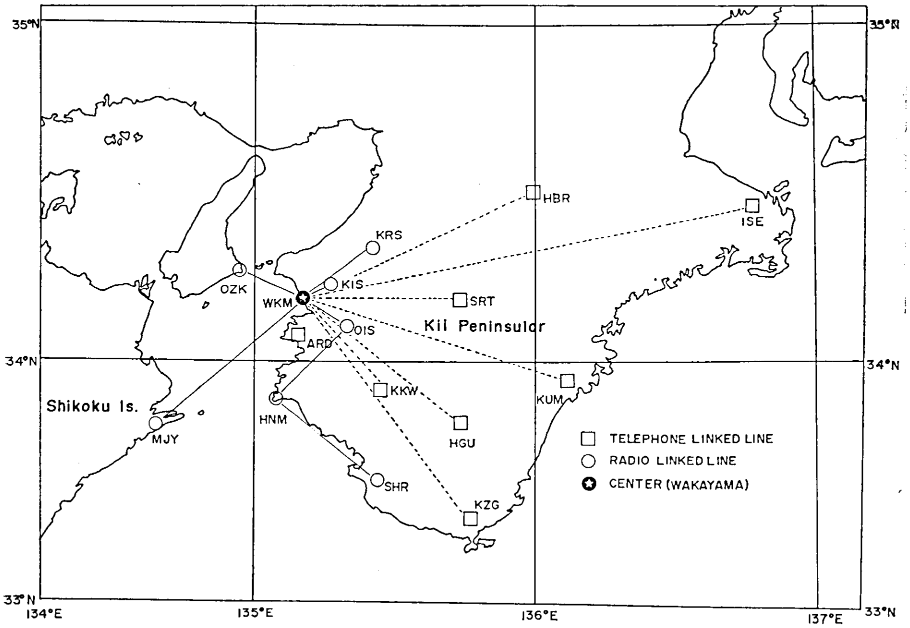


Fig. 1. Location of seismic stations for microearthquake observation in and around the Kii Peninsula operated by the Wakayama Microearthquake Observatory, E. R. I. (Earthquake Research Institute, Tokyo University) since July 1982.

At each station, the seismic signals are converted to a digital form of 10 bits/sample at a rate of 120 samples/sec and transmitted to the central receiving station WKM with a compressed form of 8 bits/sample. Each of the radio or wire telephone lines linking the satellite stations with the central station has a data transmitting rate of 9600 bits/sec, which is equivalent to 8 channel seismic wave form signals. Four channels among the eight assigned to a line are occupied by a vertical and two horizontal components of high magnification and an additional low magnification vertical component. The specification of data form gives dynamic ranges of 90 db and 60 db for the vertical and the horizontal component signals, respectively. In the ordinary times, the other four channels are not used for routine observation and are prepared for temporal observations by setting

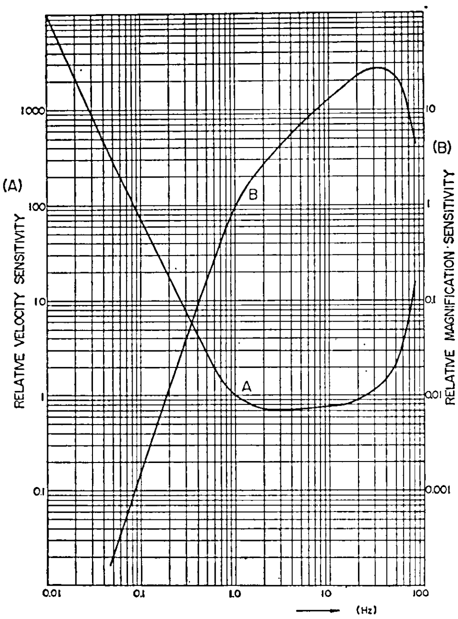


Fig. 2. Overall frequency characteristics of seismographs for (A) relative velocity sensitivity and (B) relative magnification.

Table 1. Station coordinates and magnifications of seismographs.

STATION NAME	CODE	CO-ORDINATES			PICK UP		AMP. GAIN (DB)	VELOCITY SENSITIVITY (μKine/mm)		MAGNIFICATION SENSITIVITY	
		LATITUDE	LONGITUDE	H (KM)	PERIOD (sec)	DAMP. h		1 Hz	10 Hz	1 Hz	10 Hz
WAKAYAMA	WKM	34° 11′ 27.″30	135° 10′ 02.″30	0.005	1.0	0.7	60	11	8	6000	76000
KISHINOMIYA	KIS	34 13 19.30	135 18 00.00	0.075	"	"	60	11	8	6000	76000
OISHIYAMA	OIS	34 06 05.30	135 19 18.60	0.840	"	"	54	22	16	3000	38000
ARIDA	ARD	34 05 09.20	135 09 42.20	0.041	"	"	60	11	8	6000	76000
OISHIZAKI	OZK	34 15 52.31	134 57 09.10	0.112	"	"	54	22	16	3000	38000
KATSURAGISAN	KRS	34 20 40.20	135 26 35.50	0.830	"	"	54	22	16	3000	38000
HINOMISAKI	HNM	33 52 55.80	135 03 59.70	0.189	"	"	54	22	16	3000	38000
MYOJINYAMA	MJY	33 48 05.00	134 38 47.90	0.380	"	"	54	22	16	3000	38000
SARUTANI	SRT	34 11 24.16	135 44 11.41	0.447	"	"	60	11	8	6000	76000
KAINOKAWA	KKW	33 54 03.08	135 26 56.11	0.235	"	"	60	11	8	6000	76000
SHIRAHAMA	SHR	33 37 47.02	135 24 39.45	0.170	"	"	54	22	16	3000	38000
HONGU	HGU	33 49 21.89	135 45 53.48	0.185	"	"	60	11	8	6000	76000
KOZAGAWA	KZG	33 32 12.90	135 45 42.10	0.020	"	"	60	11	8	6000	76000
KUMANO	KUM	33 57 15.10	136 06 30.70	0.325	"	"	60	11	8	6000	76000
ISE	ISE	34 27 30.60	136 46 26.30	0.440	"	"	60	11	8	6000	76000
HAIBARA	HBR	34 30 10.00	135 59 36.10	0.390	"	"	60	11	8	6000	76000

up a local network connected with a permanent station shown in Fig. 1. The compressed data forms are transformed back into the original form of 10 bits/sample data and used for the succeeding processings of automatic time picks and preliminary hypocentral determinations.

The data processing system consists of three subsystems closely associated with one another as shown by the schematic block diagram in Fig. 3. The No. 1 subsystem produces preliminary data of P and S arrival times, hypocentral coordinates and magnitudes. These processed resultes are revised through the No. 2 subsystems to improve the accuracy and reliability of the data. Digital data of seismic signals are stored on magnetic tapes together with the arrival times and hypocentral coordinates. The No. 3 subsystem is available for the off-line interactive processing to revise the preliminary data produced by the No. 2 subsystem. The precision of time markings given by the system is within an error of 30 milliseconds.

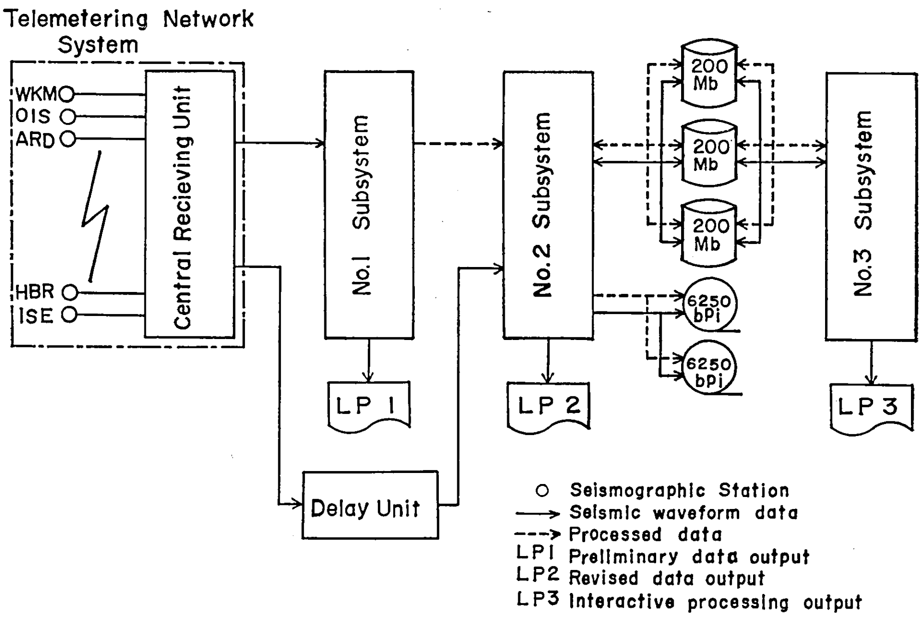


Fig. 3. Schematic block diagram of the data processing system for the microearthquake observation of Wakayama Microearthquake Observatory, E. R. I. consisting of the three subsystems designated as No. 1, 2 and 3.

3. Microearthquake distribution

During the period from January 1965 to June 1980, microearthquakes in and around the Kii Peninsula were located by the conventional type network of entrusted stations equipped with a helical drum recorders (MIZOUE, 1971). Long continued swarm activities of shallow earthquakes were detected by the observation in the northwestern part of the Kii Peninsula within a layer of 3-10 km in depths with the largest earthquakes around M5.0. Lineations of epicenters in the region are trending in the NE-SW and NW-SE directions. They are in good agreement with focal mechanisms of both strike slip and reverse faultings under the well established E-W compressional tectonic stress field in the upper crust (MIKUMO *et al.*, 1970; MIZOUE *et al.*, 1973; MIZOUE and NAKAMURA, 1976). A strike slip fault system trending in the NE-SW direction with a length of about 10 km has been confirmed by the aftershock activities accompanying the periodical occurrences of earthquakes of M 4.7-5.2 at intervals of 8-15 years (MIZOUE *et al.*, 1978).

As a more extensive mode of seismicity, remarkable activities of subcrustal earthquakes were found in the central and southern parts of

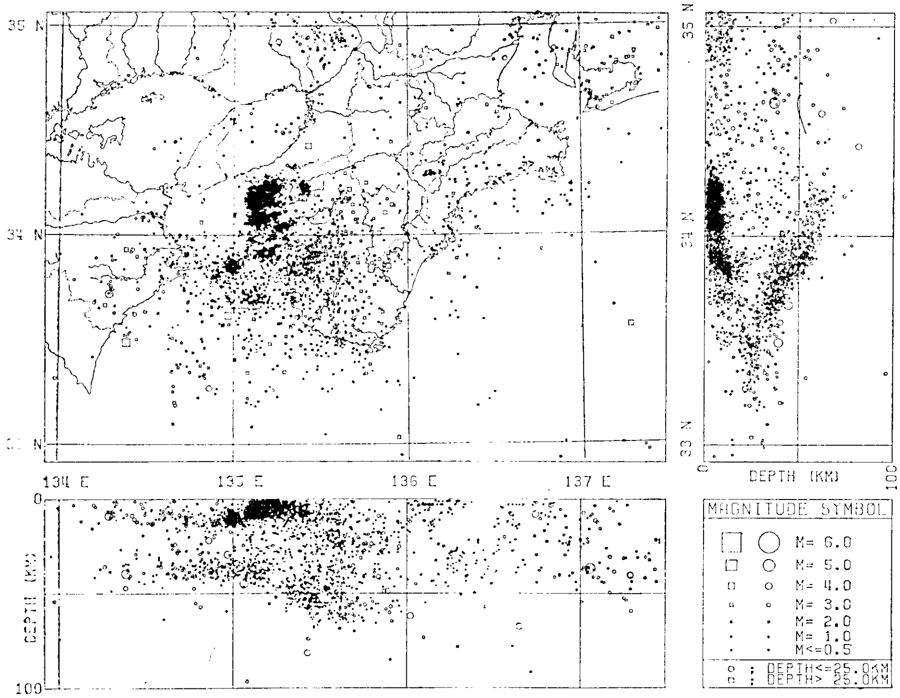
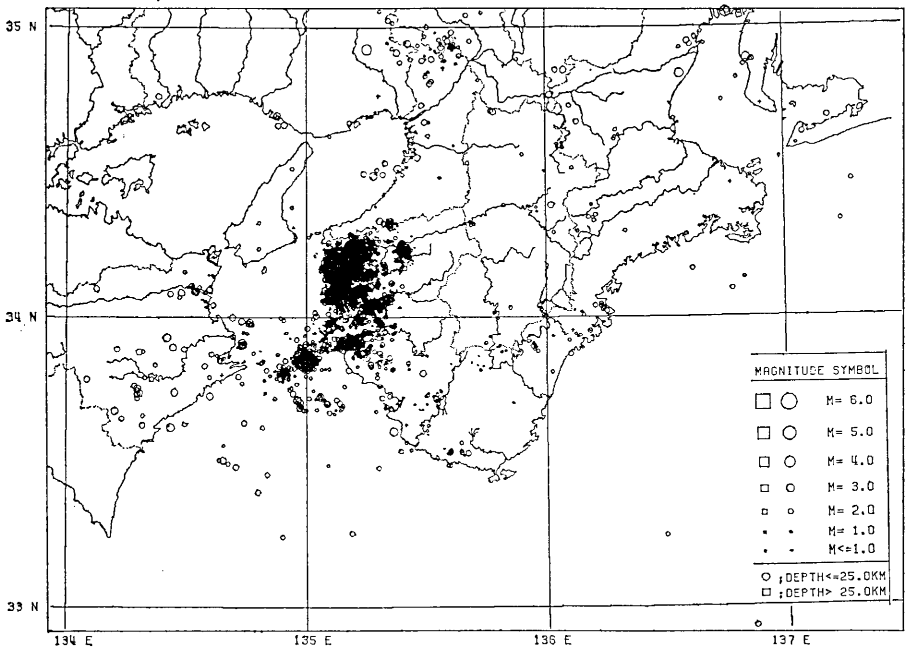
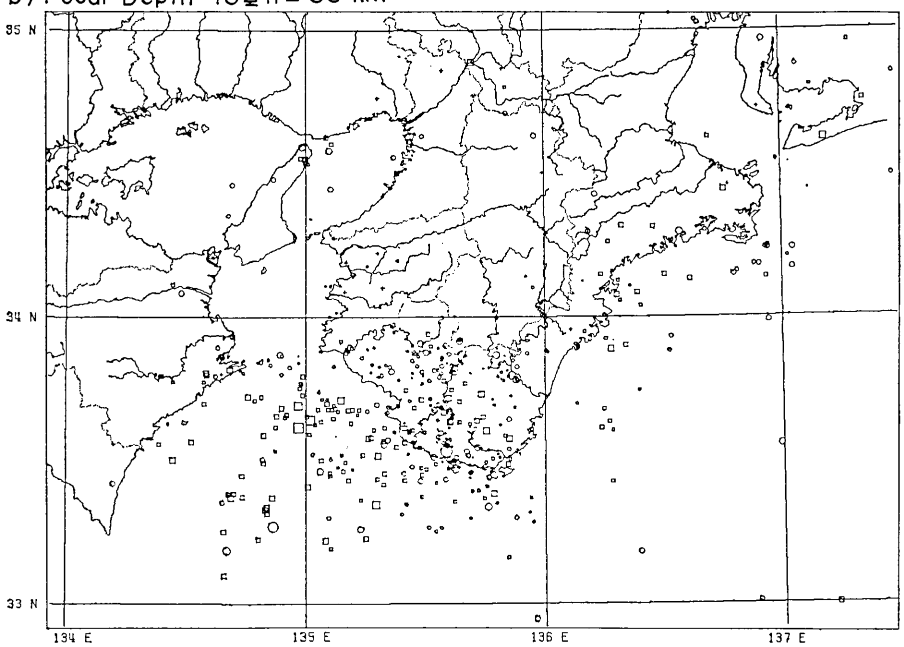


Fig. 4. Epicentral and focal depth distributions in and around the Kii Peninsula for the period from August 1980 to December 1982. Hypocenters are projected on the vertical cross-sections in the E-W and N-S directions. Focal depth and magnitude classifications are given by the symbols in the legend. Note that upper crustal earthquakes at depths less than 10 km are clearly separated from the subcrustal ones at depths of more than 35 km.

a) Focal Depth $0 \leq h < 15$ km



b) Focal Depth $15 \leq h < 35$ km



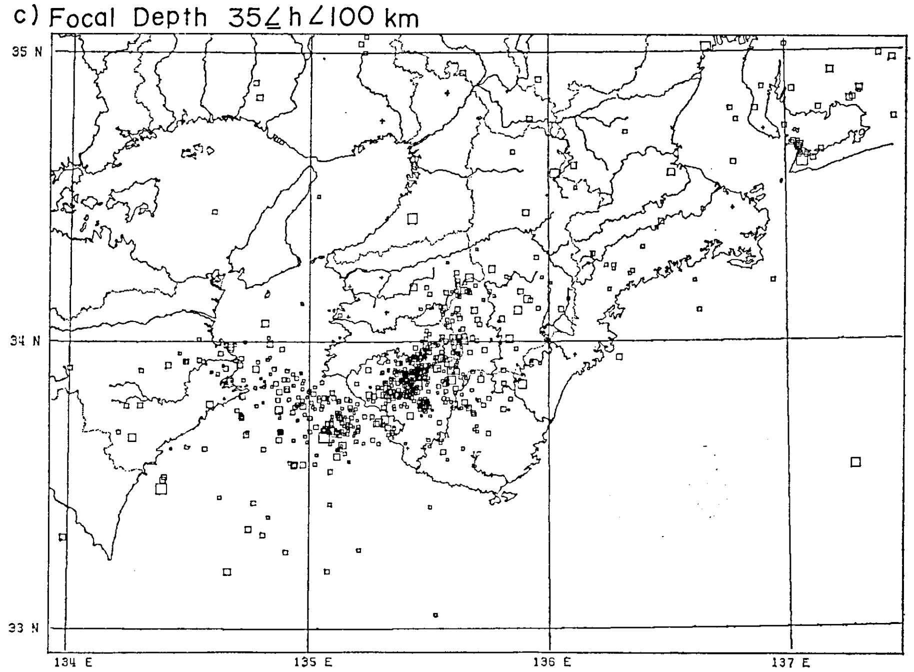


Fig. 5. Epicentral distributions for different depth ranges in and around the Kii Peninsula for the period from August, 1980 to December, 1982; (a) 0≦h<15 km, (b) 15≦h<35 km and (c) 35≦h<100 km.

the Kii Peninsula. Hypocentral data accumulated through observation since 1965 were compiled in a map to present the regional mode of the subcrustal earthquake distribution in such manner as shown by isodepth of earthquake foci (MIZOUE, 1977). It was confirmed that the subcrustal earthquakes have a systematic zonal arrangement generally striking parallel to the Nankai trough. A northwestward penetration of subcrustal foci can be interpreted by the subduction of the Philippine Sea plate with the evidence of the focal mechanisms indicating either the NW-SE compression or the NE-SW extension. The epicenter and vertical distribution of microearthquakes obtained by the new network are shown in Fig. 4 for the period from August 1980 to December 1982. Epicentral distributions are given for the three different depth ranges of 0-15 km, 15-35 km and 35-100 km as shown in Fig. 5. In the first range of focal depth of 0-15 km, most of the microearthquakes are located in the northwestern part of the Kii Peninsula showing an intensive swarm activity in and around Wakayama city. In the second range of focal depth of 15-35 km, microearthquakes are distributed in the southern part of the Kii Peninsula though the seismicity is considerably less active than those in other ranges of focal

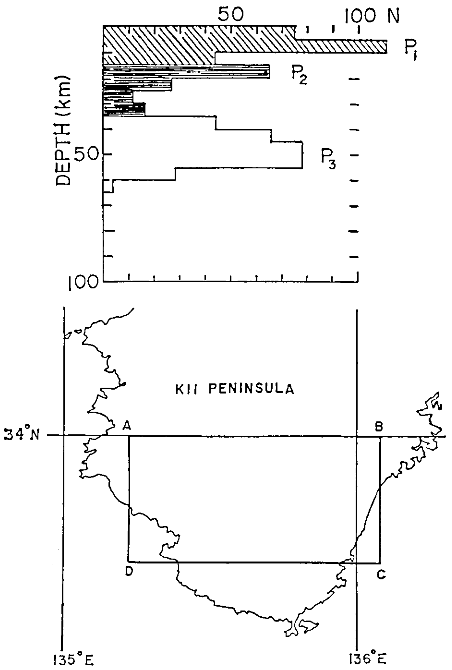


Fig. 6. Depth variation of microearthquake number N (upper figure) in the area enclosed by the rectangle ABCD (lower figure) in the southern part of the Kii Peninsula. The peaks of microearthquake number P_1, P_2 and P_3 correspond to the seismic activities in the upper crustal, the transitional and the subcrustal seismic zones, respectively.

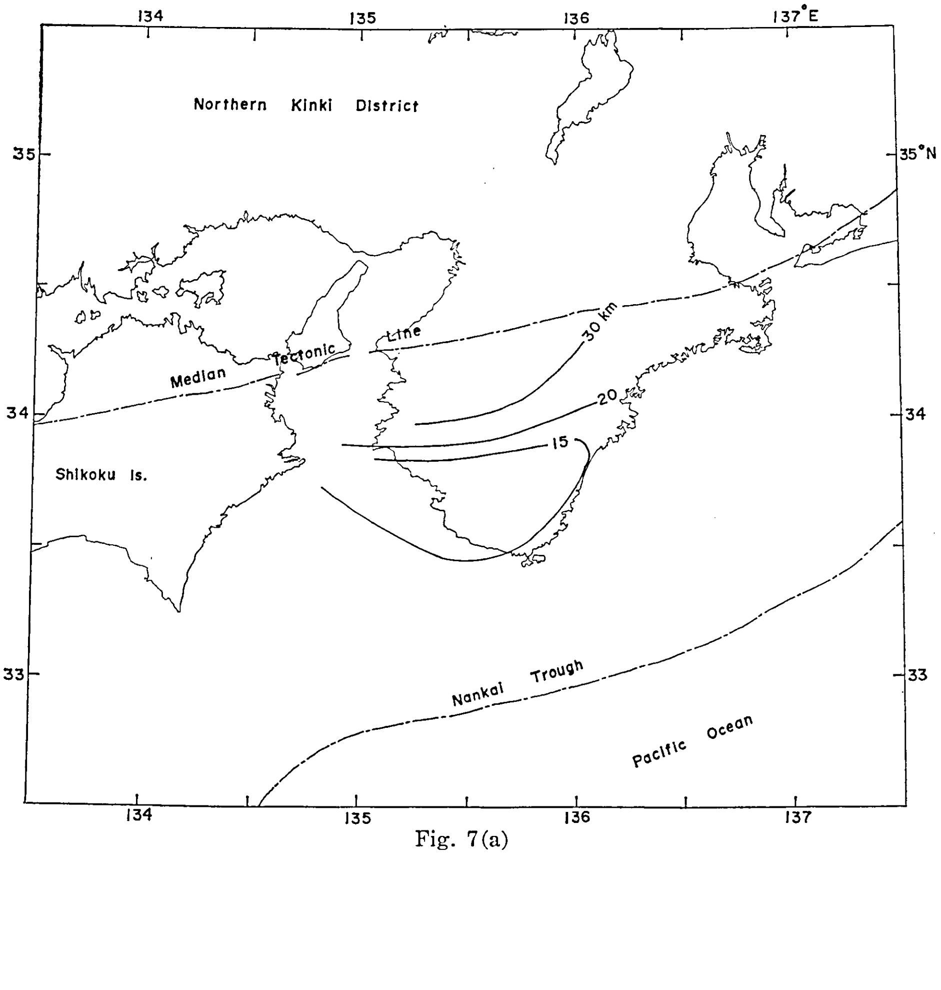


Fig. 7(a)

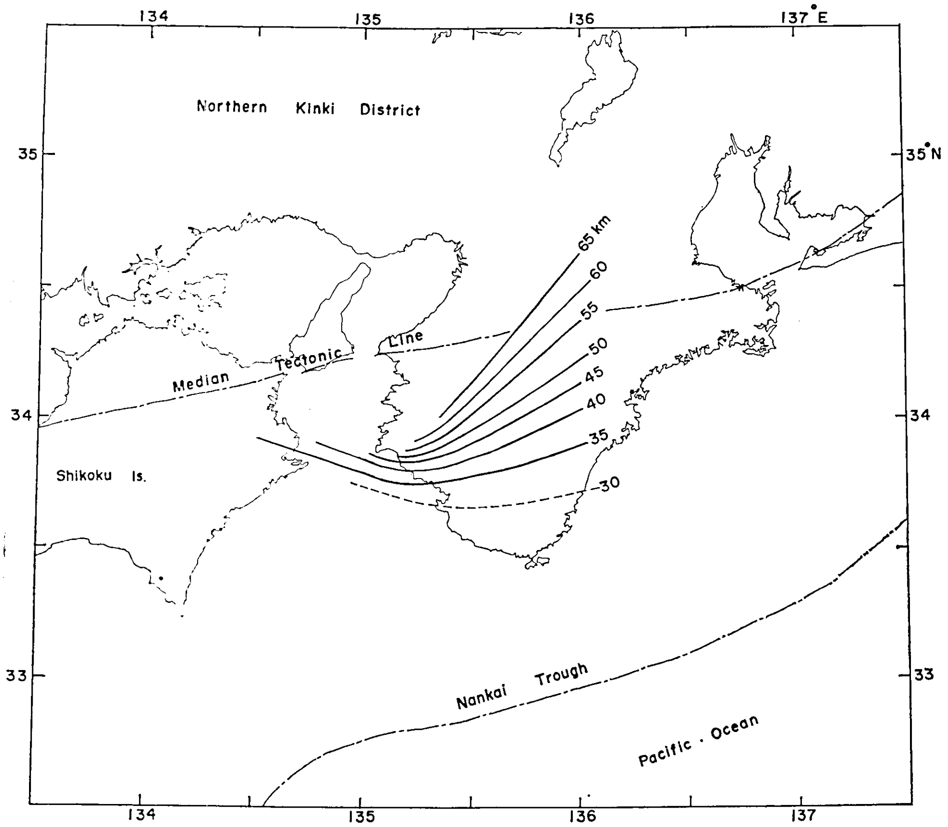


Fig. 7(b)

Fig. 7. Depth contours of microearthquakes for (a) the transitional and (b) the subcrustal seismic zones. The upper boundary of focal depths is represented for both of the seismic zones.

depth. In the third range of focal depth of 35–100 km, microearthquakes show a characteristic zonal arrangement striking parallel to the Nankai trough.

Depth variations of the number of microearthquakes are shown in Figs. 6(a) for the area enclosed by a rectangle as shown in Fig. 6(b). Earthquake foci can be classified into the group of the upper crustal, the transitional and subcrustal seismic zones from peaks of earthquake number in Fig. 6(a). Upper boundaries of focal depths for the transitional and the subcrustal seismic zones are indicated by depth contours as shown in Figs. 7(a) and (b). A sharp bend of the contour lines in the west coast of the Kii Peninsula suggests that the subduction of the Philippine Sea plate has a local irregularity in its dip direction deviated from the general trend parallel to the Nankai trough. Epicentral distribution of subcrustal earth-

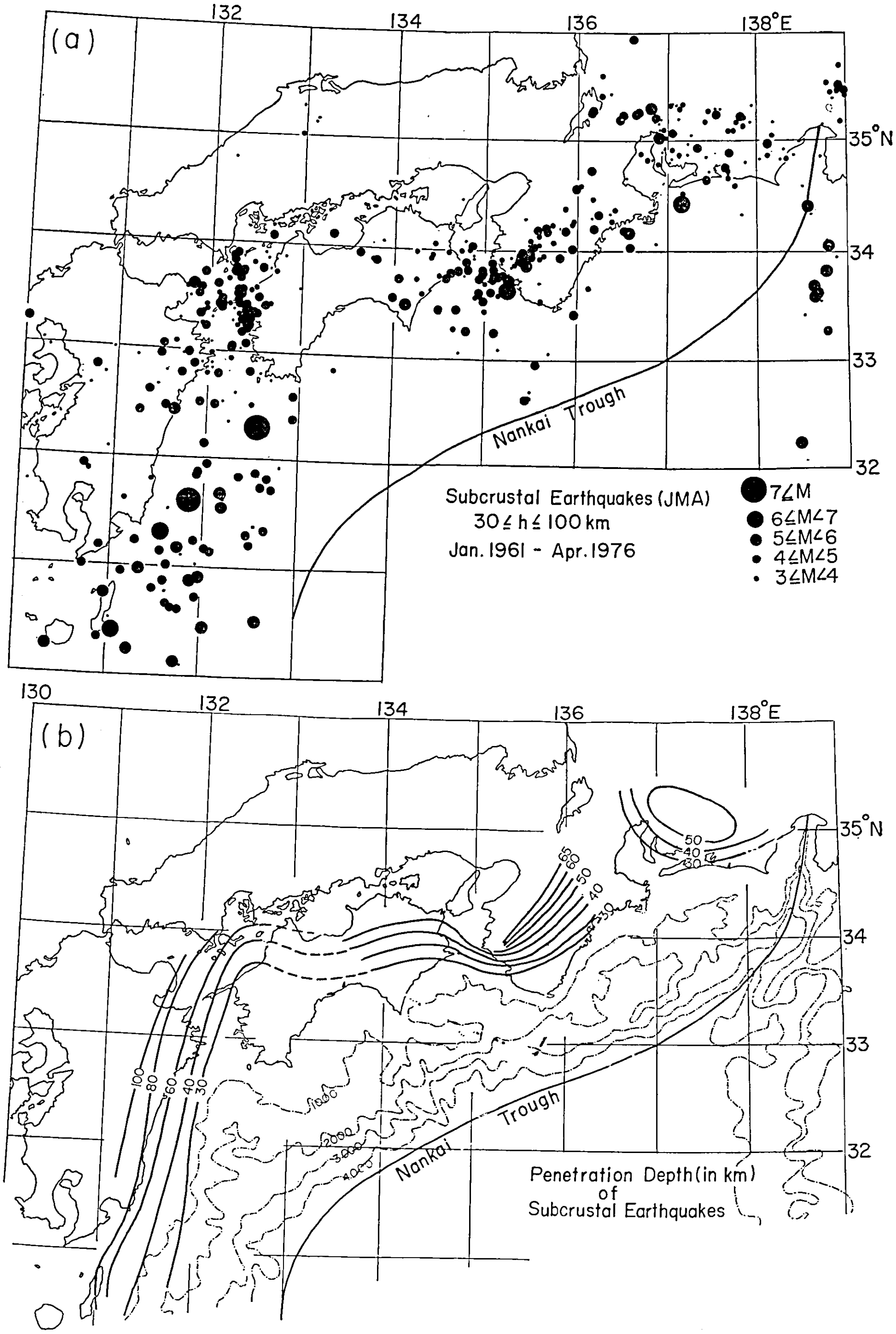


Fig. 8. Epicentral distribution of subcrustal earthquakes at depths of 30-100 km based on J. M. A. (Japan Meteorological Agency) data and (b) the corresponding isodepth contours of foci in the central and southwestern Honshu.

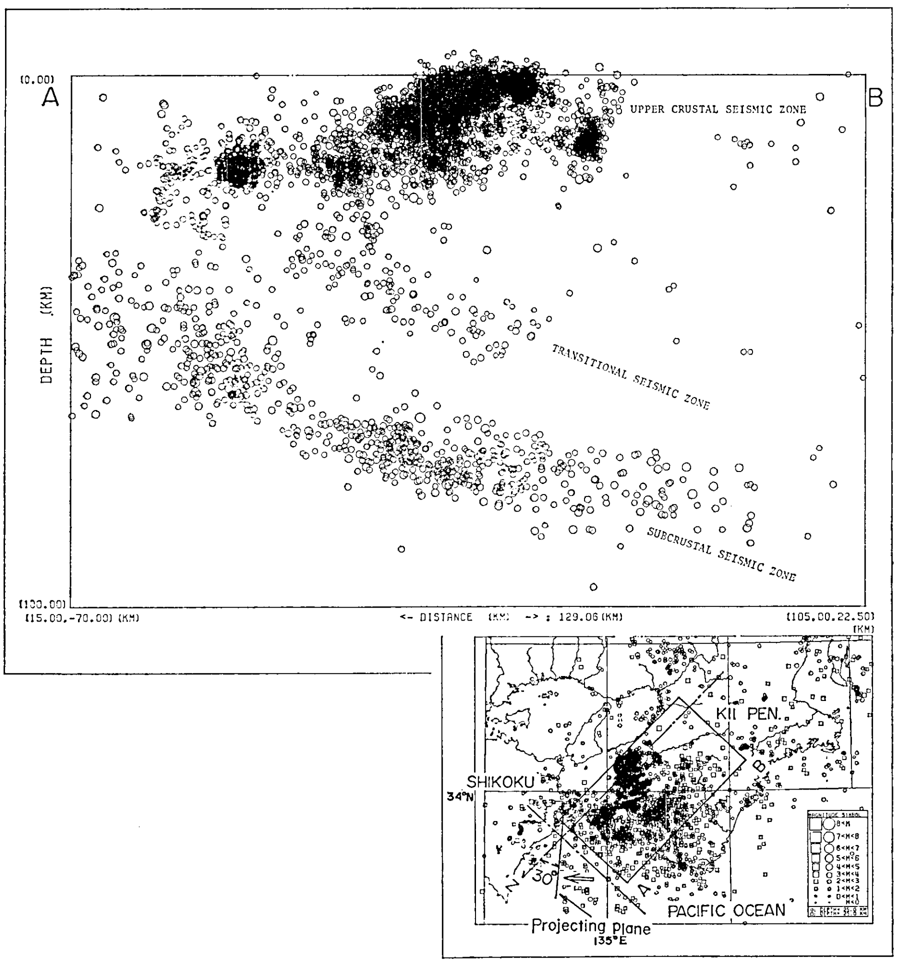


Fig. 9. Illustrations of the three-layered structure of microearthquake distribution in and around the Kii Peninsula for the period from August 1980 to July 1982 by projecting hypocenters on a plane dipping northeastward with an angle of 30° from vertical as shown in the inset.

quakes provided by J.M.A. and the corresponding isodepth contours of foci in the central and southwestern Honshu are given in Figs. 8(a) and (b) for a regional view. The three-layered structure of microearthquake distribution is clearly observed by projecting hypocenters on a plane with an angle of 30° from vertical dipping in the NE direction as shown in Fig. 9. The projecting plane is set perpendicular to the general trend of the hypocentral distribution of the transitional seismic zone as given by the isodepth contours in Fig. 7(a).

4. Depth of the Mohorovičić discontinuity

Travel time analysis for the direct, refracted and reflected P waves were made for the study of the crustal structure in the Kii Peninsula (MIZOUE, 1971). The Conrad discontinuity was located at the depth of 20-24 km with the westward inclination beneath the northwestern part of the Kii Peninsula. The depth of the Mohorovičić discontinuity was estimated at about 30 km in the same region. Seismic wave velocities in the upper and the lower crustal layers were given as 5.80 km/sec and 6.80 km/sec for the P-waves, and 3.64 km/sec and 4.05 km/sec for the S-waves, respectively. The velocity of the P_n waves was determined as 7.9 km/sec. MIZOUE (1974) analysed teleseismic P-wave data observed by the network in the Kii Peninsula for the study of the dipping structure of the Mohorovičić discontinuity by using the Zengeni's method (ZENGENI, 1970) for slowness vector evaluation. The observed slowness vectors suggest the northward inclination of the Mohorovičić discontinuity with a dip angle of $8° \pm 2°$. The Mohorovičić discontinuity in the southern end of the Kii Peninsula about 33.5°N was found at a shallower depth of about 20 km than about 30 km on the northern side of 34.2°N near the Median tectonic line.

The depth of the Mohorovičić discontinuity is reexamined on the basis of data by newly installed telemeter network shown in Fig. 1. Travel times of the direct, refracted and reflected seismic waves such as P_g, P^*, P_n and P_MP (Mohorovičić reflection) for earthquakes located near Wakayama city and off Hinomisaki, east coast of the Kii Peninsula are used for the determination of the crustal structure. For shallow earthquakes with focal depths 3-10 km in and near Wakayama city, the Mohorovičić reflections P_MP can be observed at the stations of HBR, KUM, HGU and KZG shown in Fig. 1. Southward shallowing of the Mohorovičić discontinuity can be evaluated from a decrease of travel time difference between P_MP and initial arrivals P_g. For earthquakes located off Hinomisaki with focal depths of 10-15 km, the Mohorovičić reflection P_MP can be clearly observed at the stations of KUM, HGU and KZG. In this case, the depth of the Mohorovičić discontinuity is evaluated from the difference of travel times between P_MP and the initial arrivals P_n. Examples of seismograms used for the evaluation of the depth of the Mohorovičić discontinuity are shown in Figs. 10(a)-(f) with travel time curves of P_g, P^*, P_n and P_MP calculated for appropriate models to fit the observed data. For each of the seismic ray paths from the hypocenter to the stations shown in Fig. 11, the depths of the Mohorovičić discontinuity are evaluated by the method as described

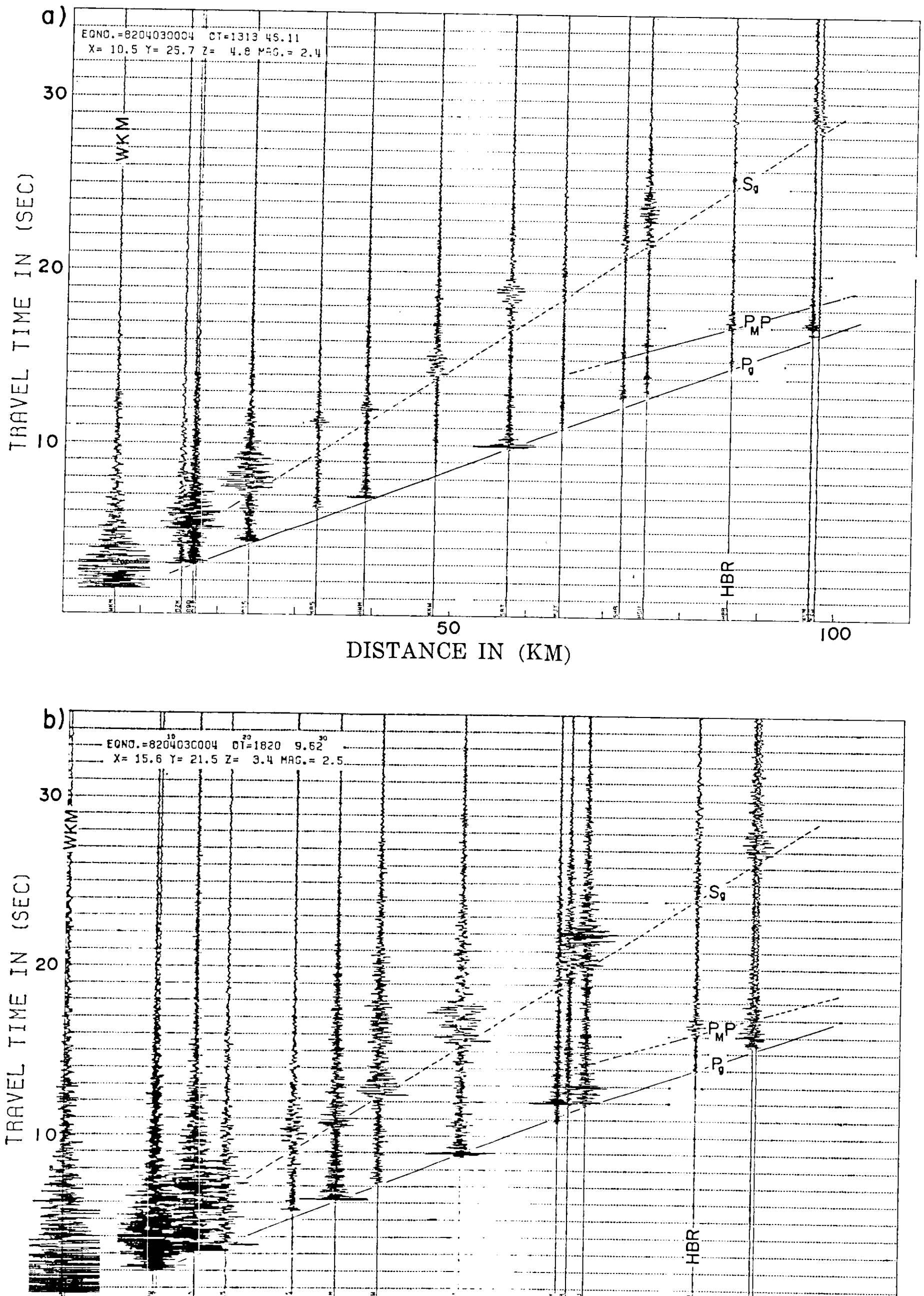
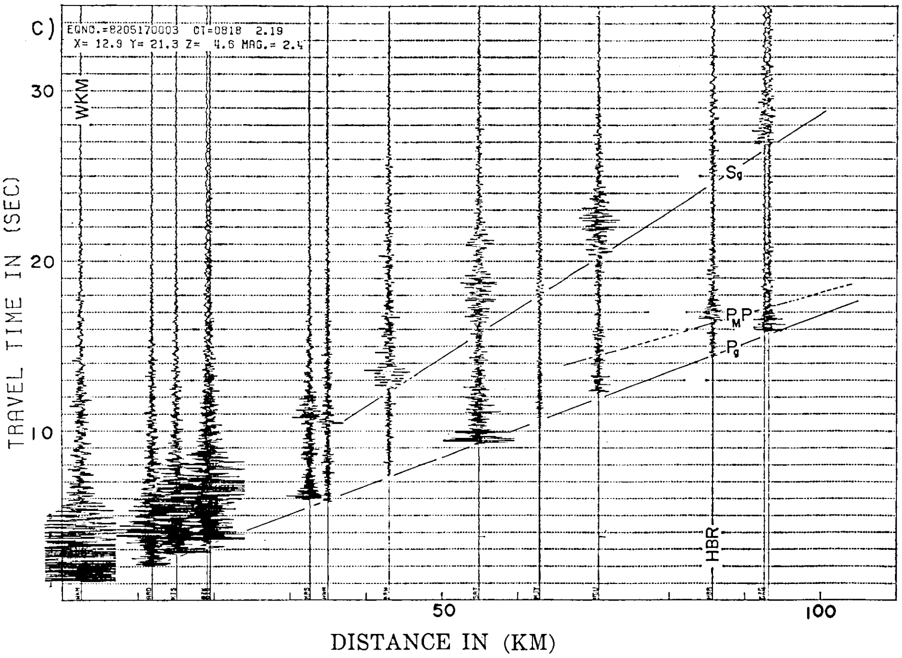
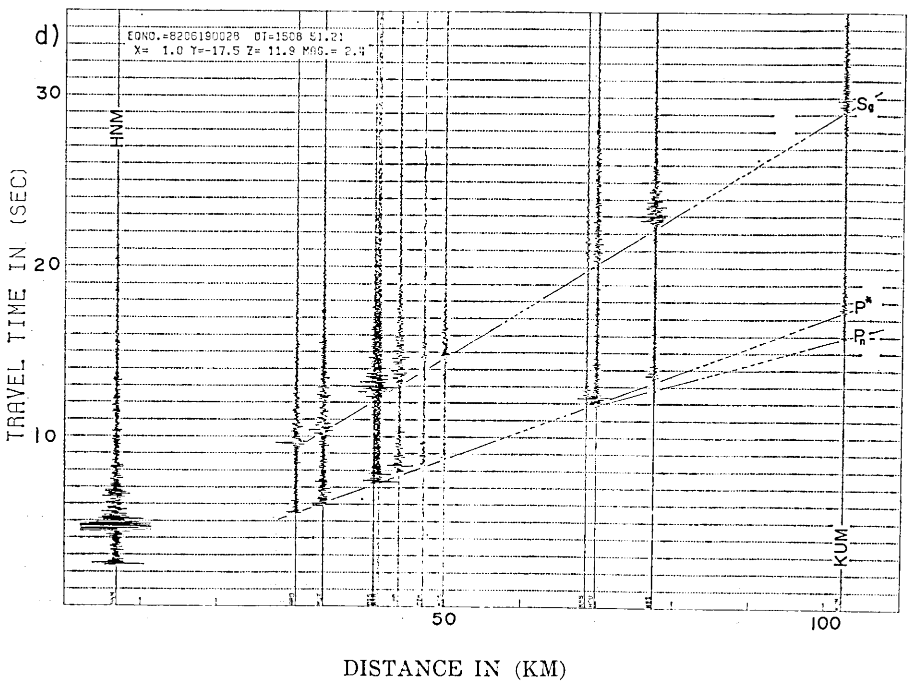
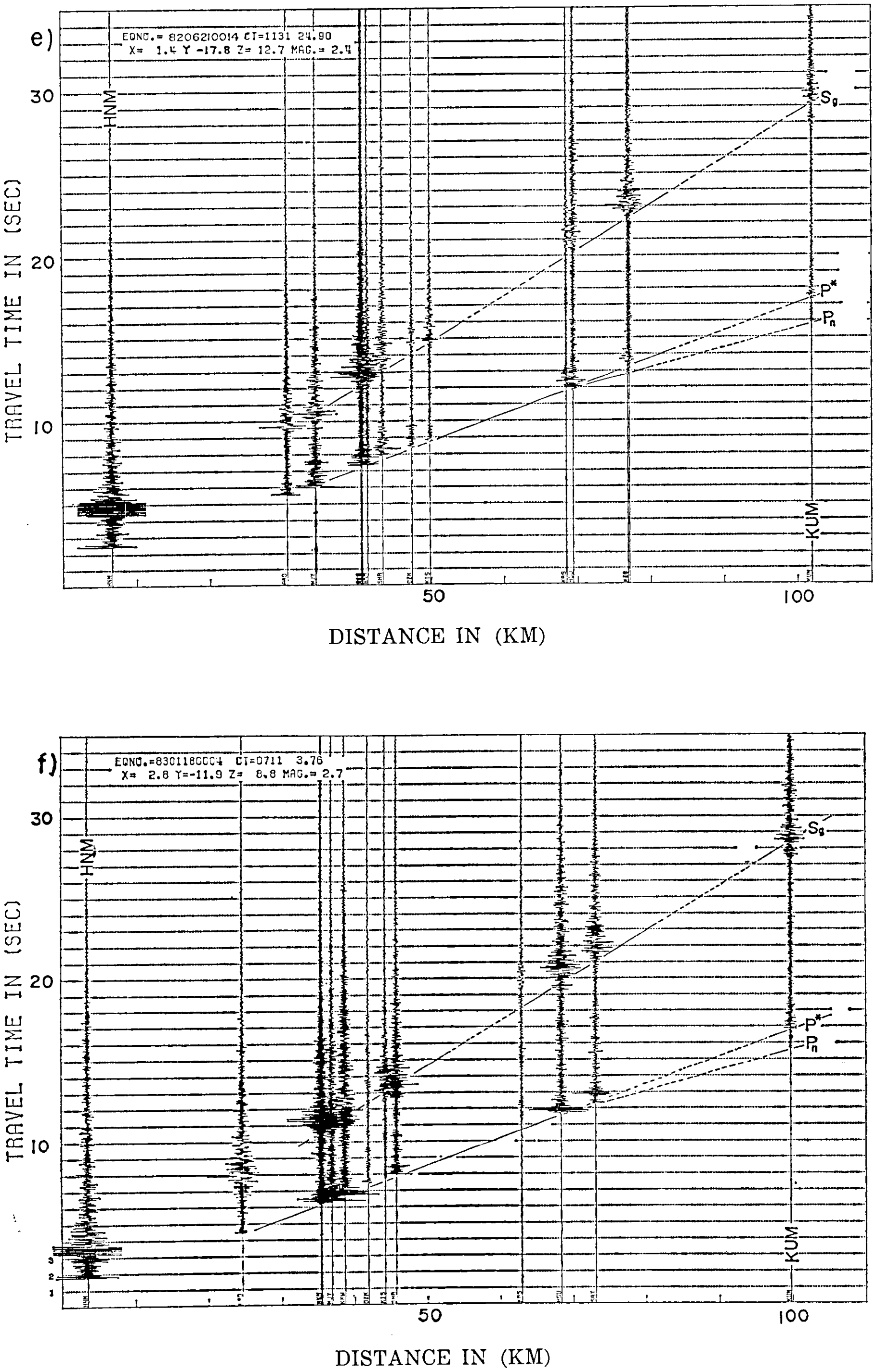


Fig. 10. Examples of seismograms with an orderly arrangement of time-distance relation for the microearthquakes located near Wakayama city and Hinomisaki, west coast of the Kii Peninsula. Calculated travel time curves are indicated for P_g, P^*, P_n and P_MP.


c)
EQNO.=8205170003 OT=0818 2.19
X= 12.9 Y= 21.3 Z= 4.6 MAG.= 2.4
WKM
HBR
Sg
PMP
Pg
TRAVEL TIME IN (SEC)
10
20
30
50
100
DISTANCE IN (KM)


d)
EQNO.=8206190028 OT=1508 51.21
X= 1.0 Y=-17.5 Z= 11.9 MAG.= 2.4
HNM
KUM
Sg
P*
Pn
TRAVEL TIME IN (SEC)
10
20
30
50
100
DISTANCE IN (KM)


e)
EQNO.= 8206210014 CT=1131 24.90
X= 1.4 Y -17.8 Z= 12.7 MAG.= 2.4
HNM
KUM
S_g
P^*
P_n
TRAVEL TIME IN (SEC)
30
20
10
50
100
DISTANCE IN (KM)
f)
EQNO.=8301180004 CT=0711 3.76
X= 2.8 Y=-11.9 Z= 8.8 MAG.= 2.7
HNM
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TRAVEL TIME IN (SEC)
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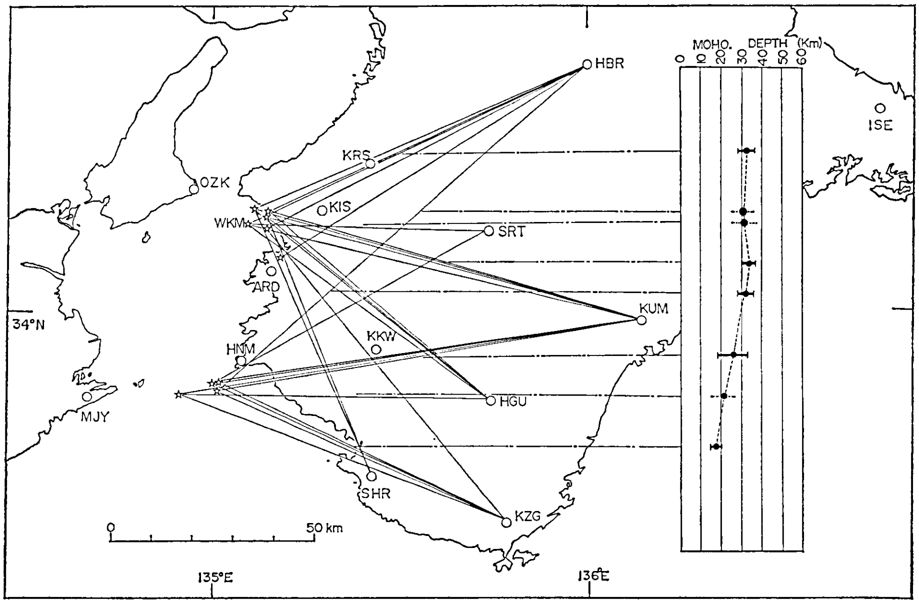

Fig. 11. Selected seismic wave paths crossing the Kii Peninsula from epicenters (star) in the west coast to the stations (open circle) in the central and east part of the Kii Peninsula used for the evaluation of the depth of the Mohorovičić discontinuity. Variation of the depth of the Mohorovičić discontinuity is indicated in the inset with error bars. Distance is measured along north-south direction. The middle point of the paths is taken for the depth plots in the inset.

above. The result is given in Fig. 11 as showing a decrease of the depth of the Mohorovičić discontinuity in the southern half of the Kii Peninsula. A simple extrapolation of the southward inclination of the discontinuity gives the depth of the Mohorovičić discontinuity as being nearly equal to or even less than 10 km in the southernmost tip of the Kii Peninsula.

5. Focal mechanism variations

Most of shallow earthquakes in the northern part of the Kii Peninsula have focal mechanisms under E-W compression common to those in the northern Kinki district, north of the Median Tectonic Line (WATANABE and KUROISO, 1967; SHIONO, 1973, 1976, 1977; MIZOUE *et al.*, 1973; MIZOUE and NAKAMURA, 1976; MIZOUE *et al.*, 1978). The E-W compression has been usually interpreted by the subduction of the Pacific plate along the Japan trench. Though the focal mechanisms under the E-W compression are predominant in both of the regions of the northwestern part of the Kii Peninsula and the northern Kinki district, there is a noticeable difference between the two regions in the rate of occurrence of earthquakes

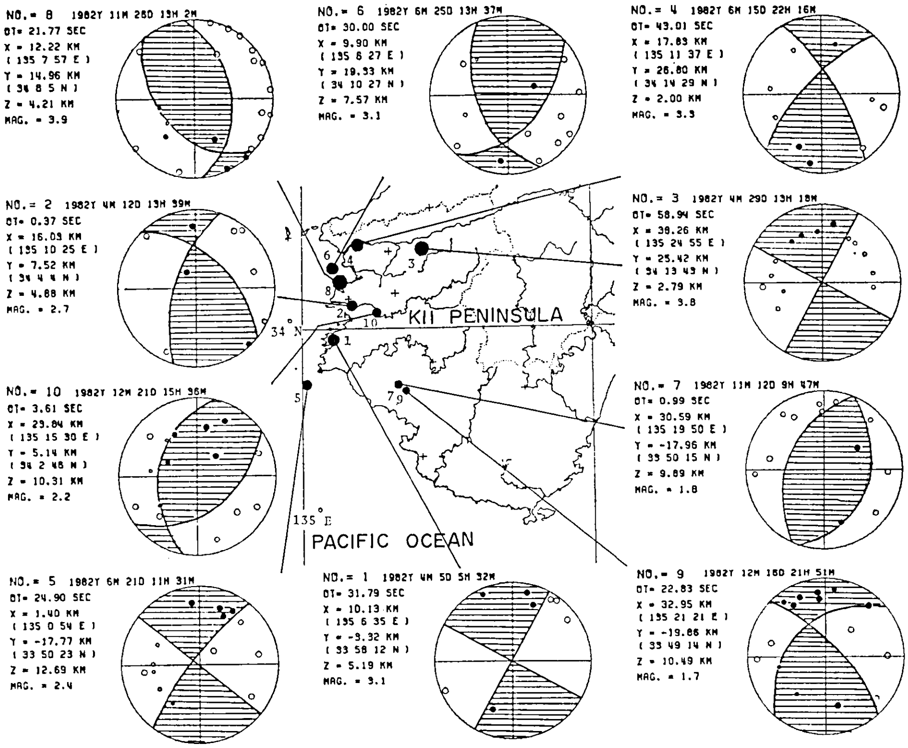

Fig. 12. Fault plane solutions for upper crustal earthquakes in the northwestern part of the Kii Peninsula at depth less than 15 km. Initial motions of the P-waves are projected on the upper hemisphere of the Wulff net with solid circles for compression and with open circles for dilatation as the same for Figs. 13 an 14.

with reverse faultings. Considerable numbers of earthquakes with reverse faultings can be observed in the northwestern part of the Kii Peninsula as shown in Fig. 12. This shows a contrast to the overwhelming rate of earthquakes of strike slip in the northern Kinki district. A large variation of fault plane solutions, having the nearly horizontal P-axes in the E-W direction and variable T-axes on a vertical N-S plane perpendicular to the P-axes, suggests a complicated feature of the stress field in the upper part of the earth's crust in the northwestern part of the Kii Peninsula. (MIKUMO *et al.*, 1970).

The existence of subcrustal earthquakes in the Pacific coast of central and southwestern Japan is in contrast to the inland and Japan Sea coast regions where seismic activities are restricted within the upper part of the earth's crust. The subcrustal earthquakes are located parallel to the Nankai trough and penetrate down into the mantle several kilometers or more (MIZOUE, 1977; SHIONO, 1977).

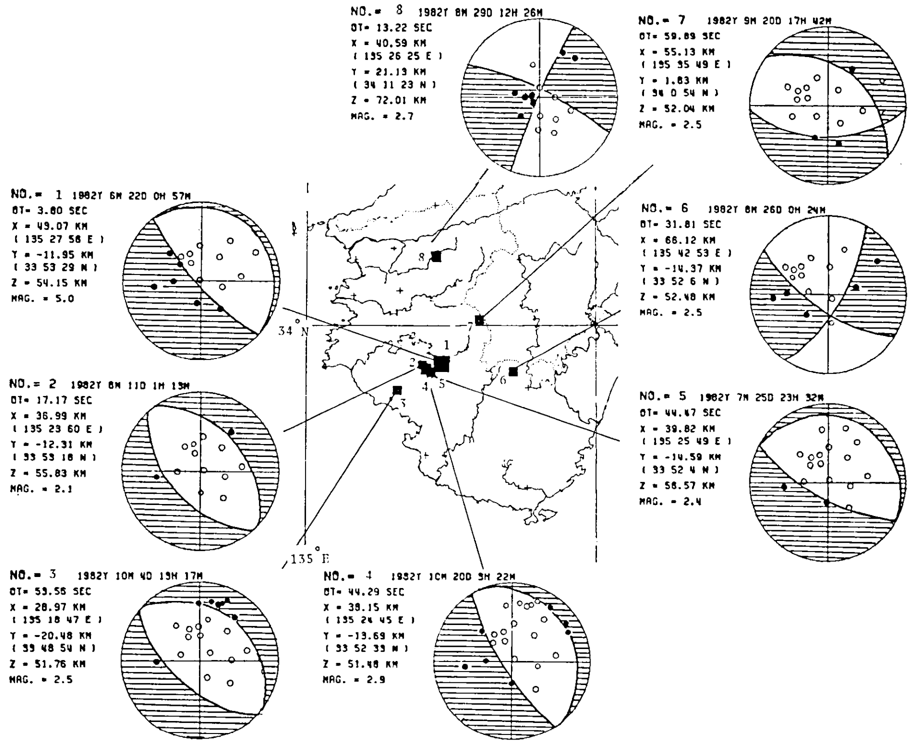

Fig. 13. Fault plane solutions of subcrustal earthquakes in and around the Kii Peninsula at depth more than 35 km.

Fault plane solutions of the subcrustal microearthquakes shown in Fig. 13 can be interpreted with relation to the subduction of the Philippine Sea plate. It has been pointed out that either the NW-SE compression perpendicular to the leading edge of the Philippine Sea plate or the NE-SW extension parallel to it has a decisive role controlling the type of faultings of the subcrustal earthquakes in and around the Kii Peninsula (SHIONO, 1973, 1977; MIZOUE, 1977; ITO *et al.*, 1979). Focal mechanisms of strike slip and normal fault correspond to the stress system of the NW-SE compression and the NE-SW extension, respectively. The existence of subcrustal earthquakes with normal fault can be interpreted by the downward movement of the plate into the mantle due to its own weight (HASHIMOTO, 1982).

The precise hypocenter location of microearthquakes in and around the Kii Peninsula clarifies a seismic zone near the Mohorovičić discontinuity transitional from the pronounced upper crustal to the subcrustal seismic zones. A large variety of fault plane solutions for earthquakes in the transitional seismic zone suggests a complicated seismogenic stress system at depths of 15-35 km in the southern part of the Kii Peninsula.

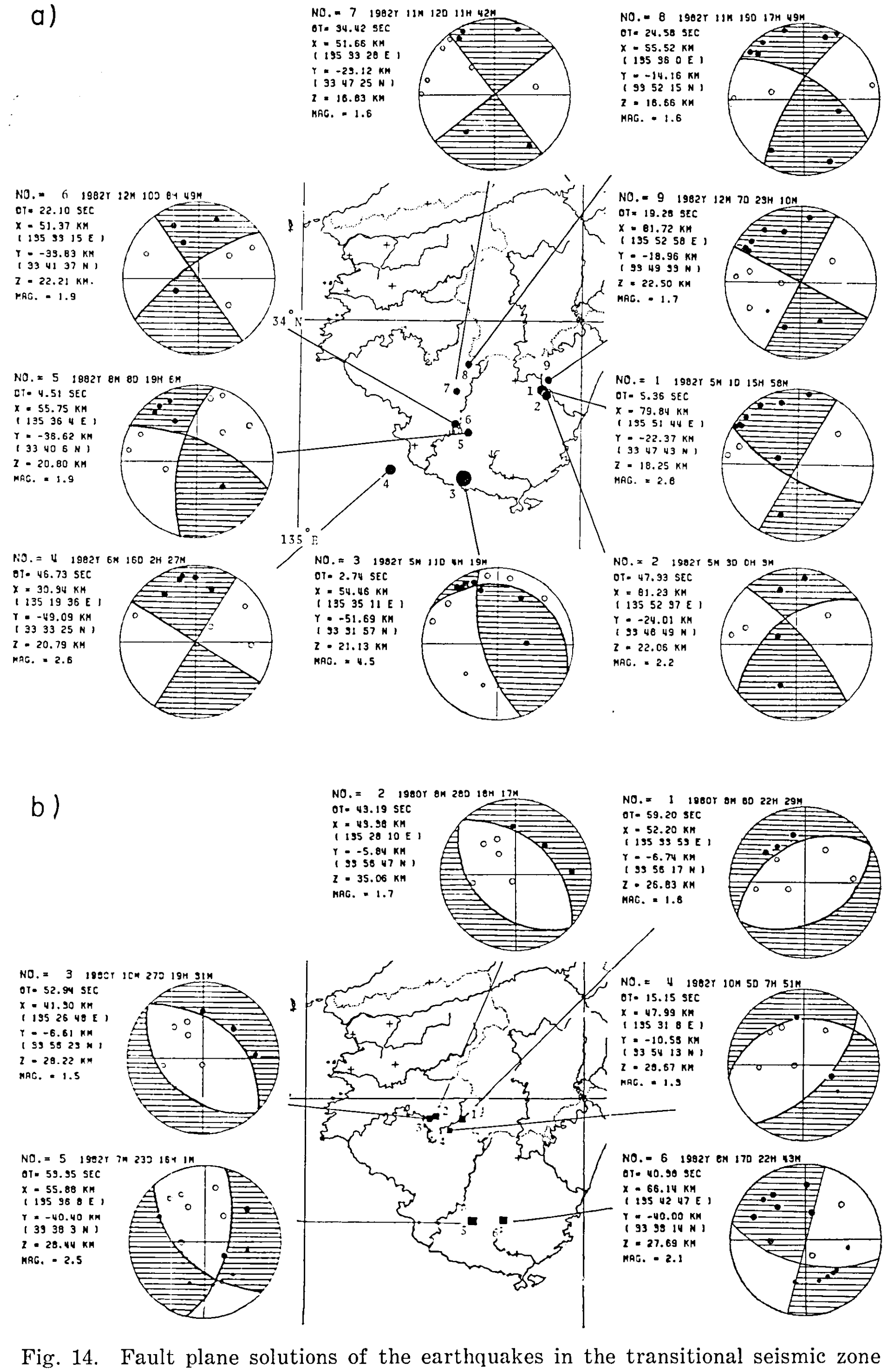

Fig. 14. Fault plane solutions of the earthquakes in the transitional seismic zone at depth range of (a) 15-25 km and (b) 25-35 km.

In the transitional seismic zone, shallower earthquakes with focal depths 15–25 km tend to show focal mechanisms of strike slip as common to those in the upper crustal seismic zone, while deeper ones with focal depths 25–35 km show focal mechanisms of normal fault as observed in the subcrustal seismic zone. These types of fault plane solutions of earthquakes in the transitional seismic zone are shown in Figs. 14(a) and (b) for the depth ranges of 15–25 km and 25–35 km, respectively. It is worth while to mention that the focal mechanisms of normal fault in Fig. 14(b) have T-axis parallel to the isodepth lines shown in Fig. 7(a) striking in the direction of NE–SW in the central part of the Kii Peninsula. Considering the depth of the Mohorovičić discontinuity 15–35 km dipping to the north, the complicated focal mechanism variation in the transitional seismic zone suggests a mechaical instability at depths near the Mohorovičić discontinuity.

6. Summary and conclusions

The accuracies of hypocentral locations in the Kii Peninsula have been considerably improved by the telemeter network operated since July 1980. As the result of this improvement, a characteristic structure of microearthquake distributions is found with the transitional seismic zone near the Mohorovičić discontinuity at a depth between the pronounced upper crustal and the subcrustal seismic zones. Focal mechanism variation can be correlated with a systematic hypocentral distribution summarized as follows;

(i) A three-layered structure of hypocentral distribution as presented by the upper crustal, the transitional and the subcrustal seismic zones can be found in the Kii Peninsula. Microearthquakes in the transitional seismic zone at depths of 15–35 km are located beneath the southern part of the Kii Peninsula with a seismic activity considerably less than those in the upper crustal and the subcrustal seismic zones.

(ii) Focal mechanisms in the transitional seismic zone can be classified into two groups depending on focal depths. Shallower earthquakes with focal depths of 15–25 km have focal mechanisms of strike slip or reverse faulting under the E–W compression as common with these in the upper crustal seismic zone. On the other hand, deeper earthquakes with focal depths of 25–35 km have focal mechanisms of normal fault under the NE–SW extension as common with those in the subcrustal seismic zone.

(iii) The depth of the Mohorovičić discontinuity in the southern part of the Kii Peninsula is estimated to be 20–25 km and less than 20 km in the southern end of the Kii Peninsula. The hypocentral distribution of the transitional seismic zone agrees well with the depth of the northward dipping Mohorovičić discontinuity.

(iv) The complicated focal mechanism variation in the transitional seismic zone suggests a mechanical instability on both sides of the Mohorovičić discontinuity at depths of 20-25 km, where the seismogenic stress field might be abruptly changed under the influence of the subduction of the Pacific and the Philippine Sea plates.

(v) The epicentral distribution of the transitional seismic zone has a relatively small area coverage restricted in the southern part of the Kii Peninsula as compared to that of the subcrustal seismic zone with an extensive area coverage over the entire part of the peninsula. This implies that the subducted Philippine Sea plate may decouple with the overriding continental crust in the northern half of the Kii Peninsula.

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11. 紀伊半島における微小地震の震源分布にみられる三層構造と発震機構との関係について

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紀伊半島の地震活動についての従来の議論は地殻上部と地殻底部の地震の2種類の区分にもとずいていた．前者は主として太平洋プレートの沈みこみによる東西方向の主圧力軸の場で発生する地震であり，後者は主としてフィリピン海プレートの沈みこみによる北西一南東方向の主圧力軸の場ないしはプレートの自重に起因する Leading edge に平行な主張力軸の場で発生する地震であろうとされている．

紀伊半島の微小地震観測網がテレメータ化されたため震源決定の精度が高まり震源分布の微細構造が従来よりさらに明確になってきた．その結果，これまでの区分による地殻上部および地殻底部の地震活動帯のほかにモホ不連続面とほぼ一致する深さのもう一つの地震活動帯が存在することが確かめられた．この新たに確認された地震活動帯の特性を要約すると次のようである．

i）この地震活動帯の震源の深さは 15～35 km で紀伊半島北西部の浅い地震（震源の深さ，3～10 km）と地殻底部の深い地震（震源の深さ 35～80 km）の中間の深さにあり他の2つのもの（地殻上部および地殻底部）に比較しその活動レベルは非常に低い．震央はおおむね半島南部に限られる．地震発生数の深さ別分布をみると震源の3層構造が判然とする．

ii）発震機構は地殻上部の地震と共通の型をもつものと地殻底地震と共通の型をもつものとがある．前者は震源の深さが 15～25 km，後者は 25～35 km である．このことから地殻上部における太平洋プレートの沈みこみの影響下にある応力場からフィリピン海プレートの沈みこみの影響下にある応力場への遷移がこの中間層の地震と対応していると考えられる．

iii）紀伊半島のモホ面の深さはその北部と南端部とでは少なくとも 10 km の差があり南端部でその深さは 20 km より浅いと推定される．このことから紀伊半島南部にみられるこの中間層の地震帯はモホ面の深さとよく一致すると考えられる．

iv）以上のことからこの中間層の地震は紀伊半島の地殻と太平洋プレートとの相互作用が深さと共にフィリピン海プレートとの相互作用におきかわる場で発生していると考えられる．また中間層の震央が半島の南半分に限られている．このことから紀伊半島の地殻とフィリピン海プレートとのディカップリングが起きているとすればその位置の南限はこの中間層の震央分布の北限と対応している可能性が高い．