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CONSISTENCY OF THE DISTRIBUTION OF FOCI OF EARTHQUAKES IN THE KAMCHATKA-KOMANDOR ISLANDS ZONE WITH THE DOUBLE-DIPOLE MODEL[1]

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A "double dipole" model with a zero moment was first used to describe faults in an earthquake focus by Honda and Vvedenskaya [1]. But until recently, publications dealing with alternative models continued to appear [2]. Generally, the uncertainty in choosing a model of the fault in the earthquake focus results from the fact that the body of input data (the signs of the arrivals in the first *P*- wave displacements) is too small to allow the construction of nodal lines.

The development of a world network of digital seismic stations has made possible a fuller analysis of earthquake recordings.

A group of scientists led by A.M. Dziewonski at Harvard has introduced the routine practice of evaluating the centroid moment tensor (CMT) of earthquake foci [3]. The ratio of the smallest (E_{min}) and largest (E_{max}) eigenvalues of the tensor gives an objective indication of which model the given seismic focus fits. For the double dipole, the quantity $E = |E_{min}/E_{max}|$ should be zero, while for a linear dipole vector it should be 0.5.

Dziewonski's group has systematically published catalogs of the centroid moment tensor in the journal "Physics of the Earth and Planetary Interiors" (1982-88), which has enabled us to develop a catalog of 109 CMT measurements for the Kamchatka-Komandor Islands region between 1977 and 1978. The range of moments is 10^{16} to 10^{19} N-m, and the focal depths range from 0 to 600 km.

Kamchatka and the Komandor Islands lie in the zone of intersection of two immense structures, the Kurile-Kamchatka and Aleutian island arcs. There are large extensional structures in the region, e.g., the Kurile-Kamchatka and Aleutian deep-water trenches, chains of active volcanoes, and the sloping Benioff seismic focus zone. As a result, the Kamchatka-Komandor zone is an excellent area for testing a variety of geotectonic hypotheses.

The distribution of the epicenters of these earthquakes is shown in Fig. 1 separately for two depth ranges: 0 to 59 and 60 to 650 km. Epicenters in three ranges of values of *E*: 0 to 0.10; 0.11 to 0.20 and 0.21 to 0.50 are indicated by different symbols. Figure 2 shows plots of *E* versus the focal depth (A) and the seismic moment (B).

For earthquakes of the Kamchatka-Komandor zone, the values of *E* have the following distribution:

Table 1

Depth of focus, km	No. of observations	Distribution of *E*, %		
		0.00–0.10	0.11–0.20	0.21–0.50
0–59	75	52	33	15
60–600	34	65	24	11
0–600	109	56	31	13

The group of foci with *E* from 0 to 0.20 (87 percent of all foci) can be fairly confidently assigned to the double dipole model. The other 13 percent of the foci have values of *E* from 0.21 to 0.43, and only two foci have $E > 0.35$. These rela-

[1]Translated from: O sootvetsvii ochagov Kamchatsko-Komandorskiky zemletryaseniy modeli tipa "dvoynoy dipol". Doklady Akademii Nauk SSSR, 1990, Vol. 314, No. 5, pp. 1095-1098.

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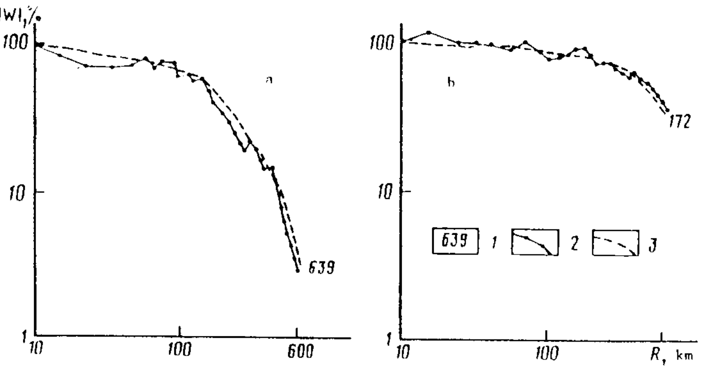

Fig. 2. Comparison of measured and predicted values of the attenuation function (|W|) in paths in southern zone of western Siberia at frequencies f = 639 kHz (a) and 172 kHz (b).

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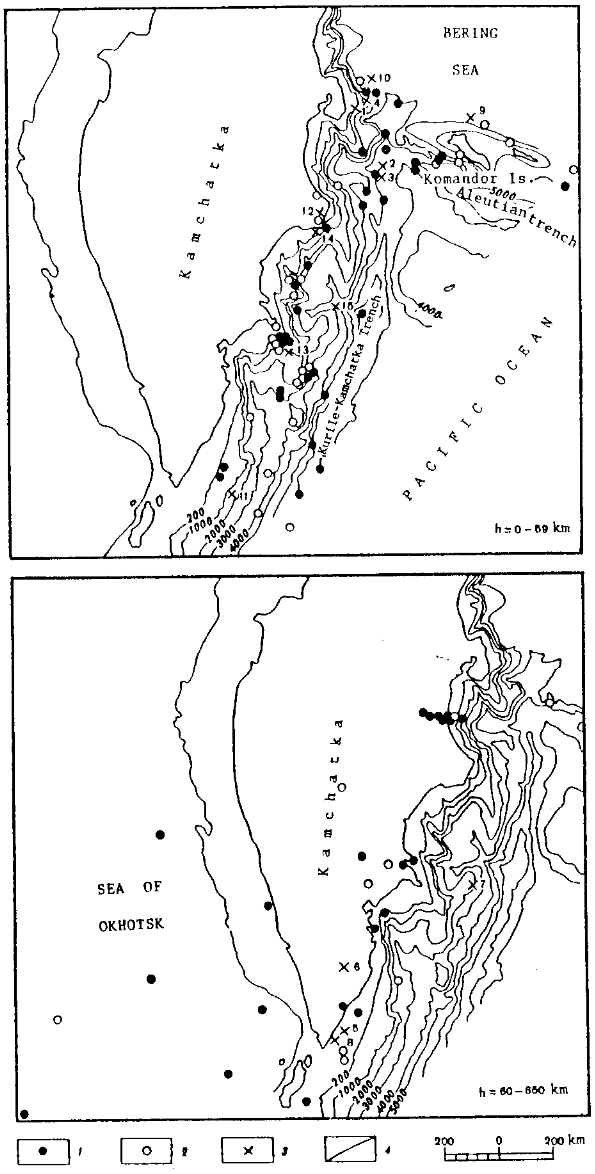

Fig. 1. Lateral distribution of epicenters of earthquakes in terms of magnitude of E: 0-0.10 (*1*); 0.11-0.20 (*2*); 0.21-0.50 (*3*); *4*) Isobaths, m. Here and in Fig. 2, the numbers of foci with E > 0.20 are shown.

tively anomalous foci are rather randomly located in plan, although one observes some clustering (7 of 11 foci from the depth interval of 0 to 59 km) in the zone of intersection of the Kurile-Kamchatka and Aleutian structures (see Fig. 1). There are no anomalous foci at depths greater than 120 km. There is no evident relationship betweeen anomalous events and seismic moments; we note only that the largest values of E (Nos. 4 and 6) are associated with earthquakes whose seismic moments are $(4$ to $9)\cdot 10^{17}$ N-m.

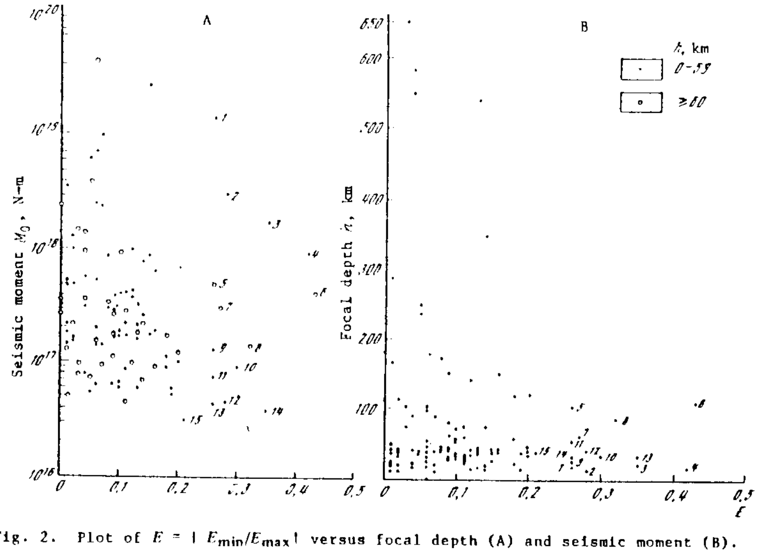

Fig. 2. Plot of $E = |E_{min}/E_{max}|$ versus focal depth (A) and seismic moment (B).

Dziewonski and Woodhouse [4] analyzed the global distributions of foci with anomalous values of E in 1981 and found, among other things, that foci at depths of 0 to 300 km and with a seismic moment of about 10^{18} N-m exhibit the largest values E. Also, anomalous foci are essentially absent at depths greater than 300 km, the are regions where deviations from the double dipole model are rather common, and th distribution of the foci of earthquakes in the northern part of the Pacific belt wi focal depths of 100 km or less is in good agreement with the double dipole model. They attribute the anomalous values of E to the curvature of the fault plane in th focus. They assume that as the focal zone expands, the curvature of the fault plan increases.

This phenomenon is observable at seismic moments of up to 10^{18} N-m. At higher values of M_0, the local effects of curvature of the fault plane are smoothed out, which is the reason why no large values E are associated with foci having seismic movements greater than 10^{18} N-m.

Data on the Kamchatka-Komandor region generally confirm the global conclusions of Dziewonski and Woodhouse [4]. It appears that the major deviations of earthquak foci distribution from the double dipole model at seismic moments of 10^{18} N-m are a real phenomenon. This value of the seismic moment is in some sense the boundary be tween weak and strong earthquakes. The above explanation of large values of E as connected with the curvature of the fault plane appears acceptable. It does accoun for the relatively large number of anomalous foci in the tectonically complex zone intersection of the Aleutian and Kurile-Kamchatka structures and the disappearance anomalous foci at depths greater than 120 km, where the Benioff seismic focus zone under Kamchatka becomes a much simpler structure. On the whole, our analysis indicates that the double dipole model fits well the distribution of earthquake foci in the Kamchatka-Komandor region.

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