A STUDY OF ANISOTROPY BENEATH GREAT BRITAIN USING THE POLARIZATIONS OF TELESEISMIC SHEAR-WAVES RECORDED BY BGS/UKNET

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The directions of the polarizations of the leading shear-wave, recorded by the United Kingdom seismometer network (UKNET) of the British Geological Survey, have been analyzed to investigate the anisotropic structure beneath the United Kingdom. Fifty-nine short-period and seventeen long-period records from 15 intermediate and deep earthquakes, mainly from the northwestern Pacific area, were used to identify the polarization directions. The short-period shear-waves show polarization directions primarily scattered around the polarization directions of long-period (about 20 s) shear-waves. Since such long-period shear-waves can preserve the polarization directions radiated at the source fixed by the geometry and orientation of the focal mechanism, the short-period polarization directions are primarily the same as the source polarization directions. This can be interpreted as indicating that anisotropy beneath the UK, if it exists, is weak and not uniformly aligned, and is localized possibly into several blocks.

1. Introduction

Anisotropy has been increasingly recognized in the Earth's crust and upper mantle. Beginning with Hess in 1964, many seismological observations have now shown the presence of seismic anisotropy in the upper mantle and more recently in the crust. There are two major data sources for studies of upper-mantle anisotropy: seismic velocities of both body and surface waves and station residuals measured over path lengths of more than 100 km; and geophysical and petrological laboratory measurements of seismic velocities and mineral alignments in ophiolite and nodules from the upper mantle. Among these studies are: 1) seismological data (HESS, 1964; RAITT *et al.*, 1969; SCHLUE and KNOPOFF, 1976; CRAMPIN and KING, 1977; DZIEWONSKI and ANDERSON, 1981) and 2) petrographic data (PESELNICK and NICOLAS, 1978; NICOLAS *et al.*, 1980; CHRISTENSEN and LUNDQUIST, 1982;

CHRISTENSEN, 1984). Combining these two kinds of information, many mineral alignment models of upper mantle anisotropy have been presented (HESS, 1964; FRANCIS, 1969; AVE'LALLEMANT and CARTER, 1970; FUCHS, 1977). In these models it is commonly assumed that the upper mantle is uniformly anisotropic from hand-specimen size upwards until the seismic velocity changes are averaged out by long seismic wavelengths. If the upper-mantle anisotropy is as uniform as these models suggest, seismic shear-waves propagating through the mantle should show splitting (bi-refrindex, or double refraction).

However, the assumption of uniform anisotropy is questioned by recent analyses of structure. The structure in the upper mantle appears to be heterogeneous, not only in active tectonic regions (e.g., HIRAHARA, 1977; HORIE *et al.*, 1984), but also stable continents (AKI *et al.*, 1976; ROMANOWICZ, 1980). It should be also noted that the upper mantle structure is not anisotropic everywhere (e.g., BAMFORD *et al.*, 1979; ANDO *et al.*, 1983). Seismic anisotropy of the upper mantle, therefore, is expected to be at least partly heterogeneous or absent. Analysis of shear-wave splitting should be able to demonstrate the existence or absence of the anisotropy and the uniformity or heterogeneity of it.

Theoretical and numerical studies show that shear-wave splitting is a diagnostic feature of propagation through an anisotropic medium (CRAMPIN, 1977, 1981; KEITH and CRAMPIN, 1977). The anisotropy can be investigated by analyzing splitting in individual three-component shear-wave arrivals. Splitting is believed to be a reliable and effective way to survey anisotropy in the upper mantle. Upon entry into an anisotropic medium, a shear-wave necessarily splits into phases (usually two if the anisotropy is weak) with different polarizations and different velocities. Since the split shear-waves propagate with different velocities and polarizations, the shear-wave splits, the usually linear particle motion of the incident shear-wave is lost, and a characteristic signature appears in the three-component shear wavetrain. This phenomenon of shear-wave polarization anomalies is diagnostic of propagation through some form of effective anisotropy, and can be used to evaluate the anisotropy along the ray path. Since the two split shear-waves follow similar ray paths through heterogeneities in the crust and mantle, it is expected that such lateral and vertical heterogeneities usually disturb shear-wave splitting less than they do P-wave velocity-anisotropy. Numerical experiments with synthetic seismograms appear to support this assertion (CRAMPIN, 1981).

The British Isles appear to be an appropriate place to investigate anisotropy in a stable upper-mantle as it has been free from orogenic activity for more than 200 m.y. and the geological structure of the upper mantle is expected to be simpler than presently active tectonic areas such as Japan. The British Geological Survey has recently developed a suitable seismometer network (UKNET) covering most of Britain which records continuously on analogue magnetic tape (BROWITT, 1979). The network currently includes 12 three-component sites. Analyzing shear-wave splitting requires three-component instrumentation and the necessary timing accuracy makes recording on magnetic tape essential. This paper interprets seismic

anisotropy beneath the UK by using the polarizations of teleseismic shear-waves from deep events recorded by UKNET.

2. *Method of Analysis*

Our primary purpose is identifying polarization anomalies in incident shear-waves resulting from propagation through the anisotropy beneath the stations. Since at least four factors control the behaviour of shear-wave polarizations at the free surface, we need to identify the cause of any effects we see. These factors are:

- 1) the effects of the interaction with the free surface;
- 2) the radiation from the source (focal mechanism);
- 3) possible inhomogeneities along the ray path; and
- 4) the anisotropy along the ray path.

We shall show that these effects can be eliminated or identified by the following considerations.

Shear-waves recorded at a free surface are modified by the interactions with the surface (e.g., NUTTLI, 1960; MENDIGUREN, 1969). Incident shear-waves are free from this distortion only when the angle of incidence at the surface is less than a critical angle $\sin^{-1}(V_s/V_p)$. This is about 35° for a Poisson's ratio of 0.25. Recently, further analysis of the effects of free surface on shear-waveforms have been made by BOOTH and CRAMPIN (1985). We restrict our analysis to teleseismic sources with an epicentral distance greater than 30° (Table 1), where the angle of incidence should be within the critical angle. Thus, the shear-waves used in this study should be free from free-surface distortions.

An earthquake source radiates shear-waves with polarizations which are fixed at the source by the geometry and orientation of the focal mechanism. These polarizations will be generally preserved at a receiver, if the shear-waves propagate through a homogeneous isotropic structure. Thus, one way to investigate anisotropy would be to determine the focal mechanism of the earthquakes and base the interpretation on the polarizations radiated from the origin. Here, we shall base the interpretation on the polarizations of the long-period shear-waves as discussed below.

Structural discontinuities, and blocks of material with different anisotropic symmetries along the ray path, could result in complicated waveforms caused by splitting, phase interference, and mode conversion. The study of polarization anisotropy on the basis of teleseismic records imposes several problems: 1) ray paths are long and the incidence angles to layer boundaries are changed significantly during the propagation, leading to difficulties in locating the relevant anisotropy; 2) significant phase changes may occur at interfaces with large impedance contrasts. Nevertheless, the polarization of the faster shear-wave is a local phenomenon controlled by the symmetry of the anisotropy near the recording site. Thus, the initial polarization of the first arrival depends only on the symmetry of the last anisotropic region the ray traversed.

3. Data

We use data from three-component records of UKNET with a natural pendulum period of 1 s. The location of the 12 three-component stations used in this study are shown in Fig. 1 and their parameters are listed in Table 1 (TURBITT, 1984). The hypocentral parameters of the teleseismic events used in this study are listed in Table 2, and their epicentres are shown in Fig. 2. The events, with magnitudes greater than $m_b = 5.6$ and depths below 70 km, were selected from the Bulletin of the International Seismological Centre, and the United States Geological Survey, Preliminary Determination of Epicenters. Firstly, 160 seismograms from 55 earthquakes for the period between January 1978 and April 1984 were identified. Secondly, 60 shear-wave arrivals of S or SKS were identified on seismograms of

Fig. 1. Three-component seismograph stations of the UKNET used in this study.

Table 1. Three-component seismograph stations of UKNET used in this study.

Code	Lat (N)	Lon (W)	Opened date	Closed date	Type of seismometer
ESK	55.3167	3.2050	12/65– 4/81–		WWSSN MK3
KYL	57.3196	5.6506	11/78–		MK3
EDI	55.9233	3.1861	1969– 9/12/81–	8/12/81	MK3
MCH	51.9977	2.9983	8/ 2/78–	4/ 4/82	MK3
HPK	53.9554	1.6240	1978–		MK3
CWF	52.7382	1.3071	1975–		MK3
LRW	60.1360	1.1779	2/ 9/78–		MK3
MCD	57.5827	3.2541	26/ 6/81–		MK3
CRQ	50.1672	5.1728	1981–		MK3
HTL	50.9944	4.4850	11/ 2/81–		MK3
DYA	50.4352	3.9309	24/ 4/82–		MK3
PGB	55.810	4.478	2/84–		MK3

MK3 refers to the Willmore Mark 3.

Table 2. Hypocentral parameters* used in this study.

No.	Date	Time	Lat	Lon	Depth	m_b	Region
1	17 Mar. 1978	02:48:47.6	31.99 N	137.61 E	441	6.5	Honshu
2	21 June 1978	11:10:38.7	48.27 N	148.66 E	380	5.8	NW of Kurile
3	28 May 1979	09:27:33.9	36.46 N	031.72 E	111	5.8	Turkey
4	17 Oct. 1979	05:43:03.1	18.49 N	145.39 E	601	6.1	Marianas
5	23 Nov. 1979	23:40:29.7	04.81 N	076.20 W	105	6.3	Colombia
6	11 Dec. 1979	17:26:18.5	28.95 N	140.94 E	126	6.2	Bonin Island
7	27 Nov. 1981	17:21:44.3	42.93 N	131.19 E	525	5.7	USSR-China
8	22 June 1982	04:18:40.5	7.34 S	126.04 E	450	6.3	Banda Sea
9	04 Apr. 1983	02:51:34.3	5.72 N	94.72 E	79	6.6	Sumatra
10	21 Dec. 1983	12:05:06.3	28.19 S	63.17 W	602	6.2	Argentina
11	30 Dec. 1983	23:52:39.9	36.37 N	70.74 E	215	6.6	Hindu Kush
12	01 Feb. 1984	07:28:28.7	49.06 N	146.59 E	573	5.9	Okhotsk
13	06 Mar. 1984	02:17:21.2	29.38 N	138.94 E	457	6.2	Honshu
14	23 Apr. 1984	21:40:35.5	47.45 N	146.69 E	414	6.0	Kuril
15	24 Apr. 1984	04:11:29.0	30.91 N	138.43 E	403	6.1	Honshu

*From Bulletin of the International Seismological Centre (1978–1981) and from the Preliminary Determination of Epicentres of the USGS National Earthquake Information Service (1982–1984).

these events. In general, it was found that earthquakes with $m_b < 6.0$ radiated small-amplitude short-period S or SKS waves. Signals from these events can only be used when the signal-to-noise ratio is large enough. The signals on the analogue magnetic tapes were digitized at every 0.04 s, and played out as seismogram traces and polarization diagrams drawn for two-second time windows.

Figure 3 shows some examples of three-component seismograms and their

Fig. 2. Azimuthal-equidistant projection of epicenters of the earthquakes used in this study and of the location of ESK, the WWSSN station in Great Britain.

polarization diagrams from event 14. The arrows indicate the arrivals and directions of the polarizations of the first shear-waves. The polarization diagrams are numbered corresponding to the 2-s time-intervals marked over the traces. The diagrams in each time-interval are normalized separately. Figure 3(a) to (d) show that azimuths of the polarizations of the leading shear-waves are 42° at EDI, 90° at ESK, 60° at HPK, and 90° at HTL. The polarization diagrams at EDI show a relatively linear horizontal motion for the first 1 s of shear-wave arrived. The diagram at ESK shows a clear westward motion for the first 1 s until the second shear-wave arrives with almost orthogonal polarization. The particle-motion at HPK is elliptical and the orientation of the first shear-wave is taken to be parallel to the first half cycle of the motion as shown in Fig. 3(c) (indicated by the arrow

Fig. 3. Typical seismograms and polarization diagrams from event 14 in Table 2, recorded by four stations: (a) EDI, (b) ESK, (c) HPK, and (d) HTL. The polarization diagrams are numbered corresponding to the 2-s time-intervals marked above the seismograms. The diagrams are, from the top, the Up-Down and North-South projection, Up-Down and East-West, and the horizontal projection. The diagrams in each time interval have been normalized separately, and the figure below each box shows the relative amplifications. The arrows on the horizontal projection of the S wave mark the arrival and orientation of the leading shear-wave.

Fig. 3

Fig. 3

with two heads). The shear-waves at HTL are impulsive and show a 1 s delay between the shear-wave arrivals on the two horizontal components.

The first shear-wave arrival can be identified unambiguously on the majority of seismograms. To recognize the effects of personal bias in measurements, the arrivals and polarization directions on all the recordings were read by two people independently. Although some large discrepancies were found, the average error in the measurements of the shear-wave polarization orientation is less than 5° , which is negligible in the study of teleseismic shear-wave polarizations. However, some signals were measured by one reader but rejected by the other, and vice versa, because of the ambiguous shear-waveforms.

Estimates of the polarization directions of the shear-wave arrivals were made for the earthquakes in Table 2. The polarization directions are plotted on equal-area projections in Fig. 4 and listed in Table 3. The polarizations show some parallel alignments at HPK, MCD, and MCH, but show wide scatter at the other stations. There are not many polarizations observed at each station and they cover only part of the equal-area plot within the shear-wave's critical angle. Any pattern in the symmetry, which is suitable for the Earth's interior, is difficult to identify in the projections in Fig. 4. Although orientations of the polarizations of the split shear-

Fig. 4. Orientations of the polarizations of the first shear-wave arrivals observed at six stations of the UKNET and those combined for all the stations. The upper diagrams are equal-area projections. The lower diagrams are histograms of the observed orientations at each station for directions East of North.

Table 3. Orientations of the first arrival shear-waves.

No.	D	Az	i	Phs	LP	CRQ	CWF	DYA	EDI	ESK	HPK	HTL	KYL	MCD	MCH	PGB
1	87	33	17	S	-60	-	-	-	-	-	-	-	-15	-	-37	-
2	74	19	19	SKS	-60	-	-	-	-	-	-	-	-77	-	-	-
3	30	114	28	S	27	-	-	-	48	-	-	-	-	-	-	-
4	102	30	16	S	41	-	-	-	-	-	+	-	-	-	-85	-
5	76	258	20	S	-18	-	-	-	0	-	-	-	-	-	-23	-
6	90	31	10	SKS	41	-	-	-	-28	-	+	-	-	-	90	-
7	75	33	19	S	39	-	-	-	-	-	+	-	-	-	28	-
8	117	60	6	SKS	45	+	-	64	76	-70	-	+	51	+	-	-
9	90	80	16	S	-67	+	+	-	-	+	75	+	-	-	86	-
	90	80	9	SKS	78	+	+	-	-	70	+	-10	-	-	51	-
10	98	230	9	SKS	50	+	75	-	90	8	72	+	+	0	80	-
11	52	79	25	S	-32	-20	18	-	-50	-28	30	-75	-20	12	-65	-
12	73	20	20	S	45	+	-	-77	-	82	-	+	50	40	58	-
13	89	32	16	S	-54	-	-	+	30	+	-50	+	-58	-	+	-
14	74	21	19	S	67	-67	-	-	42	90	60	90	-	56	62	90
15	88	32	16	S	-55	-	-	-	-	-45	+	+	-	+	-42	-41
	88	32	11	SKS	32	17	-	-	-	23	45	33	-	48	60	56

No., Event number corresponding to that in Table 2; D, epicentral distance; Az, azimuth of station to epicenter; i, incidence angle of shear-wave to the earth's surface; Phs, phase used; S or SKS; and LP, orientation of the first arrival of the long-period shear-wave observed at ESK. The values of D and Az shown are all for ESK, but can be used for other stations within an error of 30. -, Three-component seismogram recorded with a proper instrumental response is not available or station was not in operation. +, Difficult to determine the polarization direction because of its complicated waveform.

waves change rapidly with direction and incidence angle near nodal lines where the faster and slower shear-wave velocities are almost identical (e.g., Fig. 5 in CRAMPIN and MCGONIGLE, 1981), this interpretation is probably not applicable to these scattered patterns in Fig. 4. The irregular patterns suggest that anisotropy beneath the receivers is not uniform or is very weak beneath Great Britain.

4. Comparison with Long-Period Polarizations

The polarization of the leading shear-waves from short-period teleseismic events are scattered. We investigate the causes of the scatter and discuss the source polarizations. The mechanisms of the earthquakes used in this study are available in a series of papers by Dziewonski and his co-workers (e.g., DZIEWONSKI *et al.*, 1981, 1983, and others). However, the orientation of the shear-wave polarization changes rapidly around the stress axes of the double-couple mechanism, and large discrepancies may be expected in the estimate of the radiated shear-wave polarizations from comparatively minor inaccuracies in the focal parameters. Hence, we use the polarization of the long-period shear-wave measured on long-period seismograms recorded at ESK (the WWSSN station in UK) to estimate the source radiation. We read trace amplitudes of S and SKS phases on long-period NS and EW components of each shear-wave arrival. We checked for phase distortions and delays between the two components, and found no signs of such discrepancies: the onset of two component S waves are identical within a possible reading accuracy of 2 s on the long-period seismograms as shown in Fig. 5. Since S waves on the WWSSN long-period seismograms of the events used in this study are 10 to 20 s in period, phase distortions in the seismograms would not be obvious even if a possible delay of 2 s exists. The horizontal particle-motion of such a wave is a flat ellipse with its long axis oriented approximately parallel to the polarization of the incident shear-wave from the upper mantle beneath receivers. The polarizations of eleven S and five SKS phases with a suitable signal-to-noise ratio are measured on the long-period seismograms as shown in Table 3. The polarizations of the five SKS phases are very close (within 15°) to the azimuths from the epicentre to the stations. The polarization of the SKS of Event 15 is assumed to be parallel to the azimuth from station to epicenter as its small amplitude makes an accurate estimate impossible (Fig. 5). Since the SKS has only a radial component in an isotropic spherical structure, this consistency supports the assumption that the polarizations observed on the long-period S and SKS are consistent with the source mechanism. This agrees with the results of numerical experiments by CORMIER (1984) that realistic three-dimensional isotropic structures will rarely generate a derivation of more than 10° in the orientation of the S polarization vector compared to a radially homogeneous Earth.

Figure 6 shows maps of polarization orientations of the first shear-wave arrivals from short-period and long-period records for the four events, where the short-period polarizations can be read at more than five stations. In Fig. 6, the thick

Fig. 5. Long-period shear-waves at ESK: (a) event 10, and (b) event 15, the amplitude of the S phase is small on both components to determine the polarization direction, but the NS component is apparently larger than the EW one. This suggests that the assumption of $N 33^{\circ} E$ for the polarization could be reasonable.

lines with letters LP are oriented in the direction of the polarization of the long-period shear-wave at ESK and other thick lines at station positions denote that the particle-motion is nearly linear. This near-linear particle-motion suggests either: (1) one of the polarizations of the two split shear-waves permitted by the symmetry of the anisotropy is parallel to the polarization of the radiated shear-wave, or (2) the arrival-time difference (delay) between the two split shear-waves is small.

The following are brief comments on the observed polarizations:

a) Event 14: Four short-period polarizations are parallel and three nearly parallel to the long-period directions. The general trend of the short-period polarizations is a rotation of 10° to 20° counter-clockwise from the long-period polarization direction.

b) Event 15: This earthquake is the only event where both S and SKS waves can be measured at several stations. The polarization direction of the long-period SKS cannot be determined precisely because of the small trace amplitude (Fig. 5(a)), but it appears to be approximately parallel to the azimuth to the epicenter, $N32^{\circ}E$, and is, thus, near orthogonal to the LP S-wave polarization. Thus, the short-period polarization directions of the SKS phase are nearly parallel to the long-period polarizations. The short-period polarizations of the S phase can be determined at two stations; their directions are oblique to the direction of the SKS and parallel to the long-period S-wave polarization that is accurately determined on the basis of large trace amplitudes (Fig. 5(b)).

Fig. 6. Orientations of the polarization of the first SP shear-wave arrivals from teleseismic earthquakes observed at UKNET and those of the polarization of LP arrivals for: (a) event 14, (b) event 15, (c) event 10, (d) event 11; thick bars at stations indicate approximately linear SP particle-motion. Arrows indicate azimuth of arrival.

c) Event 10: The particle-motions of the short-period waves at the southernmost stations are nearly linear and parallel to the LP motion. The northernmost stations show oblique directions at short 45° to the LP motion.

d) Event 11: The short-period polarizations at three stations are nearly parallel to the long-period polarizations and are nearly linear. The directions at HPK and CWF, where the particle-motions are complicated, differ from the long-period directions by about 40° . These complications are probably due to crustal reverberations.

The above comparison suggests that the polarization direction of the short-

Fig. 7

Fig. 8

Fig. 7. The cumulative distribution of the differences of the short-period polarizations with respect to the long-period observations at ESK. The best-fit normal-distribution curve with the mean and variance of 15° and 30° , respectively, is also shown.

Fig. 8. (a) The cumulative distribution of the orientations of long-period shear-wave polarizations at ESK for earthquakes, measured East of North (open plot), and the cumulative distribution of the number of stations whose observed polarization can be determined (solid plot). (b) The cumulative distribution of short-period polarizations observed at all the stations.

period shear-wave are primarily the same as the long-period shear-waves. To confirm this, we further compare polarizations of the long-period and the short-period shear-waves as follows. We subtract the orientation of the polarization of the leading short-period shear-wave from that of the polarization of the long-period shear-wave recorded at ESK. The deviations between the two polarizations are plotted with an interval of 10° in Fig. 7. The plot suggests an almost normal distribution with a mean of 10° and a variance of 30° . This implies that the short-period polarizations observed at the UKNET are primarily controlled by the polarization of shear-waves radiated from the sources.

It should be noted that the mean of the distribution curve in Fig. 7 is not zero. This might reject the hypothesis that the homogeneous distribution of scatterers causes the observed distribution of deviations between the short-period and long-period polarization angles. Figure 8(a) shows the cumulative distribution of the observed long-period polarization directions: (1) the solid plot representing the cumulative distribution of long-period polarizations at ESK for the earthquakes

and (2) the open plot the cumulative distribution of the number of stations whose observed short-period polarizations can be determined. The cumulative distribution of the long-period polarizations in (2) that would have been observed at the stations has two broad peaks: 40° to 60° , and -30° to -70° . Figure 8(b) shows cumulative distribution of short-period polarizations in each 10° interval. The frequency of the short-period polarization in the negative range scatters around the peak of the long-period distribution, but in the positive range it increases towards 90° with a peak between 70° and 90° rather than around the peak of long-period polarizations. The numbers of the short-period polarization orientations between 70° and 90° are significantly different from the expected distribution. Out of 12 points between 70° and 90° in Fig. 8(b), eight points fall in a range of 10° and 30° in deviation between short-period and long-period polarizations. If we take these points away from Fig. 7, the distribution in Fig. 7 would become close to a normal distribution with a mean of 0° . These points are the main contribution which moves the peak away from 0° in Fig. 7.

5. Discussion

We list some of the features in the comparison of the short-period polarizations recorded at UKNET with the long-period polarizations at the WWSSN long-period seismograms at ESK:

- 1) The short-period polarizations primarily scatter around the orientation of the long-period polarizations.
- 2) The deviation between the polarizations of the short-period and the long-period shear-waves is in a normal distribution with a mean of about 10° and a variance of about 30° .
- 3) The cumulative number of orientations in the range between 70° and 90° of short-period polarizations is more than that expected from the distribution of orientations of the long-period polarizations.
- 4) The fluctuations in the deviation between the short-period and the long-period polarizations are large even for the same earthquakes.

As summarized above, large-scale anisotropy has not been found beneath the UK with a method using shear-wave polarization anomaly. This apparent absence of anisotropy is consistent with the results by BAMFORD *et al.* (1979) who analyzed several refraction surveys in the North Sea and northern Scotland and concluded that Pn-wave anisotropy is not measurable for the structure of this area within the limits of observational accuracy.

If the anisotropy of the continental lithosphere remains a feature which is locked-in after it has developed, the anisotropy of continental margins may be as complicated as its history of superimposed tectonic processes. The anisotropy in this case would reflect paleo-flow patterns rather than the present flow one in a lithosphere-asthenosphere boundary layer once the plate has cooled and thickened. This could be a possible interpretation for the scattering distribution of directions of

the short-period shear-wave polarizations. As a matter of fact the British Isles developed under a complicated history as the continental margins on the Atlantic ocean (WILSON, 1966).

6. Conclusions

Fifty-nine teleseismic seismograms from 15 earthquakes have been investigated to try to estimate anisotropy in the upper mantle beneath Great Britain. Directions of the first shear-wave arrivals are measured on two horizontal component seismograms recorded at the 12 three-component stations of the UK network. The comparison of these short-period polarization directions with the long-period polarization directions recorded at ESK, the WWSSN station, suggest that directions of short-period and long-period shear-waves are usually parallel. This implies that anisotropy if it exists beneath the UK is weak and is not uniformly aligned, and is localized possibly into several blocks.

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